2009

Missouri River Fish and Wildlife Mitigation Program Fish Community Monitoring and Habitat Assessment of Off-channel Mitigation Sites

Van Sterner
Iowa Department of Natural Resources

Royce Bowman
Iowa Department of Natural Resources

Brandon Eder
Nebraska Game and Parks Commission Missouri River Program – Fisheries Division

Sabrina Negus
Nebraska Game and Parks Commission Missouri River Program – Fisheries Division

Gerald Mestl
Nebraska Game and Parks Commission Missouri River Program – Fisheries Division

See next page for additional authors

Authors
Van Sterner, Royce Bowman, Brandon Eder, Sabrina Negus, Gerald Mestl, Kasey Whiteman, Darrick Garner, Vince Travnichek, Joshua Schloesser, Joseph McMullen, and Tracy Hill

FINAL REPORT

Missouri River Fish and Wildlife Mitigation Program

Fish Community Monitoring and Habitat Assessment of Off-channel Mitigation Sites

Section I. Introduction, Fish Sampling Methods, Chute Analytical Methods and References

Tieville-Decatur Bend[1], Louisville Bend[1], Tyson Island[1], California Cut-Off[1,2], Tobacco Island[2], Upper and Lower Hamburg Bend[2,3], Kansas Bend[2,3], Deroin Bend[2,3], Lisbon Bottom[4], North Overton Bottoms[4], Tadpole Island[4] and Tate Island[4]

Prepared for the U.S. Army Corps of Engineers

By:

[1]Van Sterner and Royce Bowman
[2]Brandon Eder, Sabrina Negus and Gerald Mestl
[3]Kasey Whiteman, Darrick Garner and Vince Travnichek
[4]Joshua Schloesser, Joseph McMullen and Tracy Hill

April 2009

[1]Van Sterner and Royce Bowman
Contract number –
Iowa Department of Natural Resources
607 10th St
Onawa, Iowa 51040

[2]Brandon Eder, Sabrina Negus and Gerald Mestl
Contract number – W9128F-05-P-0171
Nebraska Game and Parks Commission
Missouri River Program – Fisheries Division
2200 North 33rd Street
Lincoln, NE 68503

[3]Kasey Whiteman, Darrick Garner and Vince Travnichek
Contract number – W912DQ-07-D-0001
Missouri Department of Conservation
Nodaway Valley CA
21999 Hwy B
Maitland, MO 64466

[4]Joshua Schloesser, Joseph McMullen and Tracy Hill
Contract number - W59XQG83460940
U.S. Fish and Wildlife Service
Columbia National Fish & Wildlife Conservation Office
101 Park DeVille Drive, Suite A
Columbia, MO 65203-0057

Executive Summary

The Missouri River has been developed for flood control, commercial navigation, irrigation, fish and wildlife conservation, municipal water supply, water quality control and hydropower production through a series of congressional acts. However, prior to development, the lower Missouri River was characterized by a highly sinuous to braided channel with abundant log jams, sand bars, secondary channels and cut-off channels. Construction of the Bank Stabilization and Navigation Project (BSNP) converted the lower Missouri River into a narrow, self scouring channel. The active channel downstream of Sioux City, Iowa was as wide as 1.8 km before river modification, but is now confined to a 91.4 m channel. Total river and floodplain habitat altered or destroyed by the BSNP is estimated at 211,246 hectares.

The Missouri River Fish and Wildlife Mitigation Project (Mitigation Project) was established to restore fish and wildlife habitat lost by the construction, operation and maintenance of the BSNP. The Water Resources Development Act of 1986 authorized the United States Army Corps of Engineers (COE) to acquire and develop habitat on 12,100 hectares of non public lands and the development of 7,365 hectares of habitat on existing public lands to mitigate habitat losses. The Water Resources Development Act of 1999 authorized an additional 48,016 hectares to the program. The Final Supplemental Environmental Impact Statement (FSEIS) for the expanded Mitigation Project was issued in March of 2003, and it included a preferred alternative proposing the creation of additional shallow water habitat (defined as areas less than 1.5 m deep with a current velocity of less than 0.76 m/s). The preferred action in the FSEIS for the expanded

Mitigation Project included creation of 2,833 to 8,094 hectares of shallow water habitat (SWH).

In 2005, the Iowa Department of Natural Resources, Nebraska Game and Parks Commission (NGPC), Missouri Department of Conservation and U.S. Fish and Wildlife Service, Columbia Fisheries Resource Office (renamed to Columbia National Fish and Wildlife Conservation Office) were contracted by the COE to monitor and evaluate fish communities of select off-channel aquatic habitat sites that were constructed through the Mitigation Project. Additionally, the NGPC was contracted to collect physical habitat information from the secondary channels that were selected for biological monitoring in the upper channelized section above Kansas City. Sixteen sites selected for monitoring covered a range of aquatic habitats including backwaters and secondary channels with varying levels of engineering and development. Sites from upstream to downstream included Tieville-Decatur Bend (two backwaters), Louisville Bend (backwater), Tyson Island (backwater), California Bend (chute on the Nebraska bank and a chute with connected backwater on the Iowa bank), Tobacco Island (chute), Upper and Lower Hamburg Bends (one chute each), Kansas Bend (two small chutes, treated as one), Deroin Bend (chute), Lisbon Bottom (natural chute), North Overton Bottoms (chute), Tadpole Island (chute) and Tate Island (chute). The study was designed to include three field sampling seasons, but due to delays implementing contracts in 2005 another complete year of sampling was added. Thus, fish community monitoring and habitat assessment of off-channel mitigation sites began in April, 2006 and concluded in October, 2008. The objective of this project was to determine biological performance and functionality of chutes and backwaters and to compare chutes and backwaters in an effort to identify

designs most beneficial to native Missouri River fish species. Additionally, this project was designed to help determine if additional modifications are needed at existing mitigation sites, if existing designs are providing a range of habitats, if these habitats are of value to the biological diversity of the Missouri River and if these habitats are of specific value to species of concern or importance, such as pallid sturgeon.

Chutes and backwaters were sampled monthly from April thru October 2006 – 2008. Each chute was divided into 16 sampling segments, and eight segments were randomly chosen without replacement each month for each gear type used. The standard gears used for this project include; trammel nets, large and small otter trawls, push trawls, bag seines, electrofishing, large and small diameter hoop nets and mini-fyke nets. Additional gears used only in backwaters include experimental gill nets and large frame trap nets. Set lines and hook and line were used as wild gears (gears in addition to those required for standard sampling), these gears were used to target pallid sturgeon.

Chutes and backwaters provided habitat for different fish communities. Chutes were found to have more riverine species while these species were lacking in backwaters. Contiguous backwaters had greater species diversity and richness than those that were impounded. This connection to the river allowed species to access these areas that they otherwise could not have.

Chutes separated themselves out geographically. The available fish community in the main channel affected the fish community in the chutes. Chutes that were located farther up the Missouri River tended to benefit different species than those on the lower end of the river. Therefore, the benefit of a chute to the overall fish community probably depended on if the chute provided something different than what was already found in the

main channel. Also more diverse fish communities were found in the older constructed and natural chutes. This is probably due to the greater habitat diversity these chutes have developed compared to the younger chutes.

Overall, the fish communities in most sites were dominated by juveniles of most species. The habitat that has been developed via chutes and backwaters therefore are functioning as refuges for smaller fish. This is a valuable asset to the fish communities in the Missouri River. Currently little is known if these juveniles are spawned or drifted into the chutes and backwaters. It is also unknown if these juveniles are able to move out of the chutes and backwaters and into the main channel.

Predictive models indicated that chutes had different probabilities of presence for target species. In general, chutes that were relatively longer, wider, shallower and had greater sinuosity were more likely to have target species present. Conversely, chutes that were short, had low width to depth ratios and low sinuosity were less likely to have target species present.

Important predictor variables for species presence were year (85% of species models), water depth (80%), turbidity (65%), water temperature (60%), month (60%) and water velocity (50%). A year effect, likely related to river discharge, for many species supports the need for multiple year assessment programs. Water depth and, to some extent, water velocity were recognized as two variables that can be manipulated by river engineers and we found that the selected range of depths and velocities varied by species, which was expected with a diverse fish community. Many juvenile and small-bodied fishes utilized shallow water habitats (<1.0 m) over a broad range of water velocities (0.0-1.0 m/s), but large-bodied fishes tended to orient towards relatively deeper water. Therefore, creating

shallow water habitats with a range of velocities would likely benefit many juvenile native species.

Mitigation Project designs are providing a range of habitats. Backwater habitats are creating a habitat not currently available in most reaches of the Missouri River. Different backwater designs do not appear to be creating different habitats from each other; however, backwaters can only be used by riverine fish if they are connected to the river. All chutes are providing some habitat diversity, however, some chutes, including; California (NE), Upper Hamburg, Lisbon and Tate contain more habitat diversity, and therefore, are providing much needed habitat complexity to that reach of the river.

Backwater and chute habitats appear to be beneficial to the biodiversity of the Missouri River system; however, it is important to note that different reaches of the river have different needs. The highly modified middle Missouri River, from Sioux City, IA to Kansas City, MO has very little habitat diversity available within the main channel and many different habitats may be necessary to restore the healthy function of the river system. While the lower Missouri River has greater habitat diversity within the main channel, there are still habitats that may be limited, such as habitat diverse chutes (e.g., Lisbon or Tate) or backwaters that may be needed to restore a fully functioning river.

General Recommendations

- Promote natural side channel creation on suitable public lands. Allowing the river to naturally create side channel habitat may provide the most suitable habitat for riverine fish.
- We recommend constructing chutes that allow for floodplain connectivity, encourage natural river processes and maintain greater complexities of habitats (i.e. high width to depth ratios, diverse substrates, diverse depths, diverse velocities, shallow sandbars, woody debris and vegetated sandbars)
- Construction of longer chutes should receive higher priority than short chutes
- If a short chute must be built, build width, sinuosity and habitat diversity (deep scour holes, bar features and large woody debris).
- Promote channel movement through the use of structures or large woody debris.
- Soil type should be an important consideration in chute design, sites with clay or compacted soils need to be built to finished width or with wider pilot channels to hasten evolution.
- Slope banks when possible to allow large woody debris to accumulate in chutes rather than on high banks.
- Promote capture of large woody debris to increase habitat diversity and secondary productivity.
- Avoid designing chute entrances that may block upstream migration of fish (e.g., high sills or constricted entrances with high velocities and turbulence).
- Evaluate entrance structures to determine if certain life stages of some species (e.g., young of the year sturgeon) are being excluded from entering the chute.
- Avoid designs that promote sedimentation at chute entrances; keep entrances open so desired flows can be achieved.
- If a chute is intended to widen with increased main channel discharge, avoid designs where velocities decrease as main channel discharges increase such as at California (IA) and Kansas (upper).
- Use pilings, like those at Tate chute, instead of rip rap to create water control structures. Using pilings, as opposed to rock structures, may increase the permeability of water structures at varying levels of the water column, particularly the benthos.
- Include tie-channels and braids in chute designs to increase the amount of shallow, slow moving water at sites and provide more area that is in contact with the main channel.
- Design tie-channels, braids and connected backwaters to limit sedimentation.
- Tie channels can be used to direct flows to lower portions of the chute, allowing the upper portions to act more like backwater habitat.

- Create side channel habitat by building islands as opposed to digging channels, as was the case with Tate Island chute.
- Consider reopening existing, naturally formed side channels that are presently cut off from regular flows; there are at least 13 historic chutes that may be considered on the lower Missouri River.
- Contiguous dredged backwaters (such as Tyson Island and California (IA)) are recommended over impounded (disconnected) wetlands (such as Tieville, Louisville and Decatur). Contiguous sites provide connectivity that allows fish access to spawning and nursery habitat. Pumping did not provide accessible floodplain fish habitat.
- Backwaters should maintain a consistent, direct river connection. Open river connections are preferred over water control structures (culverts).
- Connectivity introduces sediment that will eventually fill backwaters. Siltation must be addressed by mechanical removal or improved backwater design.
- Backwaters of the upper channelized river become dewatered and isolated during winter discharges, backwaters should maintain adequate depth to prevent winter fish kills (approximately 3 m deep from December through February)
- Continued monitoring of chutes and backwaters would allow the determination of the rate at which the chute or backwater is evolving, the level of functionality that they can attain, value each chute has to different species, and how future manipulations affect the habitat and fish community.
- The variation in fish abundances seen among the three years of sampling indicates that a long term monitoring effort would be needed to detect population trends in chutes or backwaters. Furthermore, fish data from the chutes and backwaters should be compared to data from the main channel to determine how the chutes and backwaters are functioning with respect to main channel fish use.

TABLE OF CONTENTS

Section I

INTRODUCTION

The Missouri River has been developed for flood control, commercial navigation, irrigation, fish and wildlife conservation, municipal water supply, water quality control and hydropower production through a series of congressional acts (USFWS 2000; National Resource Council 2002). Prior to development, the lower Missouri River was characterized by a highly sinuous to braided channel with abundant log jams, sand bars, secondary channels and cut-off channels (Hesse et al. 1989; Galat et al. 1998; National Resource Council 2002).

Construction of the Bank Stabilization and Navigation Project (BSNP) converted the lower Missouri River into a narrow, self scouring channel (Hesse et al. 1989). The active channel downstream of Sioux City, Iowa was as wide as 1.8 km before river modification, but is now confined to a 91.4 m channel (National Resource Council 2002). Hydrology of the river has been altered by construction and operation of a series of reservoirs in the upper two thirds of the river (Hesse 1989; USFWS 2000; National Resource Council 2002). Annual spring flood pulses have been suppressed and late summer discharge increased (Hesse and Mestl 1993; National Resource Council 2002; Pegg et al. 2003). Construction of the navigation channel, along with the sediment imbalance created by reservoirs, has lead to extreme channel incision between Gavins Point Dam and Blair, Nebraska, further isolating the river from its floodplain (Hesse et al. 1989; National Resource Council 2002). Downstream from Blair, Nebraska, flood control levees confine the river to a narrow portion of the floodplain, (National Resource Council 2002). Total river and floodplain habitat altered or destroyed by the BSNP is estimated at 211,246 hectares (COE 2003). Standing stock of fish has decreased by 15 million pounds,

and estimated lost recreation days exceed 770,000 annually in the channelized river (COE 2003).

The Missouri River Fish and Wildlife Mitigation Project (Mitigation Project) was established to restore fish and wildlife habitat lost by the construction, operation and maintenance of the BSNP. The Water Resources Development Act of 1986 authorized the United States Army Corps of Engineers (COE) to acquire and develop habitat on 12,100 hectares of non public lands and the development of 7,365 hectares of habitat on existing public lands to mitigate habitat losses. The Water Resources Development Act of 1999 authorized an additional 48,016 hectares to the program. The Final Supplemental Environmental Impact Statement (FSEIS) for the expanded Mitigation Project was issued in March of 2003. The U.S. Fish and Wildlife Service issued the Biological Opinion on the Operation of the Missouri River Main System Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project and Operation of the Kansas River Reservoir System in 2000. The "reasonable and prudent alternatives" included the creation of 4,874 to 19,565 hectares of shallow water habitat. Shallow water habitat was defined as less than 1.5 m deep with a current velocity of less than 0.76 m/s. The preferred action in the FSEIS for the expanded Mitigation Project included creation of 2,833 to 8,094 hectares of shallow water habitat (SWH).

The Mitigation Project operates under an adaptive management approach to the identification, design, construction and management of mitigation sites (COE 2003). The preferred action in the FSEIS includes biological and hydrologic monitoring at representative sites to determine the effectiveness of constructed off-channel habitat. Monitoring is critical to the adaptive management process because results provide a tool

to evaluate objectives, management strategies and policy decisions (McDonald et al. 2007). Under an adaptive management program, management actions are treated as experiments, and results are used to refine management strategies (USGS 2006).

In 2005, the Iowa Department of Natural Resources, Nebraska Game and Parks Commission (NGPC), Missouri Department of Conservation and U.S. Fish and Wildlife Service, Columbia Fisheries Resource Office (renamed to Columbia National Fish and Wildlife Conservation Office) were contracted by the COE to monitor and evaluate fish communities of select constructed off-channel aquatic habitat sites. Fish communities provide an integrative index to complex environmental conditions (Gutreuter et al. 1995). In addition the NGPC was contracted to collect physical habitat information from the secondary channels that were selected for biological monitoring in the upper channelized section above Kansas City. Sites selected for monitoring cover a range of aquatic habitats including backwaters and secondary channels with varying levels of engineering and development. The study was designed to include three field sampling seasons but due to delays implementing contracts in 2005 another complete year of sampling was added in 2008. The objectives of the monitoring program were:

Objective 1: To collect a select group of biological indicators (i.e., CPUE, length frequency, condition via relative weight, species richness, species diversity and community similarity) for different life stages (defined by length in the published literature) on a select group of species or species groups (e.g., native, species of concern, sport, prey, invasive, etc.) using standard collection methods to assess the biological performance of off-channel sites.

Objective 2: Describe habitat use (depth, velocity, substrate, etc.) by life stage of selected fish species or species groups.

Objective 3: Collect extensive physical habitat information to be able to describe monthly and seasonal habitat conditions of each site and to compare sites.

METHODS

Data Collection

Methods for this study were developed by participating agencies and adopted from the Missouri River Standard Operating Procedures for Sampling and Data Collection (Drobish 2008). Fish sampling occurred monthly from April through October for each of the three sampling years (2006-2008). Each mitigation site was divided into 16 equal length segments using ArcGIS 9.1 software, resulting in segments with lengths that differed among mitigation sites. Segment coordinates were loaded onto boat-mounted WAAS enabled GPS depth sounders for reference in the field. Each month, eight segments within each mitigation site were randomly selected (for each gear) without replacement to be sampled with a suite of standard gears. The suite of standard gears was chosen so all available habitat types could be sampled. If a segment could not be sampled due to low water, unsafe conditions or a particular gear could not be fished properly, the next randomly ordered segment was sampled. This process was repeated until a fishable segment was drawn, there were no more segments, or a total of eight deployments per gear could be accomplished within a given mitigation site. At each sampled site, habitat measurements were taken; including substrate, water velocity, depth, conductivity, turbidity, dissolved oxygen and water temperature. Below are full descriptions of gear types used to sample fish communities and the habitat measurements taken.

Standard Sampling Gears

Trammel Nets

Trammel nets were drifted in chutes and tie channels. Trammel nets varied in length from 7.6 m (25 ft) to 38.1 m (125 ft), in standard 7.6 m (25 ft) increments. The length of trammel net used was determined by the width of each chute. Inner mesh on the nets was constructed of #9 multifilament twine with 25 mm (1 in) bar mesh, at a 2.4 m (8 ft) height. The outer mesh was #139 multifilament twine with 203 mm (8 in) bar mesh, at a height of 1.8 m (6 ft). Float lines were 13 mm (0.5 in) foam core rope; lead lines consisted of 22.7 kg (50 lb) lead core rope. Net drifts were attempted to encompass the entire length of the segment. If water velocities were not sufficient to drift, nets could be dead-set for not longer than three hours. Latitude and longitude were recorded for the start and stop point locations of each drift and distance was recorded in meters. Water depths were recorded at the beginning, mid-point and end of each segment sampled. Habitat measurements were taken at the midpoint of each drift or the midpoint of each net that was dead-set. Water velocities were recorded in meters per second at the bottom, 80% and 20% of water depth. Water temperature, substrate, dissolved oxygen and turbidity were collected at the mid-point of the sample. Catch per unit of effort (CPUE) was reported as the total number of fish per 47.6 m of net drifted 100 m.

Otter Trawl

Two sizes of benthic otter trawls were used. In larger chutes (California (NE), Upper Hamburg, Deroin, Lisbon, Overton, Tadpole and Tate) a 4.9 m (16 ft) otter trawl with a width of 4.9 m (16 ft), height of 0.9 m (3 ft) and length of 7.6 m (25 ft) was used.

The inner mesh of the trawl was 6 mm (1/4 in) bar; the outer mesh was 38 mm (1.5 in) bar. The trawl had a cod-end opening of 406 mm (16 in). All chutes (except Lisbon, Overton, Tadpole and Tate) were trawled with an envelope style (no cod-end) trawl with a 2.4 m (8 ft) head rope and a 3.0 m (10 ft) bottom rope. The net was constructed of 4 mm (0.157 in) polyester heavy ply mesh treated with black net coating. Trawl doors were made of 19 mm (3/4 in) marine plywood and measured 762 mm (30 in) by 381 mm (15 in). Trawls were fished downstream for a minimum distance of 75 m, but did not exceed the total length of the segment. Latitude and longitude were recorded at the start and stop of each trawl to determine the distance trawled in meters. Water depths were recorded at the beginning, mid-point and end of each sample. Water velocities were collected at the midpoint of each sample and recorded in meters per second at the bottom, 80% and 20% of water depth. Water temperature, substrate, dissolved oxygen and turbidity were also collected at the mid-point of each sample. CPUE was reported as the total number of fish per 100 m trawled.

Push Trawl

The push trawl was an otter trawl deployed from the front of the boat and pushed downstream slightly faster than the current. This gear was used when water depths were less that 1.5 m. Push trawls were an envelope style (no cod-end) trawl with a 2.4 m (8 ft) head rope and a 3.0 m (10 ft) bottom rope. The net was constructed of 4 mm (0.157 in) polyester heavy ply mesh treated with black net coating. Standard trawl doors 0.76-m x 0.38-m (30-in x 15-in) were used to keep the net open. A minimum distance of 15 m and maximum distance of the full segment length was trawled. Latitude and longitude were

recorded at the start and stop of each trawl to determine the distance push trawled in meters. Water depths were recorded at the beginning, mid-point and end of the segments sampled. Velocities were recorded in meters per second at the bottom, 80% and 20% of water depth at the mid-point of the sample. Water temperature, substrate, dissolved oxygen and turbidity were also collected at the mid-point of each sample. CPUE was reported as the total number of fish per 5 m or 100 m.

Electrofishing

Both banks in each side-channel were electrofished and the fish collected were combined into one sample. Sampling was conducted moving downstream with the current electrofishing all visible cover until no more fish could be collected. Backwater electrofishing sampled the entire shoreline of the segment. Dip nets with 1/8 in mesh were used to capture stunned fish. Pulsed DC boats were used with a minimum 2000 watt generator. Pulse width, duty cycle and voltage varied among crews, but typically ranged from 25 to 40 (pulse width), 60 (duty cycle) and 250-350 volts. Total output was generally kept between 6 and 10 amps. Shock time was recorded in seconds. Latitude and longitude were recorded for the start and stop of each sample. Water depths were recorded at three locations representative of the segment in side-channels and at the beginning, mid-point and end of backwater segments sampled. Water velocities were recorded in meters per second at the bottom, 80% and 20% of the water depth at a representative habitat for the segment in side-channels and at the mid-point of the sample in backwater segments. Water temperature, substrate, dissolved oxygen, conductivity

and turbidity were also collected at the habitat sample location. CPUE was reported as the total number of fish per 15 minutes or 1 hour.

Hoop Nets

Two sizes of hoop nets were used. Large hoop nets were 1.22 m (4 ft) and small hoop nets were 0.61 m (2 ft) in diameter. Hoop nets consisted of seven fiberglass hoops with two throats. Hoop nets were covered with 38 mm (1.5 in) black net coated mesh (twine size #15). Hoop nets were fished parallel to the bank and un-baited at water depths sufficient to submerge the throat while keeping the net standing. Hoop nets were set overnight for a maximum set-time of 24 hours (one net night). Latitude and longitude, water depth, water temperature, substrate, dissolved oxygen and turbidity were recorded at the mouth of the net. Water velocities were recorded in meters per second at the bottom, 80% and 20% of the water depth. CPUE was reported as the total number of fish per net night.

Mini-Fyke Net

Mini-fyke nets were constructed with two rectangular black oil-tempered spring-steel frames, both 1.2 m (3.9 ft) wide and 0.6 m (2 ft) high. From the first frame, two mesh wings extend to the middle of the second frame so that there was a 5 cm (2 in) vertical gap between each wing. A 4.5 m lead was attached to the frame. The cab was constructed of two 0.6m (2 ft) diameter spring steel hoops. A single throat was attached to the second frame and had an aperture diameter of 51 mm (2 in) that was fixed using a stainless steel ring. The mini fyke net measured 3.66 m (12 ft) when fully extended.

Mini-fyke nets were fished in areas 1.2 m or less associated with bank-lines and sandbars. Nets were deployed by staking the lead on shore perpendicular to the bank and set to a depth that was adequate to keep the throats under water. Mini-fyke nets were set overnight with start time and stop time recorded for a maximum set-time of 24 hours. Latitude and longitude, water depth, water temperature, substrate, dissolved oxygen and turbidity were recorded at the front of the frame. Water velocities were recorded in meters per second at the bottom, 80% and 20% of the water depth. CPUE was reported as the total number of fish per net night.

Large Fyke Net

Large fyke nets were a standard sampling gear for backwater sites and had two rectangular frames measuring 0.9 m x 1.8 m (3 ft x 6 ft) made of black oil tempered spring steel. The lead was 15 m (50 ft) long by 1.3 m (4 1/2 ft) high, with floats every 0.9 m (3 ft) and lead attached every 0.3 m (1 ft). The cab was constructed of six 0.9 m (3 ft) diameter tapered fiber glass hoops. Cab and frame together were 6 m (20 ft) long when extended. All netting was 1.8 cm (3/4 in) bar, black asphalt coated, #15 nylon mesh. Nets were deployed by staking the lead on shore perpendicular to the bank and set to a depth that was adequate to keep the throats under water. All nets were set overnight with start time and stop time recorded for a maximum set-time of 24 hours. Latitude and longitude, water depth, water temperature, substrate, dissolved oxygen and turbidity were recorded at the front of the cab. CPUE was reported as the total number of fish per net night.

Wild Gears

In addition to the standard gears listed above, individual crews utilized various gears termed "wild" gears not required for the standard sampling protocols established for the project. Listed below are the wild gears used during the study.

Experimental Gill Net

Experimental gill nets were 30.5 m (100 ft) by 2.4 m (8 ft) net and had four 7.6 m (25 ft) numbered panels. Bar mesh length of panels 1 through 4 were; 38.1 mm (1.5 in), 50.8 mm (2 in), 76.2 mm (3 in) and 101.6 mm (4 in), respectively. Panels one and two were constructed with #104 multifilament and panels three and four with #139 multifilament. The float line was braided poly foam core 13 mm (1/2 in) diameter. The lead line was 7.1 mm (9/32 in) diameter. Nets were staked perpendicular to shore always starting with panel 1 (1.5 in). Occasionally, nets were fished overnight until water temperatures exceeded 12.7 C (55 F). When water temperatures exceeded 12.7 C, nets were set for approximately 3 h with start time and stop time recorded. Latitude and longitude were recorded at the shoreline. Water depths were recorded at the shoreline, mid-point and outer end of each net. Water temperature, substrate, dissolved oxygen and turbidity were collected at the mid-point of each net. CPUE was reported as the total number of fish per hour.

Beam Trawl

Beam Trawls were used as a wild gear prior to sampling with 8' otter trawls. The standard beam trawl net measured 2m (6.4 ft) wide by 0.5m (1.6 ft) high by 5.5m (18 ft) long. The inner mesh of the net was 32mm (1/8 in) and the outer mesh was 38mm (1.5 in.)

bar mesh. The cod-end had an opening of 17mm (6.5 in). Attached to the net was a 96mm (3/8 in) chain bottom line. The net was supported by a trawl frame. Beam trawl sampling was conducted along the entire length of the sampling segment or as close to this at the crew leader's discretion. Latitude and longitude were recorded at the start and stop points of each trawl, and trawl distance was recorded in meters. CPUE was reported as the total number of fish per 100 m trawled.

Bag Seine

Bag seines were a standard gear in 2006 but were replaced with push trawls in 2007 and deemed a wild gear thereafter. Seining was conducted using a 9.1 m (30.0 ft) bag seine. The height of the seine was 1.8 m (6.0 ft). The mesh size was approximately 6.4 mm (1/4 in) "Ace" type nylon. The dimensions of the bag were 1.8 m x 1.8 m x 1.8 m (6.0 ft). The lead line was 29.5 kg (65 lb) lead core. Seines were deployed using the half-arc method. One person remained stationary and the other person waded out with the net fully extended from one shore arcing to the opposite side. GPS latitude/longitude, water temperature, substrate, dissolved oxygen and turbidity were collected at the mid-point of the seine when perpendicular to shore. Water depths were recorded at the farthest, and mid-point of the seine when extended perpendicular to shore. CPUE was reported as the total number of fish per 100 m^2.

Set-line

Set-lines were used to target pallid sturgeon in the spring and were fished overnight, not exceeding 24 hour sets. A set-line consisted of an anchor, main line, and buoy (for retrieval). The main line was size 18 (170 lb breaking strength) braided nylon

seine twine. Two 12-24 inch leader lines (30 lb Berkley FireLine®) with a size 10/0 or 12/0 circle hook were attached to the main line. Hooks on individual set-lines were the same size and were baited with nightcrawlers. Habitat measurements, and latitude/ longitude were taken at the first hook. This gear was used specifically to target pallid sturgeon therefore CPUE is not reported. It is noted that this gear did sample pallid sturgeon.

Hook and line

Hook and line sampling was used to target pallid sturgeon in conjunction with set-lines. Line diameter and type were not standardized. Size 1/0 and 2/0 circle hooks were used. Hooks were baited with night crawlers. Habitat measurements and latitude/longitude were taken at the stern of the boat. This gear was used specifically to target pallid sturgeon therefore CPUE is not reported. It is noted that this gear did sample pallid sturgeon.

Habitat Measurements

Substrate

Composition of substrate samples were visually estimated as a percentage of sand, silt, and/or gravel and periodically calibrated against a sieved sample with known substrate proportions to ensure accuracy. The presence, or absence, of cobble and organic materials were also determined and recorded. Samples were collected using Hesse samplers (Drobish 2006), pipe dredges, a modified garden hoe or hand grab.

Water Velocity

Water velocity measurements were collected using Marsh-McBirney, Inc. FLO-MATE Model 2000 portable flowmeters and recorded in meters per second. For water depths ≥1.2 m, velocities were taken at the bottom, 80% and 20% of the water depth. For depths <1.2 m water velocities were taken at the bottom and 60% of the water depth.

Water Depth

Water depth was measured with a meter stick in water ≤ 1 m deep. In water deeper than 1 m, depth was determined with a boat mounted GPS sonar depth finder.

Conductivity

Conductivity was recorded for all electrofishing samples. Measurements were taken using Hydrolab Quanta® water quality monitoring systems or Hach sension5 conductivity meter® and measured in µS/cm. Conductivity measurements were taken in the middle of the water column at the midpoint of the sampled area.

Turbidity

Turbidity was measured using the Hach 2100 portable turbidimeter® or Hydrolab Quanta® water quality monitoring system in nepholometric turbidity units (NTU). Samples were taken below the surface of the water at the midpoint of the sample or mouth of the net for passive gears.

Dissolved Oxygen

Dissolved oxygen was measured in mg/L using the Hach sension6® portable dissolved oxygen meter or Hydrolab Quanta® water quality monitoring system . Samples were collected at least once daily in the middle of the water column at sampled midpoints. At the discretion of the biologist, additional samples were collected if conditions were variable (i.e. stagnant areas).

Water Temperature

Water temperature was measured with either a Hach sension6® portable dissolved oxygen meter, Hydrolab Quanta® water quality monitoring system, a laboratory thermometer or a boat mounted GPS sonar depth finder. Water temperature was recorded in degrees Celsius.

Fish Data

Fish collected were held in a tub filled with river water. Water was changed periodically to maintain dissolved oxygen levels and reduce stress on the fish. Most fish were measured for total length to the nearest millimeter, and all fish were enumerated. Sturgeon species and paddlefish were measured for length, snout to fork and eye to fork, respectively. All fish large enough to obtain accurate weights were weighed in the field to the nearest gram. When a large collection of a species occurred, a subset of measurements was collected on at least 25 individuals per sample. Species not readily identifiable or not large enough to be weighed and measured accurately in the field were preserved in 10% formalin solution or 70% ethanol alcohol and taken to the lab for processing.

Chute Analyses

All side-channels (III.2-12) were analyzed independently and with similar methods to allow for comparisons among side-channels. Total catch of each species was reported by year and the percent of the total catch represented by each species was calculated. Species richness (total number of species sampled), evenness (the relative abundance of individuals among species), Shannon's diversity index, and Simpson's diversity index were calculated for each side-channel and year (Kwak and Peterson 2007). Both Shannon's and Simpson's diversity indices combine richness and evenness into a single value for comparison. However, Shannon's index is sensitive to changes in rare species while Simpson's index is influenced by abundant species. We provide both in an attempt to temper any data that may be highly influenced by rare or abundant species. Morisita's similarity index was used to compare the fish assemblage among years at each chute independently (Kwak and Peterson 2007). Life stage (juvenile or adult) was determined by length according to Pflieger (1997; Table I.1.1). Life stage proportions were analyzed using a z-test to determine if the proportion of juveniles and adults differed between years. Length was analyzed using two methods: 1) length frequency distributions of a species were compared between years using a Kolmogorov-Smirnov test and 2) mean lengths using a t-test (III.2-8) or an analysis of variance (III.9-12). For the analysis of variance, if mean length differed among all years ($P \leq 0.1$), pair-wise comparison were made between years. Catch per unit effort (CPUE) was calculated for each species by gear, which was defined accordingly: electrofishing (EFS) as fish per hour (III.2-8) or fish per five minutes (III.9-12); 4 ft hoop nets (HNS) as fish per net

night; 2 ft hoop nets (SHNS) as fish per net night; mini-fyke nets (MFS) as fish per net night; push trawls (POT02S) as fish per 100 m (III.2-8) or 5 m trawled (III.9-12); otter trawls (OT16S) as fish per 100 m trawled; trammel nets (TN) as fish per 38.1 m of net drifted 100 m. A Kruskal-Wallis test was used to determine differences in CPUE of a species between years by gear. A Bonferonni correction of 0.033 was applied to determine significance for the life stage analysis, length frequency distribution, pair-wise mean length comparisons, and CPUE comparisons (alpha = 0.1; three comparisons, 2006 vs. 2007, 2006 vs. 2008, and 2007 vs. 2008; Zar 1999). All statistical analyses were conducted with Microsoft® Office Excel, SAS 9.1 or 9.2 (SAS Institute Inc. 2002; SAS Institute Inc. 2008)

Table I.1.1. Length cut-off used to determine life stage (juvenile or adult) for each species.

Species	Juvenile length (mm)	Species	Juvenile length (mm)
Bighead Carp	< 625	Largemouth Bass	< 254
Bigmouth Buffalo	< 381	Longnose Gar	< 500
Black Buffalo	< 381	Mooneye	< 229
Black Crappie	< 150	Paddlefish	< 1070
Blue Catfish	< 508	Pallid Sturgeon	< 750
Blue Sucker	< 508	Quillback	< 305
Bluegill	< 127	Red Shiner	< 46
Bluntnose Minnow	< 38	River Carpsucker	< 305
Bullhead Minnow	< 38	River Shiner	< 51
Channel Catfish	< 305	Sand Shiner	< 43
Channel Shiner	< 43	Sauger	< 229
Common Carp	< 305	Shortnose Gar	< 381
Emerald Shiner	< 64	Shovelnose Sturgeon	< 540
Fathead Minnow	< 41	Sicklefin Chub	< 40
Flathead Catfish	< 381	Silver Carp	< 600
Freshwater Drum	< 305	Silver Chub	< 89
Gizzard Shad	< 229	Smallmouth Buffalo	< 381
Goldeye	< 356	Speckled Chub	< 40
Grass Carp	< 600	Spotfin Shiner	< 64
Highfin Carpsucker	< 229	Sturgeon Chub	< 40
Hybognathus spp.	< 74	White Crappie	< 150
Lake Sturgeon	< 1270		

REFERENCES

Carlander, K. D. 1969. Handbook of Freshwater Fishery Biology. Volume 1. Iowa State University Press, Ames, Iowa.

Carlander, K. D. 1977. Handbook of Freshwater Fishery Biology. Volume 2. Iowa State University Press, Ames, Iowa.

Carlander, K. D. 1997. Handbook of Freshwater Fishery Biology. Volume 3. Iowa State University Press, Ames, Iowa.

Clarke, K. R., and R. M. Warwick. 2001. Change in marine communities: an approach to statistical analysis and interpretation, 2nd edition. PRIMER-E: Plymouth, United Kingdom.

Dieterman, D. J., and D. L. Galat. 2004. Large-scale factors associated with sicklefin chub distribution in the Missouri and Lower Yellowstone rivers. Transactions of the American Fisheries Society 133:577-587.

Drobish, M. R. (editor). 2008. Missouri River Standard Operating Procedures for Sampling and Data Collection, Volume 1.3, April, 2008. U.S. Army Corps of Engineers, Yankton, SD.

Ellis, J. M., G. B. Farabee, and J. B. Reynolds. 1979. Fish communities in three successional stages of side channels in the Upper Mississippi River. Transactions of the Missouri Academy of Science 13:5-20.

Galat, D. L., L. H. Fredrickson, D. D. Humburg, K. J. Bataille, J. R. Bodie, J. Dohrenwend, G. T. Gelwicks, J. E. Havel, D. L. Helmers, J. B. Hooker, J. R. Jones, M. F. Knowleton, J. Kubisiak, J. Mazourek, A. C. McColpin, R. B. Renken, and R. D. Semlitsch. 1998. Flooding to restore connectivity of regulated large river wetlands. BioScience 48:721-733.

Galat, D. L., G. W. Whitledge, G. T. Gelwicks. 2004a. Influence of lateral connectivity on larval fish assemblage structure and habitat use in Lower Missouri River water bodies. Final report to Missouri Department of Conservation, Columbia, Missouri.

Galat, D. L., G. W. Whitledge, L. D. Patton, J. Hooker. 2004b. Larval fish use of Lower Missouri River scour basins in relation to connectivity. Final report to Missouri Department of Conservation, Columbia, Missouri.

Galat, D. L., C. R. Berry, W. M. Gardner, J. C. Hendrickson, G. E. Mestl, G. J. Power, C. Stone, and M. R. Winston. 2005. Spatiotemporal patterns and changes in Missouri River fishes. American Fisheries Society Symposium 45:249-291.

Gelwicks, G. T. 1995. Fish movement between the Lower Missouri River and a managed floodplain wetland in Missouri. Master's Thesis, University of Missouri, Columbia, Missouri.

Grady, J. M., and J. Milligan. 1998. Status of selected cyprinid species at historic Lower Missouri River sampling sites. USFWS Columbia Fisheries Resources Office, Columbia, MO.

Gutreuter, S., R. Burkhardt, and K. Lubinski. 1995. Long term resource monitoring program procedures: fish monitoring. National Biological Service, Environmental Management Technical Center, LTRMP 95-P002-1, Onalaska, Wisconsin.

Haines, D. E. 2000. Biological control of gizzard shad impingement at a nuclear power plant. Environmental Science & Policy 3:275-281.

Hesse, L. W., J. Schmulbach, J. Carr, K. Keenlyne, D. Unkenholz, J. Robinson, and G. Mestl. 1989. Missouri River fishery resources in relation to past, present, and future stresses. Pages 352-371 *in* D. P. Dodge, editor. Proceedings of the international large river symposium. Canadian Special Publication of Fisheries and Aquatic Sciences 106.

Hesse L. W., and G. E. Mestl. 1993. An alternative hydrograph for the Missouri River based on the precontrol condition. North American Journal of Fisheries Management 13:360-366.

Hesse, L. W., and W. Sheets. 1993. The Missouri River hydrosystem. Fisheries 18:5-14.

Jacobson, R. B., M. S. Laustrup, and M. D. Chapman. 2001. Fluvial processes and passive rehabilitation of the Lisbon Bottom Side-Channel Chute, Lower Missouri River. Pages 199-216 *in* F. A. Fitzpatrick, editor. Geomorphic Processes and Riverive Habitat. American Geophysical Union, Washington, DC.

Jacobson, R. B., H. E. Johnson, M. S. Laustrup, G. L. D'Urso, and J. M. Reuter. 2004. Physical habitat dynamics in four side-channel chutes, Lower Missouri River. U.S. Geological Survey, Open-File Report 2004-1071, Reston, Virginia.

Jacobson, R. B. 2006. Science to support adaptive habitat management, Overton Bottoms North Unit, Big Muddy National Fish and Wildlife Refuge, Missouri. U.S. Geological Survey, Scientific Investigations Report 2006-5086.

Jacobson, R. B., and D. L. Galat. 2006. Flow and form in rehabilitation of large-river ecosystems: an example from the Lower Missouri River. Geomorphology 77:249-269.

Junk, W. J., and K. M.Wantzen. 2004. The Flood Pulse Concept: New Aspects Approaches and Applications – an Update. Proceedings of the Second

International Symposium on the Management of Large Rivers for Fisheries: Volume 2:117-140.

Knighton, D. 1998. Fluvial Forms and Processes. Oxford University Press, New York.

Krebs, C. J. 1999. Ecological methodology, 2nd edition. Addison Wesley Longman, New York.

Kwak, T. J., and J. T. Peterson. 2007. Community indices, parameters, and comparisons. Pages 677-763 in C. S. Guy and M. L. Brown, editors. Analysis and interpretation of freshwater fisheries data. American Fisheries Society, Bethesda, Maryland.

McCune, B., and M. J. Medford. 1999. PC-ORD. Multivariate Analysis of Ecological Data, Version 4. MjM Software Design, Gleneden Beach, Oregon.

McCune, B. and J. B. Grace. 2002. Analysis of Ecological Communities. MjM Software, Gleneden Beach, Oregon.

McDonald, L. L., R. Bilby, and P. A. Bisson, C. C. Coutant, J. M. Epifanio, D. Goodman, S. Hanna, N. Huntley, E. Merril, B. Riddel, W. Liss, E. J. Loudenslager, D P. Phillip, W. Smoker, R. R. Whitney and R. N. Williams. 2007. Research, monitoring and evaluation of fish and wildlife restoration projects in the Columbia River Basin: lessons learned and suggestions for large-scale monitoring programs. Fisheries 32:582-590.

McMahon, T. E., A. V. Zale, and D. J. Orth. 1996. Aquatic habitat measurements. Pages 83-120 *in* B. R. Murphy and D. W. Willis, editors. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Miranda, L. E. 2005. Fish assemblages in oxbow lakes relative to connectivity with the Mississippi River. Transactions of the American Fisheries Society 134:1480-1489.

National Research Council. 2002. The Missouri River ecosystem-exploring the prospects of recovery. National Academy Press, Washington, DC.

Neumann, R.M. and M. S. Allen. 2007. Size Structure. Pages 375-422 in C. S. Guy and M. L. Brown, editors. Analysis and interpretation of freshwater fisheries data. American Fisheries Society, Bethesda, Maryland.

Pegg, M. A., C. L. Pierce, and A. Roy. 2003. Hydrological alteration along the Missouri River Basin: a time series approach. Aquatic Sciences 65:63-72.

Peterson, J. T., and C. F. Rabeni. 2001. Evaluation the physical characteristics of channel units in an Ozark stream. Transactions of the American Fisheries Society 130:898-910.

Pflieger, W. L., and T. B. Grace. 1987. Changes in the fish fauna of the Lower Missouri River, 1940-1983. Pages 166-177 *in* W. J. Matthews and D. C. Heins, editors. Community and evolutionary ecology of North American stream fishes. University of Oklahoma Press, Norman, Oklahoma.

Pflieger, W. L. 1997. The fishes of Missouri, 2nd edition. Missouri Department of Conservation, Jefferson City, Missouri.

Plauk, A., N. Utrup, W. Doyle, P. Herman, and T. Hill. 2007. Pallid sturgeon population assessment project and associated fish community monitoring for the Missouri River: Segment 13. 2006 Annual Report. U.S. Fish and Wildlife Service.

Remus, J. I. 2007. Army Corps of Engineers Chief Sedimentation and Channelization Section. Personal Communication.

Ridenour, C., A. Starostka, W. Doyle, and T. Hill. 2008. Habitat used by *Macrhybopsis* chubs associated with channel modifying structures in a large regulated river: implications for river modification. River Research and Applications DOI:10.1002/rra.1175.

SAS Institute Inc. 2002. SAS version 9.1. SAS Institute Inc., Cary, North Carolina.

SAS Institute Inc. 2008. SAS version 9.2. SAS Institute Inc., Cary, North Carolina.

Schlosser, I. J. 1987. The role of predation in age- and size-related habitat use by stream fishes. Ecology 68:651-659.

Shea, C. P., and J. T. Peterson. 2007. An evaluation of the relative influence of habitat complexity and habitat stability on fish assemblage structure in unregulated and regulated reaches of a large southeastern warmwater stream. Transactions of the American Fisheries Society 136:943-958.

USGS National Water Information System: Web Interface. 2009. Surface Water data for USA: USGS Surface-Water Annual Statistics. Available: http://waterdata.usgs.gov/nwis/annual.

COE (U.S. Army Corps of Engineers). 2003. Final supplemental environmental impact statement for the Missouri River fish and wildlife mitigation project. U.S. Army Corps of Engineers, Kansas City and Omaha Districts.

USFWS (U.S. Fish and Wildlife Service). 2000. Biological opinion on the operation of the Missouri River main stem reservoir system, operation and maintenance of the

Missouri River Bank Stabilization and Navigation Project, operation of the Kansas River reservoir system. U.S. Fish and Wildlife Service, Fort Snelling, MN.

Whitledge, G. T., D. L. Galat, G. W. Gelwicks. 2005. Habitat Use by Fishes in Periodically and Continuously Connected Lower Missouri River Floodplain Water Bodies. Final report to Missouri Department of Conservation, Columbia, Missouri.

Wildhaber, M. L., P. J. Lamberson, and D. L. Galat. 2003. A comparison of measures of riverbed form for evaluating distributions of benthic fishes. North American Journal of Fisheries Management 23:543-557.

Willis, D. W. 1987. Reproduction and recruitment of gizzard shad in Kansas reservoirs. North American Journal of Fisheries Management 7:71-80.

Zar, J. H. 1999. Biostatistical Analysis, Fourth Edition. Prentice-Hall, Upper Saddle River, N.J.

FINAL REPORT

Missouri River Fish and Wildlife Mitigation Program

Fish Community Monitoring and Habitat Assessment of Off-channel Mitigation Sites

Section II Physical Habitat Assessment

Tieville-Decatur Bend[1], Louisville Bend[1], Tyson Island[1], California Cut-Off[1,2], Tobacco Island[2], Upper and Lower Hamburg Bend[2,3], Kansas Bend[2,3], Deroin Bend[2,3], Lisbon Bottom[4], North Overton Bottoms[4], Tadpole Island[4] and Tate Island[4]

Prepared for the U.S. Army Corps of Engineers

By:

[1]Van Sterner and Royce Bowman
[2]Brandon Eder, Sabrina Negus and Gerald Mestl
[3]Kasey Whiteman, Darrick Garner and Vince Travnichek
[4]Joshua Schloesser, Joseph McMullen and Tracy Hill

April 2009

[1]Van Sterner and Royce Bowman
Contract number –
Iowa Department of Natural Resources
607 10th St
Onawa, Iowa 51040

[2]Brandon Eder, Sabrina Negus and Gerald Mestl
Contract number – W9128F-05-P-0171
Nebraska Game and Parks Commission
Missouri River Program – Fisheries Division
2200 North 33rd Street
Lincoln, NE 68503

[3]Kasey Whiteman, Darrick Garner and Vince Travnichek
Contract number – W912DQ-07-D-0001
Missouri Department of Conservation
Nodaway Valley CA
21999 Hwy B
Maitland, MO 64466

[4]Joshua Schloesser, Joseph McMullen and Tracy Hill
Contract number - W59XQG83460940
U.S. Fish and Wildlife Service
Columbia National Fish & Wildlife Conservation Office
101 Park DeVille Drive, Suite A
Columbia, MO 65203-0057

Executive Summary

The Missouri River has been developed for flood control, commercial navigation, irrigation, fish and wildlife conservation, municipal water supply, water quality control and hydropower production through a series of congressional acts. However, prior to development, the lower Missouri River was characterized by a highly sinuous to braided channel with abundant log jams, sand bars, secondary channels and cut-off channels. Construction of the Bank Stabilization and Navigation Project (BSNP) converted the lower Missouri River into a narrow, self scouring channel. The active channel downstream of Sioux City, Iowa was as wide as 1.8 km before river modification, but is now confined to a 91.4 m channel. Total river and floodplain habitat altered or destroyed by the BSNP is estimated at 211,246 hectares.

The Missouri River Fish and Wildlife Mitigation Project (Mitigation Project) was established to restore fish and wildlife habitat lost by the construction, operation and maintenance of the BSNP. The Water Resources Development Act of 1986 authorized the United States Army Corps of Engineers (COE) to acquire and develop habitat on 12,100 hectares of non public lands and the development of 7,365 hectares of habitat on existing public lands to mitigate habitat losses. The Water Resources Development Act of 1999 authorized an additional 48,016 hectares to the program. The Final Supplemental Environmental Impact Statement (FSEIS) for the expanded Mitigation Project was issued in March of 2003, and it included a preferred alternative proposing the creation of additional shallow water habitat (defined as areas less than 1.5 m deep with a current velocity of less than 0.76 m/s). The preferred action in the FSEIS for the expanded

Mitigation Project included creation of 2,833 to 8,094 hectares of shallow water habitat (SWH).

In 2005, the Iowa Department of Natural Resources, Nebraska Game and Parks Commission (NGPC), Missouri Department of Conservation and U.S. Fish and Wildlife Service, Columbia Fisheries Resource Office (renamed to Columbia National Fish and Wildlife Conservation Office) were contracted by the COE to monitor and evaluate fish communities of select off-channel aquatic habitat sites that were constructed through the Mitigation Project. Additionally, the NGPC was contracted to collect physical habitat information from the secondary channels that were selected for biological monitoring in the upper channelized section above Kansas City. Sixteen sites selected for monitoring covered a range of aquatic habitats including backwaters and secondary channels with varying levels of engineering and development. Sites from upstream to downstream included Tieville-Decatur Bend (two backwaters), Louisville Bend (backwater), Tyson Island (backwater), California Bend (chute on the Nebraska bank and a chute with connected backwater on the Iowa bank), Tobacco Island (chute), Upper and Lower Hamburg Bends (one chute each), Kansas Bend (two small chutes, treated as one), Deroin Bend (chute), Lisbon Bottom (natural chute), North Overton Bottoms (chute), Tadpole Island (chute) and Tate Island (chute). The study was designed to include three field sampling seasons, but due to delays implementing contracts in 2005 another complete year of sampling was added. Thus, fish community monitoring and habitat assessment of off-channel mitigation sites began in April, 2006 and concluded in October, 2008. The objective of this project was to determine biological performance and functionality of chutes and backwaters and to compare chutes and backwaters in an effort to identify

designs most beneficial to native Missouri River fish species. Additionally, this project was designed to help determine if additional modifications are needed at existing mitigation sites, if existing designs are providing a range of habitats, if these habitats are of value to the biological diversity of the Missouri River and if these habitats are of specific value to species of concern or importance, such as pallid sturgeon.

Chutes and backwaters were sampled monthly from April thru October 2006 – 2008. Each chute was divided into 16 sampling segments, and eight segments were randomly chosen without replacement each month for each gear type used. The standard gears used for this project include; trammel nets, large and small otter trawls, push trawls, bag seines, electrofishing, large and small diameter hoop nets and mini-fyke nets. Additional gears used only in backwaters include experimental gill nets and large frame trap nets. Set lines and hook and line were used as wild gears (gears in addition to those required for standard sampling), these gears were used to target pallid sturgeon.

Chutes and backwaters provided habitat for different fish communities. Chutes were found to have more riverine species while these species were lacking in backwaters. Contiguous backwaters had greater species diversity and richness than those that were impounded. This connection to the river allowed species to access these areas that they otherwise could not have.

Chutes separated themselves out geographically. The available fish community in the main channel affected the fish community in the chutes. Chutes that were located farther up the Missouri River tended to benefit different species than those on the lower end of the river. Therefore, the benefit of a chute to the overall fish community probably depended on if the chute provided something different than what was already found in the

main channel. Also more diverse fish communities were found in the older constructed and natural chutes. This is probably due to the greater habitat diversity these chutes have developed compared to the younger chutes.

Overall, the fish communities in most sites were dominated by juveniles of most species. The habitat that has been developed via chutes and backwaters therefore are functioning as refuges for smaller fish. This is a valuable asset to the fish communities in the Missouri River. Currently little is known if these juveniles are spawned or drifted into the chutes and backwaters. It is also unknown if these juveniles are able to move out of the chutes and backwaters and into the main channel.

Predictive models indicated that chutes had different probabilities of presence for target species. In general, chutes that were relatively longer, wider, shallower and had greater sinuosity were more likely to have target species present. Conversely, chutes that were short, had low width to depth ratios and low sinuosity were less likely to have target species present.

Important predictor variables for species presence were year (85% of species models), water depth (80%), turbidity (65%), water temperature (60%), month (60%) and water velocity (50%). A year effect, likely related to river discharge, for many species supports the need for multiple year assessment programs. Water depth and, to some extent, water velocity were recognized as two variables that can be manipulated by river engineers and we found that the selected range of depths and velocities varied by species, which was expected with a diverse fish community. Many juvenile and small-bodied fishes utilized shallow water habitats (<1.0 m) over a broad range of water velocities (0.0-1.0 m/s), but large-bodied fishes tended to orient towards relatively deeper water. Therefore, creating

shallow water habitats with a range of velocities would likely benefit many juvenile native species.

Mitigation Project designs are providing a range of habitats. Backwater habitats are creating a habitat not currently available in most reaches of the Missouri River. Different backwater designs do not appear to be creating different habitats from each other; however, backwaters can only be used by riverine fish if they are connected to the river. All chutes are providing some habitat diversity, however, some chutes, including; California (NE), Upper Hamburg, Lisbon and Tate contain more habitat diversity, and therefore, are providing much needed habitat complexity to that reach of the river.

Backwater and chute habitats appear to be beneficial to the biodiversity of the Missouri River system; however, it is important to note that different reaches of the river have different needs. The highly modified middle Missouri River, from Sioux City, IA to Kansas City, MO has very little habitat diversity available within the main channel and many different habitats may be necessary to restore the healthy function of the river system. While the lower Missouri River has greater habitat diversity within the main channel, there are still habitats that may be limited, such as habitat diverse chutes (e.g., Lisbon or Tate) or backwaters that may be needed to restore a fully functioning river.

General Recommendations

- Promote natural side channel creation on suitable public lands. Allowing the river to naturally create side channel habitat may provide the most suitable habitat for riverine fish.
- We recommend constructing chutes that allow for floodplain connectivity, encourage natural river processes and maintain greater complexities of habitats (i.e. high width to depth ratios, diverse substrates, diverse depths, diverse velocities, shallow sandbars, woody debris and vegetated sandbars)
- Construction of longer chutes should receive higher priority than short chutes
- If a short chute must be built, build width, sinuosity and habitat diversity (deep scour holes, bar features and large woody debris).
- Promote channel movement through the use of structures or large woody debris.
- Soil type should be an important consideration in chute design, sites with clay or compacted soils need to be built to finished width or with wider pilot channels to hasten evolution.
- Slope banks when possible to allow large woody debris to accumulate in chutes rather than on high banks.
- Promote capture of large woody debris to increase habitat diversity and secondary productivity.
- Avoid designing chute entrances that may block upstream migration of fish (e.g., high sills or constricted entrances with high velocities and turbulence).
- Evaluate entrance structures to determine if certain life stages of some species (e.g., young of the year sturgeon) are being excluded from entering the chute.
- Avoid designs that promote sedimentation at chute entrances; keep entrances open so desired flows can be achieved.
- If a chute is intended to widen with increased main channel discharge, avoid designs where velocities decrease as main channel discharges increase such as at California (IA) and Kansas (upper).
- Use pilings, like those at Tate chute, instead of rip rap to create water control structures. Using pilings, as opposed to rock structures, may increase the permeability of water structures at varying levels of the water column, particularly the benthos.
- Include tie-channels and braids in chute designs to increase the amount of shallow, slow moving water at sites and provide more area that is in contact with the main channel.
- Design tie-channels, braids and connected backwaters to limit sedimentation.
- Tie channels can be used to direct flows to lower portions of the chute, allowing the upper portions to act more like backwater habitat.

- Create side channel habitat by building islands as opposed to digging channels, as was the case with Tate Island chute.
- Consider reopening existing, naturally formed side channels that are presently cut off from regular flows; there are at least 13 historic chutes that may be considered on the lower Missouri River.
- Contiguous dredged backwaters (such as Tyson Island and California (IA)) are recommended over impounded (disconnected) wetlands (such as Tieville, Louisville and Decatur). Contiguous sites provide connectivity that allows fish access to spawning and nursery habitat. Pumping did not provide accessible floodplain fish habitat.
- Backwaters should maintain a consistent, direct river connection. Open river connections are preferred over water control structures (culverts).
- Connectivity introduces sediment that will eventually fill backwaters. Siltation must be addressed by mechanical removal or improved backwater design.
- Backwaters of the upper channelized river become dewatered and isolated during winter discharges, backwaters should maintain adequate depth to prevent winter fish kills (approximately 3 m deep from December through February)
- Continued monitoring of chutes and backwaters would allow the determination of the rate at which the chute or backwater is evolving, the level of functionality that they can attain, value each chute has to different species, and how future manipulations affect the habitat and fish community.
- The variation in fish abundances seen among the three years of sampling indicates that a long term monitoring effort would be needed to detect population trends in chutes or backwaters. Furthermore, fish data from the chutes and backwaters should be compared to data from the main channel to determine how the chutes and backwaters are functioning with respect to main channel fish use.

TABLE OF CONTENTS

Section II. Physical Habitat
Chapter 1
Methods

Three types of physical habitat surveys were conducted at each site. A topographic survey was done to create a base map of bank-line location. Depth and velocity surveys were conducted using boat and sled mounted acoustic Doppler current profilers (ADCP). Sediment surveys were conducted using a boat mounted acoustic sediment profiler. Data for California Cut-off (IA), California Cut-off (NE), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas and Deroin Bends were collected by Nebraska Game and Parks Commission. All Doppler data for Overton, Tate and Lisbon chutes were collected by USGS (Columbia, MO). No individual survey results are presented here however; Doppler data from these sites were used for multivariate comparisons. No sediment or topographic surveys were done at these sites.

Topographic surveys

Topographic surveys were conducted once at each chute between 2006 and 2008 using survey grade Ashtech GPS equipment. All work was conducted during winter to avoid interference from foliage. Transects were made every 15.25 m and extended 30.5 m perpendicular to the bank-line. Transects were extended down banks to the water line where conditions allowed. Significant topographic features (ditches, roads, rock structures, etc) were surveyed in greater detail as were significant features that lay between transects.

Data were transferred from hand-held data loggers and converted to text using SurveyLink software. All data were checked for quality assurance in Excel. Topographic maps were created using the Spatial Analyst extension in ArcGIS 9.1.

Depth and Velocity Surveys

Depth and velocity were mapped three times at each chute corresponding to different discharges on the main channel of the Missouri River (targets were low, medium and high, these were defined by the actual conditions that occurred at each site during this time period). Discharge measurements were taken from the nearest relevant USGS gage station at 0600 hours on the date of the survey. Discharge measurements for surveys at California Cut-off (NE and IA) were taken from the Omaha gage station (06610000); measurements for all other surveys were taken from the Nebraska City gage station (06807000).

Depth and velocity were surveyed simultaneously using a 1200 kHz Rio Grande ADCP or StreamPro ADCP (Teledyne RDI, San Diego, California). Data were logged and checked for quality assurance using WinRiver software (Teledyne RDI, San Diego, California). The ADCP internal compass was calibrated before each survey to within 0.3 degrees of error (USGS). All surveys were conducted using Bottom Mode 7 and Water Mode 1, 11 or 12 and water velocity data were collected in bins ranging from 0.05 m to 0.25 m depending on conditions. Boat speed was maintained at or below water velocity (usually <1.5m/s). Data were georeferrenced using an Ashtech digital geographic positioning system (DGPS).

Survey transects were made every 40 m or every 20 m depending on the length and width of the survey site. Distances to the bank line were estimated at the beginning and ending of all transects. In instances where obstructions such as rock structures or large woody debris hindered boat driving transects were ended as close to the obstruction as safely possible or conducted immediately upstream or downstream of the obstruction.

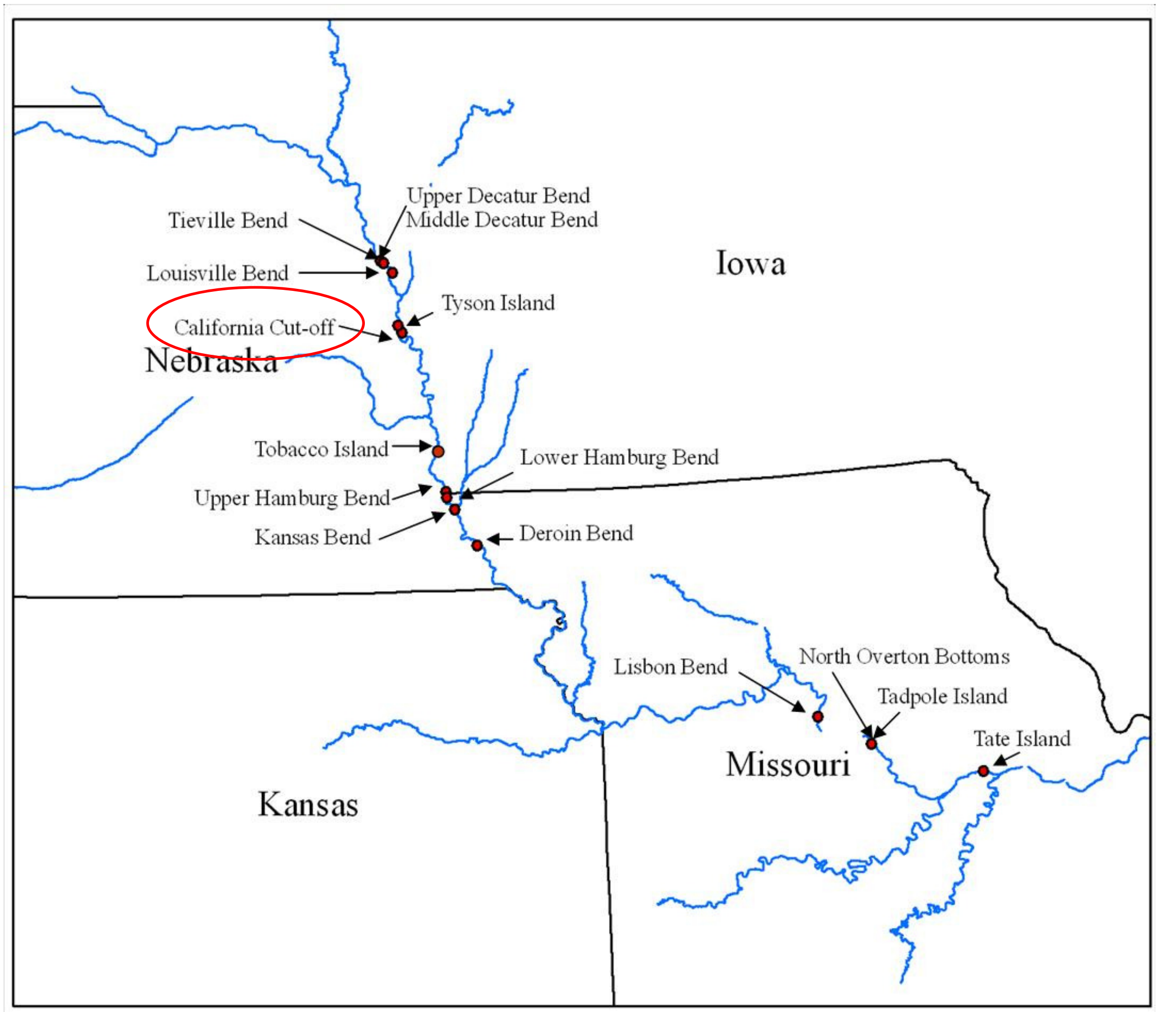
Data were processed in Excel and SigmaPlot to create histograms and cumulative frequency distributions. Frequency distributions were analyzed using SAS 9.1 (SAS Institute, Cary, North Carolina). Depth and velocity maps were created in ArcGIS 9.1(ESRI, Redlands, California) using either the Krigging or Nearest Neighbor gridding methods. Grid size was set at 3m, other settings varied between maps. Velocity data are presented as depth-averaged velocities. Depth-averaged velocities are column velocities that take into account north – south velocity as well as east – west velocity.

Sediment Surveys

Sediment surveys were conducted once at each chute using a 50 kHz Quester Tangent acoustic sediment profiler. Data were georeferrenced using an Ashtech DGPS. Data were logged using QTC View, checked for quality assurance using QTC Impact and processed in QTC CLAMS (Quester Tangent Corp, Sydney, British Columbia, Canada). Processed data were converted to points using Surfer 8 (Golden Software, Golden, Colorado) and imported into ArcGIS 9.1 where sediment maps were created.

Surveys were conducted in a zigzag manor proceeding upstream. At the conclusion of the survey “tie-lines” were driven parallel to each bank as close to the bank as conditions allowed and along the chutes centerline. The “tie-lines” crossed the original zigzag line where it met the bank and were used to collect data and for quality assurance.

Section II
Chapter 2
California (IA)



List of Tables

List of Figures

California (IA)

The chute at California (IA) is located between River Miles (RM) 650.0 and 649.5 in Harrison County, IA. The chute was reopened in 1999 as a 3.05 m wide pilot channel; a backwater area was connected to the chute was added in 2004. The chute is the shortest of the study sites at 1,204 m and is the only study chute with both the entrance and exit located on the outside of a bend. The channel is dominated by sandy substrates and contains some large woody debris. Some bar habitat is present at the entrance and on the inside of the chute's single bend. Erosion has widened the chute to approximately 40 m.

Topographic Survey

A topographic survey was performed over four days between 15 November and 27 November 2007. The survey included both banks of the chute and the backwater area. The completed topographic survey including spot elevations and the 2007 bankline is shown in Figure II.2.1. The location of bank lines from the 2007 survey as well as from the 2003, 2006 and 2008 aerial photography are shown in Figure II.2.2.

Depth and Velocity

Three surveys of depth and velocity were conducted at California (IA) in 2007 and 2008. Table II.2.1 lists survey dates, relative water stage and corresponding mean depth and depth-averaged velocity. The first survey was conducted on 15 March 2007 and will be referred to as the High survey. Discharges at the Omaha gage station were 55,500 cfs. The second survey was done on 1 July 2008 at a discharge of 24,000 cfs and

will be referred to as the Low survey. The final survey was completed on 29 July 2008 at a discharge of 28,400 cfs and will be referred to as the Mid survey. Figure II.2.3 shows the depth frequency and cumulative frequency distributions for the three surveys. Figure II.2.4 shows the depth-averaged velocity frequency and cumulative frequency distributions for the three surveys.

During the Low survey the maximum depth was 3.5 m and the average depth was 1.7 m (Table II.2.1). Eighty-three percent of depths surveyed were between 1.5 m and 3.5 m (Figure II.2.3). The maximum velocity surveyed was 1.63 m/s and the average velocity was 0.67 m/s (Table II.2.1). Sixty-eight percent of velocities surveyed were less than 0.76 m/s and 94% were less than 1.0 m/s (Figure II.2.4). Distribution of depths and depth-averaged velocities are shown in Figure II.2.5 and Figures II.2.6, respectively.

The maximum depth for the Mid survey was 2.8 m and the average depth was 1.7 m (Table II.2.1). Twenty-one percent of depths were less than 1.5 m and 100% were less than 3.7 m (Figure II.2.3). The maximum velocity surveyed was 1.38 m/s and the average velocity was 0.61 m/s (Table II.2.1). Eighty-three percent of velocities surveyed were less than 0.76 m/s and 98% were less than 1.0 m/s (Figure II.2.4). The distribution of depths (Figures II.2.7) and depth-averaged velocities (Figures II.2.8) are shown for the Mid survey at California (IA).

The maximum depth recorded during the High survey was 7.5 m and the average depth was 3.9 m (Table II.2.1). Sixty-seven percent of depths were greater than 3.7 m and no depths were less than 1.5 m (Figure II.2.3). The maximum velocity surveyed was 1.39 m/s and the average velocity was 0.57 m/s (Table II.2.1). Eighty-six percent of velocities were less than 0.76 m/s and 98.5% were less than 1.0 m/s (Figure II.2.4). The

distribution of depths (Figures II.2.9) and depth-averaged velocities (Figures II.2.10) are shown for the High survey at California (IA).

We compared depth frequency distributions using a KS test and found no difference between the Low and Mid surveys (Table II.2.2). We compared depth-averaged velocity frequency distributions between surveys and found differences between all surveys (Table II.2.2). We compared mean depths (Table II.2.1) using an ANOVA and found differences among the group (F = 6355.83, $p < 0.0001$) and no difference between the Low and Mid surveys (Table II.2.3). A comparison of mean depth-averaged velocities (Table II.2.1) using ANOVA also found differences among the group (F = 114.27, $p < 0.0001$) and differences among all pairwise comparisons except between the Low and Mid surveys (Table II.2.3).

Sediment

A sediment survey was conducted at California (IA) on 21 March 2007. Results from the survey were inconclusive and did not match grab samples taken by NGPC crews. The sediment survey is not presented in this report.

Summary

As expected, different main channel discharges resulted in different depth and velocities at California Cut-off (IA). What was not expected was that as main channel discharges increased the average velocity of the chute decreased. If this chute was intended to erode and widen under high flow conditions, this design might fail to evolve in a site with less erodible soils.

The majority of depth data could be found within a small range of depths during all three surveys (Figure II.2.3). This is indicative of a chute with steep banks and little or no bar habitat. The deepest portion of the chute is a scour hole immediately downstream of the chute entrance.

The chute's general shape is that of a crescent, consisting of a single bend. A defined channel is present on the outer portion of this bend with slower velocities on the inner portion of the bend. These slower velocities have led to deposition and some bank associated sand bar formation. Velocities in this chute do not vary greatly with discharge (Figure II.2.4) because of the chutes location on the outside bend of the main river channel.

Although the chute has widened approximately 37 m in 10 years it has experienced little other geomorphic evolution. Its single bend shape does not provide the necessary means for channel migration and bar formation. If bank erosion continues the outside bend of the chute will eventually erode away the thin strip of land separating the chute from the backwater and the two will merge. The lack of evolution at this site raises concerns regarding future sites of this design.

Key features:

- Decreasing velocities as main channel discharges increase
- Steep "U" shaped banks
- Short
- Shallow
- Sand is dominant substrate

- Banks are sand
- Some large woody debris (due mainly to beaver activity)
- Connected backwater – small strip of land separating backwater and chute may eventually erode joining chute and backwater

Recommendations for modification:

- Modify design so that velocities inside the chute increase as main channel discharges increase
- Remove strip of land separating chute and backwater
- Slope banks to encourage large woody debris to accumulate in chute
- Increase length

Table II.2.1. List of survey dates for California (IA) and relative stage with mean depth and mean depth-averaged velocity for each relative stage.

Survey Date	Discharge (cfs)	Stage	Mean Depth (m)	Mean Depth-averaged Velocity (m/s)
15 March 2007	55,500	High	3.9	0.56
1 July 2008	28,400	Low	1.7	0.68
29 July 2008	24,000	Mid	1.7	0.62

Table II.2.2. Results of Kolmogorov-Smirnov tests for differences in distributions between surveys. Results are significant at a Bonferonni adjusted p value of 0.033 (alpha = 0.10). Significant results are shown in bold.

	Depth		Depth-averaged Velocity	
Survey	**D**	**p-value**	**D**	**p-value**
High vs. Low	**0.97**	**<0.0001**	**0.39**	**<0.0001**
High vs. Mid	**0.99**	**<0.0001**	**0.22**	**<0.0001**
Low vs. Mid	0.03	0.7271	**0.34**	**<0.0001**

Table II.2.3. Results of pairwise tests (ANOVA) of mean depth and mean depth-averaged velocity. Results are significant at a Bonferonni adjusted p value of 0.033 (alpha = 0.10). Significant results are shown in bold.

	Depth		Depth-averaged Velocity	
Survey	**F**	**p-value**	**F**	**p-value**
High vs. Low	**102.17**	**<0.0001**	**-14.62**	**<0.0001**
High vs. Mid	**104.22**	**<0.0001**	**-7.05**	**<0.0001**
Low vs. Mid	0.64	0.5223	**9.60**	**<0.0001**

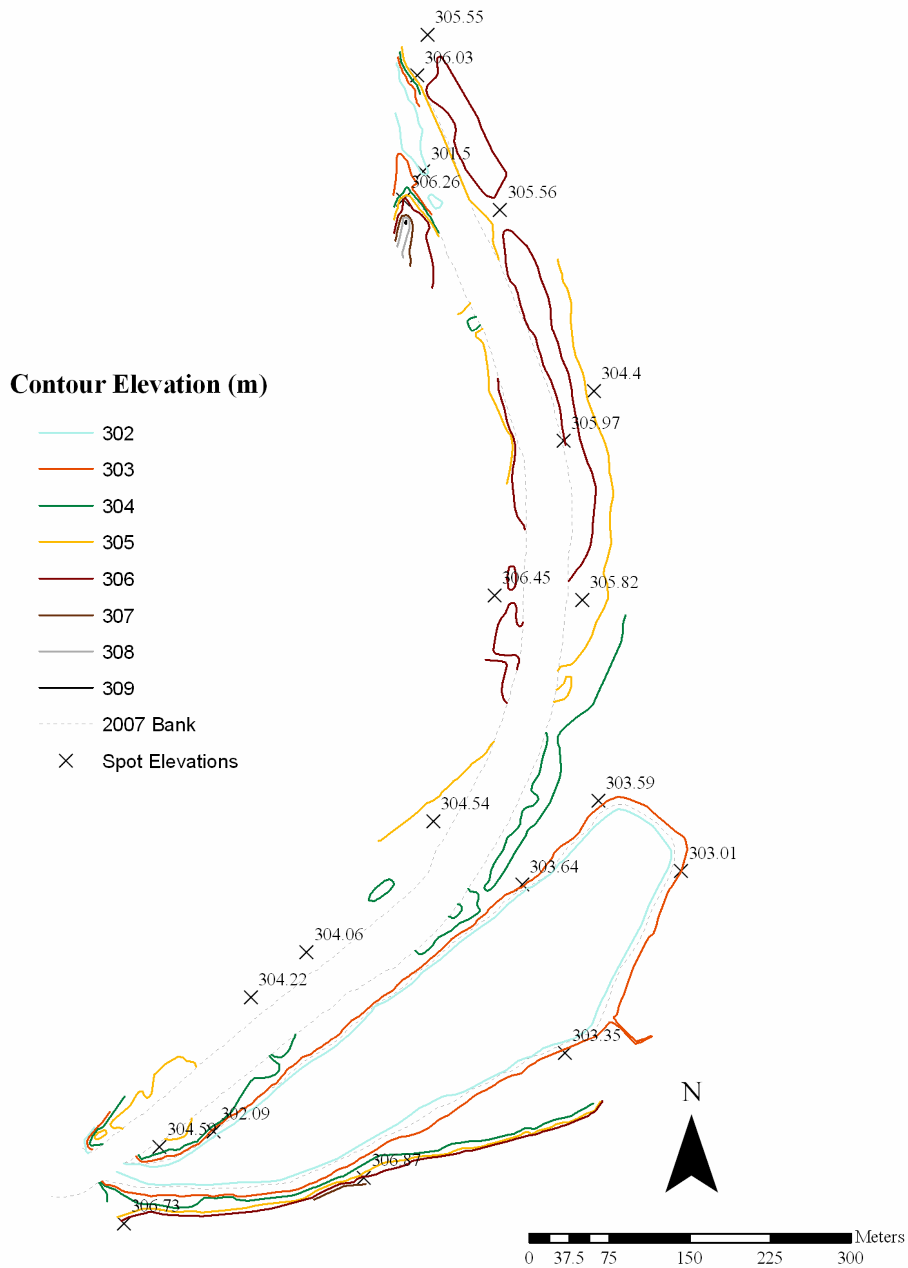


Figure II.2.1. Topographic survey of California (IA) with spot elevations and 2006 bankline.

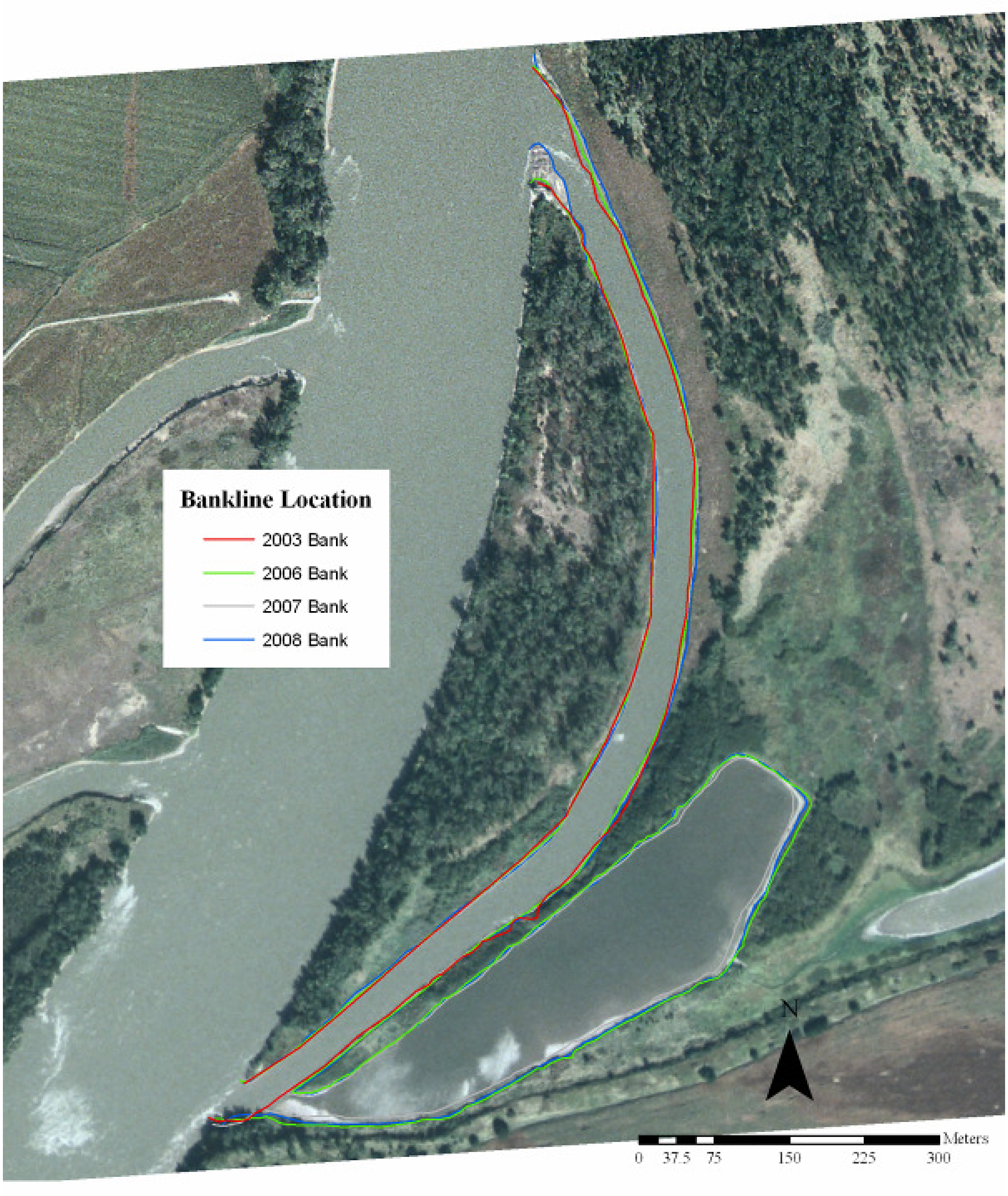


Figure II.2.2. Aerial photograph of California (IA) with bankline locations from 2003, 2006 and 2008 aerial photography and the 2007 topographic survey.

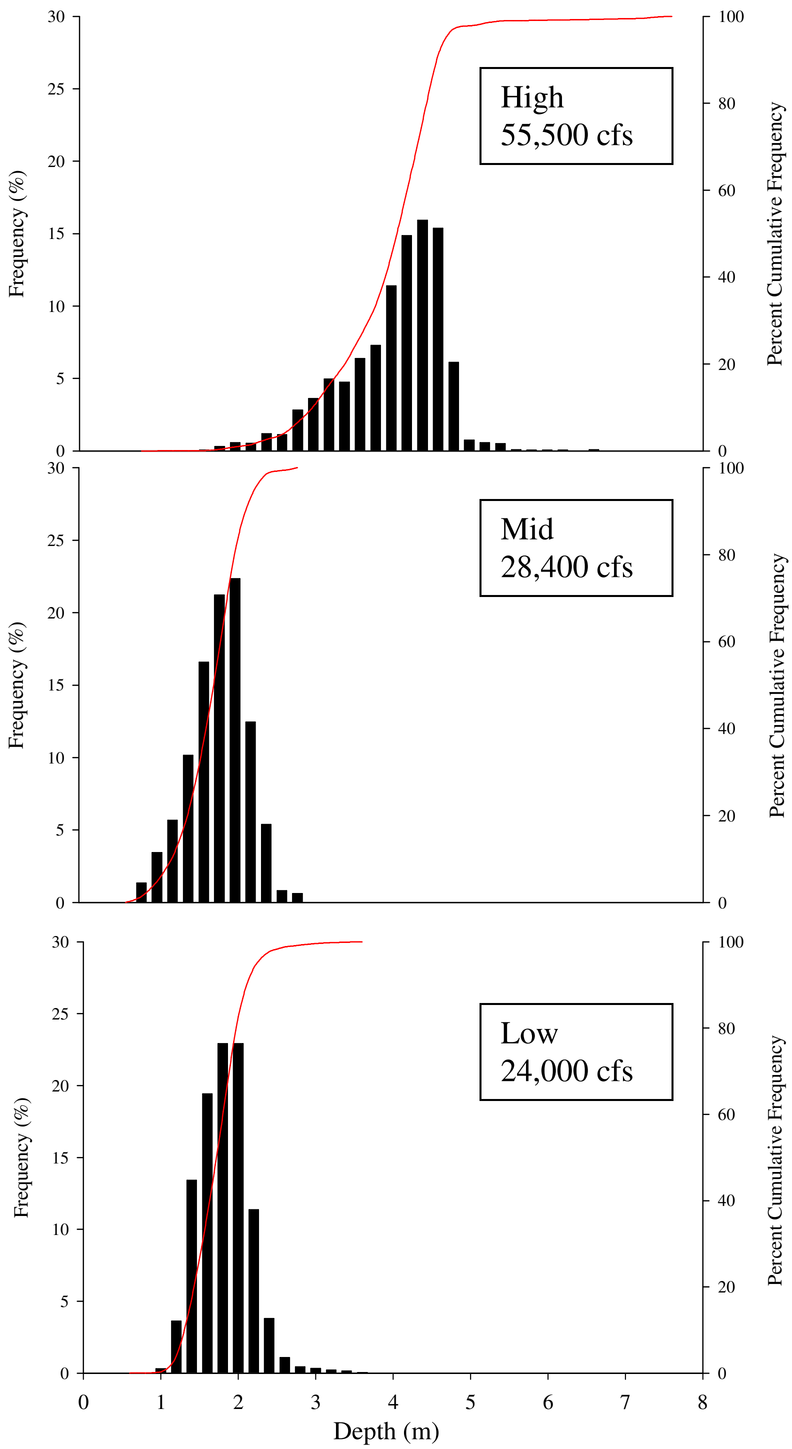


Figure II.2.3. Depth frequency distributions and cumulative frequency distributions at California (IA) for all three Doppler surveys.

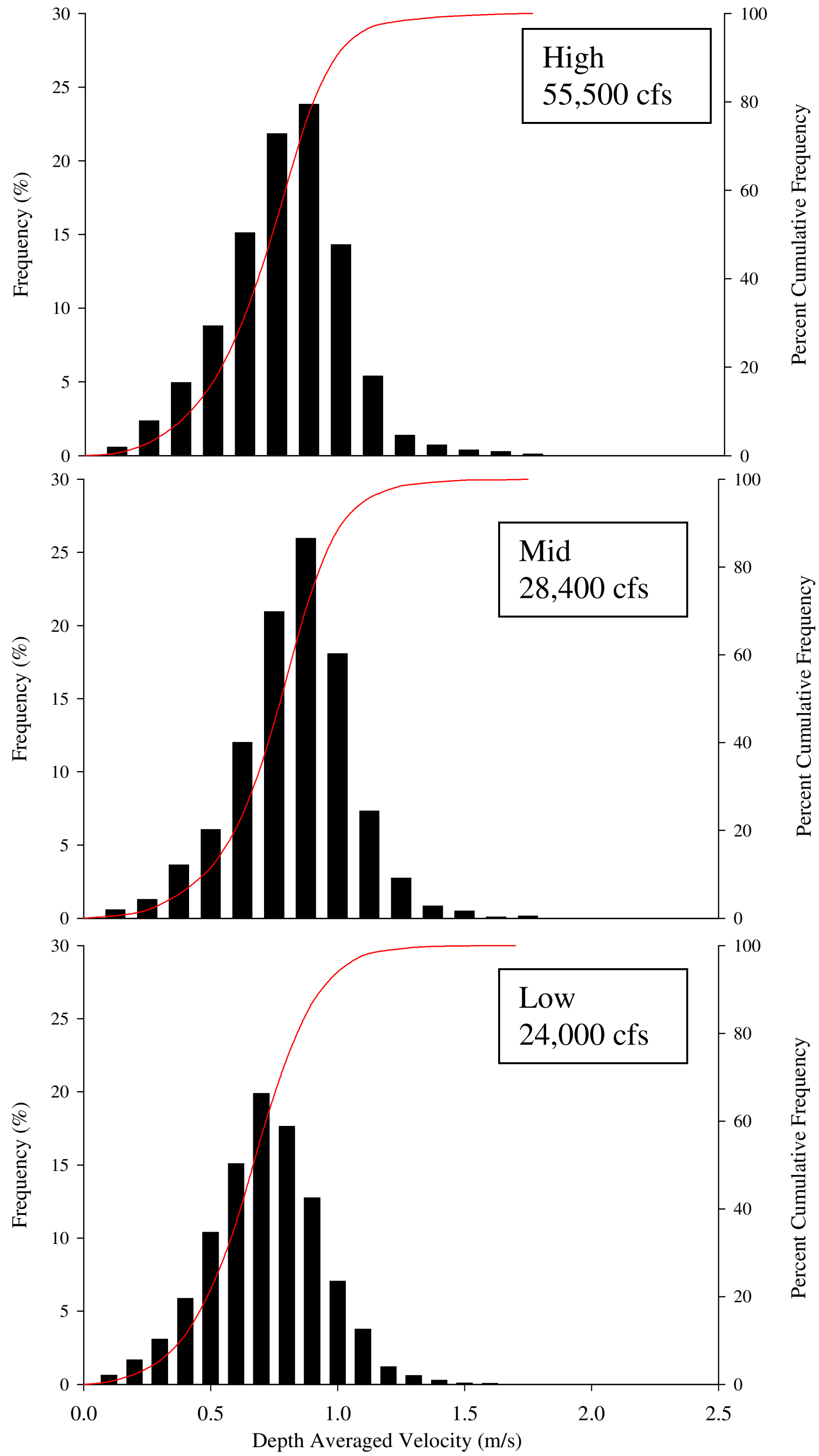


Figure II.2.4. Depth-averaged velocity frequency distributions and cumulative frequency distributions at California (IA) for all three Doppler surveys.

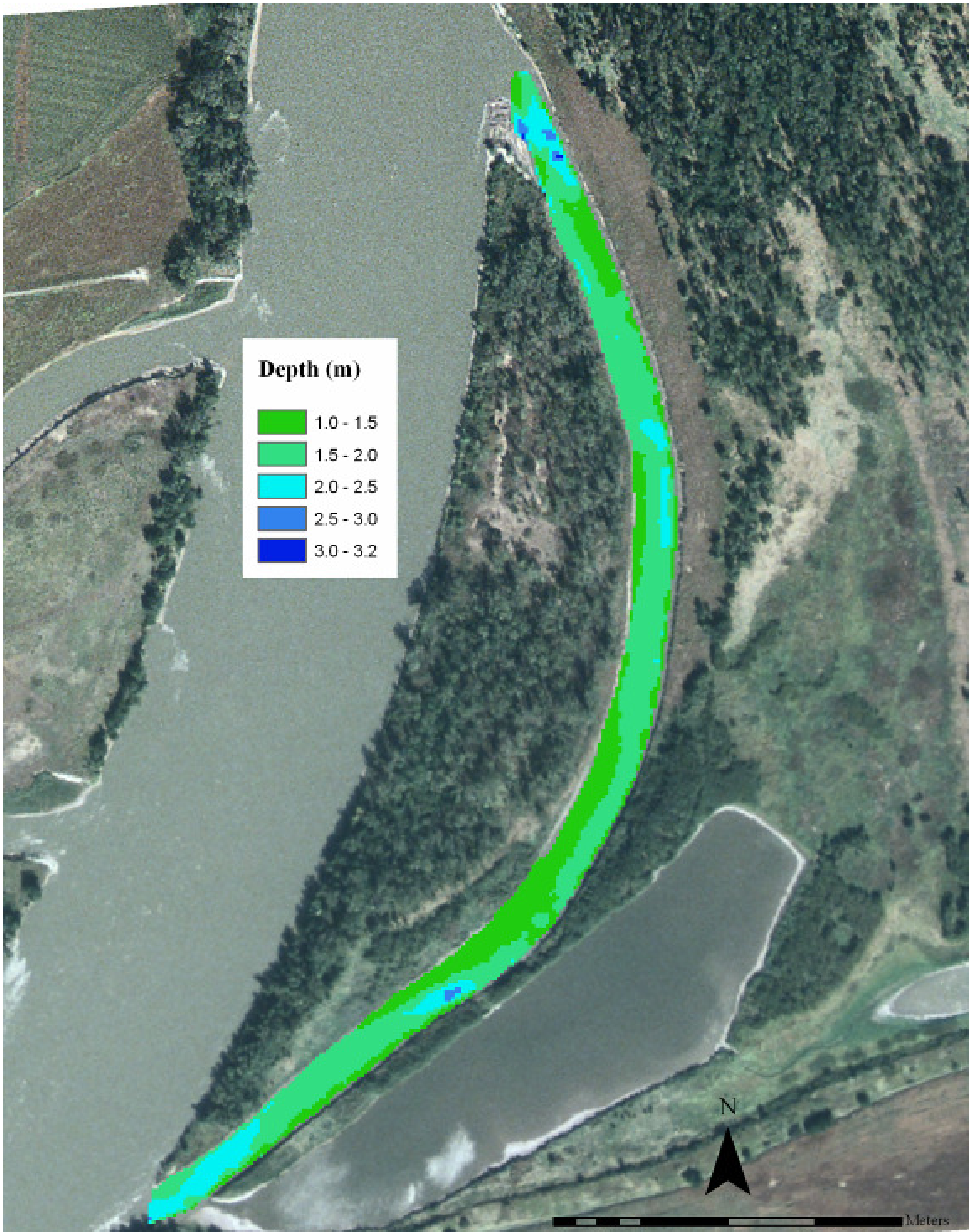


Figure II.2.5. Depth distributions from the Low survey (24,000 cfs) at California (IA).

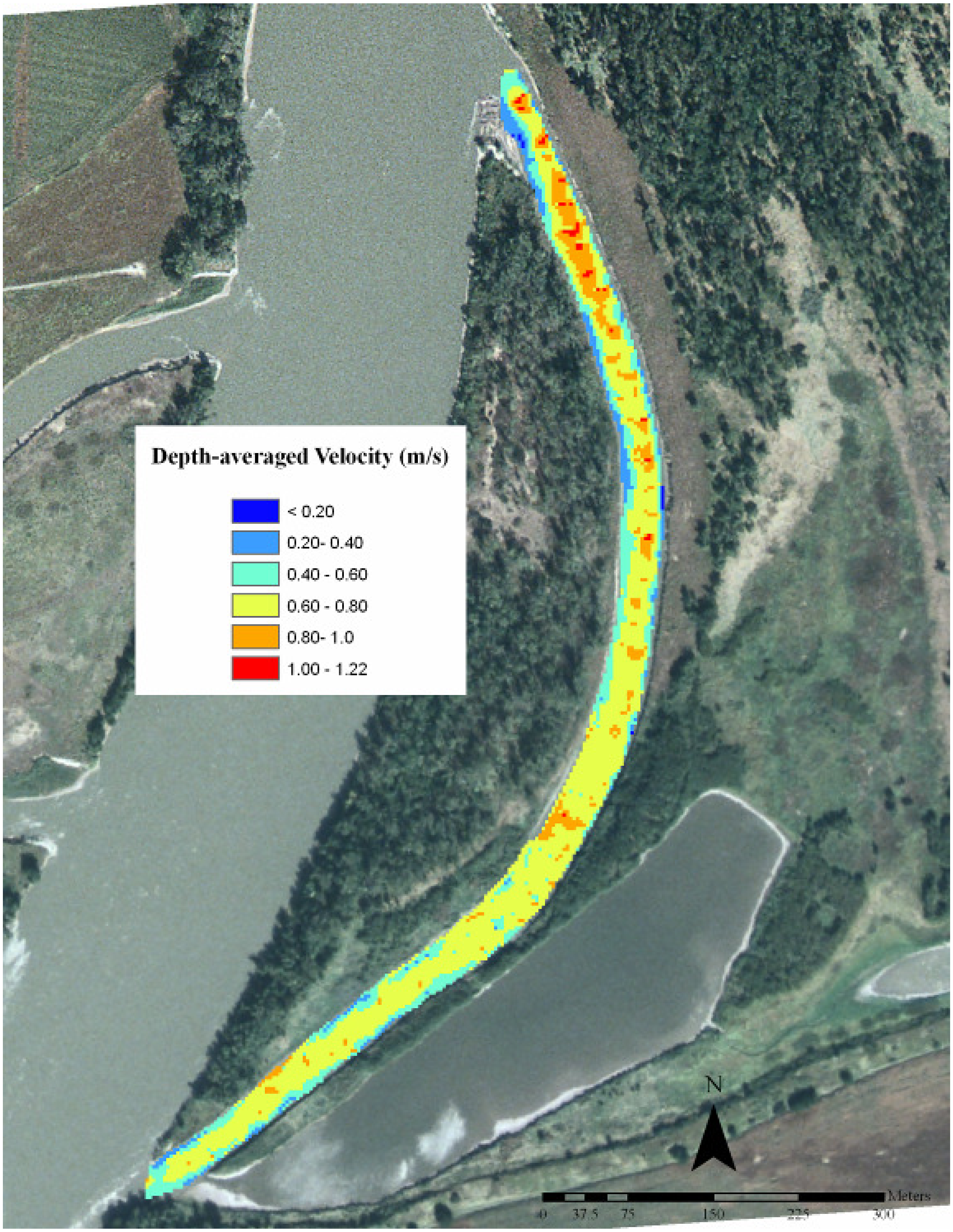


Figure II.2.6. Depth-averaged velocity distributions from the Low survey (24,000 cfs) at California (IA).

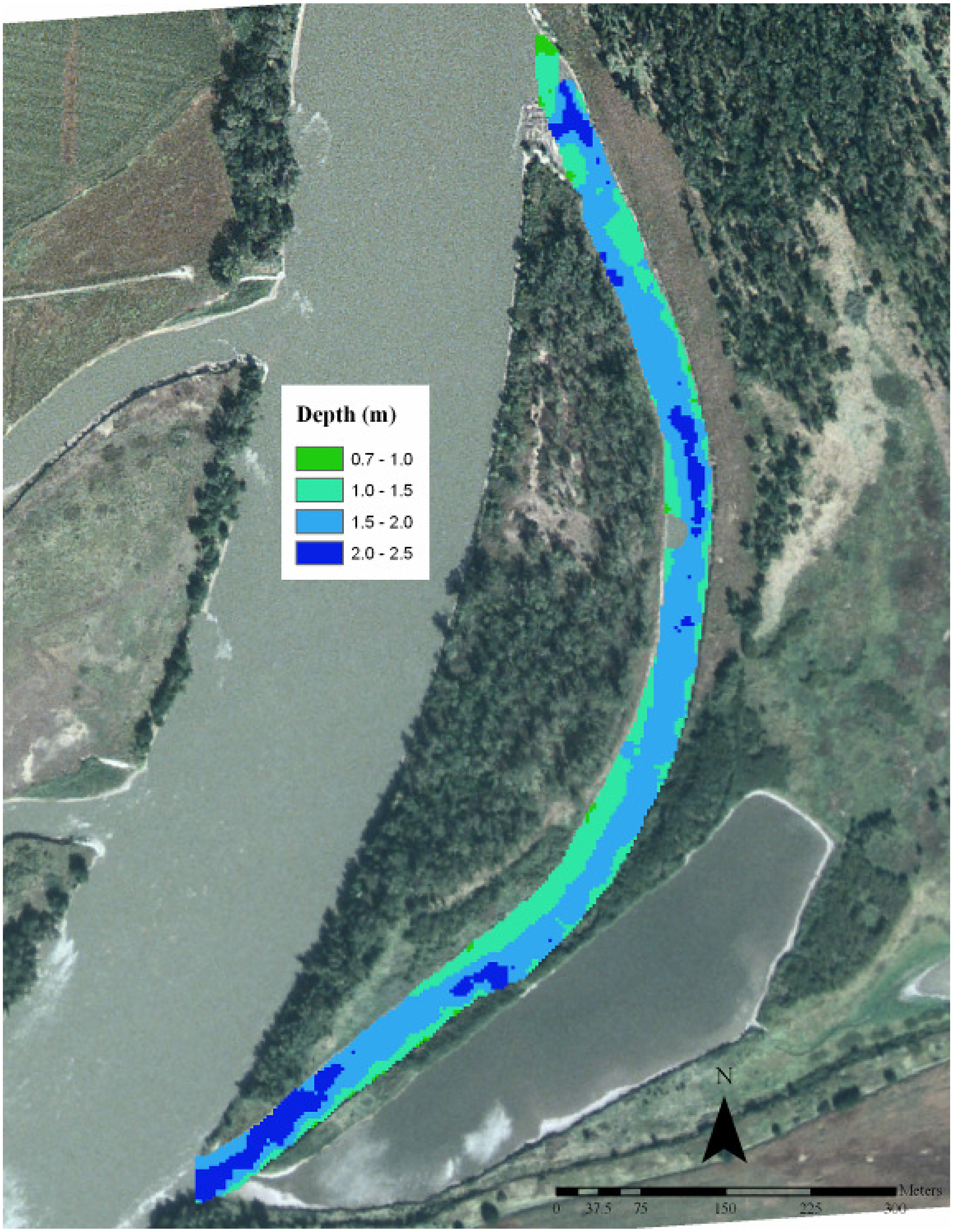


Figure II.2.7. Depth distributions from the Mid survey (28,400 cfs) at California (IA).

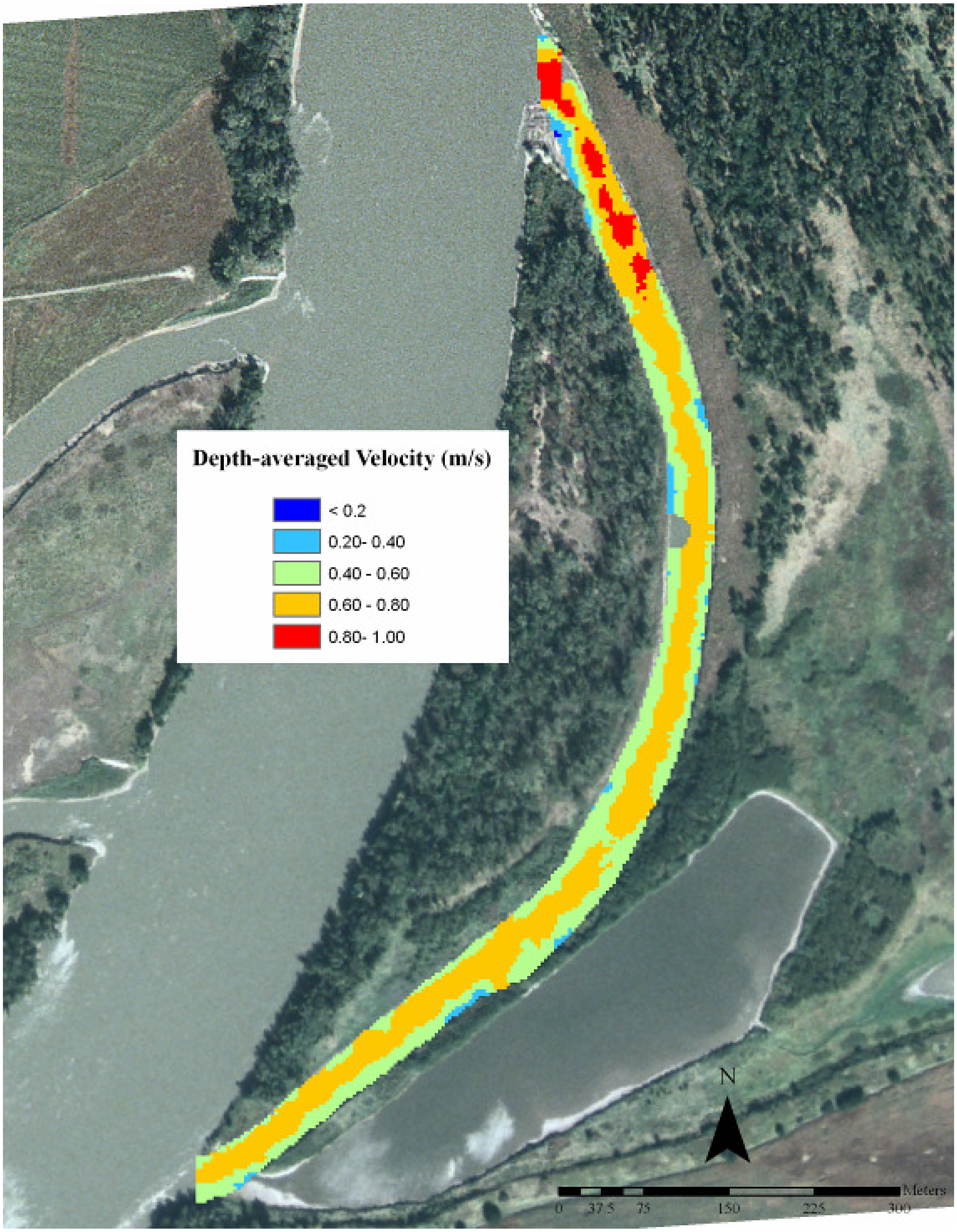


Figure II.2.8. Depth-averaged velocity distributions from the Mid survey (28,400 cfs) at California (IA).

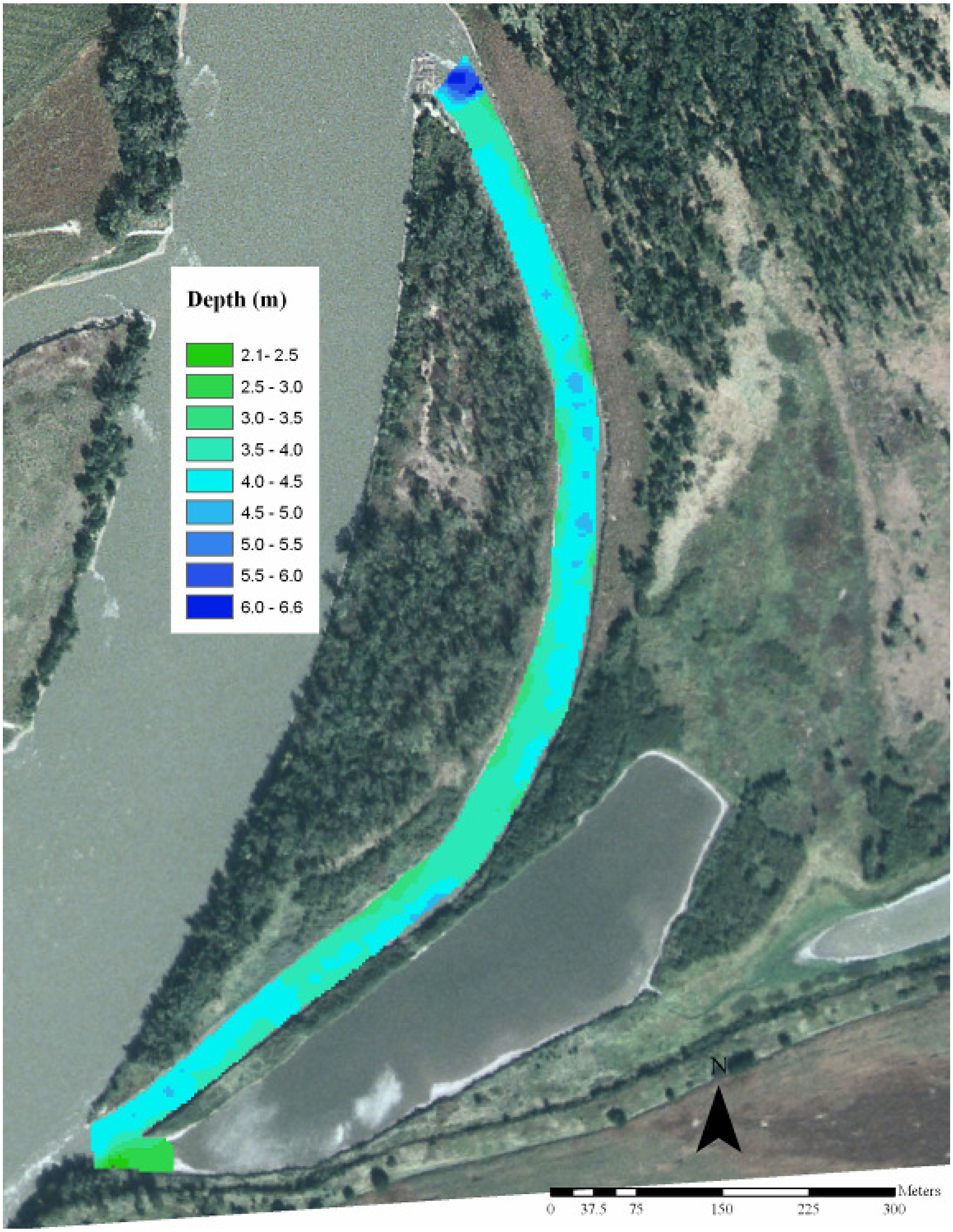


Figure II.2.9. Depth distributions from the High survey (55,500 cfs) at California (IA).

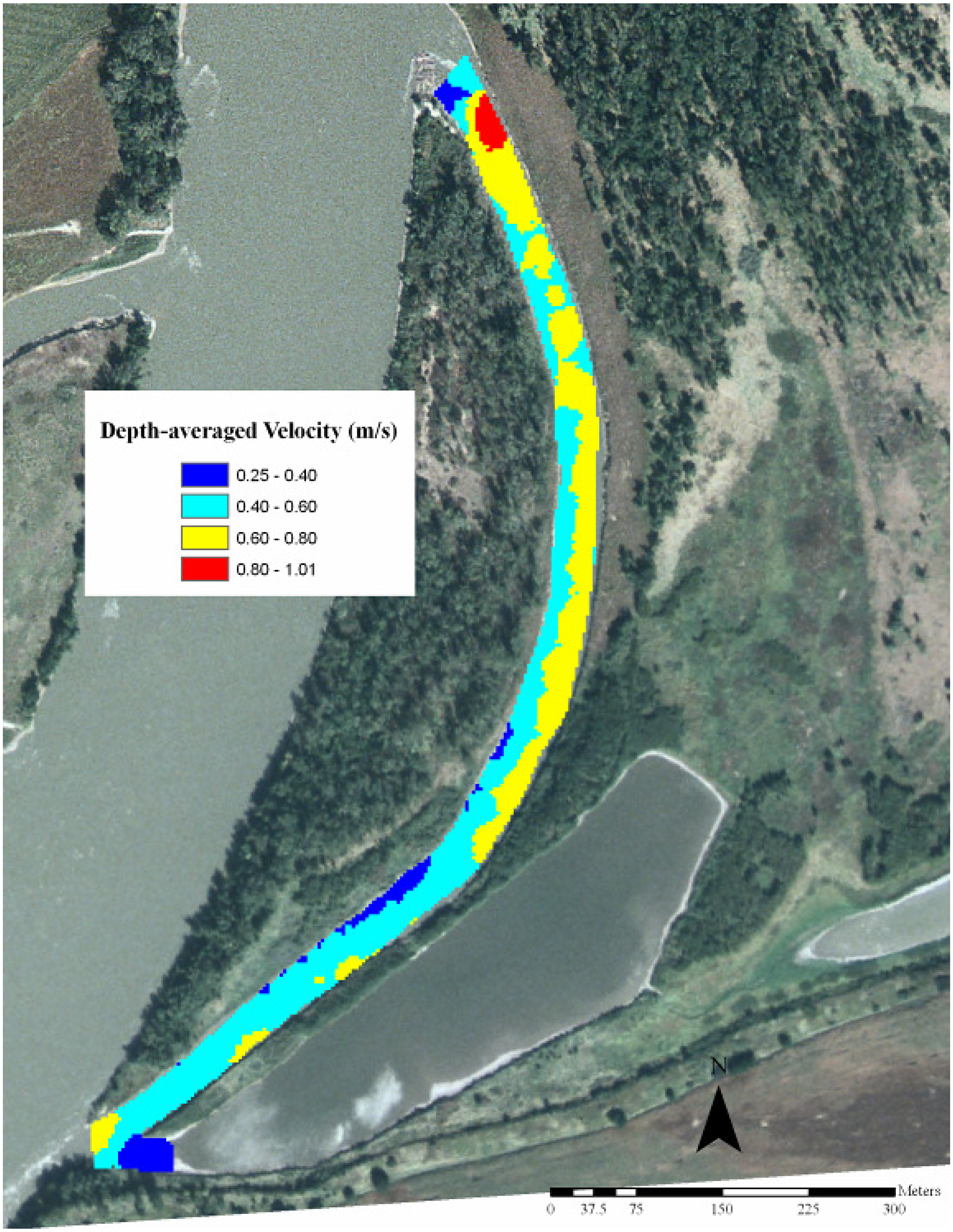
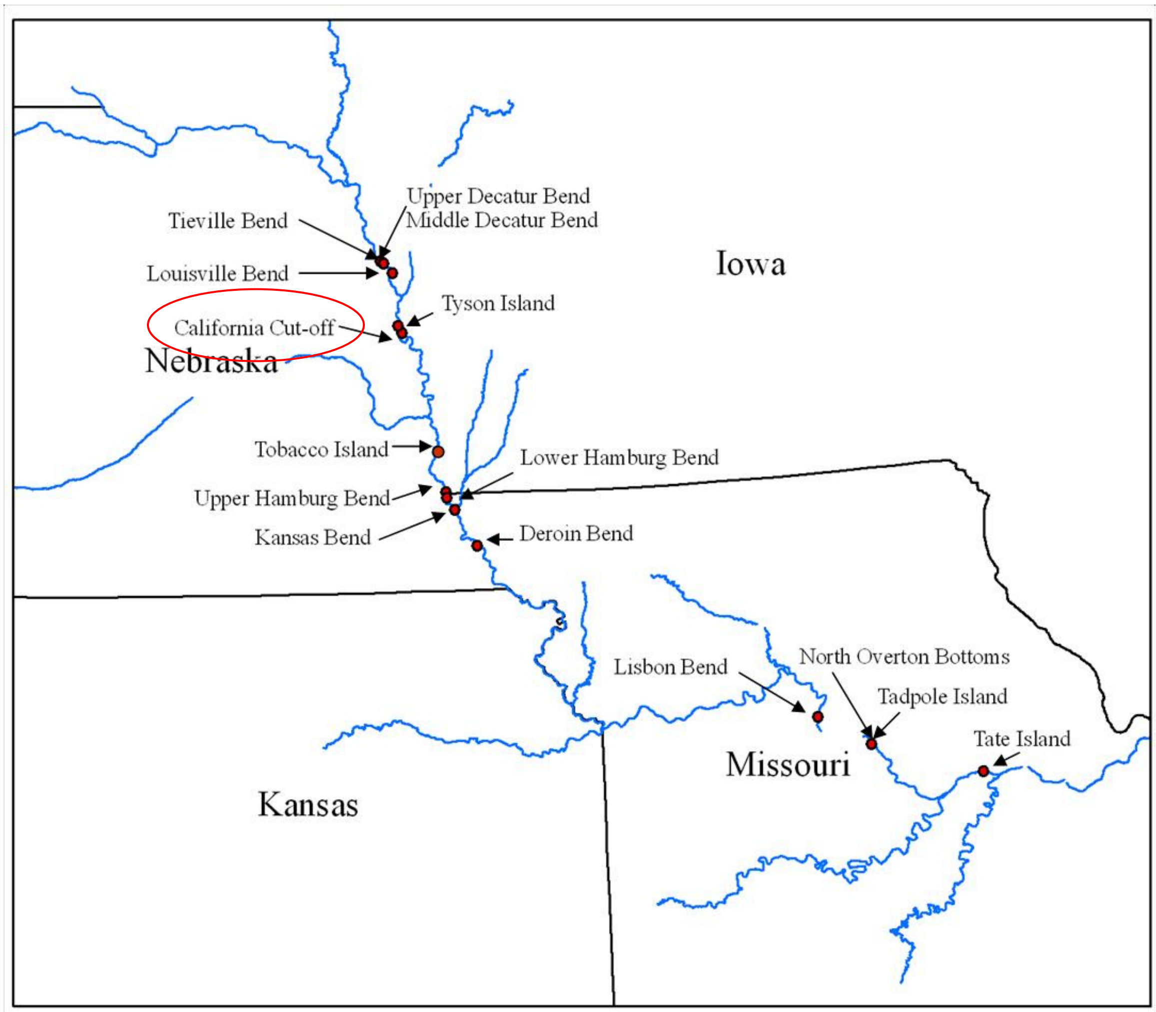


Figure II.2.10. Depth-averaged velocity distribution from the High survey (55,500 cfs) at California (IA).

Section II
Chapter 3
California (NE)



List of Tables

List of Figures

California (NE)

The chute at California (NE) is located between RM 651.1 and 648.5 in Washington County, Nebraska. The site is located on the inside bend and is the larger of two chutes situated on the bend. The chute was constructed to a finished width of 61 m and has two entrances and two exits to the main river. The upper end of the chute is dominated by shallow water and sandy substrate. The lower end of the chute is deeper and contains varied substrates along with large woody debris. As of 2008 little bank-line movement had been noted.

The chute also contains two tie-channels connecting the mid-section of the chute to the main river channel. In 2006 both tie channels contained water for the majority of the summer. High flow events in 2007 and 2008 deposited large amounts of sediment in these tie-channels (along with bar areas at both entrances). Currently both tie-channels are dry except during periods of high water.

Topographic Survey

A topographic survey of the chute at California (NE) was completed on 21 December 2005. At the time of the survey water levels were low enough to allow surveying of the stream bed in the upper half of the chute. The completed survey is shown in Figures II.3.1 and II.3.2. Significant sedimentation has occurred in both tie-channels since the time of the survey and elevations in these areas are no longer accurate. The locations of banklines from the 2005 survey and also from 2006 and 2008 aerial photography are shown in Figures II.3.3 and II.3.4. Bankline movement has been minimal at the site except for a large area of sloughing at the midpoint of the chute.

During the high water event in the spring of 2008 a large portion of the outside bank sloughed into the chute, subsequent attempts to repair the bank with rock also sloughed into the chute. Figures II.3.5-II.3.7 show a close-up of the area from 2008 aerial photography (NAIP) and photographs taken by NGPC crews in 2008.

Depth and Velocity Surveys

Three surveys for depth and velocity were conducted at California Cut-off (NE) from 2006 - 2008. Table II.3.1 shows the survey date, relative water stage, mean depth and mean depth-averaged velocity. The first survey was conducted on 23 August 2006 and will be referred to as the Mid survey. Discharges for the main channel were 32,000 cfs at the Omaha gage station. The second survey was conducted on 15 March 2007 at bankful conditions and will be referred to as the High survey. Discharges at the Omaha gage station were 55,500 cfs. The third survey was conducted on 28 July 2008 and will be referred to as the Low survey. Discharges at the Omaha gage station were 29,400 cfs at the time of the survey.

The average depth for the Low survey was 1.3 m (Table II.3.1) and the maximum depth was 5.2 m (Figure II.3.8). Sixty-four percent of depths were less than 1.5 m and 99% were less than 3.7 m (Figure II.3.8). The average velocity during the survey was 0.56 m/s (Table II.3.1) and the maximum was 1.39 m/s. Ninety-one percent of velocities were less than 0.76 m/s and 99.5% were less than 1.0 m/s (Figure II.3.9). Distribution of depths (Figures II.3.10-11) and depth-averaged velocities (Figures II.3.12-13) are shown for the Low survey at California (NE).

The average depth during the Mid survey was 2.1 m (Table II.3.1) and the maximum depth was 3.7 m (Figure II.3.8). Ninety-six percent of depths were between 1.5 m and 3.7 m (Figure II.3.8). The average velocity during the survey was 0.67 m/s (Table II.3.1) and the maximum velocity was 1.69 m/s (Figure II.3.9). Ninety-eight percent of velocities were less than 1.0 m/s and 69% percent were less than 0.76 m/s (Figure II.3.9). The distribution of depths (Figures II.3.14-15) and depth-averaged velocities (Figures II.3.16-17) are shown for the Mid survey at California (NE).

The average depth for the High survey was 3.4 m (Table II.3.1) and the max depth was 5.4 m (Figure II.3.8). Forty-two percent of depths were greater than 3.7 m and 99.3% were greater than 1.5 m (Figure II.3.8). The average velocity during the survey was 0.73 m/s (Table II.3.1) and the maximum velocity measured was 1.68 m/s (Figure II.3.9). Eighty-two percent of velocities were less than 1.0 m/s and 49% were less than 0.76 m/s (Figure II.3.9). Figures II.3.18 and II.3.19 show depth data and Figures II.3.20 and II.3.21 show velocity data for the High survey. The distribution of depths (Figures II.3.18-19) and depth-averaged velocities (Figures II.3.20-21) are shown for the High survey at California (NE).

We compared depth frequency distributions and depth-averaged velocity frequency distributions between surveys using a Kolmogorov-Smirnov (KS) test and found differences between all surveys for both depth and depth averaged velocity (Table II.3.2). We compared mean depth using analysis of variance (ANOVA) and found differences among the group ($F = 3394.50$, $p < 0.0001$) and all pairwise comparisons (Table II.3.3). A comparison of depth-averaged velocities also showed differences among the group ($F = 333.38$, $p < 0.0001$) and all pairwise comparisons (Table II.3.3).

Sediment

A sediment survey was conducted on 10 June 2008. Discharges at the Omaha gage station were 53,000 cfs. Three classes of sediment were defined at the site: sand, sand/silt, and rock or rough bottom. Sand and silt/sand mixtures were the dominant substrates (Figures II.3.22 and II.3.23). A sand substrate exists at the majority of the site with a hard sand bottom in areas with relatively high velocities and a sand/silt mixture occurring near bank lines and in other areas with relatively low velocities (Figures II.3.22 and II.3.23). Some boulder substrate occurs at the entrance and exits of the chute where rock was placed to prevent erosion (Figures II.3.22 and II.3.23).

Summary

Our surveys show that even during high water events California (NE) provides a refuge with slow moving water (at least 82% of velocities under 1.0 m/s) (Figure II.3.9). In the upper half of the chute we found low velocities associated with shallow water, a combination that is missing in the main channel (Hesse and Mestl 1993).

The upper one-half of the chute is an area of very shallow, slow moving water. Some sand bar formation has occurred since the completion of our surveys. Little morphological evolution has occurred in the lower one-half of the chute. No bar formation has occurred and no defined channel has been established. A minimal amount of bank line erosion has occurred in the lower portions of the chute.

Sand is the dominant substrate throughout the chute. Areas of silt occur, but only in areas near the bank line where velocities are slowed. Areas that contained silt (tie-channels) have been filled in by sediment deposited during high water events. Rock occurs in areas where it has been placed to armor the bank line.

Key features:

- Slow velocities
- Sandy substrate
- Banks are sand
- Little large woody debris
- Some rock substrate
- Two entrances
- Two exits
- Tie channels (high sedimentation- rarely hold water)
- Dug to finished width – little bankline movement

Recommendations for Modification:

- Remove sediment from tie-channels or redesign tie channels to promote flowing water to reduce sedimentation
- Introduce large woody debris

Table II.3.1. List of survey dates for California (NE) and relative stage with mean depth and mean depth-averaged velocity for each relative stage.

Survey Date	Discharge (cfs)	Stage	Mean Depth (m)	Mean Depth-averaged Velocity (m/s)
23 August 2006	32,000	Mid	2.1	0.67
15 March 2007	55,500	High	3.4	0.73
28 July 2008	29,400	Low	1.3	0.56

Table II.3.2. Results of Kolmogorov-Smirnov tests for differences in distributions between surveys. Results are significant at a Bonferonni adjusted p-value of 0.033 (alpha = 0.10).

	Depth		Depth-averaged velocity	
Survey	D	p-value	D	p-value
Low vs. Mid	0.54	<0.0001	0.45	<0.0001
Low vs. High	0.87	<0.0001	0.54	<0.0001
Mid vs. High	0.71	<0.0001	0.38	<0.0001

Table II.3.3. Results of pairwise tests (ANOVA) of mean depth and mean depth-averaged velocity. Results are significant at a Bonferonni adjusted p-value of 0.033 (alpha = 0.10).

	Depth		Depth-averaged velocity	
Survey	D	p-value	D	p-value
Low vs. Mid	-28.02	<0.0001	-17.55	<0.0001
Low vs. High	80.64	<0.0001	25.34	<0.0001
Mid vs. High	50.55	<0.0001	6.65	<0.0001

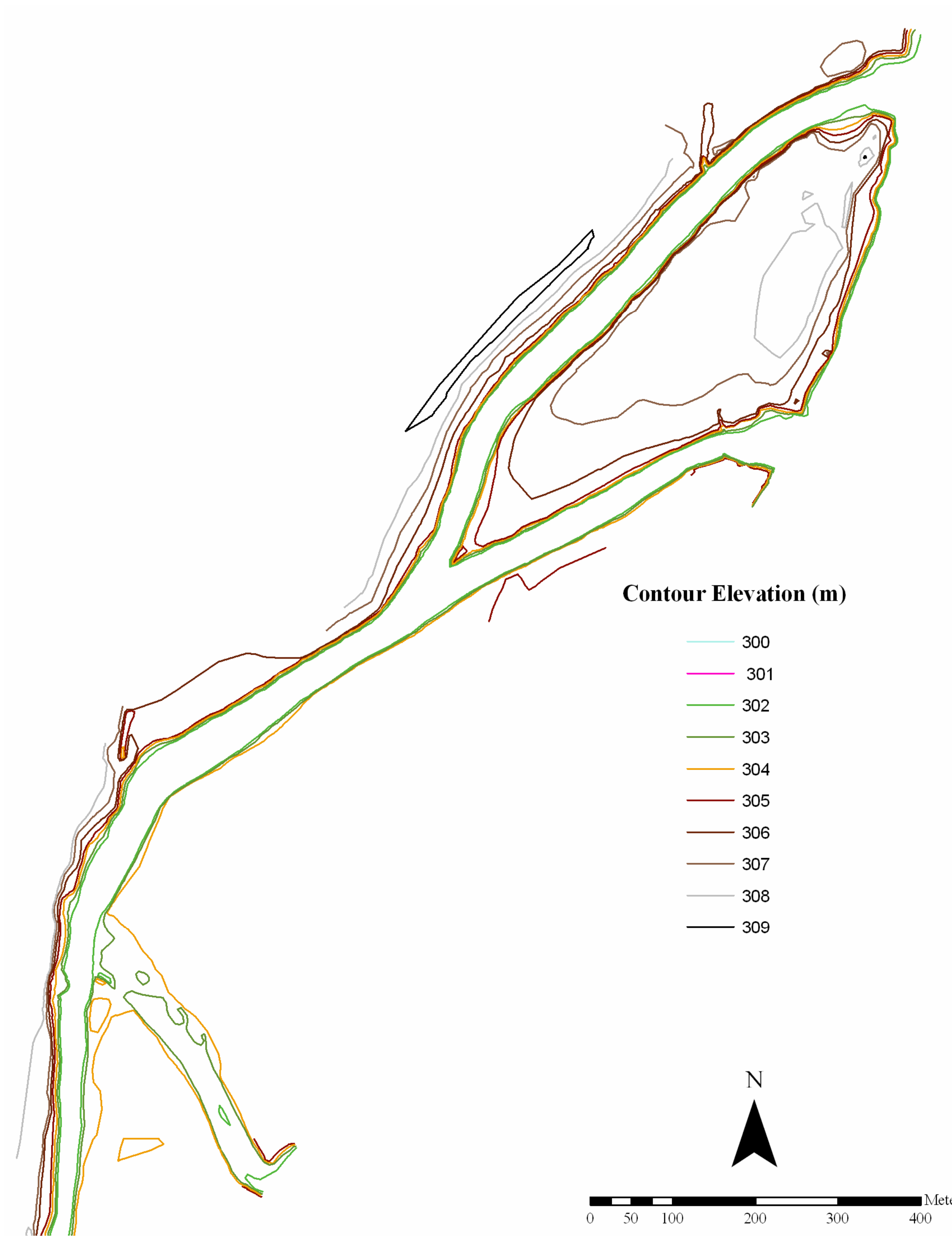


Figure II.3.1. Topographic survey of the upper half of California (NE).

Figure II.3.2. Topographic survey of the lower half of California (NE).

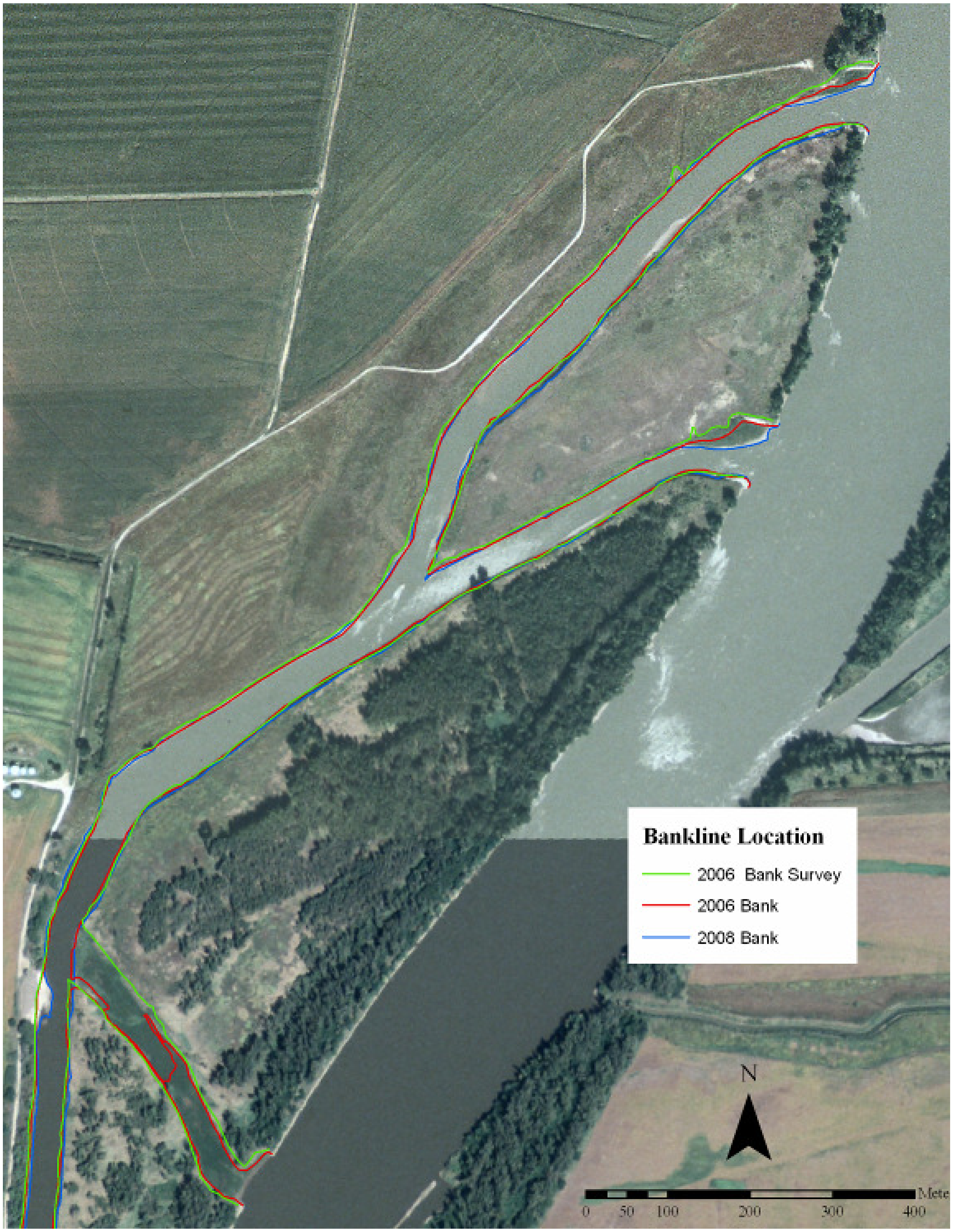


Figure II.3.3. Aerial photograph of the upper half of California (NE) with bankline locations from 2006 and 2008 aerial photography and the 2006 topographic survey.

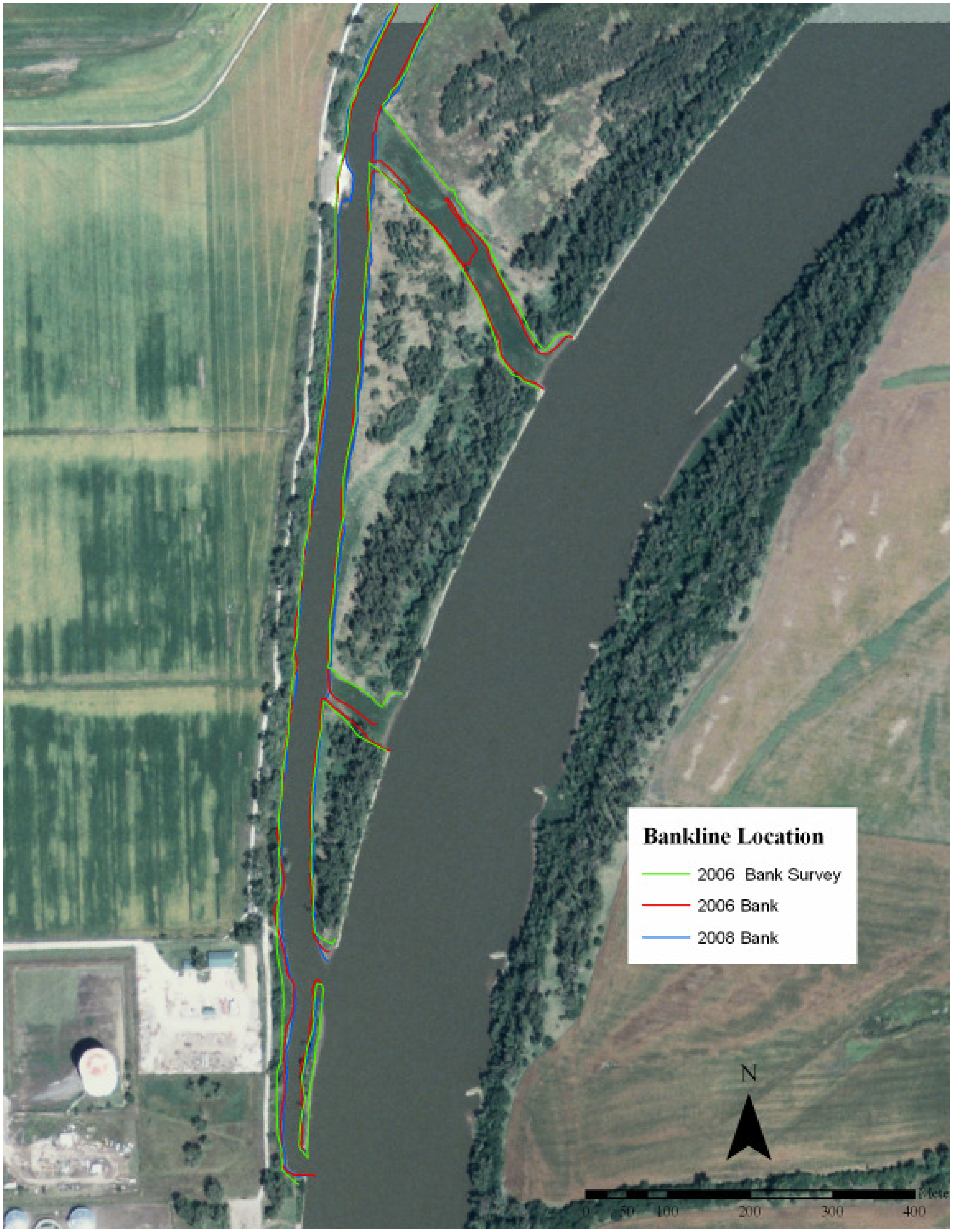


Figure II.3.4. Aerial photograph of the lower half of California (NE) with bankline locations from 2006 and 2008 aerial photography and the 2006 topographic survey.

Figure II.3.5. Close up of sloughed bank with bankline locations from 2006 topographic survey and 2008 aerial photography.

Figure II.3.6.   Photograph from July, 2008 of sloughed bank looking downstream.

Figure II.3.7. Photograph from July, 2008 of sloughed bank looking upstream.

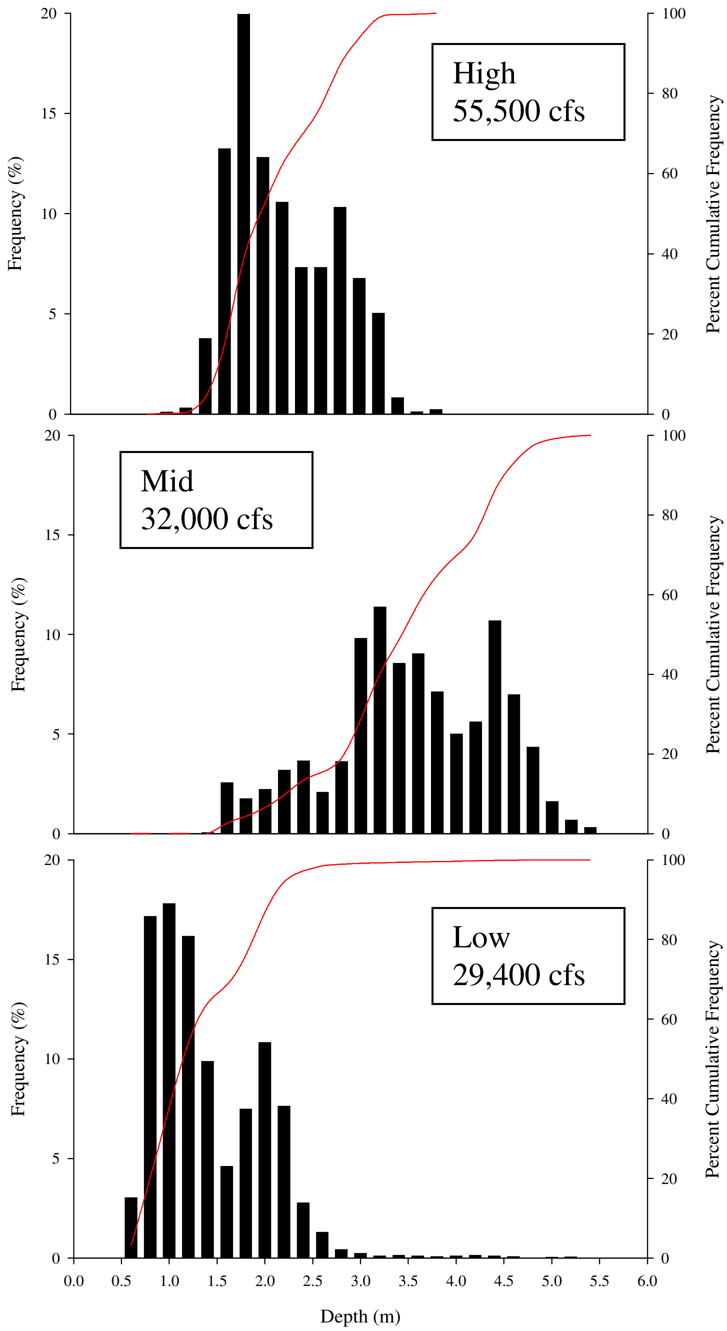


Figure II.3.8. Depth frequency and cumulative frequency distributions at California (NE) for all three Doppler surveys.

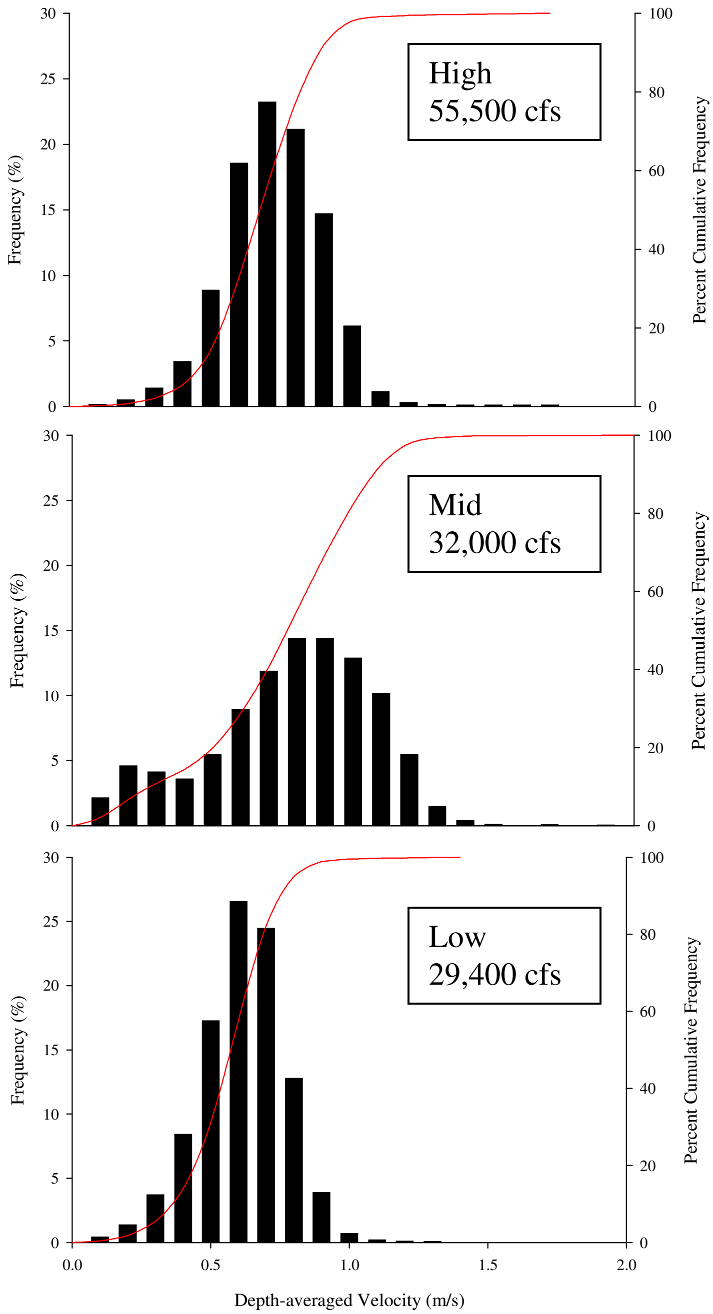


Figure II.3.9. Depth-averaged velocity frequency and cumulative frequency distributions at California (NE) for all three Doppler surveys.

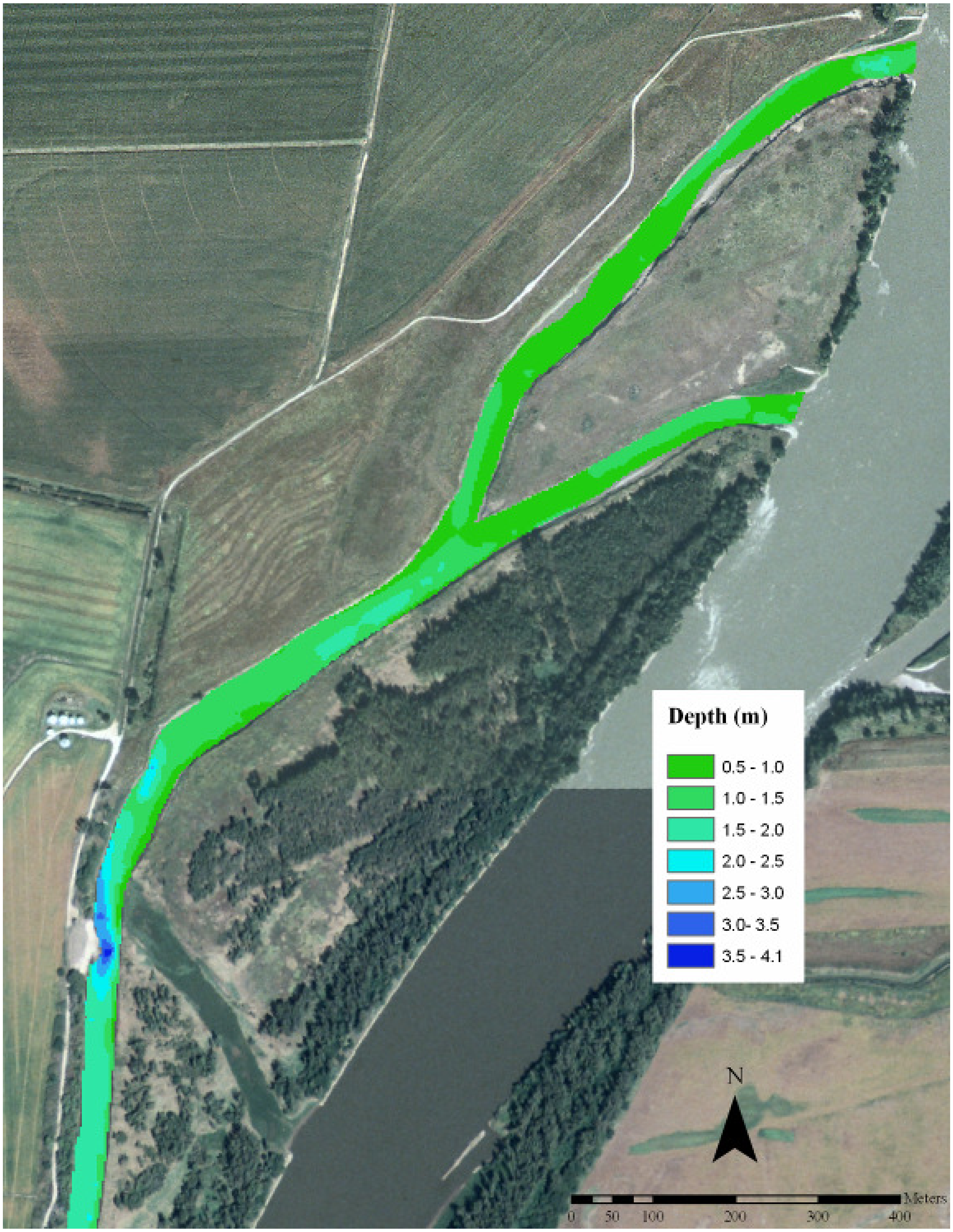


Figure II.3.10. Depth distribution from the Low survey (29,400 cfs) for the upper half of California (NE).

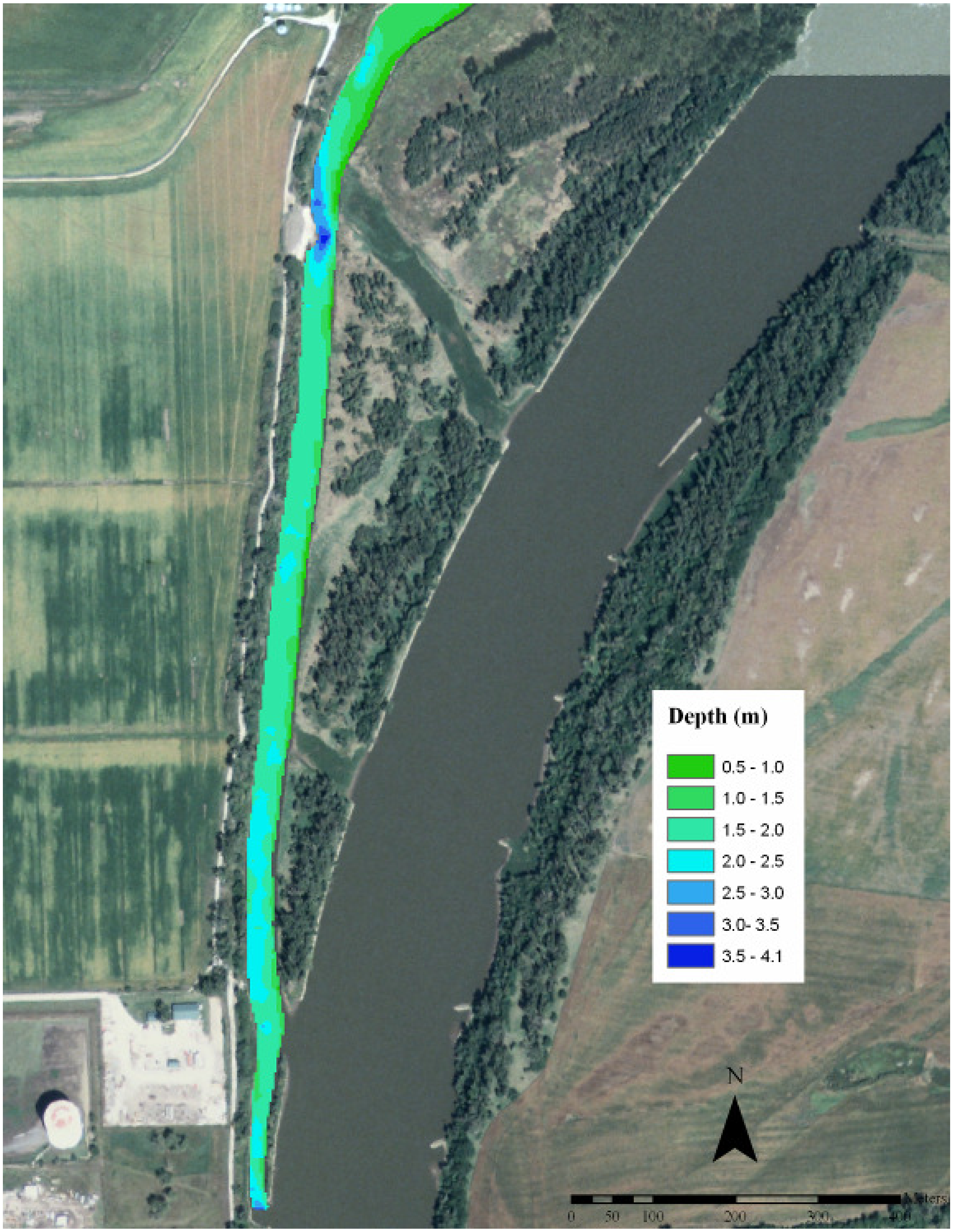


Figure II.3.11. Depth distribution from the Low survey (29,400 cfs) for the lower half of California (NE).

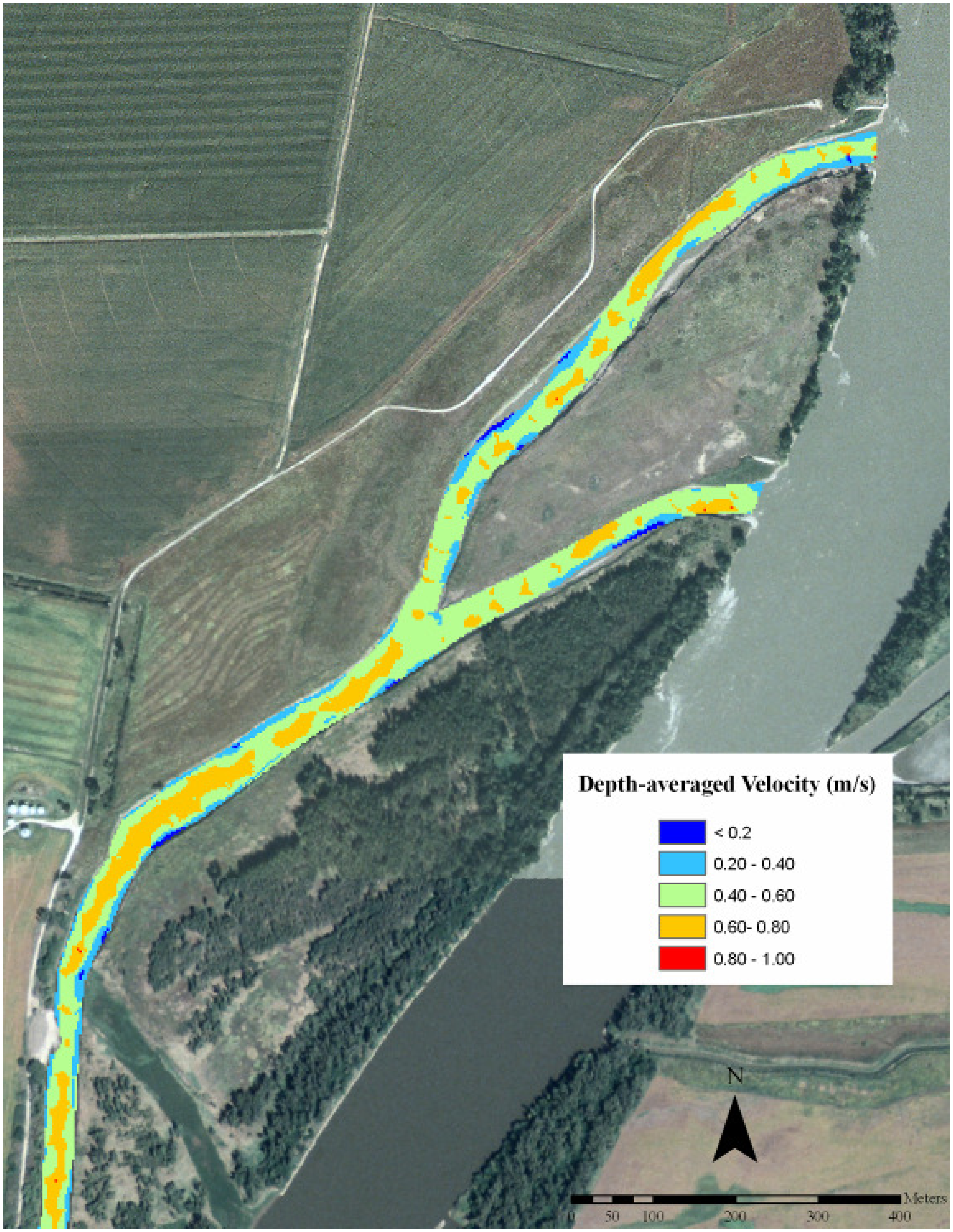


Figure II.3.12. Depth-averaged velocity distribution from the Low survey (29,400 cfs) for the upper half of California (NE).

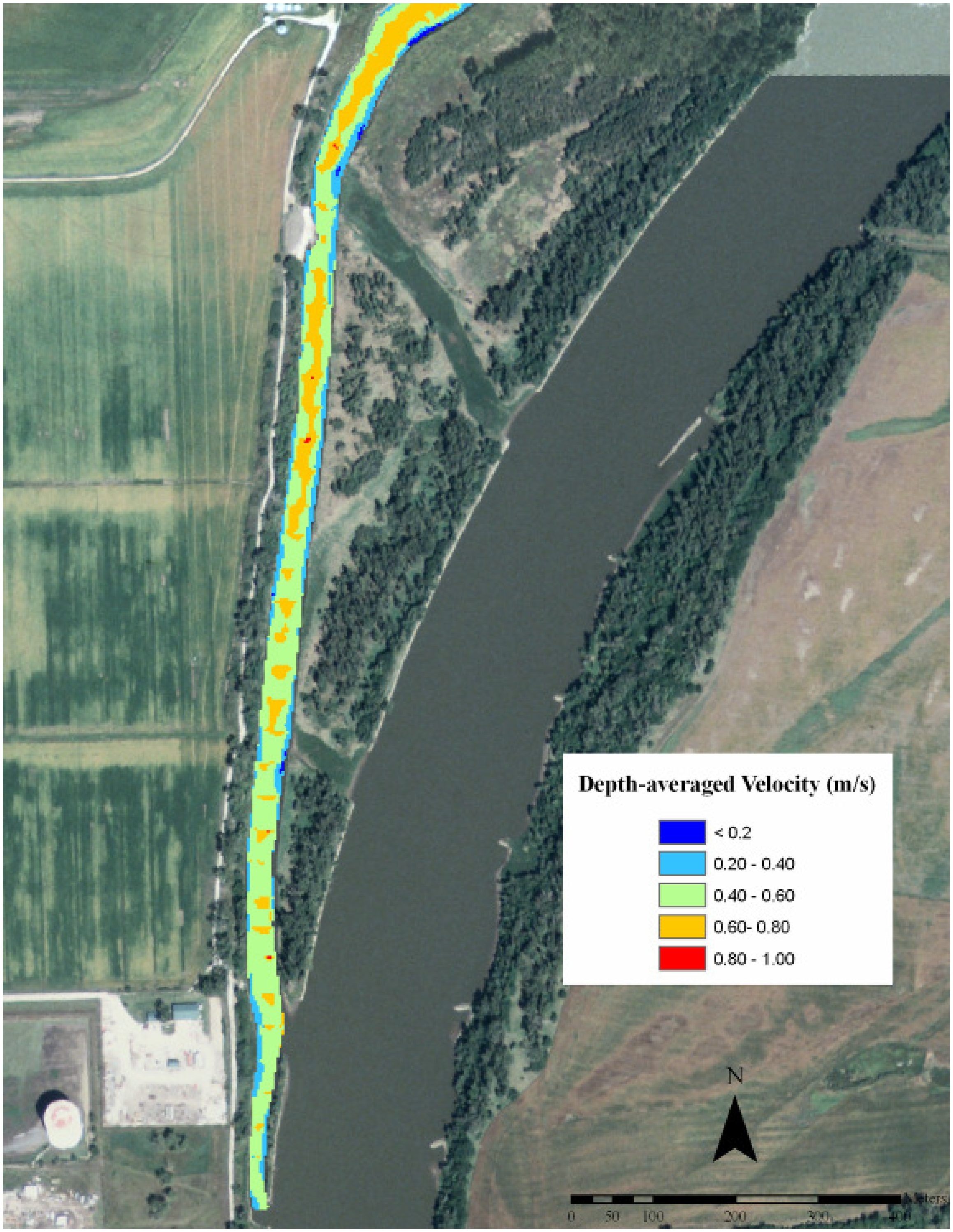


Figure II.3.13. Depth-averaged velocity distribution from the Low survey (29,400 cfs) for the lower half of California (NE).

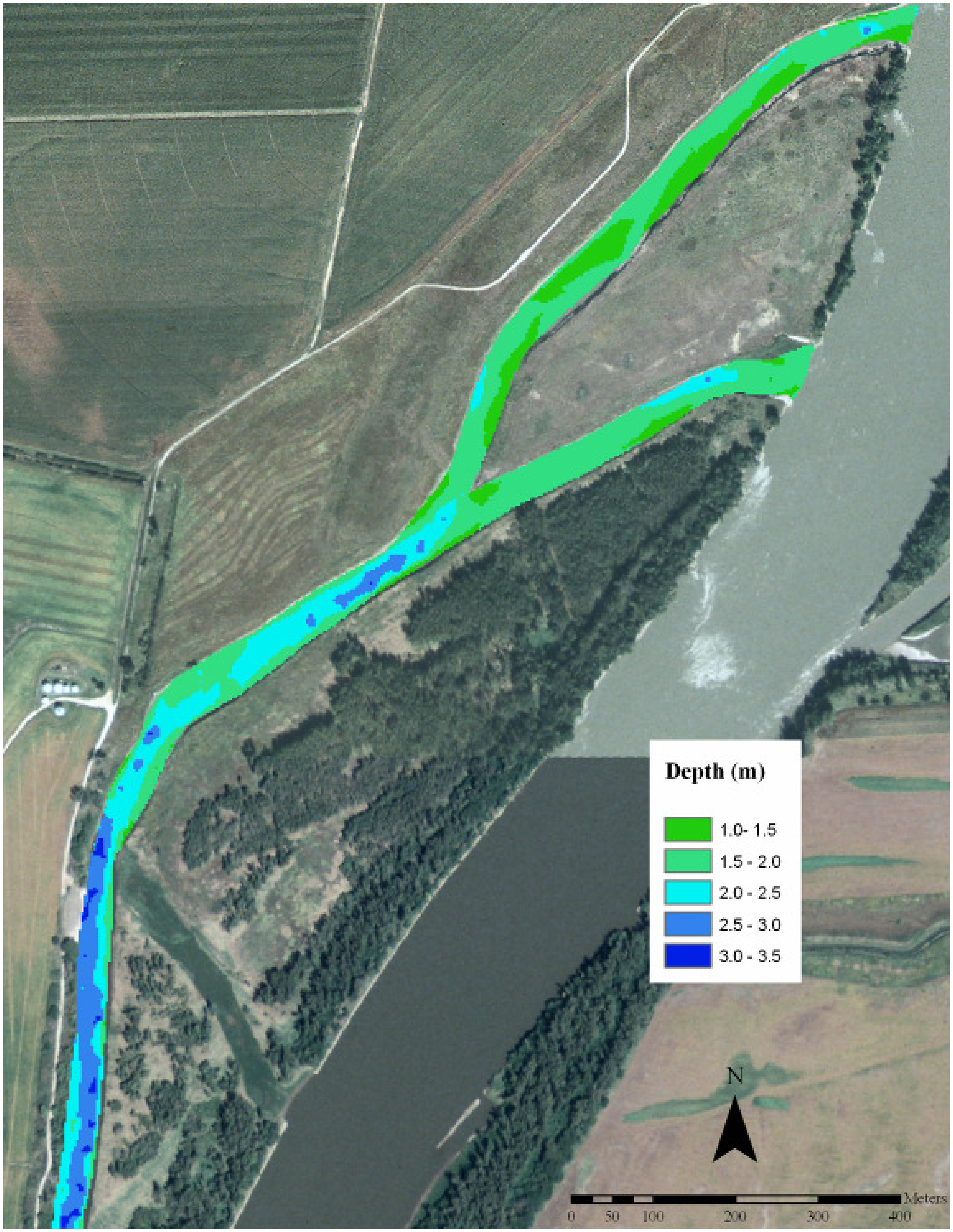


Figure II.3.14. Depth distribution from the Mid survey (32,000 cfs) for the upper half of California (NE).

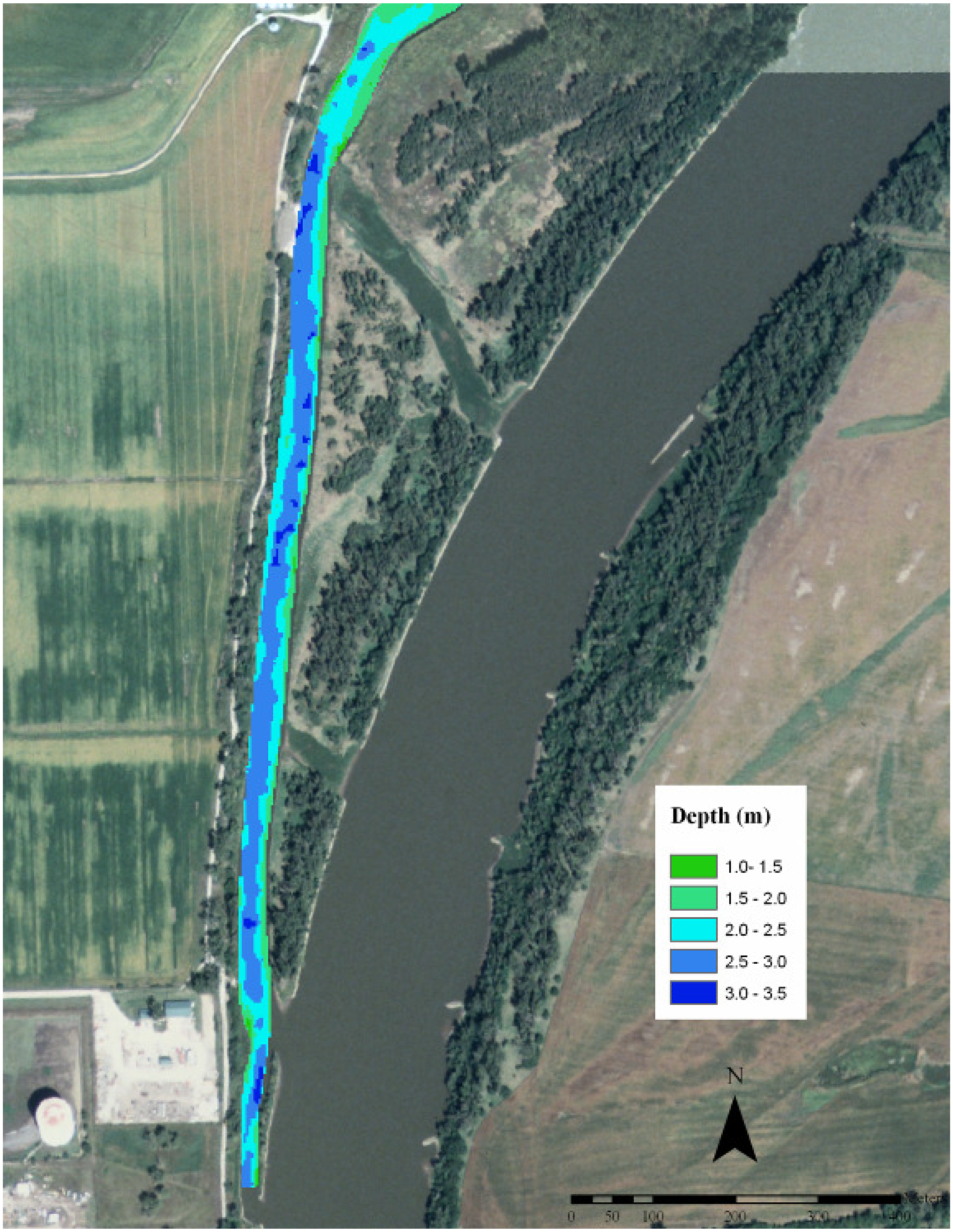


Figure II.3.15. Depth distribution from the Mid survey (32,000 cfs) for the lower half of California (NE).

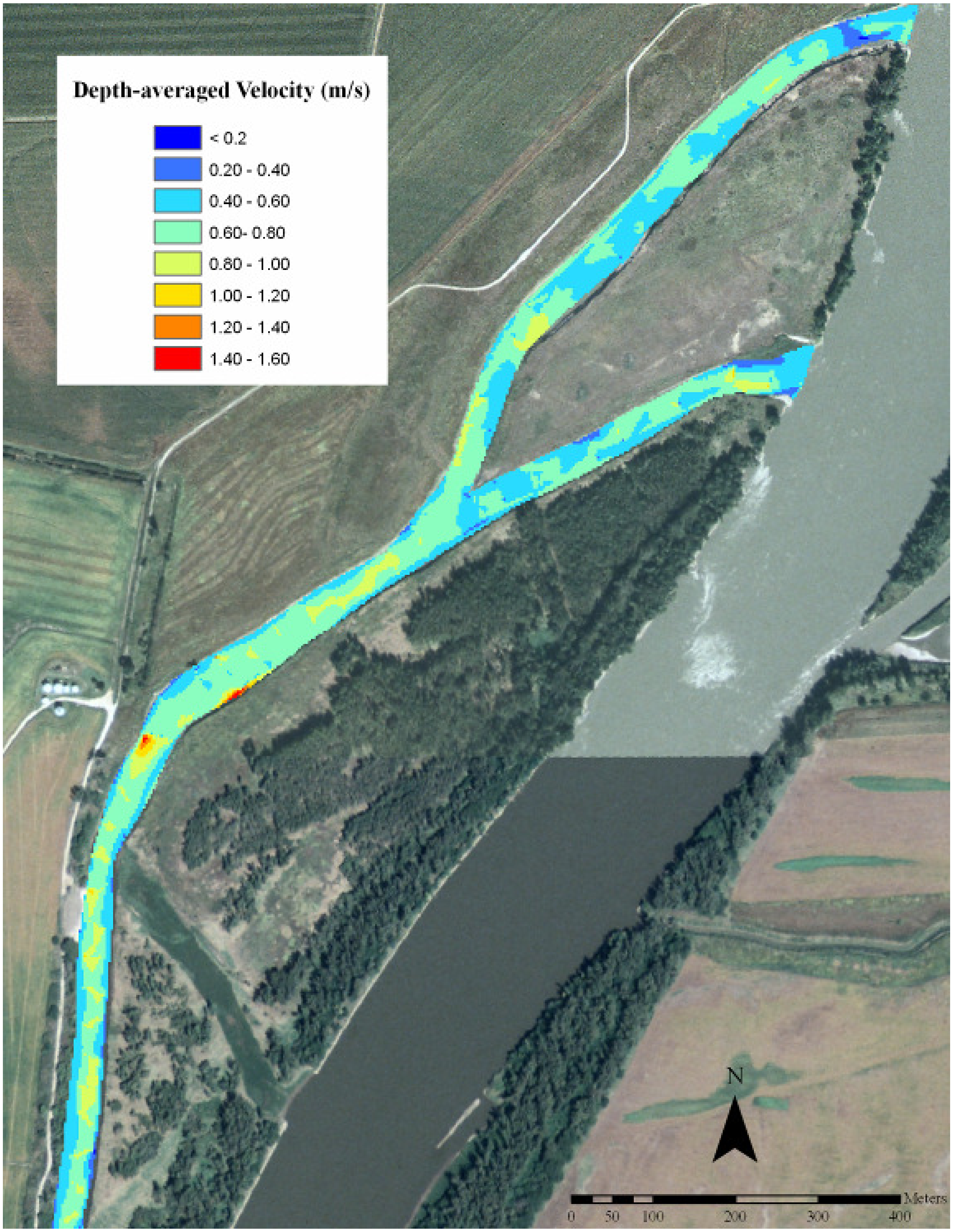


Figure II.3.16. Depth-averaged velocity distribution from the Mid survey (32,000 cfs) for the upper half of California (NE).

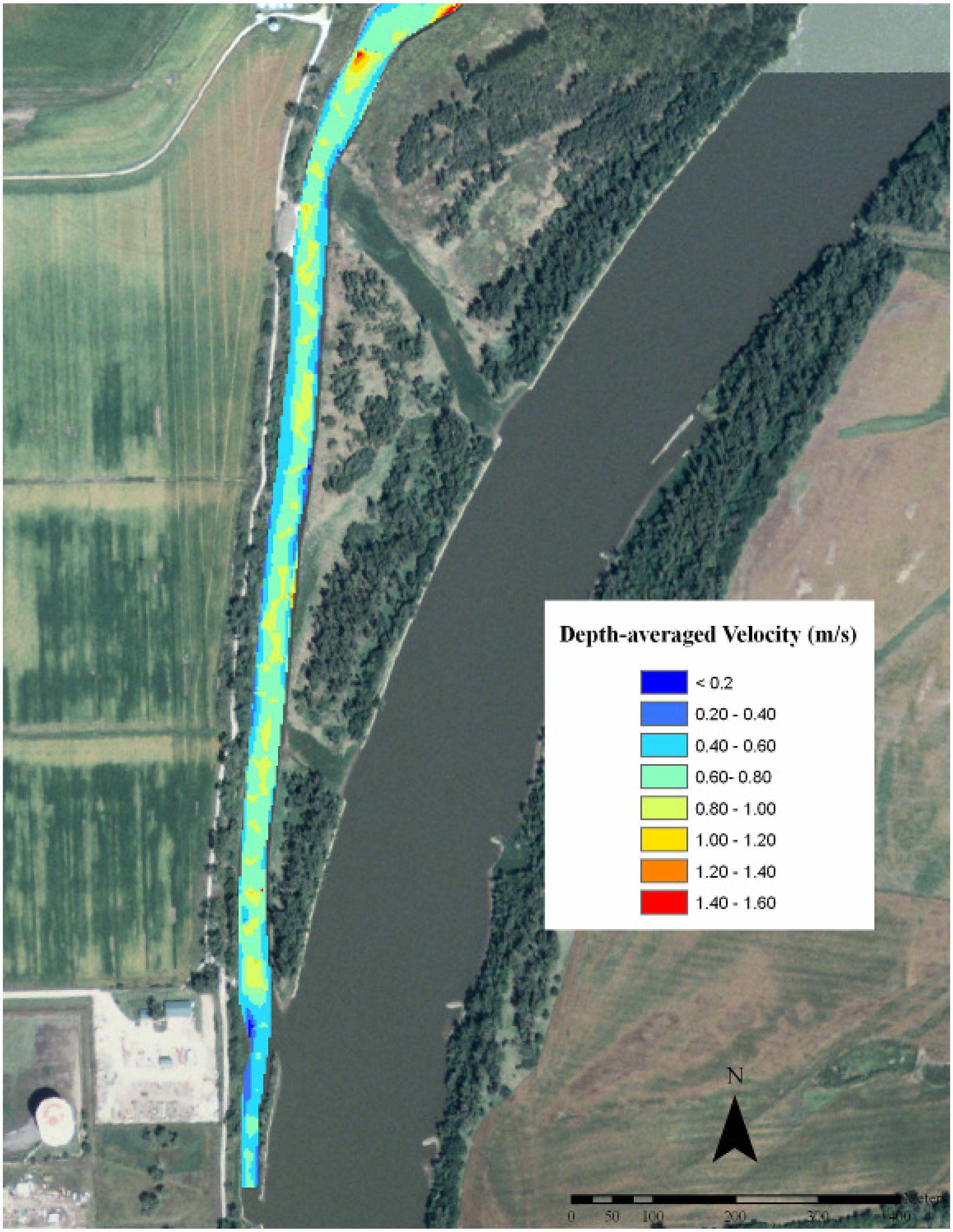


Figure II.3.17. Depth-averaged velocity distribution from the Mid survey (32,000 cfs) for the lower half of California (NE).

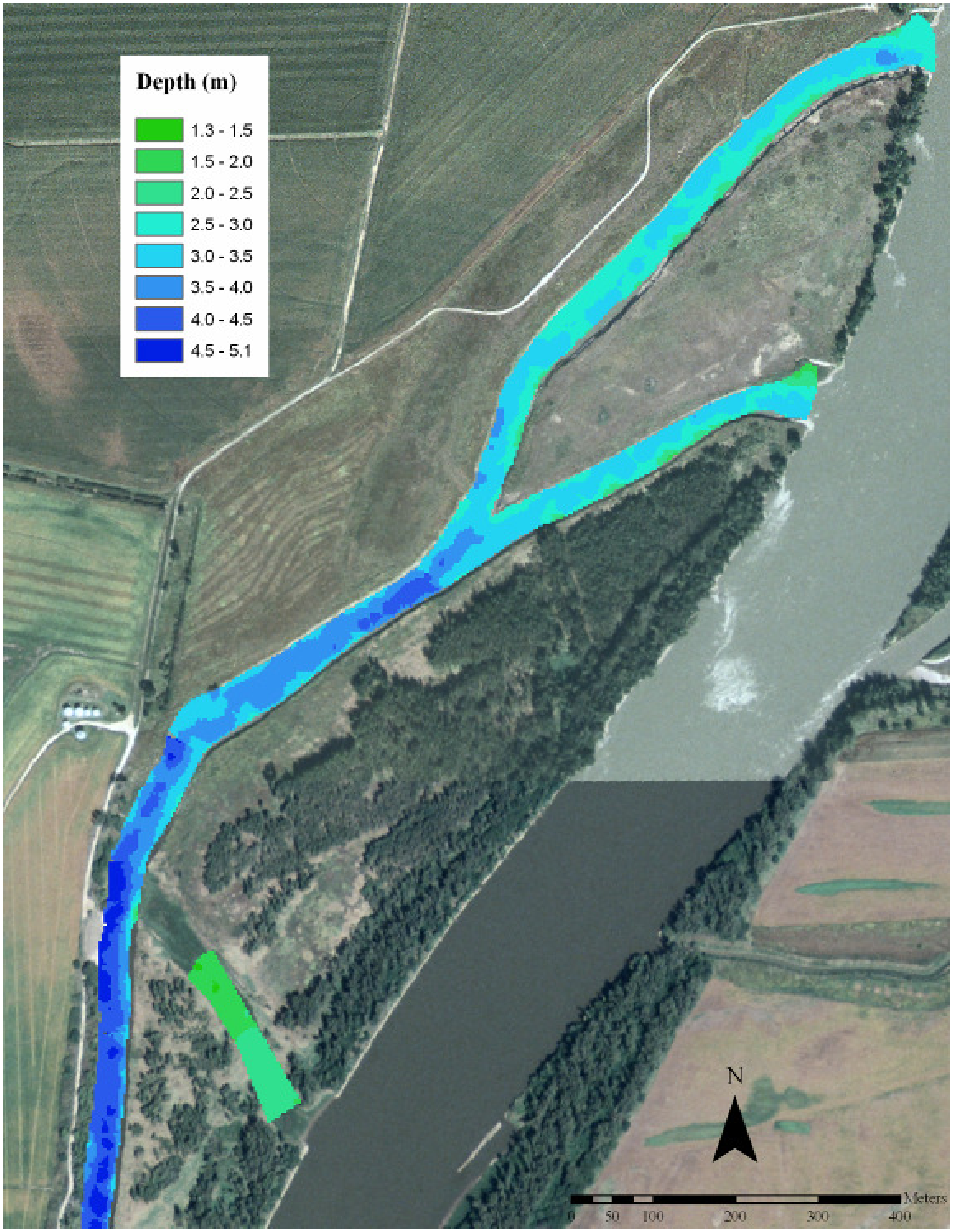


Figure II.3.18. Depth distribution from the High survey (55,500 cfs) for the upper half of California (NE).

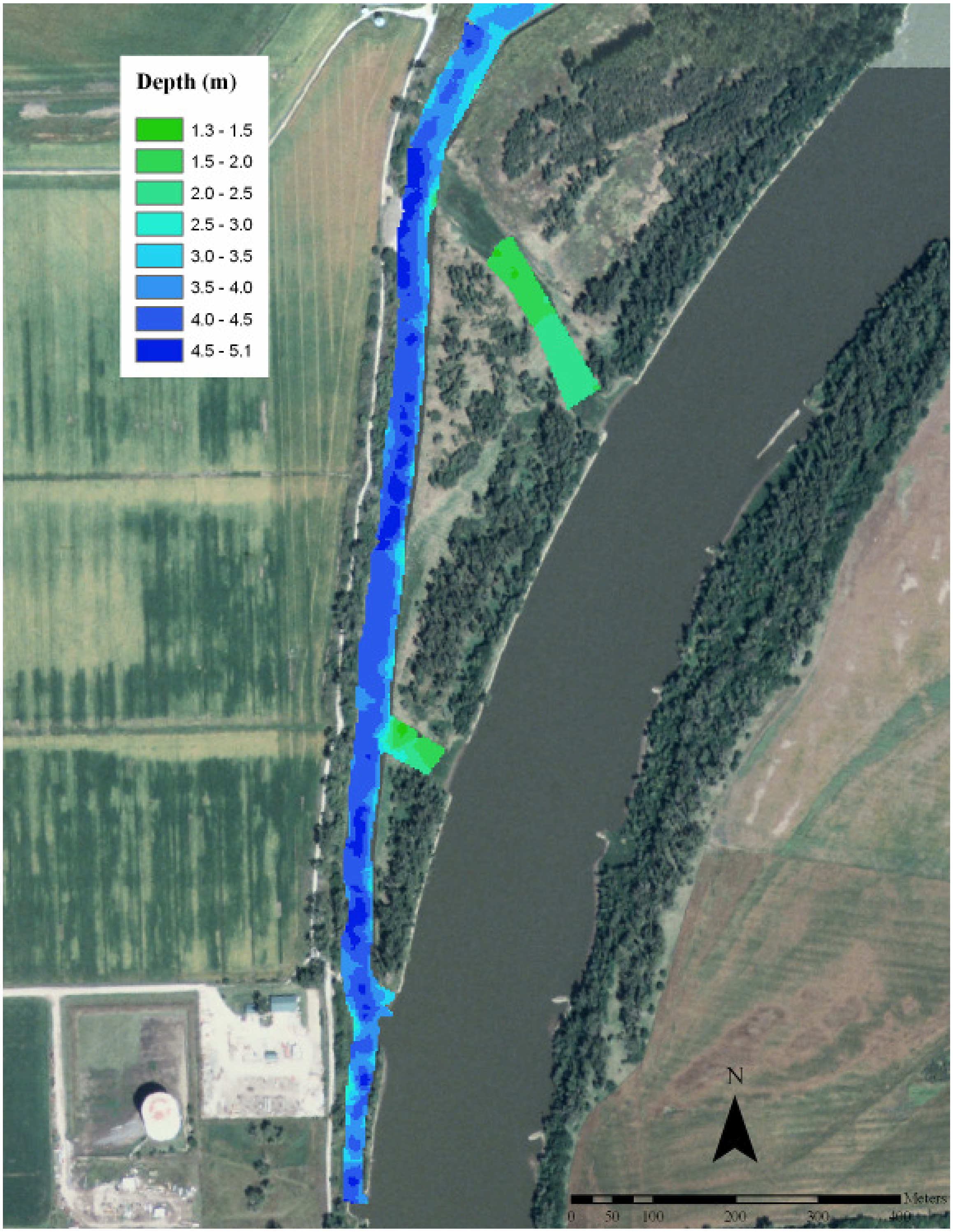


Figure II.3.19. Depth distribution from the High survey (55,500 cfs) for the lower half of California (NE).

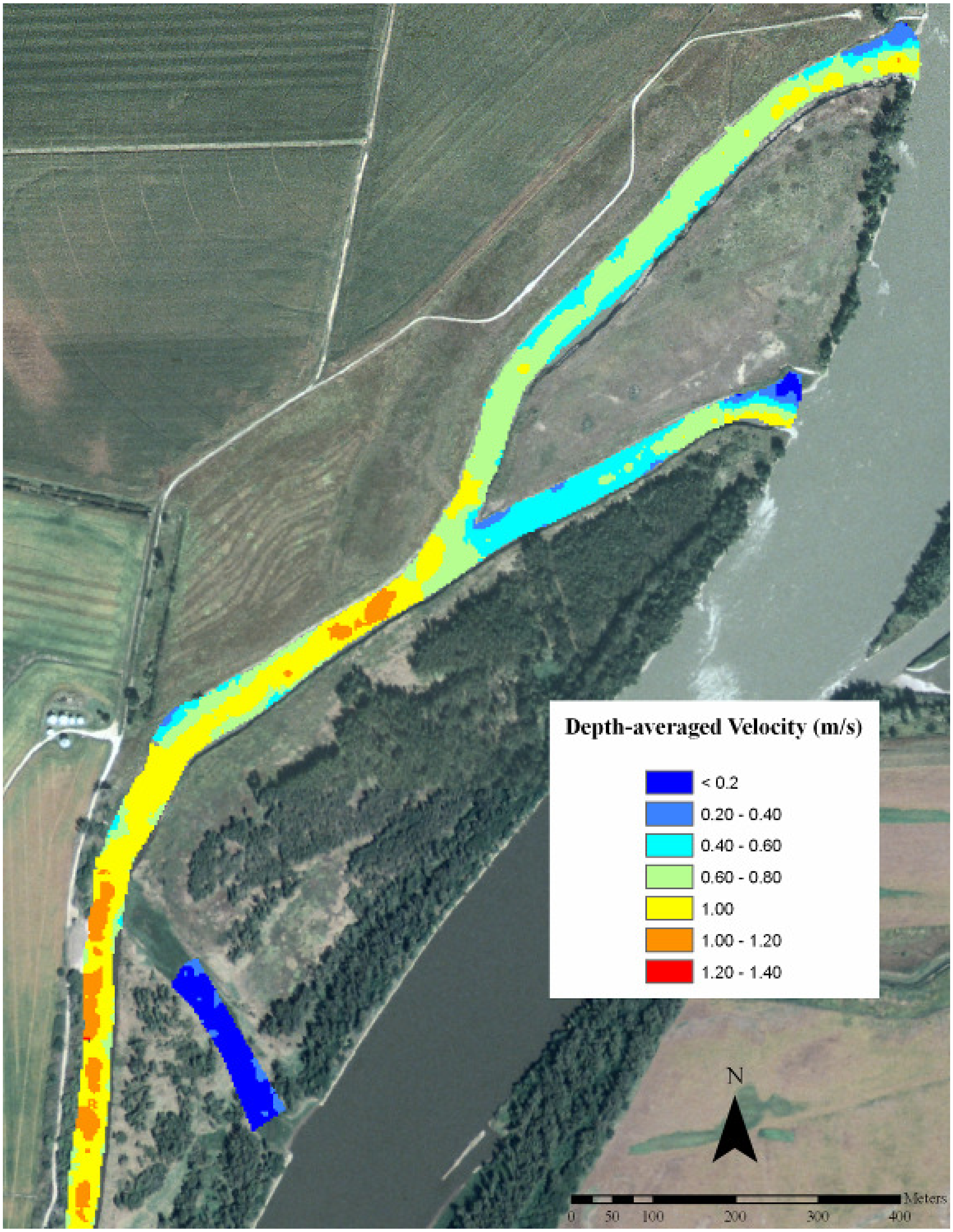


Figure II.3.20. Depth-averaged velocity distribution from the High survey (55,500 cfs) for the upper half of California (NE).

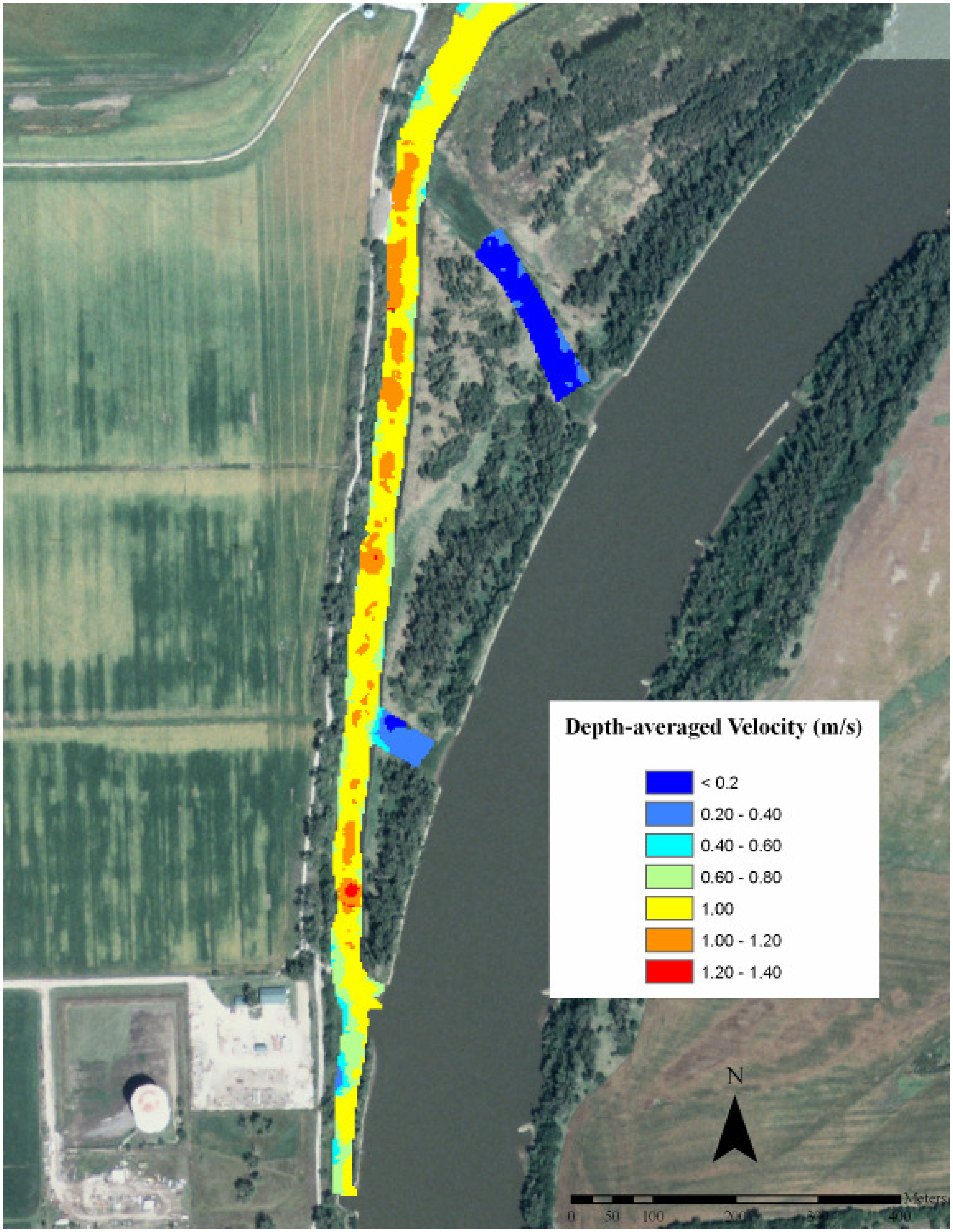


Figure II.3.21. Depth-averaged velocity distribution from the High survey (55,500 cfs) for the lower half of California (NE).

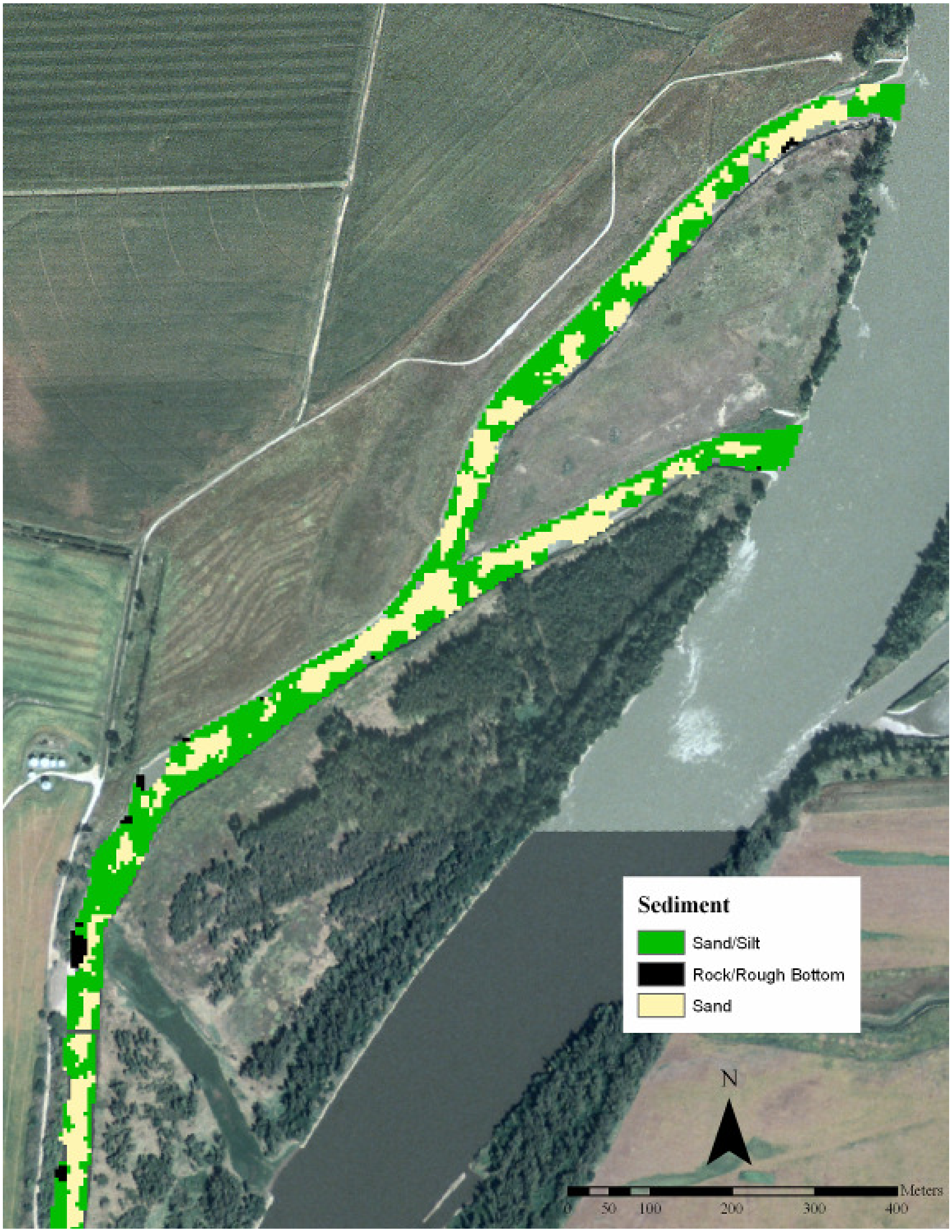


Figure II.3.22. Sediment distribution for the upper half of California (NE).

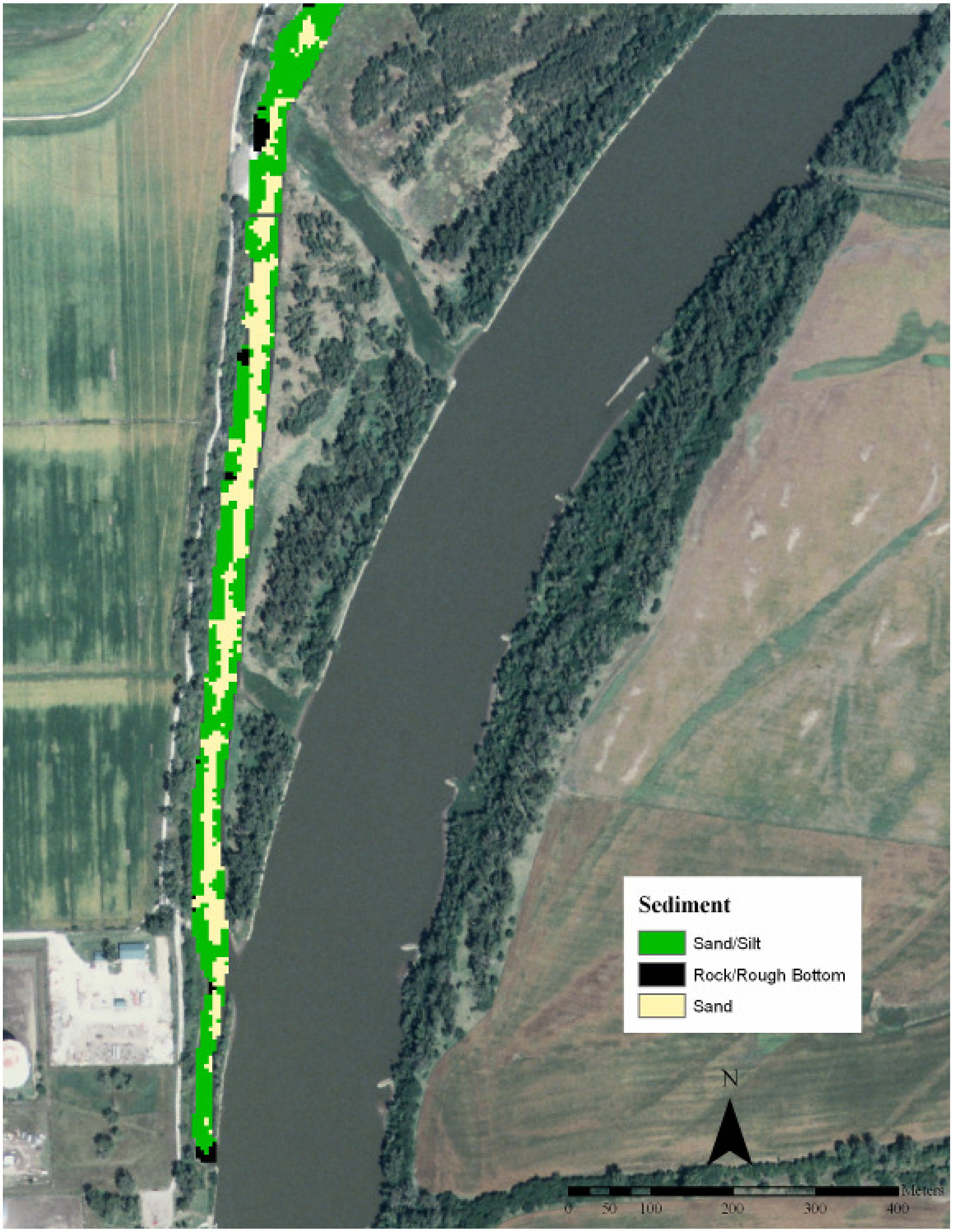
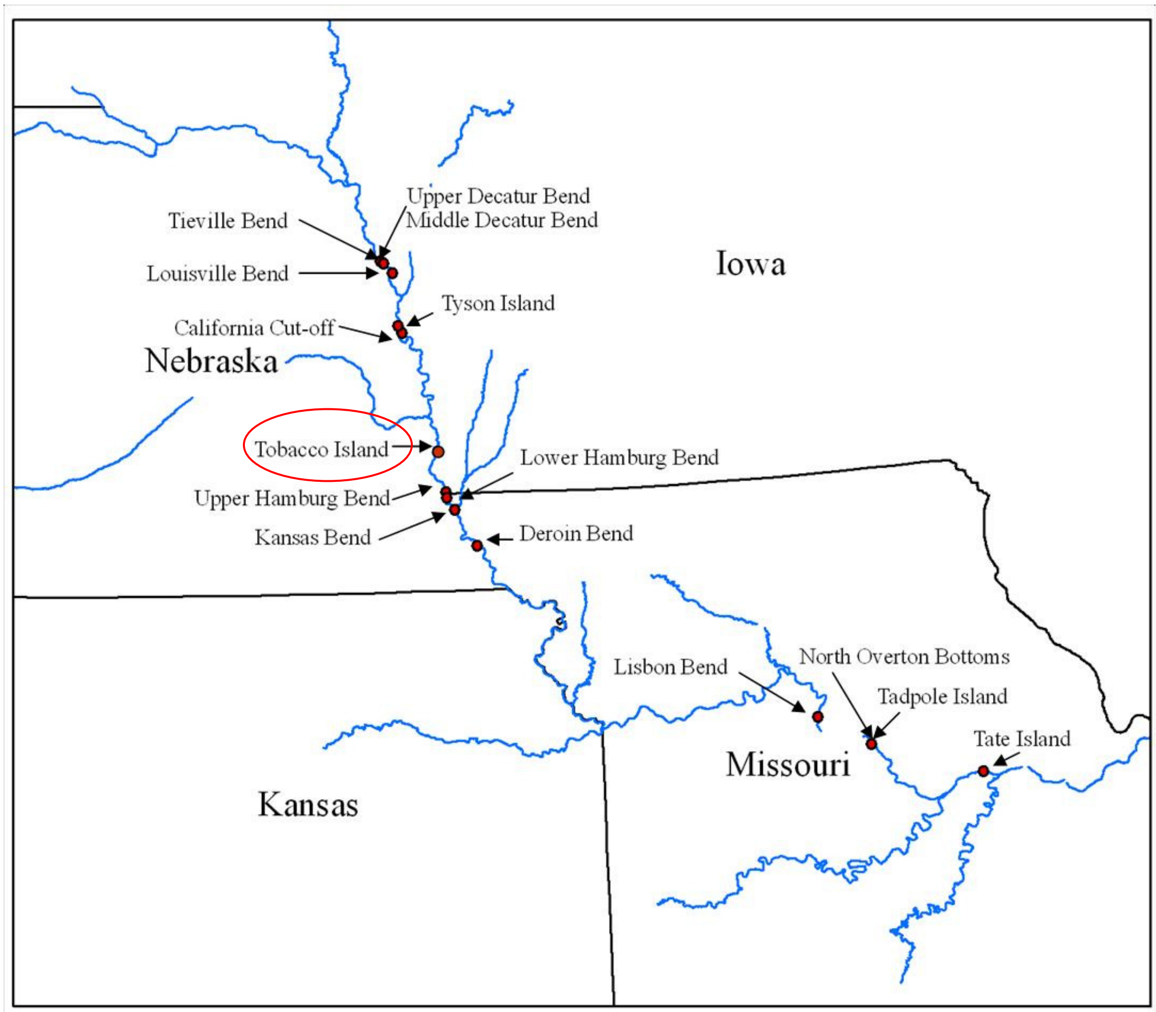


Figure II.3.23. Sediment distribution for the lower half of California (NE).

Section II
Chapter 4
Tobacco Island



List of Figures

Tobacco Island

Tobacco Island is located between RM 589.0 and 586.3 in Cass County, Nebraska. The chute is located on a site that historically contained side-channels. The current side-channel was re-opened in 2001 as a 3.05 m wide pilot channel. The 4,750 m long site is characterized by shallow water and slow water velocities. The site is a nearly uniform "U" shaped channel with high, steep banks. Two wide, shallow areas containing grade control structures occur at one-third and two-thirds of the chute's length. These areas initially contained the only sandbar habitat at the site. During high flow events in 2007 and 2008 these sites were silted in and no longer contain the shallow sand bars that previously existed. Erosion has widened the chute to approximately 15 m. The site was re-worked in the winter of 2007-2008 in an attempt to increase flows and bank erosion; more work is scheduled to take place in 2009.

Topographic Survey

A topographic survey of Tobacco Island was initiated on 24 January 2006 and completed on 30 January 2006. The completed topographic survey shows a narrow channel with steep banks (Figures II.4.1-4). The location of banklines in 2003 (from aerial survey), 2006 and 2009 (from topographic surveys) are shown in Figures II.4.5-8. High flow events in 2007 and 2008 significantly altered the morphology of the top 1/8 of the chute (Figure II.4.5). Lateral bank movement of up to 15 m was documented in the 2009 survey. These events were also responsible for large deposits of sediment at the entrance of the chute. Figure II.4.9 shows the sand bar at the entrance with spot

elevations from surveys in 2006 and 2009. Approximately 2 m of sediment has accumulated on this bar since the 2006 survey.

Depth and Velocity Survey

Three surveys for depth and velocity were conducted at Tobacco Island between 2006 and 2008. The first survey was done on 14 and 15 March 2007 and will be referred to as the High survey. Discharge at the Nebraska City gage station averaged 48,500 cfs and the chute was at bankful conditions. A second survey was conducted on 15 April 2008; this survey will be referred to as the Mid survey. Discharge at the Nebraska City gage station measured 37,500 cfs. The third survey was initiated in September 2006 at a discharge of 35,200 cfs and was completed in August of 2007 at 39,000 cfs. This survey was conducted using the StreamPro ADCP because of low water levels. Due to the length of time between surveys, varied discharges between surveys and possible channel altering flow events between surveys this survey is not included in this report. The depth frequency and cumulative frequency distributions for both surveys (Mid and High) are shown in Figure II.4.10. The depth-averaged velocity frequency and cumulative frequency distributions for both surveys are shown in Figure II.4.11.

During the Mid survey the average depth was 1.6 m (Table II.4.1) and the maximum depth was 2.5 m. Sixteen percent of depths were less than 1.5 m and 100% were less than 3.7 m (Figure II.4.10). During the Mid survey the average velocity was 0.73 m/s (Table II.4.1) and the maximum velocity was 1.57 m/s. Approximately 57% of velocities were 0.76 m/s or less and 99% of velocities were less than 1.0 m/s (Figure II.4.

11). The distribution of depths (Figures II.4.12-14) and depth-averaged velocities (Figures II.4.15-17) are shown for the Mid survey at Tobacco.

During the High survey the average depth was 2.3 m (Table II.4.1) and the maximum surveyed depth was 3.4 m. Fewer than 5% of depths were 1.5 m or less and 100% were less than 3.7 m (Figure II.4.10). The maximum velocity was 1.52 m/s and the average velocity was 0.79 m/s (Table II.4.1). Approximately 32% of velocities recorded were 0.76 m/s or less (Figure II.4.11). Eighty-two percent of velocities were less than 1.0 m/s (Figure II.4.11). The distribution of depths (Figures II.4.18-20) and depth-averaged velocities (Figures II.4.21-23) are shown for the High survey at Tobacco.

We compared surveys using a Kolmogorov-Smirnov test and found differences between depth frequency distributions ($D = 0.75$, $p < 0.0001$) and between depth-averaged velocity frequency distributions ($D = 0.35$, $p < 0.0001$). We also compared surveys and found differences between mean depths (one sample t (2010), $t = 32.53$, $p < 0.0001$) and between mean depth-averaged velocities (one sample t (2010), $t = 10.28$, $p < 0.0001$).

Sediment

A sediment survey was conducted at Tobacco Island on 21 March 2007. We were unable to process the data due to errors in GPS reception. The raw data were sent to Quester Tangent Corp and the GPS problem was fixed, however the data were not received in time to be processed for this report.

Summary

Our surveys show that even during high flow events Tobacco Island chute exhibits low flow velocities. Velocities rarely exceed 1.0 m/s. During the two boat surveys over 10,000 data points were logged, of these only six exceeded 1.5 m/s. The majority of depths occurred over small ranges in both surveys. These results indicate a chute with steep banks and little bar habitat or deep scour holes. We anticipate that more bar and scour hole habitats will develop as the chute ages. Anecdotal evidence points to some creation of bars on inside bends and scour holes at the entrance of the chute after high flow events in the spring and early summer of 2008. These high flow events were responsible for the erosion of bank-lines throughout the chute and especially at the entrance. Our 2009 survey shows bank-line movement of up to 12 m from 2006 to 2009. This indicates the potential for morphological evolution at the site.

Key features:

- Narrow
- Slow velocities
- Shallow
- Compacted soils
- Sandy substrate
- Little bankline movement
- Little large woody debris
- Steep “U” shaped banks

- Some bar formation

Recommendations for modification:

- Redesign entrance to reduce sedimentation
- Remove sediment from wide areas at grade control structures to return these areas to shallow sand bar habitat
- Increase width
- Introduce large woody debris
- Slope banks to allow large woody debris to accumulate in chute instead of on banks

Table II.4.1. List of survey dates for California (NE) and relative stage with mean depth and mean depth-averaged velocity for each relative stage.

Survey Date	Discharge (cfs)	Stage	Mean Depth (m)	Mean Depth-averaged Velocity (m/s)
15 April 2008	37,500	Mid	1.6	0.73
14 March 2007	48,500	High	2.3	0.79
NA	NA	Low	NA	NA

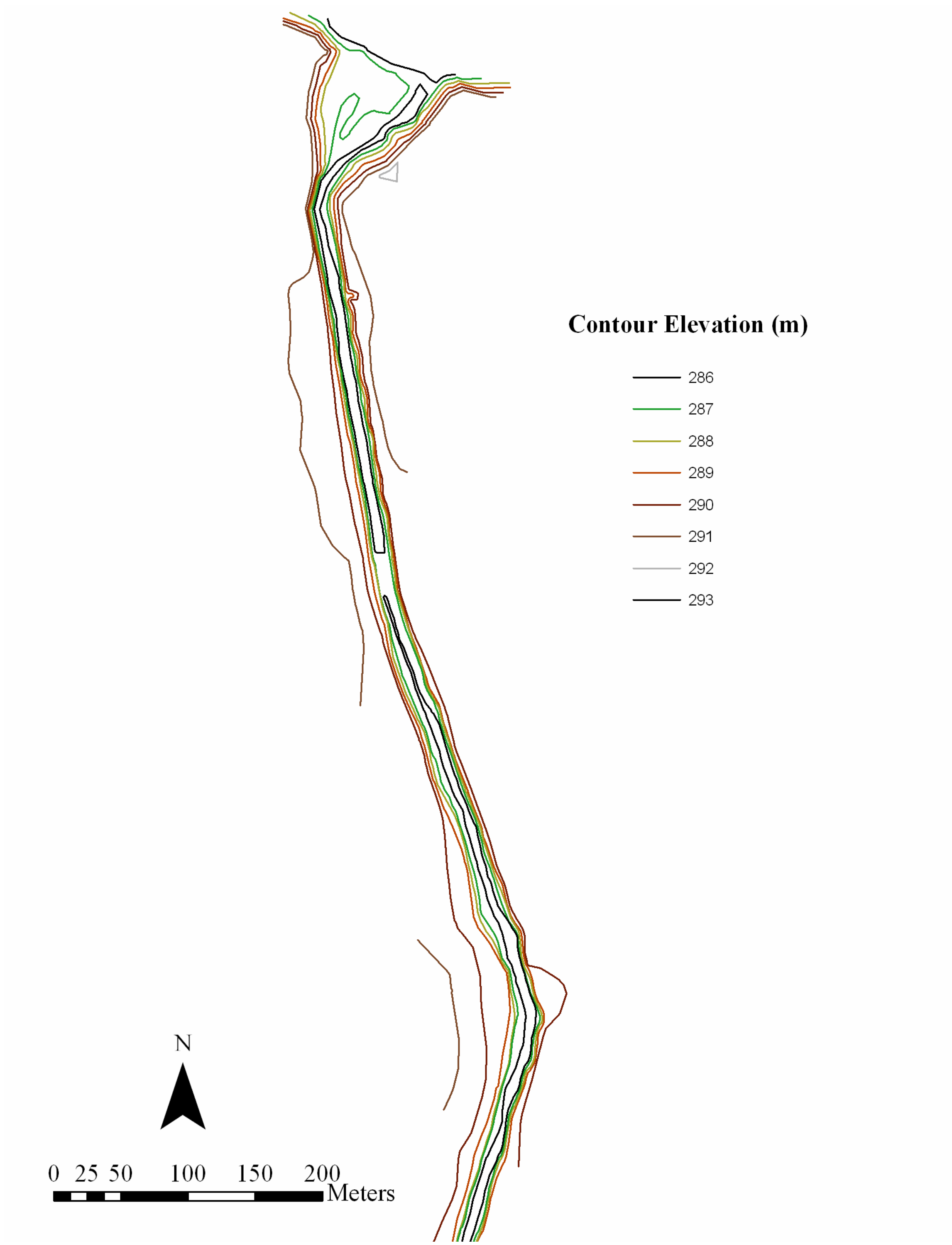


Figure II.4.1. Topographic survey of the upper quarter of Tobacco Island.

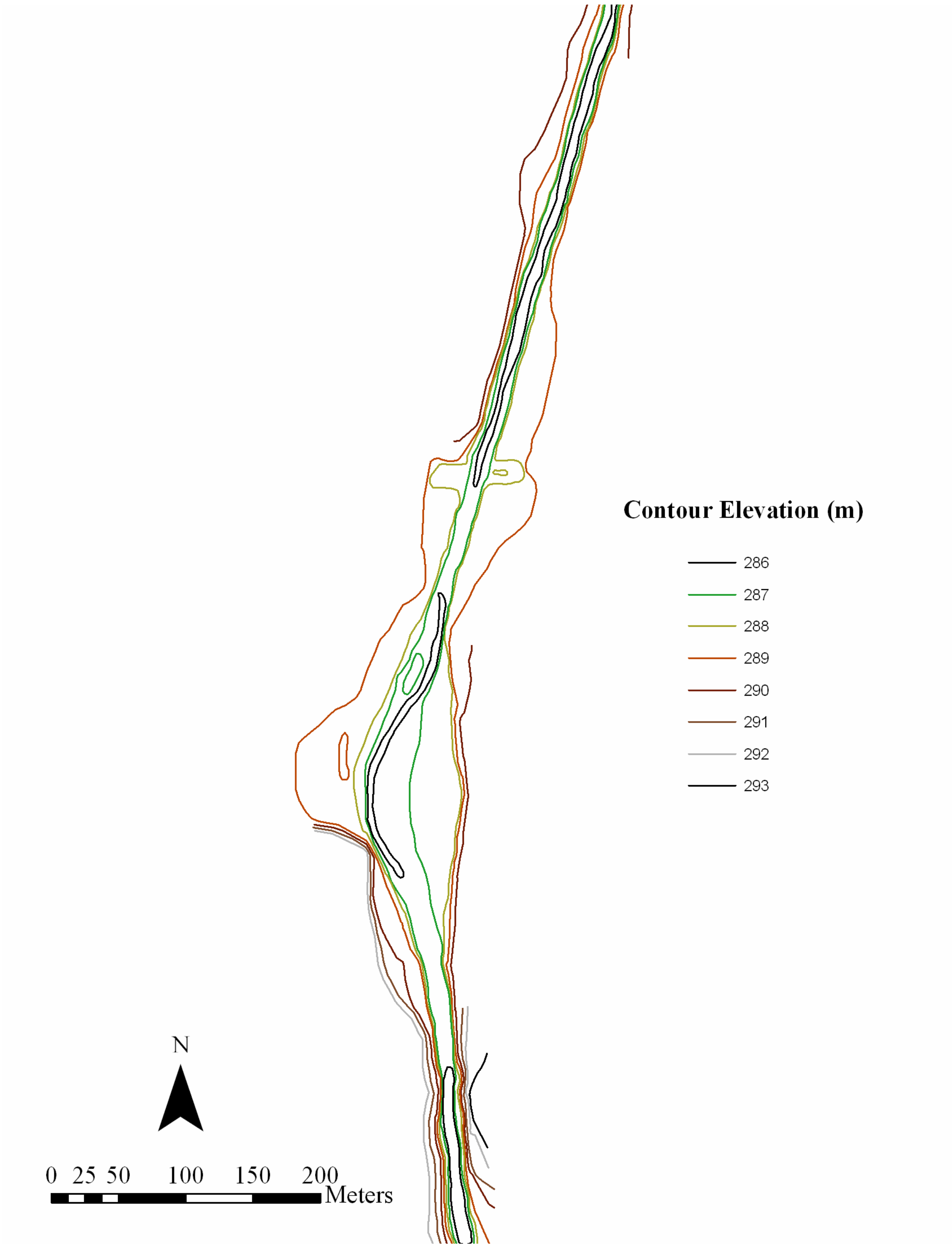


Figure II.4.2. Topographic survey of the second quarter of Tobacco Island.

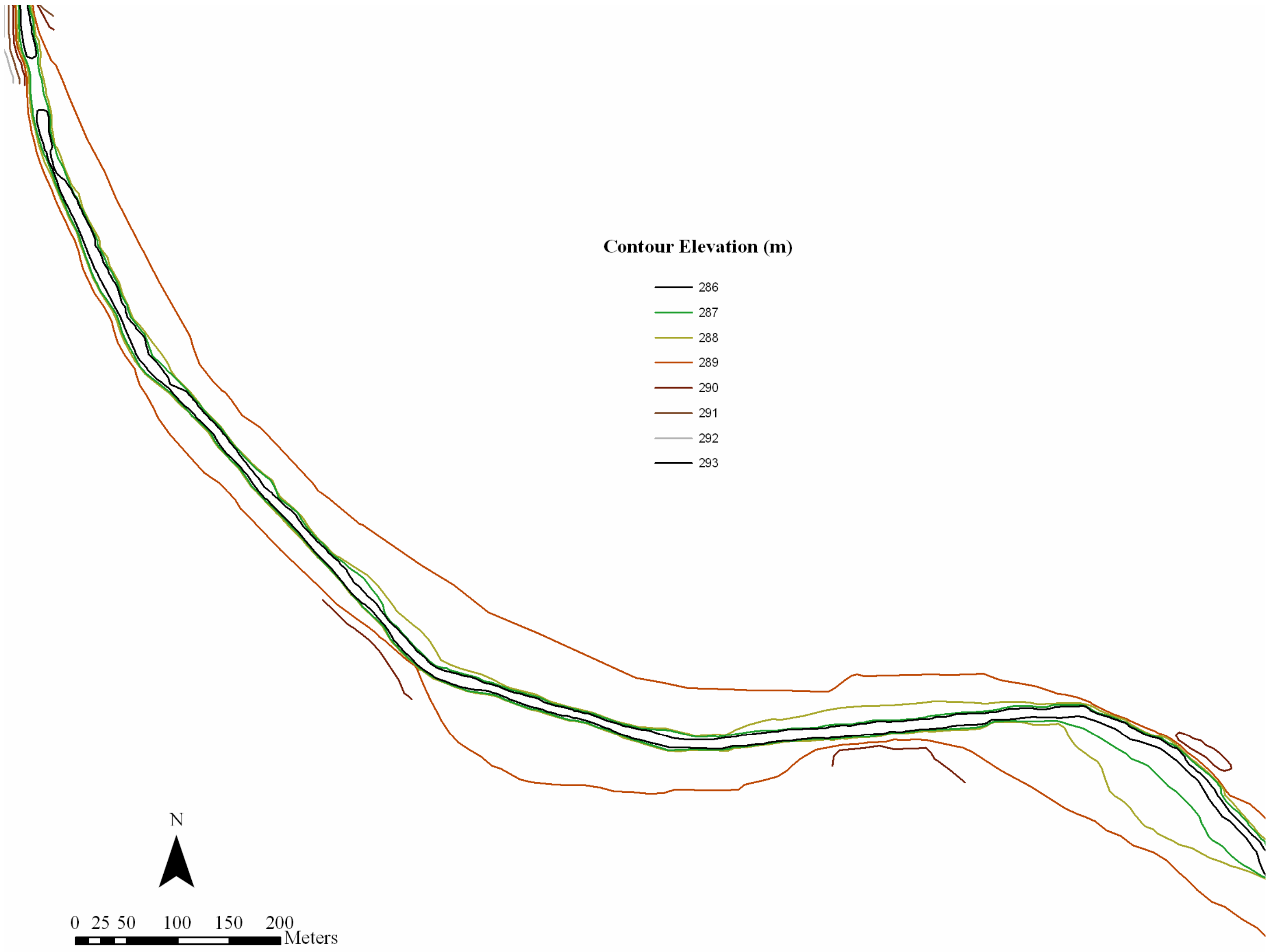


Figure II.4.3. Topographic survey of the third quarter of Tobacco Island.

Figure II.4.4. Topographic survey of the lower quarter of Tobacco Island.

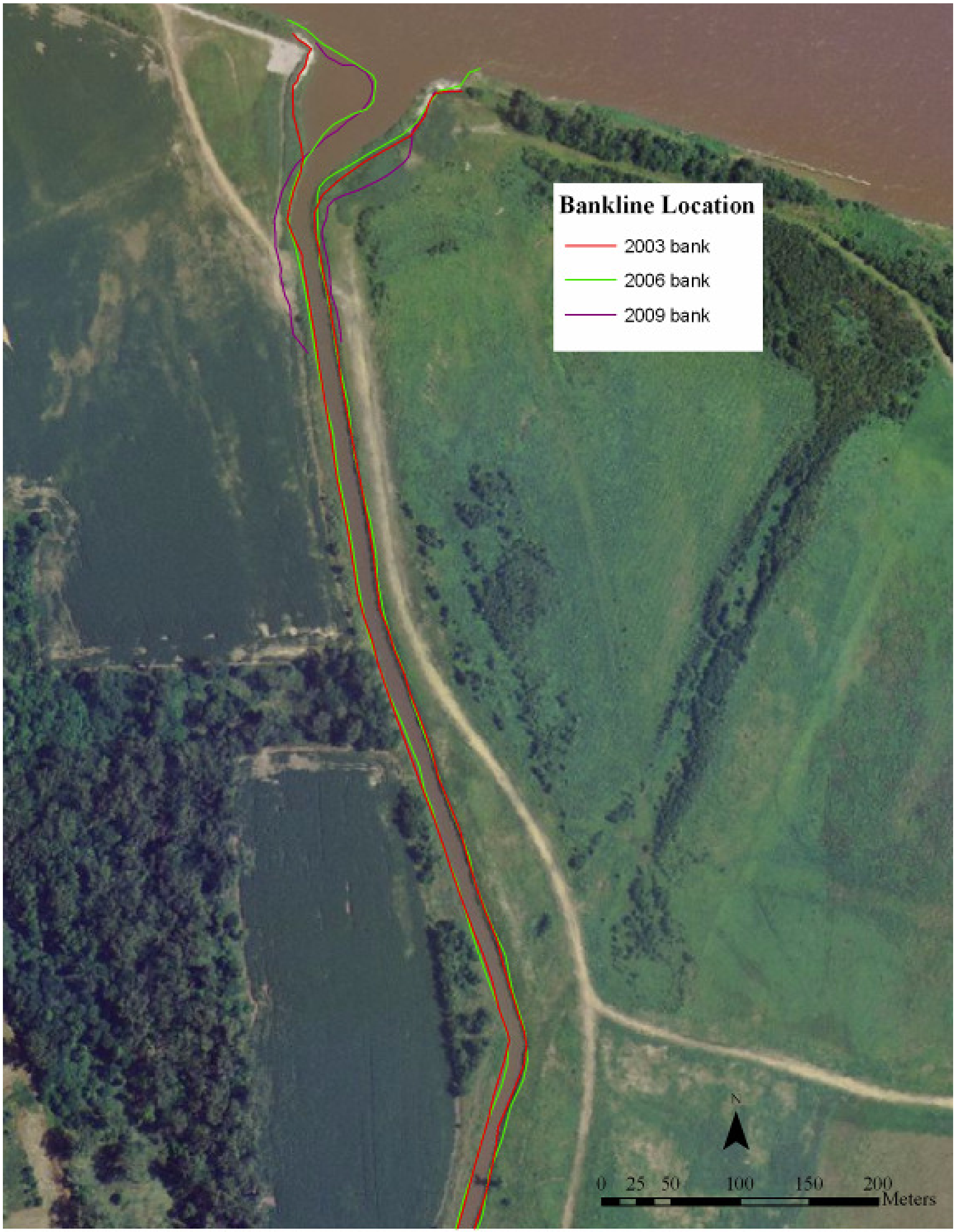


Figure II.4.5. Aerial photograph of the upper quarter of Tobacco Island with bankline locations from 2003 aerial photography and 2006 and 2009 topographic surveys.

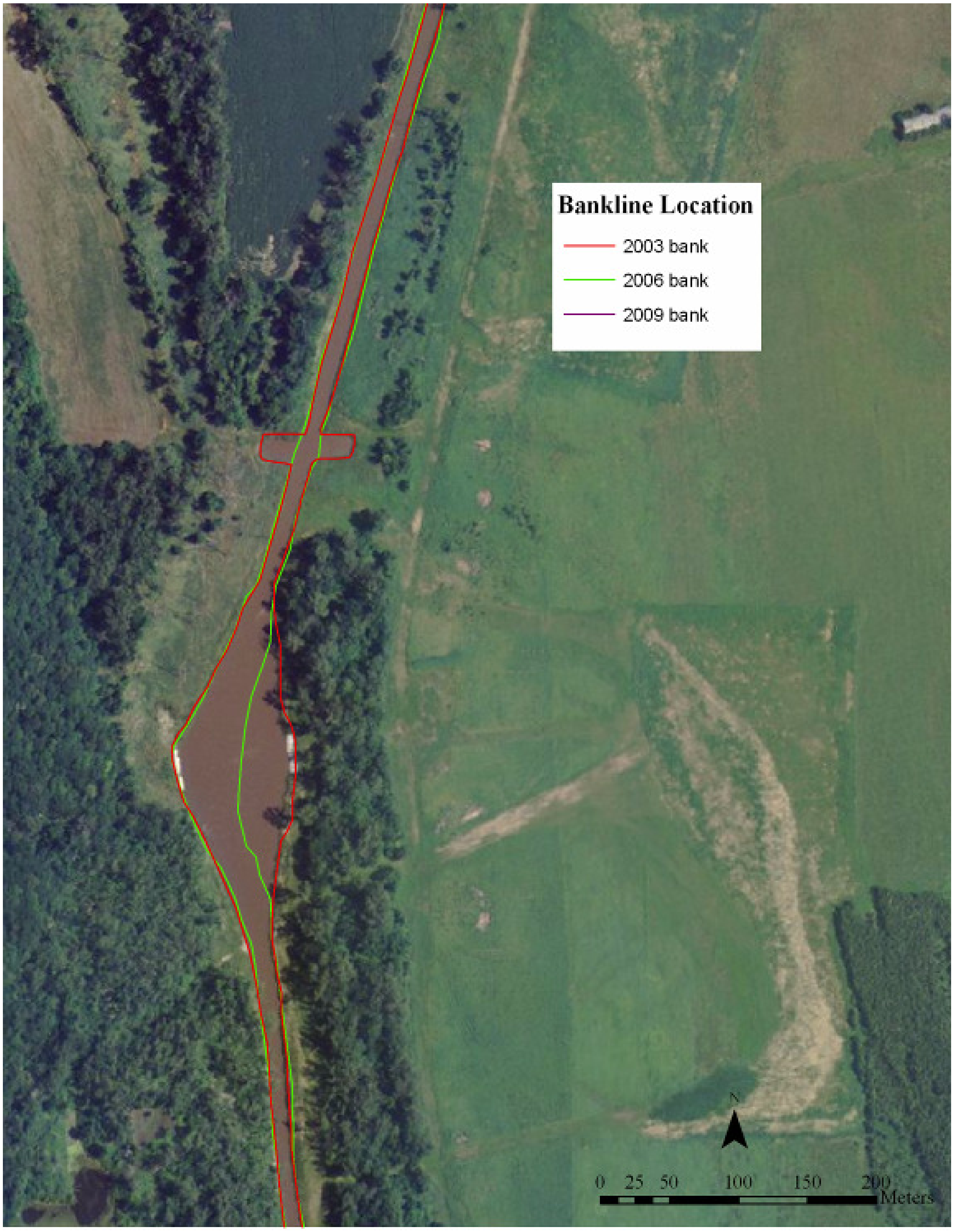


Figure II.4.6. Aerial photograph of the second ¼ of Tobacco Island with bankline locations from 2003 aerial photography and 2006 and 2009 topographic surveys.

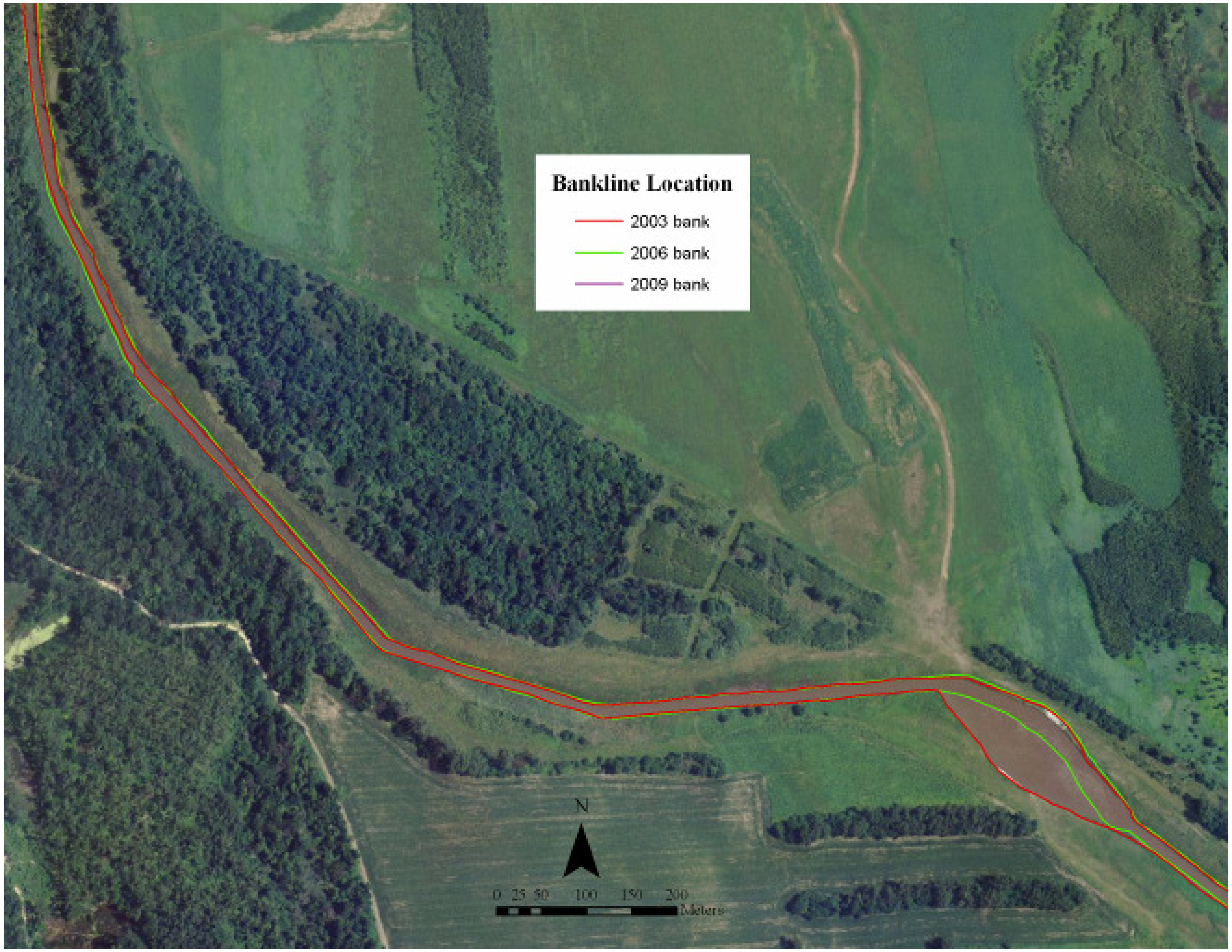


Figure II.4.7. Aerial photograph of the third quarter of Tobacco Island with bankline locations from 2003 aerial photography and 2006 and 2009 topographic surveys.

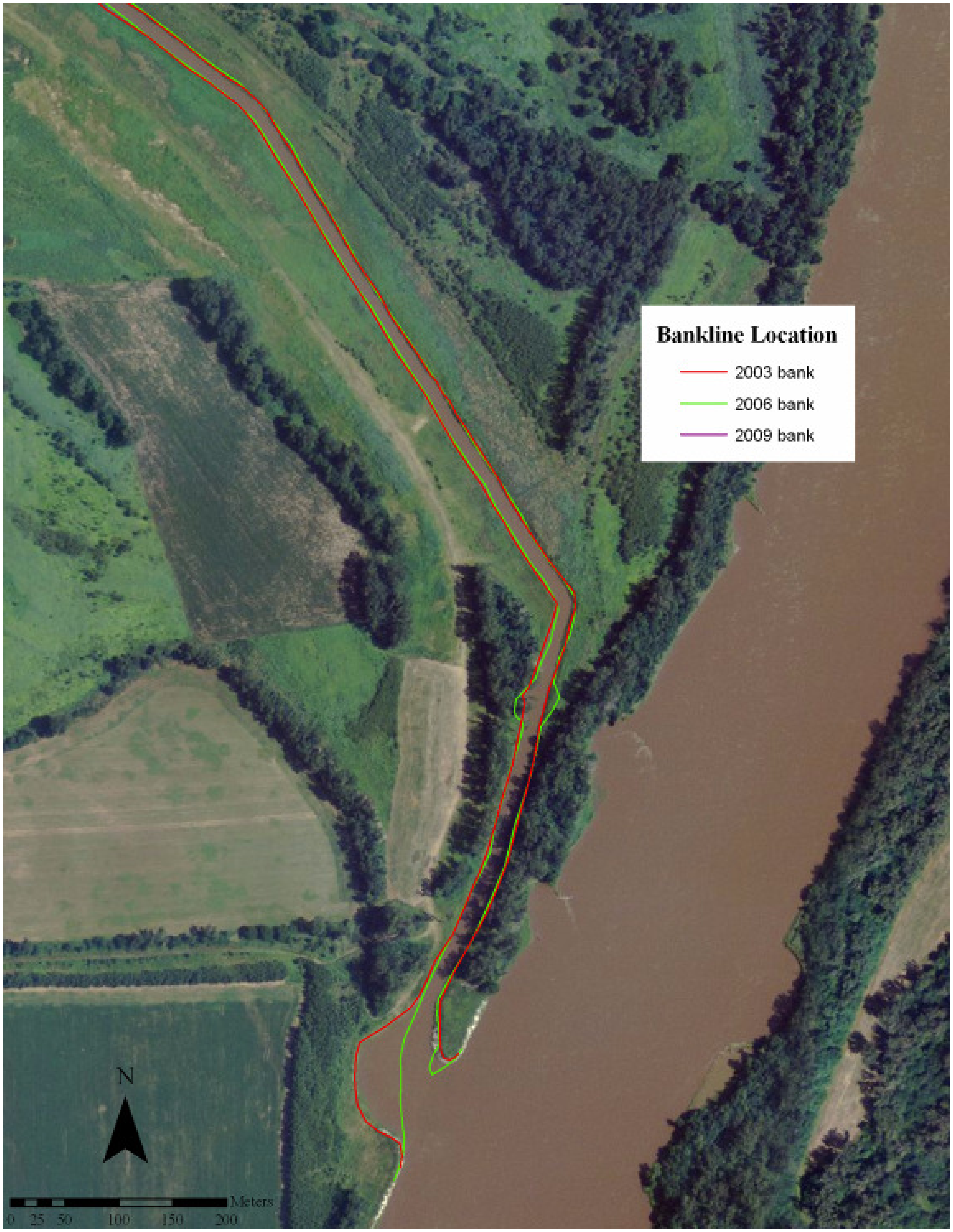


Figure II.4.8. Aerial photograph of the lower quarter of Tobacco Island with bankline locations from 2003 aerial photography and 2006 and 2009 topographic surveys.

Figure II.4.9. Spot elevations from 2006 and 2009 surveys with contours from the 2006 topographic survey of the sand bar at the entrance of Tobacco chute.

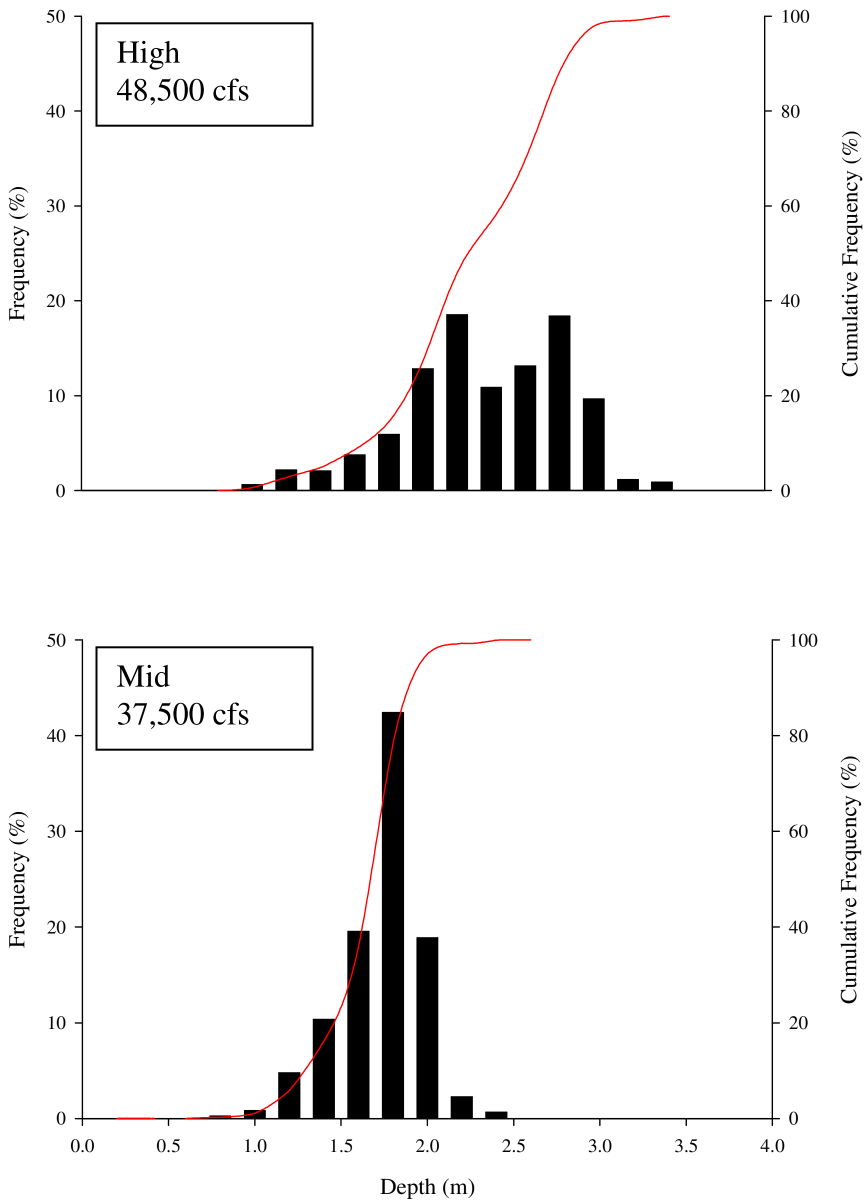


Figure II.4.10. Depth frequency distributions and cumulative depth frequency distributions (line) at Tobacco Island for both Doppler surveys.

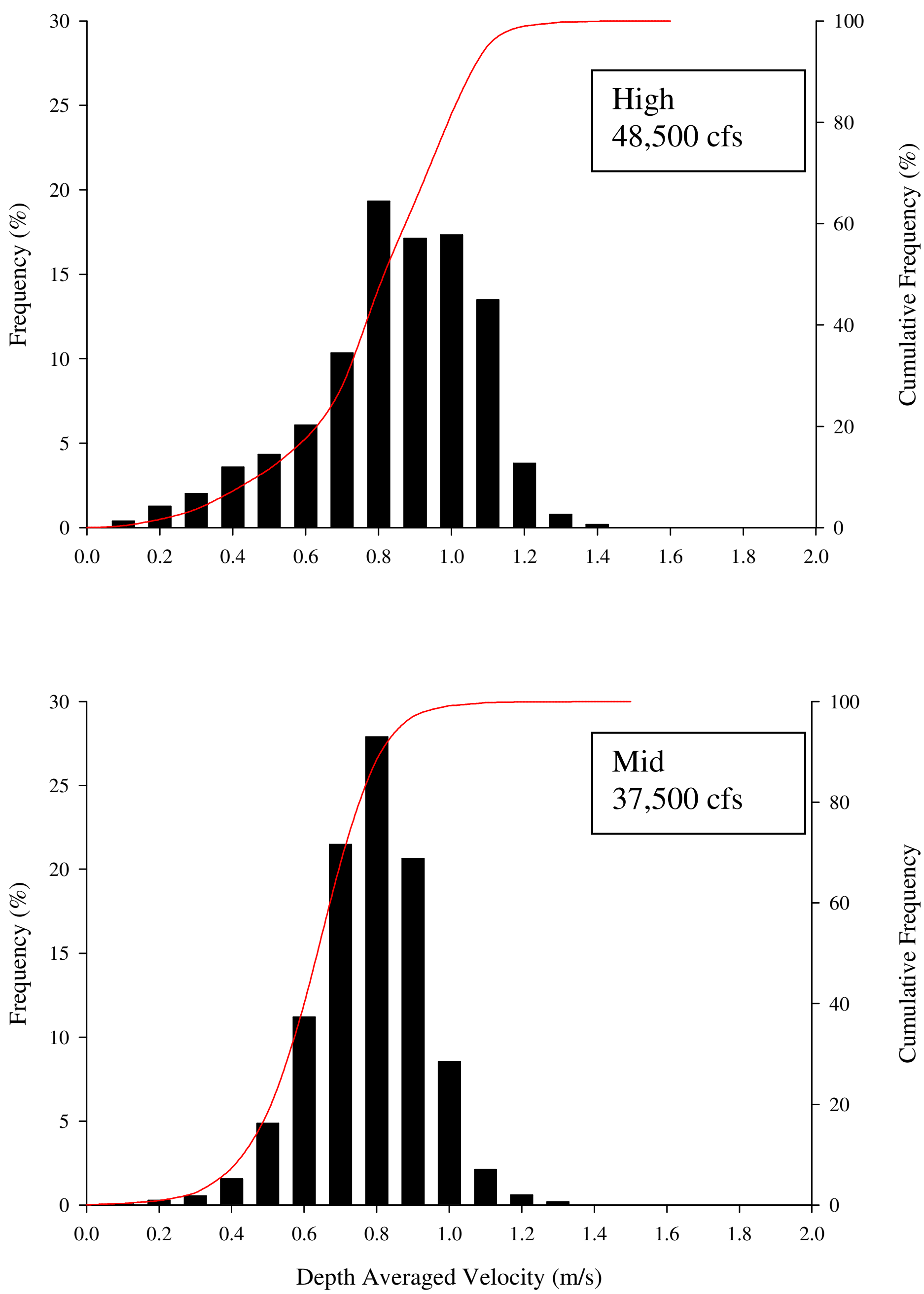


Figure II.4.11. Depth averaged velocity frequency distributions and cumulative depth averaged velocity (line) frequency distributions at Tobacco Island for both Doppler surveys.

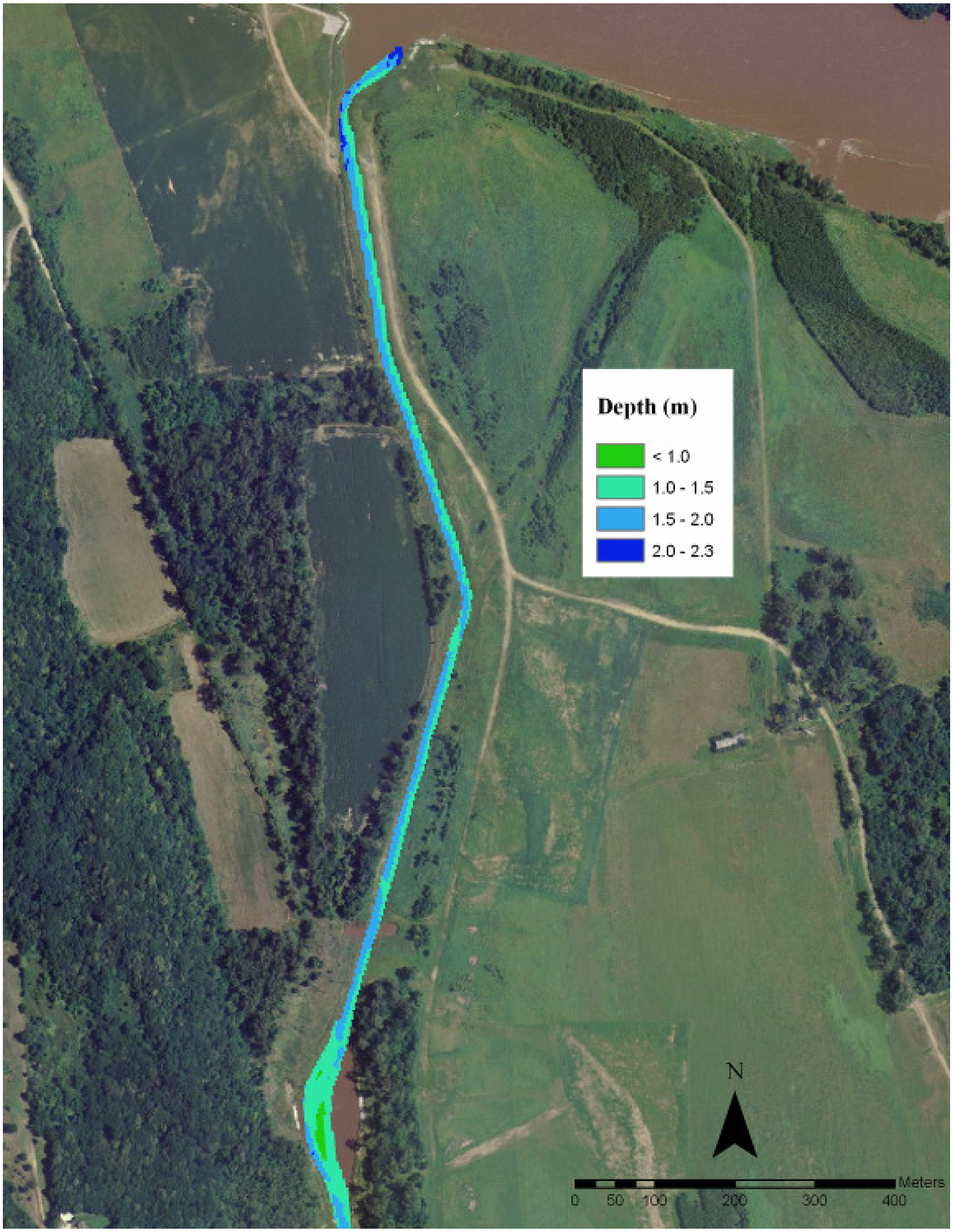


Figure II.4.12. Depth distribution from the Mid survey (37,500 cfs) for the upper third of Tobacco Island.

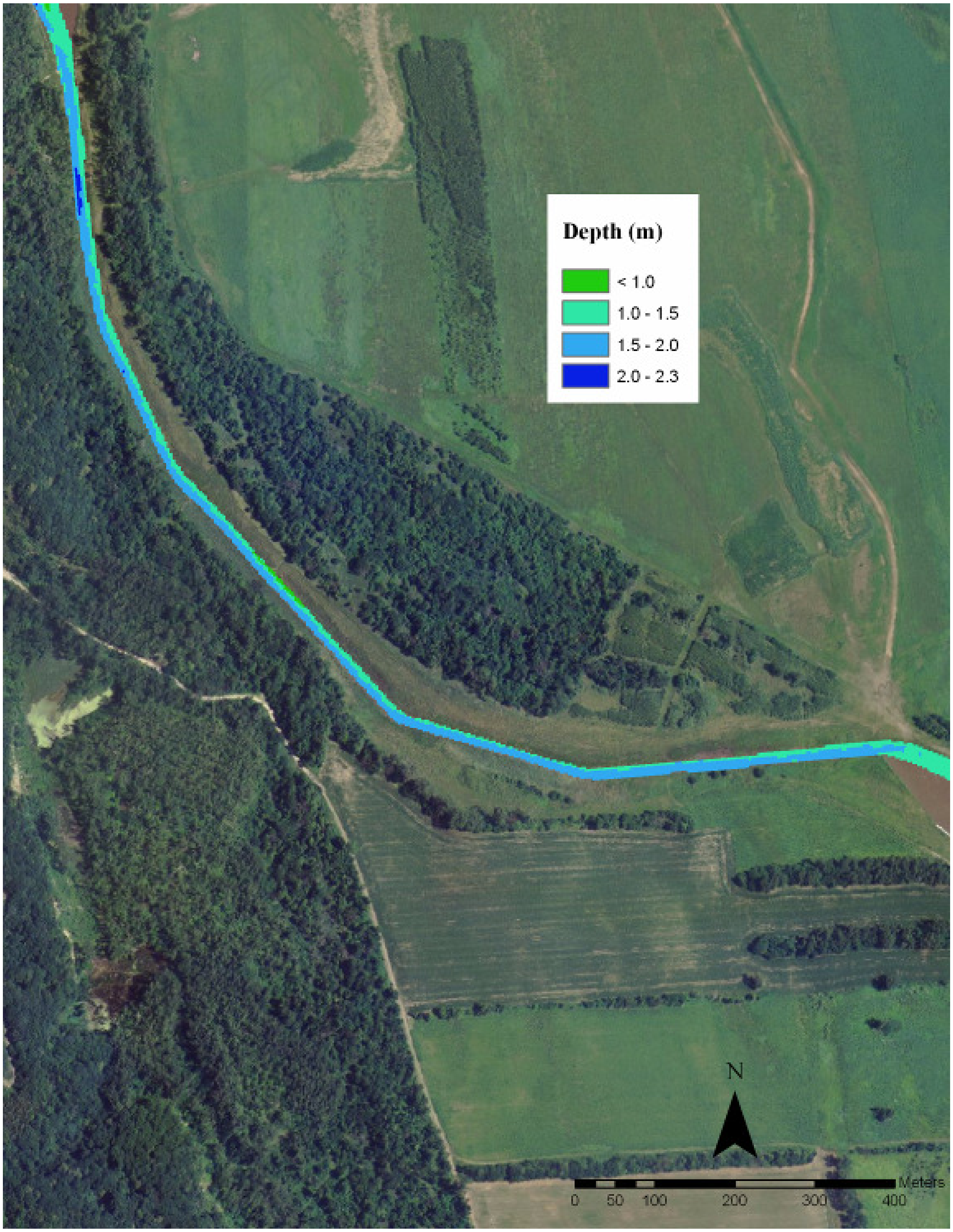


Figure II.4.13. Depth distribution from the Mid survey (37,500 cfs) for the middle third of Tobacco Island.

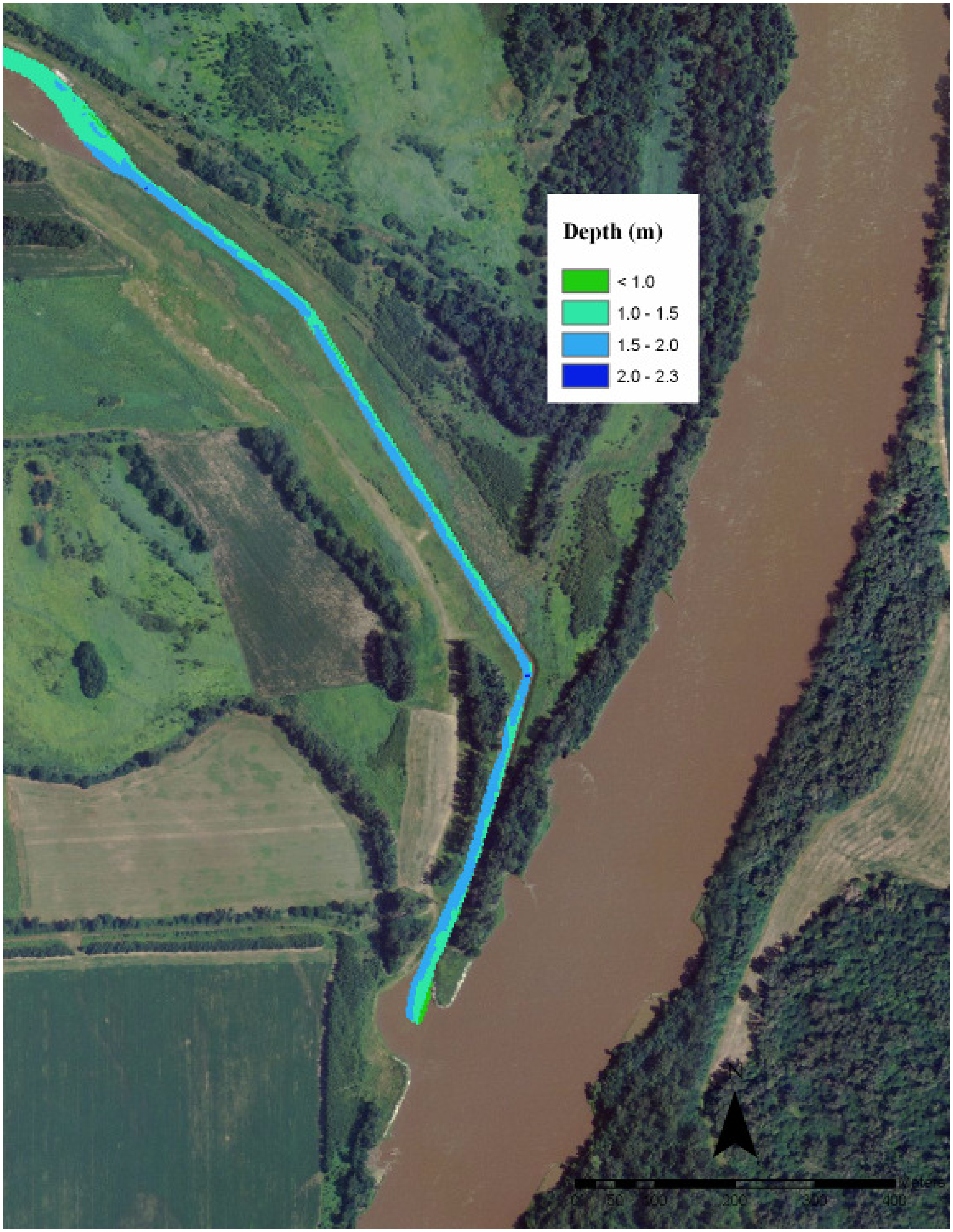


Figure II.4.14. Depth distribution from the Mid survey (37,500) for the lower third of Tobacco Island.

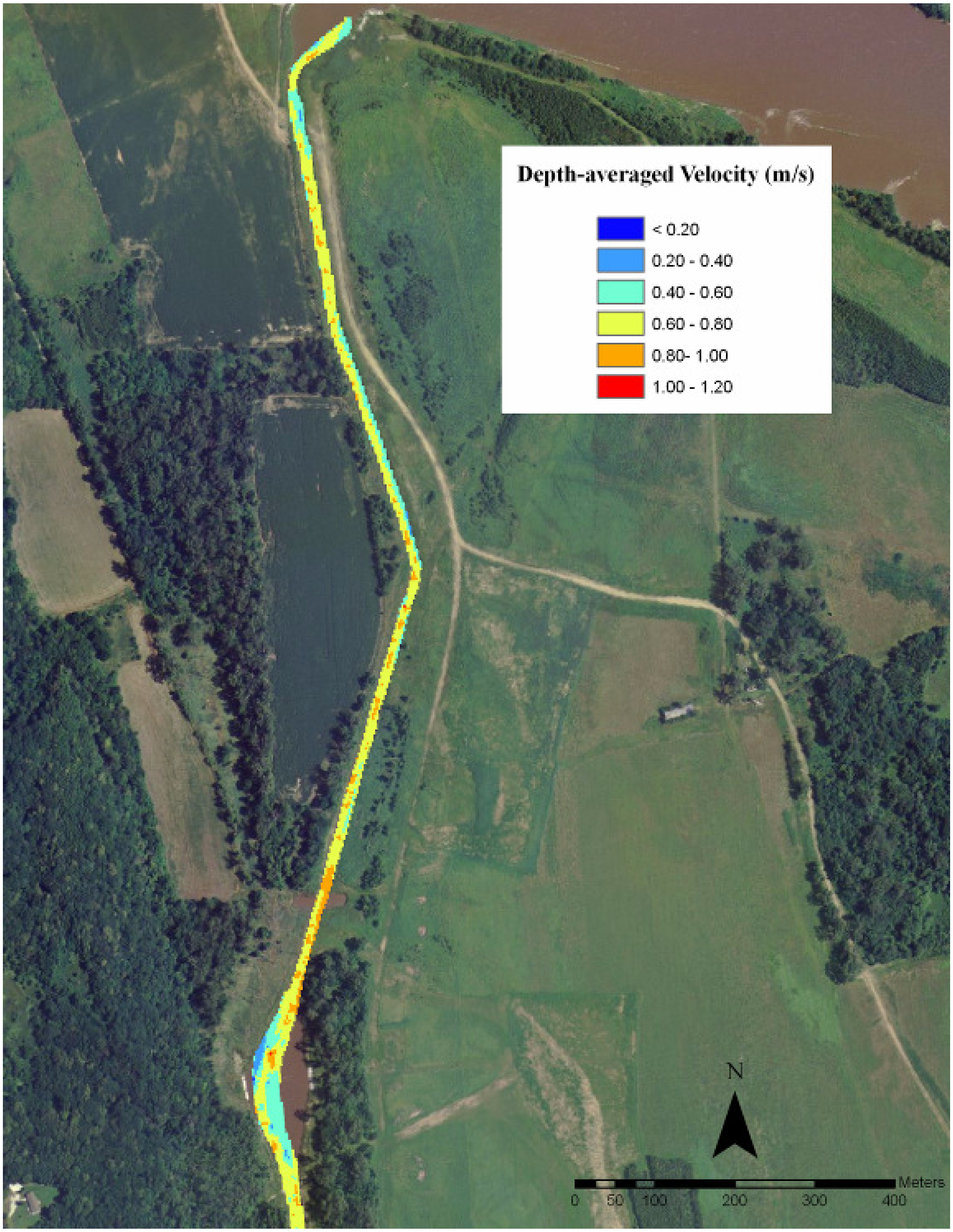


Figure II.4.15. Depth averaged velocity distribution from the Mid survey (37,500 cfs) for the upper third of Tobacco Island.

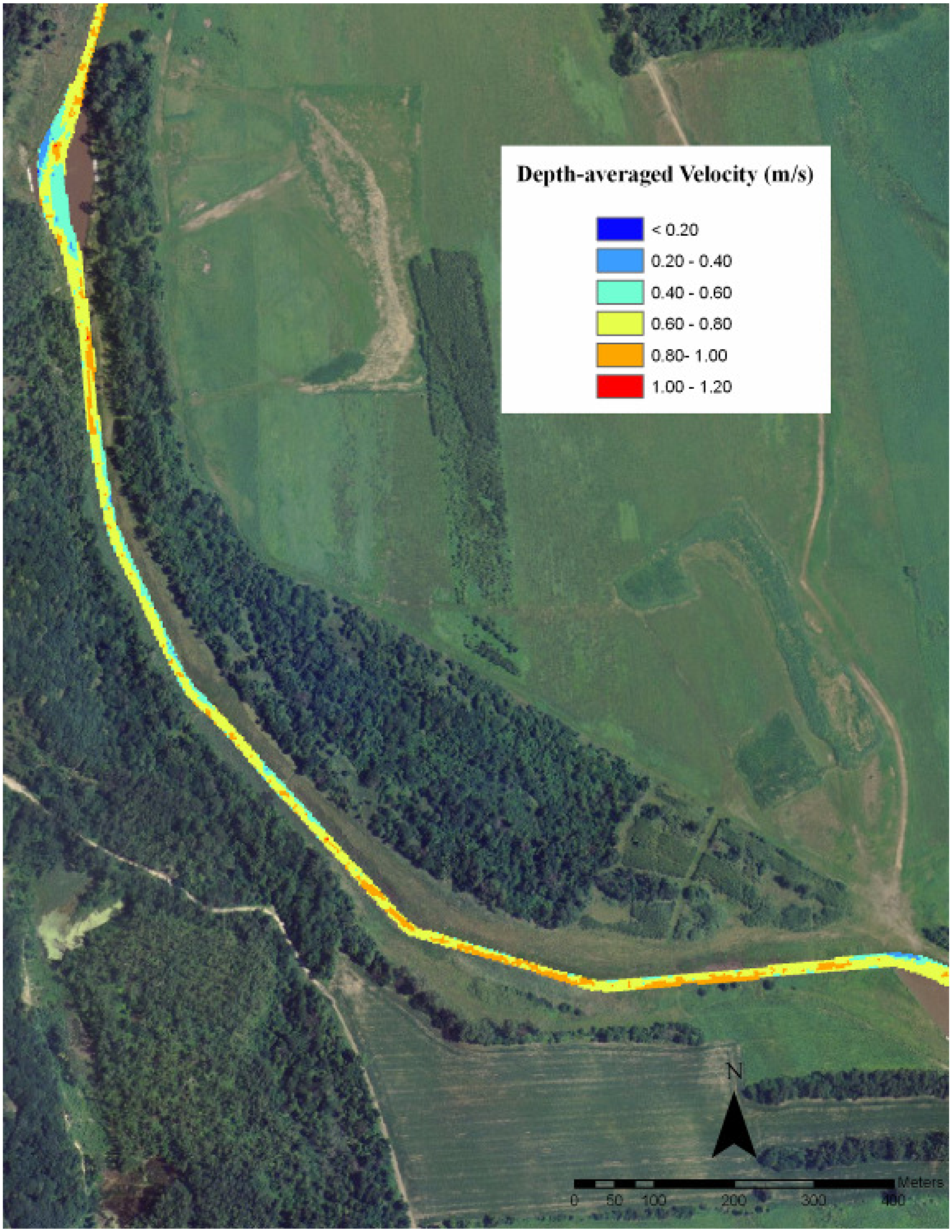


Figure II.4.16. Depth averaged velocity distribution from the Mid survey (37,500 cfs) for the middle third of Tobacco Island.

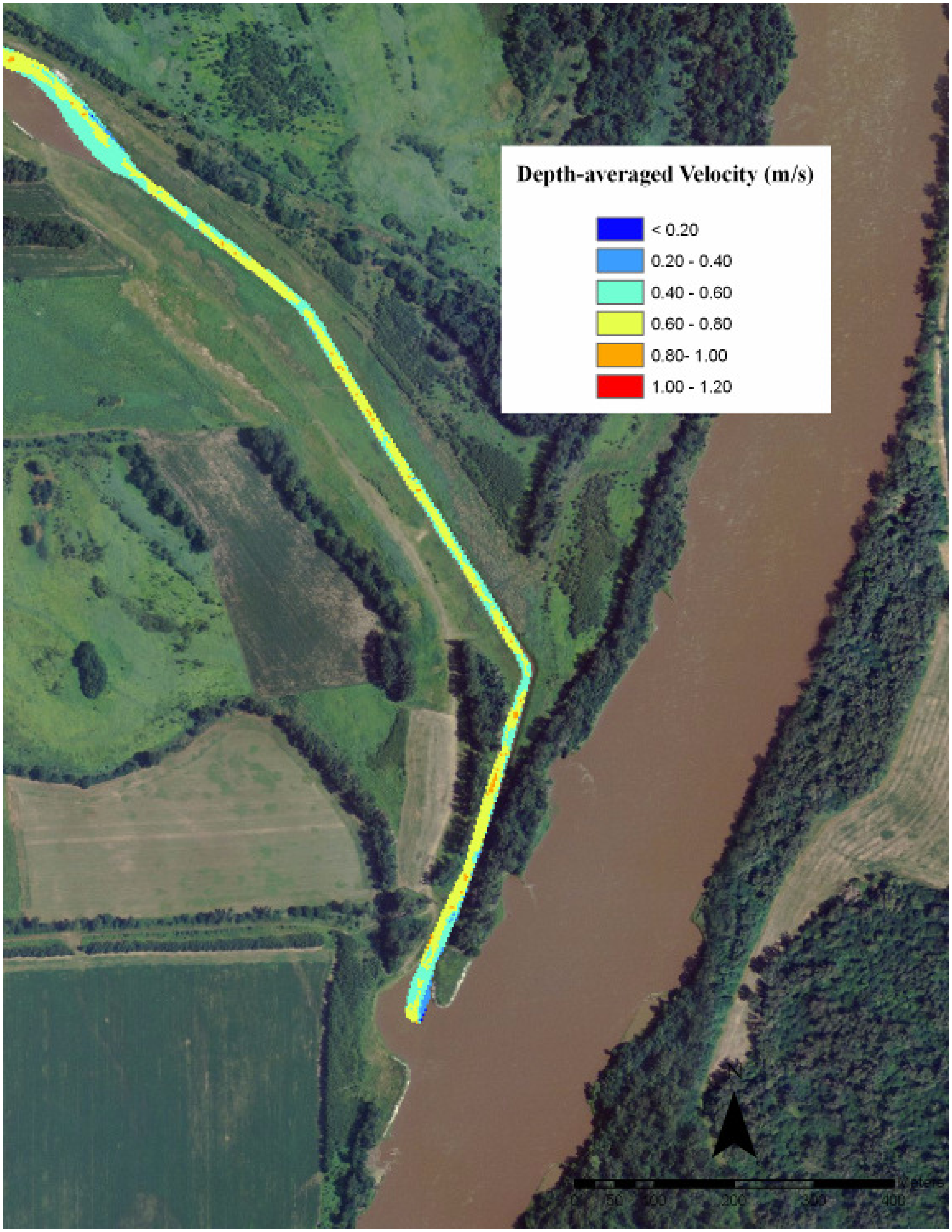


Figure II.4.17. Depth averaged velocity distribution from the Mid survey (37,500 cfs) for the lower third of Tobacco Island.

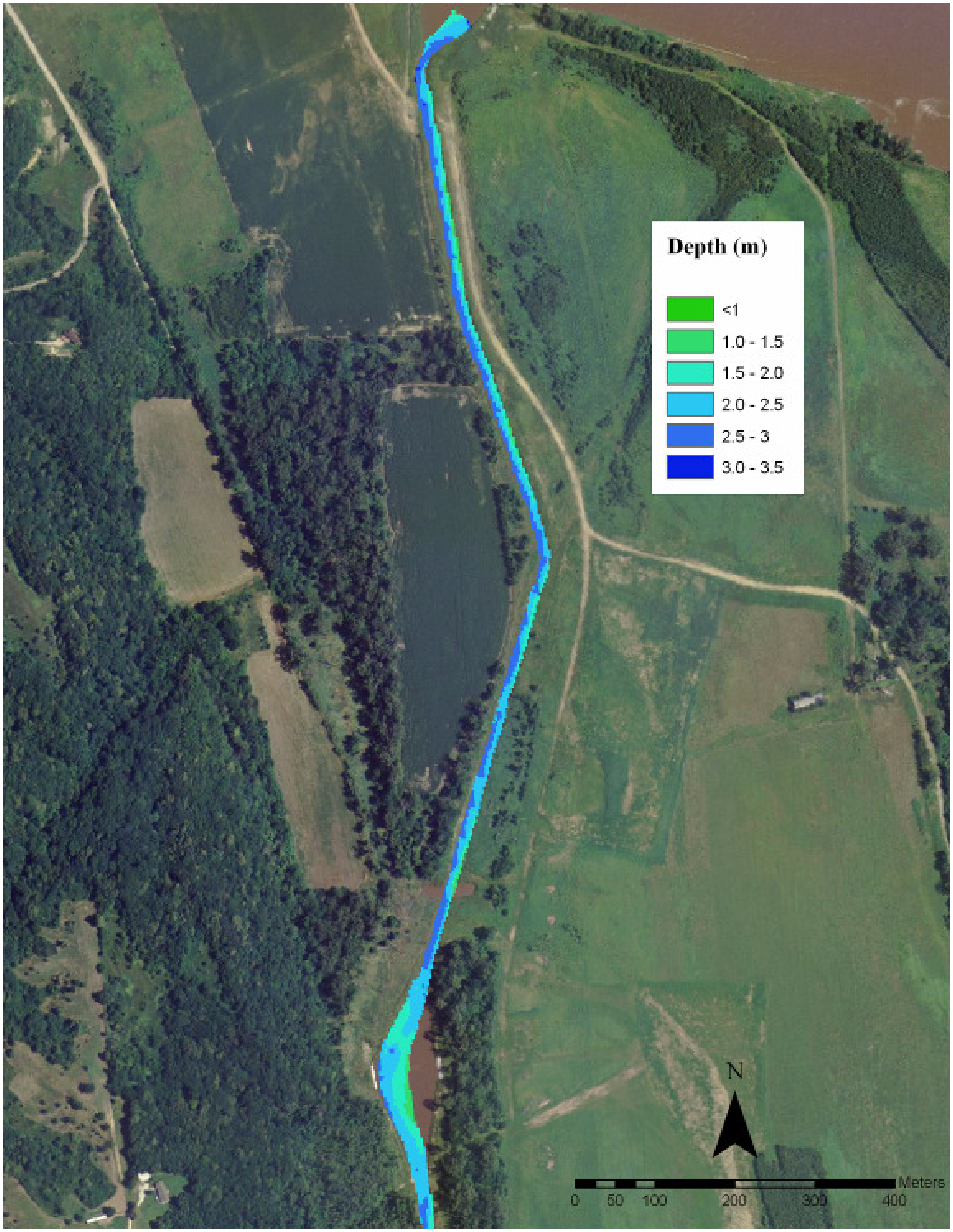


Figure II.4.18. Depth distribution from the High survey (48,500 cfs) for the upper third of Tobacco Island.

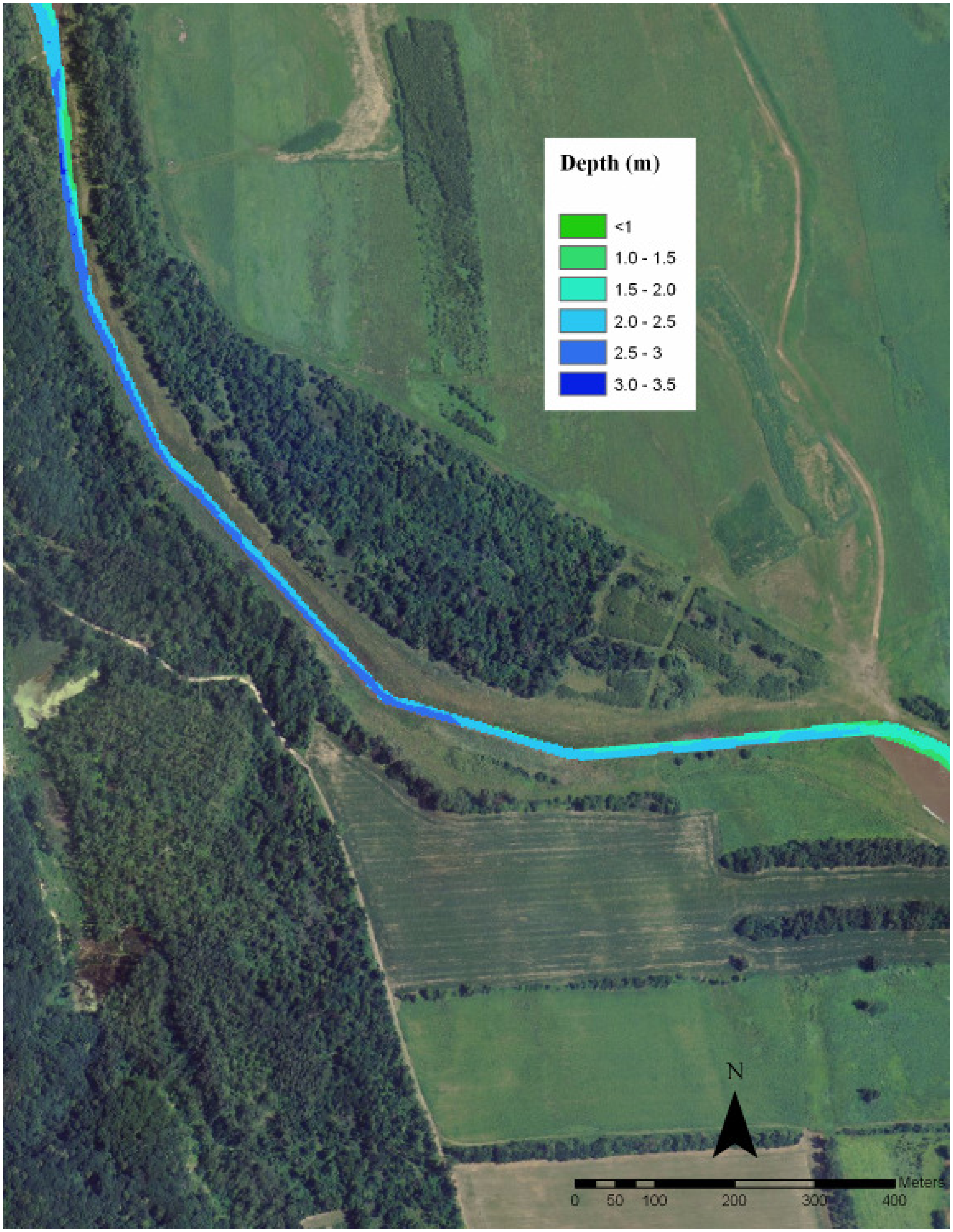


Figure II.4.19. Depth distribution from the High survey (48,500 cfs) for the middle third of Tobacco Island.

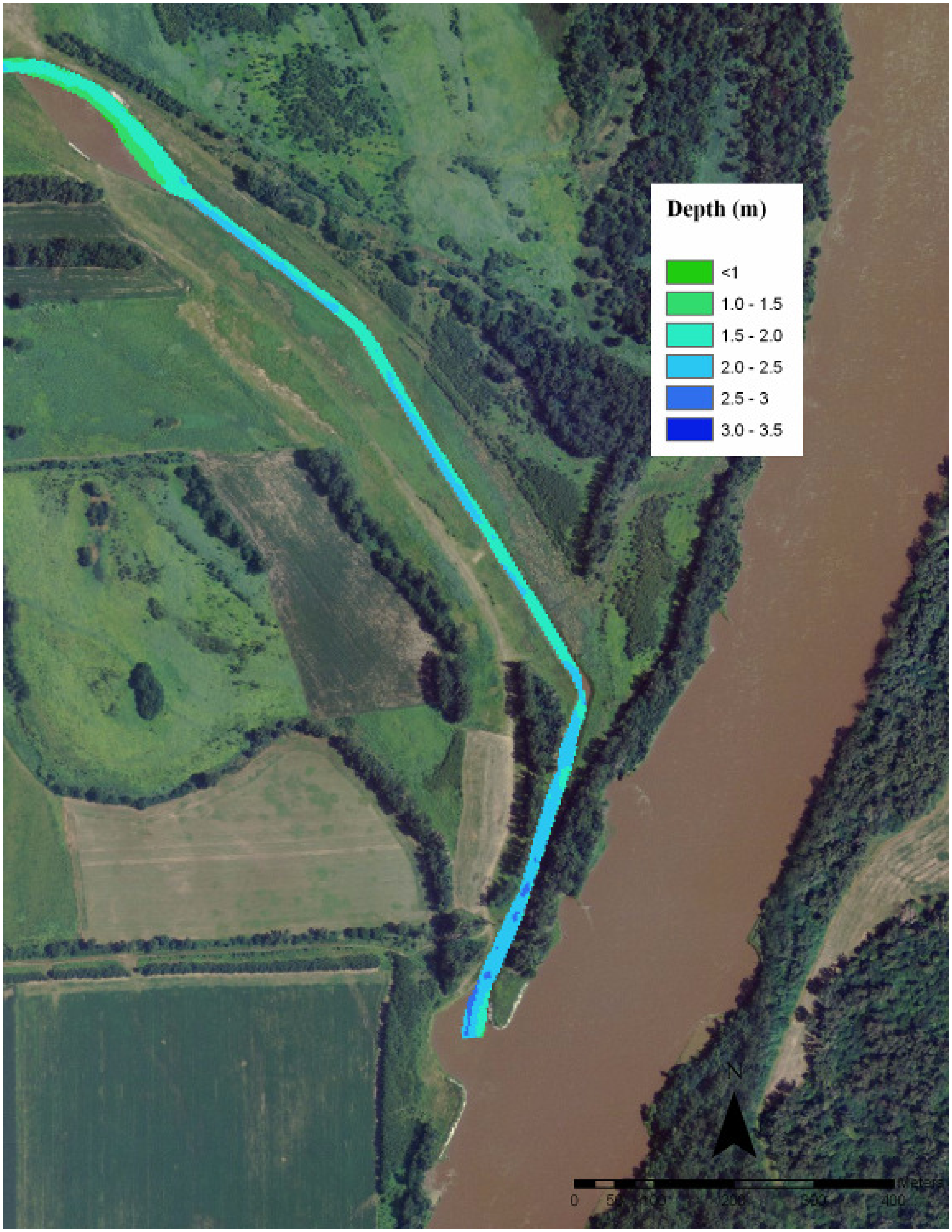


Figure II.4.20. Depth distribution from the High survey (48,500 cfs) for the lower third of Tobacco Island.

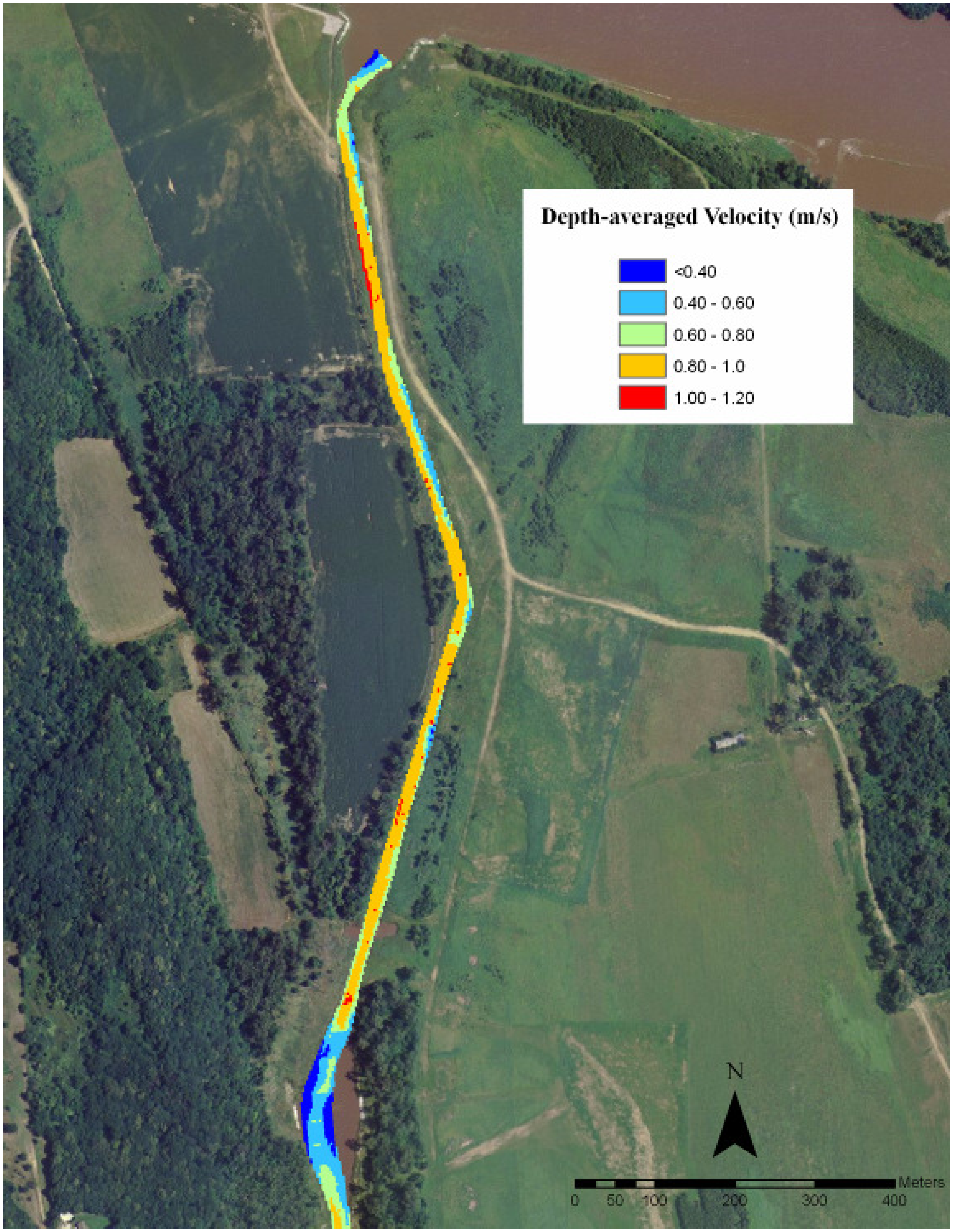


Figure II.4.21. Depth averaged velocity distribution from the High survey (48,500 cfs) for the upper third of Tobacco Island.

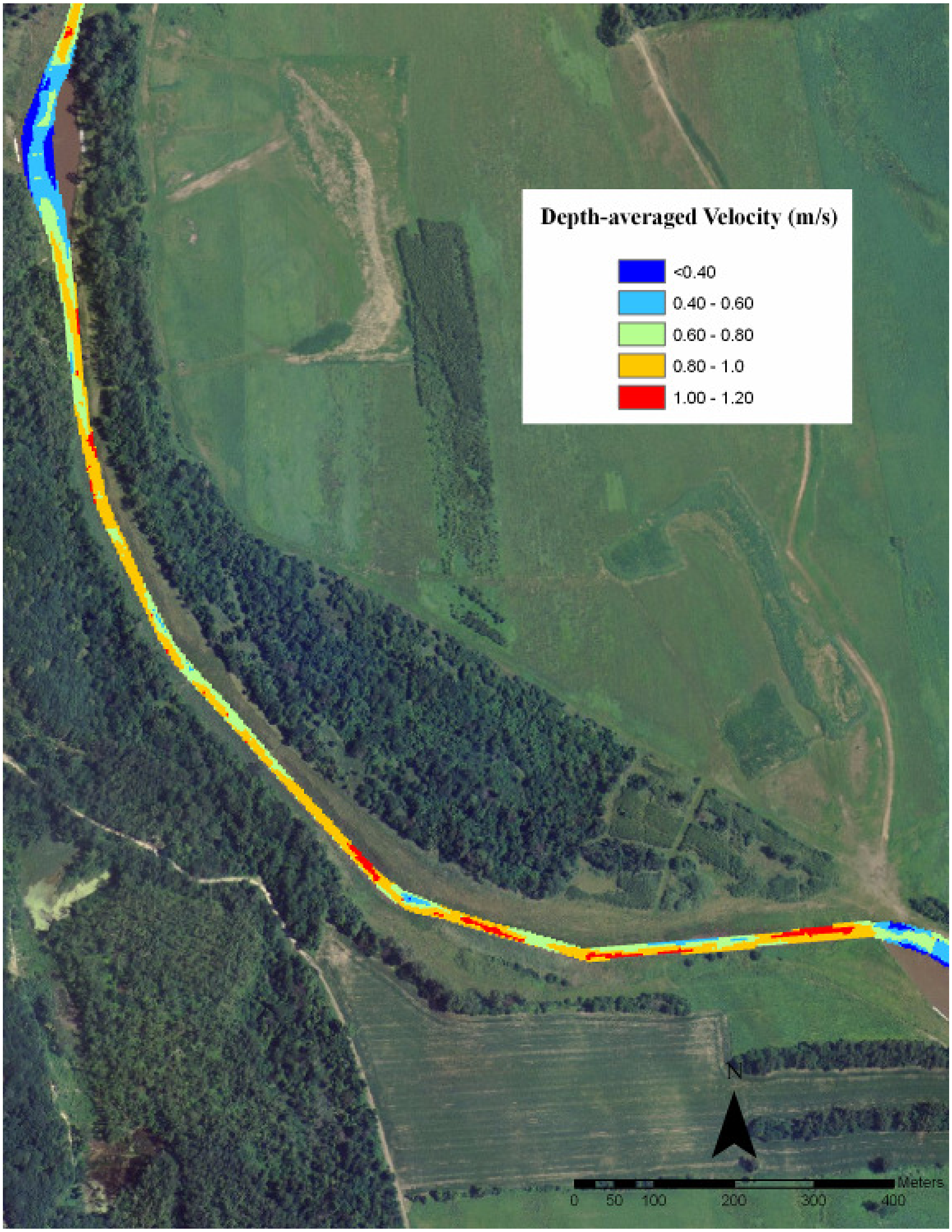


Figure II.4.22. Depth averaged velocity distribution from the High survey (48,500 cfs) for the middle third of Tobacco Island.

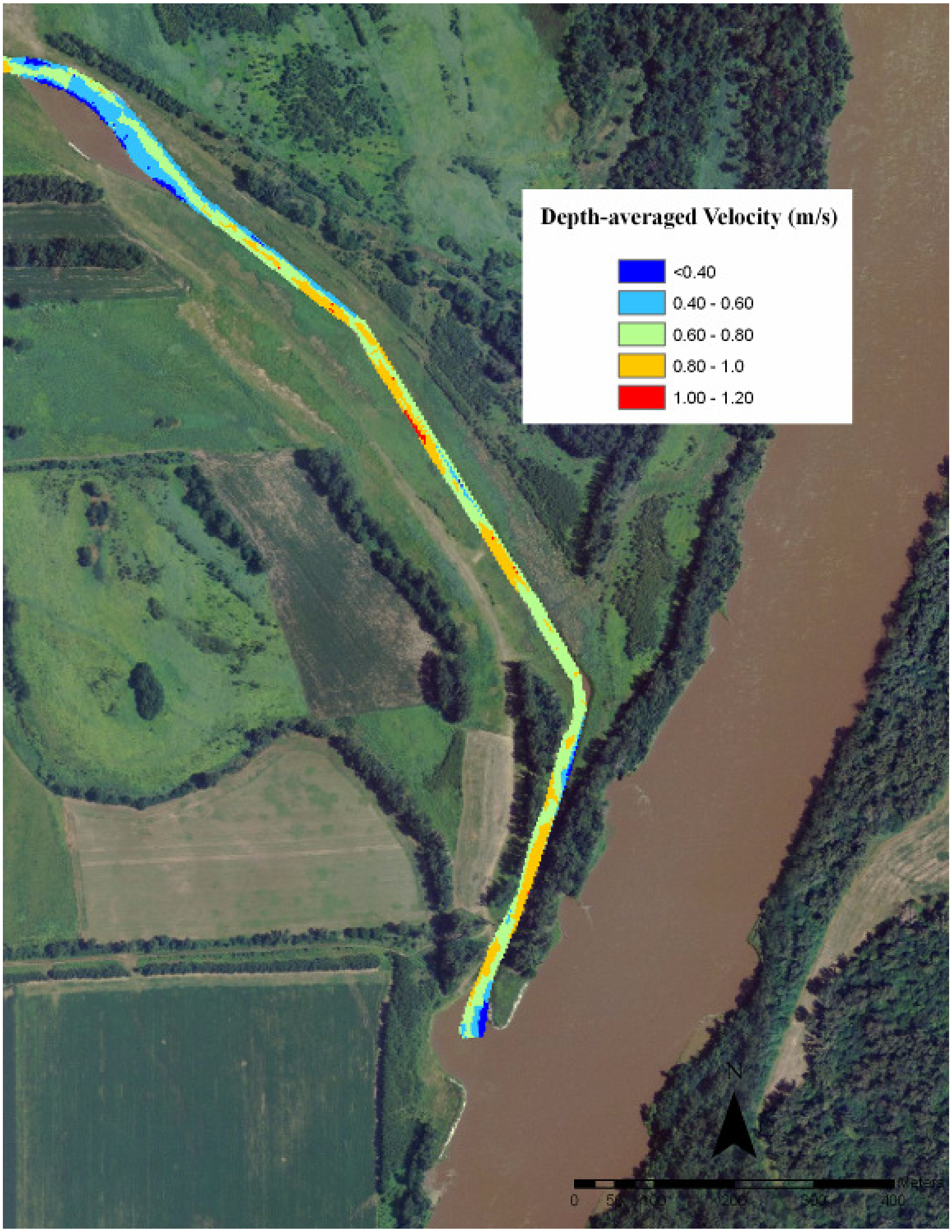
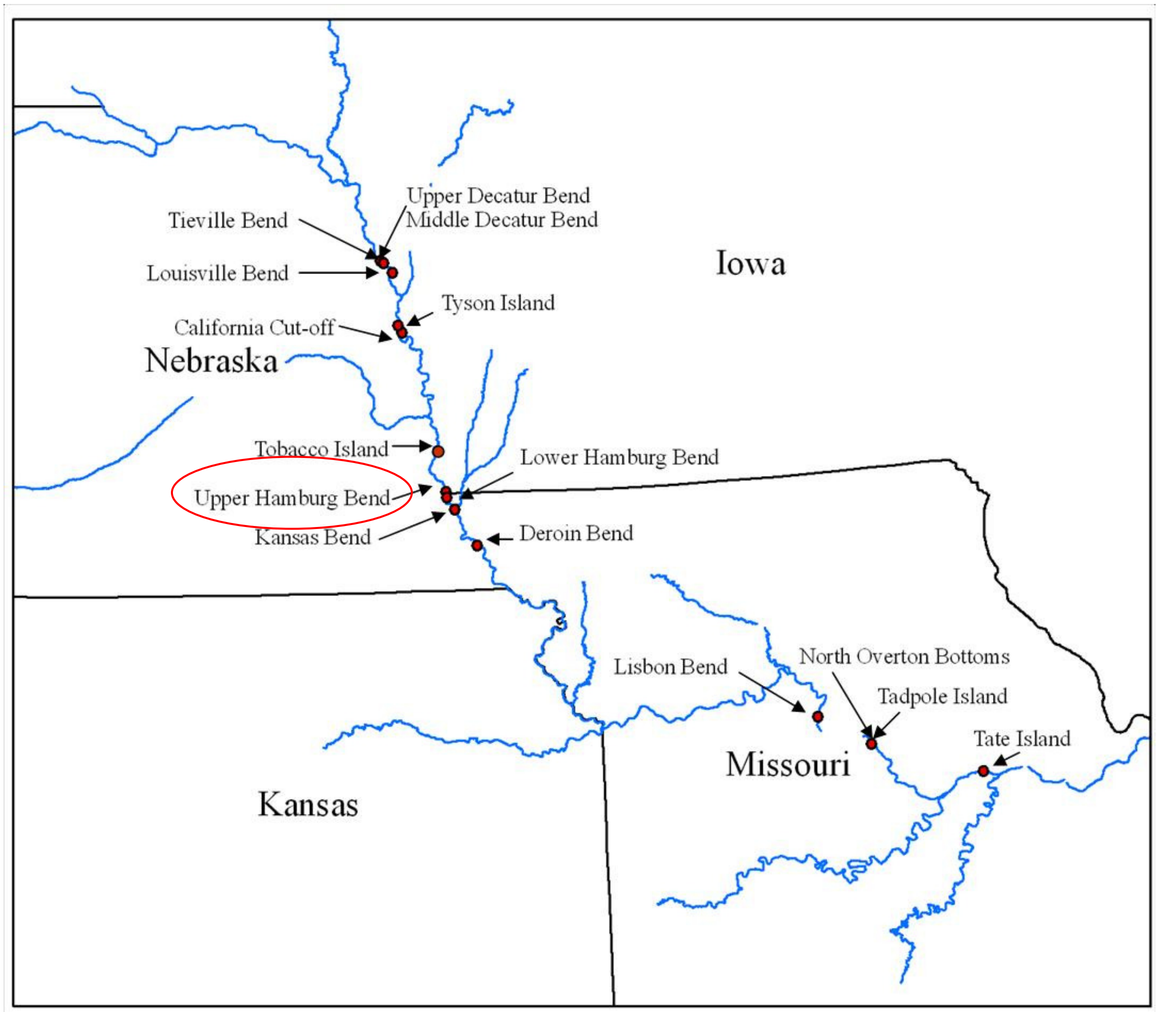


Figure II.4.23. Depth averaged velocity distribution from the High survey (48,500 cfs) for the lower third of Tobacco Island.

Section II
Chapter 5
Upper Hamburg



List of Tables

List of Figures

Upper Hamburg

Upper Hamburg Bend chute is located on the right hand descending bank between RM 556.0 and 552.0 in Otoe County, NE. The chute is 5,094 m in length and averages 72 m in width. The chute was reopened in 1996 and was immediately subjected to a series of high water events. The chute evolved rapidly because of these events and continues to evolve. The upper end of the chute is characterized by shallow slow moving water and a sandy substrate. Emergent sand bars often form behind rock structures present in this section. The lower one-half of the chute exhibits a defined channel with eroding outside banks and aggrading inside banks. Large woody debris is found in the lower portions of the chute, especially on eroded outside bends. Large sandbars have formed on the insides of these bends. Deep scour holes have formed at the entrance and exit of the chute as well as behind the remnants of old pile dikes. Considerable bank-line movement is visible at Upper Hamburg.

Work was done in the summer of 2008 to restrict the amount of water entering the chute. Rock was added to the entrance of the chute, constricting it considerably. The entrance now exhibits some of the swiftest moving water in any of the study chutes. This fast moving water is a potential barrier that could prevent fish from moving out the top of the chute. More work is scheduled in the winter of 2009 to raise the first grade control structure to further restrict flows through the chute.

Topographic Survey

A topographic survey of Upper Hamburg chute was conducted in March of 2008. The completed survey with bankline locations from 2008 aerial photography is shown in

Figures II.5.1-3. The location of bank lines during the 2008 survey as well as bank line locations from a 1996 NGPC survey and 2003, 2006 aerial photography is shown in Figures II.5.4-6. Significant bank line movement has occurred since the chute was opened in 1996. Bank line movement of up to 50 m has occurred in some outside bend areas of the chute.

Depth and Velocity

Three surveys of depth and velocity were conducted at Upper Hamburg chute in 2007 and 2008. The first survey took place on 4 June 2007 during bankful conditions and will be referred to as the High survey. Discharges at the Nebraska City gage station were 50,100 cfs. The second survey was conducted on 27 August 2007 and will be referred to as the Mid survey. Discharges at the Nebraska City gage station were 43,500 cfs. The third survey was conducted on 2 July 2008 and will be referred to as the Low survey. Discharges at the Nebraska City gage station were 34,100 cfs.

The average depth during the Low survey was 2.9 m (Table II.5.1) and the maximum depth was 13.8 m. Eleven percent of depths were less than 1.5 m and 23% were greater than 3.7 m (Figure II.5.7). The average velocity was 0.82 m/s (Table II.5.1) and the maximum was 2.31 m/s. Approximately 38% of velocities were less than 0.76 m/s and 75% were less than 1.0 m/s (Figure II.5.8). The distribution of depths (Figures II.5.9-11) and depth-averaged velocities (Figures II.5.12-14) are shown for the Low survey at Upper Hamburg.

The average depth during the Mid survey was 3.2 m (Table II.5.1) and the maximum depth was 12.3 m. Only 2% of depths were less than 1.5 m and 70% were between 1.5 m and 3.7 m (Figure II.5.7). The average velocity was 0.82 m/s (Table II.5.1) and the maximum velocity was 2.46 m/s. Approximately 36% of velocities were less that 0.76 m/s and 77% were less than 1.0 m/s (Figure II.5.8). The distribution of depths (Figures II.5.15-17) and depth-averaged velocities (Figures II.5.18-20) are shown for the Mid survey at Upper Hamburg.

The average depth during the High survey was 3.6 m (Table II.5.1) and the maximum depth was 13.1 m. Only 0.9% of depths were less than 1.5 m and 43% were greater than 3.7 m (Figure II.5.7). The average velocity during the survey was 0.86 m/s (Table II.5.1) and the maximum velocity was 2.09 m/s. Thirty percent of velocities were less than 0.76 m/s and 70% were less than 1.0 m/s (Figure II.5.8). The distribution of depths (Figures II.5.21-23) and depth-averaged velocities (Figures II.5.24-26) are shown for the High survey at Upper Hamburg.

We compared depth frequency distributions and depth-averaged velocity frequency distributions between surveys using a KS test and found significant differences between all surveys for both depth and depth averaged velocity (Table II.5.2). We compared mean depth using analysis of variance (ANOVA) and found differences among the group ($F = 587.93$, $P < 0.0001$) and all pairwise comparisons (Table II.5.3). A comparison of depth-averaged velocities using ANOVA also showed differences among the group ($F = 56.76$, $p < 0.0001$). All pairwise comparisons were different except no difference was found between the Mid and Low surveys.

Sediment

A sediment survey was conducted at Upper Hamburg on 26 August 2008 and included support members from Quester Tangent Corp (manufacturer of the equipment). Results from the survey were inconsistent and did not match grab samples collected by NGPC crews. The sediment survey is not presented in this report.

Summary

Upper Hamburg chute has undergone the most morphological change of all the study sites. Bank-line movement of over 50 m is seen on some outside bends of the chute. The chute also contains a defined channel and most inside bends have large sand bar areas associated with them. In addition, the chute contains multiple deep scour holes situated behind rock points or pile dike structures.

Depth data for the three surveys were not confined to a small range, unlike at other study sites. This is indicative of a mature chute with deep outside bends and shallow inside bends, scour holes and sand bar formations. Likewise, velocity distributions are equal over their range indicating a chute that has evolved to include slow moving inside bends and faster moving outside bends.

Upper Hamburg is the oldest of the study sites and has been subjected to numerous high water events. The site most accurately reflects what a "mature" site would look like in the Nebraska reach of the Missouri River.

The entrance of the chute has been constricted to restrict flows entering the chute. This constriction has resulted in a 3-5 foot "waterfall" at the entrance of the chute. In addition, velocities inside the entrance are consistently greater than 2.0 m/s and may be

higher as water is forced through the renovated entrance and turbulence at the entrance is significant. We feel these factors may prohibit fish, especially migrating pallid sturgeon, that from exiting at the top of the chute. If the chute is acting as a fish "trap" it may hinder the efforts of pallid sturgeon and other fishes that make long upstream spawning migrations.

Key Features:

- Significant drop in elevation at entrance of chute with extreme turbulence and high velocities – may block fish passage
- Diverse habitat with deep scour holes and shallow sand bars and areas of high velocities and low velocities
- Sand and gravel substrate
- Significant bankline movement
- Large woody debris present on eroded outside bends
- Deep scour holes – may contain deepest water in that reach of the river

Recommendations for modification:

- Redesign entrance to eliminate drop in elevation and promote fish passage
- Remove rock structures within chute to promote more bankline movement

Table II.5.1. List of survey dates for Upper Hamburg and relative stage with mean depth and mean depth-averaged velocity for each relative stage.

Survey Date	Discharge (cfs)	Stage	Mean Depth (m)	Mean Depth-averaged Velocity (m/s)
4 June 2007	50,100	High	3.6	0.86
27 August 2007	43,500	Mid	3.2	0.82
2 July 2008	34,100	Low	2.9	0.82

Table II.5.2. Results of Kolmogorov-Smirnov tests for differences in distributions between surveys at Upper Hamburg. Results are significant at a Bonferonni adjusted p value of 0.033 (alpha = 0.10).

	Depth		Depth-averaged velocity	
Survey	**D**	**p-value**	**D**	**p-value**
Low vs. Mid	0.19	<0.0001	0.08	<0.0001
Low vs. High	0.28	<0.0001	0.12	<0.0001
Mid vs. High	0.15	<0.0001	0.12	<0.0001

Table II.5.3. Results of pairwise tests (ANOVA) of mean depth and mean depth-averaged velocity at Upper Hamburg. Results are significant at a Bonferonni adjusted p value of 0.033 (alpha = 0.10). Significant results are shown in bold.

	Depth		Depth-averaged velocity	
Survey	**D**	**p-value**	**D**	**p-value**
Low vs. Mid	**3.54**	**0.0004**	1.77	0.0760
Low vs. High	**31.14**	**<0.0001**	**8.13**	**<0.0001**
Mid vs. High	**28.33**	**<0.0001**	**10.09**	**<0.0001**

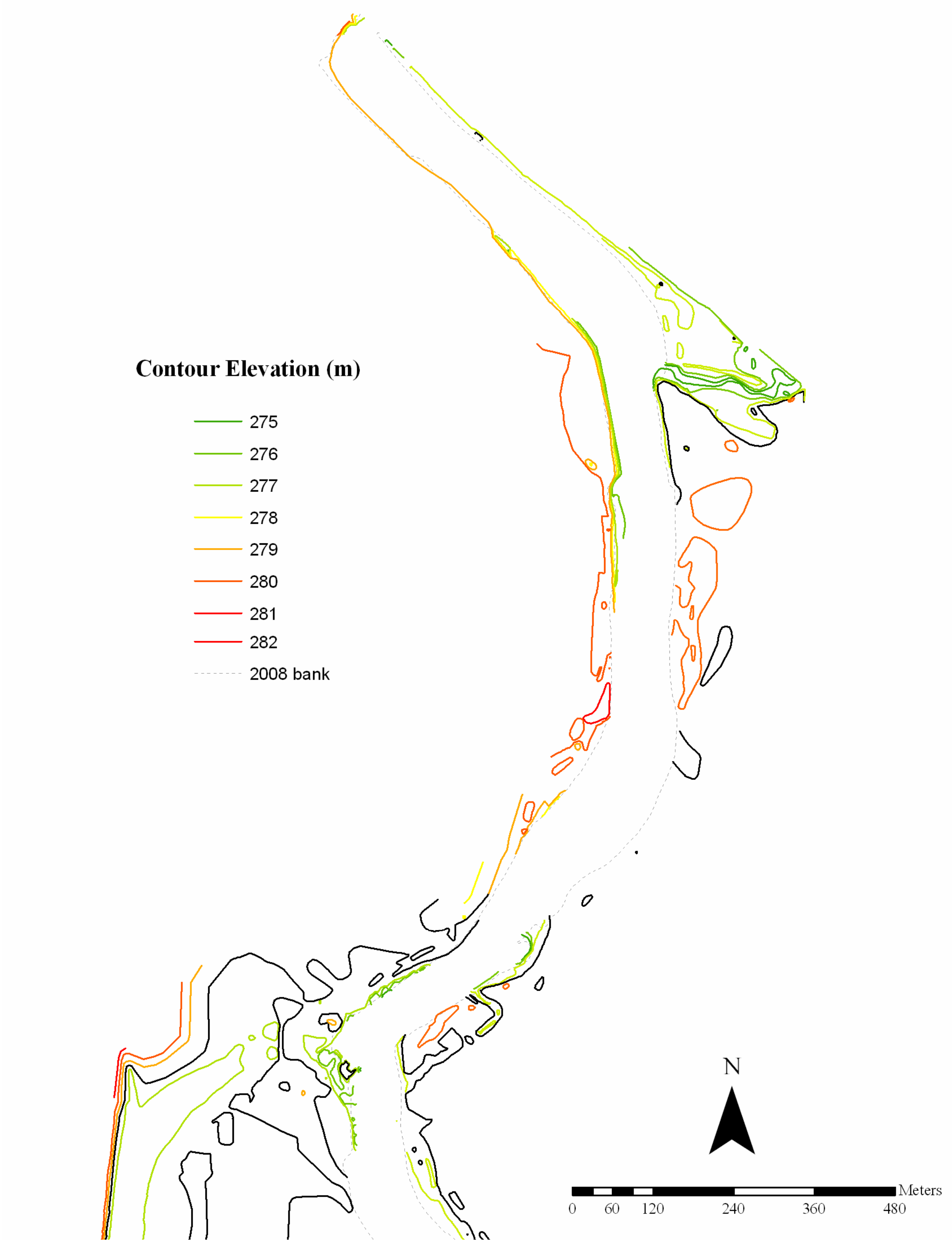


Figure II.5.1. Topographic survey of upper third of Upper Hamburg with bankline location from 2008 aerial photography.

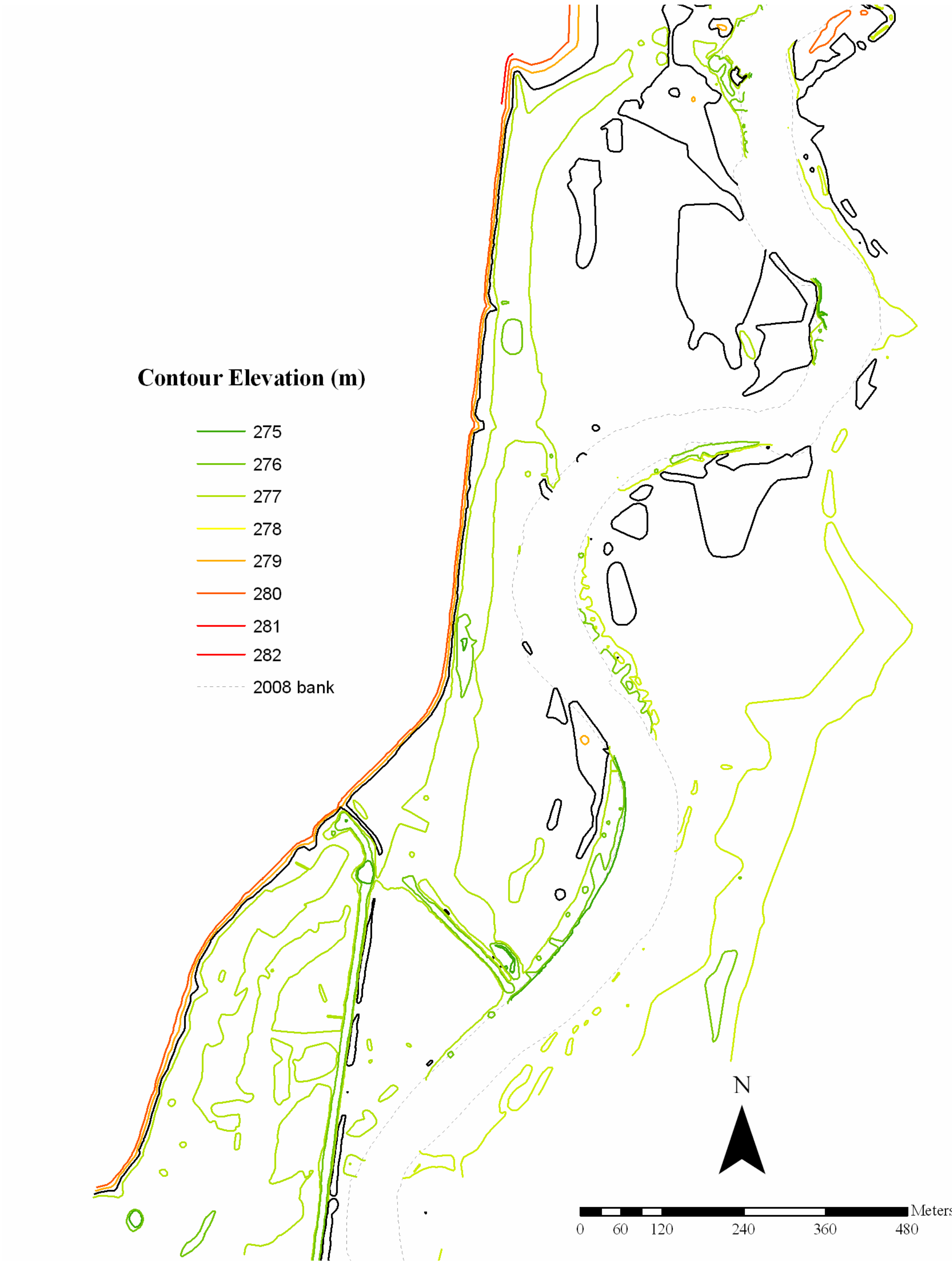


Figure II.5.2. Topographic survey of middle third of Upper Hamburg with bankline location from 2008 aerial photography.

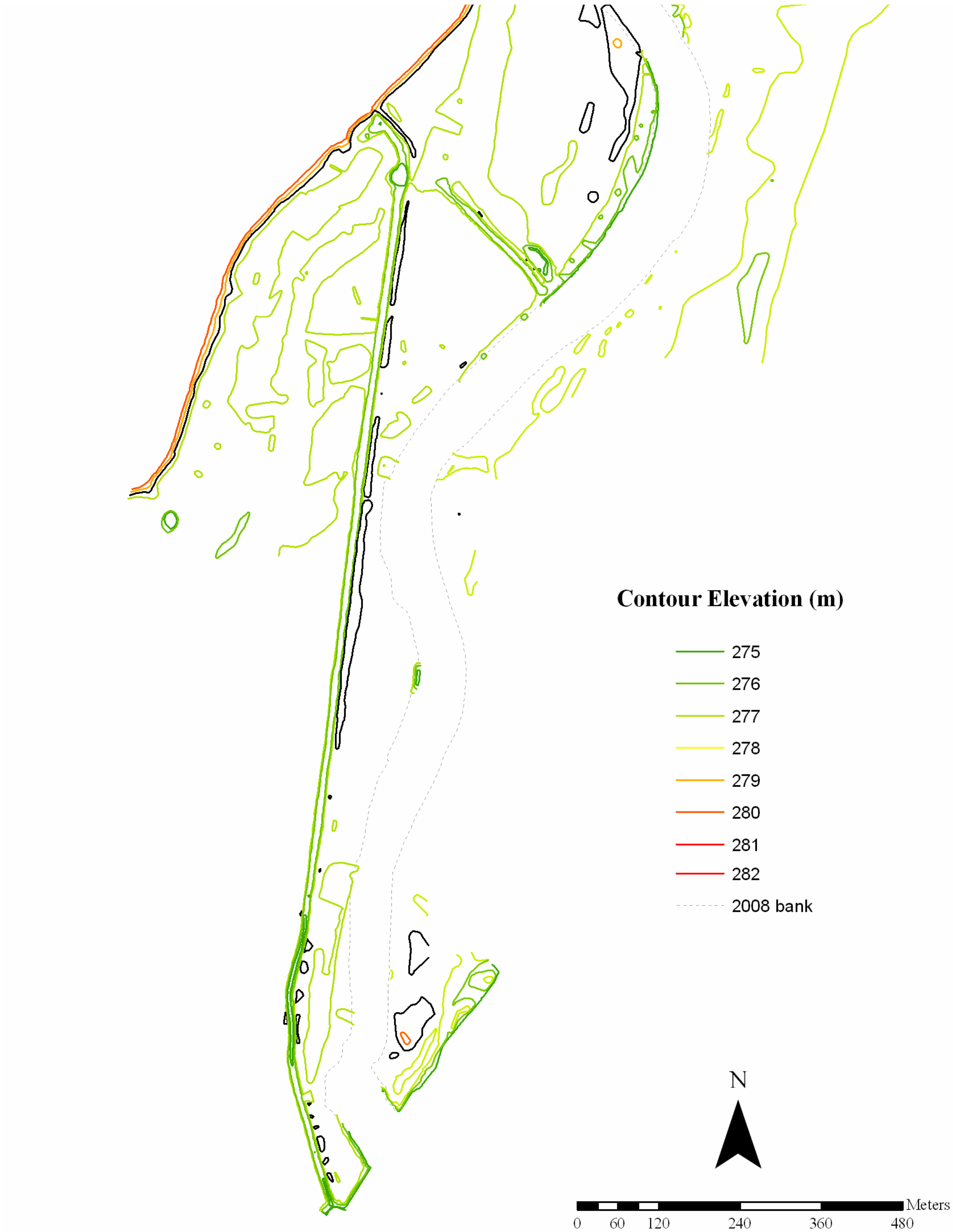


Figure II.5.3. Topographic survey of lower third of Upper Hamburg with bankline location from 2008 aerial photography.

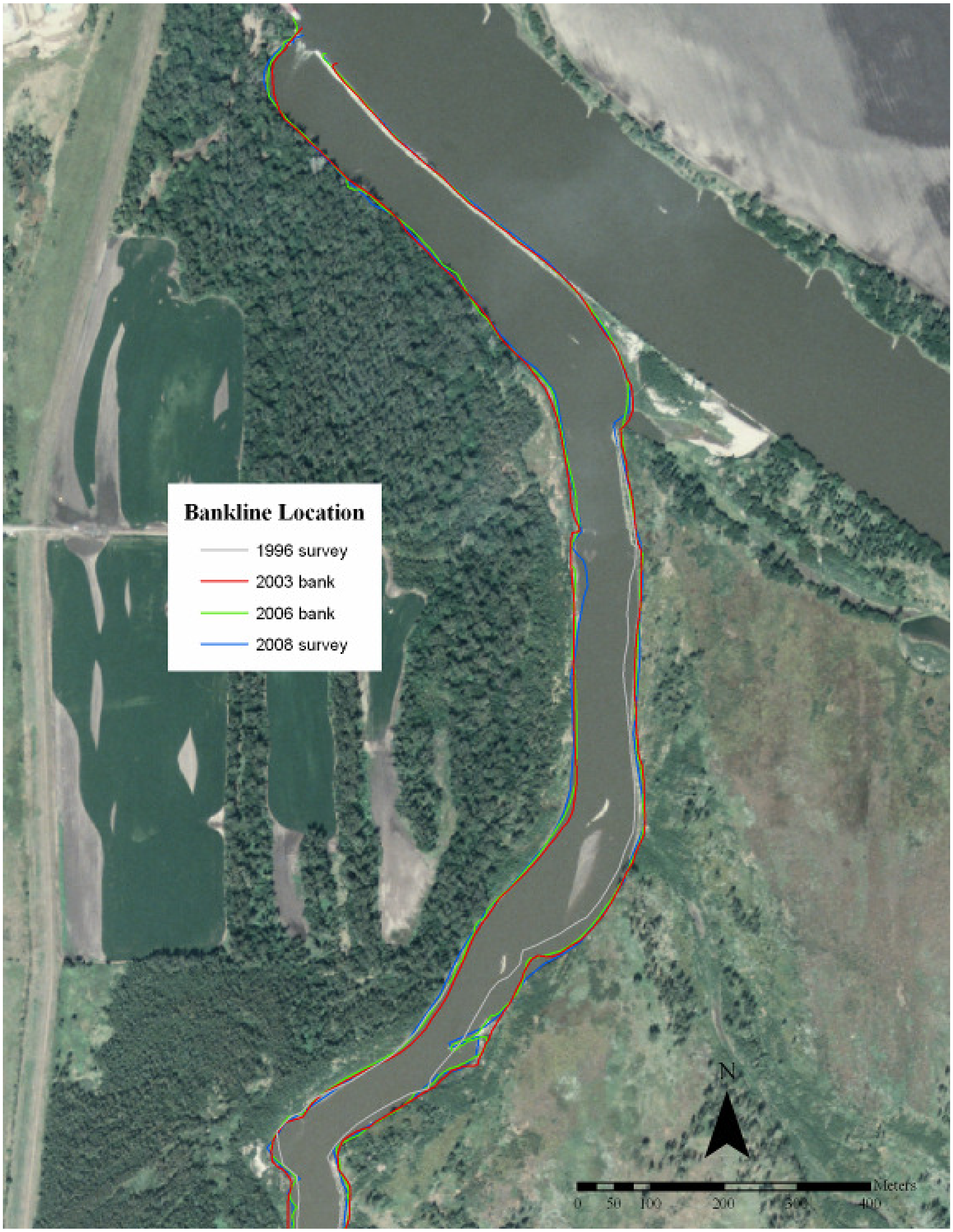


Figure II.5.4. Aerial photography of the upper third of Upper Hamburg with bankline locations from 2003, 2006 aerial photography and the 1996 and 2008 topographic surveys.

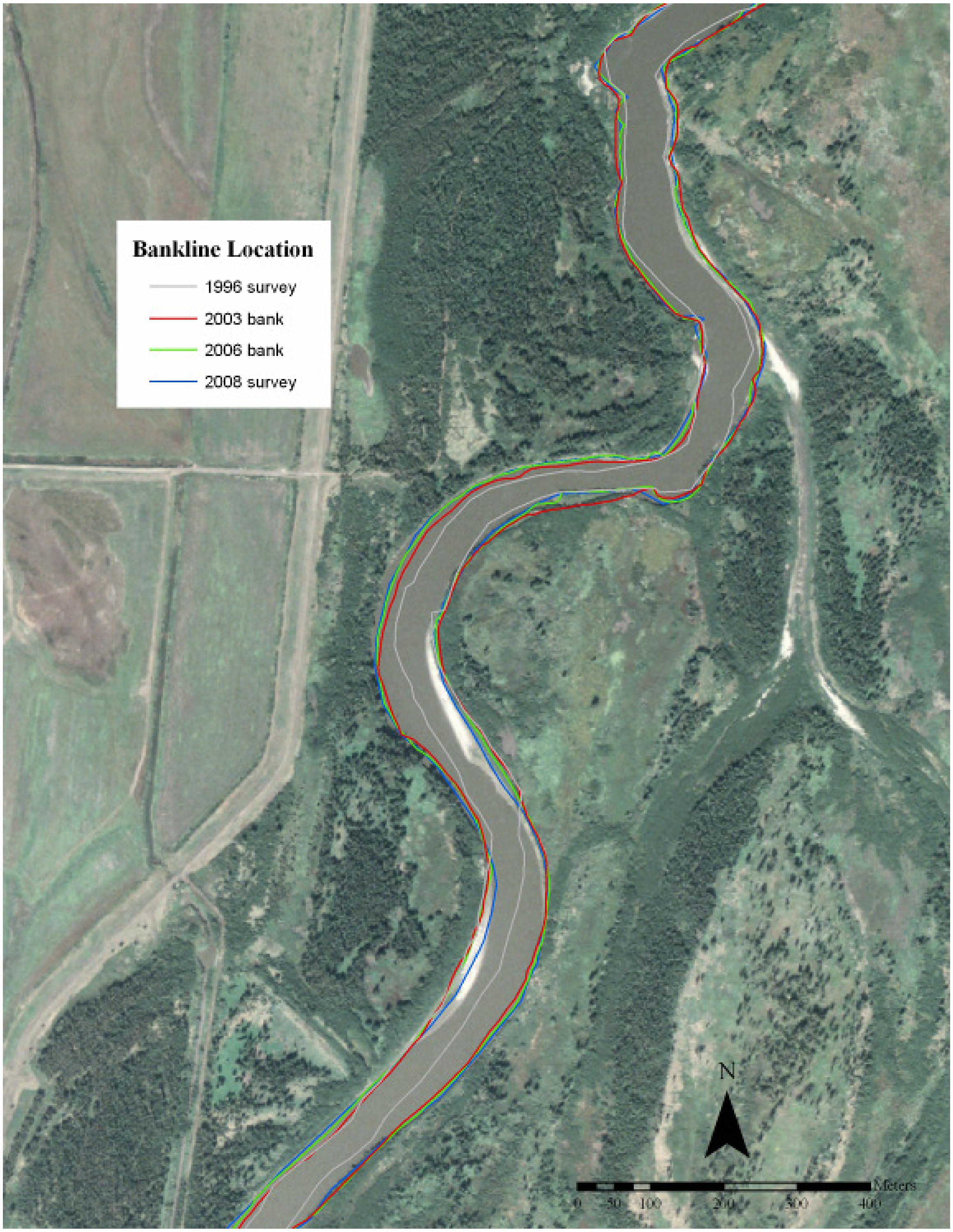


Figure II.5.5. Aerial photography of the middle third of Upper Hamburg with bankline locations from 2003, 2006 aerial photography and the 1996 and 2008 topographic surveys.

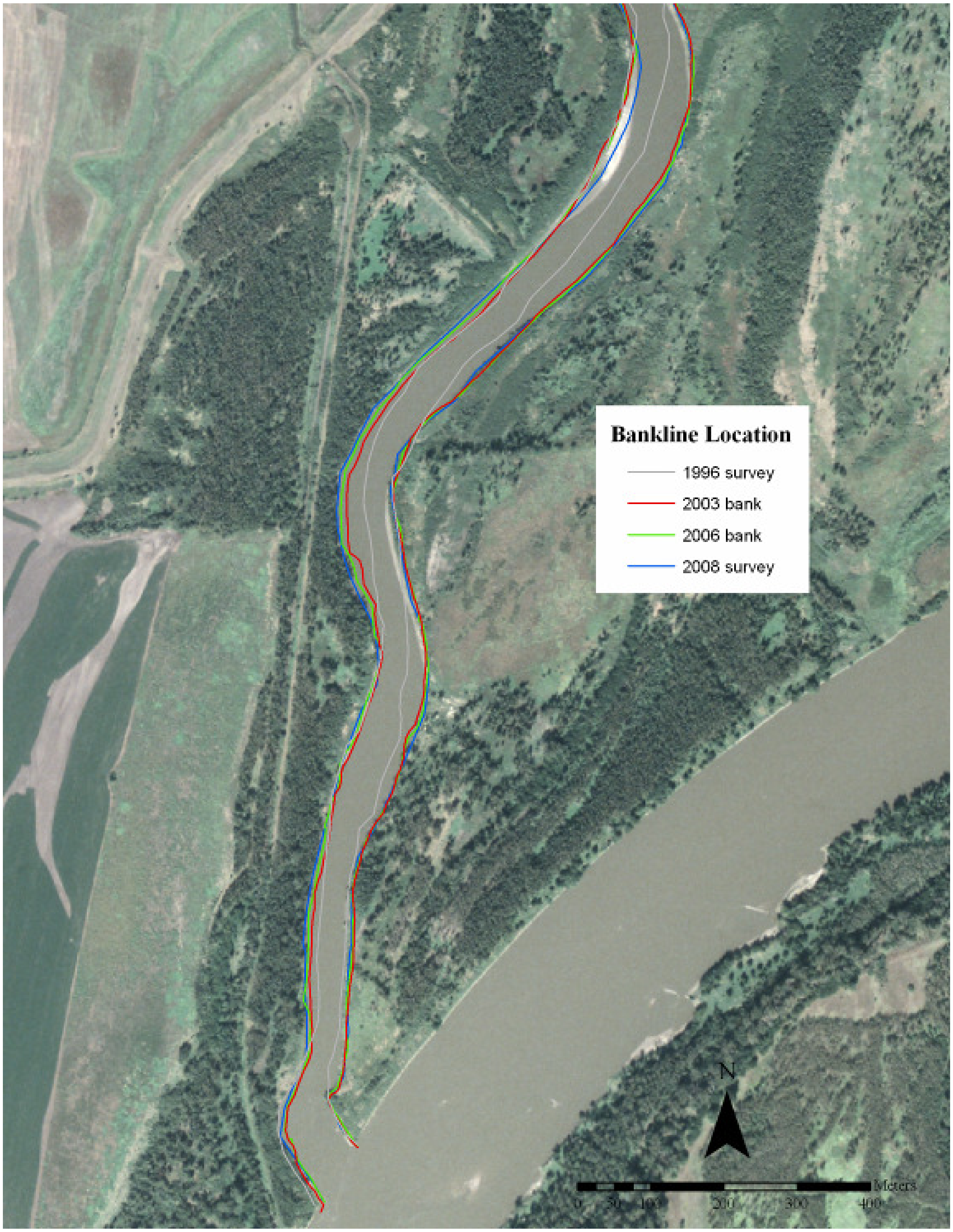


Figure II.5.6. Aerial photography of the lower third of Upper Hamburg with bankline locations from 2003, 2006 aerial photography and the 1996 and 2008 topographic surveys.

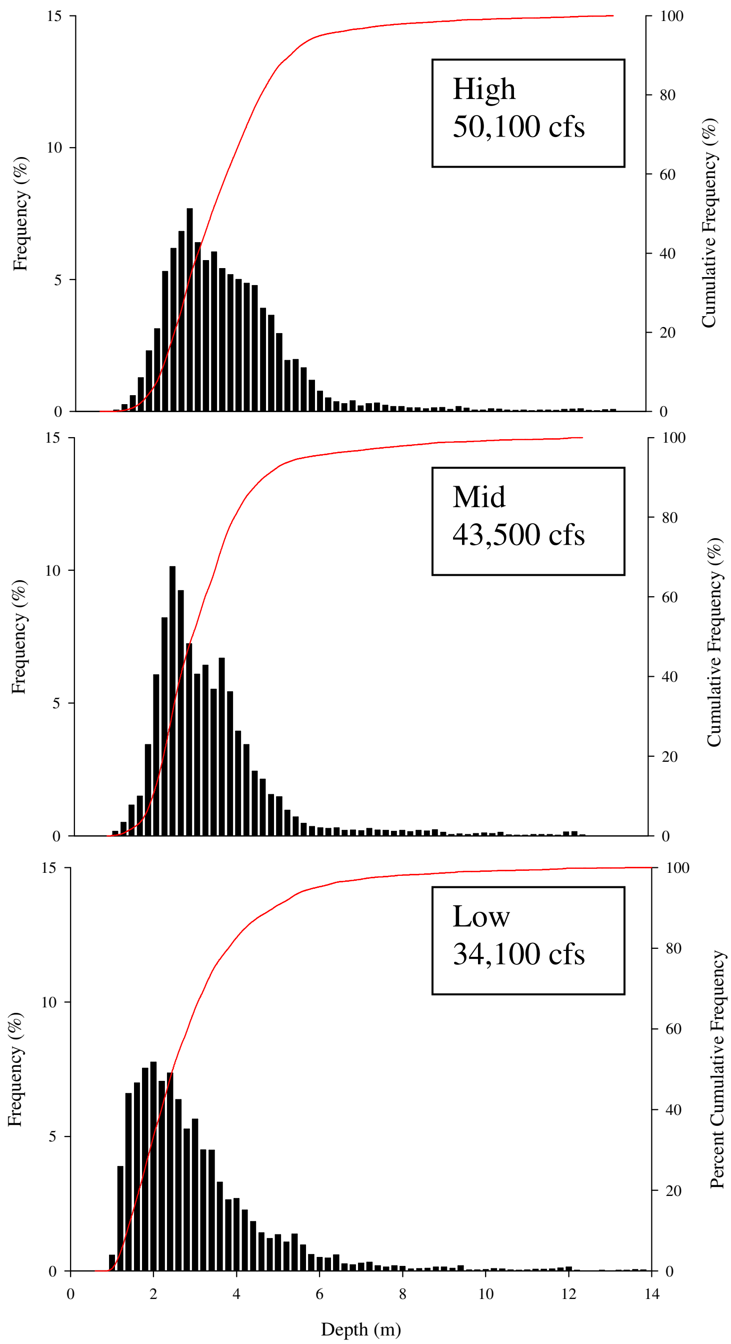


Figure II.5.7. Depth frequency and cumulative frequency (line) distributions for Upper Hamburg during all three Doppler surveys.

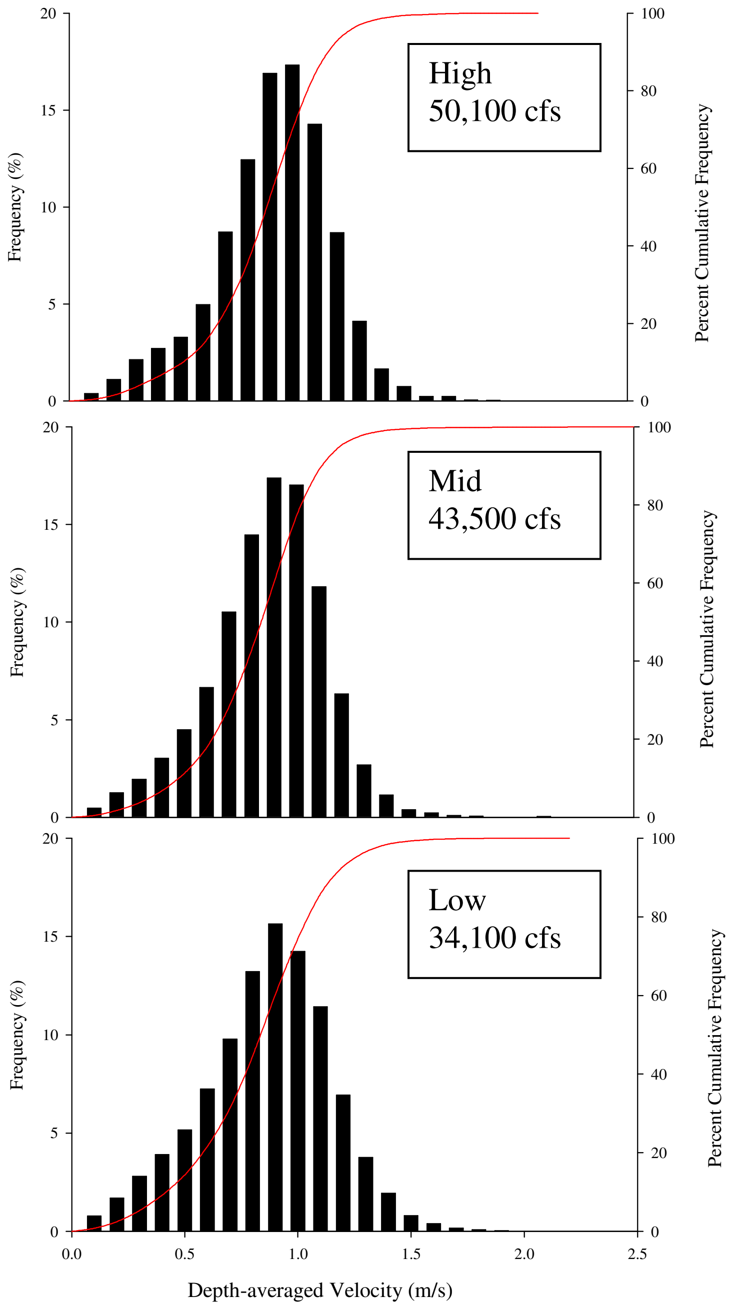


Figure II.5.8. Depth-averaged velocity frequency and cumulative frequency (line) distributions for Upper Hamburg during all three Doppler surveys.

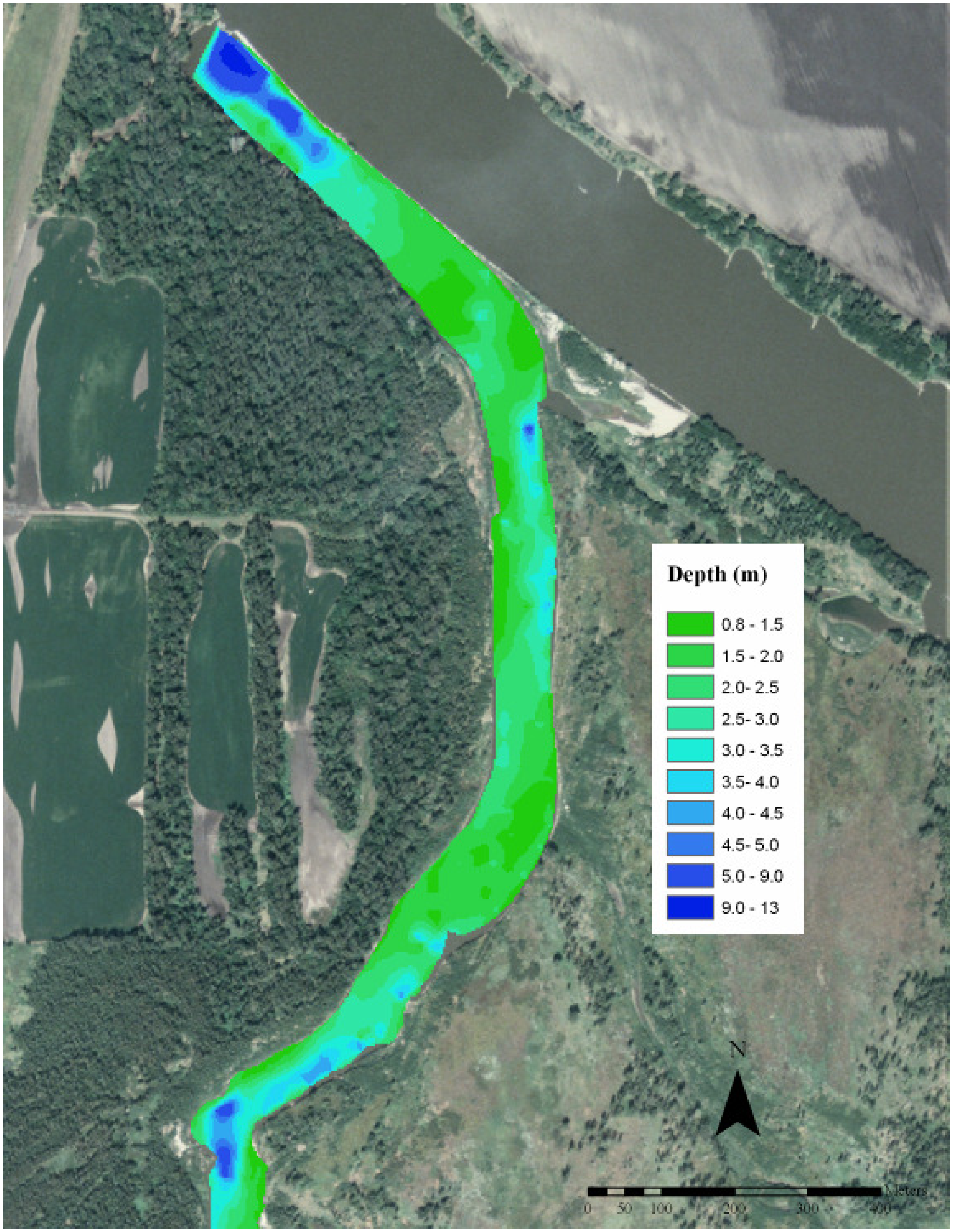


Figure II.5.9. Depth distribution from the Low survey (34,100 cfs) for the upper third of Upper Hamburg.

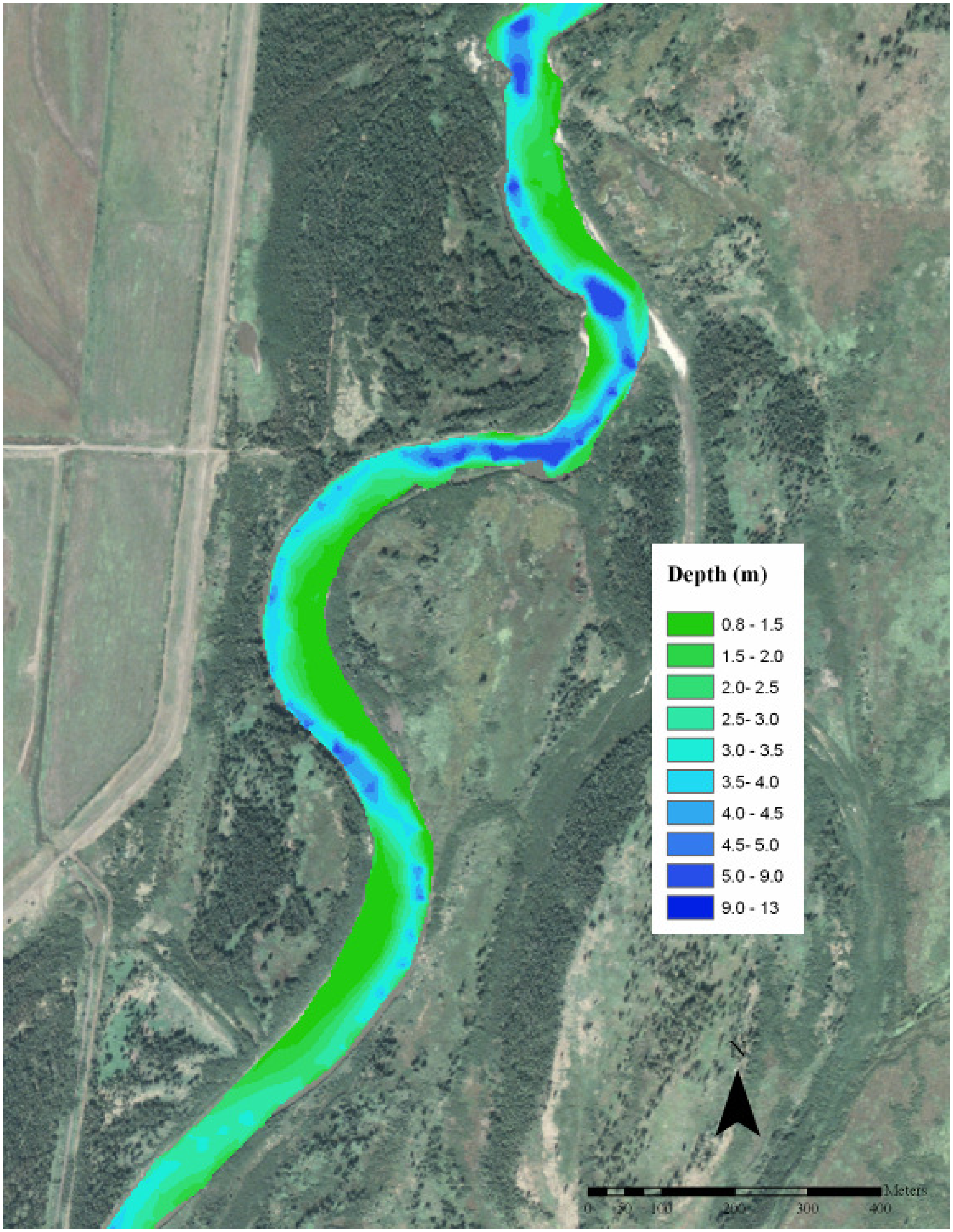


Figure II.5.10. Depth distribution from the Low survey (34,100 cfs) for the middle third of Upper Hamburg.

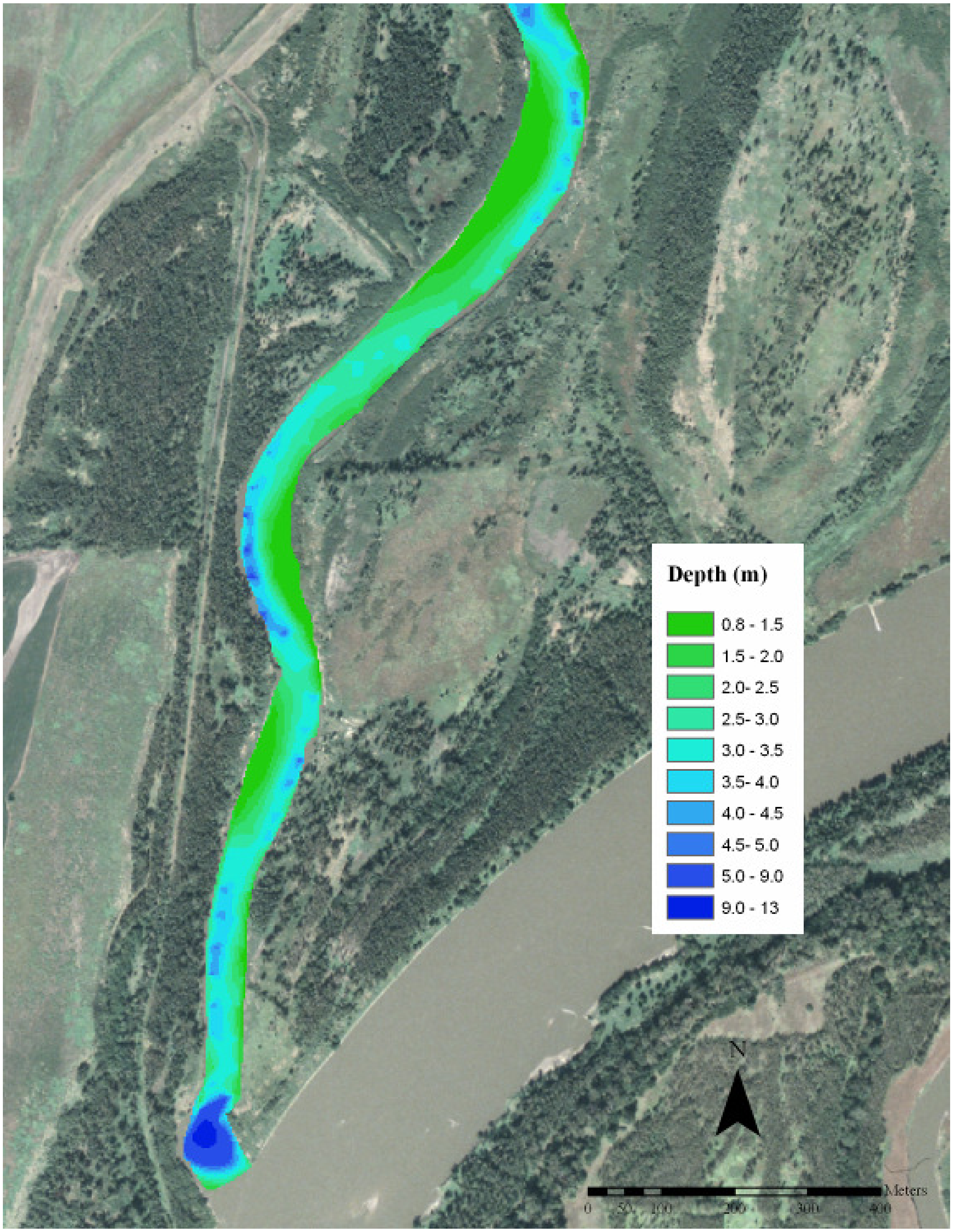


Figure II.5.11. Depth distribution from the Low survey (34,100 cfs) for the bottom third of Upper Hamburg.

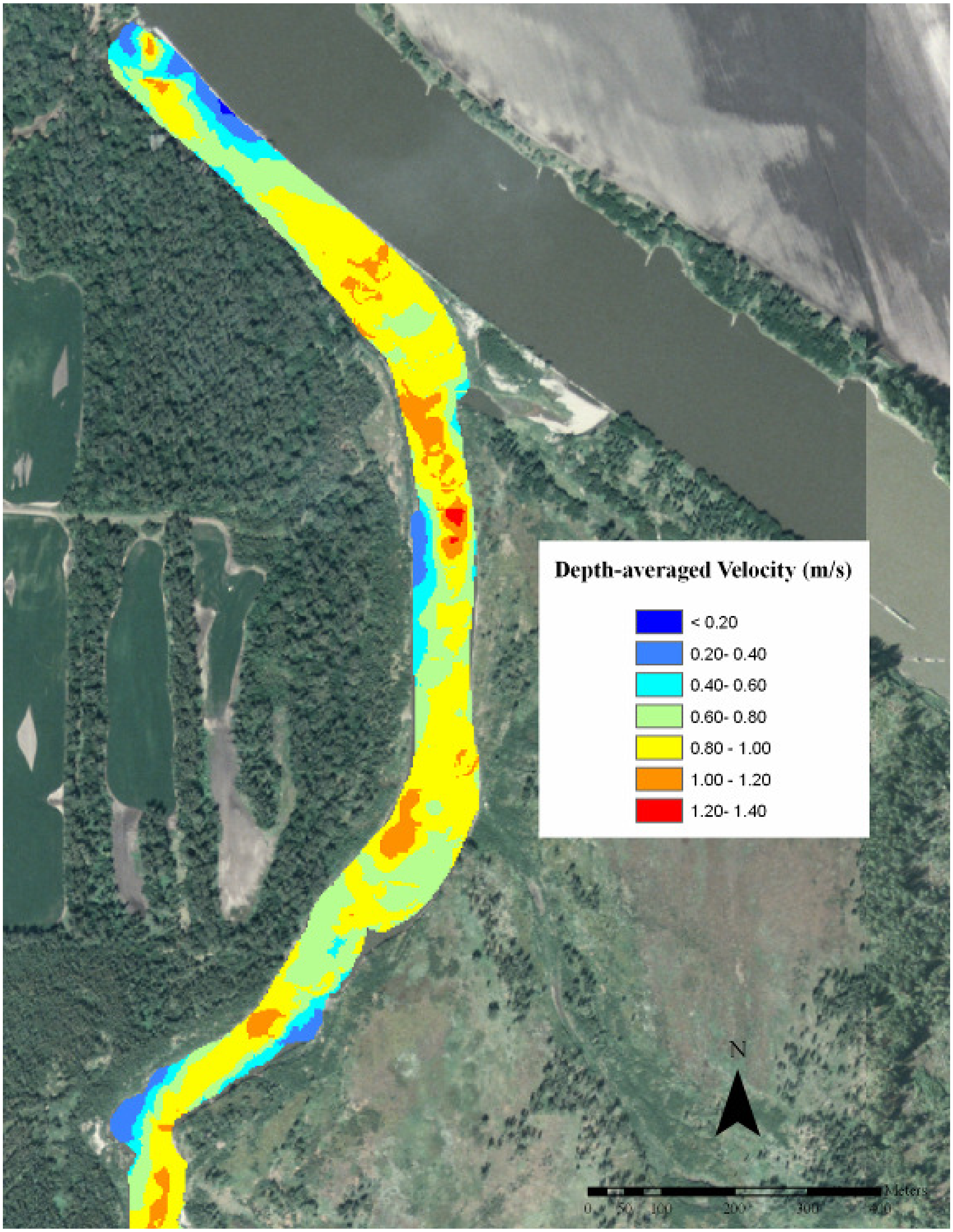


Figure II.5.12. Depth-averaged velocity distribution from the Low survey (34,100 cfs) for the upper third of Upper Hamburg.

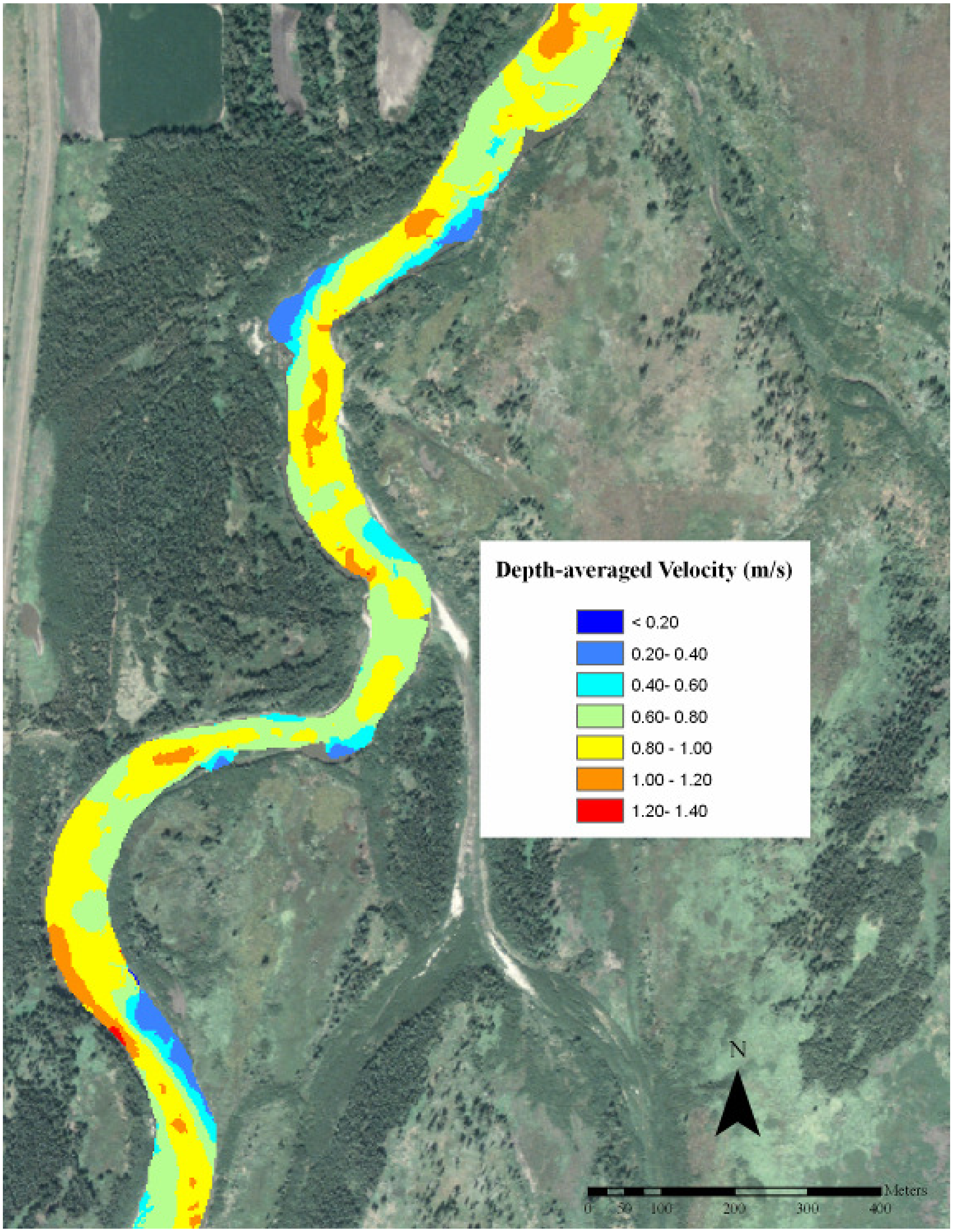


Figure II.5.13. Depth-averaged velocity distribution from the Low survey (34,100 cfs) for the middle third of Upper Hamburg.

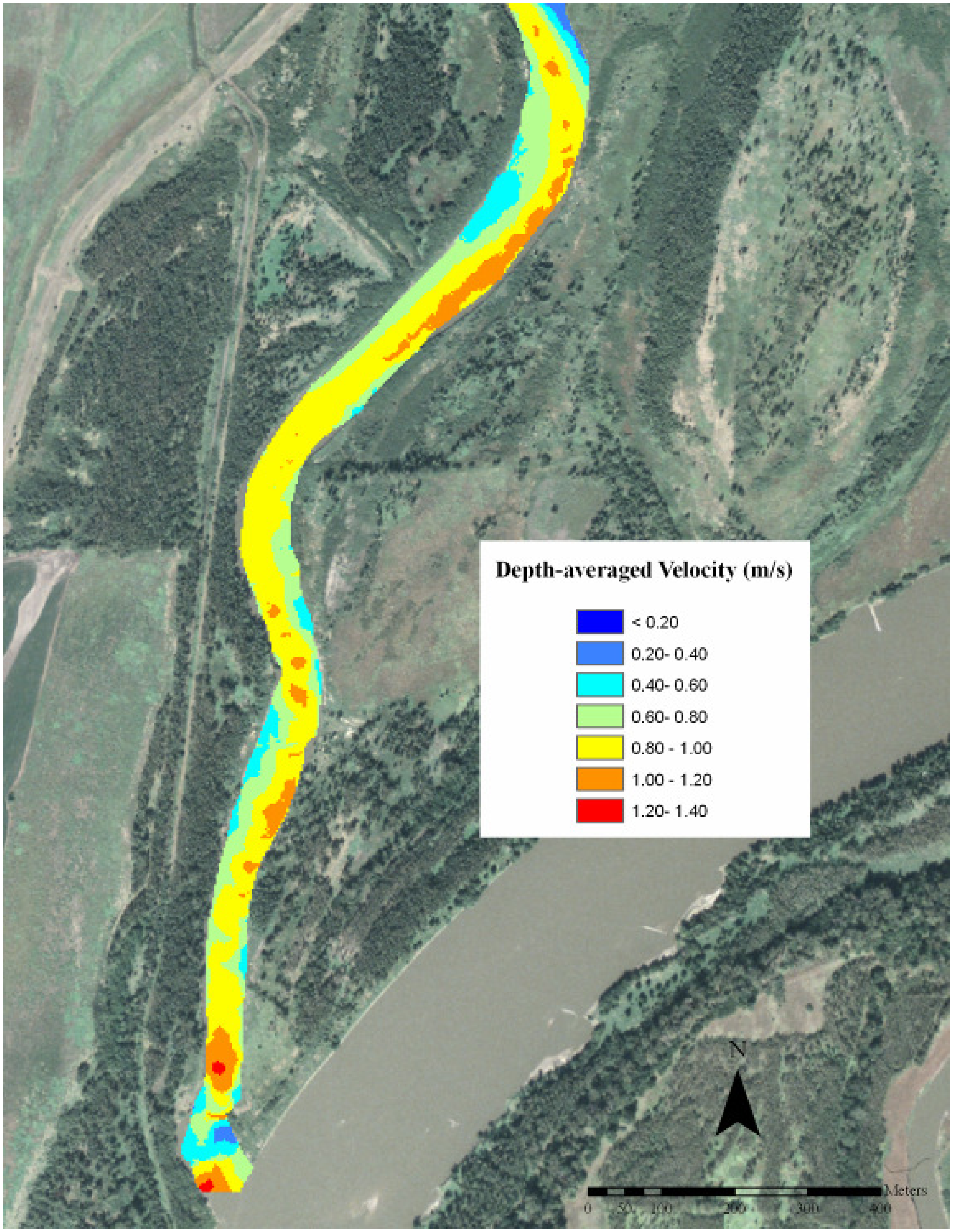


Figure II.5.14. Depth-averaged velocity distribution from the Low survey (34,100 cfs) for the bottom third of Upper Hamburg.

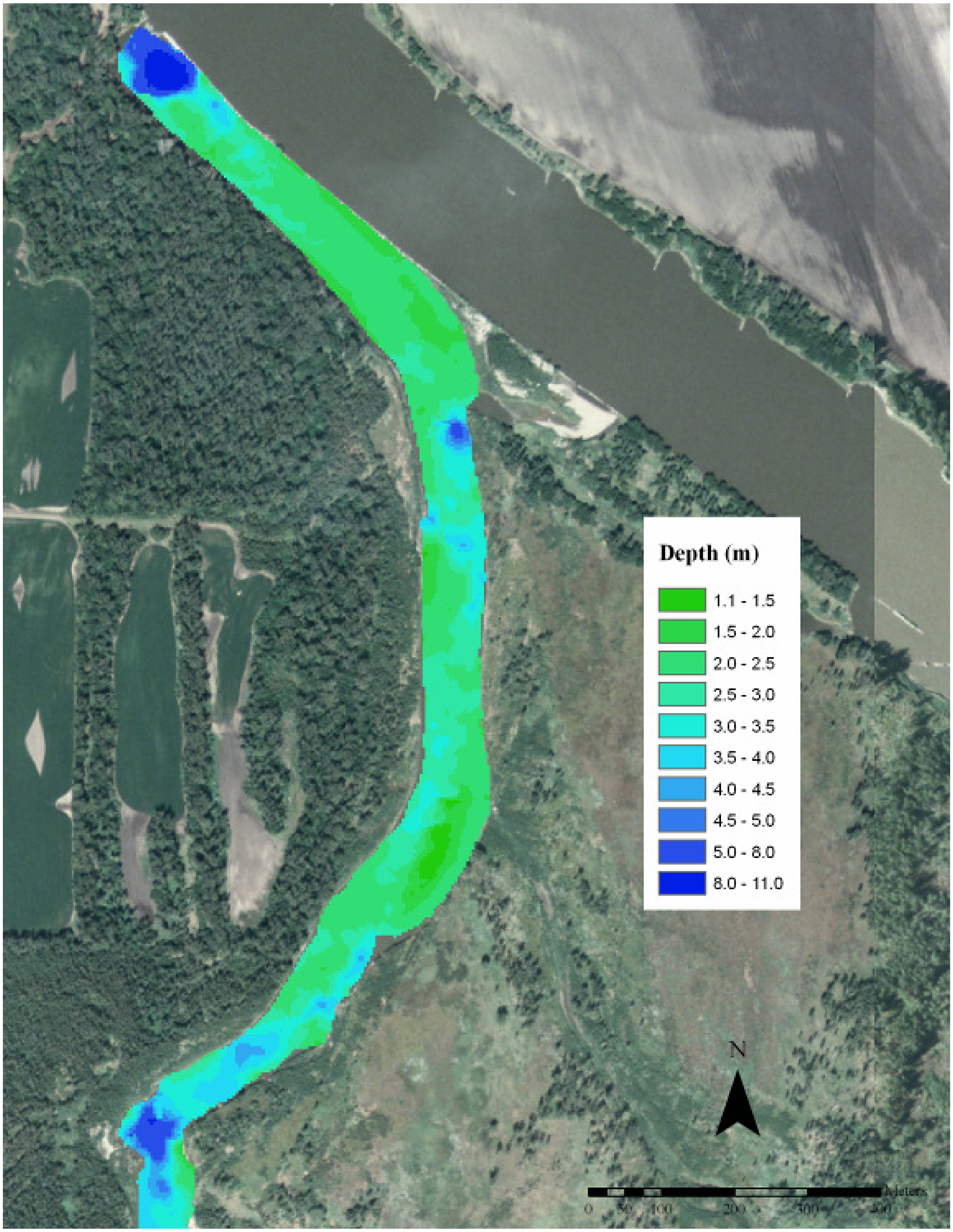


Figure II.5.15. Depth distribution from the Mid survey (43,500 cfs) for the upper third of Upper Hamburg.

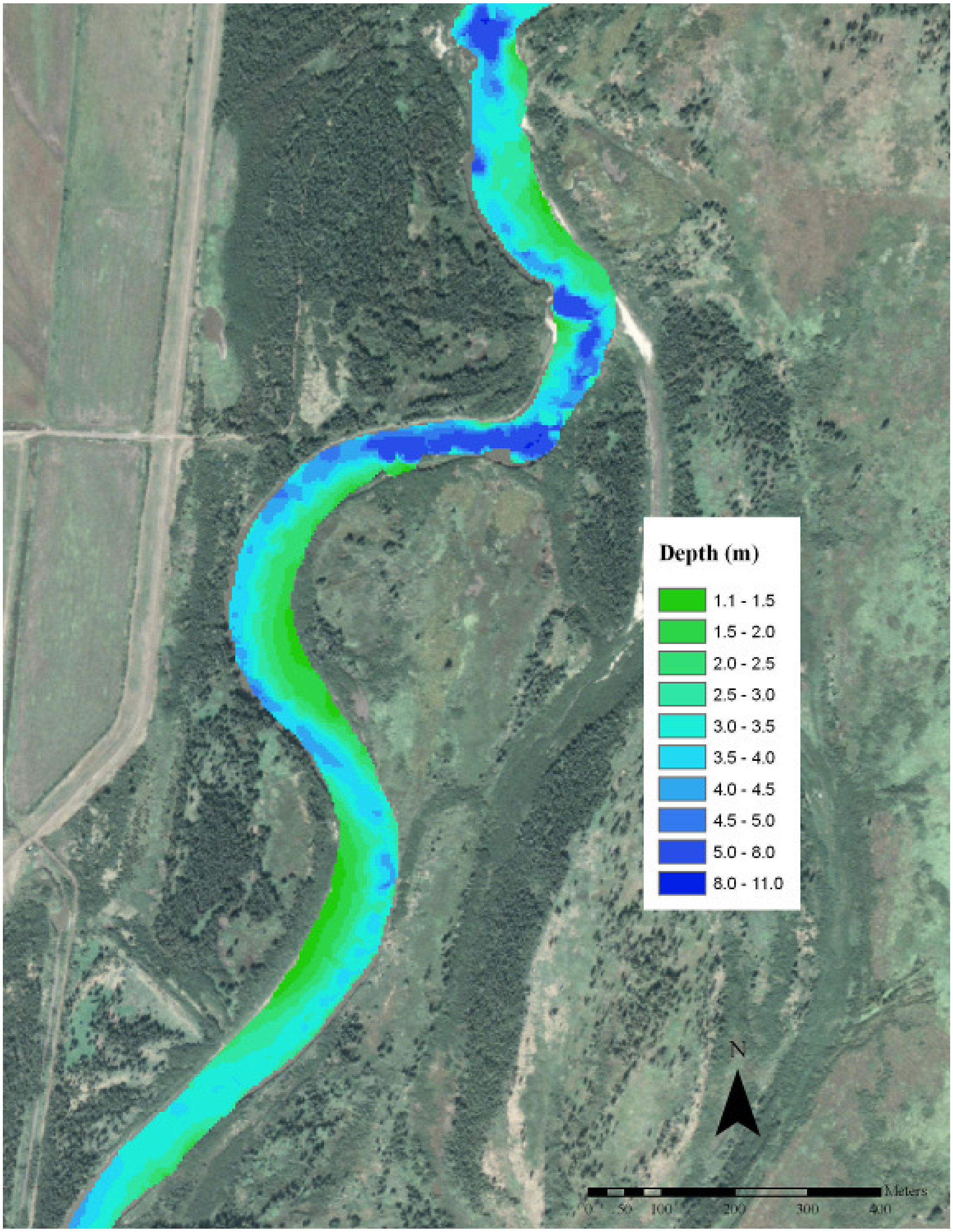


Figure II.5.16. Depth distribution from the Mid survey (43,500 cfs) for the middle third of Upper Hamburg.

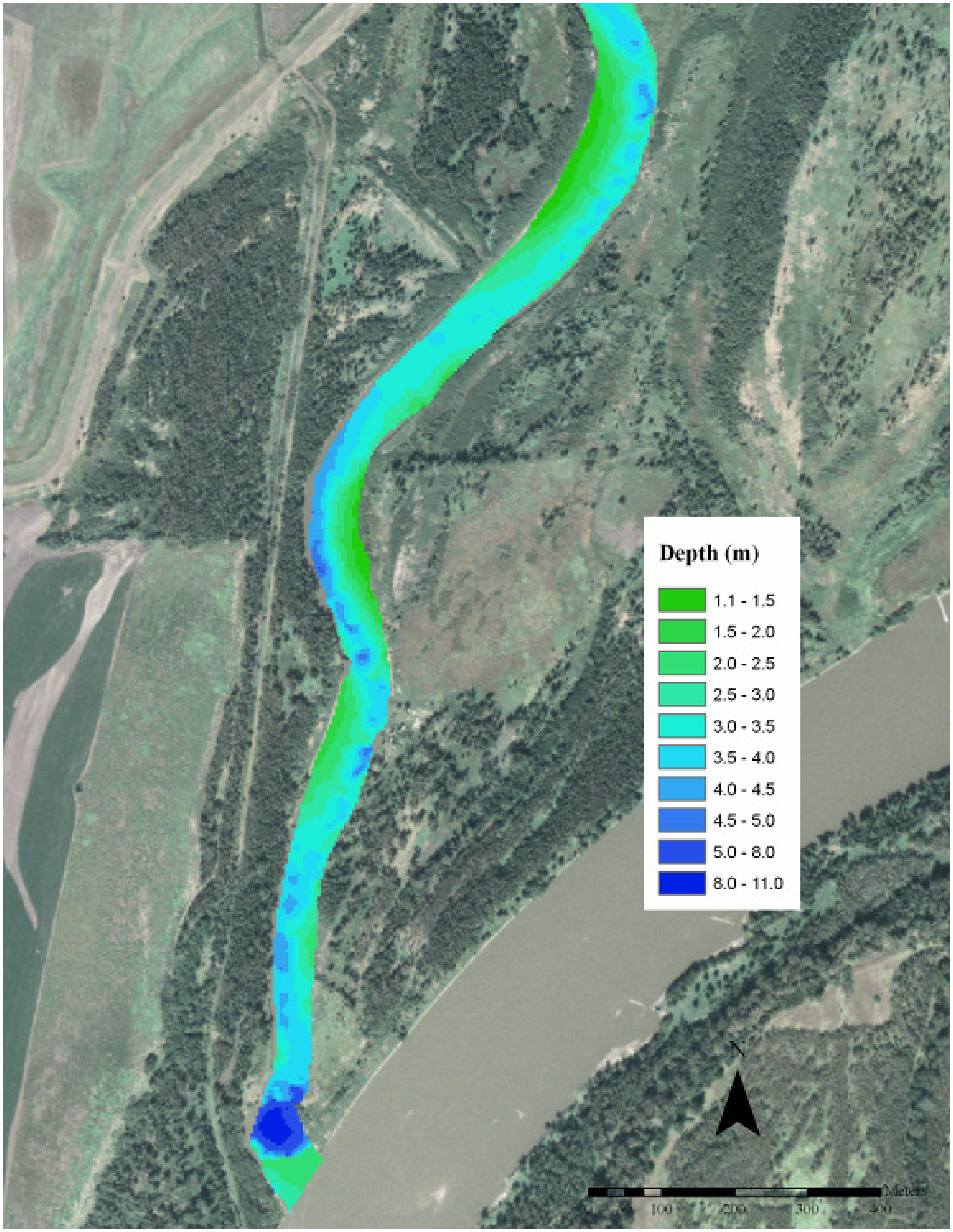


Figure II.5.17. Depth distribution from the Mid survey (43,500 cfs) for the bottom third of Upper Hamburg.

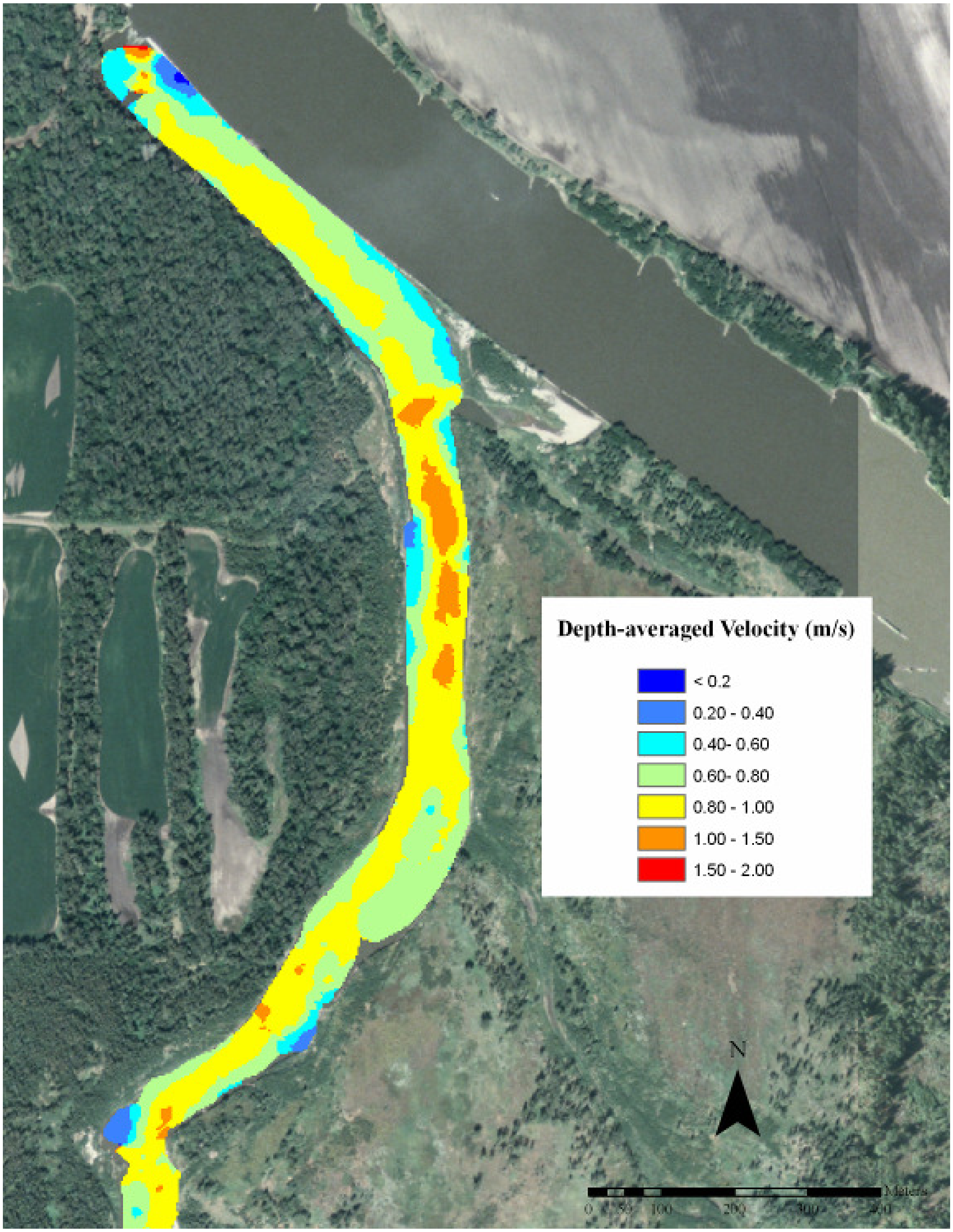


Figure II.5.18. Depth-averaged velocity distribution from the Mid survey (43,500 cfs) for the upper third of Upper Hamburg.

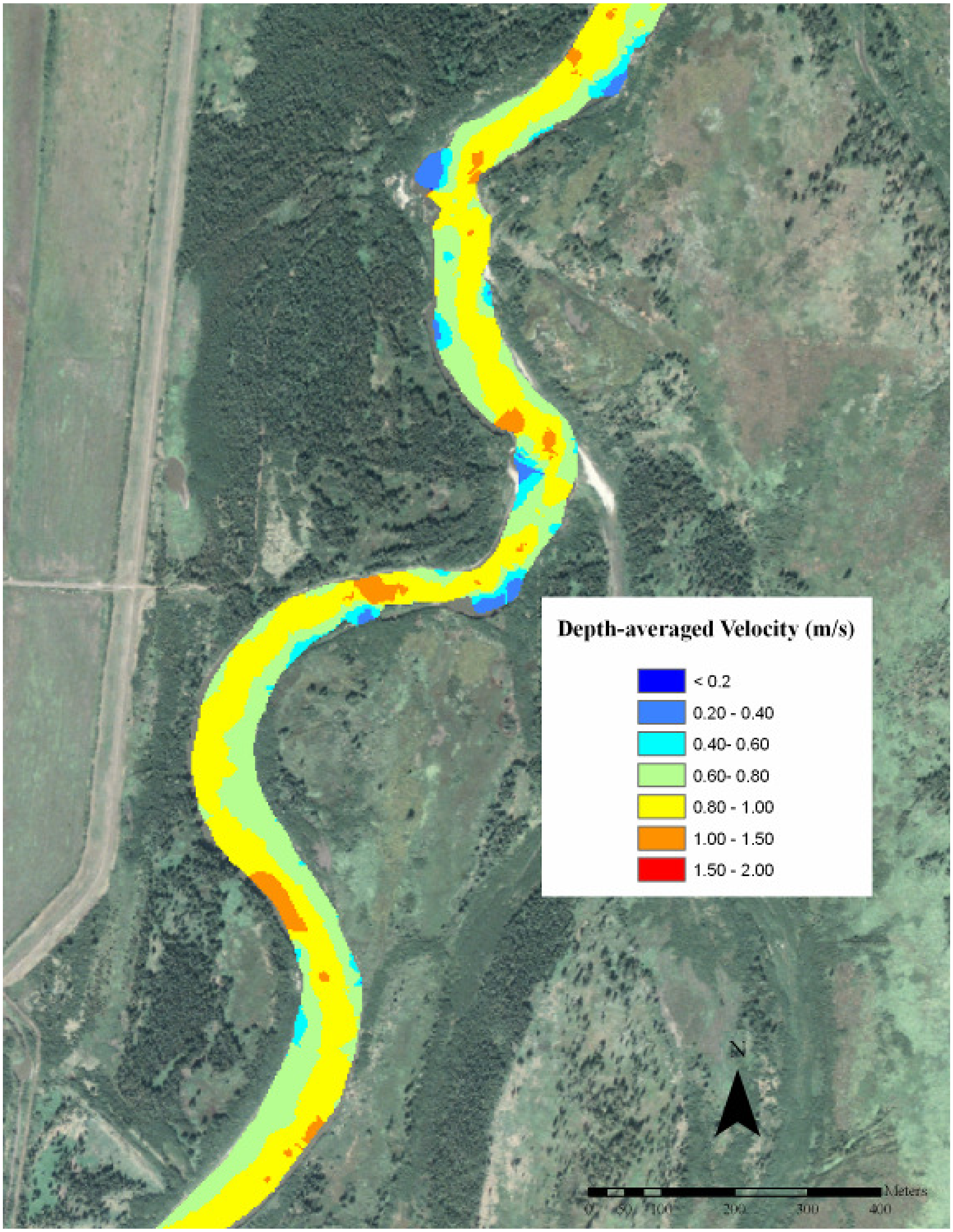


Figure II.5.19. Depth-averaged velocity distribution from the Mid survey (43,500 cfs) for the middle third of Upper Hamburg.

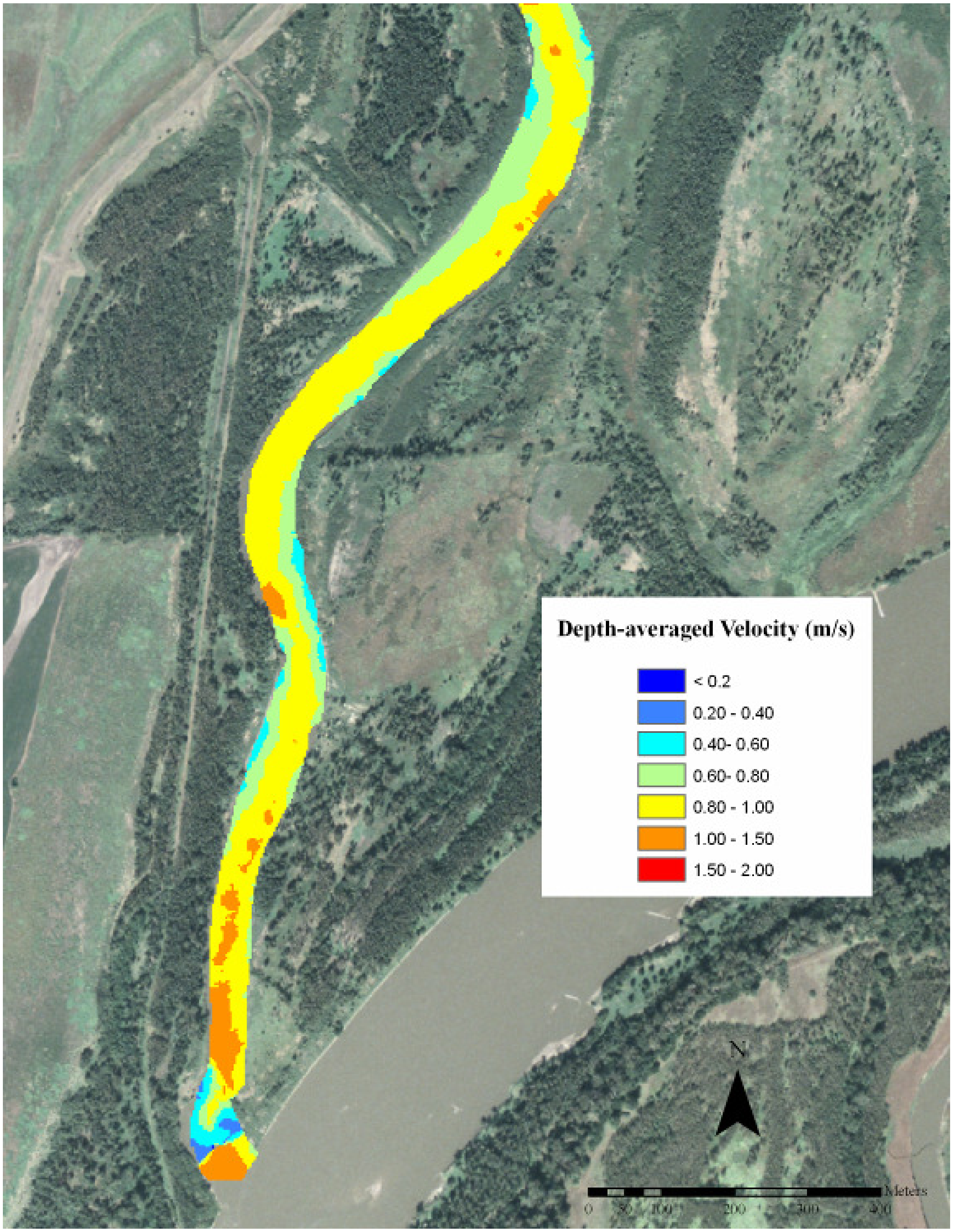


Figure II.5.20. Depth-averaged velocity distribution from the Mid survey (43,500 cfs) for the bottom third of Upper Hamburg.

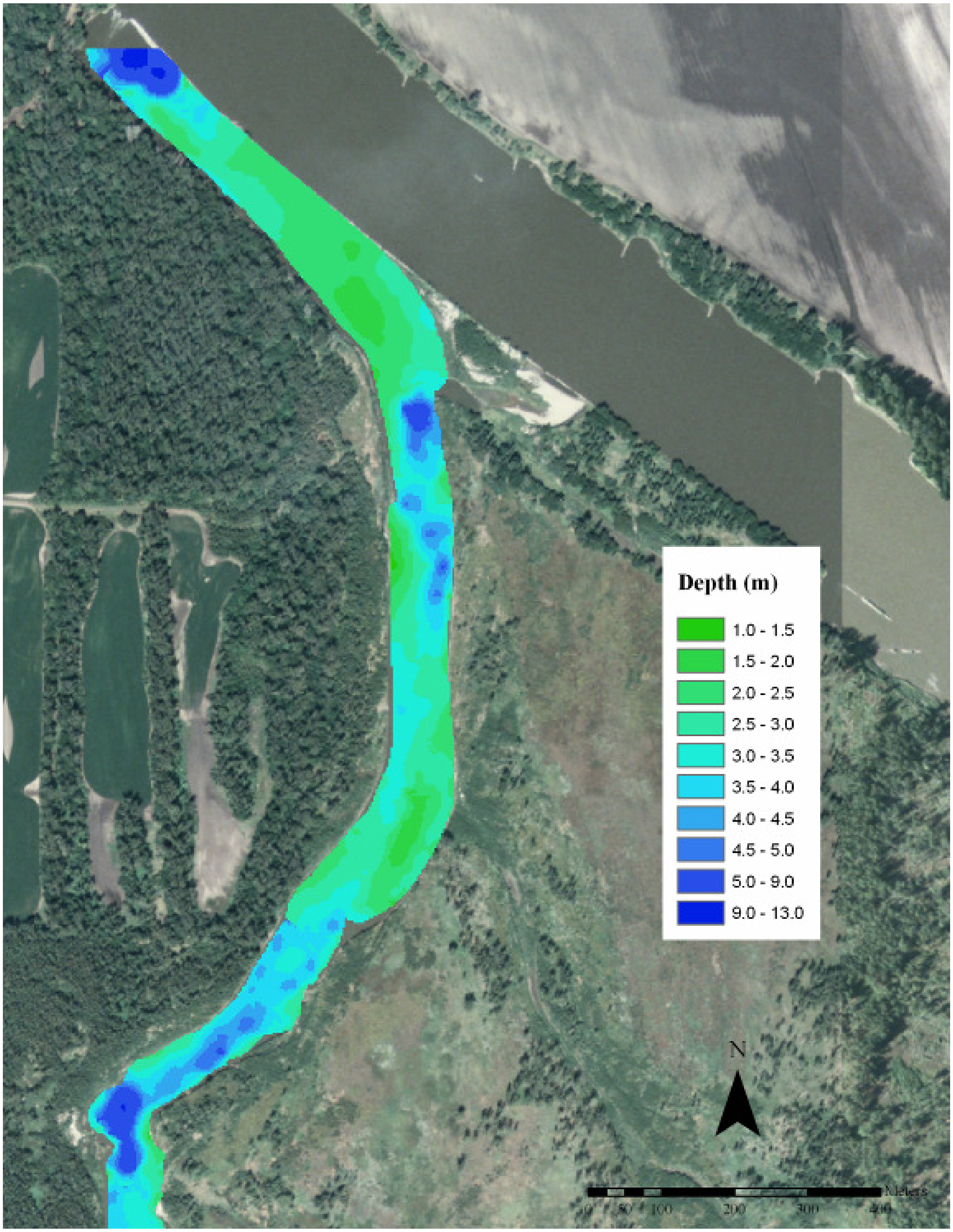


Figure II.5.21. Depth distribution from the High survey (50,100 cfs) for the upper third of Upper Hamburg.

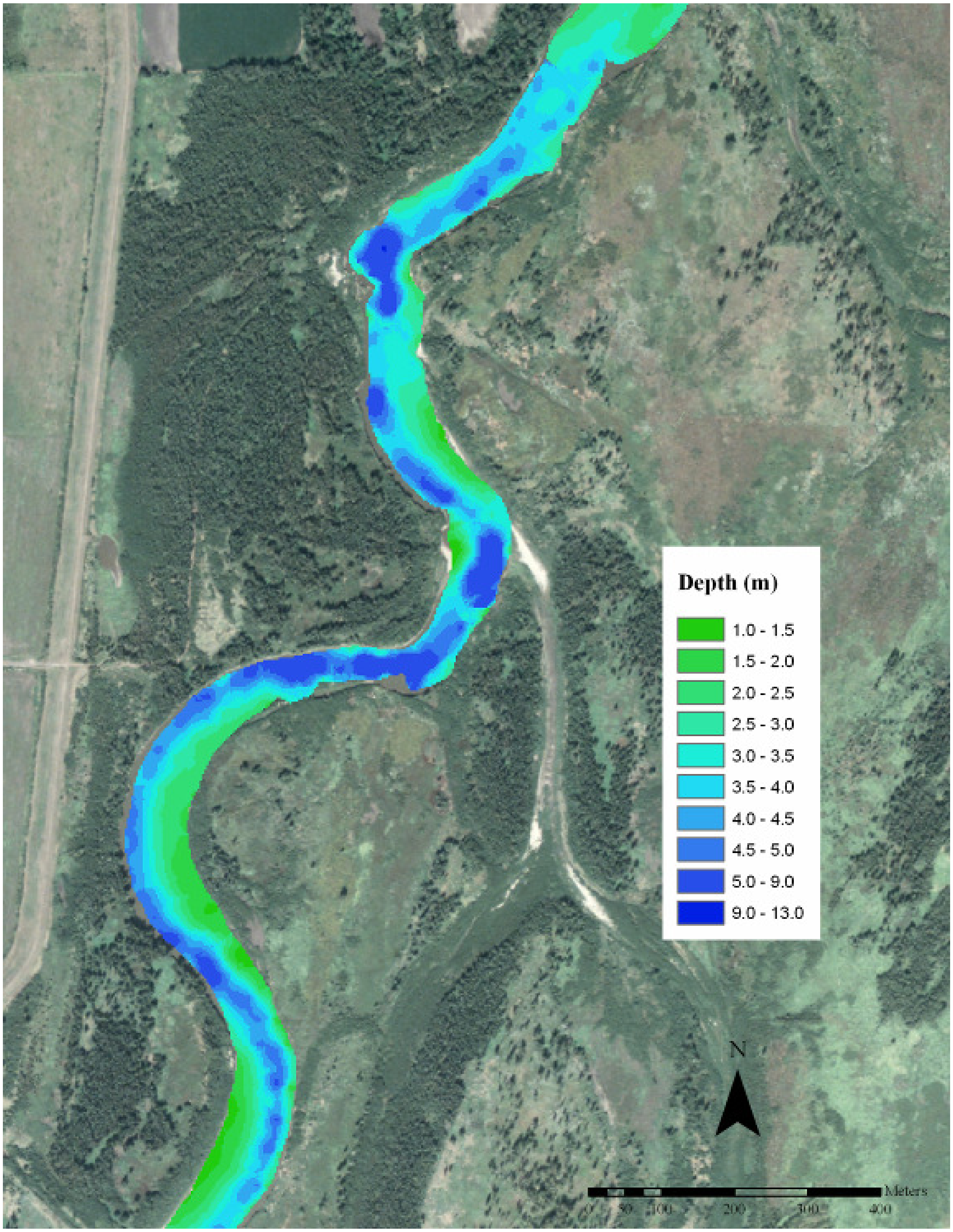


Figure II.5.22. Depth distribution from the High survey (50,100 cfs) for the middle third of Upper Hamburg.

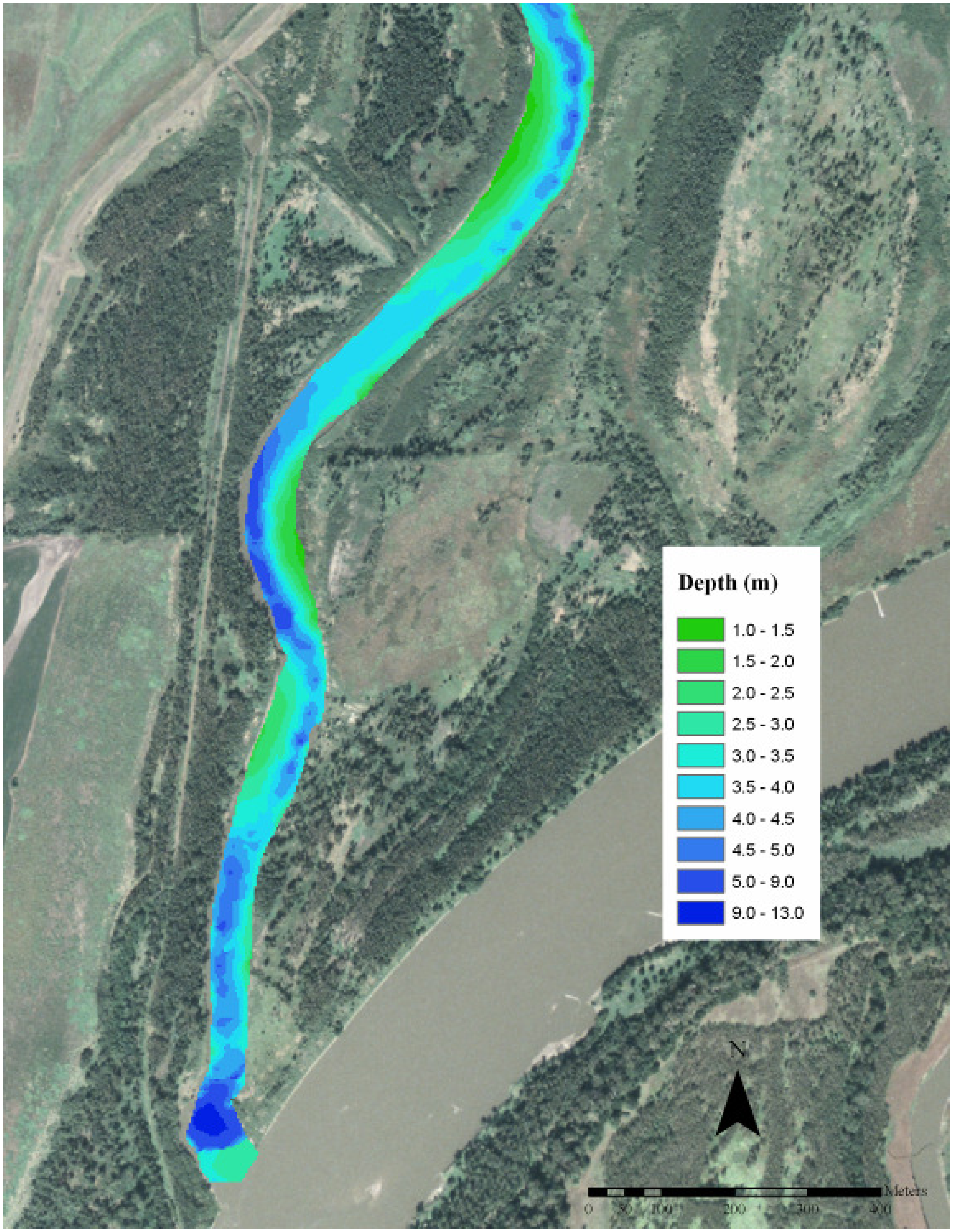


Figure II.5.23. Depth distribution from the High survey (50,100 cfs) for the bottom third of Upper Hamburg.

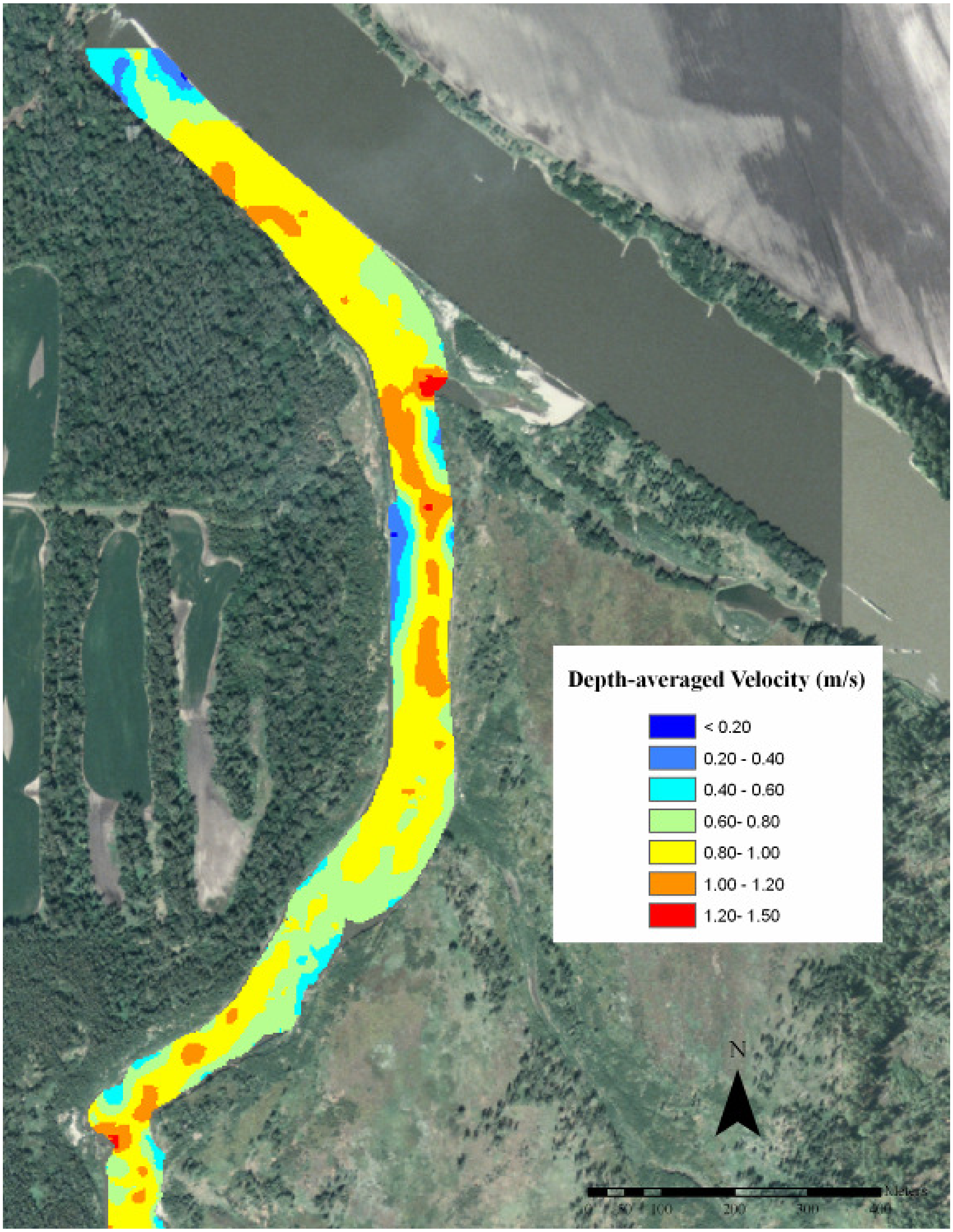


Figure II.5.24. Depth-averaged velocity distribution from the High survey (50,100 cfs) for the upper third of Upper Hamburg.

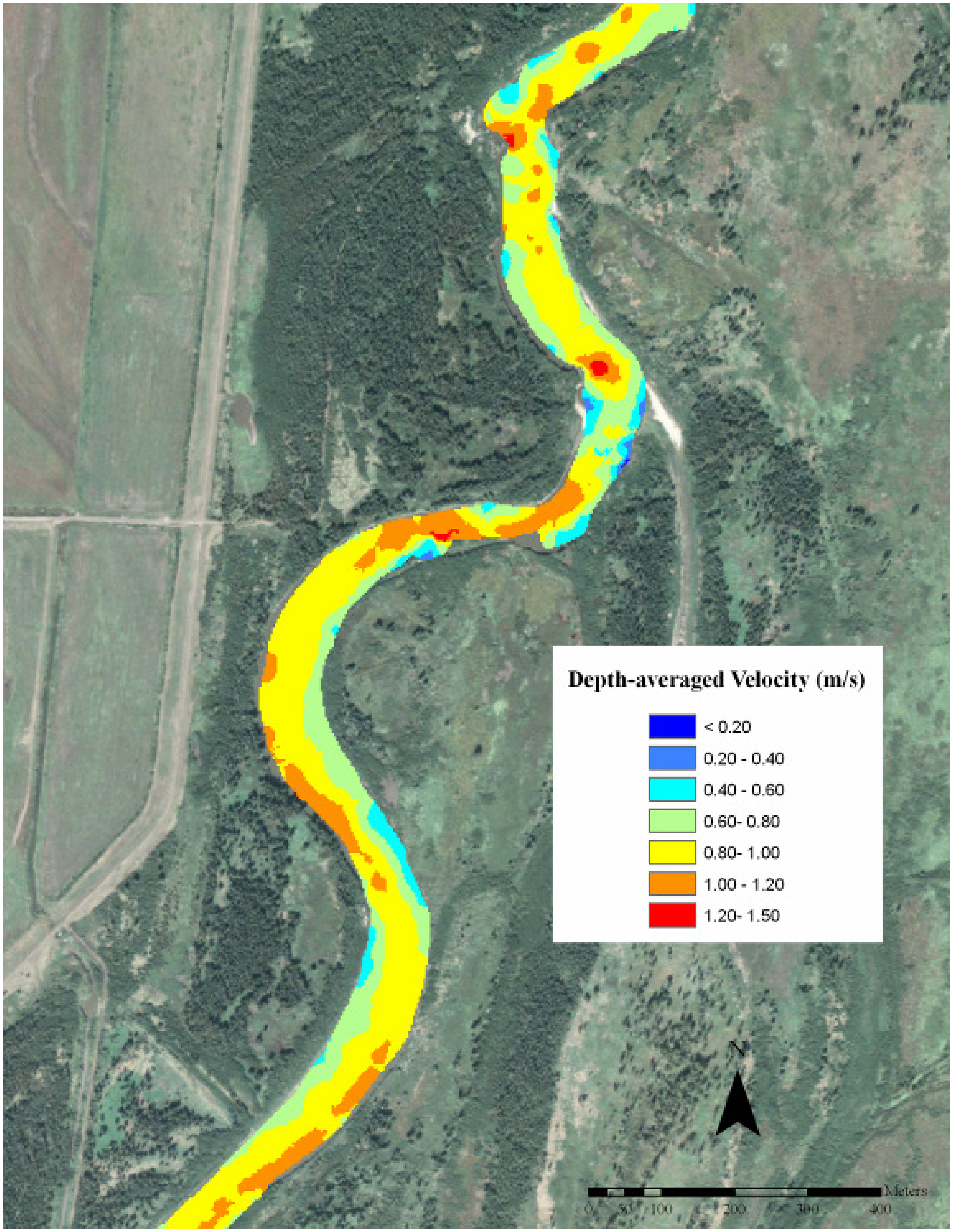


Figure II.5.25. Depth-averaged velocity distribution from the High survey (50,100 cfs) for the middle third of Upper Hamburg.

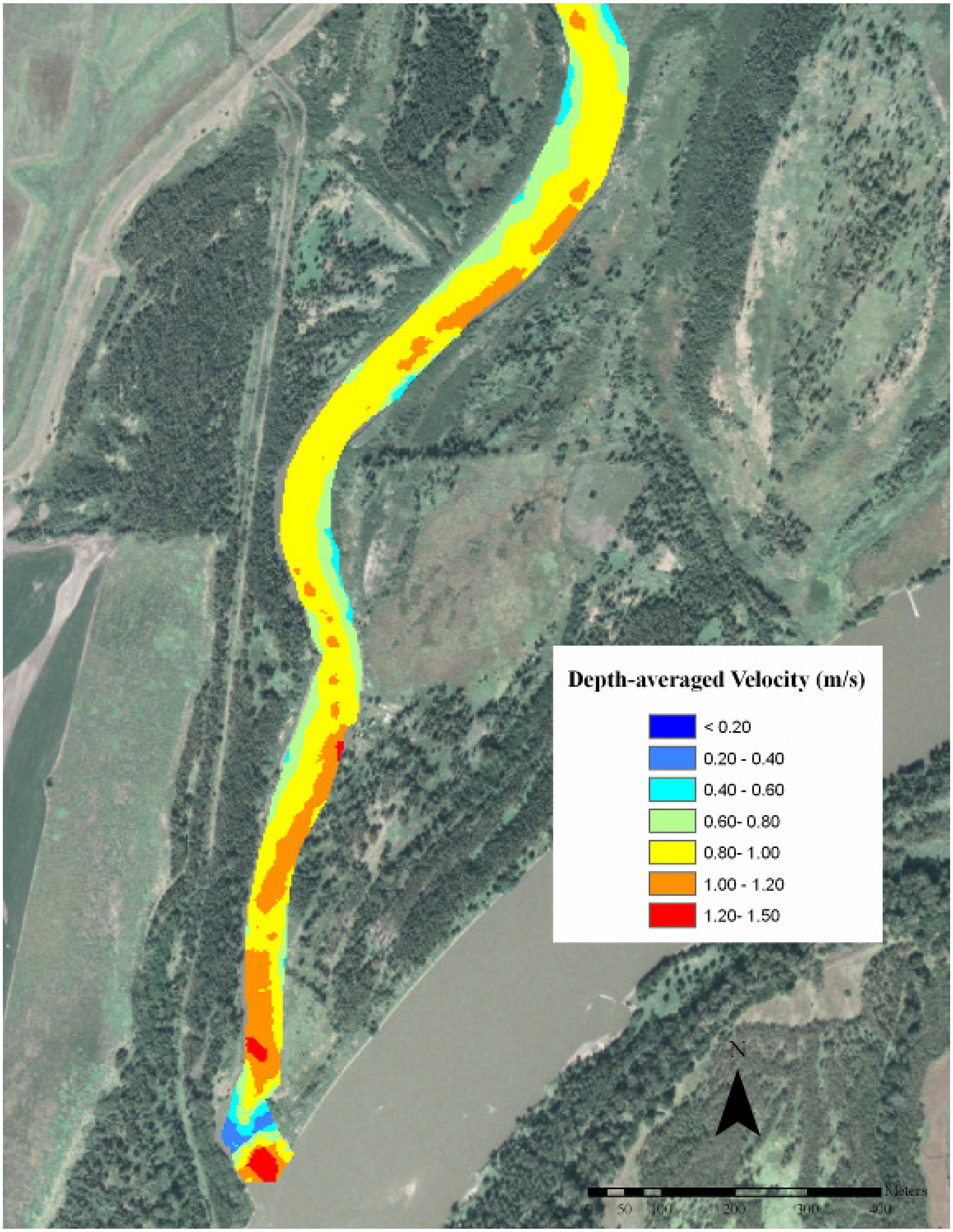
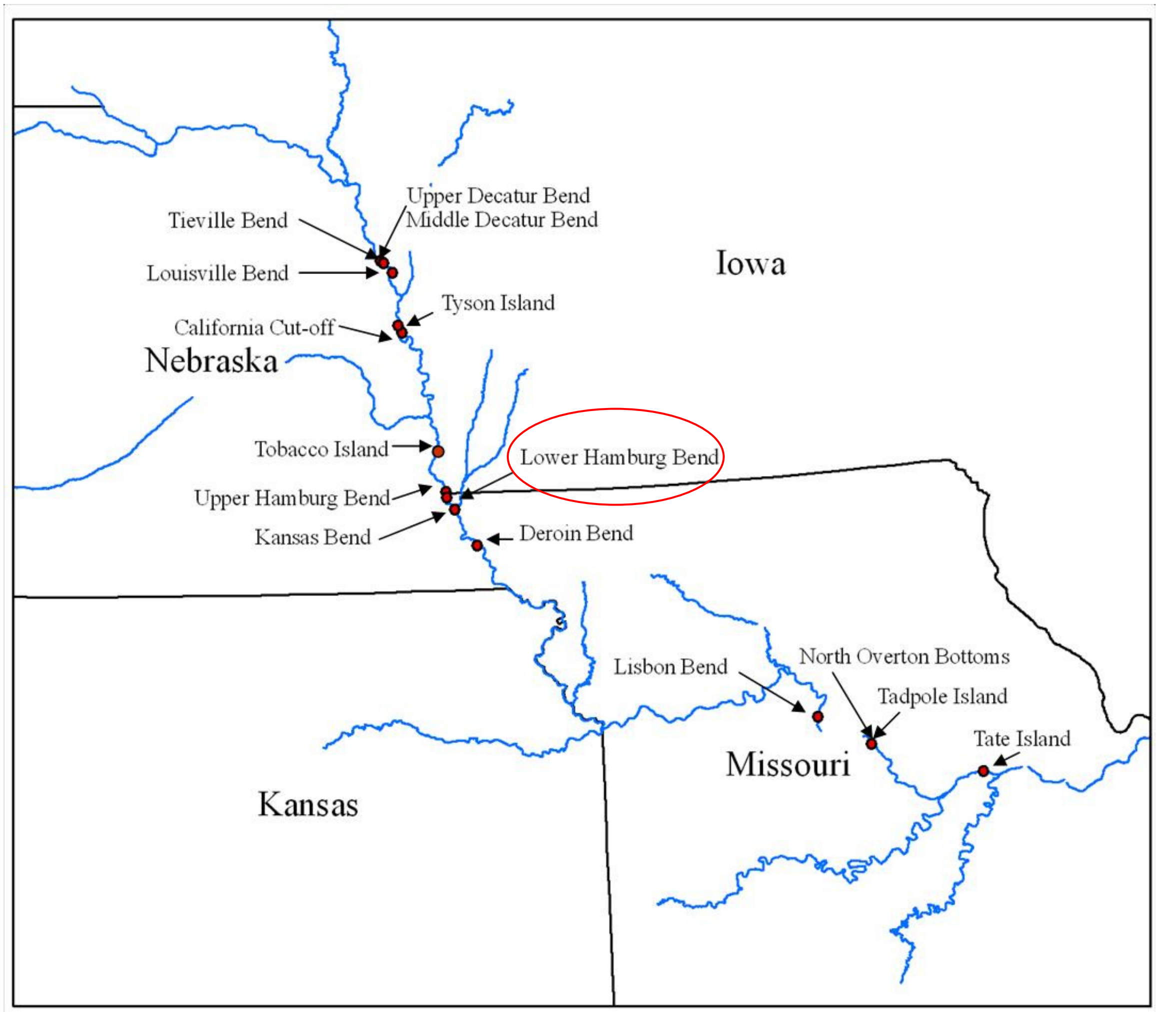


Figure II.5.26. Depth-averaged velocity distribution from the High survey (50,100 cfs) for the bottom third of Upper Hamburg.

Section II
Chapter 6
Lower Hamburg



List of Tables

List of Figures

Lower Hamburg

The chute at Lower Hamburg Bend is located between RM 553.1 and 550.6 in Fremont County, IA and Atchison County, MO and was reopened in 2004. It is approximately 3,900 m long and averages 31 m in width. The site is a relatively uniform "U" shaped channel with steep banks along its entirety. The site also initially contained a backwater connecting to the chute which has subsequently been disconnected by sediment deposited during high flow events in 2007 and 2008. A limited amount bank-line movement has occurred at this site resulting in some areas of channel meandering and deposition on inside bends. Sediment in the chute is dominated by sand with some fines near bank-lines and inside bends and some gravel in areas with higher velocities.

Modifications to navigation structures on Upper Hamburg Bend were made in 2007 to minimize in-channel sand bar formation. The purpose of the modifications was to force more water to the outside (navigation channel side) of the bend. More water was subsequently forced into the chute at Lower Hamburg because of its location on the outside bend. Work was also done at the entrance of the chute in the summer of 2008 to restrict flows through the chute. Rock was placed at the entrance constricting it by approximately 50 percent.

Topographic Survey

A topographic survey of Lower Hamburg Bend chute was initiated in the spring of 2007 and completed in the fall of 2007. The complete survey is shown in Figures II.6.1 and II.6.2. Both banks of the chute were surveyed along with the perimeter of the associated backwater. Bank-line locations from the 2007 survey and from 2003, 2006

and 2008 aerial photography are shown in Figures II.6.3 and II.6.4. The chute has widened and moved laterally in bend areas. Large woody debris has been added to the chute as banks erode. Sediment deposition has disconnected the backwater from the chute.

Depth and Velocity Survey

Three surveys for depth and velocity were conducted in 2007 and 2008. The first survey was done on 22 March 2007 at near bank-full conditions and will be referred to as the High survey. Discharges at the Nebraska City gage station were 50,000 cfs. The second survey was conducted on 20 September 2007 and will be referred to as the Low survey. Discharges at the Nebraska City gage station measured 34,500 cfs on the day of the survey. The final survey was conducted on 14 April 2008 and will be referred to as the Mid survey. Discharges at the Nebraska City gage station were 41,100 cfs on the day of the survey.

The average depth during the Low survey was 2.5 m (Table II.6.1) and the maximum depth was 5.3 m. Only 1.5% of depths were less than 1.5 m and 92% were less than 3.7 m (Figure II.6.5). The average velocity during the survey was 0.86 m/s (Table II.6.1) and the maximum was 1.79 m/s. Twenty-one percent of velocities were less than 0.76 m/s and 74% were less than 1.0 m/s on the day of the survey (Figure II.6.6). The distribution of depths (Figures II.6.7-8) and depth-averaged velocities (Figures II.6.9-10) are shown for the Low survey at Lower Hamburg.

The average depth surveyed during the Mid survey was 2.9 m (Table II.6.1) and the maximum was 4.8 m. Only 2% of depths surveyed were less than 1.5 m and 99% of

depths were less than 3.7 m (Figure II.6.5). The average velocity during the survey was 0.89 m/s (Table II.6.1) and the maximum velocity 1.67 m/s. Twenty-eight percent of velocities surveyed were less than 0.76 m/s and 69% were less than 1.0 m/s (Figure II.6.6). The distribution of depths (Figures II.6.11-12) and depth-averaged velocities (Figures II.6.13-14) are shown for the Mid survey at Lower Hamburg.

The Average depth during the High survey was 2.9 m (Table II.6.1) and the maximum depth was 4.6 m. Only 0.2% of depths were less than 1.5 m and 92% of depths were between 1.5 m and 3.7 m (Figure II.6.5). The average velocity during the survey was 0.89 m/s (Table II.6.1) and the maximum velocity was 1.66 m/s. Twenty – three percent of velocities were less than 0.76 m/s and 68% were less than 1.0 m/s (Figure II.6.6). The distribution of depths (Figures II.6.15-16) and depth-averaged velocities (Figures II.6.17-18) are shown for the High survey at Lower Hamburg.

We compared depth frequency distributions and depth-averaged velocity frequency distributions between surveys using a KS test and found no differences between the low and high surveys for both depth and depth averaged velocity (Table II.6.2). We compared mean depth using analysis of variance (ANOVA) and found differences among the group ($F = 255.31$, $p < 0.0001$) and all pairwise comparisons (Table II.6.3). A comparison of depth-averaged velocities using ANOVA also showed differences among the group ($F = 259.16$, $p < 0.0001$) and all pairwise comparisons (Table II.6.3).

Sediment

A sediment survey was conducted at Lower Hamburg on 29 March 2007. The data were not able to be processed due to GPS receiver issues. The data were sent to Quester Tangent Corp for repair but were not received by NGPC in time to be included in this report.

Summary

The chute at Lower Hamburg has widened since its opening in 2004. The average width of the chute during the 2007 topographic survey was 31 m. Erosion is evident at the site and bank-line movement has taken place. The backwater at the site was connected to the chute in 2005 and 2006 but has been cut off by sediment deposition during high water events in 2007 and 2008.

The chute is characterized by high, steep banks and a uniform width. During the surveys the majority of depth data were confined to a small range indicating a generally "U" shaped chute. A defined thalweg is present but little to no shallow sandbar habitat is seen. Depth and velocity data from the three surveys may not be comparable due to modifications to in-channel navigation structures. These modifications were done in the summer of 2007, between our ADCP surveys in March 2007 and April 2008. Our surveys show that discharges in the chute were greater after the modifications (2,580 cfs on 3 March 2007 and 2,720 cfs on 14 April 2008) even though main channel discharges were less (50,000 cfs on 3 March 2007 and 41,100 cfs on 14 April 2008). These increased flows may have expedited bank-line erosion in the chute. In the summer of 2008 it was determined that too much water was being directed into the chute. In

response to this the entrance was partially filled with rock, limiting the amount of water that could enter the chute. No surveys were conducted after this work was done.

Key features:

- Steep "U" shaped banks
- Little depth diversity
- Sandy substrate with some clays
- Repeated flow alterations throughout study
- High rates of erosion during period when large amounts of water were forced through the chute by main channel modifications
- Increasing large woody debris
- Little bar creation
- Backwater connected in 2006 but cut off from chute in 2007 by sedimentation

Recommendations for modification:

- Remove control structure at the entrance of the chute to allow more flow and accelerate evolution
- Increase width in areas to increase shallow sand bar habitat
- Reconnect backwater and redesign the entrance to reduce sedimentation or add a connection to the chute at the top of the backwater to create a flow through environment with shallow water and slow water velocities
- Slope banks to allow large woody debris to accumulate in chutes rather than on banks

Table II.6.1. List of survey dates for Lower Hamburg and relative stage with mean depth and mean depth-averaged velocity for each relative stage.

Survey Date	Discharge (cfs)	Stage	Mean Depth (m)	Mean Depth-averaged Velocity (m/s)
22 March 2007	50,000	High	2.9	0.89
20 September 2007	34,500	Low	2.5	0.86
14 April 2008	41,100	Mid	2.9	0.89

Table II.6.2. Results of Kolmogorov-Smirnov tests for differences in distributions between surveys at Lower Hamburg. Results are significant at a Bonferonni adjusted p value of 0.033 (alpha = 0.10). Significant results are shown in bold.

	Depth		Depth-averaged velocity	
Survey	**D**	**p-value**	**D**	**p-value**
Low vs. Mid	**0.36**	**<0.0001**	**0.18**	**<0.0001**
Low vs. High	0.04	0.4259	0.03	0.6461
Mid vs. High	**0.38**	**<0.0001**	**0.16**	**0.0001**

Table II.6.3. Results of pairwise tests (ANOVA) of mean depth and mean depth-averaged velocity at Lower Hamburg. Results are significant at a Bonferonni adjusted p value of 0.033 (alpha = 0.10).

	Depth		Depth-averaged velocity	
Survey	**D**	**p-value**	**D**	**p-value**
Low vs. Mid	18.02	<0.0001	2.84	0.0046
Low vs. High	3.45	0.0006	21.23	<0.0001
Mid vs. High	20.88	<0.0001	18.05	<0.0001

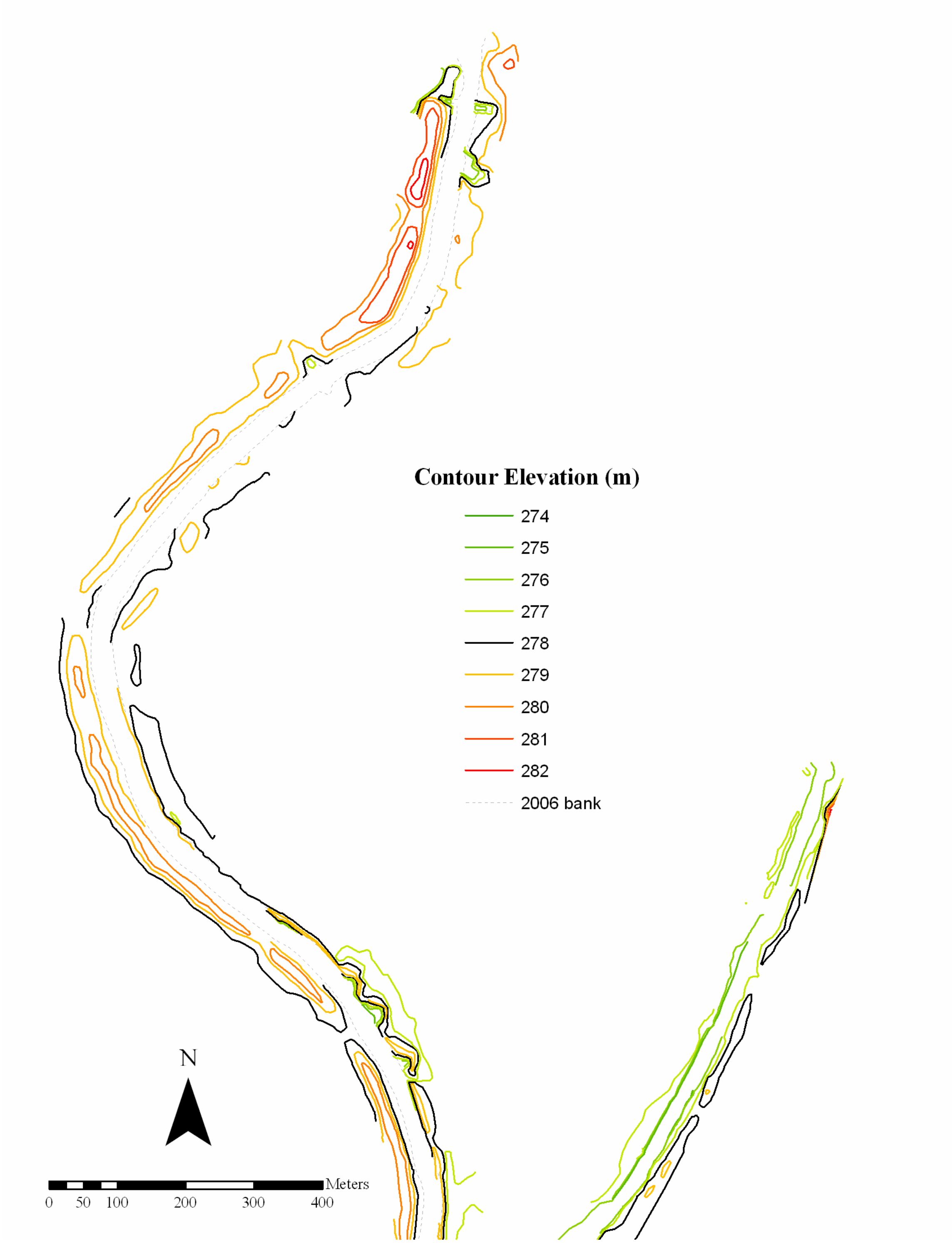


Figure II.6.1. Topographic survey of the upper half of Lower Hamburg with bankline location from 2006 aerial photography.

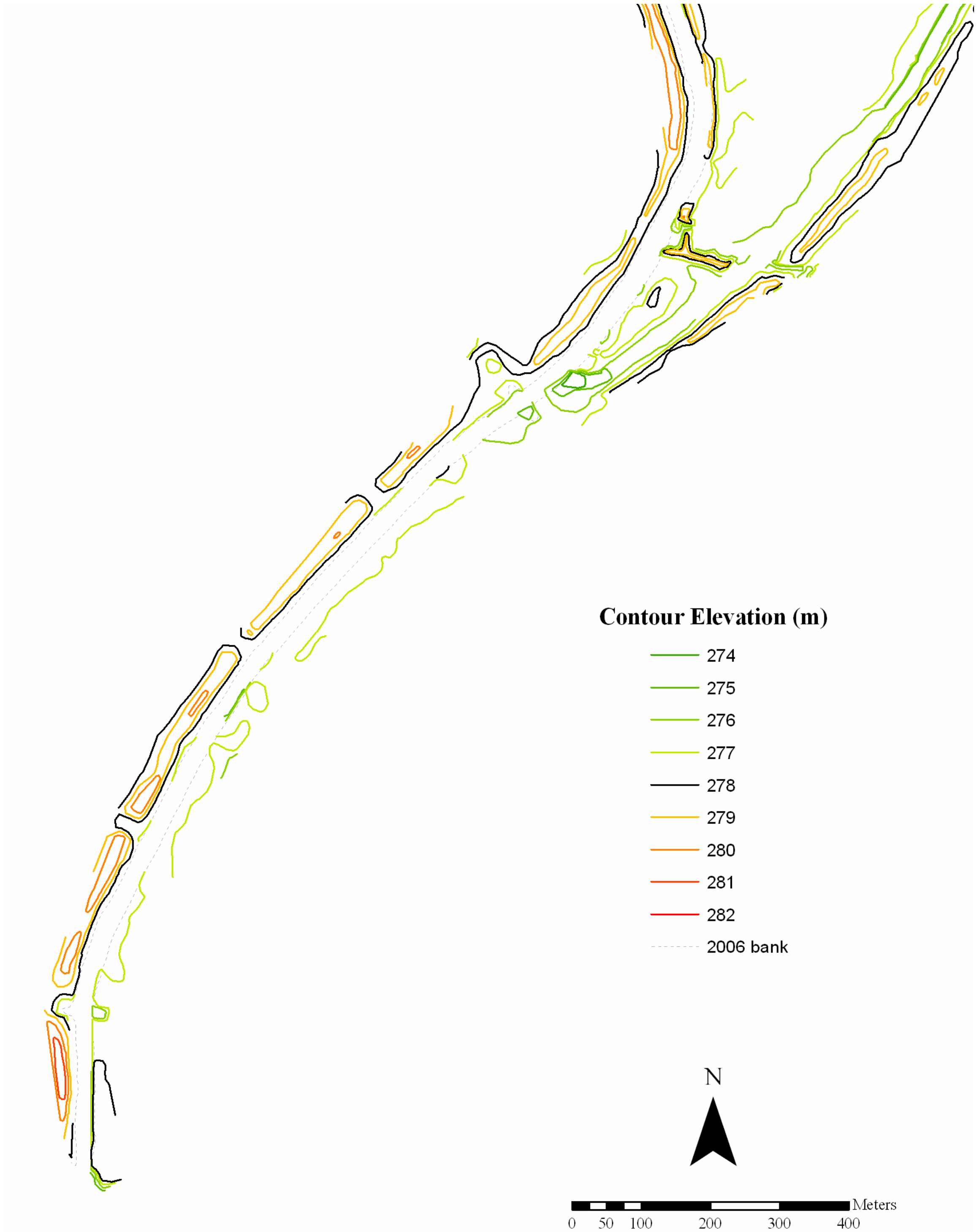


Figure II.6.2. Topographic survey of the lower half of Lower Hamburg with bankline location from 2006 aerial photography.

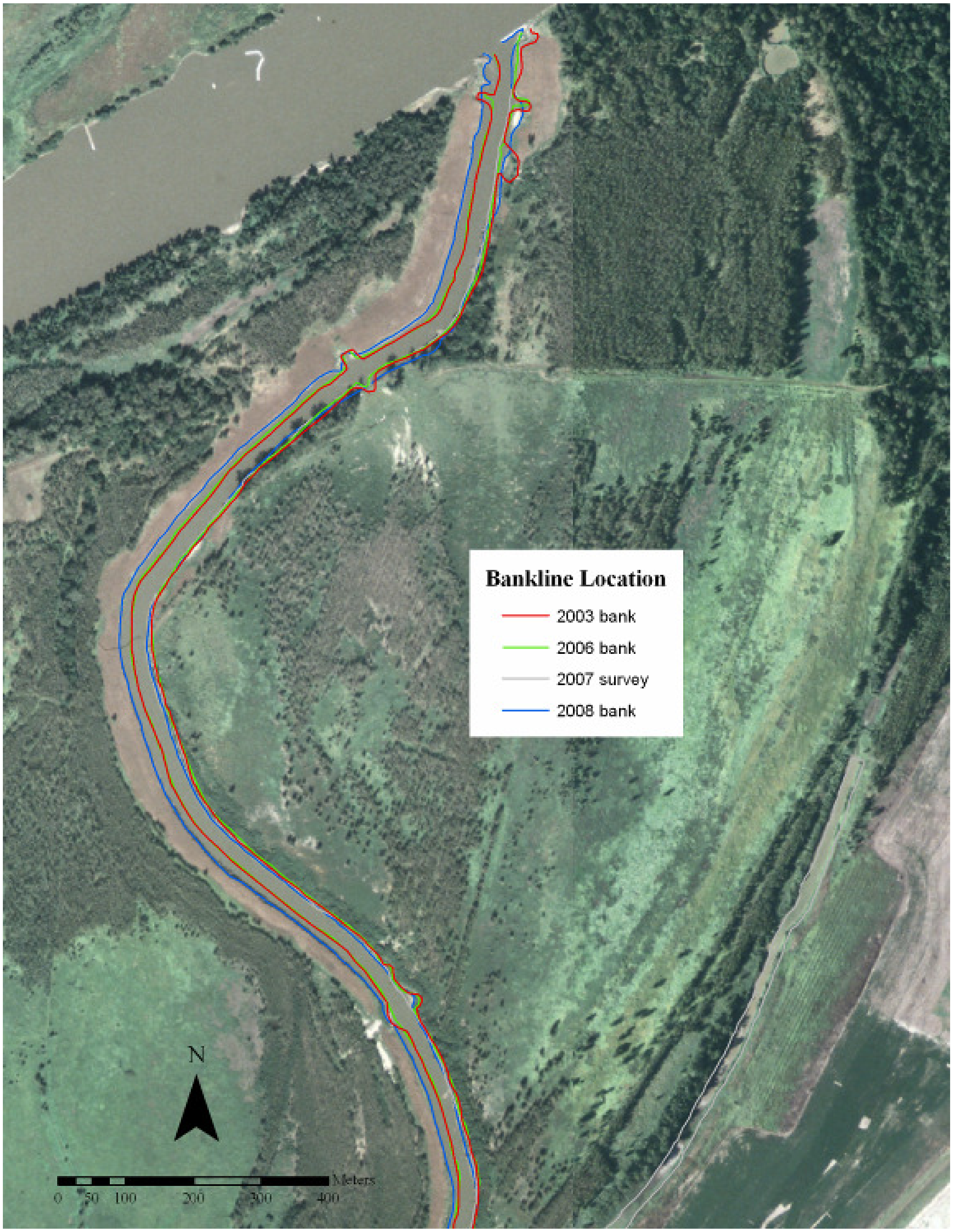


Figure II.6.3. Aerial photograph of the upper half of Lower Hamburg with bankline locations from 2003, 2006 and 2008 aerial photography and from 2007 topographic survey.

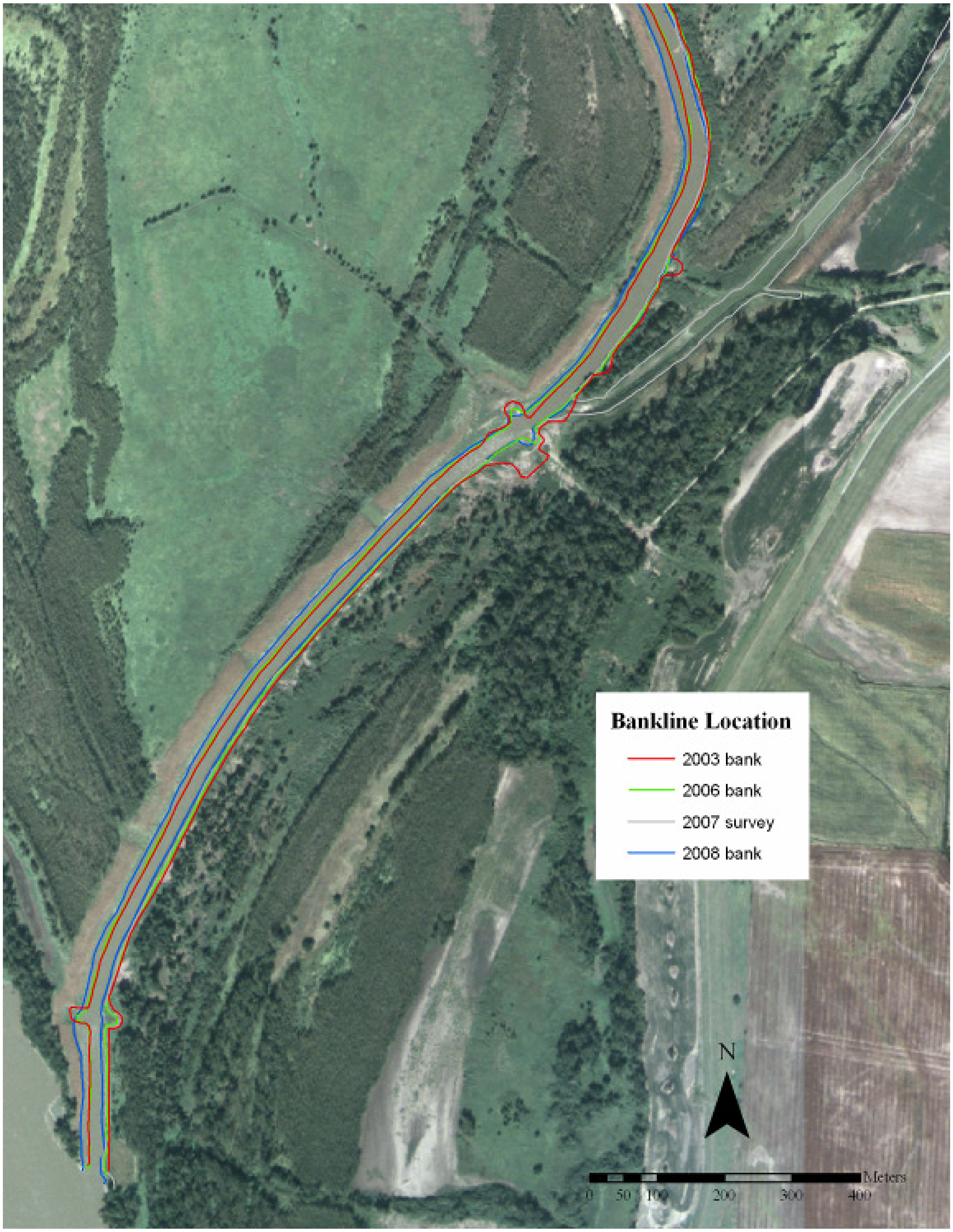


Figure II.6.4. Aerial photograph of the lower half of Lower Hamburg with bankline locations from 2003, 2006 and 2008 aerial photography and from 2007 topographic survey.

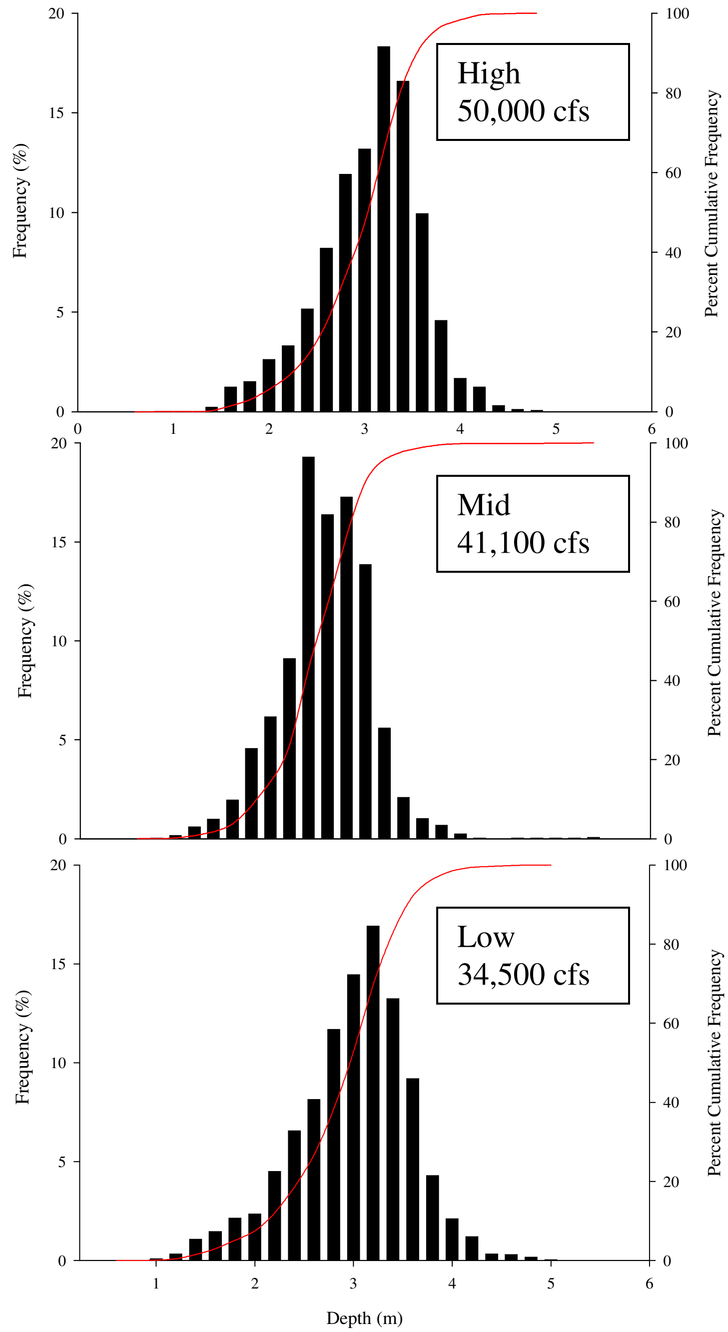


Figure II.6.5. Depth frequency and cumulative frequency (line) distributions for Lower Hamburg for all three Doppler surveys.

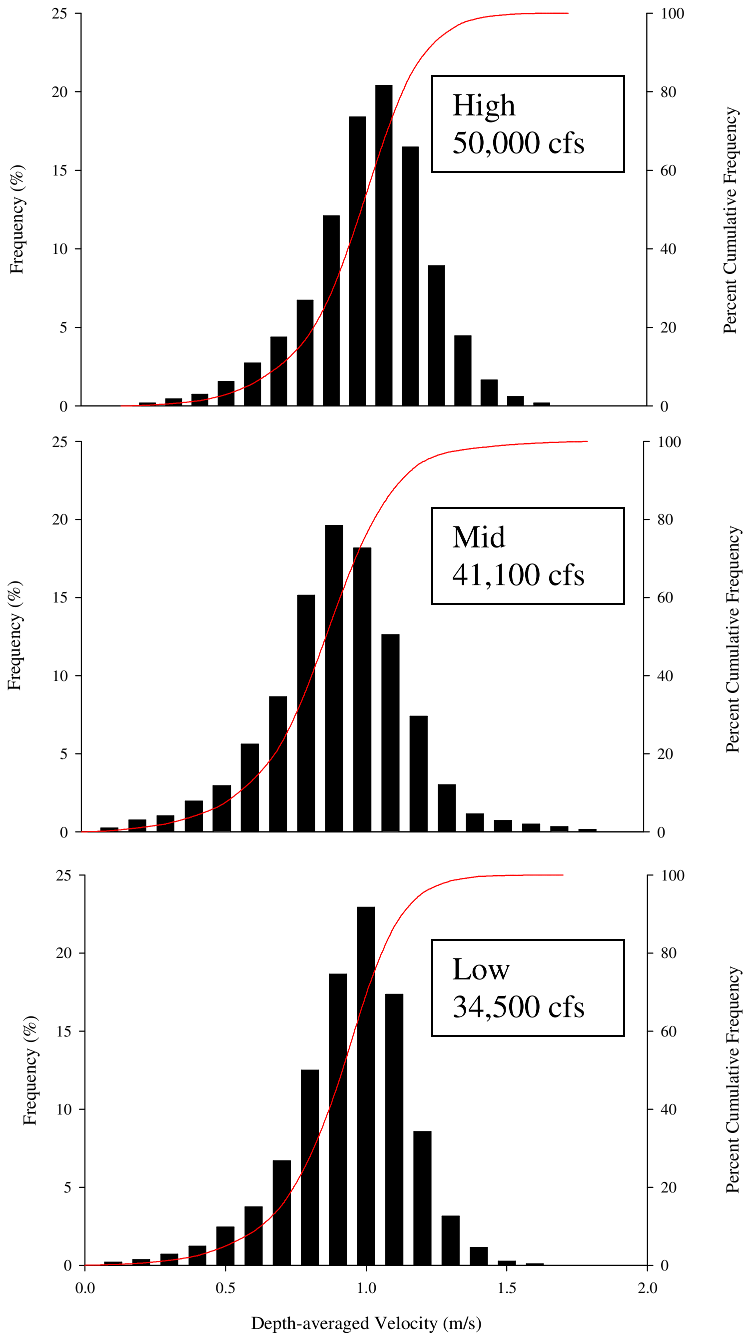


Figure II.6.6. Depth-averaged velocity frequency and cumulative frequency (line) distributions for Lower Hamburg for all three Doppler surveys.

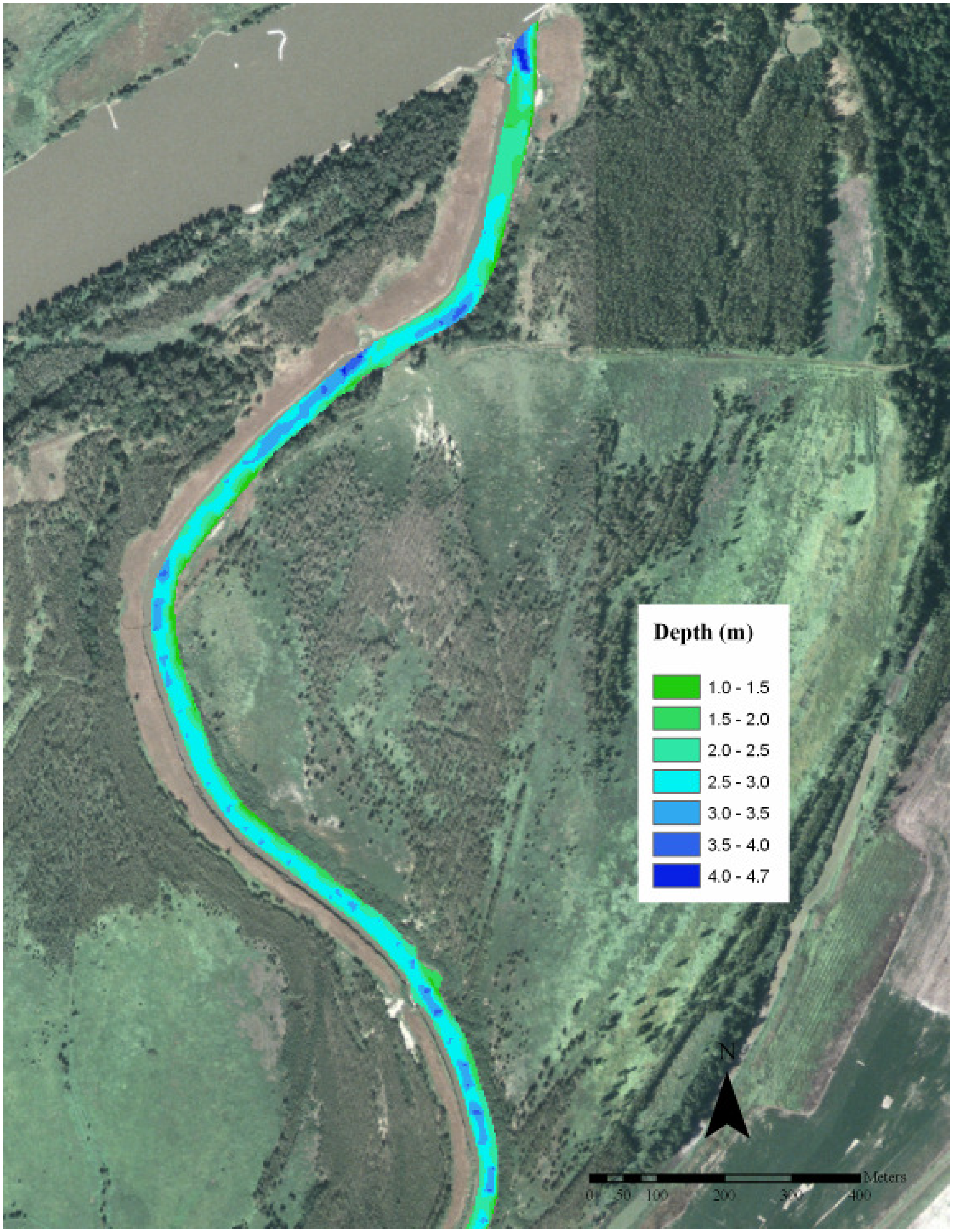


Figure II.6.7. Depth distribution from the Low survey (34,500 cfs) for the upper half of Lower Hamburg.

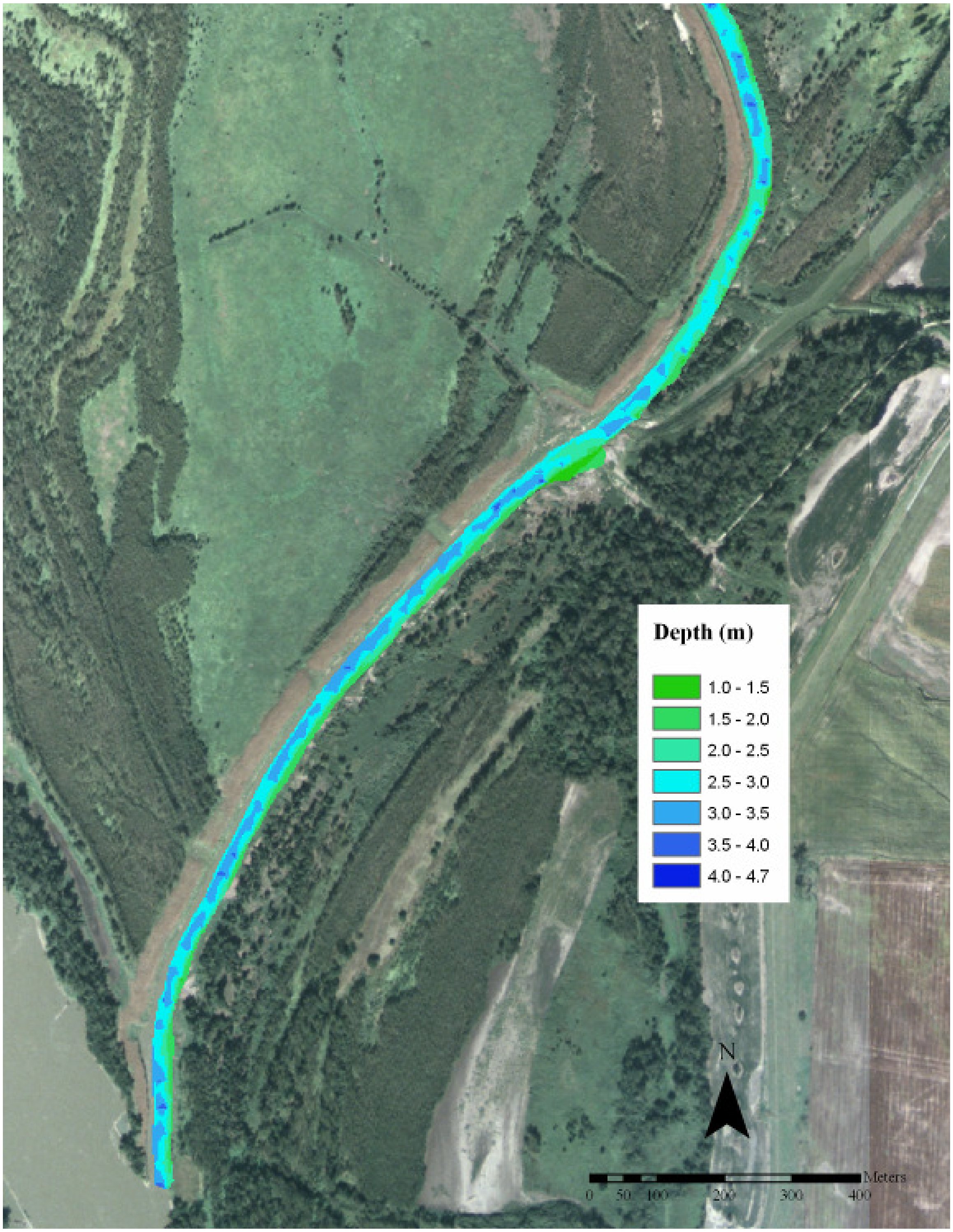


Figure II.6.8. Depth distribution from the Low survey (34,500 cfs) for the bottom half of Lower Hamburg.

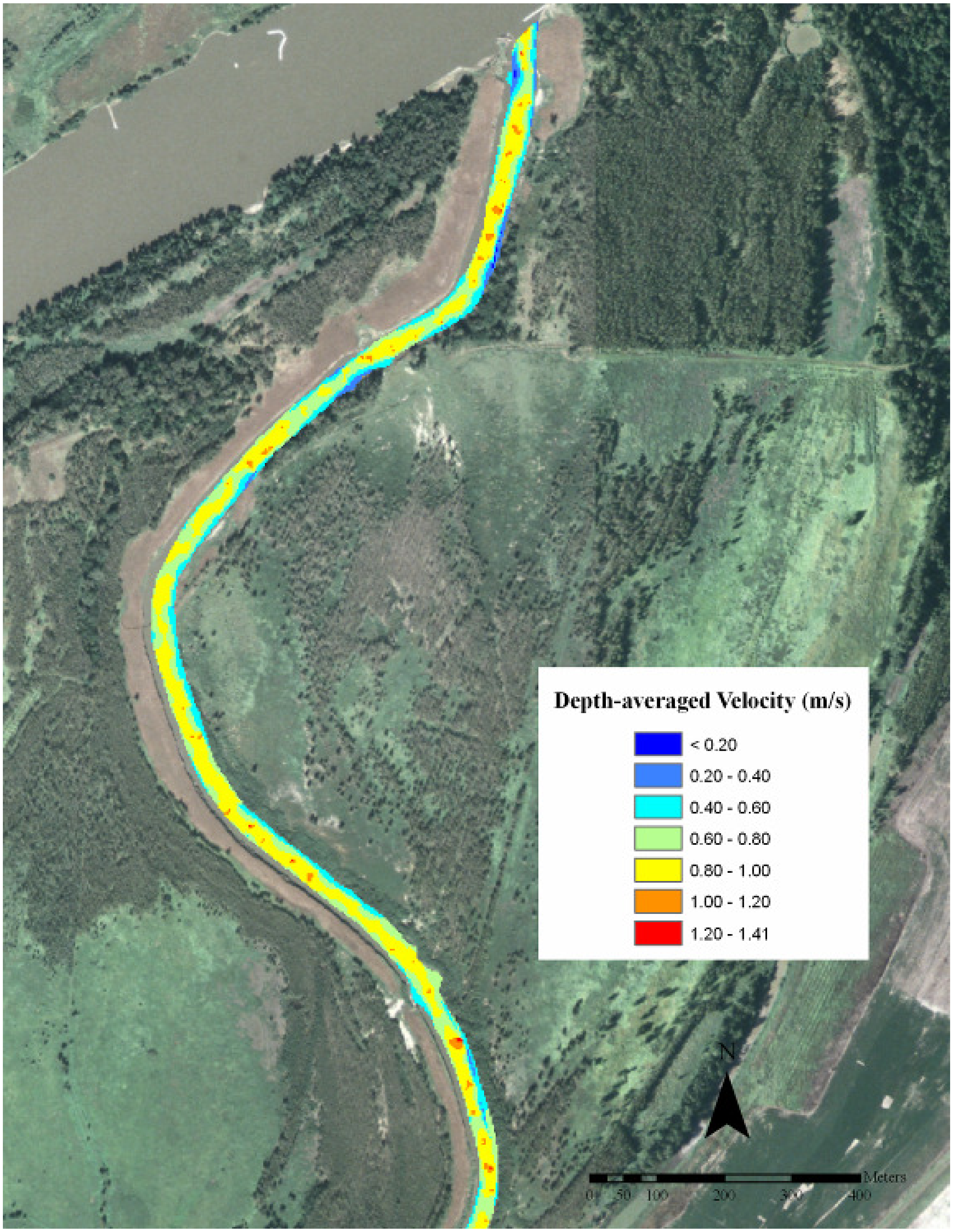


Figure II.6.9. Depth-averaged velocity distribution from the Low survey (34,500 cfs) for the upper half of Lower Hamburg.

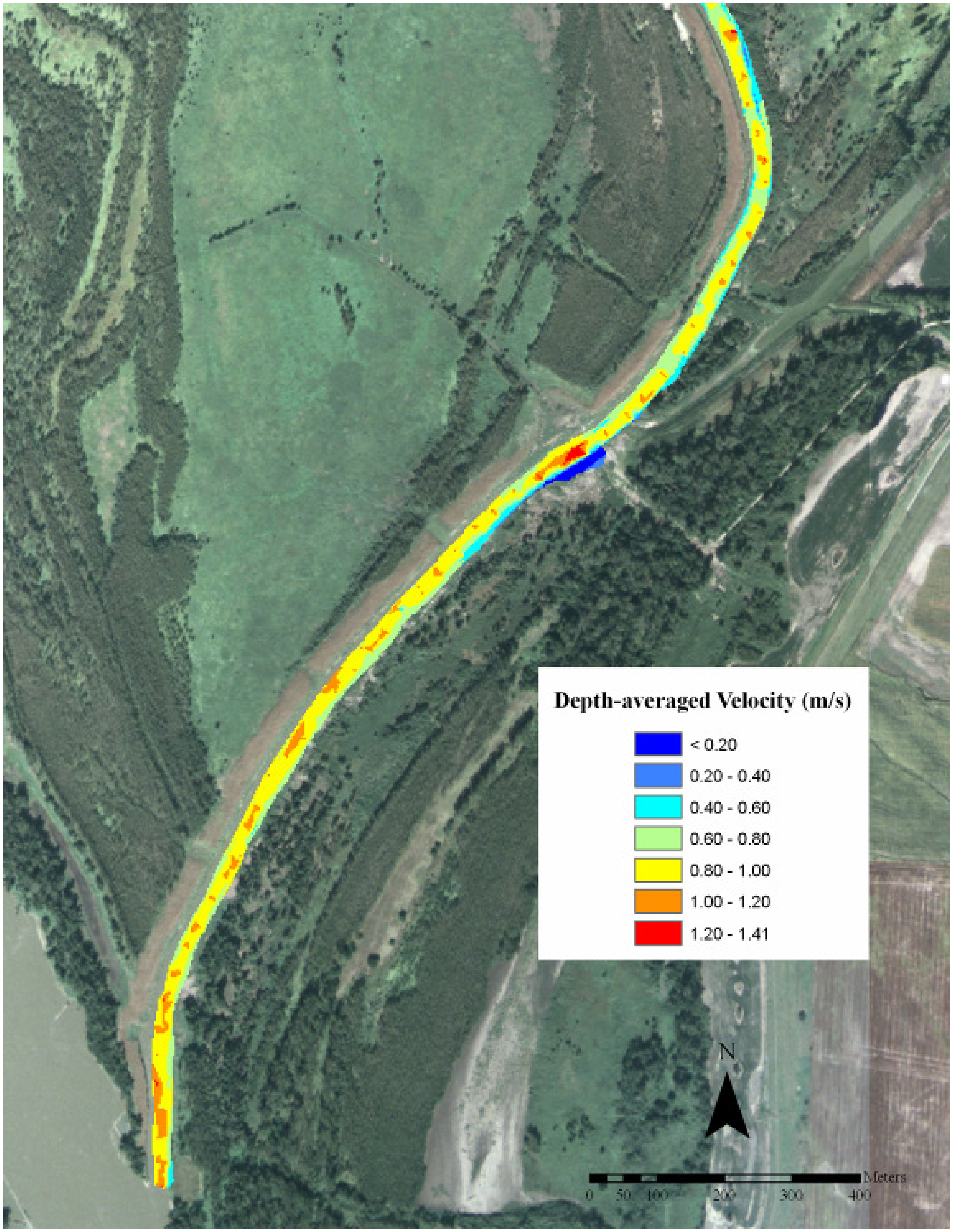


Figure II.6.10. Depth-averaged velocity distribution from the Low survey (34,500 cfs) for the bottom half of Lower Hamburg.

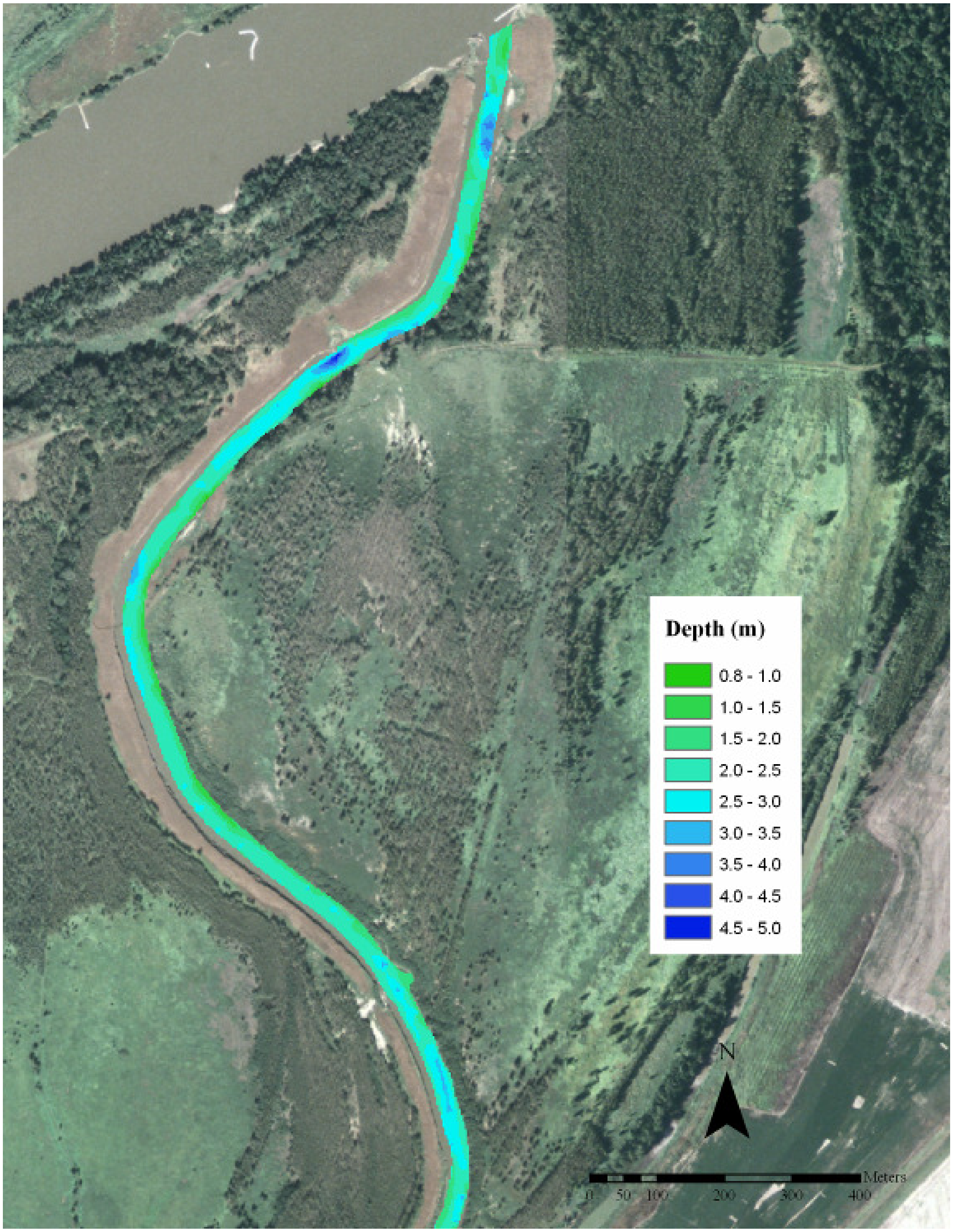


Figure II.6.11. Depth distribution from the Mid survey (41,100 cfs) for the upper half of Lower Hamburg.

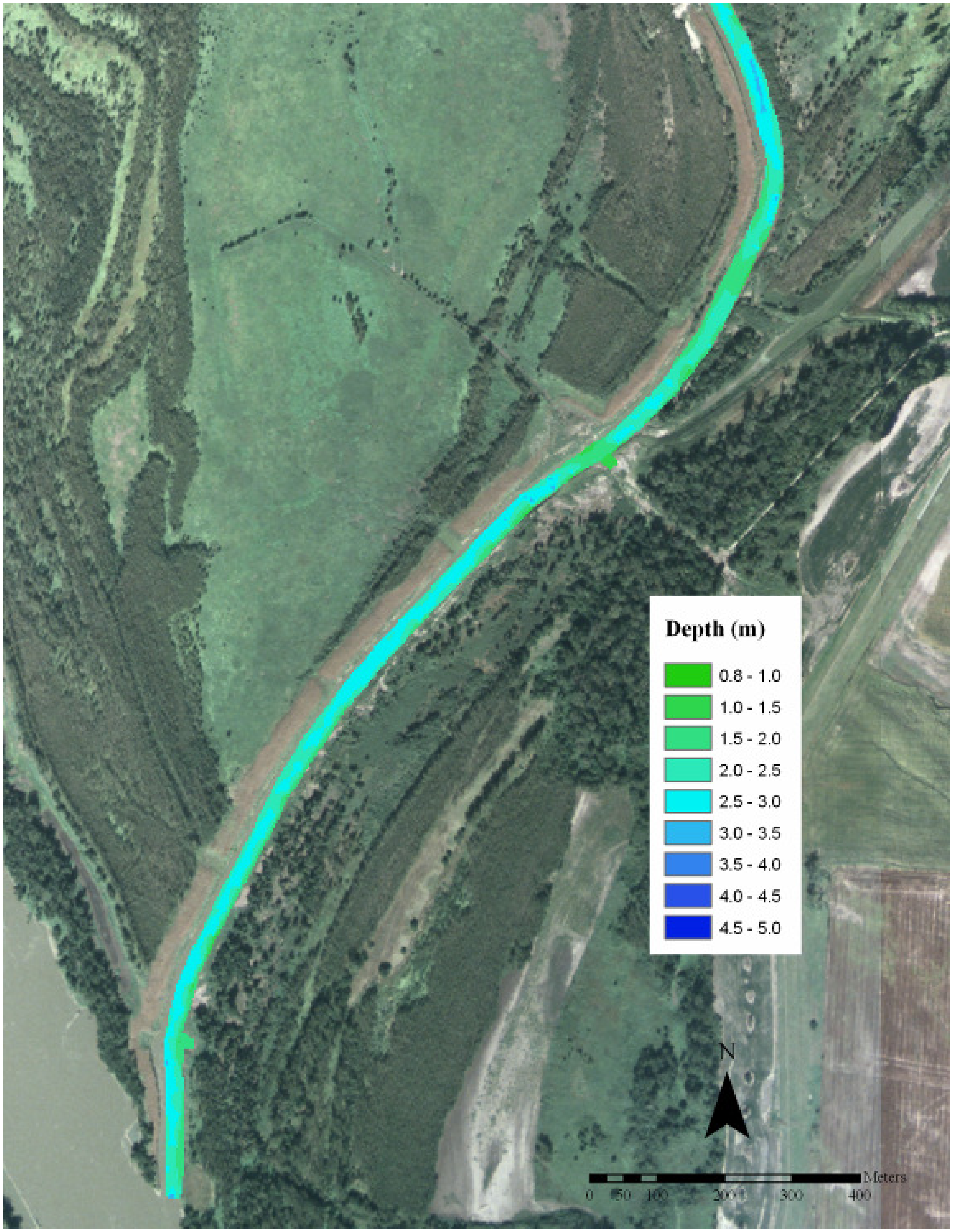


Figure II.6.12. Depth distribution from the Mid survey (41,100 cfs) for the upper half of Lower Hamburg.

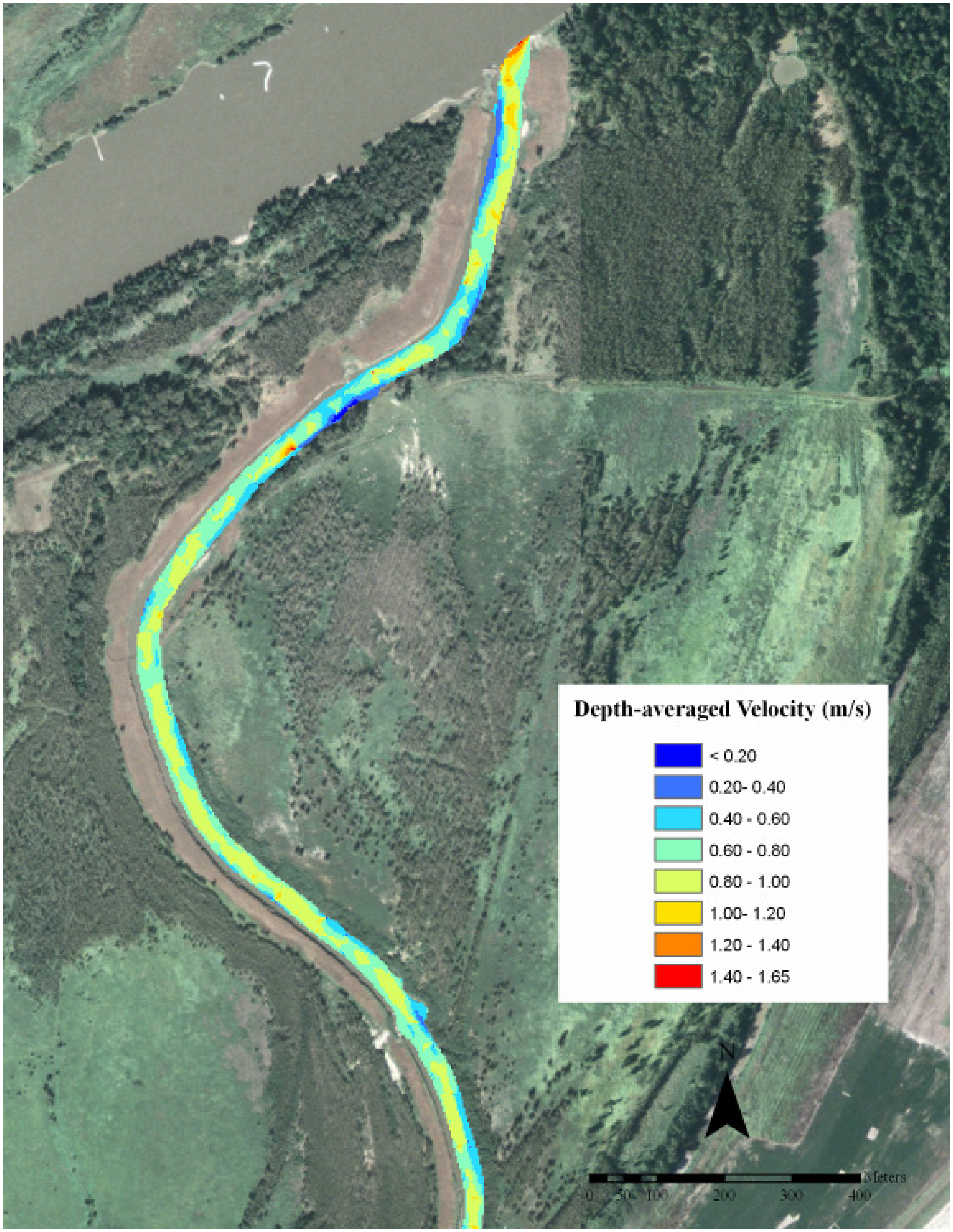


Figure II.6.13. Depth-averaged velocity distribution from the Mid survey (41,100 cfs) for the upper half of Lower Hamburg.

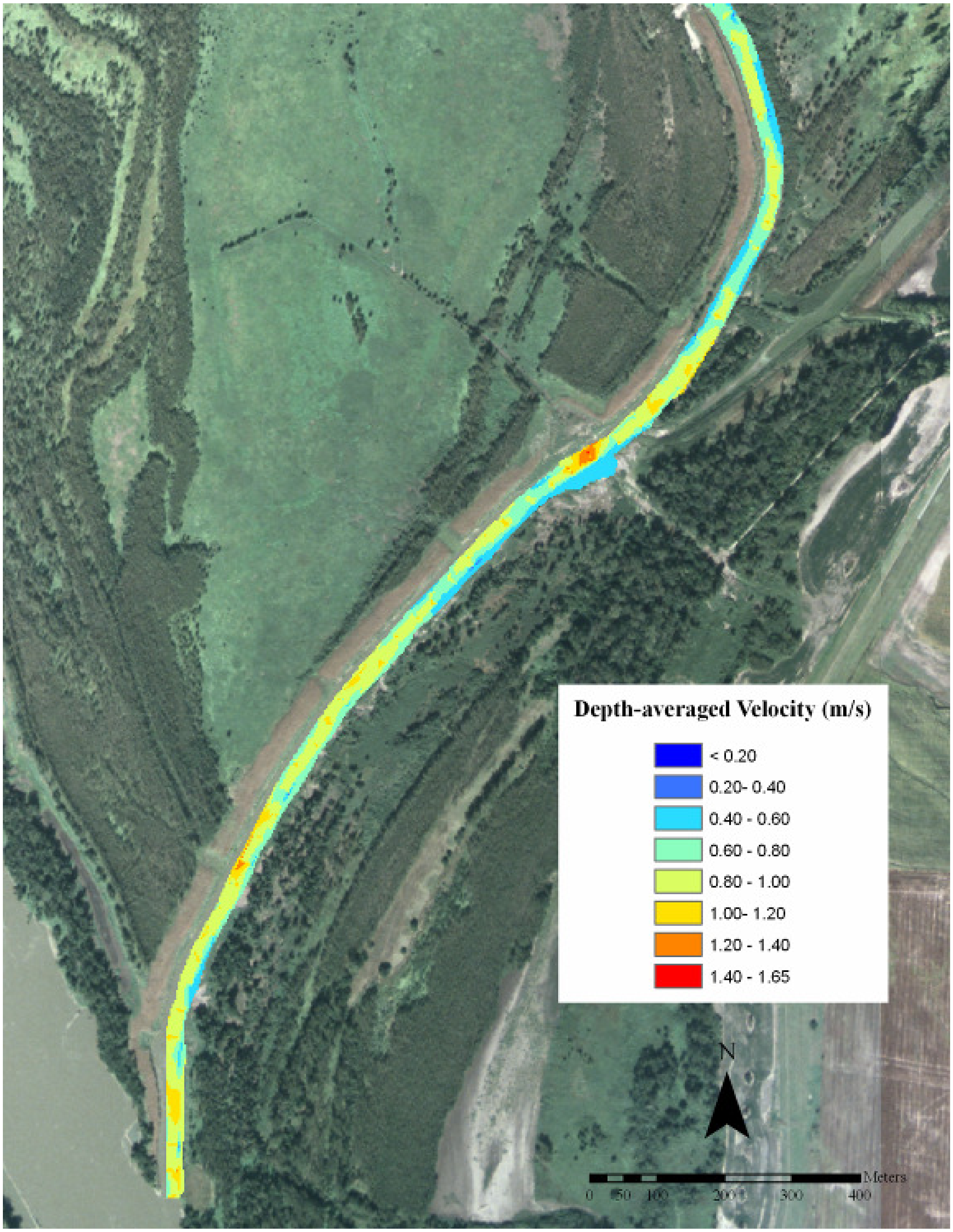


Figure II.6.14. Depth-averaged velocity distribution from the Mid survey (41,100 cfs) for the bottom half of Lower Hamburg.

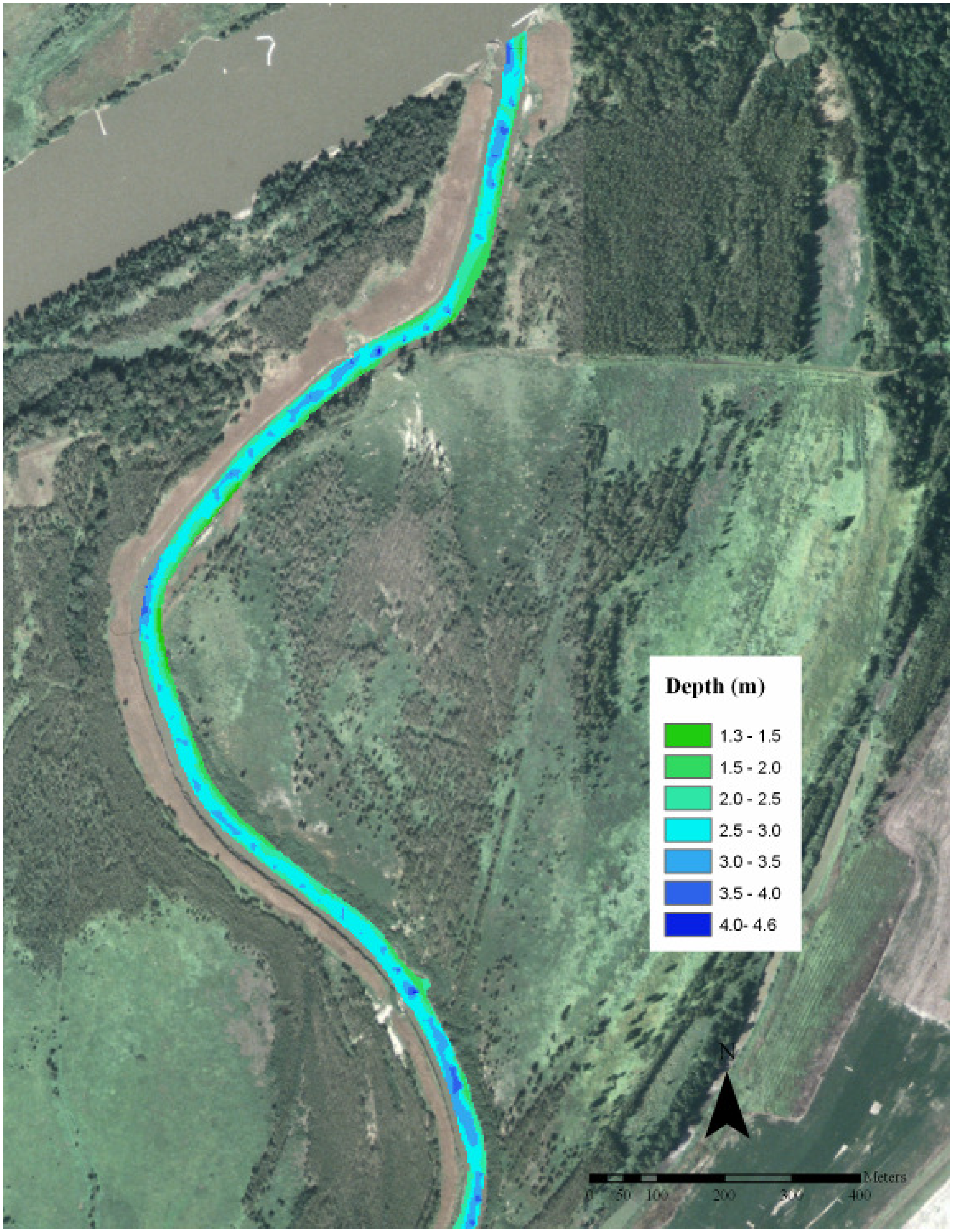


Figure II.6.15. Depth distribution from the High survey (50,000 cfs) for the upper half of Lower Hamburg.

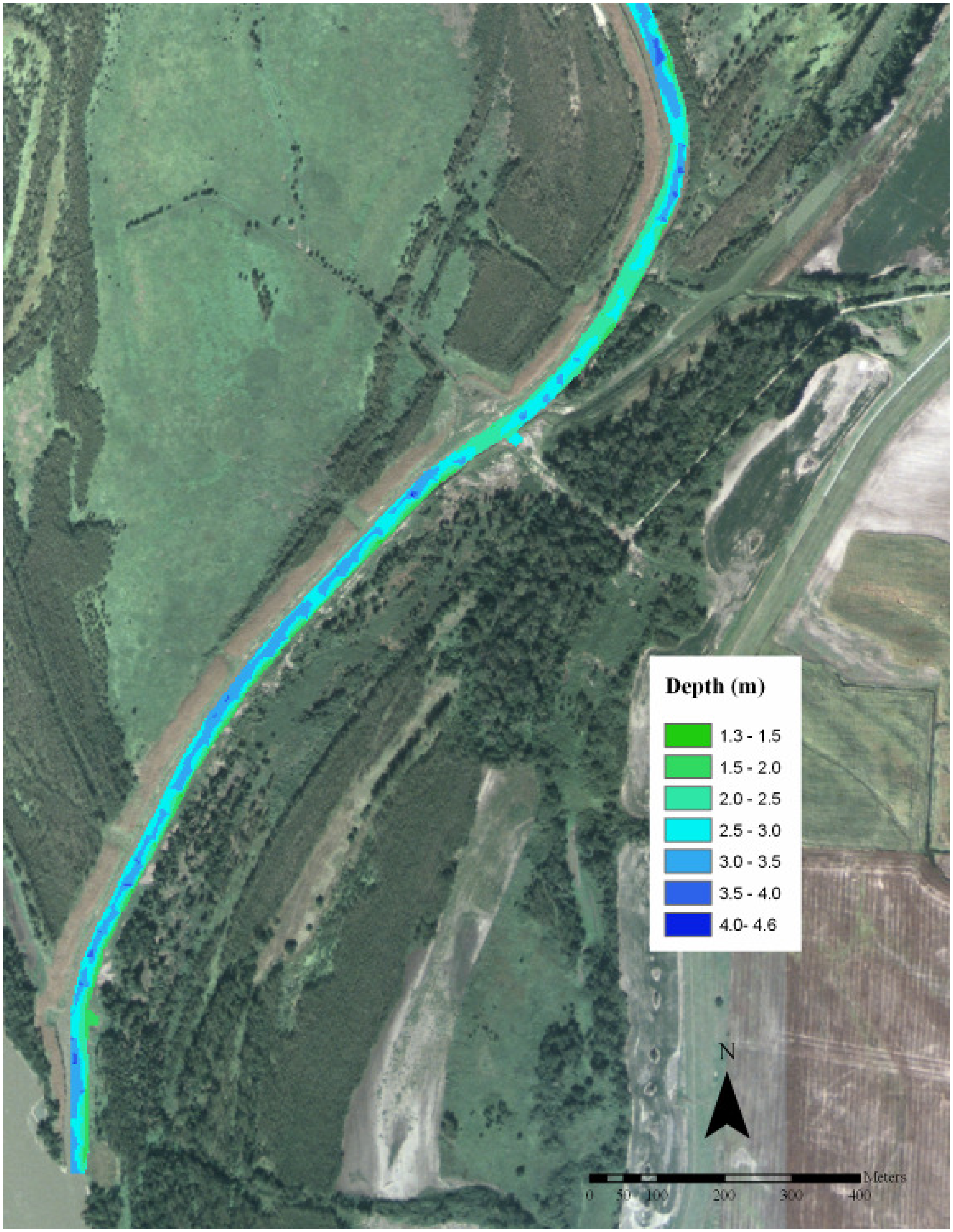


Figure II.6.16. Depth distribution from the High survey (50,000 cfs) for the bottom half of Lower Hamburg.

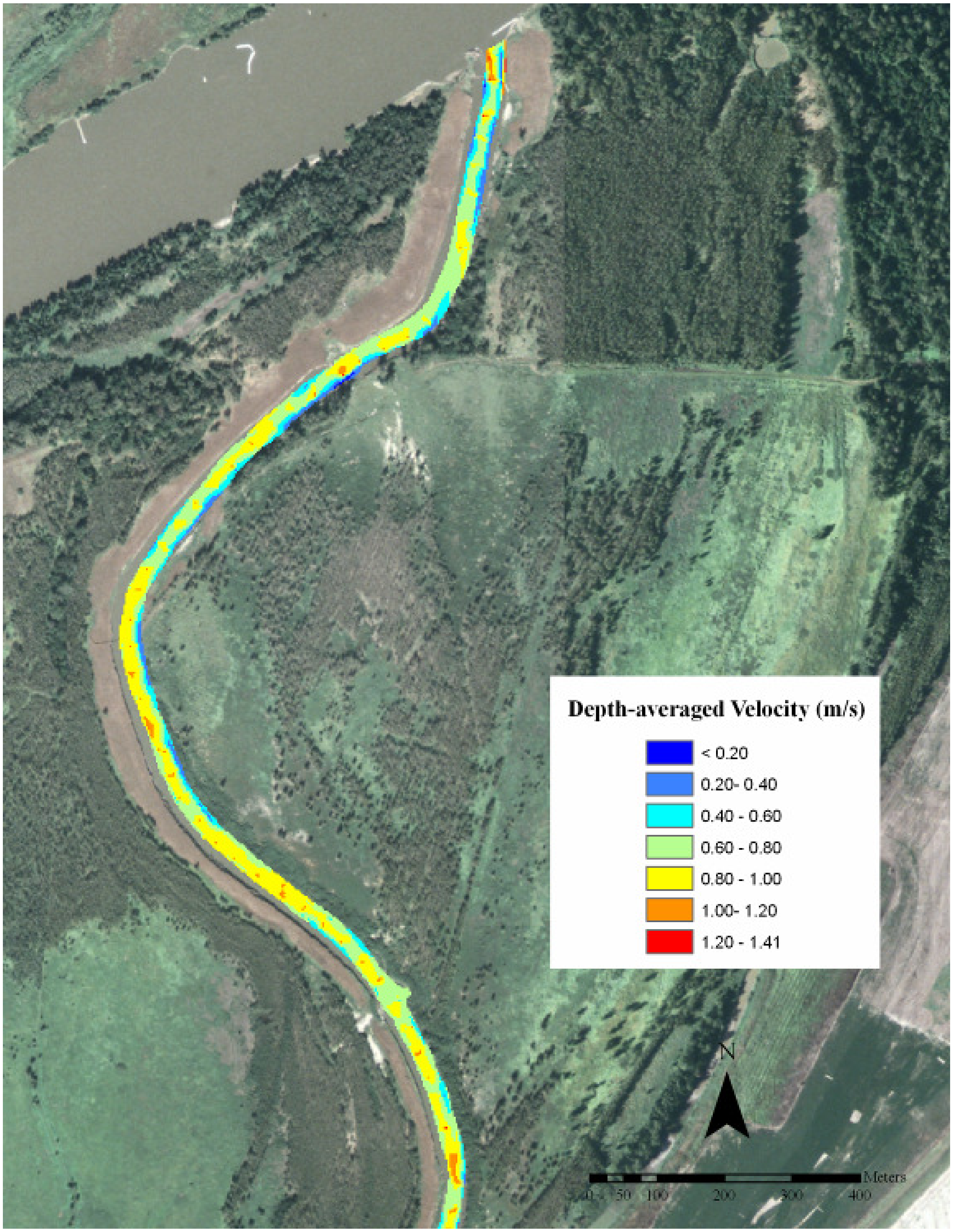


Figure II.6.17. Depth-averaged velocity distribution from the High survey (50,000 cfs) for the upper half of Lower Hamburg.

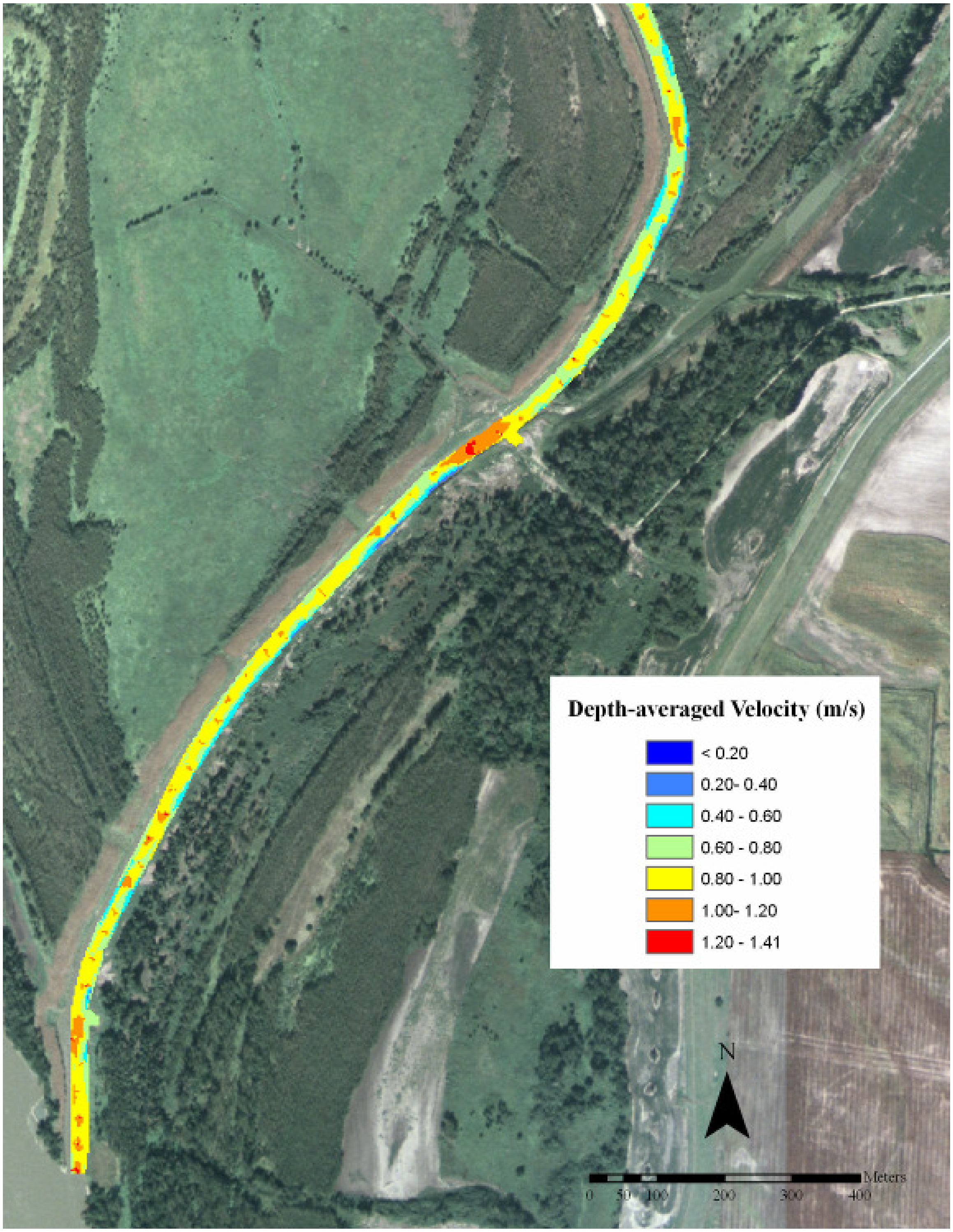
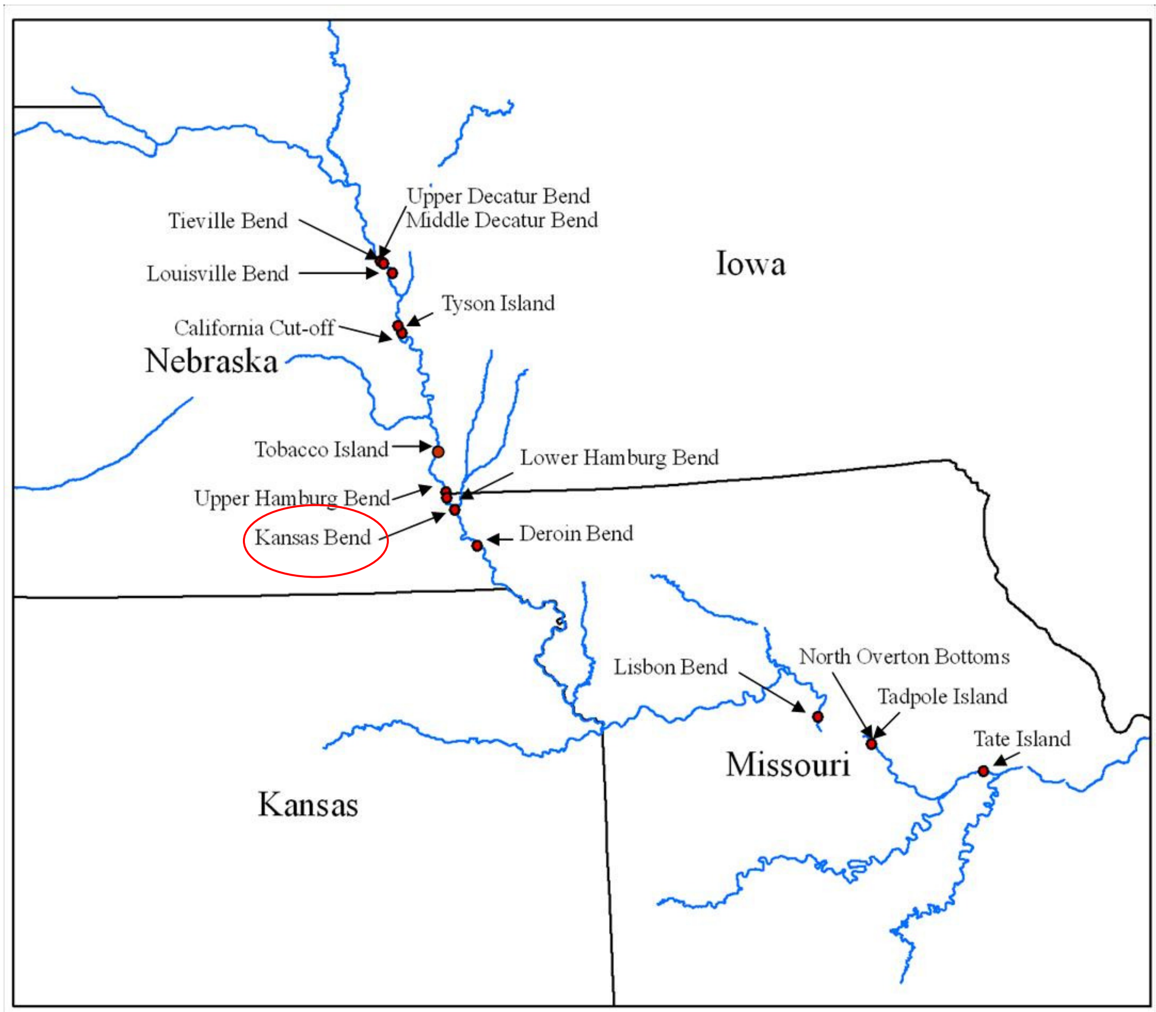


Figure II.6.18. Depth-averaged velocity distribution from the High survey (50,000 cfs) for the bottom half of Lower Hamburg.

Section II
Chapter 7
Kansas (upper)



List of Tables

List of Figures

Kansas (upper)

The chute at Kansas Bend is located between RM 547.0 and 544.0 in Nemaha County, Nebraska. The site reopened in December of 2004 and consists of two chutes separated by private land. For this portion of the report the site is treated as two separate entities.

The upstream site is approximately 2,100 m long and averages 37 m in width. It is characterized by deep, fast moving water. The banks of the chute are steep and tall, forming a uniform "U" shape. Substrates at the site consist of sand and gravel in the swift moving areas and large blocks of clays near the bank lines. Erosion has been noted at the site, especially after the high water events of 2007 and 2008, but little or no formation of shallow bar habitat has been seen.

Topographic Survey

A topographic survey was initiated at the Kansas (upper) site in March of 2006 and completed in December of 2007. Figure II.7.1 show the completed topographic survey and Figure II.7.2 show bank-line locations from the 2006-2007 survey and from 2006 and 2008 aerial photography.

Depth and Velocity Survey

Three surveys for depth and velocity were conducted at the Kansas (upper) Bend site in 2007 and 2008. The first survey was done on 22 March 2007 at bank-full conditions and will be referred to as the High survey. Discharges at the Nebraska City gage station were 47,100 cfs on the day of the survey. The second survey was conducted

on 31 July 2008 and will be referred to as the Mid survey. Discharges at the Nebraska City gage station were 35,000 cfs on the day of the survey. The third survey was conducted on 25 August 2008 and will be referred to as the Low survey. Discharges at the Nebraska City gage station were 31,000 cfs on the day of the survey.

The average depth surveyed during the Low survey was 3.5 m (Table II.7.1) and the maximum was 6.2 m. Only 3% of depths recorded were less than 1.5 m and 56% were less than 3.7 m (Figure II.7.3). The average velocity surveyed was 1.0 m/s (Table II.7.1) and the maximum velocity was 2.0 m/s. Twenty percent of velocities surveyed were less than 0.76 m/s and 45% were less than 1.0 m/s (Figure II.7.4). The distribution of depths (Figure II.7.5) and depth-averaged velocities (Figure II.7.6) are shown for the Low survey at Kansas (upper).

The average depth surveyed during the Mid survey was 3.7 m (Table II.7.1) and the maximum depth was 6.4 m. Only 2.6% percent of depths surveyed were less than 1.5 m and 54% were greater than 3.7 m (Figure II.7.3). The average velocity surveyed was 1.0 m/s (Table II.7.1) and the maximum velocity was 2.0 m/s. Only 19% of velocities surveyed were less than 0.76 m/s and 40% were less than 1.0 m/s (Figure II.7.4). The distribution of depths (Figure II.7.7) and depth-averaged velocities (Figure II.7.8) are shown for the Mid survey at Kansas (upper).

The average depth surveyed during the High survey was 3.9 m (Table II.7.1) and the maximum depth was 6.8 m. Only 1% of surveyed depths were less than 1.5 m and only 39% were less than 3.7 m (Figure II.7.3). The average velocity during the survey was 0.94 m/s (Table II.7.1) and the maximum was 1.8 m/s. Twenty-seven percent of velocities were less than 0.76 m/s and 54% were less than 1.0 m/s (Figure II.7.4). The

distribution of depths (Figure II.7.9) and depth-averaged velocities (Figure II.7.10) are shown for the High survey at Kansas (upper).

We compared depth frequency distributions and depth-averaged velocity frequency distributions between surveys using a KS test and found significant differences between all surveys for both depth and depth averaged velocity (Table II.7.2). We compared mean depth using analysis of variance (ANOVA) and found differences among the group ($F = 16.98$, $p < 0.0001$) and between all pairwise comparisons (Table II.7.3). A comparison of depth-averaged velocities using ANOVA also showed differences among the group ($F = 27.13$, $p < 0.0001$). All pairwise comparisons of depth-averaged velocities were different (Table II.7.3).

Sediment

A sediment survey was conducted at Kansas (upper) on 28 August 2008. Results from the survey were inconclusive and did not match grab samples taken by NGPC crews. The sediment survey is not presented in this report.

Summary

The upstream chute at the Kansas Bend site is characterized by deep, fast moving water. Banks at the site are steep and high, forming a uniform "U" shaped channel for the entire length of the chute. Despite the high velocities exhibited in all surveys little erosion has taken place at the site. Bank-line movement is minimal and few sand bars are present except at the wide points of the entrance and exit of the chute. This may be due to the fact that as main channel discharges increase velocities in Kansas (upper) decrease. Even during low flow periods the site exhibits some of the fastest flowing water found at

any of the study sites. Fast water is ubiquitous at the Kansas (upper) site, unlike other chutes where fast water is generally associated with constricted entrances or rock structures.

The tall, steep banks and swift currents at the site mean little shallow water is found except at the entrance and exit of the site. Velocities at these shallow points are high, in keeping with the rest of the chute. The length of the chute and its relatively few bends do little to slow velocities and are not conducive to deposition of sediment. The potential for morphological evolution at the site may be limited.

Key features:

- Velocities decrease as main channel discharges increase
- Short
- Narrow
- Deep
- Fast
- Sand and gravel substrate
- Clay or other highly compacted soils are hindering bankline movement
- Steep banks
- Little to no bar formation
- No large woody debris

Recommendations for modification:

- Slope banks to allow large woody debris to accumulate in chute rather than on banks
- Increase length
- Connect to lower chute

Table II.7.1. List of survey dates for Kansas (upper) and relative stage with mean depth and mean depth-averaged velocity for each relative stage.

Survey Date	Discharge (cfs)	Stage	Mean Depth (m)	Mean Depth-averaged Velocity (m/s)
7 June 2007	47,100	High	3.9	0.94
31 July 2008	35,000	Mid	3.7	1.03
25 August	31,000	Low	3.5	1.00

Table II.7.2. Results of KS tests for differences in distributions between surveys at Kansas (upper). Results are significant at a Bonferonni adjusted p value of 0.033 (alpha = 0.10).

	Depth		Depth-averaged velocity	
Survey	**D**	**p-value**	**D**	**p-value**
Low vs. Mid	0.10	0.0004	0.12	<0.0001
Low vs. High	0.23	<0.0001	0.20	<0.0001
Mid vs. High	0.15	<0.0001	0.28	<0.0001

Table II.7.3. Results of pairwise tests (ANOVA) of mean depth and mean depth-averaged velocity at Kansas (upper). Results are significant at a Bonferonni adjusted p value of 0.033 (alpha = 0.10).

	Depth		Depth-averaged velocity	
Survey	**D**	**p-value**	**D**	**p-value**
Low vs. Mid	2.66	0.0079	3.45	0.0006
Low vs. High	5.83	<0.0001	4.11	<0.0001
Mid vs. High	3.36	0.0008	7.37	<0.0001

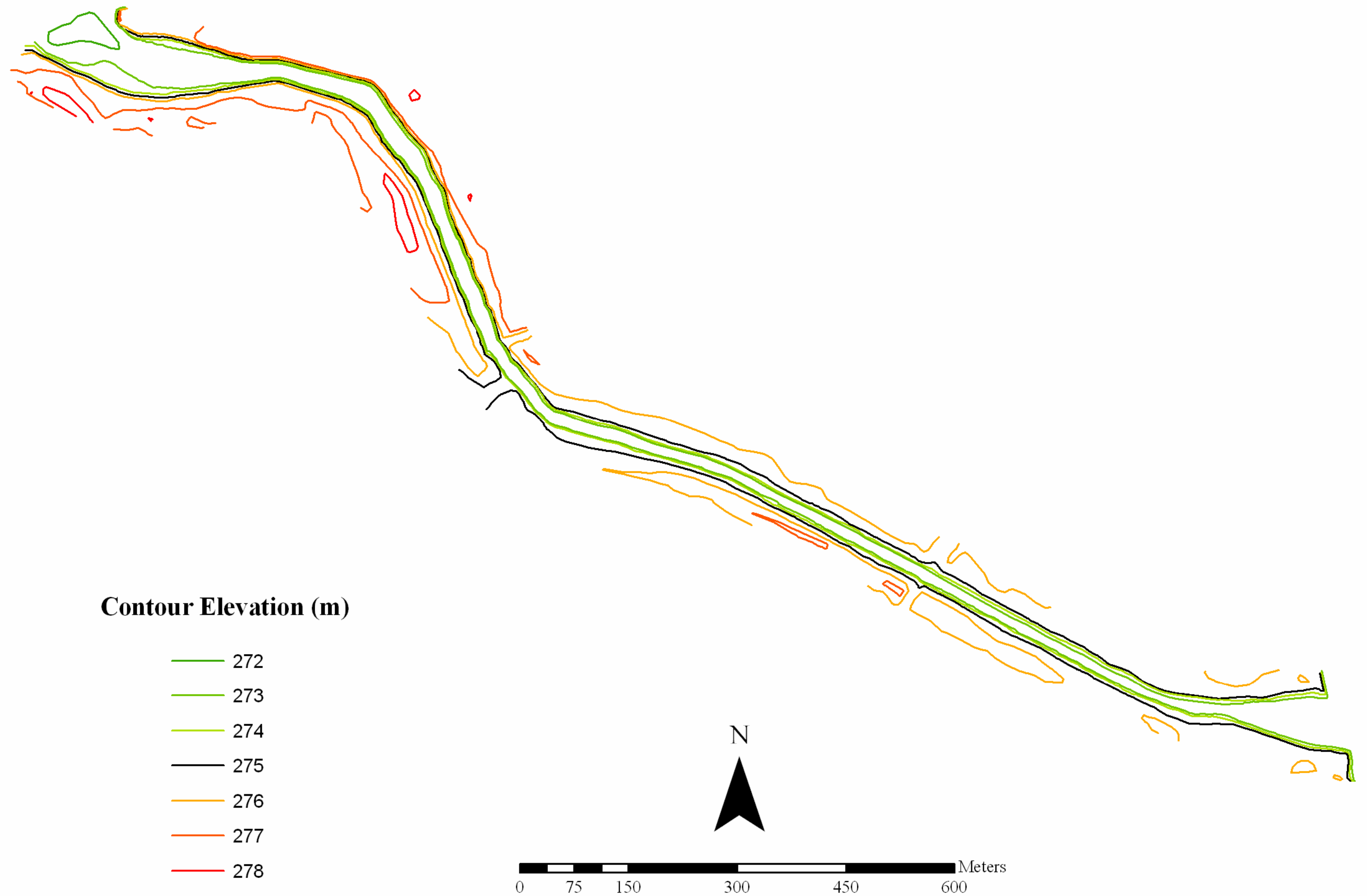


Figure II.7.1. Topographic survey of Kansas (upper) Chute.

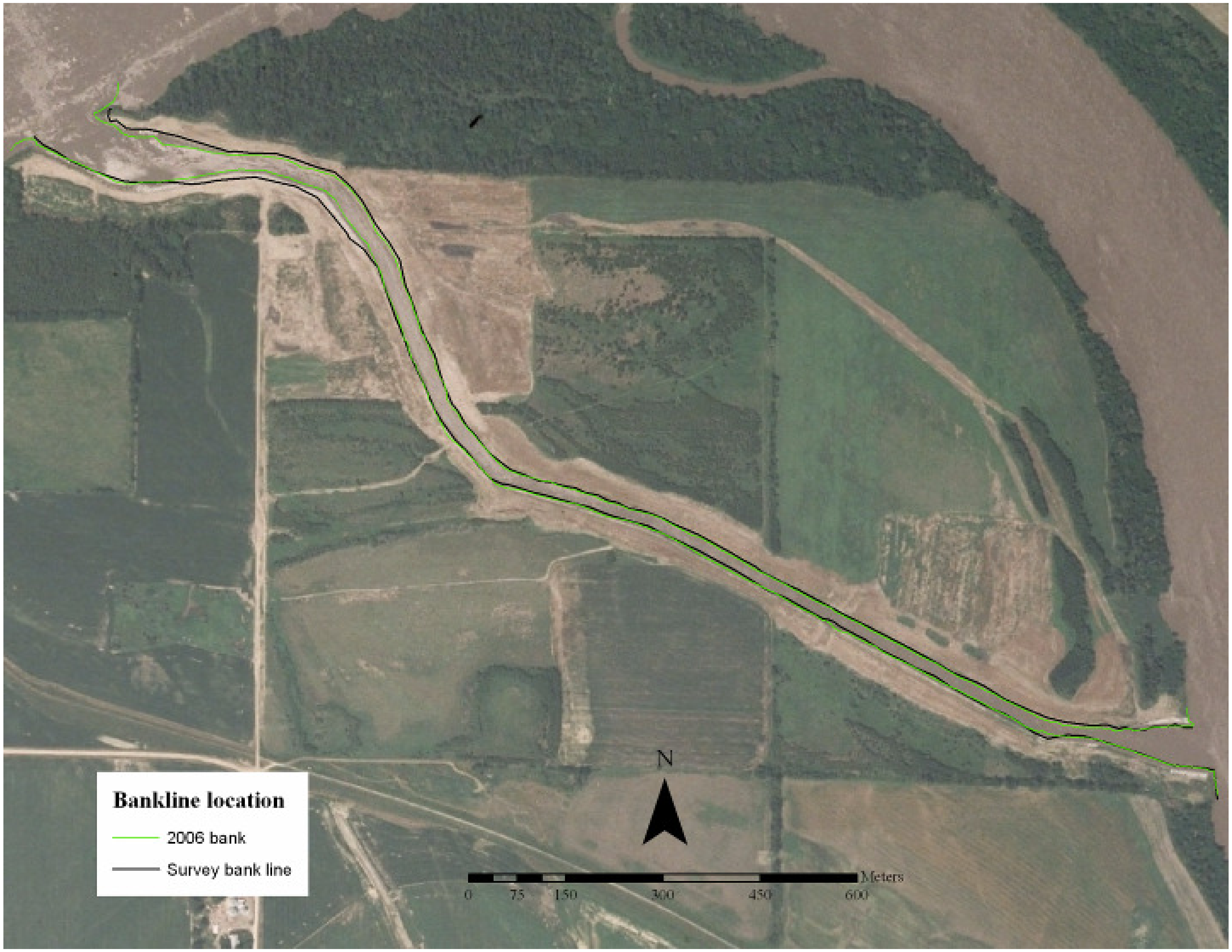


Figure II.7.2. Aerial photograph of Kansas (upper) with bankline location from 2006 aerial photography and the topographic survey.

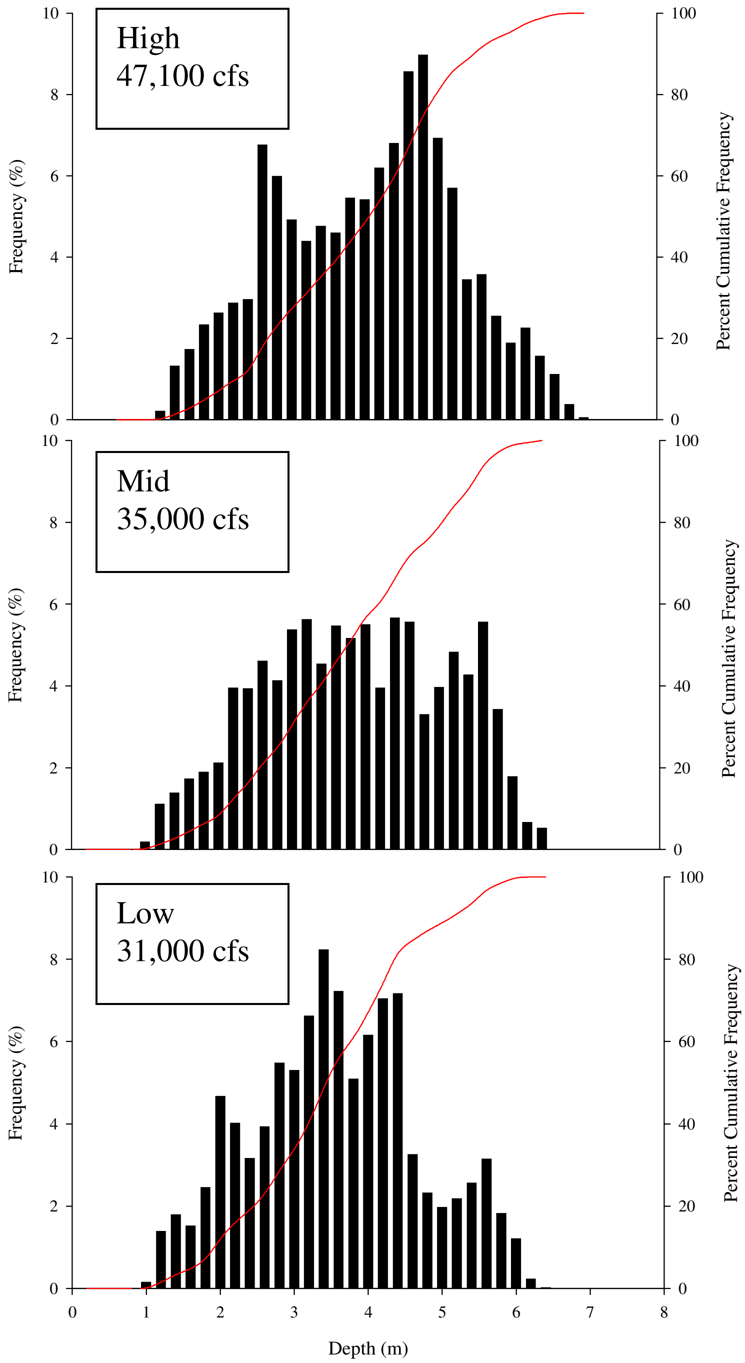


Figure II.7.3. Depth frequency and cumulative frequency (line) distributions at Kansas (upper) for all three Doppler surveys.

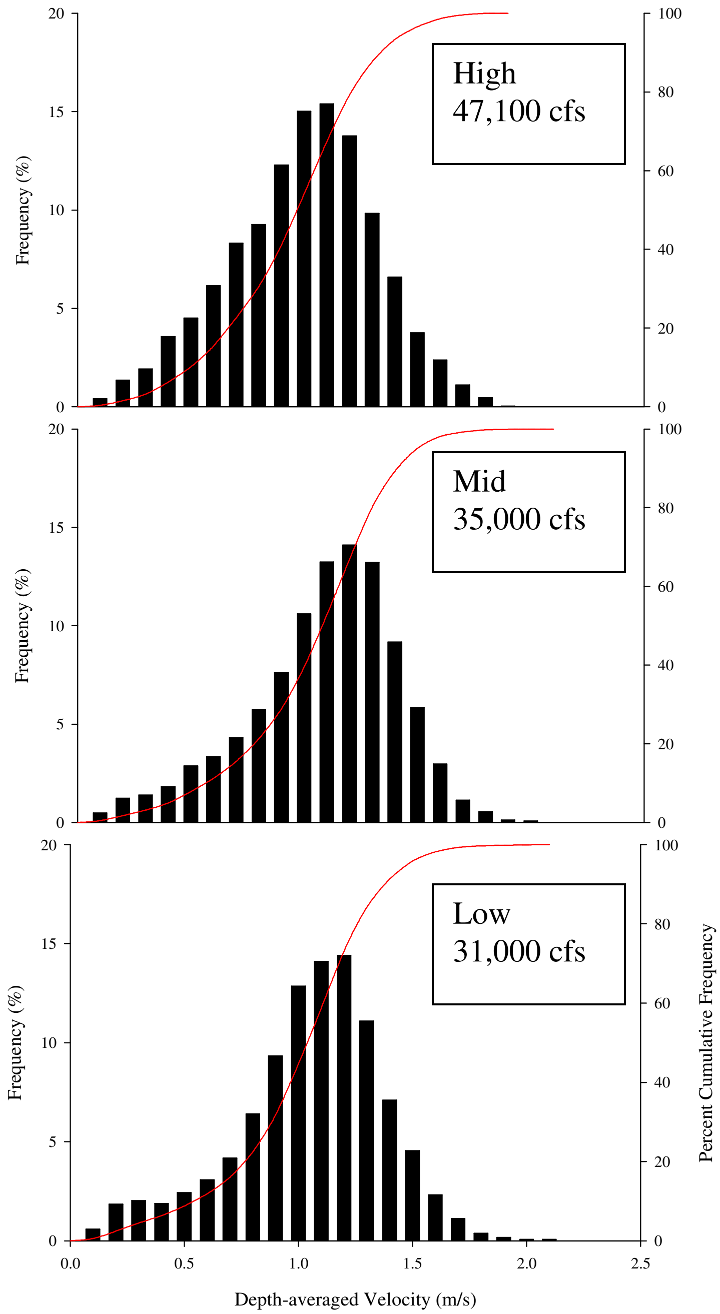


Figure II.7.4. Depth-averaged velocity frequency and cumulative frequency (line) distributions at Kansas (upper) for all three Doppler surveys

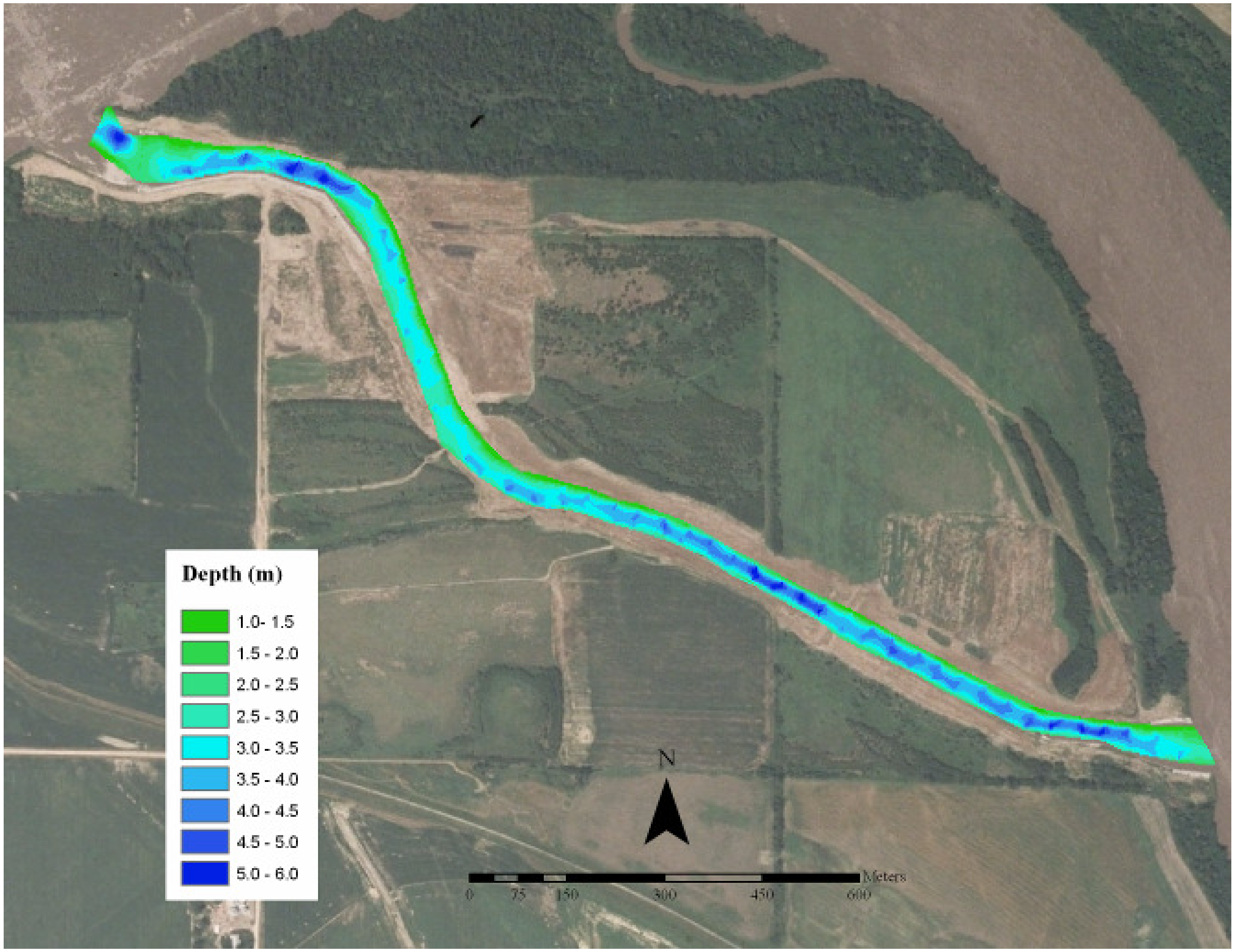


Figure II.7.5. Depth distribution from the Low survey (31,000 cfs) at Kansas (upper).

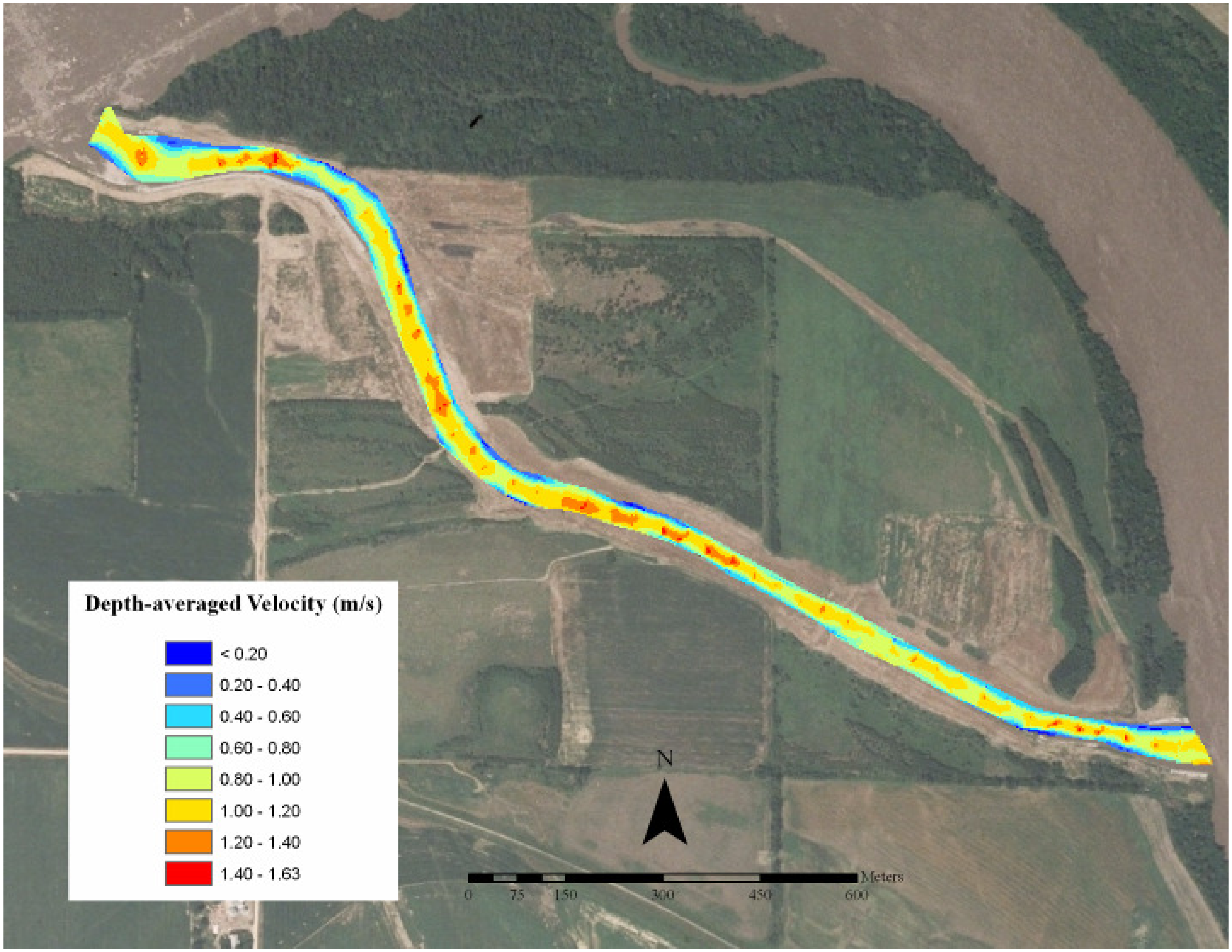


Figure II.7.6. Depth-averaged velocity distribution from the Low survey (31,000 cfs) at Kansas (upper).

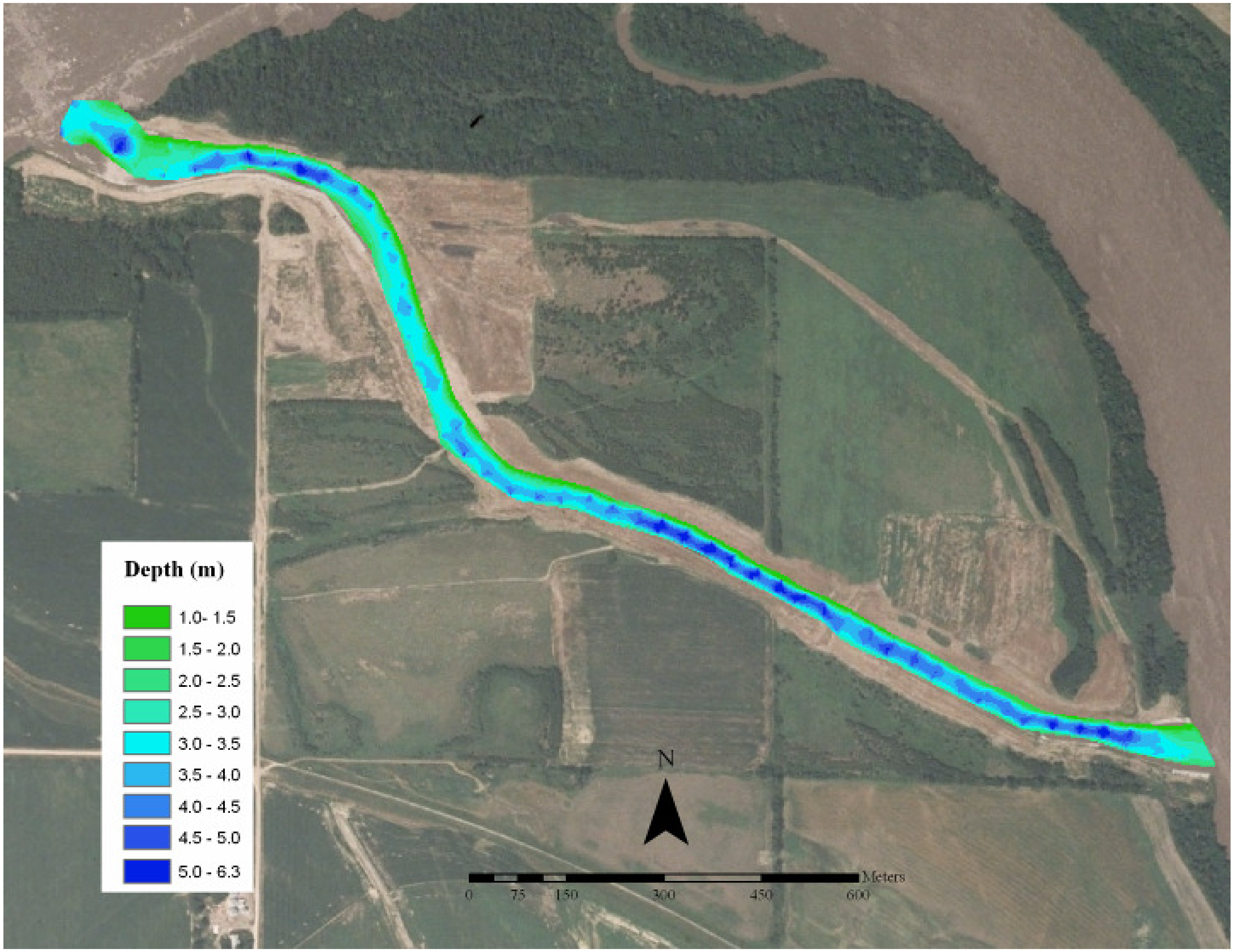


Figure II.7.7. Depth distribution from the Mid survey (35,000 cfs) at Kansas (upper).

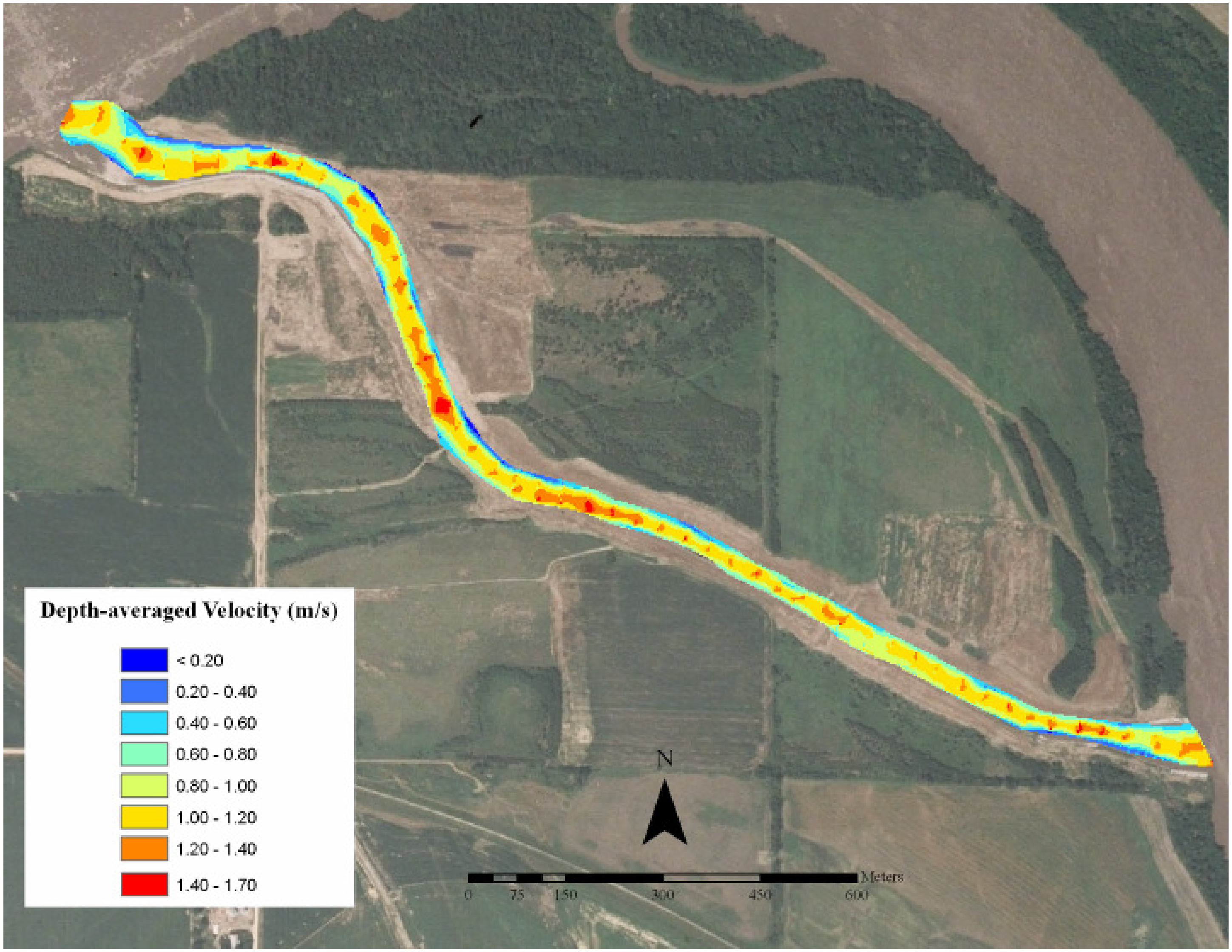


Figure II.7.8. Depth-averaged velocity distribution from the Mid survey (35,000 cfs) at Kansas (upper).

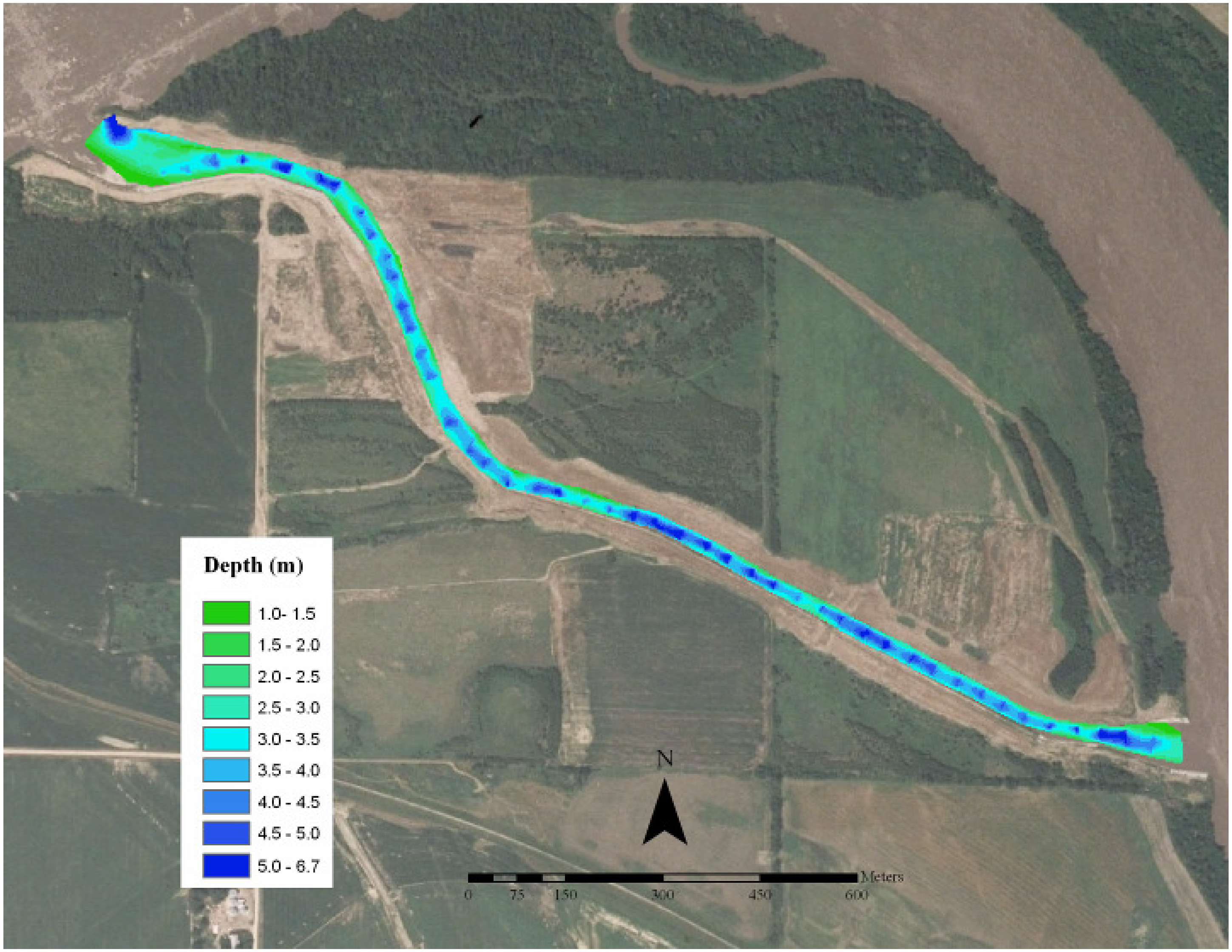


Figure II.7.9. Depth distribution from the High survey (47,100cfs) at Kansas (upper).

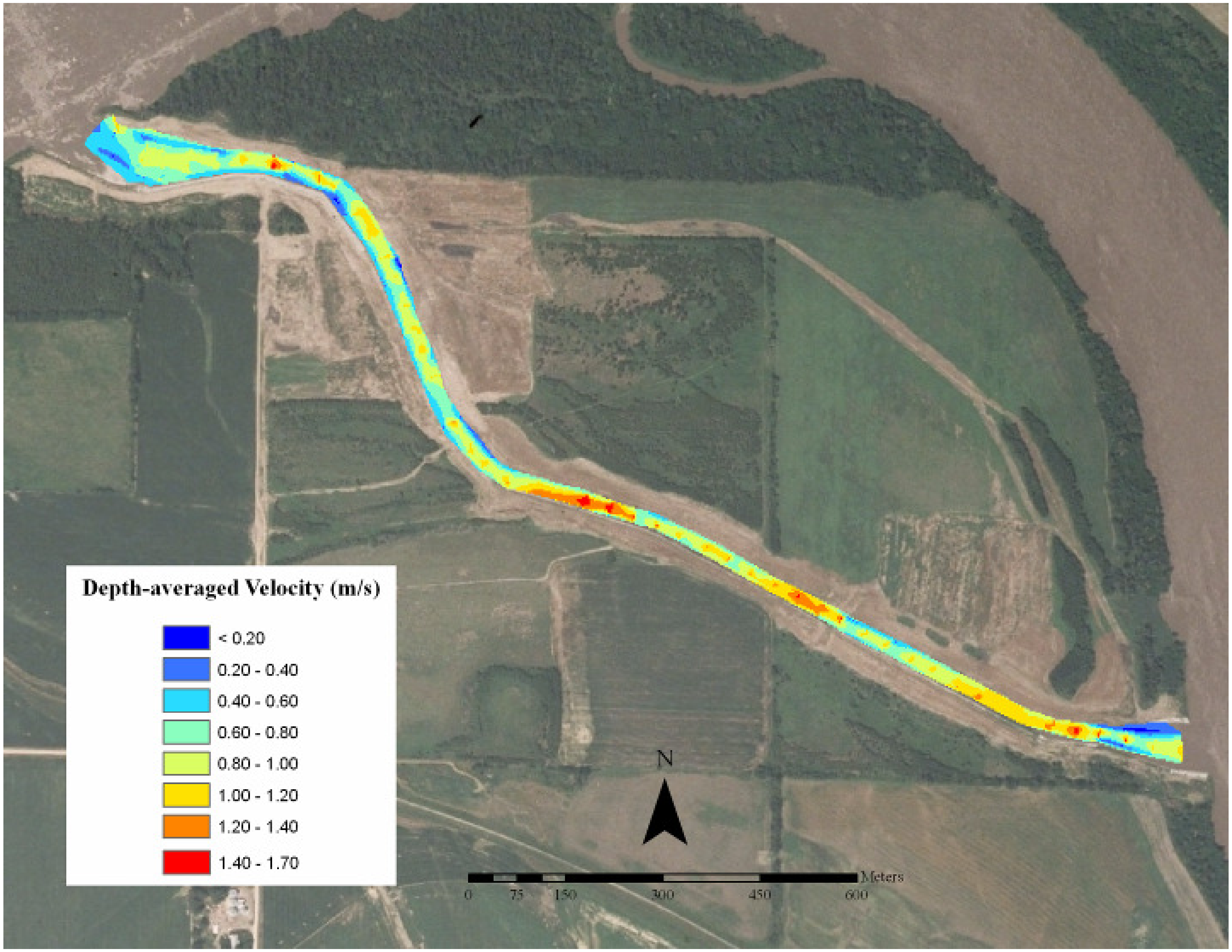
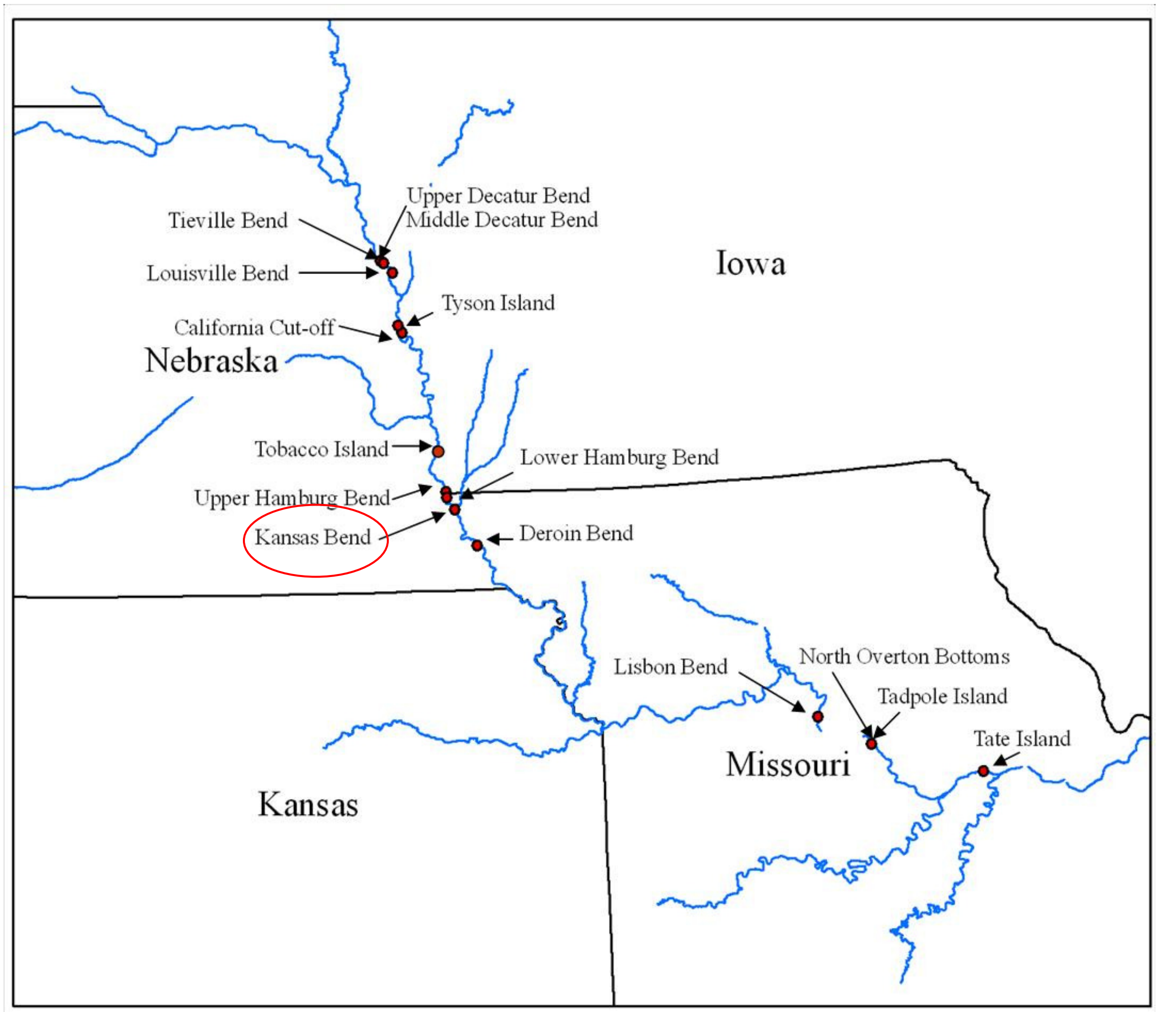


Figure II.7.10. Depth-averaged velocity distribution from the High survey (47,100 cfs) at Kansas (upper).

Section II
Chapter 8
Kansas (lower)



List of Tables

List of Figures

Kansas (lower)

The downstream site at Kansas Bend is located between RM 543.7 and 542.5 and is approximately 1700 m long and averages 37 m in width. The lower chute at Kansas Bend is similar to the upper chute in that it contains relatively deep, fast flowing water. The upper one-half of the site contains rock structures intended to slow erosion of the landward bank. Some bank line movement and bar formation has been noted at the downstream end of the site. Sediments here are generally sand and gravel with clay blocks near the bank lines. Observations by field crews noted that velocities at the downstream end of the site slowed considerably after the high water events of 2008.

Topographic Survey

A topographic survey of the Kansas (lower) site was initiated in March of 2006 and completed in March of 2008. Figure II.8.1 shows the completed survey. Figure II.8.2 shows bank-line locations from the topographic survey and from 2006 aerial photography. Most bank-line movement occurred during high water periods in 2007 and 2008.

Depth and Velocity Survey

Three surveys for depth and velocity were conducted at the Kansas (lower) Bend site in association with the Kansas (upper) Bend site. The first survey took place on 7 June 2007 at near bankful conditions and will be referred to as the High survey. Discharges at the Nebraska City gage station were 47,100 cfs on the day of the survey. The second survey was conducted on 31 July 2008 and will be referred to as the Mid

survey. Discharges at the Nebraska City gage station were 35,000 cfs on the day of the survey. The final survey was done on 25 August 2008 and will be referred to as the Low survey. Discharges at the Nebraska City gage station were 31,000 cfs on the day of the survey

The average depth during the Low survey was 2.3 m and the maximum was 7.3 m (Table II.8.1). Eighty-nine percent of depths were between 1.5 m and 3.7 m while only 6% were less than 1.5 m (Figure II.8.3). The average velocity was 0.76 m/s and the maximum was 1.79 m/s (Table II.8.1). Forty-five percent of velocities were less than 0.76 m/s and 86% were less than 1.0 m/s (Figure II.8.4). Figure II.8.5 shows depth data and Figure II.8.6 shows velocity data for the Low survey.

The average depth during the Mid survey was 2.7 m (Table II.8.1) and the maximum depth was 6.8 m. Only 5% percent of depths were less than 1.5 m and 8% were greater than 3.7 m (Figure II.8.3). The average velocity was 0.78 m/s (Table II.8.1) and the maximum was 1.59 m/s. Forty-three percent of velocities were less than 0.76 m/s and 83% were less than 1.0 m/s (Figure II.8.4). Figure II.8.7 shows depth data and Figure II.8.8 shows velocity data from the Mid survey.

The average depth during the High survey was 3.6 m (Table II.8.1) and the maximum depth was 5.8 m. Only 1% of depths surveyed were less than 1.5 m and 60% were greater than 3.7 m (Figure II.8.3). The average velocity surveyed was 0.80 m/s (Table II.8.1) and the maximum was 1.64 m/s. Thirty-seven percent of velocities were less than 0.76 m/s and 83% were less than 1.0 m/s (Figure II.8.4). Figure II.8.9 shows depth data and Figure II.8.10 shows velocity data from the High survey.

We compared depth frequency distributions and depth-averaged velocity frequency distributions between surveys using a KS test and found significant differences between all depth surveys (Table II.8.2). We compared mean depth using analysis of variance (ANOVA) and found differences among the group (F = 252.79, p <0.0001) and all pairwise comparisons (Table II.8.3). A comparison of depth-averaged velocities using ANOVA also showed differences among the group (F = 9.86, $p < 0.0001$). All pairwise comparisons were different except that there was no difference of depth-averaged velocities between the Mid and Low surveys.

Sediment

A sediment survey was conducted at Kansas (lower) on 28 August 2008. Results from the survey were inconclusive and did not match grab samples taken by NGPC crews. The sediment survey is not presented in this report.

Summary

The chute at the Kansas (lower) Bend site has widened at a similar pace to the Kansas (upper) Bend chute but little habitat diversity has been created. The chute contains very little shallow water (between 1 and 6%) and water velocity is relatively fast and remains fairly constant (between 0.76 and 0.80 m/s) at all flows. Some sand bar formation is present at the wide areas of the entrance and exit and where large woody debris has accumulated. However, the site is very short and there is little room for evolution due to its length and lack of bends. In addition, the upper portion of the chute contains rock structures designed to limit erosion on the right descending bank in order to

protect a nearby levee. These factors suggest that there is limited potential for evolution at the site.

Key features:

- Short
- Narrow
- Deep
- Fast
- Rock structures at top prohibiting bankline movement
- Sand and gravel substrate
- Clay or other highly compacted soils hindering bankline movement
- Steep banks
- Little large woody debris
- Little bar formation

Recommendations for modification:

- Increase length
- Connect lower chute with upper chute
- Add width to slow velocities and promote shallow water habitat
- Remove rock structures on west bank to promote bankline movement
- Slope banks to allow large woody debris to accumulate in chute rather than on banks

Table II.8.1. List of survey dates for Kansas (lower) and relative stage with mean depth and mean depth-averaged velocity for each relative stage.

Survey Date	Discharge (cfs)	Stage	Mean Depth (m)	Mean Depth-averaged Velocity (m/s)
7 June 2007	47,100	High	3.6	0.80
31 July 2008	35,000	Mid	2.7	0.78
25 August	31,000	Low	2.3	0.76

Table II.8.2. Results of KS tests for differences in distributions between surveys at Kansas (lower). Results are significant at a Bonferonni adjusted p value of 0.033 (alpha = 0.10).

	Depth		Depth-averaged velocity	
Survey	**D**	**p-value**	**D**	**p-value**
Low vs. Mid	0.33	<0.0001	0.10	0.0077
Low vs. High	0.67	<0.0001	0.12	0.0002
Mid vs. High	0.55	<0.0001	0.11	0.0024

Table II.8.3. Results of pairwise tests (ANOVA) for mean depth and mean depth-averaged velocity at Kansas (lower). Results are significant at a Bonferonni adjusted p value of 0.033 (alpha = 0.10). Significant results are shown in bold

	Depth		Depth-averaged velocity	
Survey	**D**	**p-value**	**D**	**p-value**
Low vs. Mid	**5.43**	**<0.0001**	1.54	0.1247
Low vs. High	**21.56**	**<0.0001**	**4.37**	**<0.0001**
Mid vs. High	**15.92**	**<0.0001**	**2.78**	**0.0055**

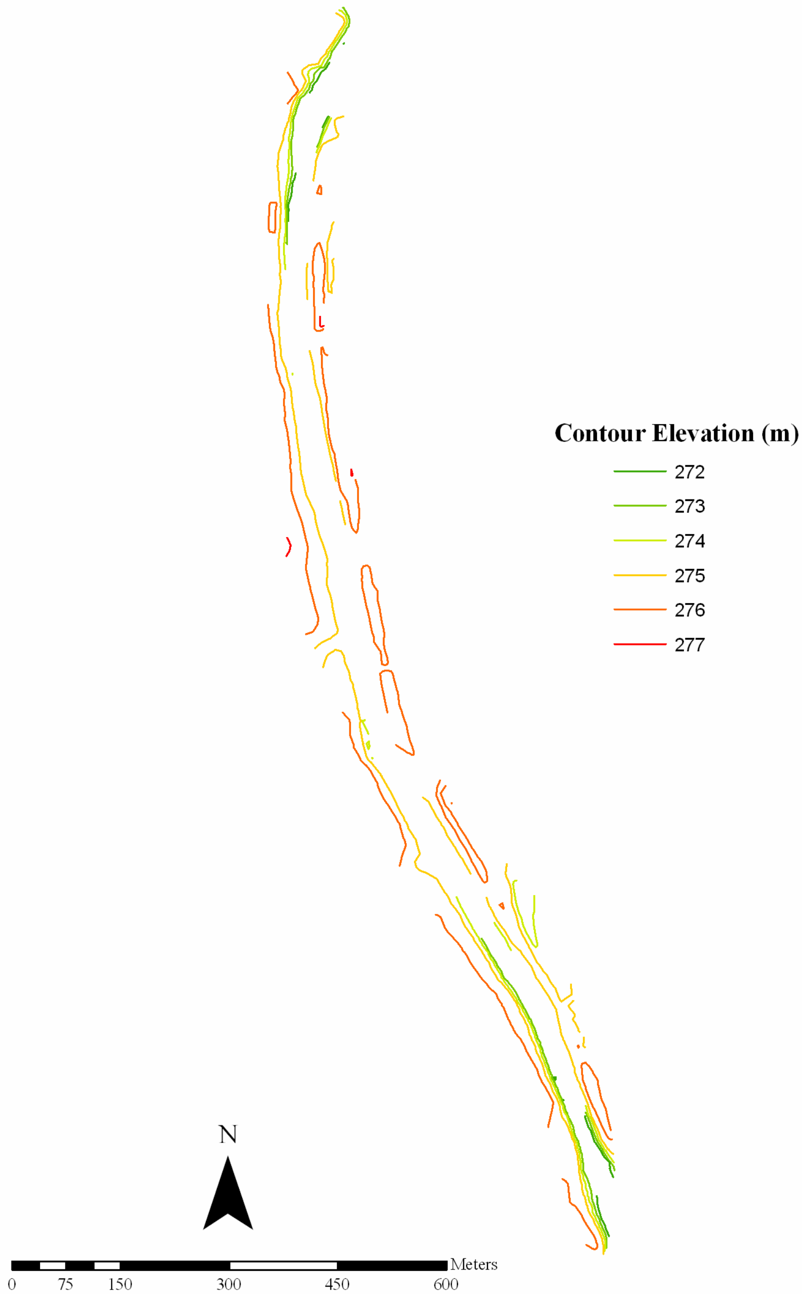


Figure II.8.1. Topographic survey of Kansas (lower).

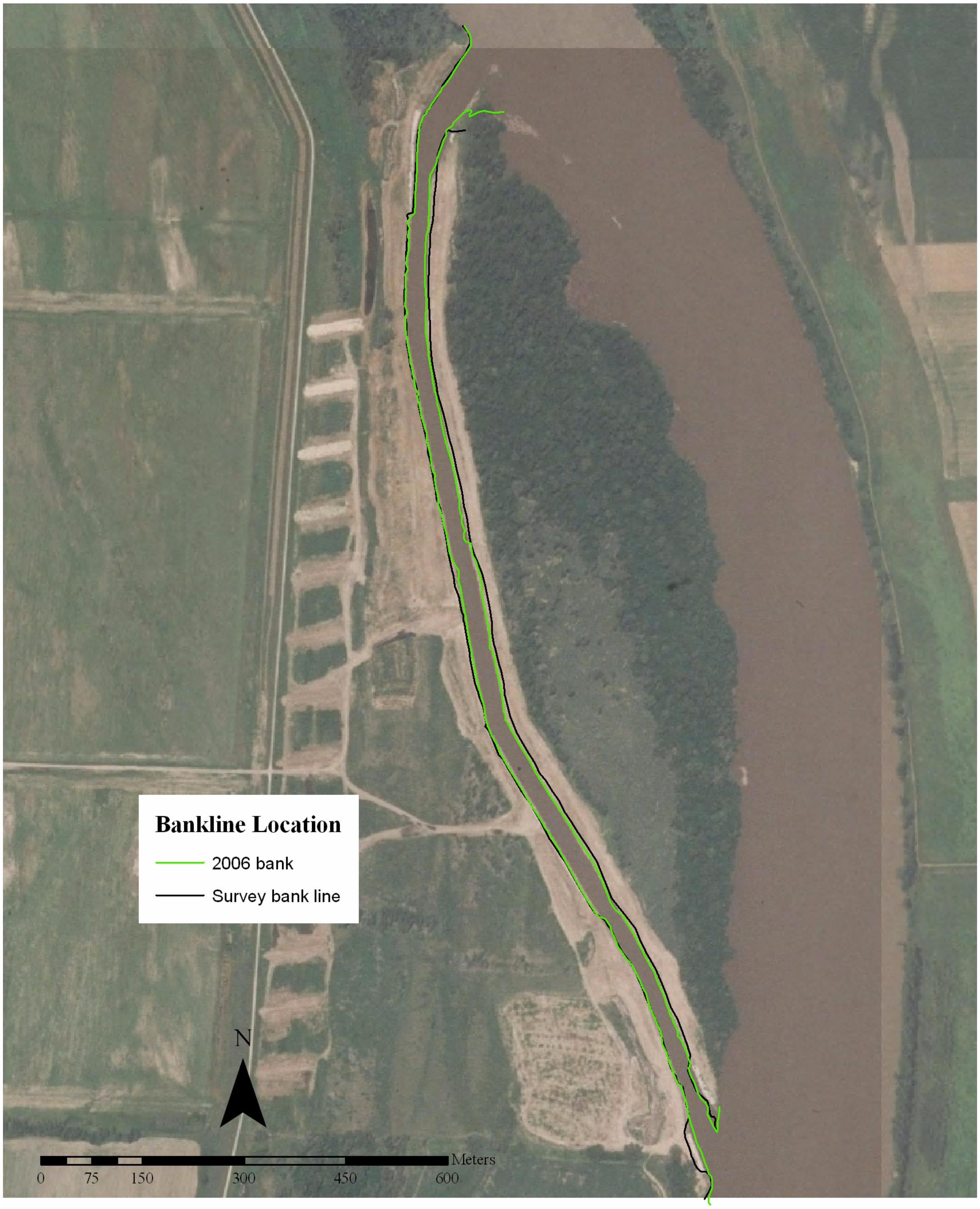


Figure II.8.2. Aerial photograph of Kansas (lower) with bankline locations from 2006 aerial photography and the topographic survey.

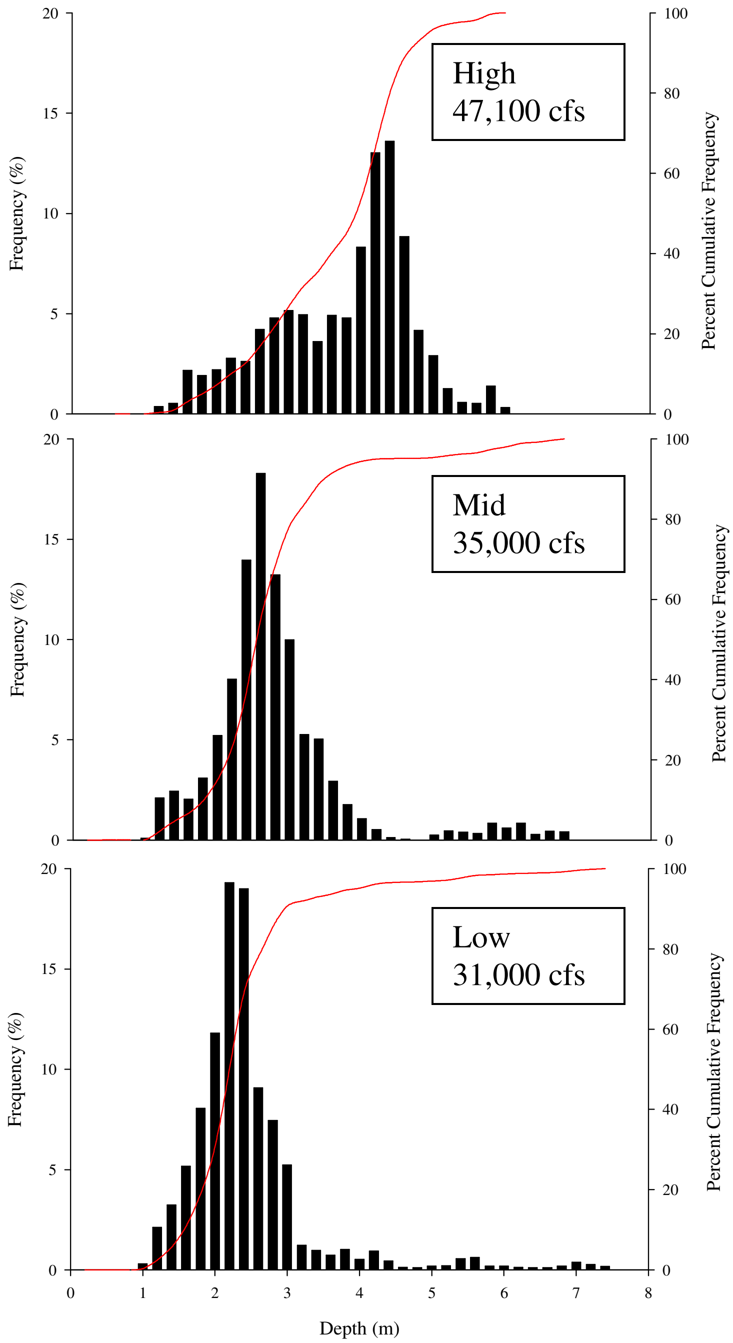


Figure II.8.3. Depth frequency and cumulative frequency (line) distributions for Kansas (lower) for all three Doppler surveys.

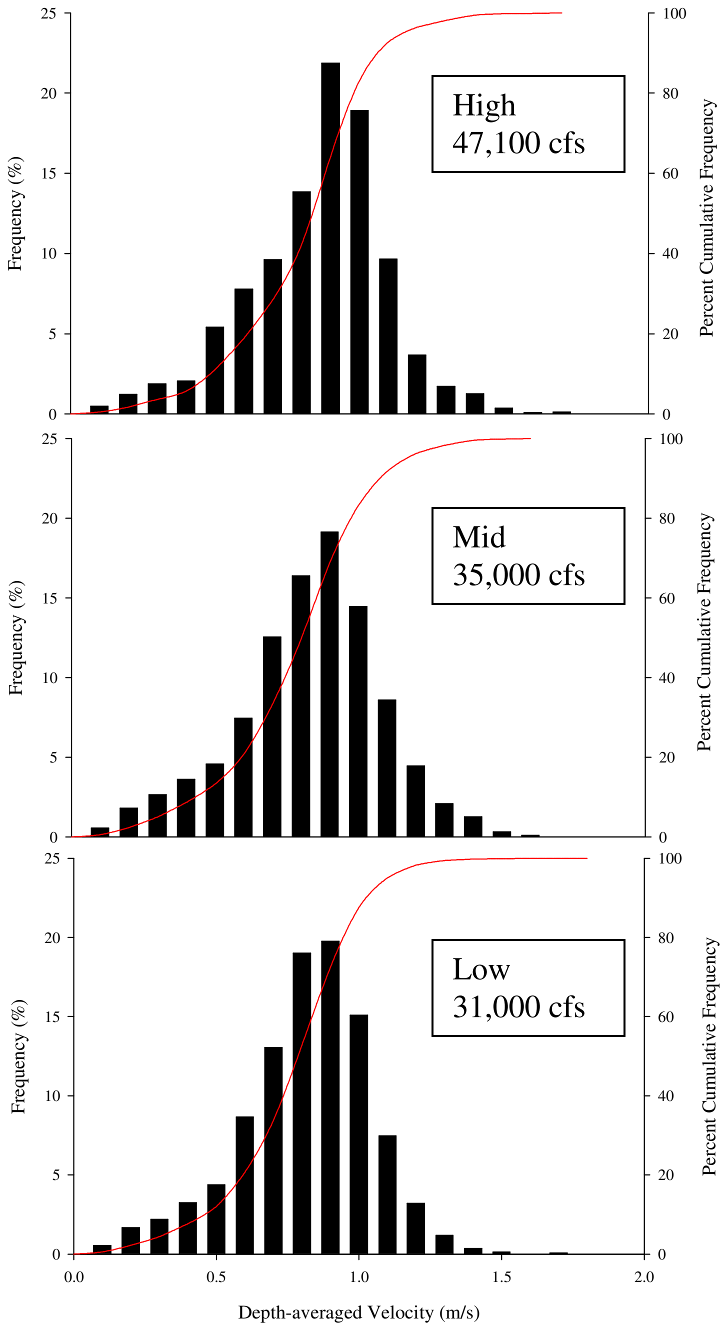


Figure II.8.4. Depth-averaged velocity frequency and cumulative frequency (line) distributions for Kansas (lower) for all three Doppler surveys.

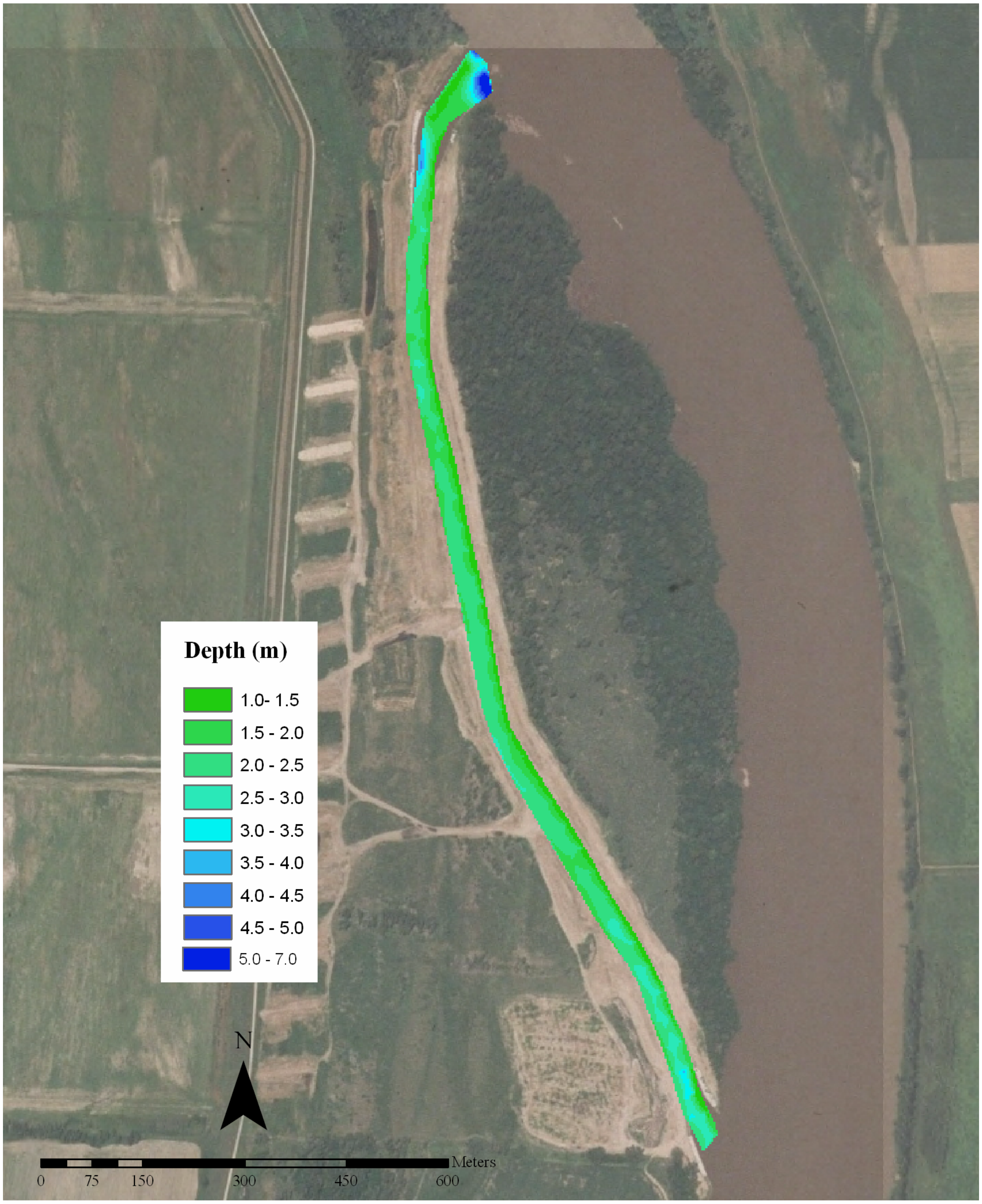


Figure II.8.5. Depth distribution from the Low survey (31,000 cfs) for Kansas (lower).

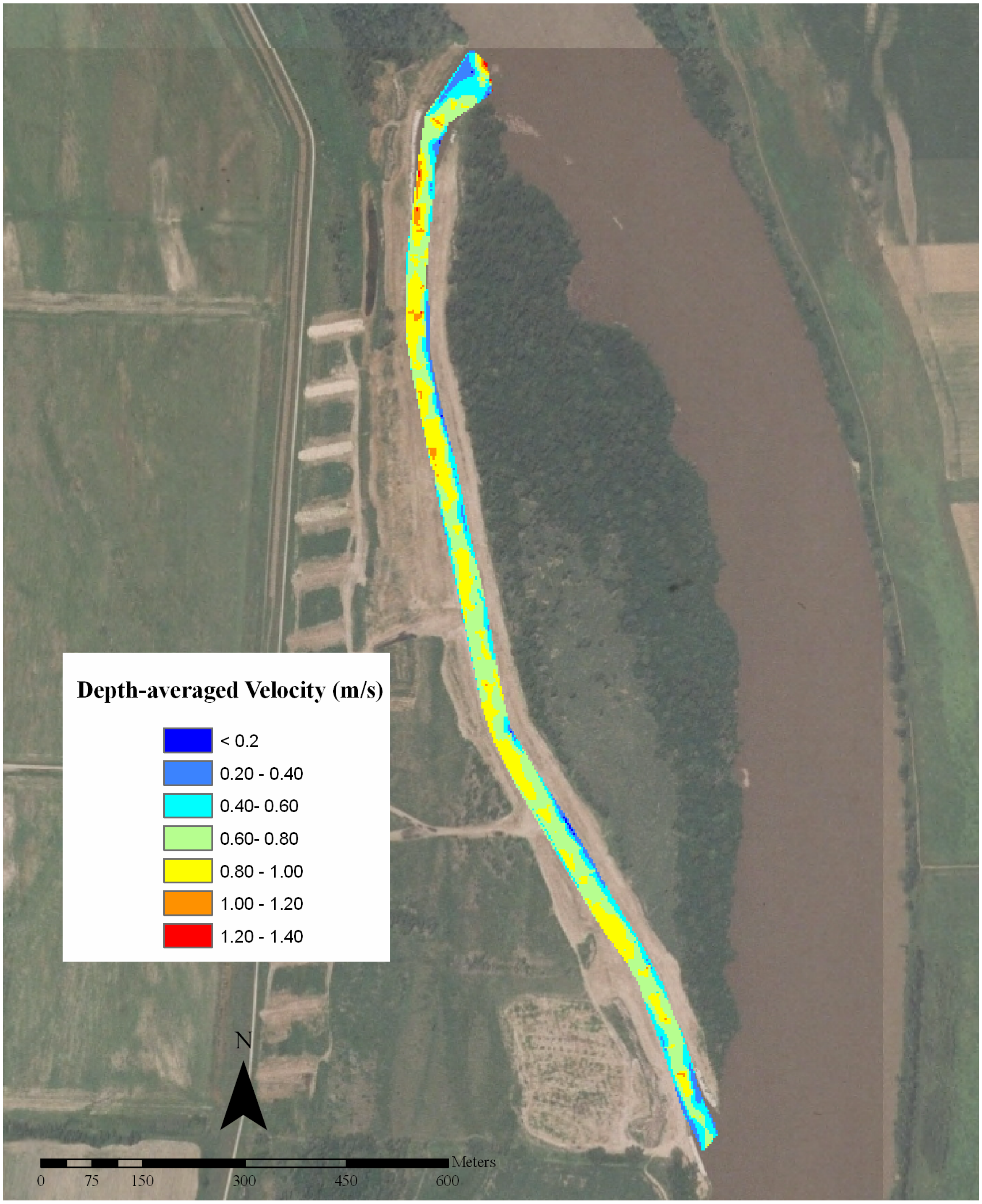


Figure II.8.6. Depth-averaged velocity distribution from the Low survey (31,000 cfs) for Kansas (lower).

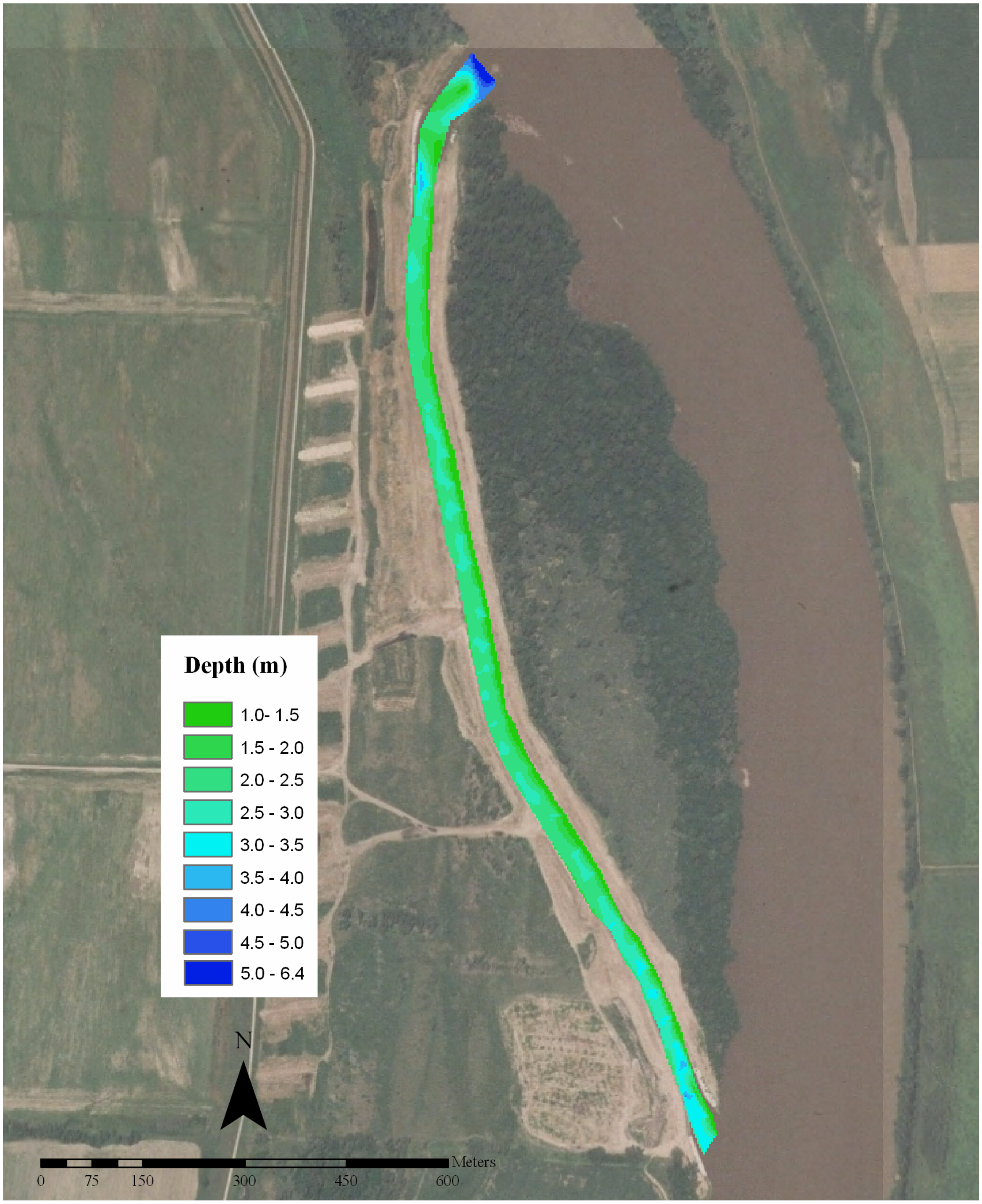


Figure II.8.7. Depth distribution from the Mid survey (35,000 cfs) for Kansas (lower).

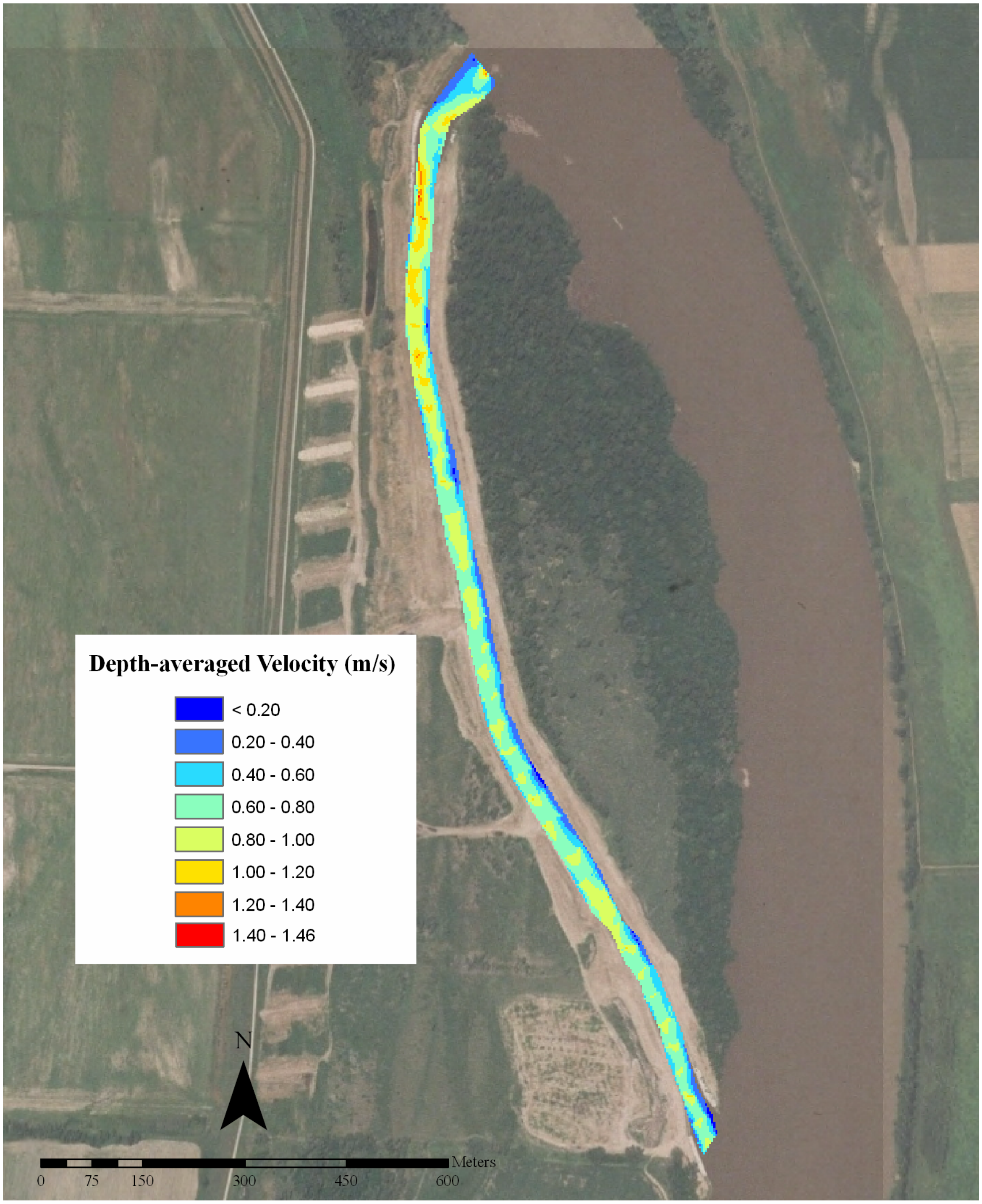


Figure II.8.8. Depth-averaged velocity distribution from the Mid survey (35,000 cfs) for Kansas (lower).

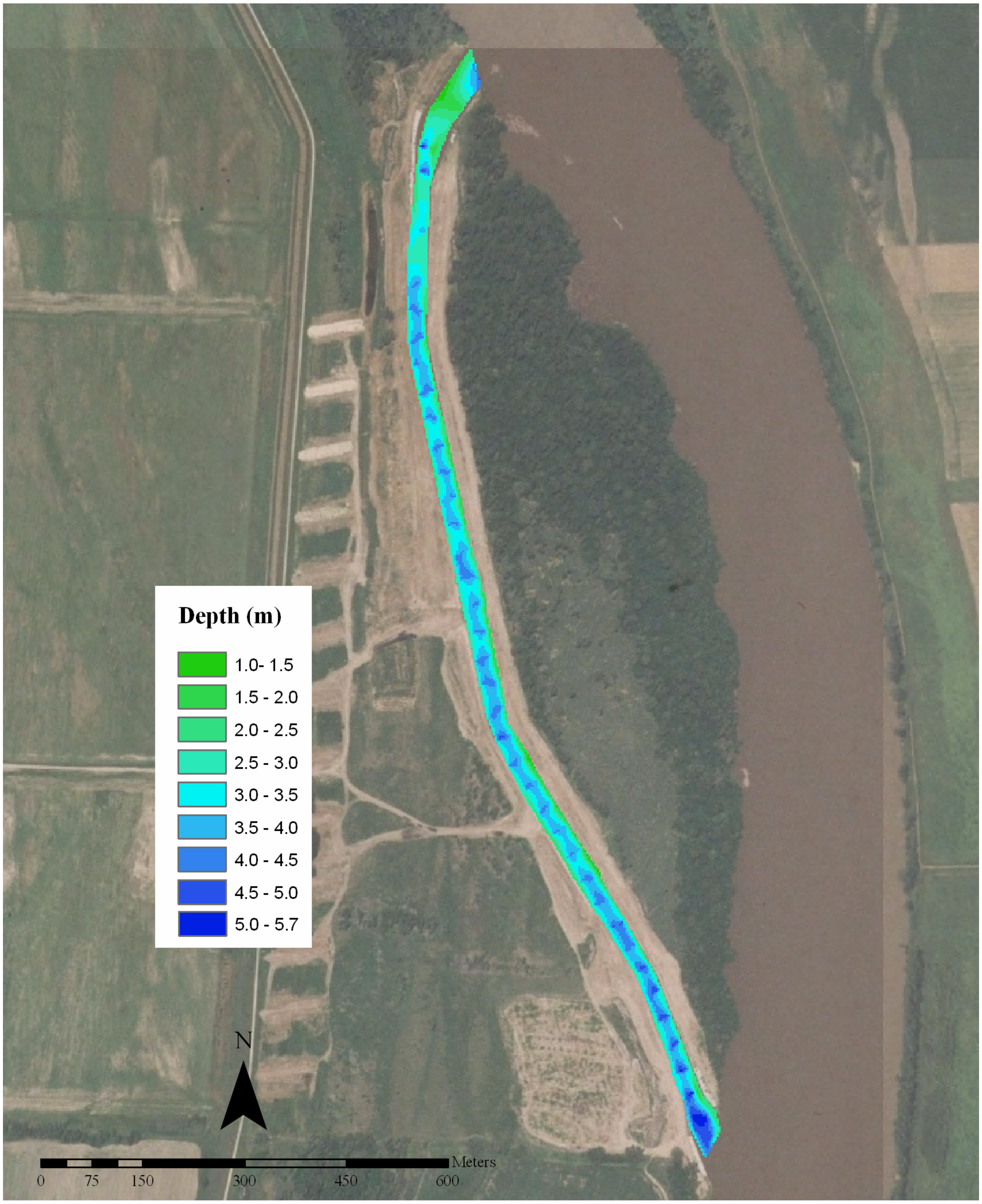


Figure II.8.9. Depth distribution from the High survey (47,100 cfs) for Kansas (lower).

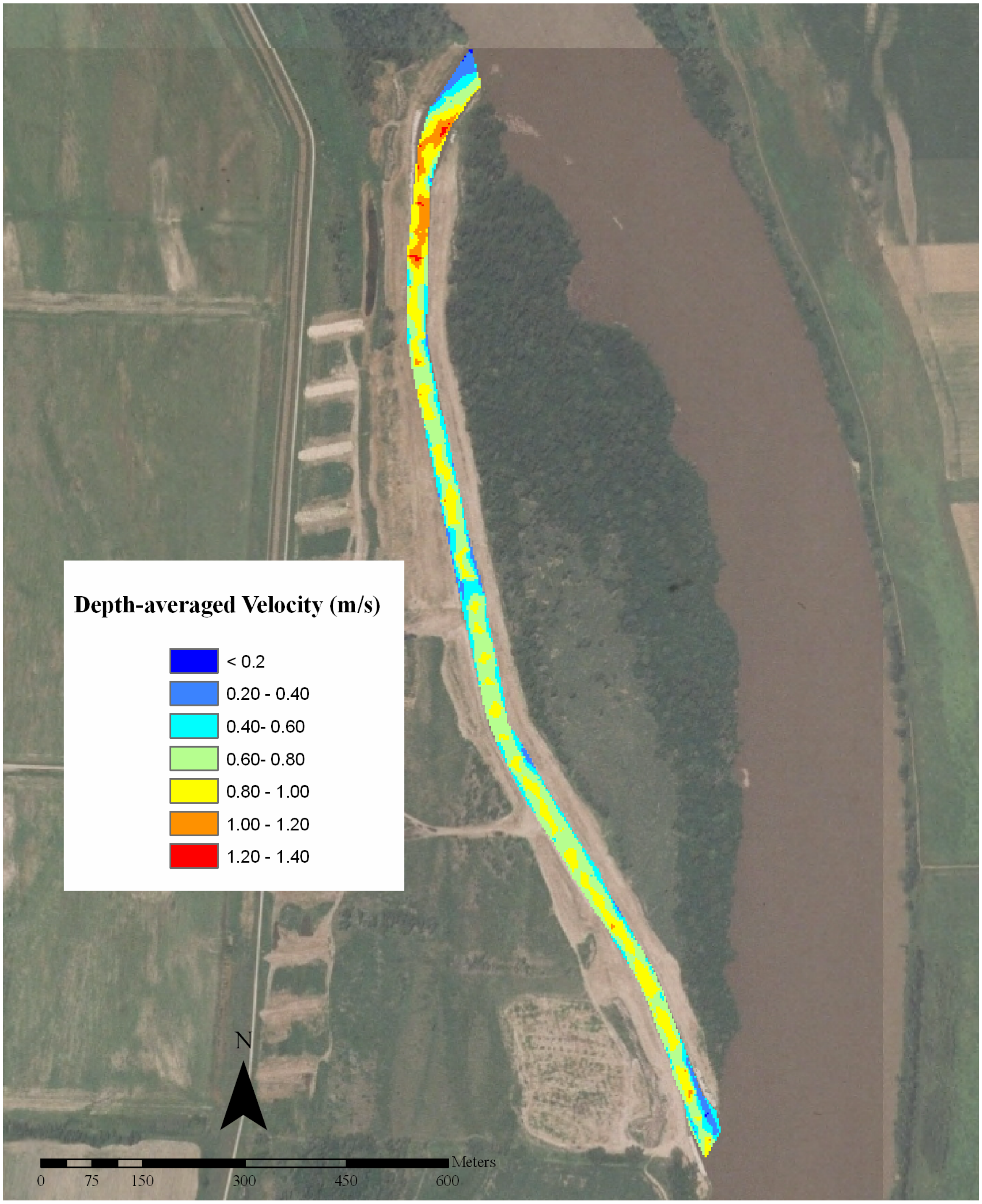
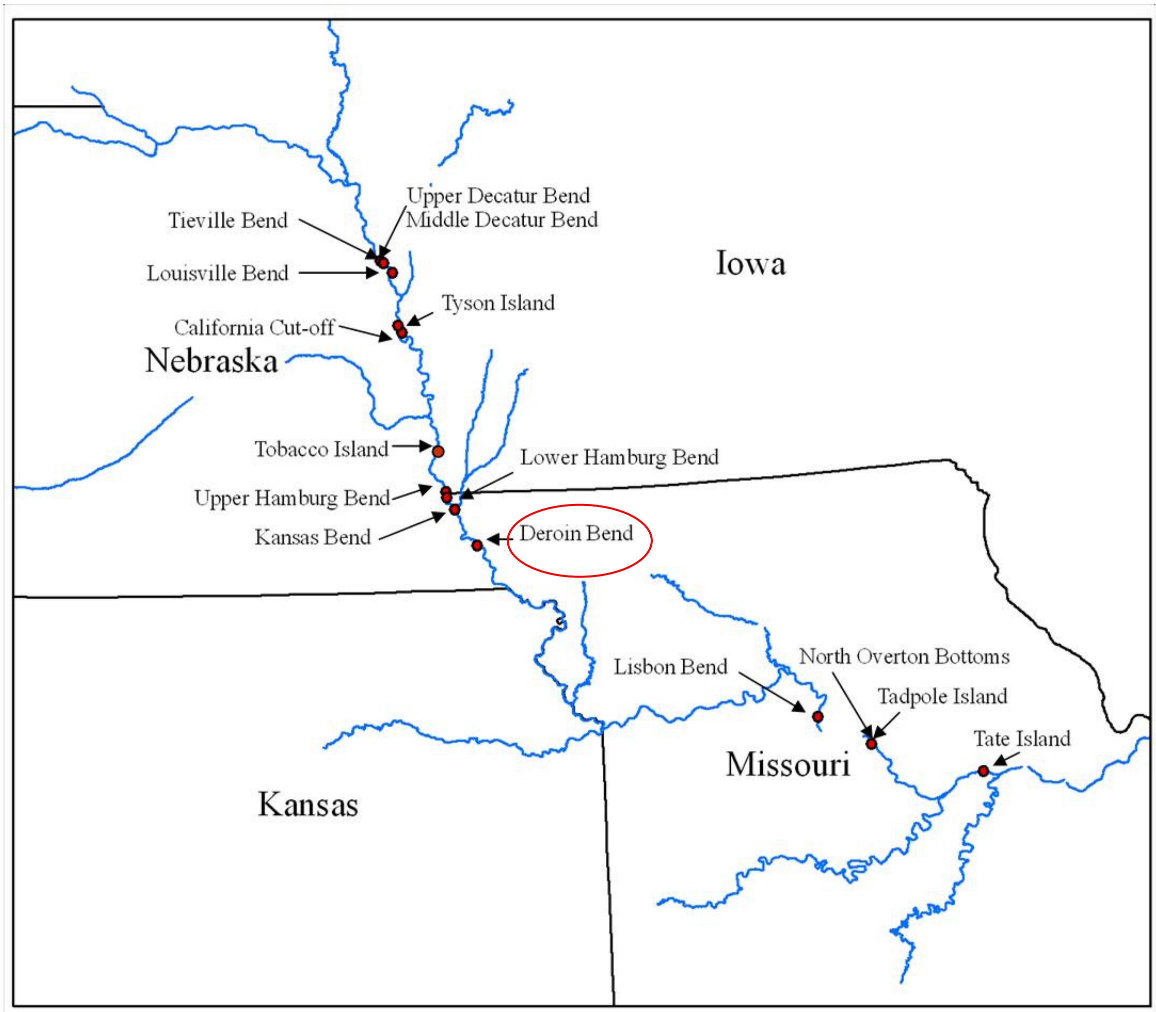


Figure II.8.10. Depth-averaged velocity daistribution from the High survey (47,100 cfs) for Kansas (lower).

Section II
Chapter 9
Deroin



List of Tables

List of Figures

Deroin

The chute at Deroin Bend is located between RM 520.4 and 516.5 in Atchison and Holt Counties, Missouri. The site was reopened in 2001 and contains an approximately 4,950 m flow through chute and a connected backwater area. Deroin was initially constructed with a 21.3 m pilot channel.

The chute is characterized by moderately deep, swift moving water. A defined thalweg has formed in the lower portion of the chute and some bar areas are forming on the inside bends and behind rock and pile dike structures. Bank lines at the site remain steep and tall in most areas. By 2007 erosion had widened the chute to approximately 55 m. Sediments at the chute are dominated by sand and gravel.

A small backwater area and a secondary channel are present at the top of the chute. Initially these sites provided an area of shallow slow moving water not present in other portions of the site. In 2007 and 2008 floods deposited large amounts of sediment at the upper entrance to the backwater eliminating that entrance. The lower entrance is still open, but the flow through element of the backwater has been eliminated.

Control structures are present at the entrance of the chute. Their design was to minimize bank line movement on the landward side of the chute in order to protect a nearby levee. By 2007 water had cut behind and around several of the upstream most structures. At a meeting between the FWS, USACE and MDC it was determined that the structures would not be immediately modified (Kasey Whiteman, MDC, Personal Communication). By 2008 all of the structures had been compromised. Large scour holes and point bars are now present adjacent to all of these structures. Bank line movement behind the structures has been swift.

Topographic Survey

A topographic survey was initiated in December of 2005. The left descending bank and backwater are of the site were completed in the winter of 2006. The island side was not surveyed due to time constraints, equipment failures and unfavorable conditions (ice and tree cover). Figures II.9.1-3 show the completed survey with bankline locations from 2006 aerial photography. Figures II.9.4-6 show bank line locations from our survey and from 2003, 2006 and 2007 aerial photography. Significant erosion took place in 2008.

Depth and Velocity Surveys

Three depth and velocity surveys were conducted at Deroin Bend chute in 2007 and 2008. The first survey was done on 5 June 2007 at bankful conditions and will be referred to as the High survey. Discharges at the Nebraska City gage station were 52,200 cfs on the day of the survey. The second survey was conducted on 30 July 2008 and will be referred to as the Mid survey. Discharges at the Nebraska City gage station were 40,000 cfs on the day of the survey. The final survey was done on 30 September 2008 and will be referred to as the Low. Discharges at the Nebraska City gage station were 29,700 cfs on the day of the survey.

The average depth during the Low survey was 2.3 m (Table II.9.1) and the maximum was 7.4 m. Only 6% of depths surveyed were less than 1.5 m and 91% of depths were between 1.5 m and 3.7 m (Figure II.9.4). The average velocity was 0.80 m/s (Table II.9.1) and the maximum velocity was 2.30 m/s. Approximately 40% of velocities

were less than 0.76 m/s and 79% were less than 1.0 m/s (Figure II.9.4). The distribution of depths (Figures II.9.6-8) and depth-averaged velocities (Figures II.9.9-11) are shown for the Low survey at Deroin.

The average depth surveyed during the Mid survey was 2.8 m (Table II.9.1) and the maximum was 8.1 m. At the time of the survey 2% of depths were less than 1.5 m and 90% of depths were less than 3.7 m (Figure II.9.4). The average velocity was 0.88 m/s (Table II.9.1) and the maximum was 2.29 m/s. Thirty percent of velocities were less than 0.76 m/s and 66% were less than 1.0 m/s (Figure II.9.5). The distribution of depths (Figures II.9.12-14) and depth-averaged velocities (Figures II.9.15-17) are shown for the Mid survey at Deroin.

The average depth during the High survey was 3.5 m (Table II.9.1) and the maximum was 9.5 m. At bankful 2% of the depths surveyed were less than 1.5 m and 44% were greater than 3.7 m (Figure II.9.4). The average velocity during the survey was 0.89 m/s (Table II.9.1) and the maximum was 1.88 m/s. Twenty-eight percent of velocities were less than 0.76 m/s and 63% were less than 1.0 m/s (Figure II.9.5). The distribution of depths (Figures II.9.18-20) and depth-averaged velocities (Figures II.9.21-23) are shown for the High survey at Deroin.

We compared depth frequency distributions and depth-averaged velocity frequency distributions between surveys using a KS test and found significant differences between all surveys for both depth and depth averaged velocity (Table II.9.2). We compared mean depth using analysis of variance (ANOVA) and found differences among the group ($F = 2032.24$, $p < 0.0001$) and all pairwise comparisons (Table II.9.3). A comparison of depth-averaged velocities using ANOVA also showed differences among

the group ($F = 46.89$, $p < 0.0001$). All pairwise comparisons were different except no difference was found between the Mid and High surveys (Table II.9.3).

Sediment

A sediment survey was conducted at Deroin on 29 September 2008. Results from the survey were inconclusive and did not match grab samples taken by NGPC crews. The sediment survey is not presented in this report.

Summary

Bank-line locations from our survey and aerial photography show some lateral bank-line movement at outside bend locations at the site. Significant movement has also taken place at the top of the chute where high water events eroded the bank behind rock structures and have formed large scallops. Some bar formation has been noted behind pile dike structures and grade control structures.

Deroin exhibits some of the fastest flowing water at the study sites. Pile dikes and rock structures constrict the channel at multiple points and are responsible for these high water velocities as well as deep scour holes and some bar formation. Deroin also contains some of the deepest water of the study sites, approaching 10 m in some scour holes. The sites length and sinuosity combined with the rock structures and pile dikes give the site a great deal of potential for evolution.

Key features:

- High velocities

- Relatively deep with some deep scour holes
- Sand and gravel substrate
- Sand and clay banks
- Some large woody debris
- Some bar formation
- Flow through tie-channel/backwater area connected during periods of high water
- Tie-channel/backwater area contains large amounts of large woody debris
- Some bankline movement noted after sustained high water event in 2008

Recommendations for modification:

- Redesign secondary channel / backwater to promote flow and reduce sedimentation
- Continue to allow erosion behind rock structures at the top of the site
- Add width in areas to create shallow sand bar habitat and decrease velocities
- Slope banks to allow large woody debris to accumulate in chute rather than on banks
- Restrict entrance to decrease velocities

Table II.9.1. List of survey dates for Deroin and relative stage with mean depth and mean depth-averaged velocity for each relative stage.

Survey Date	**Discharge (cfs)**	**Stage**	**Mean Depth (m)**	**Mean Depth-averaged Velocity (m/s)**
5 June 2007	52,200	High	3.5	0.89
30 July 2008	40,000	Mid	2.8	0.88
30 September 2008	29,700	Low	2.3	0.80

Table II.9.2. Results of Komogovor-Smirnov tests for differences in distributions between surveys at Deroin. Results are significant at a Bonferonni adjusted p value of 0.033 (alpha = 0.10).

	Depth		**Depth-averaged velocity**	
Survey	**D**	**p-value**	**D**	**p-value**
Low vs. Mid	0.34	<0.0001	0.40	<0.0001
Low vs. High	0.70	<0.0001	0.32	<0.0001
Mid vs. High	0.48	<0.0001	0.20	<0.0001

Table II.9.3. Results of pairwise tests (ANOVA) of mean depth and mean depth-averaged velocity at Deroin. Results are significant at a Bonferonni adjusted p value of 0.033 (alpha = 0.10). Significant results are shown in bold.

	Depth		**Depth-averaged velocity**	
Survey	**D**	**p-value**	**D**	**p-value**
Low vs. Mid	**28.82**	**<0.0001**	**8.88**	**<0.0001**
Low vs. High	**63.73**	**<0.0001**	**7.63**	**<0.0001**
Mid vs. High	**37.50**	**<0.0001**	0.59	0.5527

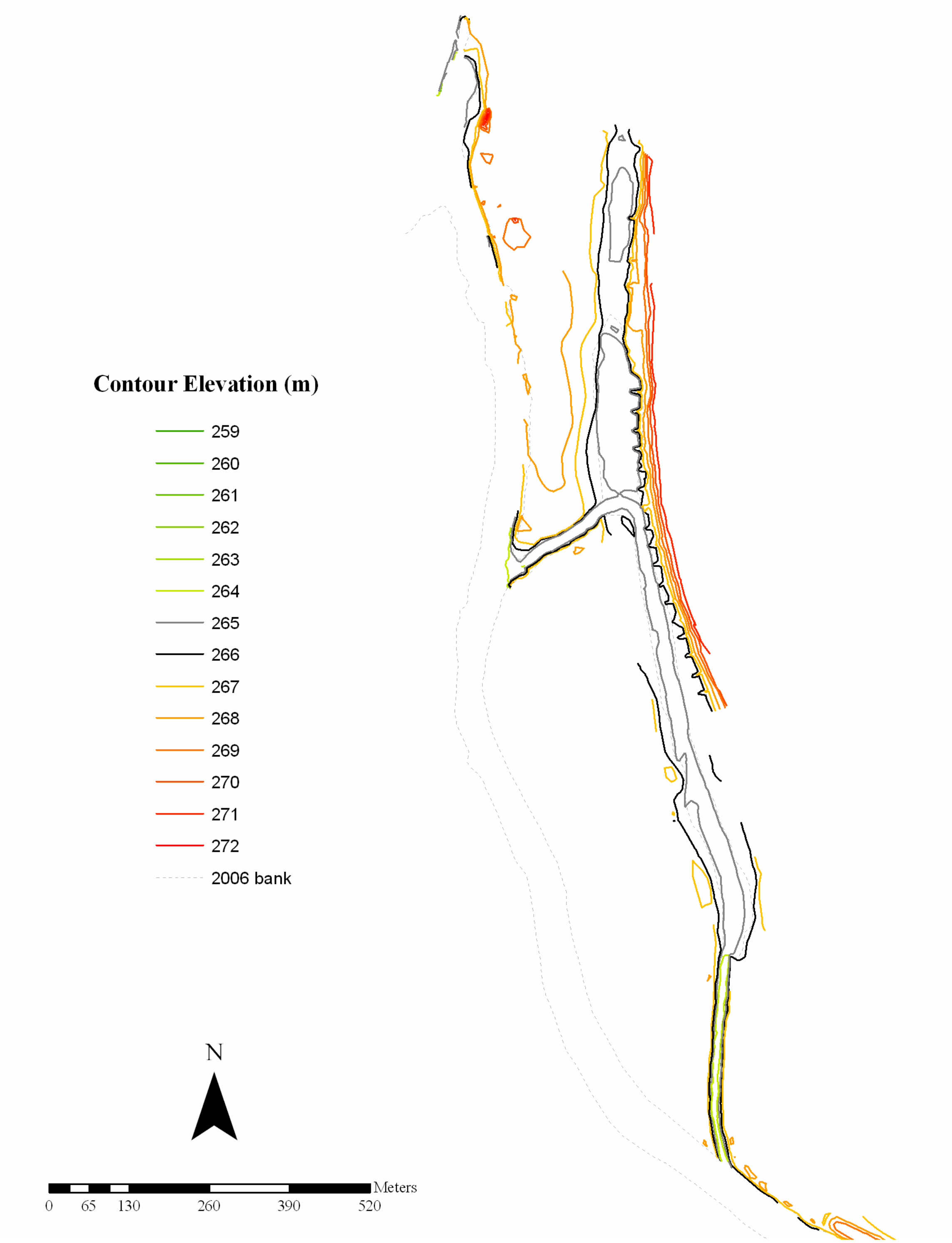


Figure II.9.1. Topographic survey of the upper third of the left bank of Deroin with bankline locations from aerial photography.

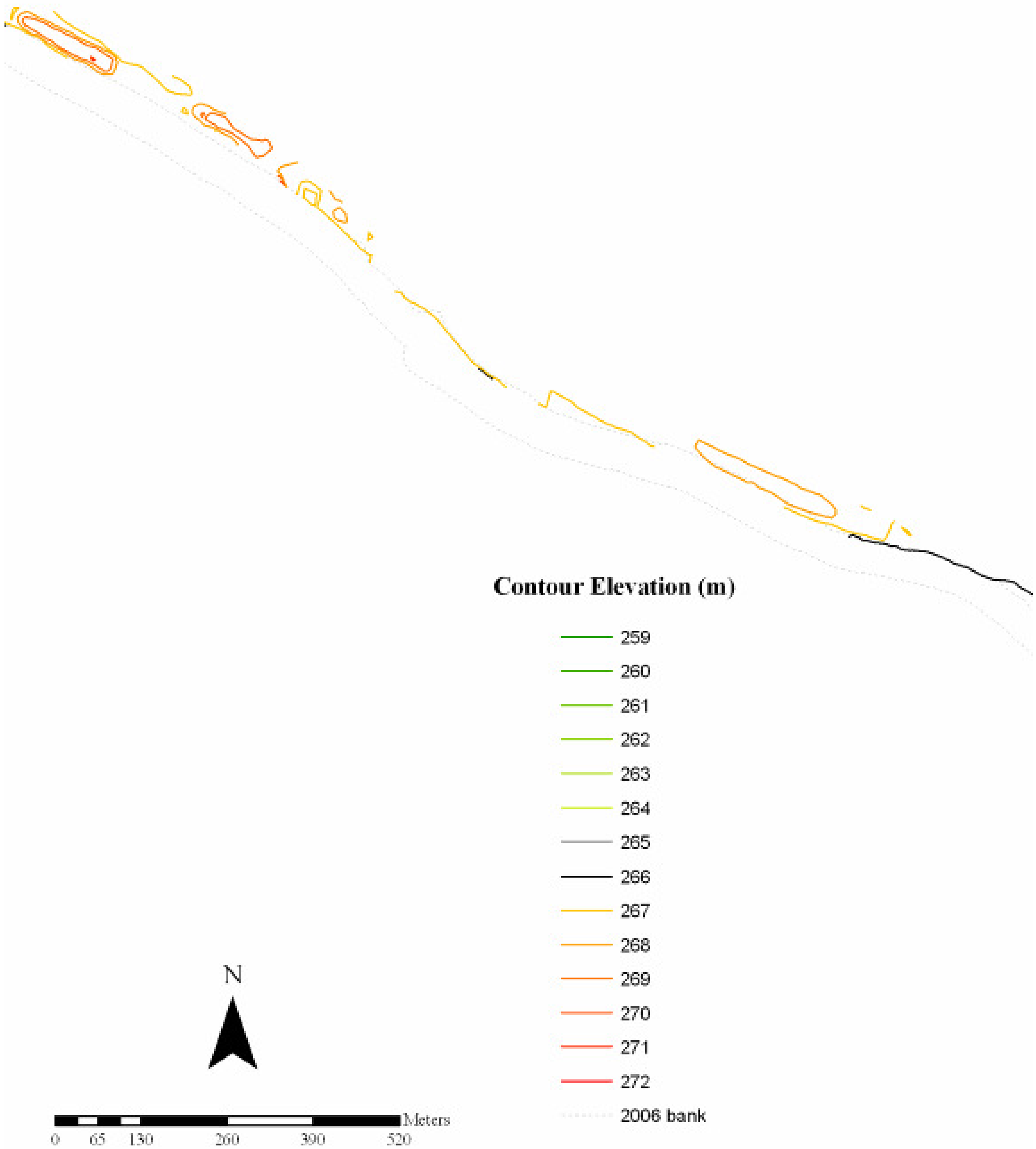


Figure II.9.2. Topographic survey of the middle third of the left bank of Deroin with bankline locations from 2006 aerial photography.

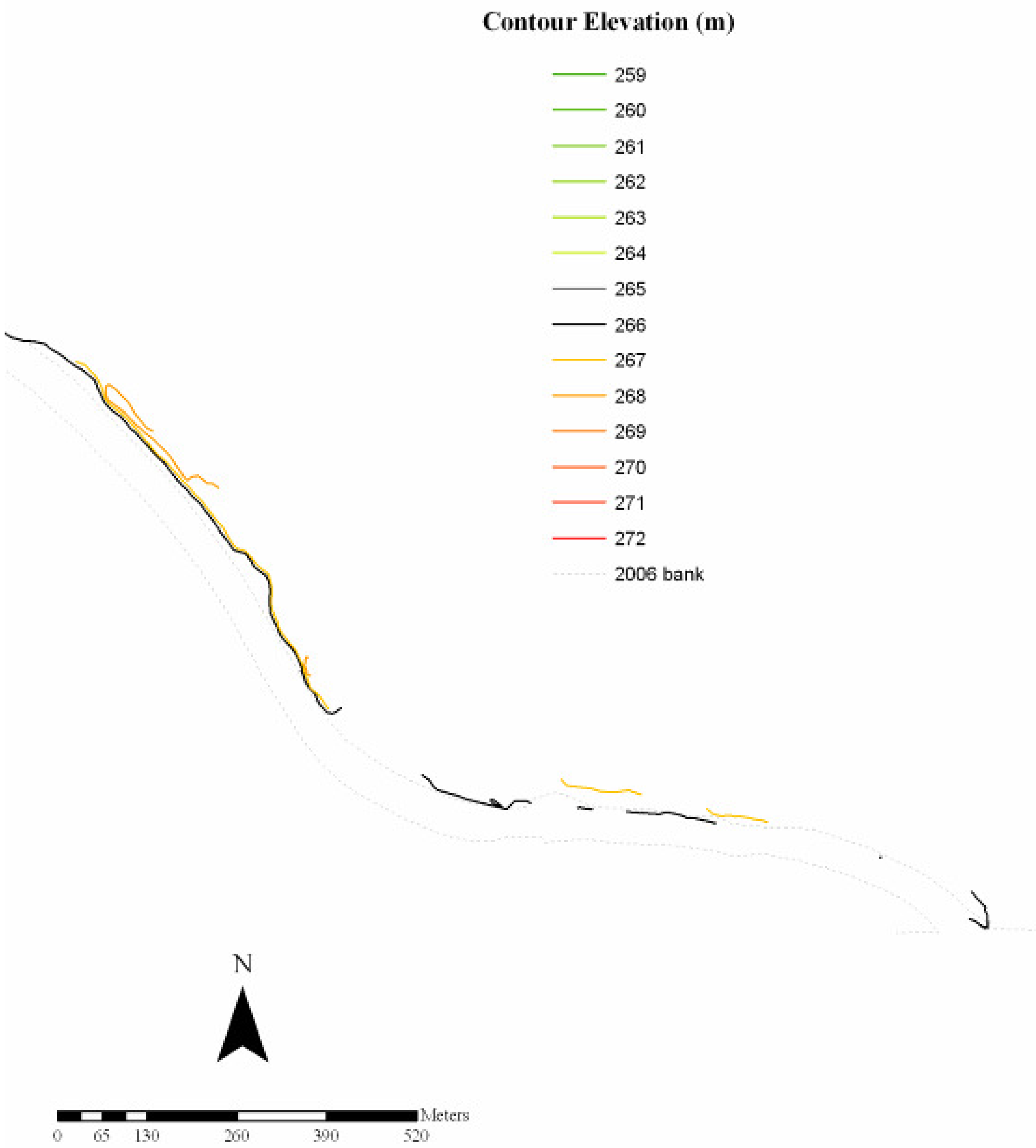


Figure II.9.3. Topographic survey of the bottom third of the left bank of Deroin with bankline locations from 2006 aerial photography.

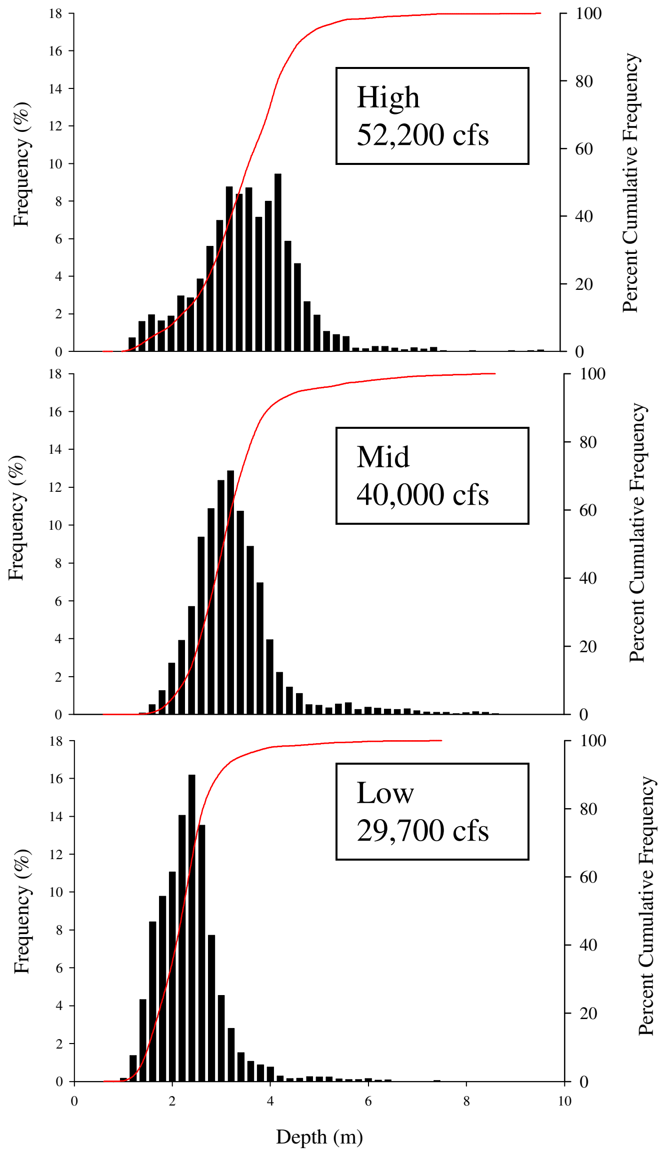


Figure II.9.4. Depth frequency and cumulative frequency (line) distributions at Deroin for all three Doppler surveys.

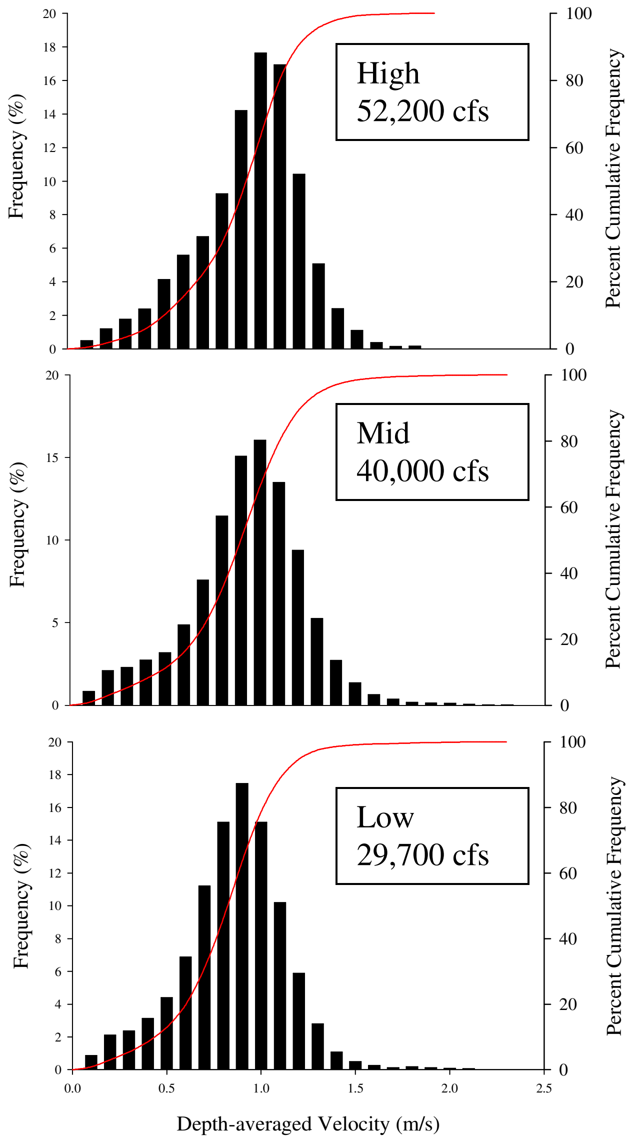


Figure II.9.5. Depth-averaged velocity frequency and cumulative frequency (line) distributions for Deroin during all three Doppler surveys.

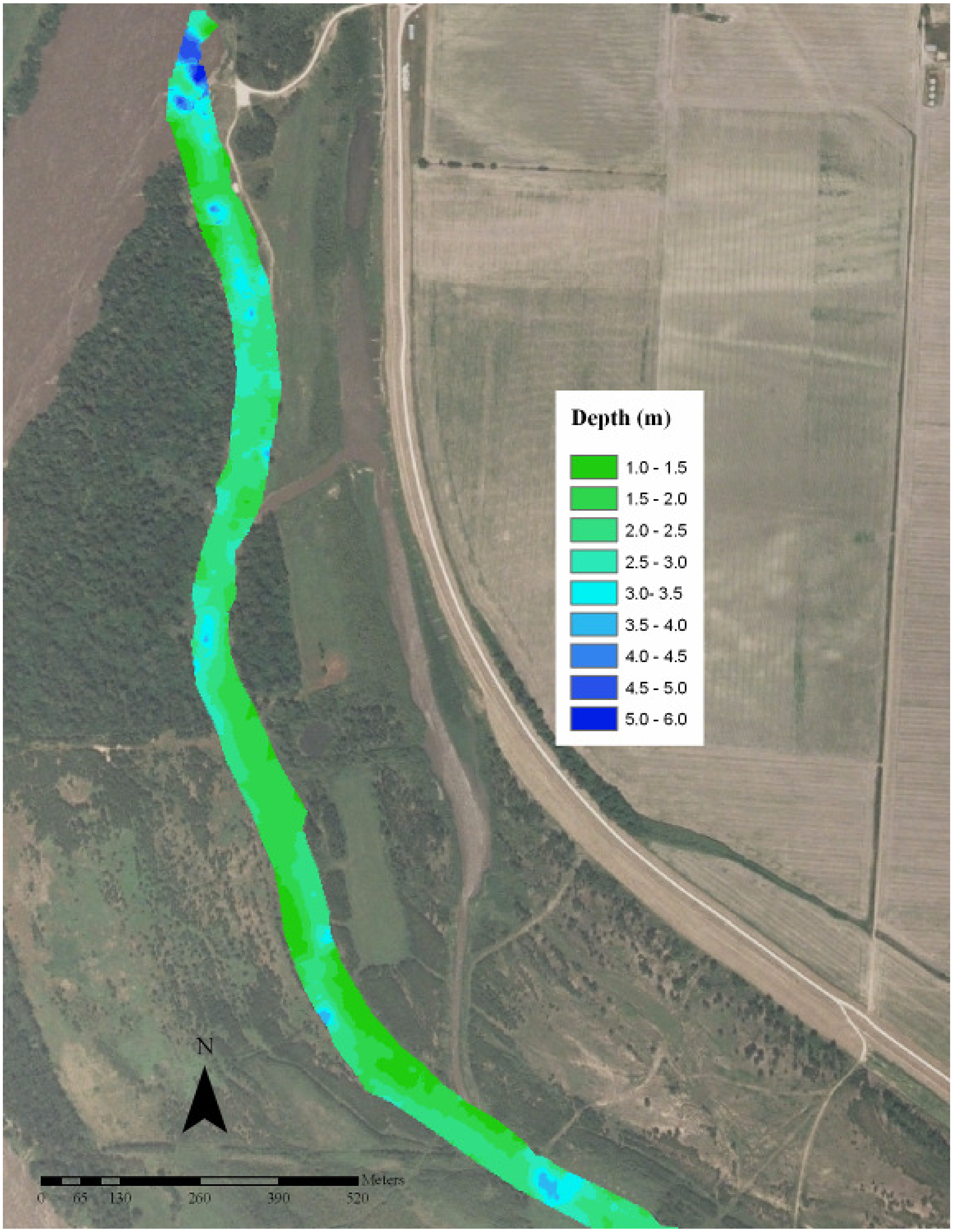


Figure II.9.6. Depth distribution from the Low survey (29,700 cfs) for the upper third of Deroin.

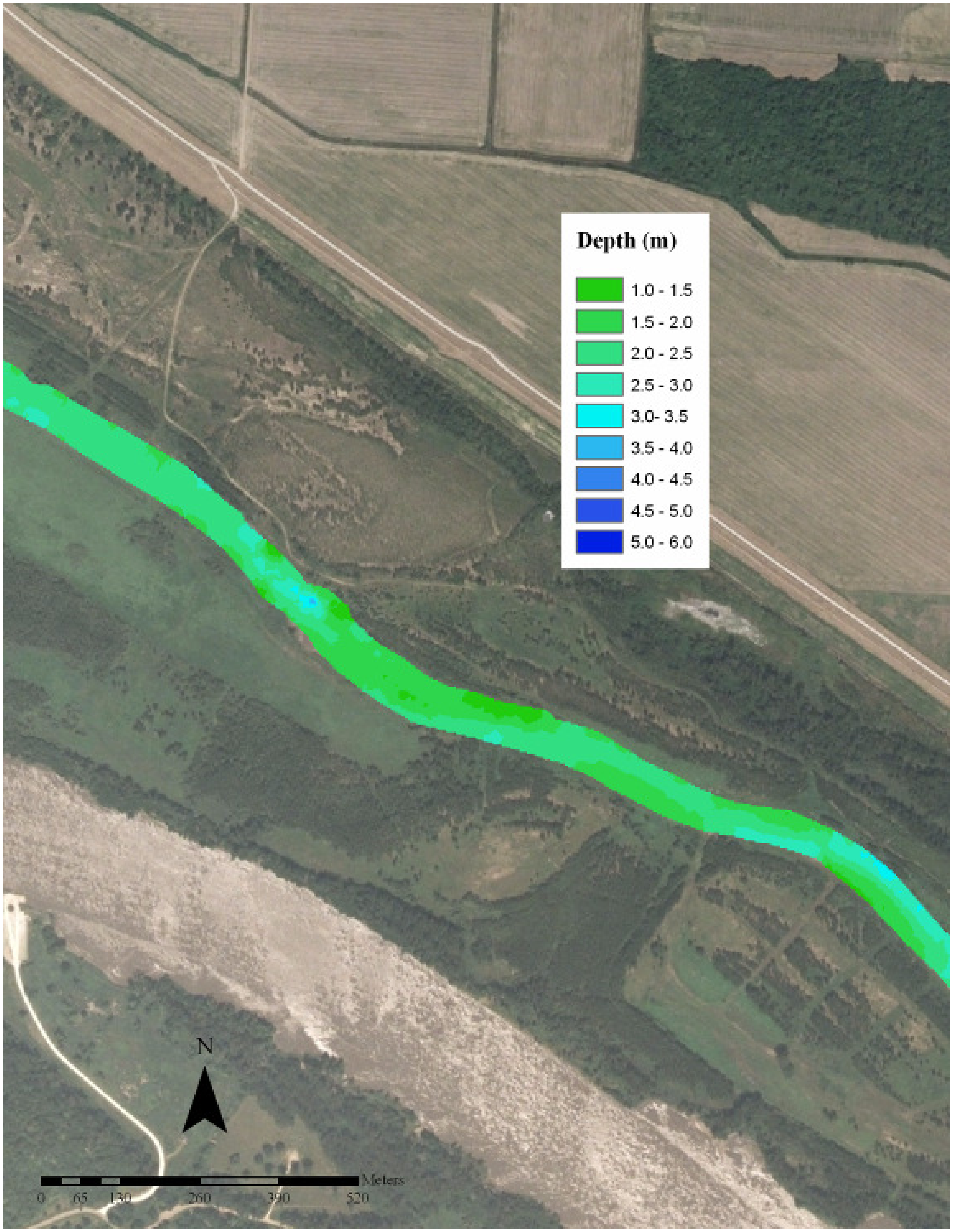


Figure II.9.7. Depth distribution from the Low survey (29,700 cfs) for the middle third of Deroin.

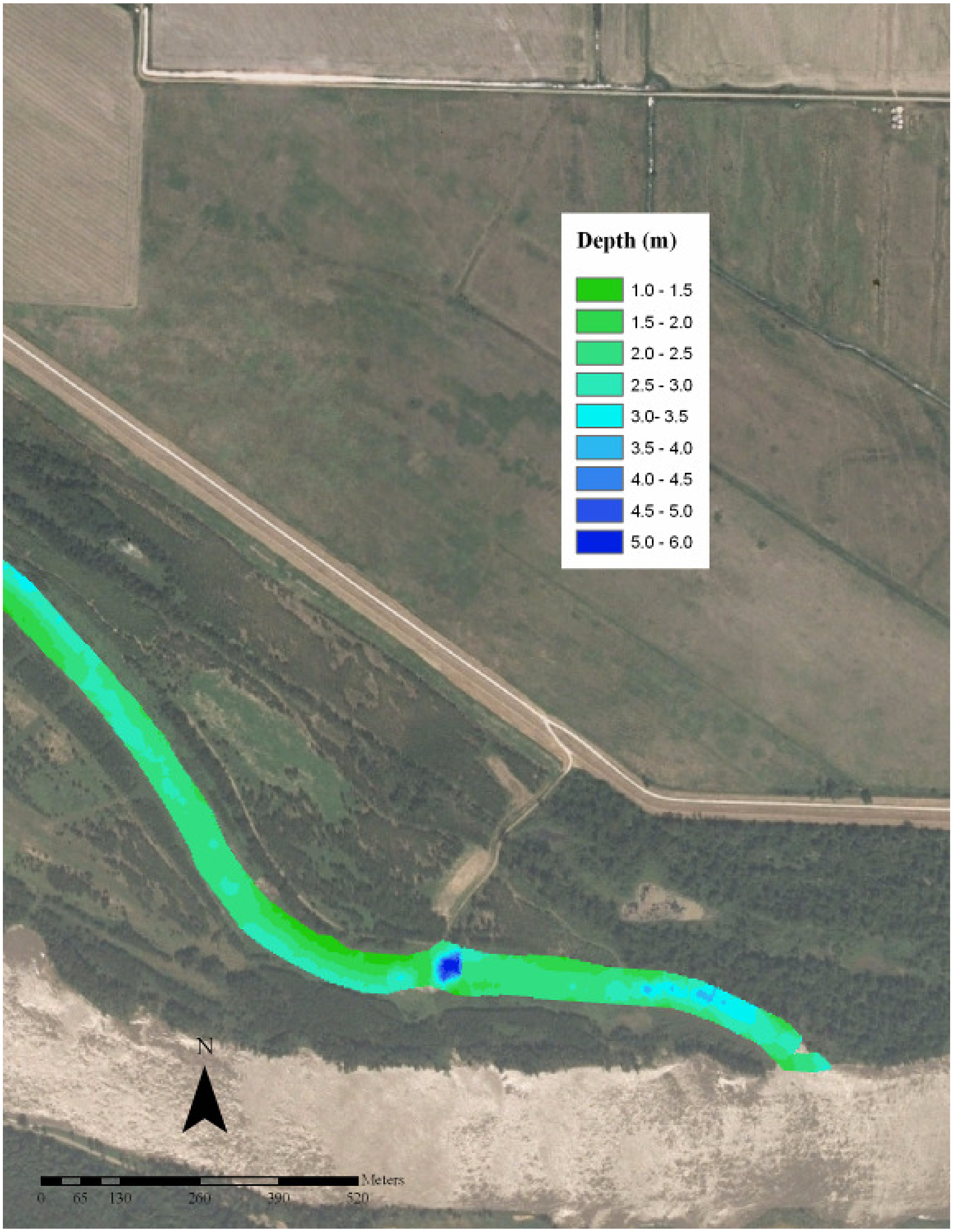


Figure II.9.8. Depth distribution from the Low survey (29,700 cfs) for the bottom third of Deroin.

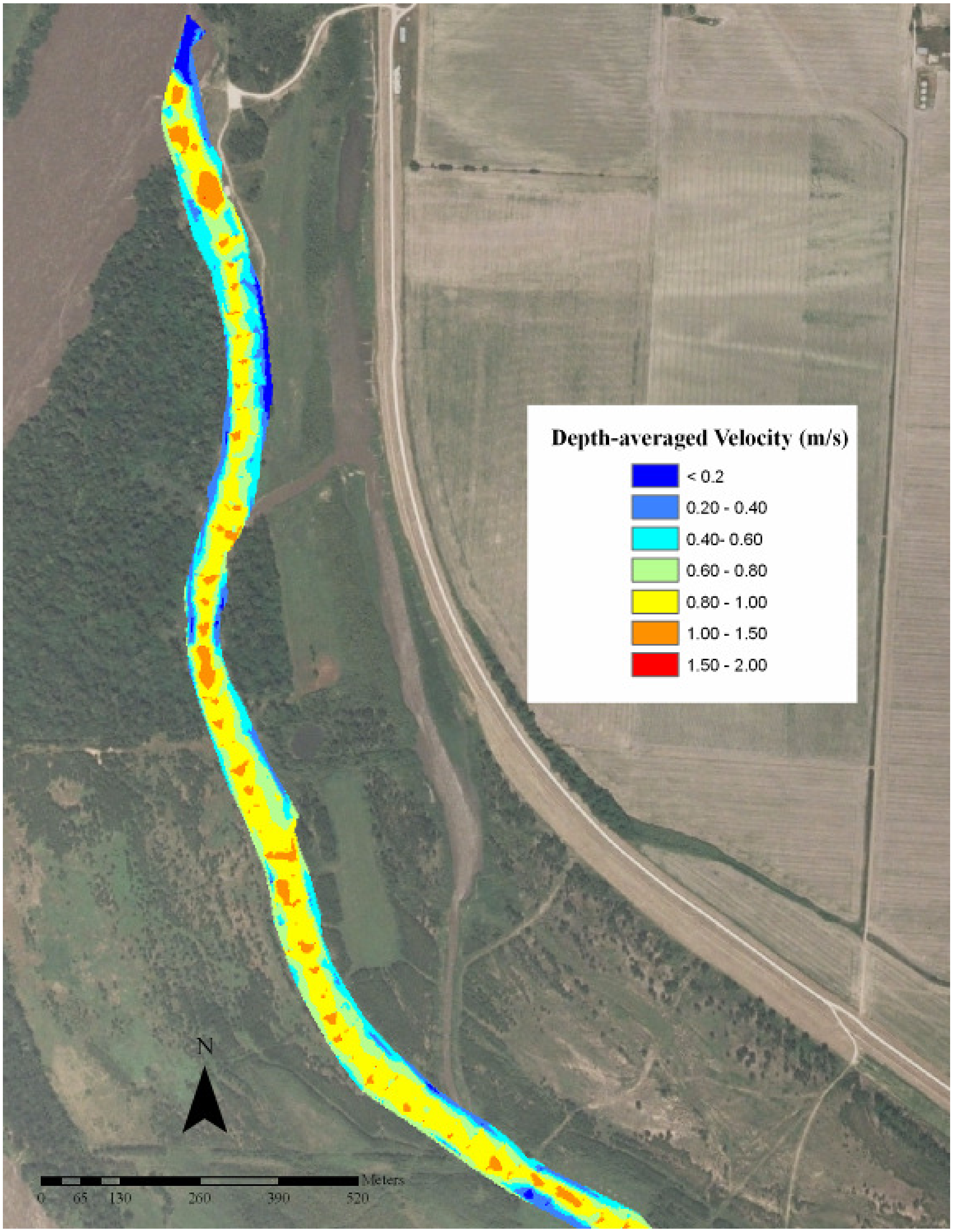


Figure II.9.9. Depth-averaged velocity distribution from the Low survey (29,700 cfs) for the upper third of Deroin.

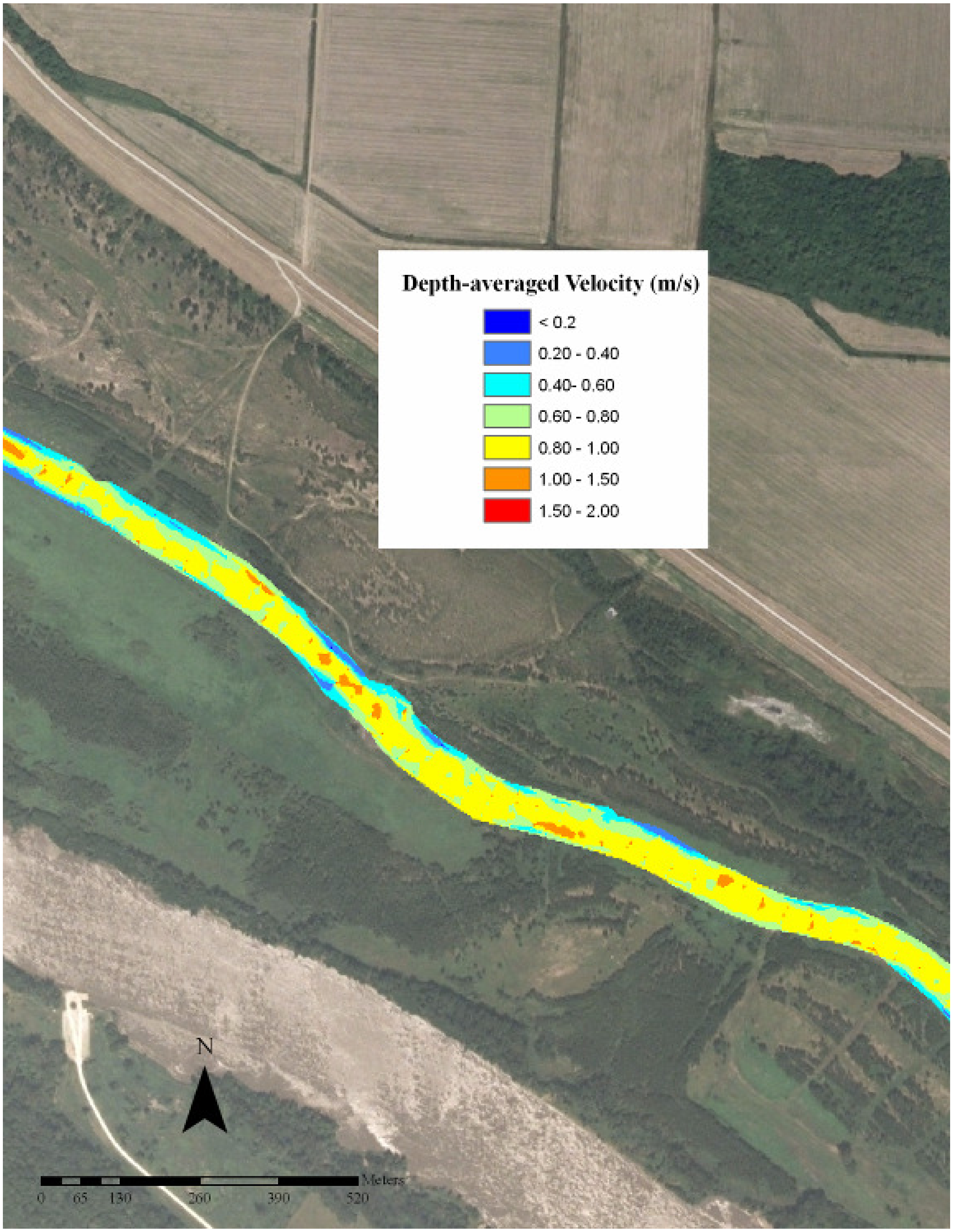


Figure II.9.10. Depth-averaged velocity distribution from the Low survey (29,700 cfs) for the middle third of Deroin.

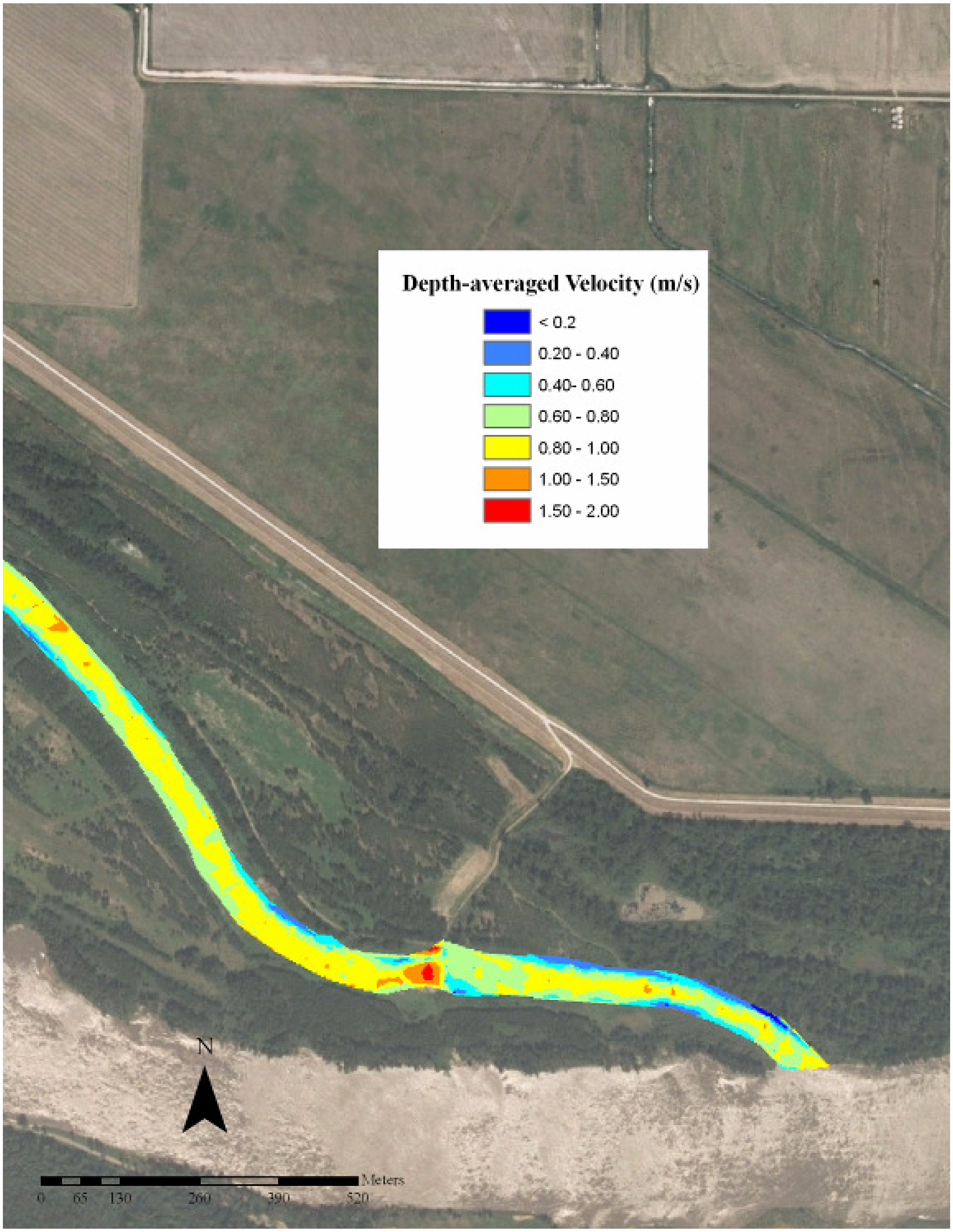


Figure II.9.11. Depth-averaged velocity distribution from the Low survey (29,700 cfs) for the upper third of Deroin.

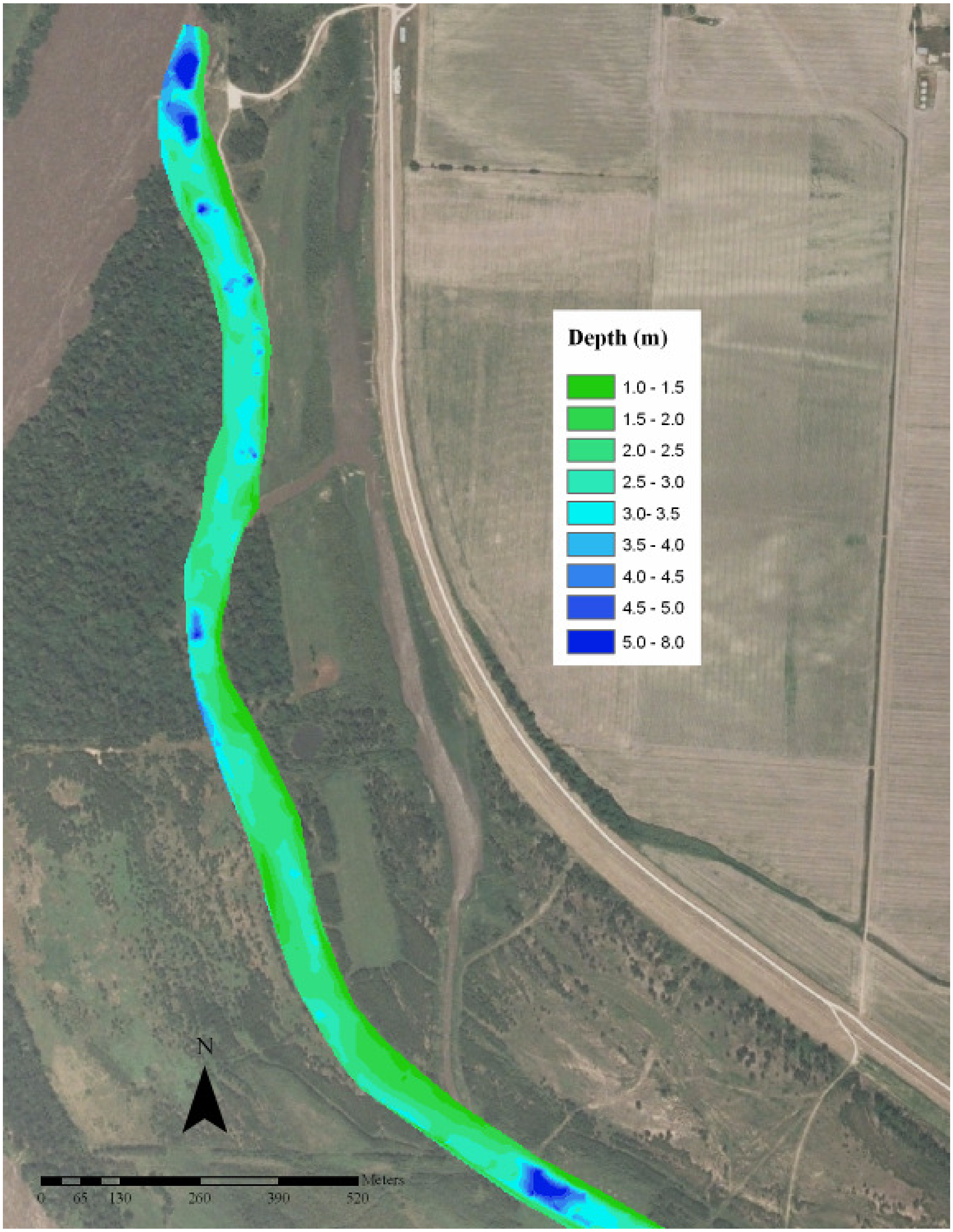


Figure II.9.12. Depth distribution from the Mid survey (40,000 cfs) for the upper third of Deroin.

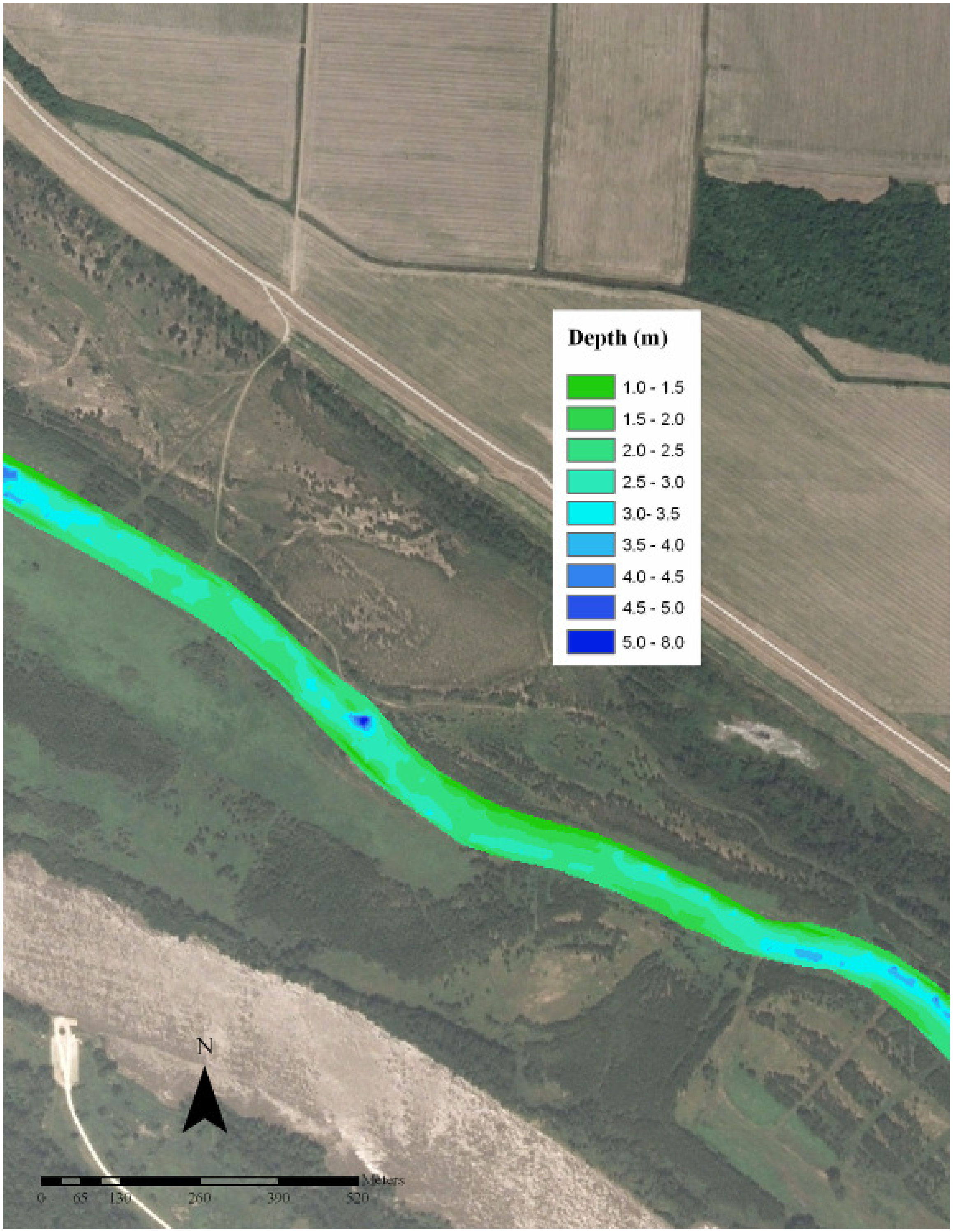


Figure II.9.13. Depth distribution from the Mid survey (40,000 cfs) for the middle third of Deroin.

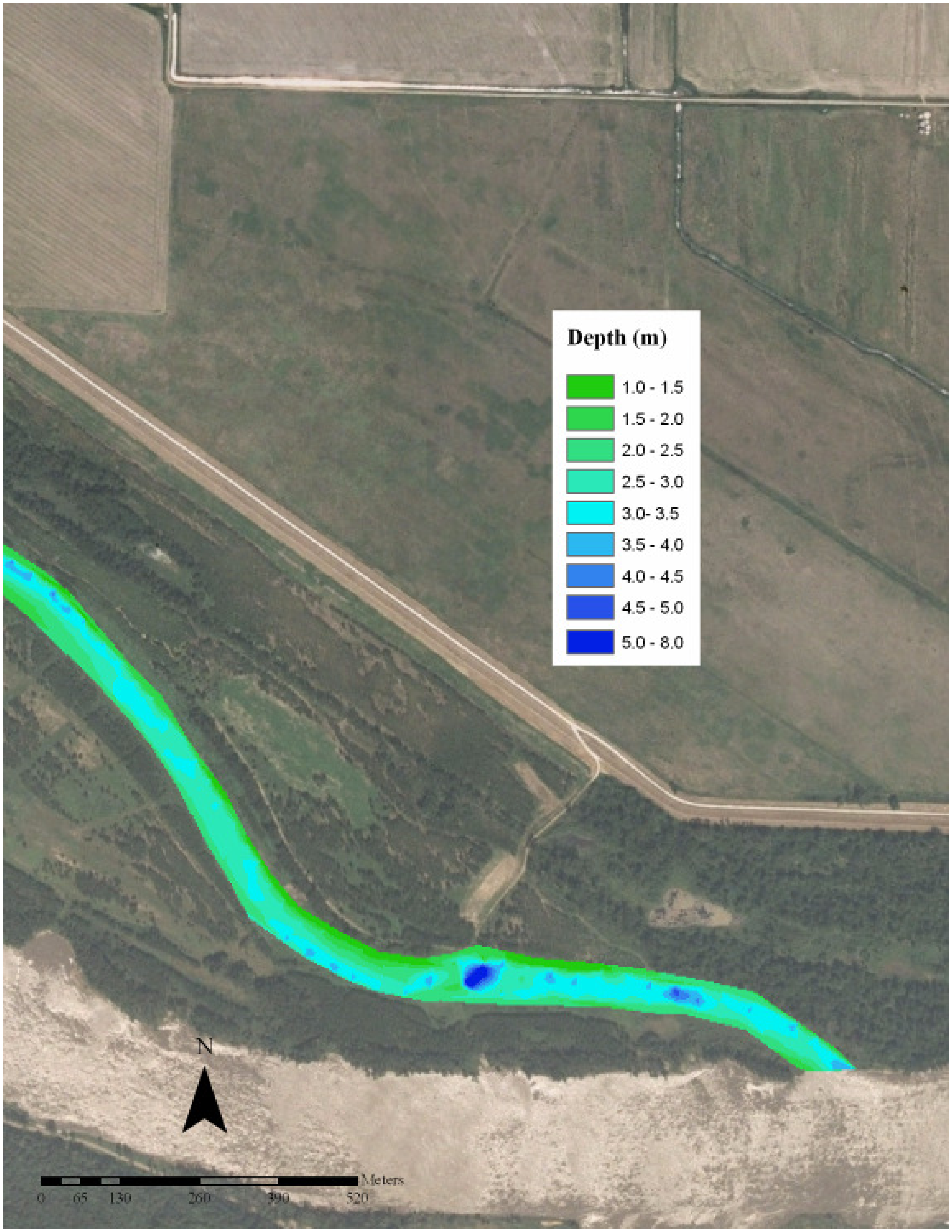


Figure II.9.14. Depth distribution from the Mid survey (40,000 cfs) for the bottom third of Deroin.

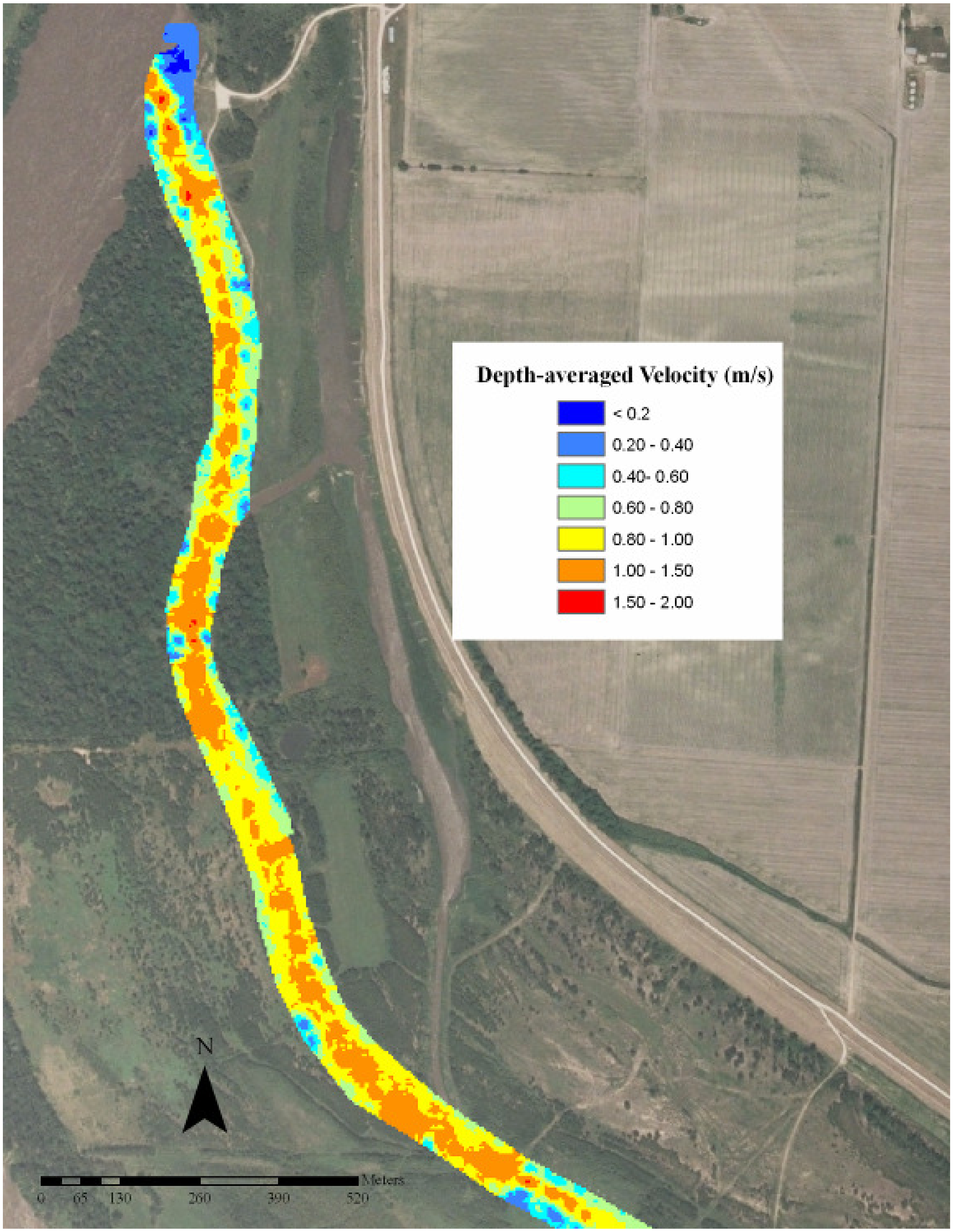


Figure II.9.15. Depth-averaged velocity distribution from the Mid survey (40,000 cfs) for the upper third of Deroin.

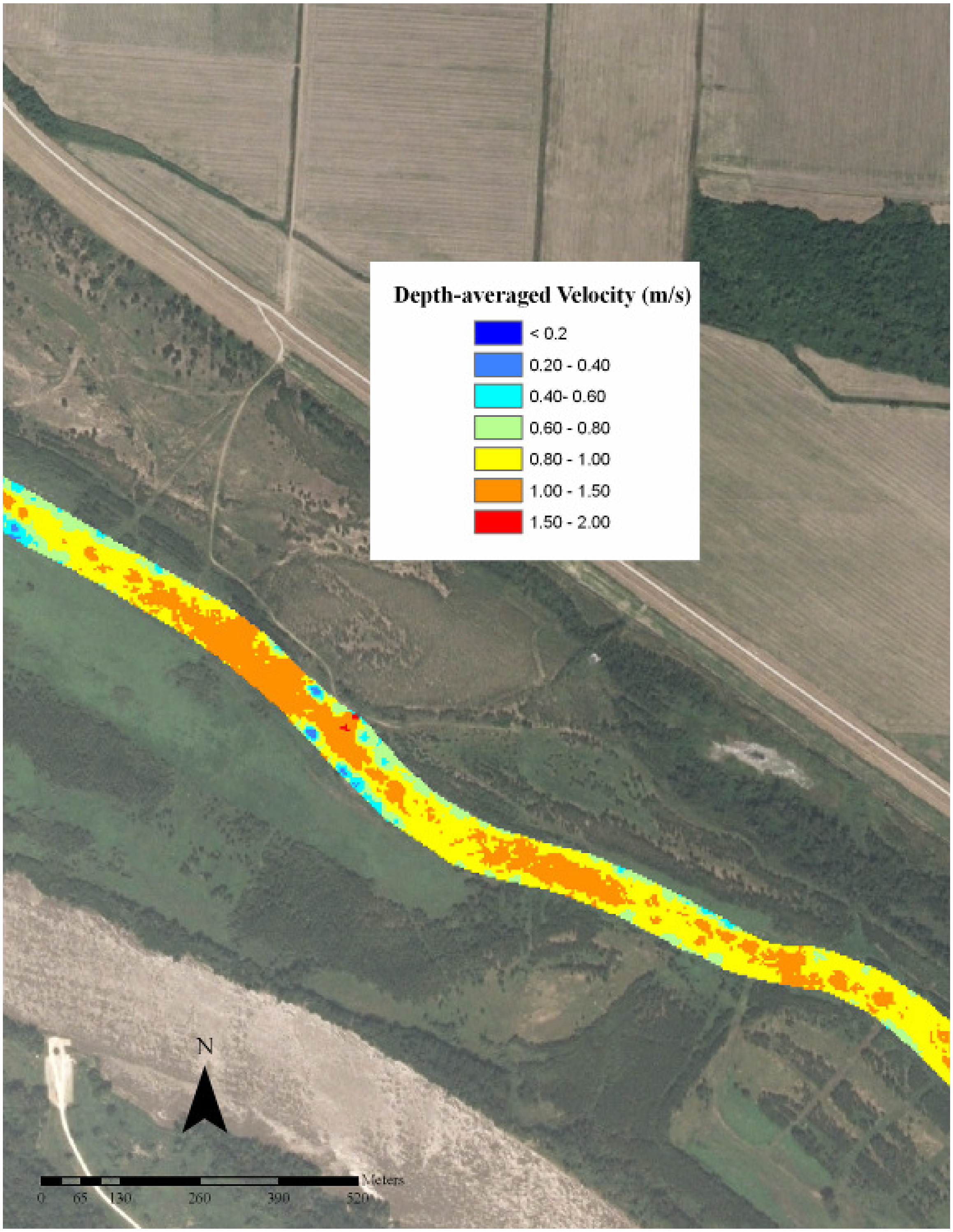


Figure II.9.16. Depth-averaged velocity distribution from the Mid survey (40,000 cfs) for the middle third of Deroin.

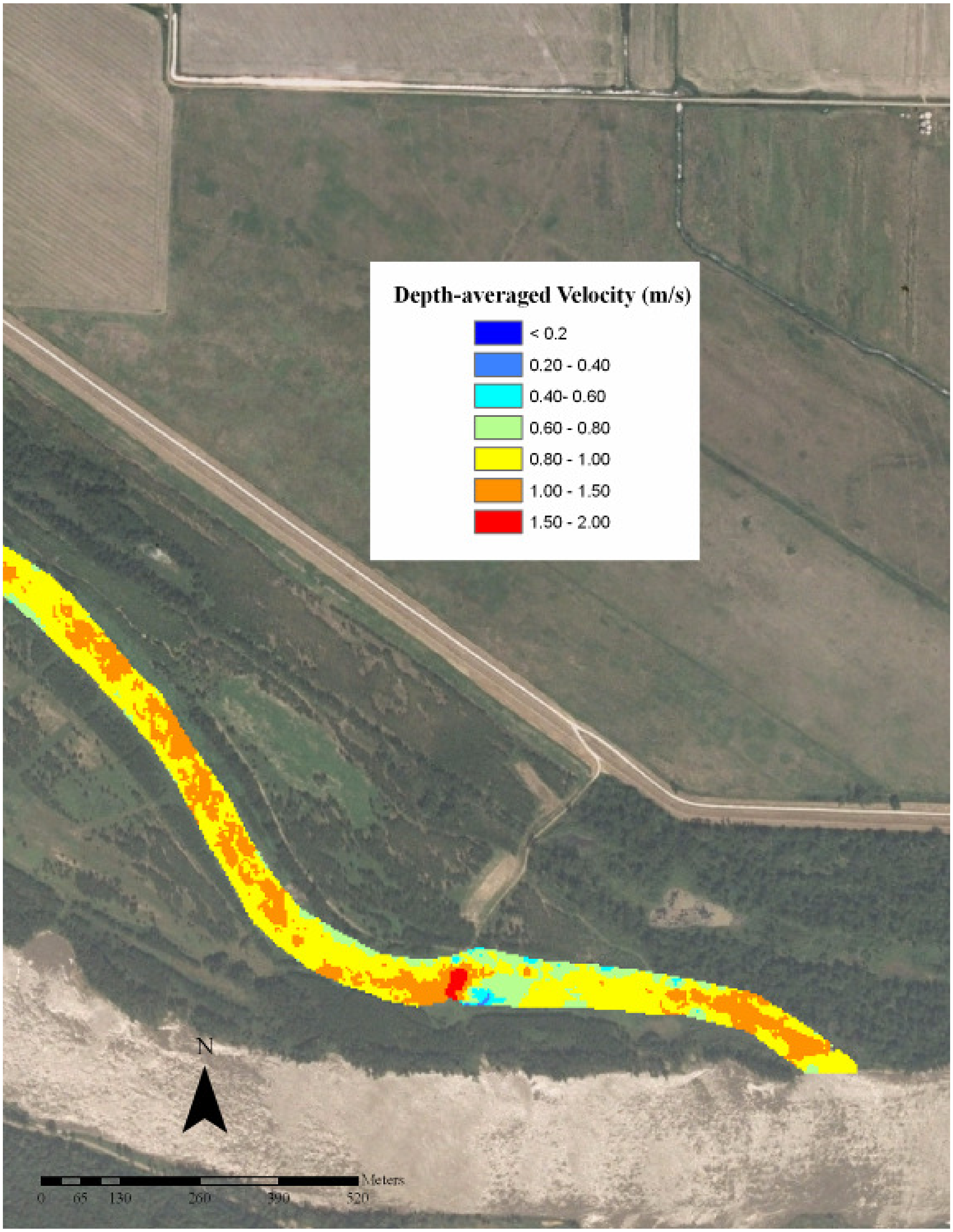


Figure II.9.17. Depth-averaged velocity distribution from the Mid survey (40,000 cfs) for the lower third of Deroin.

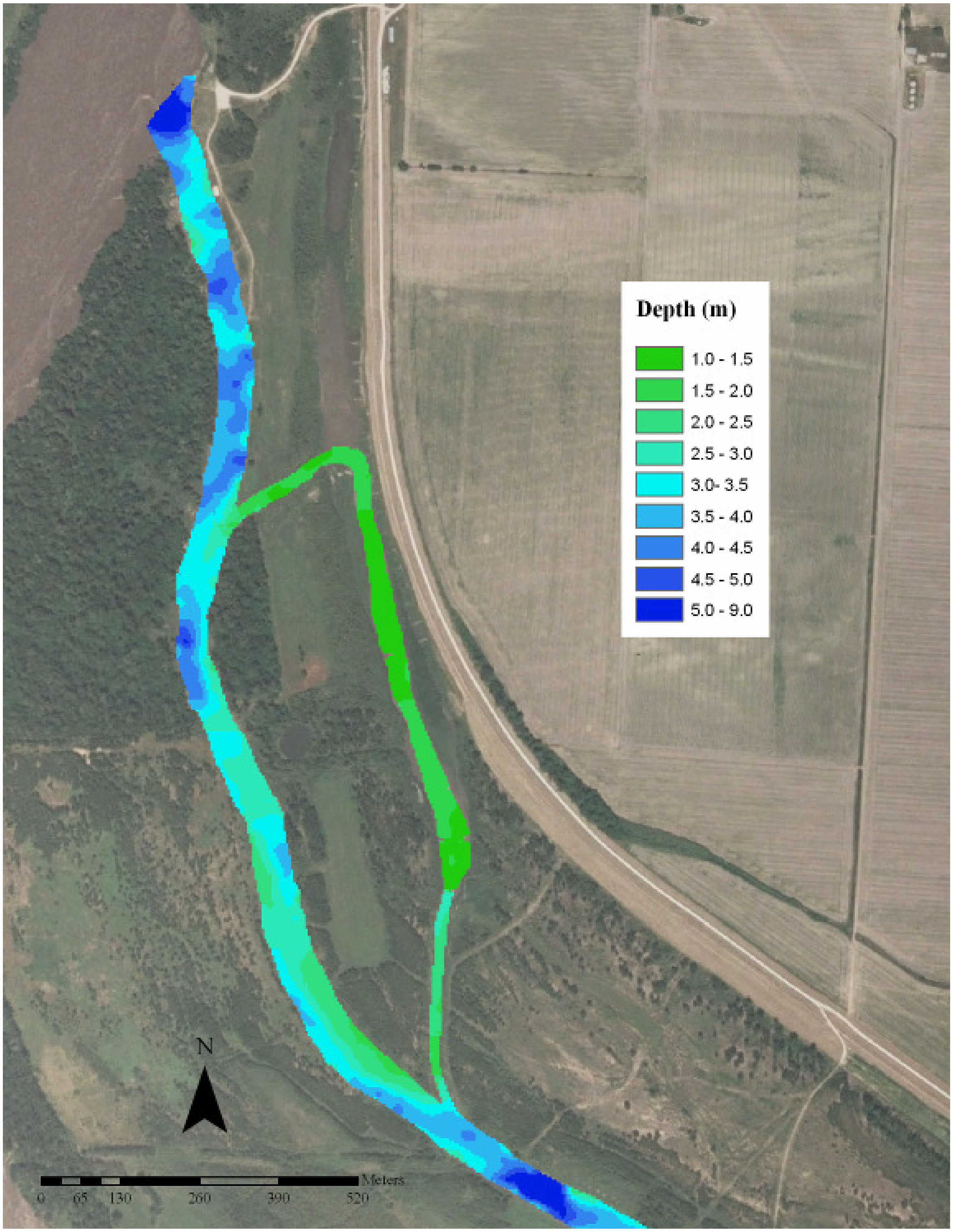


Figure II.9.18. Depth distribution from the High survey (52,200 cfs) for the upper third of Deroin.

Figure II.9.19. Depth distribution from the High survey (52,200 cfs) for the middle third of Deroin.

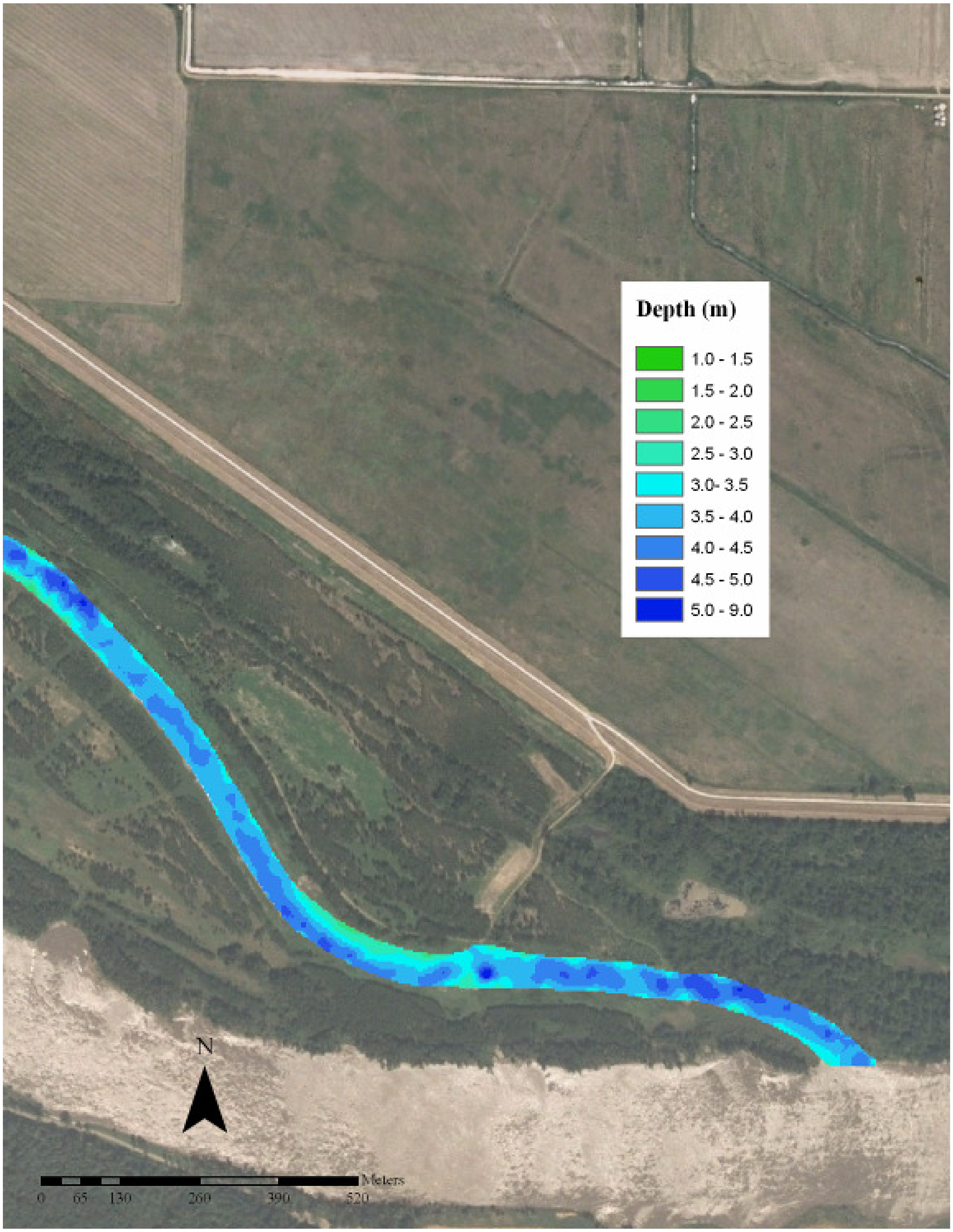


Figure II.9.20. Depth distribution from the High survey (52,200 cfs) for the bottom third of Deroin.

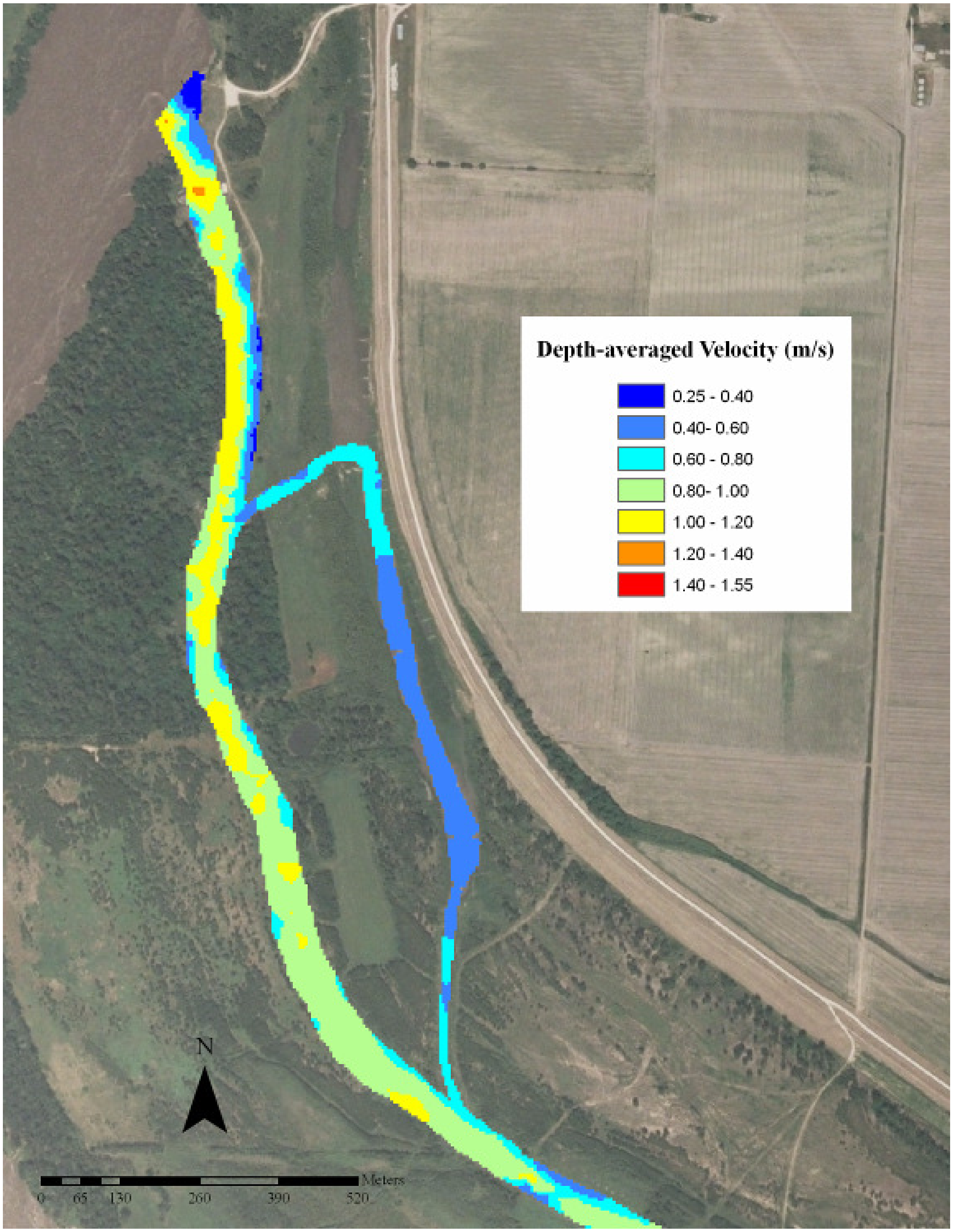


Figure II.9.21. Depth-averaged velocity distribution from the High survey (52,200 cfs) for the upper third of Deroin.

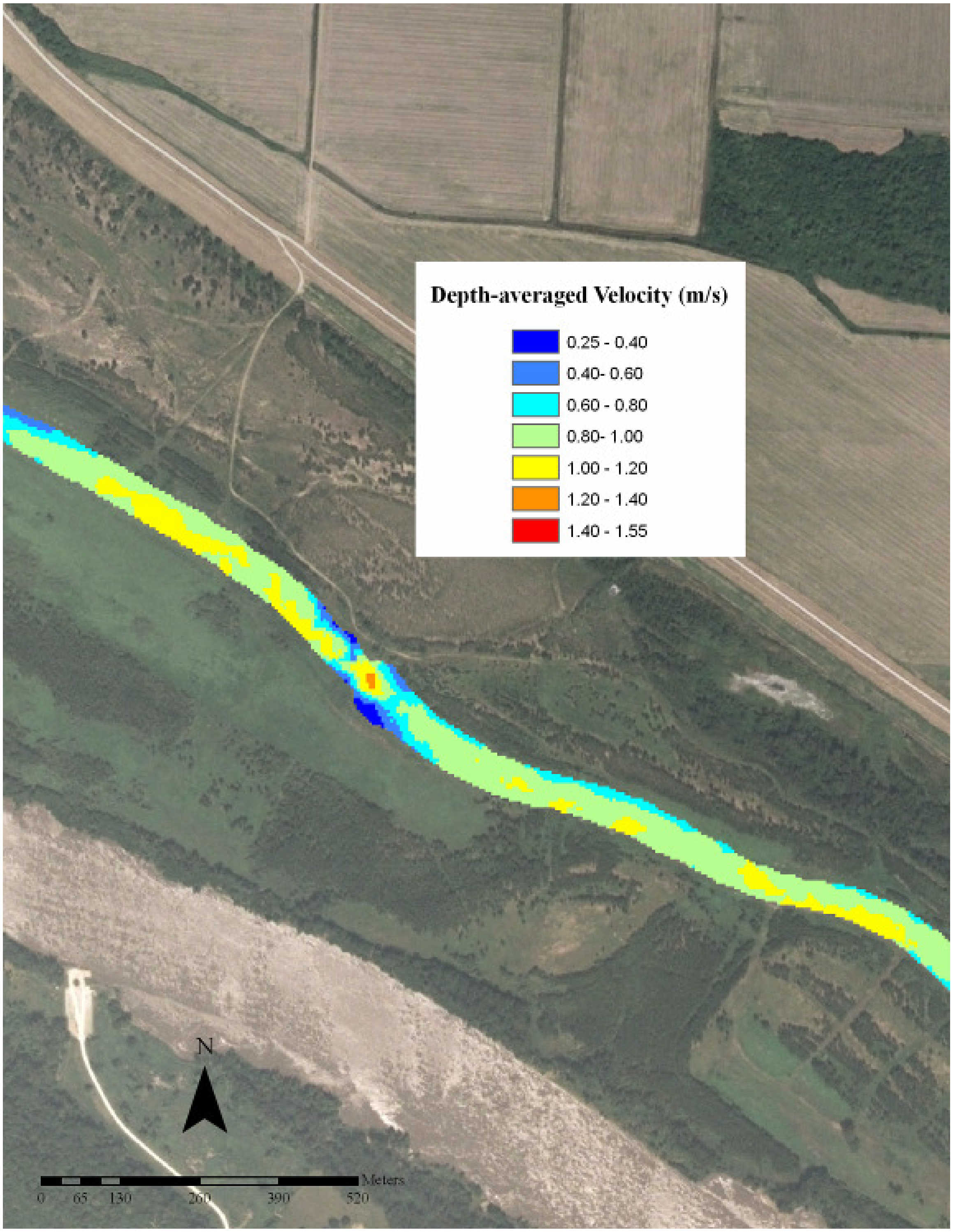


Figure II.9.22. Depth-averaged velocity distribution from the High survey (52,200 cfs) for the middle third of Deroin.

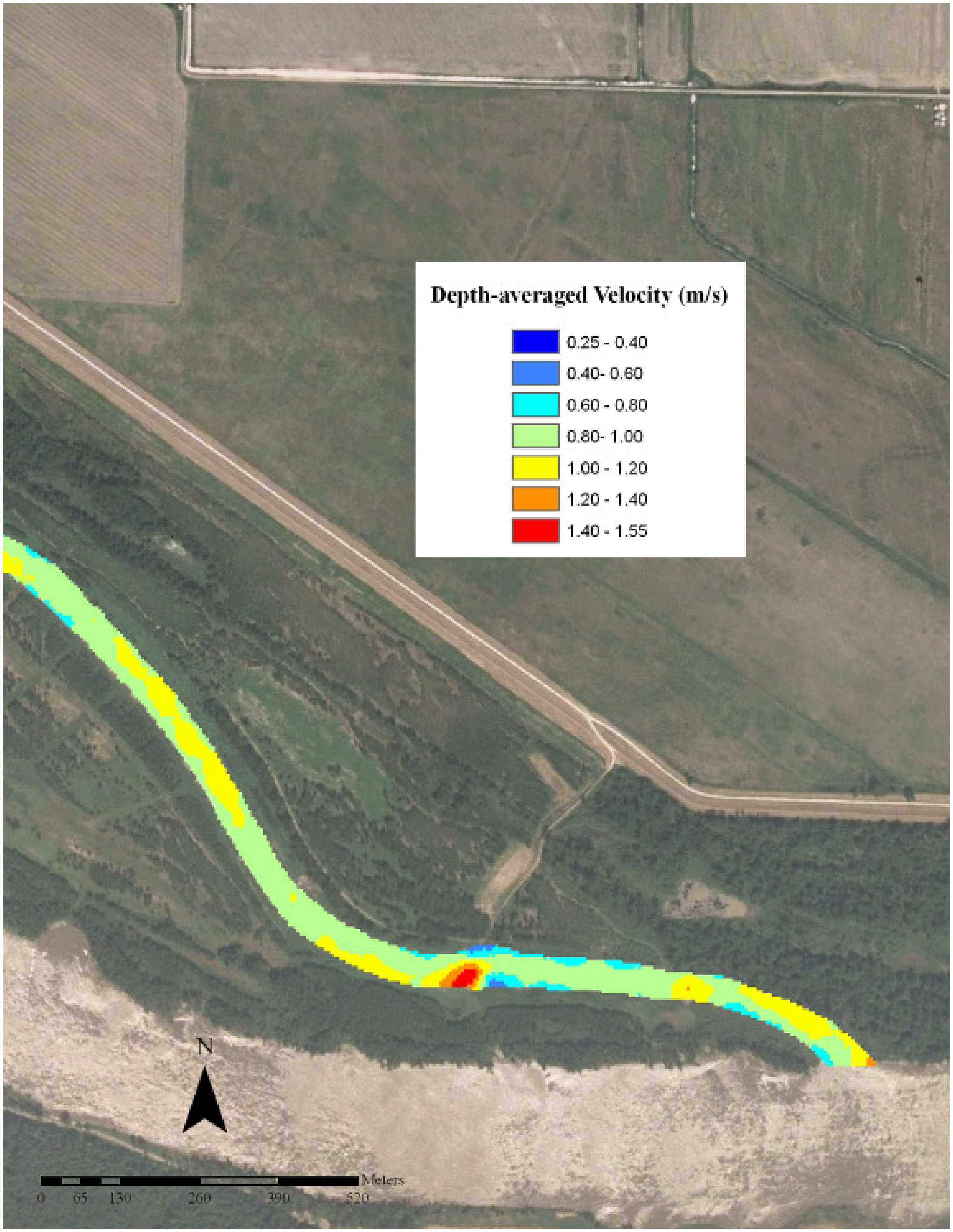
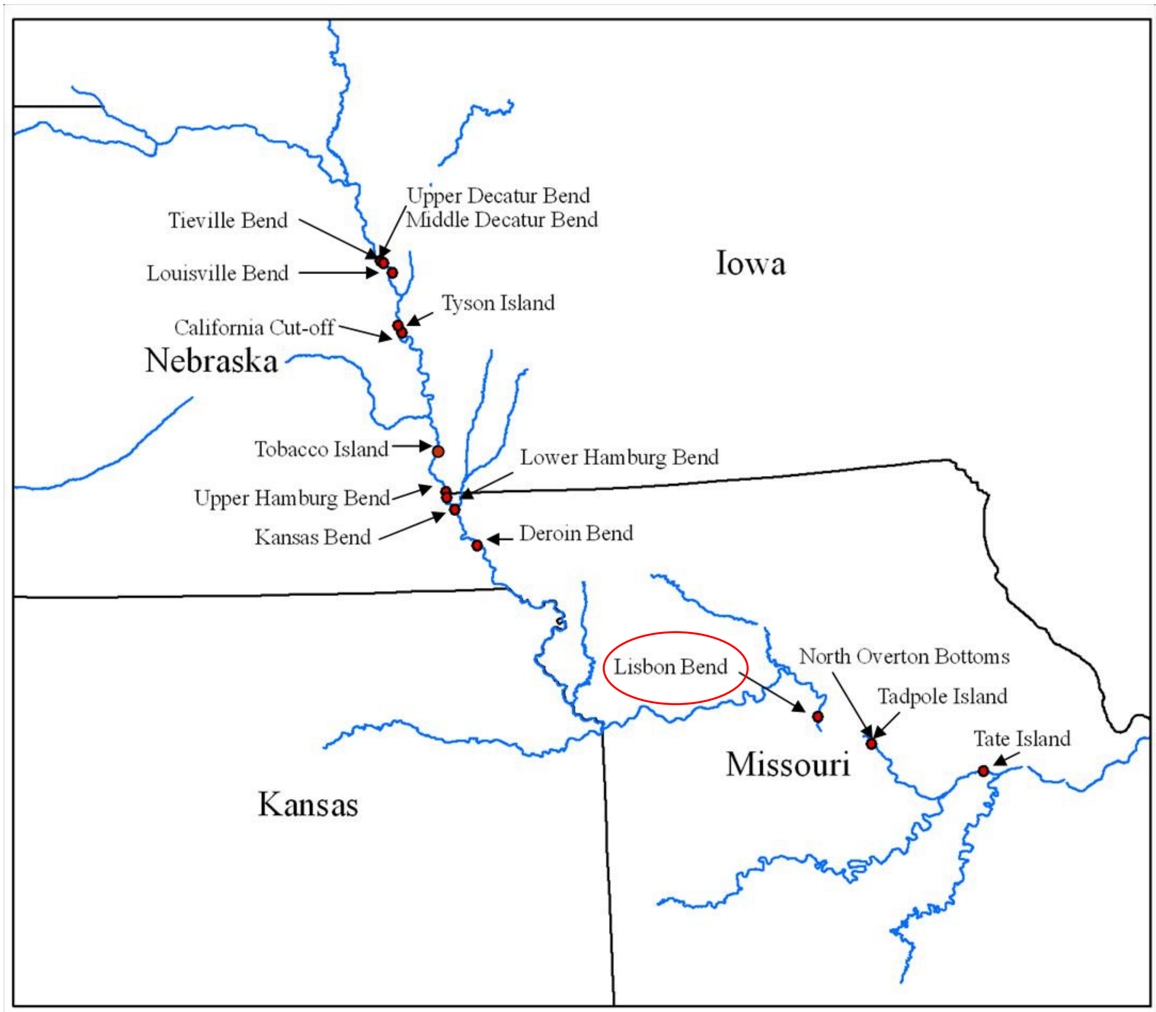


Figure II.9.23. Depth-averaged velocity distribution from the High survey (52,200 cfs) for the bottom third of Deroin.

Section II
Chapter 10
Lisbon Bottoms



List of Figures

Lisbon Bottoms

Lisbon Bottom Chute (Lisbon) is located at RM 220.0 in Howard County, Missouri. Lisbon occurs in an area of the Missouri River where the tight configurations of bends extend across the floodplain from bluff to bluff on each side (Jacobson et al. 2004). Side-channel formation and braiding has historically occurred in this section of the river before channel modifications began in the early 1900's (Jacobson et al. 2001). Between 1885 and 1910, intensive engineering alterations for improved navigability (e.g., wing dikes, bank revetments, levees) were made to the main channel of the Missouri River resulting in little change in the river configuration near Lisbon since the 1920's (Figure II.10.1).

Lisbon Chute was formed during a span of high water flows between 1993 and 2000 that resulted in a total of sixteen distinct floods (Jacobson et al. 2001; Jacobson et al. 2004). During the flood of 1993, and subsequent floods from 1993-1999, levees ruptured in the upper portion of the present day chute which resulted in a naturally formed side-channel scour that reconnected with the main channel approximately 3.3 km downstream. During this formation period, as much as 20% of the total flow of the Missouri River was diverted through the chute (Jacobson et al. 2004). To reduce flow through Lisbon, the U.S. Army Corps of Engineers, in consultation with the U.S. Fish and Wildlife Service, installed notched revetment at the top of the chute, a notched hydraulic control structure approximately 270 m downstream from the top, and a grade control structure near the bottom (Figure II.10.2). These structures were designed to restrict flow divergence from the main channel while at the same time allowing water to flow through the structure 95% of the time (Jacobson et al. 2004). These structures have

been modified over the past four years to create a deeper and wider notch at the top of the chute and the grade control structure has been reduced to allow more flow near the bottom. The current status of the control structures is accepted with no plans for further modification. The resulting chute maintains constant flow throughout most of the year with increasing flow as main stem discharge increases. Any additional “conditioning” of the chute will be the result of the natural rise and fall of the river. Lisbon has changed more than other Lower Missouri River chutes due to un-stabilized banks and fluctuating flows. This was observed during several flood events during 2008. Conditioning of the chute is expected to continue until the banks become stabilized by vegetation and timber growth.

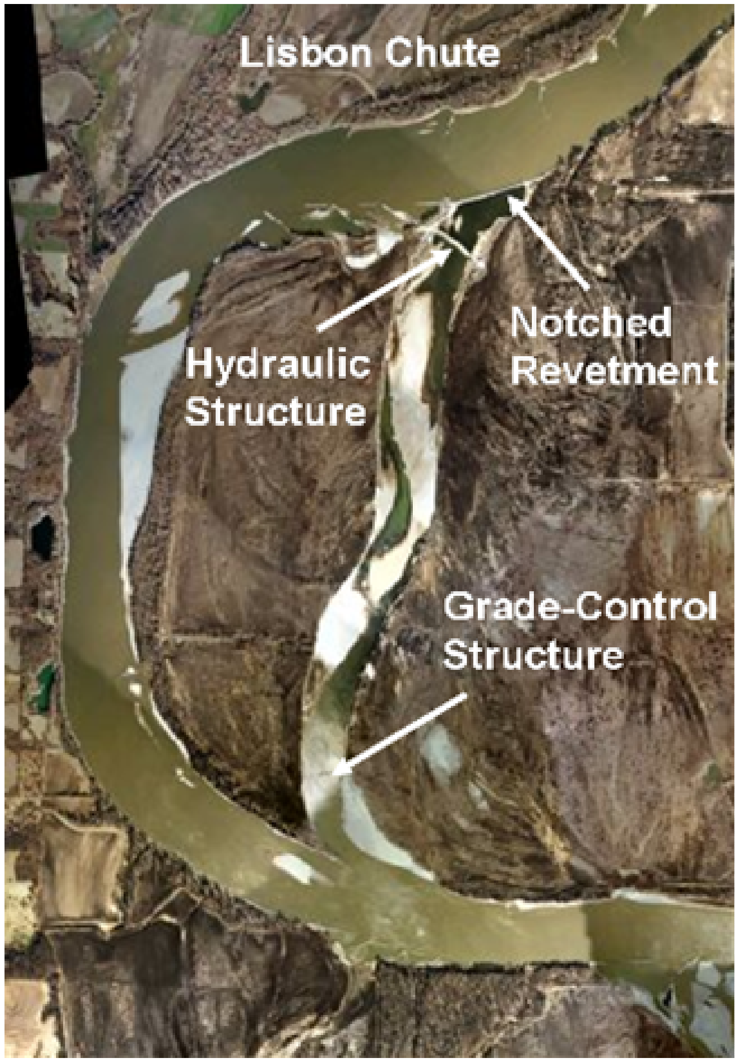


Figure II.10.1. Aerial photograph of Lisbon Bottoms Chute, 2000, showing the locations of the engineered structures designed to control flow through the chute. Base image courtesy of U.S. Army Corps of Engineers.

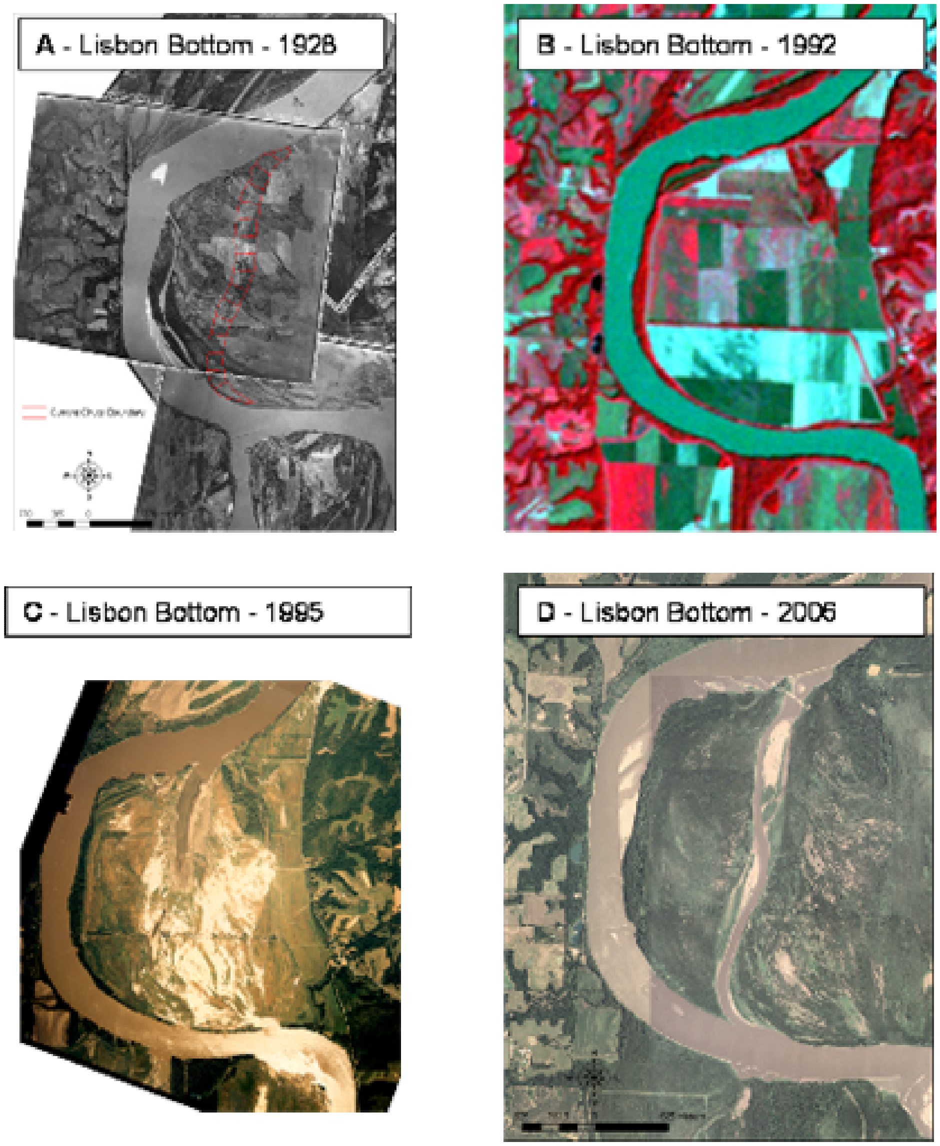
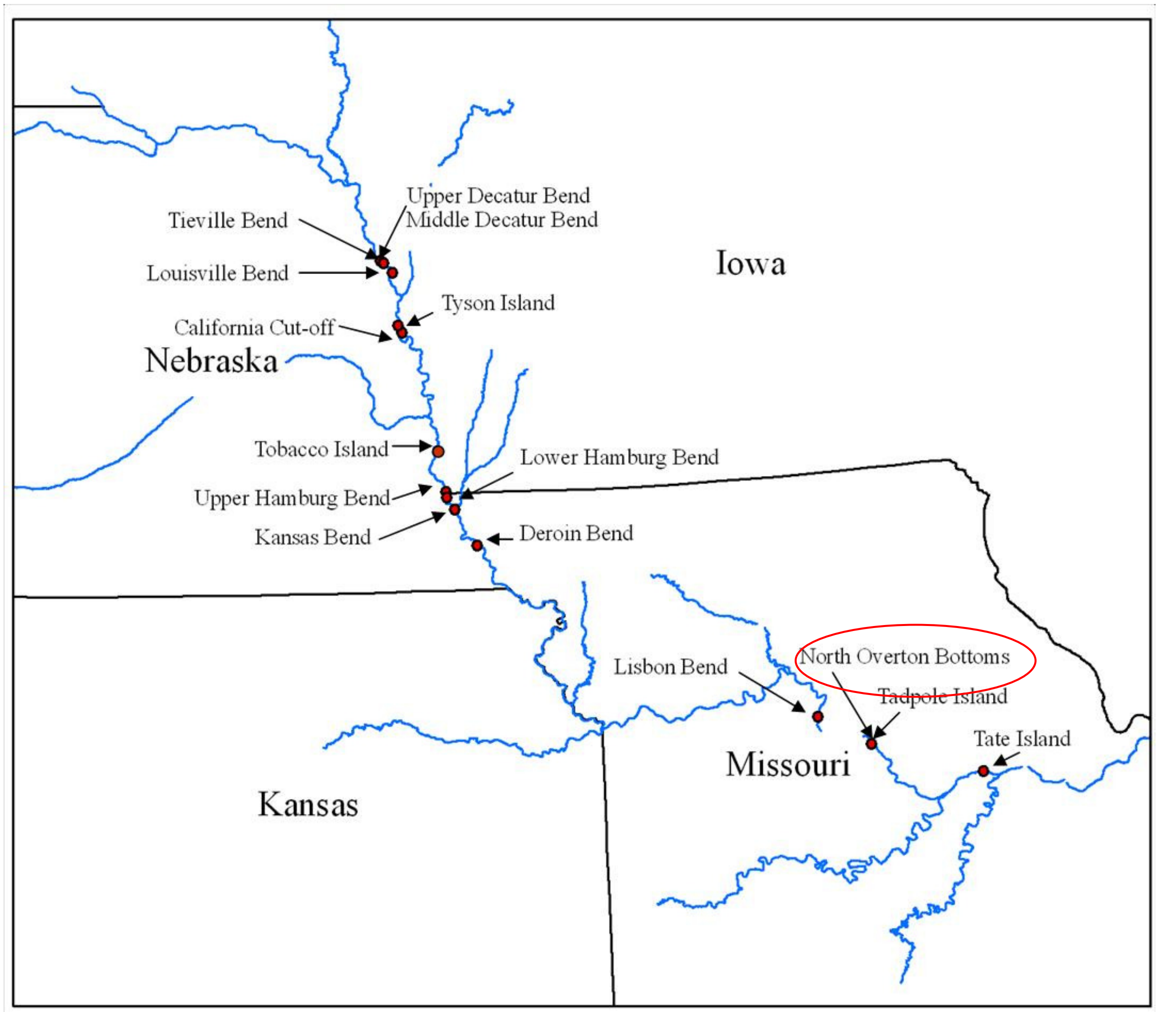


Figure II.10.2. Images of Lisbon Bottom from 1928 to 2006 showing changes over the years. (A) Historical aerial photograph of Lisbon Bottom taken in 1928, prior to intense construction of river confinement structures. Photo includes the outline of the current chute boundary for reference. (B) Pre-flood Thematic Mapper image taken 24 September 1992, Boonville discharge = 1,870 cms. (C) Post-flood aerial photo taken 23 September 1995, showing initial chute formation. (D) Current image of Lisbon Chute taken 8 August 2006. Base image A courtesy of Chance Bitner, U.S. Army Corps of Engineers; images B and C courtesy of Robert B. Jacobson, U.S. Geological Survey; image D courtesy of the National Agriculture Imagery Program (NAIP); U.S. Department of Agriculture.

Section II
Chapter 11
North Overton Bottoms



List of Figures

North Overton Bottoms

North Overton Bottoms chute (Overton) is located at RM 189.1 in Cooper County, Missouri. North Overton Bottoms Chute (Overton) is a relatively recently constructed side-channel chute, originally constructed in 2001 with an inlet located at RM 187.5. The original pilot channel was 2.4 km in length; approximately 3.0 meters wide, had an average depth of 3.0 m, and only passed flows during high river stages. In 2003, the chute was reconstructed and redesigned so it could pass flows for most of the year. In 2003 the inlet was moved downstream and the chute was excavated to 12.2 m wide; the total length of the chute was shortened to 0.9 km. The high elevation and increased width and depth allowed the chute to sustain flows throughout most of the year and hold water all year long.

Overton has changed little since it's reconstruction in 2003. From 2000 through 2006, the Lower Missouri River has experienced a drought allowing little opportunity for the river to scour and widen Overton Chute. During the spring of 2007, however, the Lower Missouri River experienced a 50 year flood event resulting in significant scouring of Overton Chute. Recently constructed chutes, including Overton, were built with high steep banks to encourage undercutting and bank erosion. These processes are dependent on high water events and flood-pulses to initiate erosion and allow for the conditioning of the chute. In 2008, Overton Chute experienced several high water events which caused an increase in bank erosion and undercutting. Figure II.11.1 shows a historical aerial photo of the Overton Bottoms area taken in 1928 illustrating how wide and complex the river channel was prior to intense construction of river confinement structures.

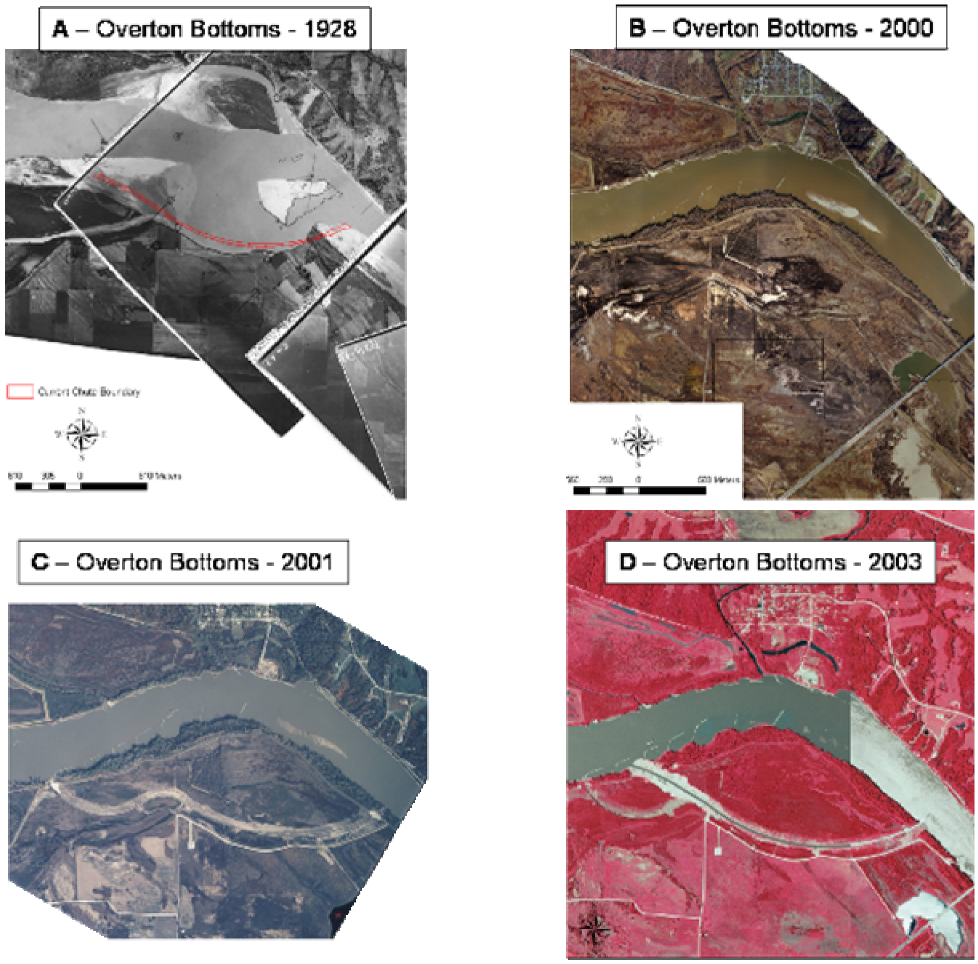
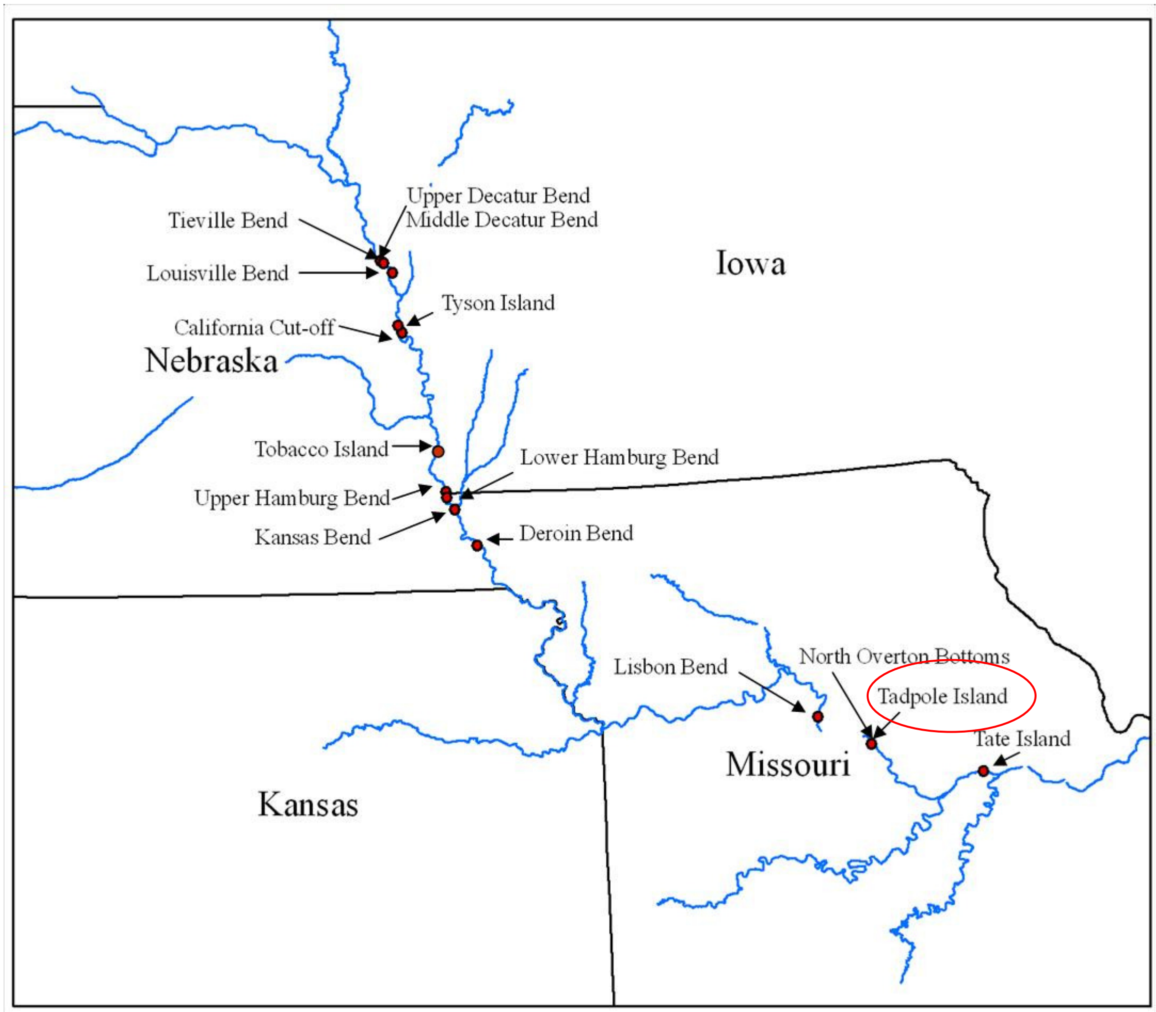


Figure II.11.1. Images of Overton Bottoms from 1928 to 2003 showing changes over the years. (A) Historical aerial photograph of Overton Bottoms taken in 1928, prior to intense construction of river confinement structures. Notice the width and complexity of the river channel. Photo includes the outline of the current chute boundary for reference. (B) Image of Overton Bottoms taken prior to the initial chute construction (C) Image of Overton Bottoms after initial construction of the chute in 2001. (D) Near infrared image of Overton Chute after reconstruction in 2003. Base image A courtesy of Chance Bitner, U.S. Army Corps of Engineers; image B courtesy of U.S. Army Corps of Engineers; image C USFWS file photo; image D courtesy of the National Agriculture Imagery Program (NAIP); U.S. Department of Agriculture.

Section II
Chapter 12
Tadpole Island



List of Figures

Tadpole Island

Tadpole Island Chute (Tadpole) is located at RM 181.6 in Moniteau County, Missouri. Tadpole was the most recently constructed side-channel chute in the study area. Construction of Tadpole began in January of 2006 and the chute was officially opened the following May (Figure II.12.1). The banks at Tadpole were created similar to those at Overton, high and steep, to encourage undercutting and erosion. Since construction, this chute has undergone more conditioning from erosion than Overton Chute because it has less vegetative encroachment on the banks and a higher sand content in the soil. Figure II.12.2 shows how Tadpole Island looked in 1928 with no river confinement structures and how increased channelization of the river over the past 80 years closed off the natural side-channel that created Tadpole Island. During the high water events of 2008 Tadpole has undergone the most change out of all the chutes, with high water causing significant bank erosion, undercutting and widening of the chute.

Figure II.12.2. Photo looking upstream from the middle of Tadpole Island Chute while under construction. Photo taken on 12 February 2006 by USFWS, Columbia NFWCO staff.

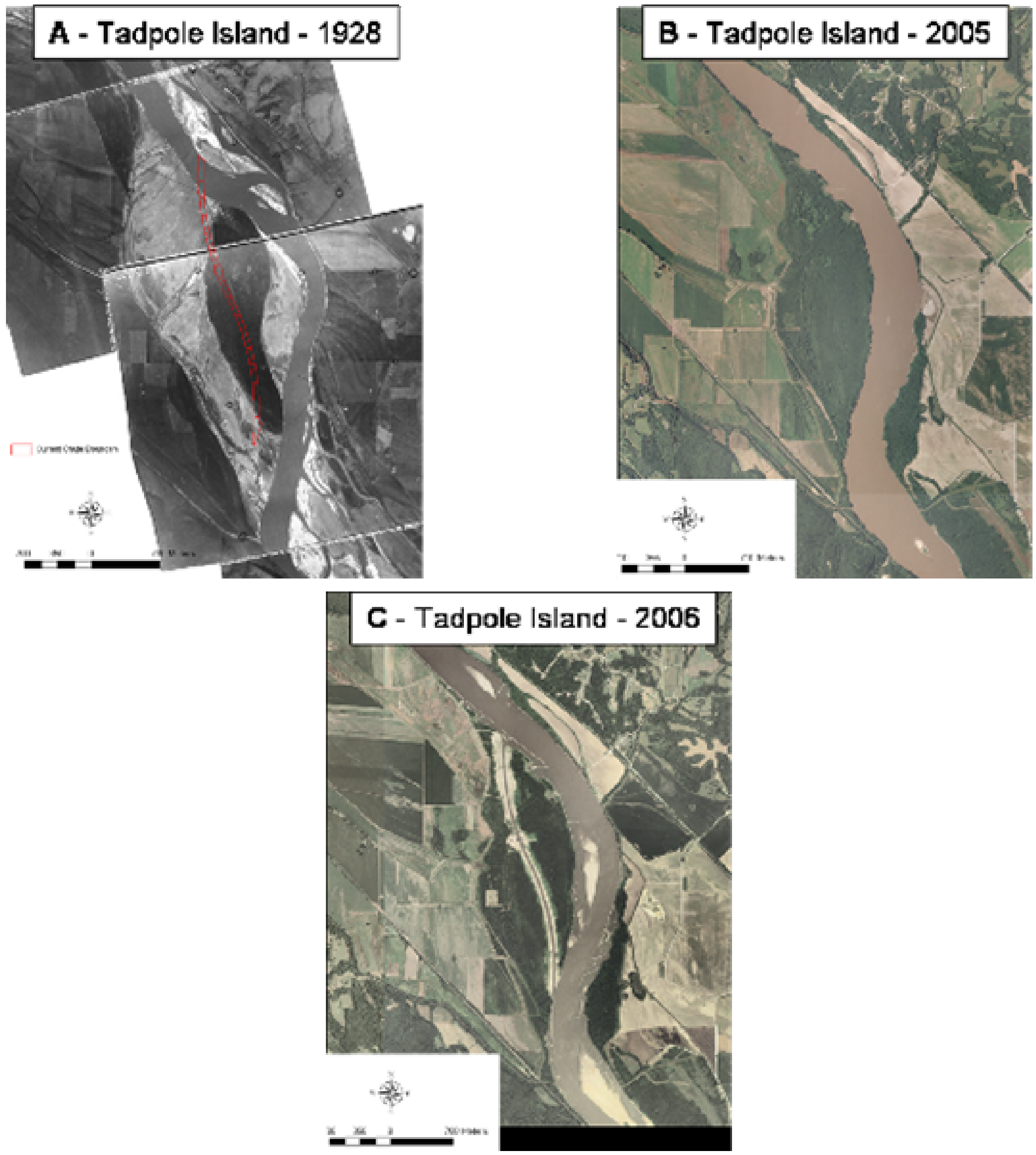
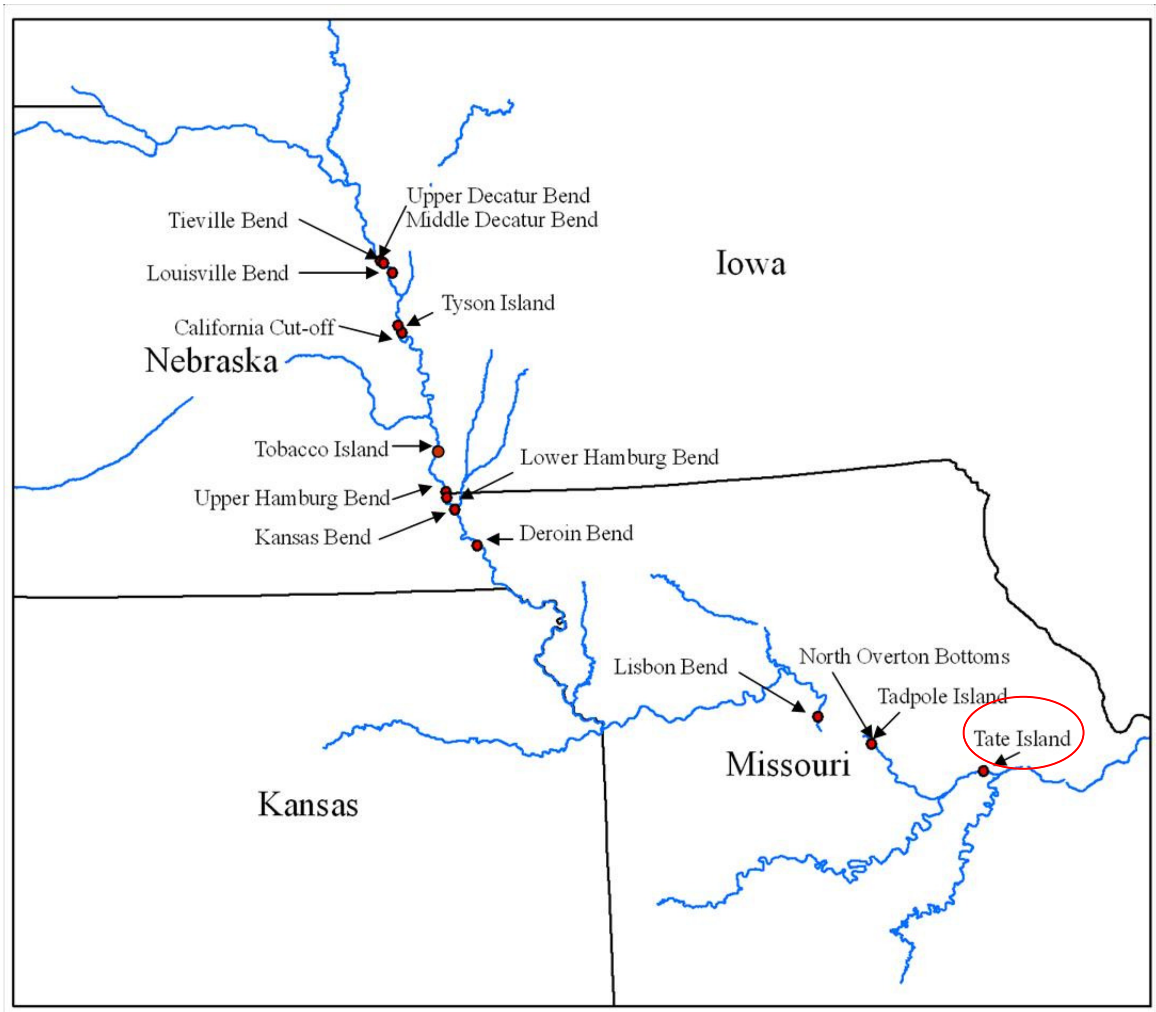


Figure II.12.3. Images of Tadpole Island from 1928 to 2006 showing changes over the years. (A) Historical aerial photograph of Tadpole Island taken in 1928, prior to intense construction of river confinement structures. Notice the width and complexity of the river channel and the presence of a large, tadpole shaped, island in the middle of the river channel (i.e., Tadpole Island). Photo includes the outline of the current chute boundary for reference. (B) Image of Tadpole Island taken prior to the initial chute construction (C) Image of Tadpole Island after chute construction in 2006. Base image A courtesy of Chance Bitner, U.S. Army Corps of Engineers; images B and C courtesy of the National Agriculture Imagery Program (NAIP); U.S. Department of Agriculture.

Section II
Chapter 13
Tate Island



List of Figures

Tate Island

Tate Island Chute (Tate) is located at RM 115.9 in Callaway County, Missouri. Tate is a unique side-channel complex that formed more than 60 years ago and has stabilized over the past 50 years. The islands are made up of forested and moist shrub land dominated by mature cottonwoods and willow species (Salix spp.). Tate is unique in that it is the only chute being studied that has a tributary influence; Tavern and Little Tavern Creeks empty into the chute. This chute also contains unique backwater habitats and tie channels that are not typical to the other chutes in the study area (except, to some degree, Lisbon Chute). A U.S. Army Corps of Engineers survey in the 1920's (Figure II.13.1) shows no island in the Tate area whereas maps from the 1950's show the formation of a sandbar and backwater complex with engineered banks (Robert B. Jacobson; USGS; Personal Communication). At present, the chute is stabilized with notched revetments. No additional modifications are currently planned.

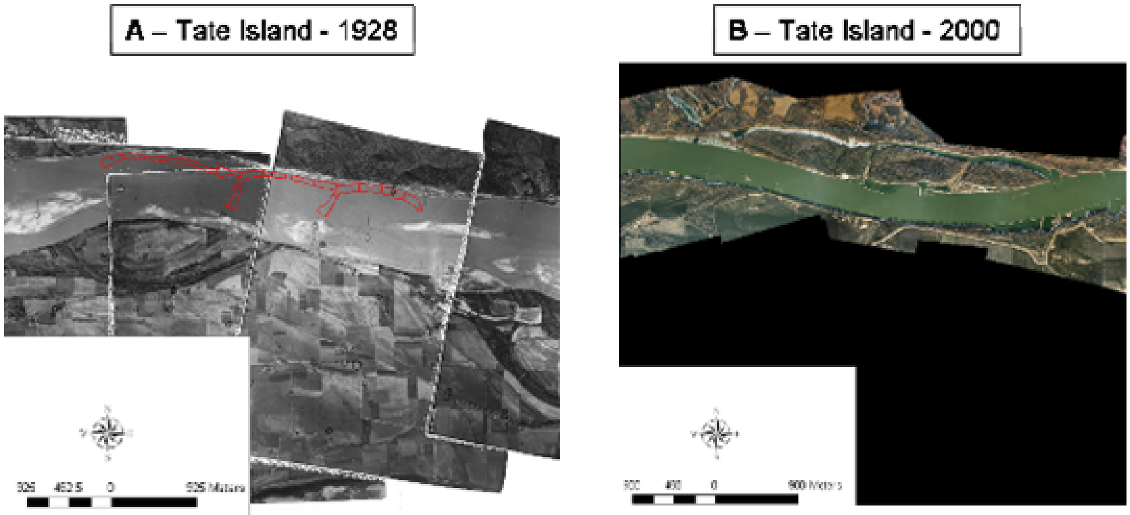
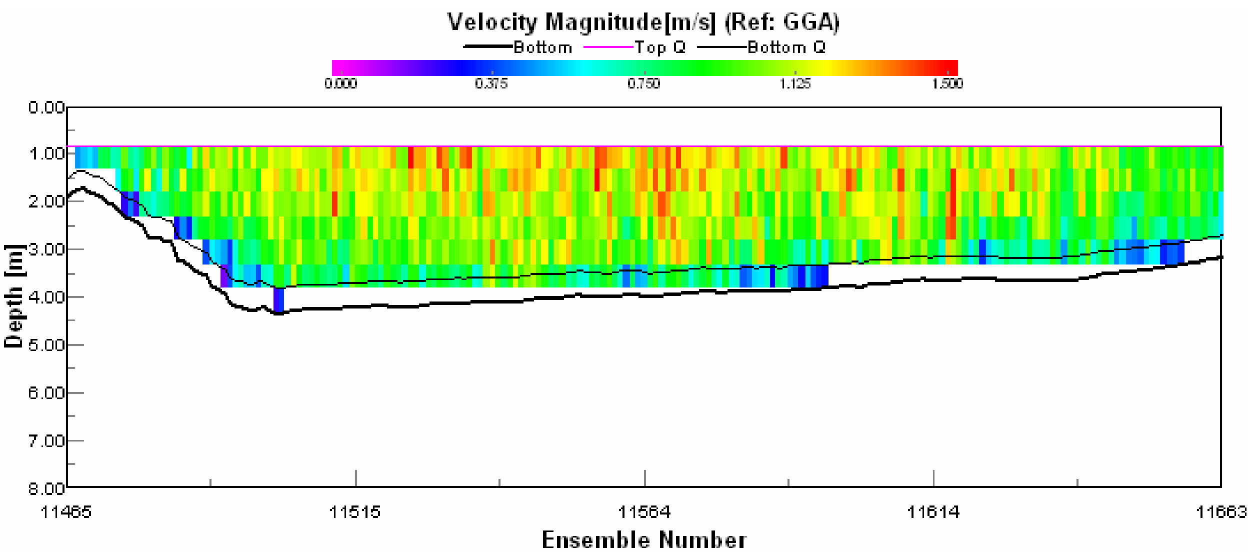


Figure II.13.4. Images of Tate Island from 1928 and 2000 showing changes over the years. (A) Historical aerial photograph of Tadpole Island taken in 1928, prior to intense construction of river confinement structures. Photo includes the outline of the current chute boundary for reference. (B) Image of Tadpole Island taken in 2000. Base images A and B courtesy of U.S. Army Corps of Engineers.

Section II
Chapter 14
Combined Physical Habitat Analysis



List of Tables

List of Figures

Methods

We analyzed seven physical habitat variables at eight constructed side channels. We chose to analyze variables we believed could be directly controlled by engineers in the design and construction phase of the project. These variables include: length, width, sinuosity, average depth, length to width ratio, width to depth ratio and chute length to channel length ratio (Table II.14.1). Length and sinuosity measurements were measured in ArcView 9.1 from aerial photography. Width measurements were made at 30 random transects (from Doppler surveys overlaid on aerial photography) and averaged to get an overall average width. Average depth and was calculated in SAS 9.1 using gridded data.

Multivariate analysis

Instead of testing the individual variables separately we decided to use multivariate statistics to test them in combination. A multivariate analysis gives us an idea of how the variables relate to the study site as a whole, rather than individually. Individual variables such as depth or length are important factors of a sites physical make-up but the interaction of these variables gives us a better description of how the sites may or may not differ. A multivariate analysis also allows us to reduce a large amount of data into a concise, easily interpreted result (McCune and Grace 2002).

Prior to analysis the habitat data were relativized (general) to account for different units of measure, checked for skewness and coefficient of variation and tested for outliers. We chose to use a Principal Components Analysis (PCA in PC-ORD, McCune & Medford 1999) with a Euclidean distance measure and a correlation cross products matrix for our ordination for our first analysis.

We then tested the hypothesis that the differences in variables observed between chutes could be related to chute age. To test this hypothesis, data were analyzed using a Bray-Curtis (Polar) ordination (in PC-ORD, McCune & Medford 1999) with a Sorenson distance measure and subjective endpoint selection. Endpoints selected were Upper Hamburg (oldest site) and Tadpole (youngest site).

Depth and Velocity analysis

Depth and depth-averaged velocity data were collected at three different flow events for each site. The flow event that most closely resembled the August median flow level for each site was used for this analysis.

Two problems presented themselves in the data analysis. The first was that due to factors such as GPS reception, boat speed and course and water speed, data were not evenly spaced across transects. Large gaps between data were uncommon but clusters of data where multiple points lay in a small area or on top of each other were common. The second problem was the large size of our data sets. The Kolmogorov-Smirnov (KS) test is an effective test for detecting differences between frequency distributions but is sensitive to large data sets (Neumann and Allen 2007). We accounted for clustered data by gridding the raw data using Kriging or Nearest Neighbors methods in ArcView 9.1. A 3m gridded map was created for each site and clipped by the original transect line so that only grid cells that originally contained raw data were used. The grid cells were then converted back to point data containing the resampled data. By resampling the data contained inside the 3m grid cells we also reduced both our data set size and the problems inherent with testing large data sets with the KS test.

After the gridding and conversion process the data were analyzed using the KS test in SAS. Depth data were binned in 0.5m bins and velocity data were binned in 0.2m bins. We ran a series of 28 KS tests each for depth and velocity with a Bonferonni adjusted p value of 0.0035 (alpha=0.10). The same gridded data set was also used to compare the mean depth and depth-averaged velocity between chutes using PROC GLM with a Bonferonni adjusted p value of 0.0035 (alpha = 0.10).

Results

Multivariate analysis

Our hypothesis that the differences observed between chutes could be related to chute age was supported by the Bray-Curtis (Polar) ordination (Figure II.14.1). A single axis solution shows a nearly linear relationship with the youngest chutes near the origin and the oldest chutes in the upper right hand corner. Some chutes are situated out of order in the ordination, suggesting that these chutes have either not evolved or evolved at a different rate than the other chutes in the study.

Tadpole is situated in the bottom left-hand corner of the ordination (Figure II.14.1), because it was chosen as the subjective pole (youngest chute – constructed in 2006) for the ordination. The site displays low sinuosity and is narrow (Table II.14.1), characteristics of a young chute (Knighton, 1998). Overton (five years) is also situated in the lower left corner of the ordination. This site also has a low sinuosity value and is narrow (Table II.14.1).

The two Kansas site (four years old – constructed in 2004) are situated next to each other in the ordination indicating that they have evolved at similar rates. Both sites are short, narrow

and deep. As the sites evolve they are expected to widen and become shallower. The sites are in proper locations on the ordination based on their age.

California (NE) (two years old at the time of the surveys but constructed in 2004) is a chute that seems to fall out of order in the ordination. However, it is the only study site that was constructed to finished width instead of as a narrow pilot channel, meaning that the site "skipped" the evolution phase of its life cycle. California (NE) should be expected to have conditions similar to those of older chutes and that is reflected in its position on the ordination.

Lower Hamburg (four years old – constructed in 2004) is situated the farthest to the right of the four year old chutes indicating that it has evolved faster than the other four year old sites. The site scores high in length, sinuosity, and the depth variables (Table II.14.1). Depth variables at the site were most likely inflated due to modifications made in the main channel during 2007. Navigation structures on Upper Hamburg Bend were modified to deflect more water to the outside bend to reduce shoaling in the main channel (Dan Pridahl, USACE, Personal Communication) which subsequently increased flows through the chute. The increased flows may also have hastened erosion in the chute leading to a greater width than would have been seen otherwise.

California (IA) (nine years old – constructed in 1999) is situated out of order on the ordination. The site is the shortest of the study sites and is also narrow and shallow. The sites length is the main factor inhibiting its potential to evolve. It is possible that the site will remain in the middle or to the left on the ordination as other sites evolve and pass it.

Deroin (seven years – constructed in 2001) is situated in the upper right-hand portion of the ordination. Deroin scored high in length, width, length to width ratio and both depth variables, but had one of the lowest chute length to channel length ratios. Most of the variables

the site exhibited high values for are indicative of an older chute and therefore Deroin's place on the ordination is correct.

Tobacco Island (seven years old – constructed in 2001) seems slightly out of place on the ordination given it scores low in the width, average depth and 90th percentile depth variables (Table II.14.1), variables that would generally increase in score as the chute ages. Conversely, Tobacco Island scored high in the sinuosity and length variables. These variables are essentially defined by the construction design and site parameters such as acreage. Despite its lack of width and depth Tobacco Island is situated in the correct place on the ordination given its age.

Two of the last three chutes on the ordination (Tate and Upper Hamburg) are the oldest of the study sites. Two of the sites (Lisbon - 1993 and Tate - 1958) were formed naturally by high water events and Upper Hamburg is the only constructed site old enough (12 years old - constructed in 1996) to have been subjected to multiple high water events. These chutes should show characteristics of a mature chute and it is fitting that they are located in the upper right hand corner of the ordination.

For the PCA analysis we chose to interpret a two-dimensional solution that explained a cumulative 63% of the original variation. The results of this solution are shown in Figure II.14.2. The first axis of the solution accounts for 36% of the variation between chutes and is driven by the variables width to depth ratio ($r = -0.926$), width ($r = -0.847$) and length to width ratio ($r = 0.758$). Chutes that had high width to depth ratios are found on the left side of the ordination include Lisbon and Tate (Table II.14.1). Chutes that had high length to width rations are located on the right side of the ordination and include Tobacco Island and Lower Hamburg.

The second axis of the solution accounts for 27% of the variation between chutes (Figure II.14.2) and is driven by the variables length ($r = 0.857$) and sinuosity ($r = 0.706$). Long chutes

are located in the upper half of the ordination and include Upper Hamburg, Tobacco and Deroin. Sinuous chutes are also located in the upper half of the ordination and include Tobacco Island and Upper and Lower Hamburg.

We divided the ordination graph into four Blocks using the origin of the variable vectors as the center. The average depth vector was extended left and right to divide axis 2 in half and the width vector was extended top to bottom to divide axis 1 in half creating the four blocks as shown in Figure II.14.3. Figure II.14.4 shows schematic diagram showing the Blocks, Block descriptions and chute locations. Block 1 chutes can be characterized as deep, narrow, short and straight. These chutes would also be likely to exhibit high water velocities as a result of these characteristics. These characteristics are indicative of a young stream (chute) that has not matured (Knighton 1998). We would expect only recently constructed chutes to be located in this Block. Chutes in Block 2 generally exhibit shallow depths and are narrow with low length to width ratios and are most likely short. Chutes in Block 3 can be described as long, moderately deep and narrow to moderately wide. They would also tend to have high sinuosity and high length to width ratios. Chutes in Block 4 can be characterized as being moderately long to long, wide, and shallow. These characteristics are indicative of an old stream (Knighton 1998) and may be considered an end state for our study chutes. Chutes in Block 2 exhibit favorable conditions similar to those in Block 4, but do not posses the length or width of chutes in Block 4. Table II.14.2 shows the chutes and their corresponding Block.

Depth and Velocity

Table II.14.2 shows the mean depth and depth-averaged velocity at each chute during the median August flow survey. All results from the KS tests show highly significant differences ($p < 0.0001$) between all chutes for depth (Table II.14.3) and depth-averaged velocity (Table II.14.4). For further comparison we provide the cumulative frequency distributions (CFD) (Figures II.14.4 and II.14.5).

We also compared mean depth and mean depth-averaged velocity between chutes at the median August flow level. We used a one-way ANOVA with an LSMeans statement to make pairwise comparisons (Bonferonni adjusted p value of 0.0035).

. Results were highly significant for both depth (F = 317.19, $p < 0.0001$) and depth-averaged velocity (F = 224.06, $p<0.0001$). Pairwise depth comparisons were significant for all tests (Table II.14.5) except Tobacco Island vs. California (IA) (F = 2.27, $p = 0.0231$) and Lower Hamburg vs. California (NE) (F = -2.47, $p = 0.0135$). Pairwise depth-averaged velocity comparisons were significant for all tests (Table II.14.6) except Tobacco Island vs. California (NE) (F = -1.11, $p = 0.2669$) and Tobacco vs. Deroin (F = 2.24, $p = 0.0219$).

A measure of site diversity that is relatively insensitive to discharge is decile slope. A sites decile slope is calculated from its cumulative frequency distribution as:

$$(0.9-0.1) / (90^{th} \text{ percentile depth} - 10^{th} \text{ percentile depth})$$

Sites with low decile slope values (approaching zero) will have more diversity than those with higher decile slopes (approaching infinity). Overton (0.20), Tate (0.20) and Upper Hamburg (0.23) have the lowest decile slope values for depth (Table II.14.7) indicating that they contain

the most depth diversity of the study sites. Tobacco Island (1.36) has the highest depth decile slope value and thus, the least amount of depth diversity. Tate (0.95), Upper Kansas (0.95) and Upper Hamburg (1.08) and Deroin (1.08) contain the highest diversity of depth-averaged velocities and Tobacco Island (2.22) contains the lowest. Caution must be used when comparing habitat diversity based solely on decile slopes. A combination of decile slope value and an examination of the depth or velocity CFD (Figures II.14.4 and II.14.5) will give a better understanding of diversity than the decile slope alone. For example, Kansas (upper) may have decile slopes that indicate diverse velocities but an examination of the CFD shows that the majority of those velocities (approximately 75%) occur in the range above 1 m/s. The site may contain a wide range of velocities but only a small portion of those velocities may be suitable to the fish community. The same is true for depth diversity. While a site may exhibit a diverse range of depths the majority of those depths may be deep and thus, even though the site is diverse it may not contain the shallow water it was intended to. Table II.14.7 shows our study sites and their corresponding slopes for both depth and velocity.

We also compared the percentage of shallow water (<1.5 m) and deep water (>3.7 m) (Table II.14.8) as well as the percentage of slow moving water (<0.76 m/s) and fast moving water (>1.0 m/s) (Table II.14.9) present at each site during all three surveys. In general, the percentage of shallow water decreased and deep water increased as flow increased except at California (IA) and at Lower Hamburg, both of which showed no pattern. Slow moving water decreased at California (NE), Tobacco, Upper Hamburg, Lower Kansas and Deroin and increased at California (IA) as main channel flows increased. The other chutes showed no patterns. Fast moving water decreased at California (NE), Tobacco Island, Lower Hamburg, Lower Kansas and Deroin and increased at California (IA) as flows increased. The other chutes

showed no patterns. We were not able to document any areas that may have been flooded during high water events that may have produced increased slow and shallow water during those events.

Discussion

The Bray-Curtis ordination gives a good view of how the chutes are evolving. The most recently constructed sites (Tadpole, Overton and both Kansas sites) group together and are located in the lower left portion of the ordination where we would expect young chutes to be. The most mature sites, whether because of age or because of a natural formation, are located in the upper right hand corner where the most mature sites should be located. There are exceptions in the middle of the ordination such as California (IA) which is a small chute where many of the physical features were established during design and construction and has not and may not evolve because of its design.

The study sites can also be evaluated based on their corresponding Block from the PCA ordination. We suggest that only Block 1 would be considered an unfavorable condition for our sites; that Blocks 2 and 3 exhibit certain favorable conditions and that Block 4 might be considered a target condition chute based on physical characteristics alone. Some sites may lack important features such as length that prohibit them from achieving Block 4 status but still hold the potential to evolve into Block 2 or Block 3 chutes. The two Kansas sites along with Overton are the only study chutes that remain in Block 1 despite being the same age as or older than the two California sites and Lower Hamburg at the time of the survey. Even though the Kansas sites exhibit high velocities they have been slow to widen. Their length, chute length to channel length ratio and sinuosity are factors of their site and design and will not change naturally. With time the two sites may eventually widen enough to become Block 2 chutes.

The majority of the sites fall into Block 2 and 3. These chutes are a mixture of young and old and long and short. Chutes in Block 2 probably evolved from Block 1 chutes and may have the potential to become Block 3 or Block 4 chutes; however the shortest of the Block 2 chutes (both California sites) may lack the length to move out of Block 2. Block 2 may be an end state for the shortest of the chutes.

Lower Hamburg and Tobacco Island chutes are two examples of sites that contain favorable conditions associated with Block 3 and have the potential to reach Block 4 with some conditioning. Both sites are relatively long and sinuous but were relatively narrow at the time of the survey. Lower Hamburg has shown that it will widen with sustained periods of high water. However, recent work has constricted its entrance limiting the amount of water entering the chute and thereby slowing its evolution. On the other hand, Tobacco Island has shown a reluctance to erode and widen and therefore construction is planned to create another entrance upstream of the existing entrance to allow more water to enter the chute and hasten its evolution (Dan Pridahl,USACE, Personal Communication).

Block 3 chutes are generally long, wide and moderately deep. The exception is Tobacco Island which is narrow and relatively shallow but is still included in Block 3 because of its high length to width ratio. While Block 3 chutes are in a generally favorable state they do have some unfavorable characteristics. These include a narrow width and low width to depth ratios. In general though, Block 3 chutes exhibit favorable conditions.

Block 4 chutes exhibit generally favorable conditions for most variables. They are long, wide and have a high width to depth ratios. These chutes likely have deep scour holes and shallow sand bar areas. Block 4 contains three chutes: Upper Hamburg, Lisbon and Tate. Lisbon and Tate are both natural chutes created by high water events. Upper Hamburg is the only

constructed chute to be subjected to numerous high water events. It is because of these factors that we have considered Lisbon, Tate and Upper Hamburg to be our "reference" chutes or what we would expect a mature, fully evolved chute to resemble. The fact that the sites lie in Block 4 of our ordination (exhibiting favorable conditions for most variables) reinforces our thoughts. All three chutes contains a diverse array of habitats from shallow sand bar areas to deep scour holes to deep, slow moving areas. In addition, Upper Hamburg exhibits more favorable sinuosity and length to width values than do the other two chutes indicating that a location in Block 4 nearer to Block 3 may be the most favorable condition on the ordination.

Using decile slopes as an indicator of diversity is a good way to compare our study sites. Upper Hamburg (0.23) and upper Kansas (0.24) have the lowest depth slope values. Our gridded data show us however that Upper Hamburg contains more shallow areas and more scour holes than does upper Kansas. This is evident when it is noted that the mean depth at upper Kansas (3.7 m) is nearly 1 m deeper than the mean depth at Upper Hamburg (2.9 m).

Upper Hamburg also has one of the lowest velocity slopes along with Deroin and upper Kansas. A look at the gridded data shows that Upper Hamburg and Deroin contain more slow water area than Kansas (upper) (See Section II, Chapters 5, 9 and 7 respectively). A look at mean velocities shows that Kansas (upper) (1.03 m/s) averages nearly 0.20 m/s faster on average than Upper Hamburg and Deroin. So, while Kansas (upper)may have a diverse range of velocities most of that diversity is contained in the upper range of velocities rather than in the lower range where it may be more beneficial to the fish community.

Results from the KS tests of depth and velocity distributions indicate that each chute presents a unique environment. This is reiterated by the general lack of tight grouping in the PCA. We are still able compare and contrast the sites and give them a rank or label such as

unfavorable or favorable based on conditions we think are beneficial to the fish community.

We found as main channel discharges increased so did chute depths and velocities. Some chutes increased more than others and some did not show strong patterns. The exception to this rule was at California (IA) (Table II.2.1) and Kansas (upper) (Table II.7.1) where velocities decreased as main channel discharges increased. We do not know what caused this anomaly but suspect it is related to the chute's location on the outside bend of the main channel. If the chute were located on a site with adhesive or compacted soils this "backwater" effect would have a severe effect on erosion rates. This is likely the reason that although Kansas (upper) has some of the fastest moving water of all the study sites it has not exhibited fast rates of erosion. The majority of the sites were built as pilot channels and left to erode during high water periods to a finished width. If a design leads to lower velocities during high water events a site may never reach its target width. We suggest that this design be looked at carefully by engineers if the chute is designed to evolve through erosion.

We suggest that length and width are two of the most important variables to consider during the design process. Longer chutes inherently have more capacity to evolve habitats that are considered important for many fish species. Longer chutes generally have higher sinuosity (more bends and crossovers) than shorter chutes. This increased sinuosity allows for the formation of areas of shallow water that may not exist in a short chute such as inside bend sand bar formations. The increased sinuosity of longer chutes also means that they may have greater capacity to slow water that may be entering the chute at high velocities. Wider chutes also posses the ability to slow water better than narrow "U" shaped chutes which can constrict and accelerate flows. Increased length and width increase the chances of habitat diversity within the chute. Both are more likely to result in deep scour holes and shallow bars as well as deposition

of large woody debris or contain areas where high water can flood terrestrial vegetation. After the high water events of 2007 and 2008 large amounts of large woody debris were observed on the banks of most chutes however, very little large woody debris was observed in the chutes. Alternative bank designs (sloping etc.) could facilitate large woody debris being deposited in the chutes rather than on the banks. Habitat diversity has been described as missing in the main channel of the Missouri River (Hesse and Mestl 1993) and should be an important part of chute design.

Key points:

- Soil type should be an important consideration in chute design, sites with clay or compacted soils need to be built to finished width or with wider pilot channels to hasten evolution
- Avoid designs where velocities decrease as main channel discharges increase such as at California (IA) and Kansas (upper)
- Build long chutes whenever possible
- Build width into short chutes
- Build diversity into short chutes (deep scour holes, bar features, large woody debris)
- Slope banks when possible to allow large woody debris to accumulate in chutes rather than on high banks
- Tie-channels and braids increase the amount of shallow, slow moving water at sites

- Tie-channels, braids and connected backwaters can be disconnected from chute by sediment from high water events – consider designs that limit sedimentation at entrances to these sites
- Avoid designs that promote sedimentation at entrances – keep entrances open so desired flows can be achieved
- Avoid sites with entrances that may block upstream migration of fish (high sills, constricted entrances with high velocities and turbulence)
- A chute with diverse habitat may not contain desired shallow water depths and slower water velocities

Table II.14.1. List of variables used in multivariate analysis. Year is year constructed, length is measured along the thalweg from the entrance to the exit of the chute, width is the average width from 30 random transects, W:D is width divided average depth, L:W is length divided by width, average depth is the average of the gridded data and Chute:Chan is the chute length divided by the length of the main channel from chute entrance to exit. All measurements were made at approximate median August flow.

Chute	Year	Length (m)	Sinuosity	Width (m)	W:D	L:W	Ave Depth (m)	Chute:Chan
California (IA)	1999	1204	1.17	40	23	30	1.7	1.15
California (NE)	2004	2763	1.10	45	21	61	2.1	1.07
Tobacco	2001	4748	1.21	23	14	207	1.6	0.97
Upper Hamburg	1996	5094	1.22	72	30	71	2.4	0.88
Lower Hamburg	2004	3927	1.16	31	13	126	2.3	0.92
Kansas (upper)	2004	2106	1.06	37	11	57	3.5	0.74
Kansas (lower)	2004	1693	1.05	37	14	46	2.6	0.97
Deroin	2001	4943	1.12	54	19	92	2.8	0.76
Lisbon	1993	3336	1.07	75	58	45	1.3	0.66
Overton	2003	2464	1.05	28	14	88	2.0	0.90
Tadpole	2006	2960	1.03	36	19	82	1.9	0.90
Tate	1958	3819	1.01	62	39	62	1.6	0.97

Table II.14.2. Mean depth (m) and depth-averaged velocity (m/s) of gridded data at median August flow.

Chute	Mean Depth (m)	Mean Depth-averaged Velocity (m/s)
California (IA)	1.7	0.62
California (NE)	2.1	0.69
Tobacco	1.6	0.70
Upper Hamburg	2.4	0.82
Lower Hamburg	2.3	0.86
Kansas (upper)	3.5	1.03
Kansas (lower)	2.6	0.77
Deroin	2.8	0.72

Table II.14.3. Results of KS tests comparing depth frequency distributions at median August flows. Results are significant at a Bonferonni adjusted p value of 0.0035 (alpha = 0.10).

Chute	**California (IA)**	**California (NE)**	**Tobacco**	**Upper Hamburg**	**Lower Hamburg**	**Kansas (upper)**	**Kansas (lower)**	**Deroin**
California (IA)		0.37 *<0.0001*	0.24 *<0.0001*	0.75 *<0.0001*	0.70 *<0.0001*	0.83 *<0.0001*	0.70 *<0.0001*	0.73 *<0.0001*
California (NE)			0.55 *<0.0001*	0.42 *0.0001*	0.34 *<0.0001*	0.61 *<0.0001*	0.34 *<0.0001*	0.37 *<0.0001*
Tobacco				0.88 *<0.0001*	0.83 *<0.0001*	0.88 *<0.0001*	0.82 *<0.0001*	0.86 *<0.0001*
Upper Hamburg					0.39 *<0.0001*	0.20 *<0.0001*	0.29 *<0.0001*	0.23 *<0.0001*
Lower Hamburg						0.58 *<0.0001*	0.10 *0.0007*	0.17 *<0.0001*
Kansas (upper)							0.49 *<0.0001*	0.42 *<0.0001*
Kansas (lower)								0.10 *0.0002*
Deroin								

Table II.14.4. Results of KS tests comparing depth-averaged velocity frequency distributions at median August flows. Results are significant at a Bonferonni adjusted p value of 0.0035 (alpha = 0.10).

Chute	California (IA)	California (NE)	Tobacco	Upper Hamburg	Lower Hamburg	Kansas (upper)	Kansas (lower)	Deroin
California (IA)		0.33 *<0.0001*	0.39 *<0.0001*	0.60 *<0.0001*	0.76 *<0.0001*	0.75 *<0.0001*	0.53 *<0.0001*	0.74 *<0.0001*
California (NE)			0.09 *<0.0001*	0.45 *<0.0001*	0.57 *<0.0001*	0.76 *<0.0001*	0.38 *<0.0001*	0.72 *<0.0001*
Tobacco				0.36 *<0.0001*	0.51 *<0.0001*	0.69 *<0.0001*	0.29 *<0.0001*	0.65 *<0.0001*
Upper Hamburg					0.17 *<0.0001*	0.53 *<0.0001*	0.09 *<0.0001*	0.42 *<0.0001*
Lower Hamburg						0.57 *<0.0001*	0.26 *<0.0001*	0.41 *<0.0001*
Kansas (upper)							0.50 *<0.0001*	0.26 *<0.0001*
Kansas (lower)								0.42 *<0.0001*
Deroin								

Table II.14.5. Results of pairwise comparisons of mean depth at median August flow. Non-significant results are shown in bold. Results are significant at a Bonferonni adjusted p value of 0.0035 (alpha = 0.10).

Chute	California (IA)	California (NE)	Tobacco	Upper Hamburg	Lower Hamburg	Kansas (upper)	Kansas (lower)	Deroin
California (IA)		8.92 *<0.0001*	**2.27** ***0.0231***	-17.31 *<0.0001*	-11.33 *<0.0001*	-33.11 *<0.0001*	-14.28 *<0.0001*	-25.32 *<0.0001*
California (NE)			12.08 *<0.0001*	-6.98 *<0.0001*	**-2.47** ***0.0135***	-25.78 *<0.0001*	-7.18 *<0.0001*	-15.69 *<0.0001*
Tobacco				22.66 *<0.0001*	14.74 *<0.0001*	37.84 *<0.0001*	16.98 *<0.0001*	31.64 *<0.0001*
Upper Hamburg					3.98 *<0.0001*	-24.63 *<0.0001*	-3.00 *0.0026*	12.76 *<0.0001*
Lower Hamburg						-23.62 *<0.0001*	-5.23 *<0.0001*	12.81 *<0.0001*
Kansas (upper)							14.38 *<0.0001*	-16.43 *<0.0001*
Kansas (lower)								3.54 *0.0004*
Deroin								

Table II.14.6. Results of pairwise comparisons of mean depth-averaged velocity at median August flow. Non-significant results are shown in bold. Results are significant at a Bonferonni adjusted p value of 0.0035 (alpha = 0.10).

Chute	**California (IA)**	**California (NE)**	**Tobacco**	**Upper Hamburg**	**Lower Hamburg**	**Kansas (upper)**	**Kansas (lower)**	**Deroin**
California (IA)		5.86 *<0.0001*	-7.10 *<0.0001*	-19.67 *<0.0001*	-19.94 *<0.0001*	-31.79 *<0.0001*	-10.04 *<0.0001*	-10.28 *<0.0001*
California (NE)			**-1.11** ***0.2669***	-13.52 *<0.0001*	-14.75 *<0.0001*	-27.41 *<0.0001*	-5.40 *<0.0001*	-3.49 *0.0005*
Tobacco				-12.86 *<0.0001*	-14.15 *<0.0001*	-27.21 *<0.0001*	-4.64 *<0.0001*	**-2.29** ***0.0219***
Upper Hamburg					-4.70 *<0.0001*	-20.67 *<0.0001*	3.85 *0.0001*	14.36 *<0.0001*
Lower Hamburg						-13.78 *<0.0001*	6.44 *<0.0001*	14.63 *<0.0001*
Kansas (upper)							17.43 *<0.0001*	29.46 *<0.0001*
Kansas (lower)								3.51 *0.0004*
Deroin								

Table II.14.7. Decile slope values for depth and velocity at all study sites.

Chute	Depth Decile Slope	Velocity Decile Slope
California (IA)	0.89	1.78
California (NE)	0.57	1.90
Tobacco Island	1.36	2.22
Upper Hamburg	0.23	1.08
Lower Hamburg	0.53	1.48
Kansas (upper)	0.24	0.95
Kansas (lower)	0.47	1.23
Deroin	0.47	1.08
Lisbon	0.42	1.16
Overton	0.19	1.35
Tate	0.20	0.95

Table II.14.8. Percentage of depths less than 1.5 m and greater than 3.7 m at each chute for the Low, Mid, and High surveys.

Depth						
	Percent of depths < 1.5 m			Percent of depths > 3.7 m		
Chute	Low	Mid	High	Low	Mid	High
California (IA)	17	21	0	0	0	67
California (NE)	64	4	0.7	1	0.2	42
Tobacco Island	NA	16	5	NA	0	0
Upper Hamburg	11	2	0.9	23	28	43
Lower Hamburg	1.5	2	0.2	8	1	8
Kansas (upper)	3	2.6	1	44	54	61
Kansas (lower)	6	5	1	5	8	60
Deroin	6	2	2	3	8	44

Table II.14.9. Percentage of depth-averaged velocities less than 0.6 m/s and 1.0 m/s at each chute for the Low, Mid, and High surveys.

	Depth-averaged Velocity					
	Percent of Velocities < 0.76 m/s			**Percent of Velocities <1.0 m/s**		
Chute	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
California (IA)	68	83	86	94	98	98.5
California (NE)	91	69	49	99.5	98	82
Tobacco Island	NA	57	32	NA	99	82
Upper Hamburg	38	36	30	75	77	70
Lower Hamburg	21	28	23	74	69	68
Kansas (upper)	21	19	27	45	40	54
Kansas (lower)	45	43	37	86	83	83
Deroin	40	30	28	79	66	63

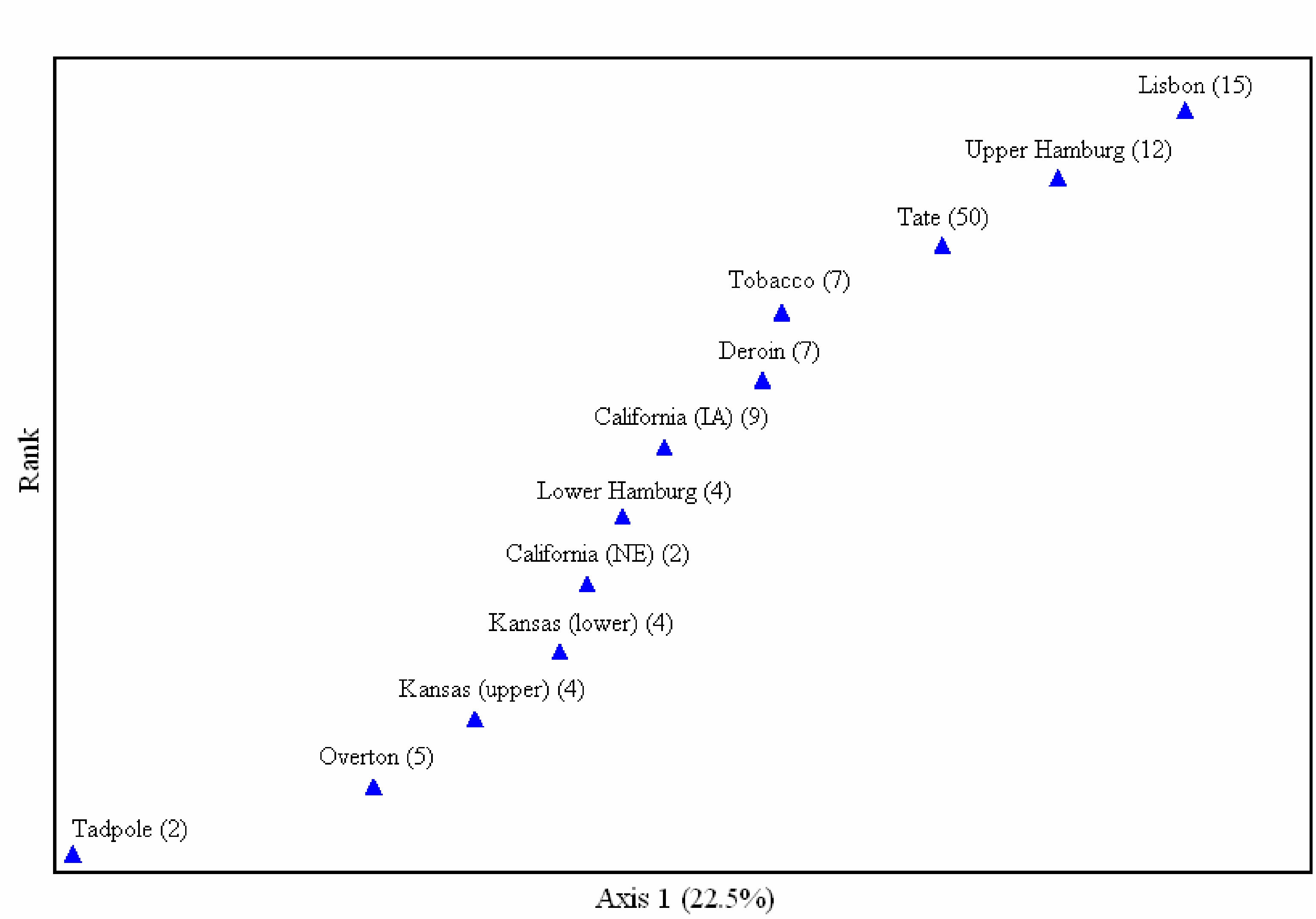


Figure II.14.1. Bray-Curtis (Polar) Ordination using Upper Hamburg (oldest) and Tadpole (youngest) chutes as subjective poles. Chutes are labeled with age at time of survey in parenthesis.

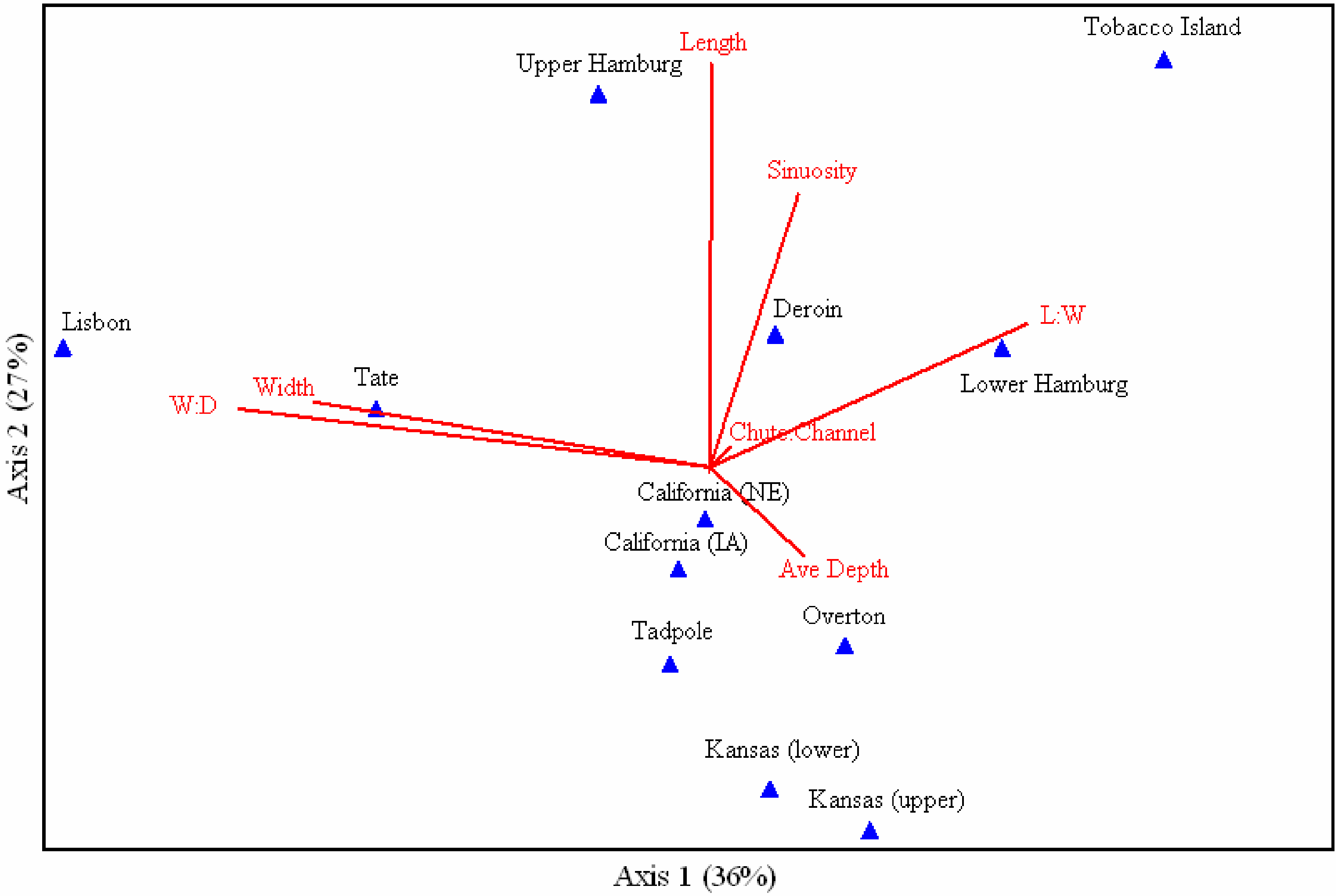


Figure II.14.2. PCA ordination with variable vectors.

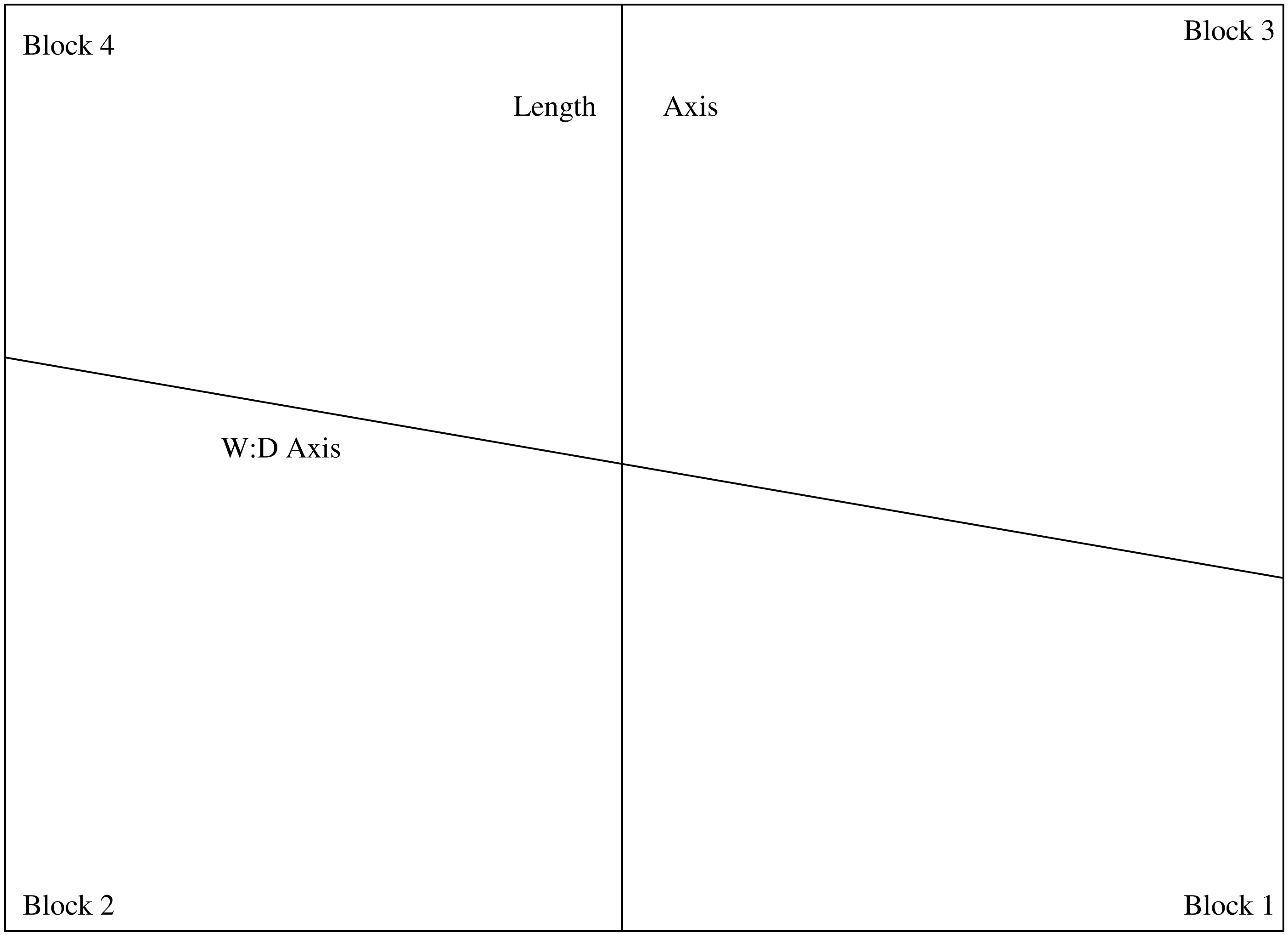


Figure II.14.3. Schematic diagram of the PCA ordination Blocks showing average depth axis, width axis and Block location.

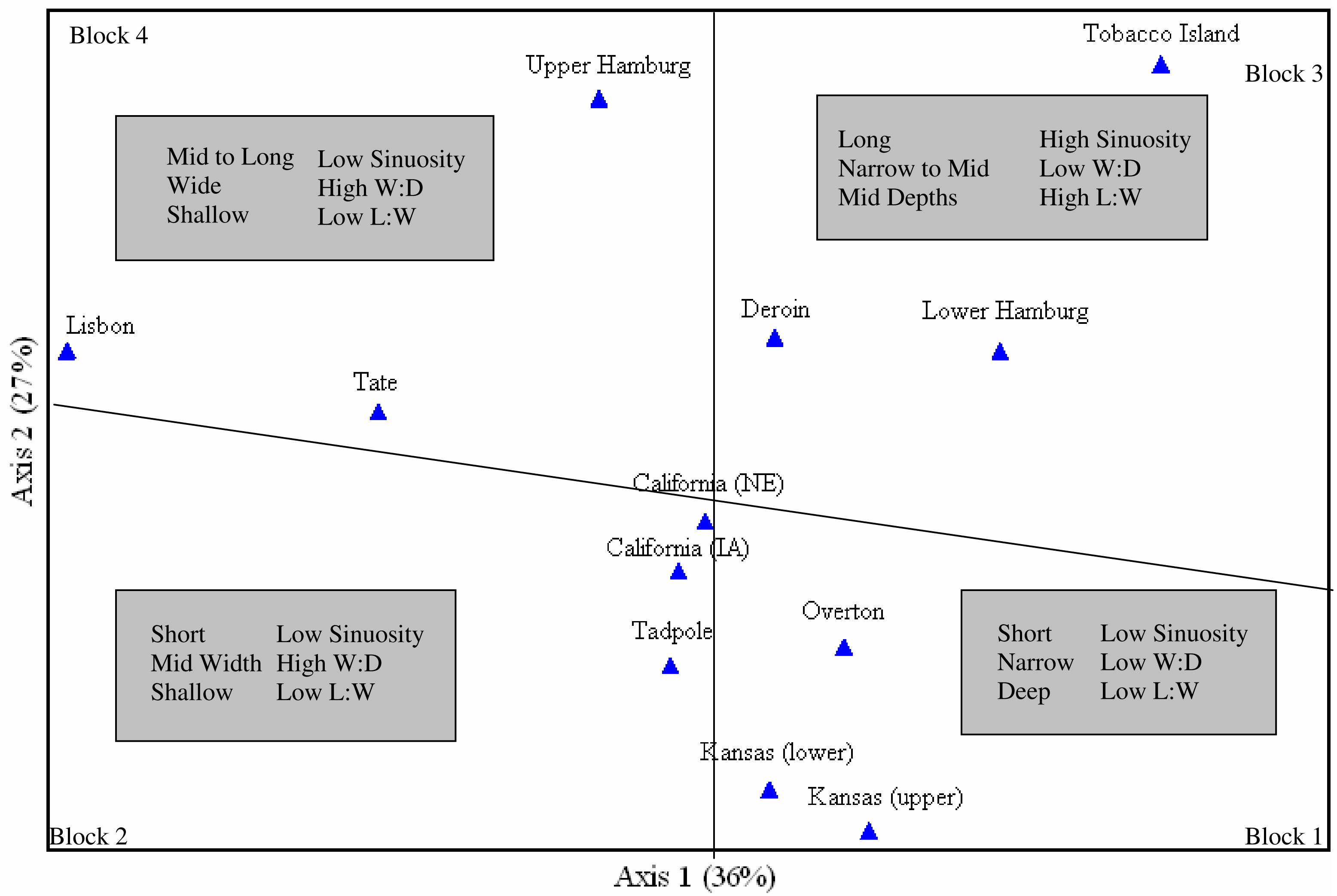


Figure II.14.4. Schematic diagram of the PCA ordination Blocks with block description and chute location.

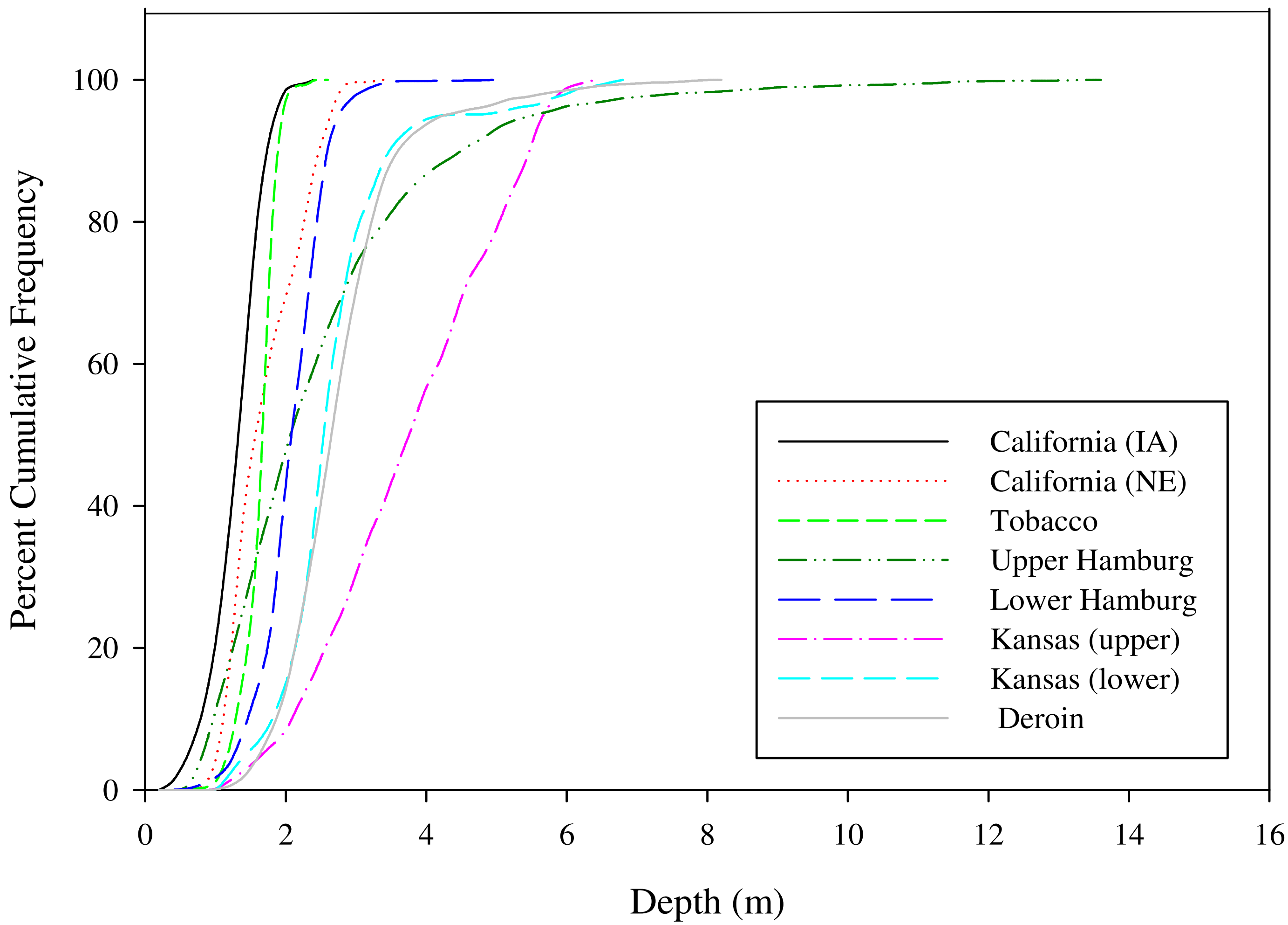


Figure II.14.5. Cumulative depth frequency distributions for all chutes at median August flow.

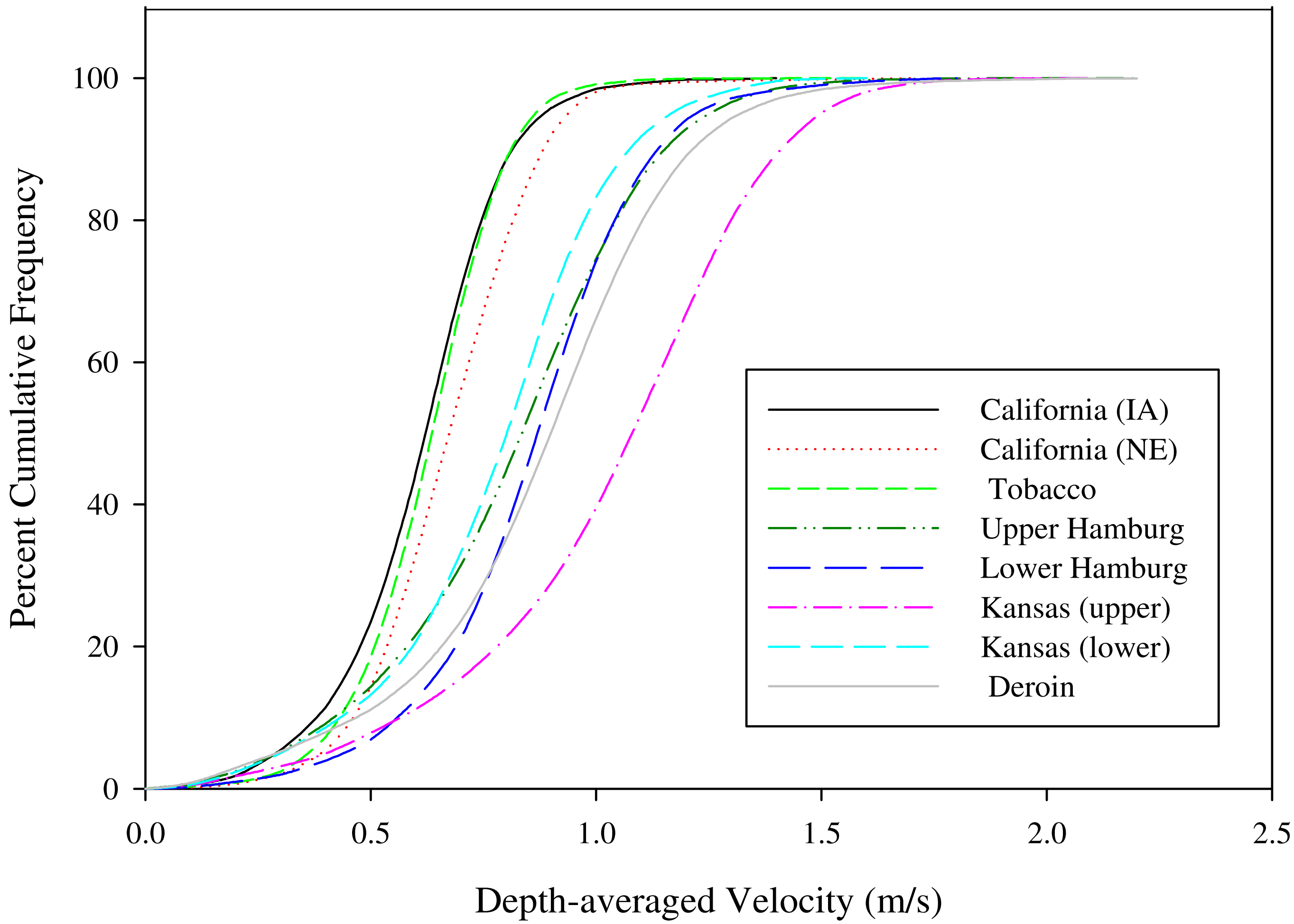


Figure II.14.6. Cumulative depth-averaged velocity frequency distributions for all chutes at median August flow.

FINAL REPORT

Missouri River Fish and Wildlife Mitigation Program

Fish Community Monitoring and Habitat Assessment of Off-channel Mitigation Sites

Section III Biological Monitoring (Chapters 1-3)

Tieville-Decatur Bend[1], Louisville Bend[1], Tyson Island[1], California Cut-Off[1,2], Tobacco Island[2], Upper and Lower Hamburg Bend[2,3], Kansas Bend[2,3], Deroin Bend[2,3], Lisbon Bottom[4], North Overton Bottoms[4], Tadpole Island[4] and Tate Island[4]

Prepared for the U.S. Army Corps of Engineers

By:

[1]Van Sterner and Royce Bowman
[2]Brandon Eder, Sabrina Negus and Gerald Mestl
[3]Kasey Whiteman, Darrick Garner and Vince Travnichek
[4]Joshua Schloesser, Joseph McMullen and Tracy Hill

April 2009

[1]Van Sterner and Royce Bowman
Contract number –
Iowa Department of Natural Resources
607 10th St
Onawa, Iowa 51040

[2]Brandon Eder, Sabrina Negus and Gerald Mestl
Contract number – W9128F-05-P-0171
Nebraska Game and Parks Commission
Missouri River Program – Fisheries Division
2200 North 33rd Street
Lincoln, NE 68503

[3]Kasey Whiteman, Darrick Garner and Vince Travnichek
Contract number – W912DQ-07-D-0001
Missouri Department of Conservation
Nodaway Valley CA
21999 Hwy B
Maitland, MO 64466

[4]Joshua Schloesser, Joseph McMullen and Tracy Hill
Contract number - W59XQG83460940
U.S. Fish and Wildlife Service
Columbia National Fish & Wildlife Conservation Office
101 Park DeVille Drive, Suite A
Columbia, MO 65203-0057

Executive Summary

The Missouri River has been developed for flood control, commercial navigation, irrigation, fish and wildlife conservation, municipal water supply, water quality control and hydropower production through a series of congressional acts. However, prior to development, the lower Missouri River was characterized by a highly sinuous to braided channel with abundant log jams, sand bars, secondary channels and cut-off channels. Construction of the Bank Stabilization and Navigation Project (BSNP) converted the lower Missouri River into a narrow, self scouring channel. The active channel downstream of Sioux City, Iowa was as wide as 1.8 km before river modification, but is now confined to a 91.4 m channel. Total river and floodplain habitat altered or destroyed by the BSNP is estimated at 211,246 hectares.

The Missouri River Fish and Wildlife Mitigation Project (Mitigation Project) was established to restore fish and wildlife habitat lost by the construction, operation and maintenance of the BSNP. The Water Resources Development Act of 1986 authorized the United States Army Corps of Engineers (COE) to acquire and develop habitat on 12,100 hectares of non public lands and the development of 7,365 hectares of habitat on existing public lands to mitigate habitat losses. The Water Resources Development Act of 1999 authorized an additional 48,016 hectares to the program. The Final Supplemental Environmental Impact Statement (FSEIS) for the expanded Mitigation Project was issued in March of 2003, and it included a preferred alternative proposing the creation of additional shallow water habitat (defined as areas less than 1.5 m deep with a current velocity of less than 0.76 m/s). The preferred action in the FSEIS for the expanded

Mitigation Project included creation of 2,833 to 8,094 hectares of shallow water habitat (SWH).

In 2005, the Iowa Department of Natural Resources, Nebraska Game and Parks Commission (NGPC), Missouri Department of Conservation and U.S. Fish and Wildlife Service, Columbia Fisheries Resource Office (renamed to Columbia National Fish and Wildlife Conservation Office) were contracted by the COE to monitor and evaluate fish communities of select off-channel aquatic habitat sites that were constructed through the Mitigation Project. Additionally, the NGPC was contracted to collect physical habitat information from the secondary channels that were selected for biological monitoring in the upper channelized section above Kansas City. Sixteen sites selected for monitoring covered a range of aquatic habitats including backwaters and secondary channels with varying levels of engineering and development. Sites from upstream to downstream included Tieville-Decatur Bend (two backwaters), Louisville Bend (backwater), Tyson Island (backwater), California Bend (chute on the Nebraska bank and a chute with connected backwater on the Iowa bank), Tobacco Island (chute), Upper and Lower Hamburg Bends (one chute each), Kansas Bend (two small chutes, treated as one), Deroin Bend (chute), Lisbon Bottom (natural chute), North Overton Bottoms (chute), Tadpole Island (chute) and Tate Island (chute). The study was designed to include three field sampling seasons, but due to delays implementing contracts in 2005 another complete year of sampling was added. Thus, fish community monitoring and habitat assessment of off-channel mitigation sites began in April, 2006 and concluded in October, 2008. The objective of this project was to determine biological performance and functionality of chutes and backwaters and to compare chutes and backwaters in an effort to identify

designs most beneficial to native Missouri River fish species. Additionally, this project was designed to help determine if additional modifications are needed at existing mitigation sites, if existing designs are providing a range of habitats, if these habitats are of value to the biological diversity of the Missouri River and if these habitats are of specific value to species of concern or importance, such as pallid sturgeon.

Chutes and backwaters were sampled monthly from April thru October 2006 – 2008. Each chute was divided into 16 sampling segments, and eight segments were randomly chosen without replacement each month for each gear type used. The standard gears used for this project include; trammel nets, large and small otter trawls, push trawls, bag seines, electrofishing, large and small diameter hoop nets and mini-fyke nets. Additional gears used only in backwaters include experimental gill nets and large frame trap nets. Set lines and hook and line were used as wild gears (gears in addition to those required for standard sampling), these gears were used to target pallid sturgeon.

Chutes and backwaters provided habitat for different fish communities. Chutes were found to have more riverine species while these species were lacking in backwaters. Contiguous backwaters had greater species diversity and richness than those that were impounded. This connection to the river allowed species to access these areas that they otherwise could not have.

Chutes separated themselves out geographically. The available fish community in the main channel affected the fish community in the chutes. Chutes that were located farther up the Missouri River tended to benefit different species than those on the lower end of the river. Therefore, the benefit of a chute to the overall fish community probably depended on if the chute provided something different than what was already found in the

main channel. Also more diverse fish communities were found in the older constructed and natural chutes. This is probably due to the greater habitat diversity these chutes have developed compared to the younger chutes.

Overall, the fish communities in most sites were dominated by juveniles of most species. The habitat that has been developed via chutes and backwaters therefore are functioning as refuges for smaller fish. This is a valuable asset to the fish communities in the Missouri River. Currently little is known if these juveniles are spawned or drifted into the chutes and backwaters. It is also unknown if these juveniles are able to move out of the chutes and backwaters and into the main channel.

Predictive models indicated that chutes had different probabilities of presence for target species. In general, chutes that were relatively longer, wider, shallower and had greater sinuosity were more likely to have target species present. Conversely, chutes that were short, had low width to depth ratios and low sinuosity were less likely to have target species present.

Important predictor variables for species presence were year (85% of species models), water depth (80%), turbidity (65%), water temperature (60%), month (60%) and water velocity (50%). A year effect, likely related to river discharge, for many species supports the need for multiple year assessment programs. Water depth and, to some extent, water velocity were recognized as two variables that can be manipulated by river engineers and we found that the selected range of depths and velocities varied by species, which was expected with a diverse fish community. Many juvenile and small-bodied fishes utilized shallow water habitats (<1.0 m) over a broad range of water velocities (0.0-1.0 m/s), but large-bodied fishes tended to orient towards relatively deeper water. Therefore, creating

shallow water habitats with a range of velocities would likely benefit many juvenile native species.

Mitigation Project designs are providing a range of habitats. Backwater habitats are creating a habitat not currently available in most reaches of the Missouri River. Different backwater designs do not appear to be creating different habitats from each other; however, backwaters can only be used by riverine fish if they are connected to the river. All chutes are providing some habitat diversity, however, some chutes, including; California (NE), Upper Hamburg, Lisbon and Tate contain more habitat diversity, and therefore, are providing much needed habitat complexity to that reach of the river.

Backwater and chute habitats appear to be beneficial to the biodiversity of the Missouri River system; however, it is important to note that different reaches of the river have different needs. The highly modified middle Missouri River, from Sioux City, IA to Kansas City, MO has very little habitat diversity available within the main channel and many different habitats may be necessary to restore the healthy function of the river system. While the lower Missouri River has greater habitat diversity within the main channel, there are still habitats that may be limited, such as habitat diverse chutes (e.g., Lisbon or Tate) or backwaters that may be needed to restore a fully functioning river.

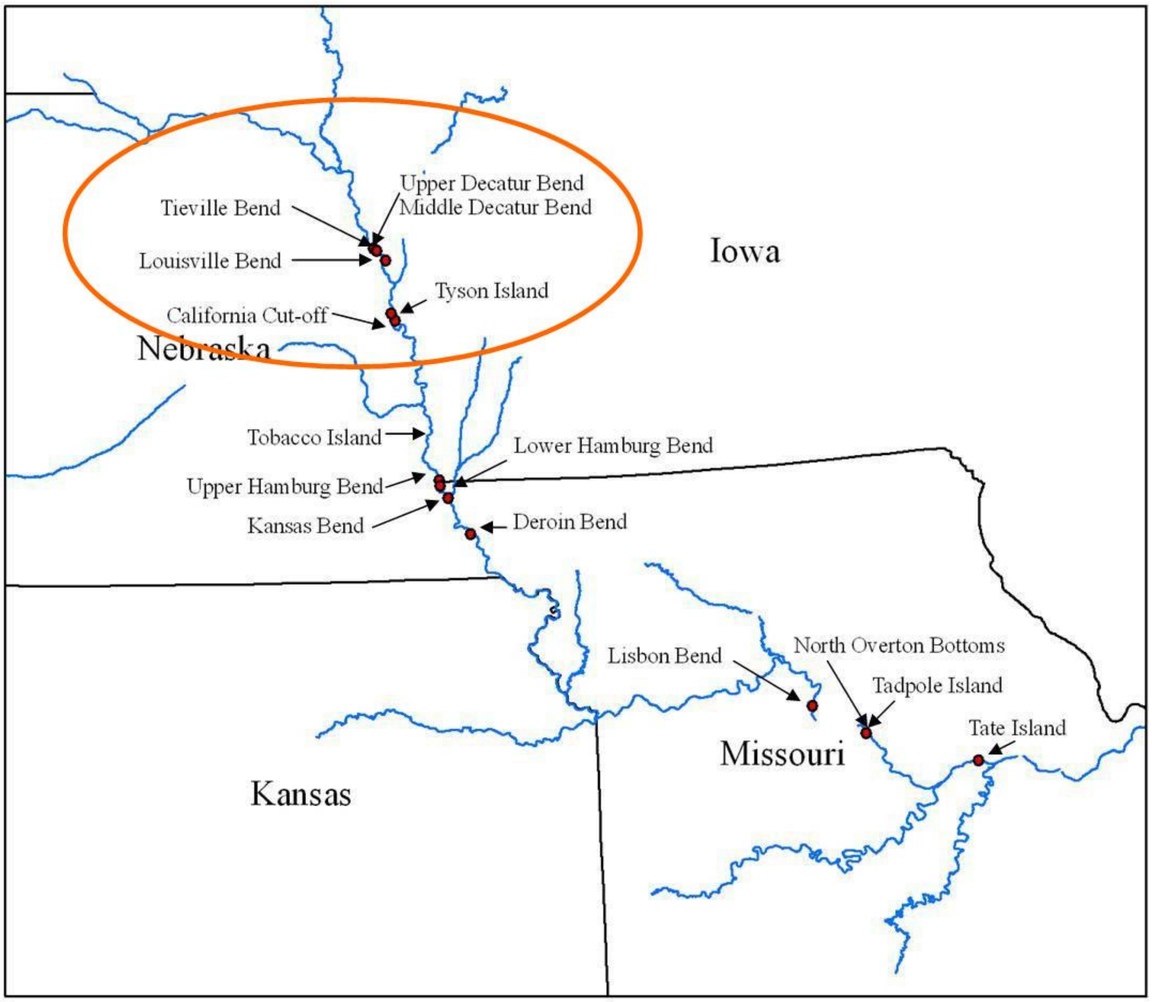
General Recommendations

- Promote natural side channel creation on suitable public lands. Allowing the river to naturally create side channel habitat may provide the most suitable habitat for riverine fish.
- We recommend constructing chutes that allow for floodplain connectivity, encourage natural river processes and maintain greater complexities of habitats (i.e. high width to depth ratios, diverse substrates, diverse depths, diverse velocities, shallow sandbars, woody debris and vegetated sandbars)
- Construction of longer chutes should receive higher priority than short chutes
- If a short chute must be built, build width, sinuosity and habitat diversity (deep scour holes, bar features and large woody debris).
- Promote channel movement through the use of structures or large woody debris.
- Soil type should be an important consideration in chute design, sites with clay or compacted soils need to be built to finished width or with wider pilot channels to hasten evolution.
- Slope banks when possible to allow large woody debris to accumulate in chutes rather than on high banks.
- Promote capture of large woody debris to increase habitat diversity and secondary productivity.
- Avoid designing chute entrances that may block upstream migration of fish (e.g., high sills or constricted entrances with high velocities and turbulence).
- Evaluate entrance structures to determine if certain life stages of some species (e.g., young of the year sturgeon) are being excluded from entering the chute.
- Avoid designs that promote sedimentation at chute entrances; keep entrances open so desired flows can be achieved.
- If a chute is intended to widen with increased main channel discharge, avoid designs where velocities decrease as main channel discharges increase such as at California (IA) and Kansas (upper).
- Use pilings, like those at Tate chute, instead of rip rap to create water control structures. Using pilings, as opposed to rock structures, may increase the permeability of water structures at varying levels of the water column, particularly the benthos.
- Include tie-channels and braids in chute designs to increase the amount of shallow, slow moving water at sites and provide more area that is in contact with the main channel.
- Design tie-channels, braids and connected backwaters to limit sedimentation.
- Tie channels can be used to direct flows to lower portions of the chute, allowing the upper portions to act more like backwater habitat.

- Create side channel habitat by building islands as opposed to digging channels, as was the case with Tate Island chute.
- Consider reopening existing, naturally formed side channels that are presently cut off from regular flows; there are at least 13 historic chutes that may be considered on the lower Missouri River.
- Contiguous dredged backwaters (such as Tyson Island and California (IA)) are recommended over impounded (disconnected) wetlands (such as Tieville, Louisville and Decatur). Contiguous sites provide connectivity that allows fish access to spawning and nursery habitat. Pumping did not provide accessible floodplain fish habitat.
- Backwaters should maintain a consistent, direct river connection. Open river connections are preferred over water control structures (culverts).
- Connectivity introduces sediment that will eventually fill backwaters. Siltation must be addressed by mechanical removal or improved backwater design.
- Backwaters of the upper channelized river become dewatered and isolated during winter discharges, backwaters should maintain adequate depth to prevent winter fish kills (approximately 3 m deep from December through February)
- Continued monitoring of chutes and backwaters would allow the determination of the rate at which the chute or backwater is evolving, the level of functionality that they can attain, value each chute has to different species, and how future manipulations affect the habitat and fish community.
- The variation in fish abundances seen among the three years of sampling indicates that a long term monitoring effort would be needed to detect population trends in chutes or backwaters. Furthermore, fish data from the chutes and backwaters should be compared to data from the main channel to determine how the chutes and backwaters are functioning with respect to main channel fish use.

TABLE OF CONTENTS

Section III
Chapter 1
Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Cut-off



List of Tables

List of Figures

Study Sites

Study sites consist of five constructed backwaters between river miles 650 and 693. The backwaters may be categorized into two different types; impounded wetlands and contiguous backwaters. The impounded wetlands; Tieville Bend, Decatur Bend and Louisville Bend are remnant channels developed with dikes, water level control structures and supplemental water, primarily for waterfowl management. These sites are typically impounded in late August utilizing stop logs and filled by pumping water from the main channel. These sites are located between river miles 683 and 693.

Surface area of **Tieville** is 17 hectares (Figures III.1.1-III.1.3). Development of this site was completed in 2003. Maximum depth is approximately 3 meters depending on local water conditions and whether the site is impounded with stop logs. The entire shoreline is ringed with emergent vegetation. The elevation of Tieville, relative to the incised channel and below average river discharges (Figure III.1.14) isolated this site from the river for most of the study period. Pumps were operated spring and summer of 2006 and 2007 in an attempt to create a flow-through connection to the river. Pumps were not operated in 2008 until late August for waterfowl management. The stop log structure is located at the highway embankment (Figures III.1.1 and III.1.2). Two 67 meter long, 0.9 meter diameter culverts were installed through the highway embankment that outlet to the south. The distance between the outfall of Tieville and the main channel is approximately 1.2 kilometers. Below Tieville is a series of eight notched weirs intended to facilitate fish passage (Figures III.1.2 and III.1.3). Through each weir is a 0.6 meter diameter culvert (Figure III.1.10). Culvert length ranges from 20.4 to 26.9 meters.

Decatur Bend is a 34 hectare oxbow lake with a maximum depth of 4 meters. This site is connected to the river during spring and summer with a 2.8 kilometer gravity flow canal (Figures III.1.3-III.1.6). Water levels in the lake are maintained by another series of control structures leading to the river on the downstream end of the site (Figure III.1.9). Peak river discharges in March, 2007 and May, 2008 (Figure III.1.14) allowed a downstream connection as well, creating flow through conditions. Emergent and submergent vegetation is scattered throughout the lake. There was no evidence of winter-kill at Decatur during the study period, which was not the case at Tieville and Louisville Bends.

The surface area of the impounded wetland at **Louisville Bend** is 10 hectares and maximum depth is 2.5 meters (Figure III.1.11). Emergent vegetation is abundant. As with the other impounded sites, water control structures remain open during the spring and summer to allow opportunistic connectivity. Pumps were operated spring and summer of 2006 and 2007 in an attempt to create a flow-through connection to the river. Elevation of Louisville Bend allowed for passive connectivity on numerous occasions during the study period. The river back-filled into the wetland through the control structure during all three seasons despite below average discharges.

The contiguous backwaters at **Tyson Island** (Figure III.1.12) and **California Bend** (Figure III.1.13) were created by U.S. Army Corps of Engineers dredging projects in 2004. The sites maintained an open connection to the river throughout the study period. Silt deposition reduced overall depth and volume and silt accumulation at the mouth of the sites nearly isolated the backwaters by the end of the study period. Surface area of California Bend and Tyson Island is 6.5 and 11.2 hectares, respectively. Maximum depth is 1 meter and varies little. These

backwaters are void of any type of aquatic vegetation. Discharge events in May of 2007 (Figure III.1.15) and June of 2008 allowed the river to overtop the banks of the dredged backwaters, inundating large expanses of terrestrial habitat.

Results

A total of twenty four hundred and sixty one gear deployments was made over the study period. Nearly one hundred and seventy thousand fish were collected. In 2006 54,854 fish were sampled (Table III.1.1), in 2007 65,908 fish were collected (Table III.1.2) and in 2008 49,147 fish were caught (Table III.1.3). A total of 45 species was sampled in 2006, 53 in 2007 and 51 in 2008. Number of species sampled by site ranged from 26 at Tieville to 41 at Tyson Island in 2006, 37 at Tieville and Louisville to 46 at Tyson Island and California in 2007 and 24 at Tieville to 39 at Tyson Island and Decatur in 2008.

We did not have equal sampling effort among sites because low water levels prevented sampling at some sites during portions of the study period. For this reason, we used rarefaction to compare richness among sites. Rarefaction allows richness comparisons of different communities and different sample size by standardizing samples to a common sample size of the same number of individuals (Krebs 1999). Rarefaction curves for mini fyke nets, large fyke nets, electrofishing and experimental gill nets are displayed in Figures III.1.16 – III.1.19. To make comparisons among sites we used the number of individuals that would allow inclusion of all sites in all years for each gear. This reduced the number of fish to 850 for mini fyke nets, 350 for large fyke nets, 65 for gill nets and 20 for electrofishing. Table III.1.5 displays expected species

richness for a common number of fish. We used a Kruskal-Wallis one way analysis of variance to compare expected richness among sites with each gear. The null hypothesis of no difference was rejected with all gears (Table III.1.5). Results of all pair-wise comparison of mean ranks indicate that richness was greater at Tyson Island than Tieville (Table III.1.5) with mini fyke nets, large fyke nets and gill nets. Expected richness values for each gear were pooled by sites with an open river connection (Tyson Island and California) and sites managed with water control structures (Tieville, Decatur and Louisville). Differences were assessed with the normal approximation of a one tailed Mann-Whitney rank test (Zar 1999). There was a significant difference in richness between sites with open connections for electrofishing, mini fyke nets and large fyke nets (Table III.1.6). Expected richness values were paired with the number of days a site maintained a passive connection with the main channel within a given sampling season. We used a spearman rank correlation to assess the relationship between passive connectivity and richness. There was a significant, positive relationship between richness and duration of connectivity for mini fyke nets ($r = 0.87$, $P < 0.01$), large fyke nets ($r = 0.77$, $P < 0.01$) and gill nets ($r = 0.52$, $P = 0.05$).

Species diversities by year and site using the Shannon-Wiener Index, Brillouin's Index, Simpson's Index, and the reciprocal of Simpson's Index are presented in Table III.1.7. Ninety percent confidence intervals were calculated by bootstrapping with 5000 iterations (Krebs 1999). The Shannon-Wiener and Brillouin indices are sensitive to rare species while Simpson's and the reciprocal of the Simpson index are more sensitive to abundant species (Krebs 1999). Diverity using all indices was highest in Tyson's Island and California and lowest in Tieville except in 2006 when the species diversity at Tyson's Island was the second lowest.

A Kruskal-Wallis one way analysis of variance was used to compare diversity indices among sites. There was a significant difference ($P < 0.10$) between sites with all diversity indices (Table III.1.8). The all-pair wise comparison of mean ranks test concluded diversity at California was significantly higher ($P < 0.10$) than Tieville with all indices (Table III.1.8). There was a significant difference between all diversity indices for sites with open connections and those managed with water control structures (Mann-Whitney, $P<0.05$).

Target species selected for the project represent taxa that utilize off-channel habitat during all or part of their life history. Species listed in the contract are; channel catfish *Ictalurus punctatus*, crappie *Pomoxis spp*., sauger *Sander canadensis*, largemouth bass *Micropterus salmoides,* bigmouth buffalo *Ictiobus cyprinellus*, Asian carp *Hypopthalmichthys spp*., paddlefish *Polyodon spathula*, bigmouth buffalo *Ictiobus cyprinellus*, smallmouth buffalo *Ictiobus bubalus*, river carpsucker *Carpiodes carpio*, gizzard shad *Dorosoma cepedianum*, goldeye *Hiodon alosoides*, emerald shiner *Notropis atherinoides* and other small bodied forage fish.

Mean monthly catch per unit effort (CPUE) was calculated for target species (Tables III.1.12 – III.1.33). Mini fyke nets were selected as a standard gear based on their ability to collect small fish including young of the year (Drobish 2008). Mini fyke net CPUE was used to assess juvenile abundance of large bodied target species including; channel catfish, crappie, sauger, largemouth bass, bigmouth buffalo and river carpsucker. All, or nearly all, of the catch of these species were juveniles as indicated by length (Pflieger 1997, Carlander 1969, 1977, 1997, personal communication, Joshua Schloesser, USFWS). Push trawling was used to assess the abundance of juvenile smallmouth buffalo. black and white crappies were grouped into *Pomoxis*

spp. and a minnow-shiner group that included emerald shiner, river shiner *Notropis blennius,* sand shiner *Notropis stramineus,* red shiner *Cyprinella lutrensis,* spotfin shiner *Cyprinella spiloptera*, and fathead minnow *Pimephales promelas* were also combined for comparison of CPUE among sites.

We used a Kruskal-Wallis one way analysis of variance to compare CPUE of target species among sites with select gears. The null hypothesis of no difference in CPUE between backwater sites was rejected all three years for channel catfish caught in large fyke nets and mini fyke nets, crappie in large fyke nets, largemouth bass in mini fyke nets and electrofishing, river carpsucker caught in mini fyke nets and combined minnow-shiners in mini fyke nets (Table III.1.9). There was no difference in CPUE in any year for crappie caught with mini fyke nets, bigmouth buffalo in mini fyke nets or large fyke nets, smallmouth buffalo with push trawling and gizzard shad caught with mini fyke nets (Table III.1.9). CPUE at Tieville was less than one or more sites in all significant pair wise comparisons including all three years for channel catfish and crappie caught with large fyke nets.

Mean monthly CPUE for target species and standard gears were pooled by sites with an open river connection (Tyson Island and California) and sites managed with water control structures (Tieville, Decatur and Louisville). Differences were assessed with the normal approximation of a one tailed Mann-Whitney rank test (Zar 1999). There was a highly significant difference ($P < 0.01$) in CPUE between sites with open connections and those managed with water control structures for seven of twenty one species and gears tested (Table III.1.10).

Spearman rank correlations for CPUE and duration of connectivity are displayed in Table III.1.11. There was a significant, positive relationship for juvenile channel catfish, crappie,

smallmouth buffalo, river carpsucker and gizzard shad. There was also a significant, positive relationship for silver chub and minnow-shiner species combined caught in mini fyke nets, gizzard shad and goldeye caught with gill nets and channel catfish caught with large fyke nets.

Discussion

Our results conclude that richness, diversity and abundance of most target species were greater in contiguous dredged backwaters at Tyson Island and California Bend than the impounded wetlands at Tieville, Louisville and Decatur Bends. Tieville performed poorly in comparison to the other impounded wetlands. The elevation of the Tieville Bend wetland with respect to the adjacent river channel and relatively low discharges during the study period prevented the river from back-filling through the control structure. There were few opportunities for fish from the river to access the site. Winter kill and fish imported through pumping (Gelwicks 1995) probably influenced the fish community more than passive connectivity. Fish imported through pumping were probably responsible for young of the year sauger catches in 2006. Catches of young of the year blue sucker *Cycleptus elongatus* and bigmouth buffalo at Tieville mirrored catches at the contiguous sites in June of 2007. Production of these two species was a segment-wide occurrence (personal communication Brandon Eder NGPC and Kasey Whiteman MDC), and their appearance at Tieville occurred when there was no other opportunity to gain access. It is unknown whether the system of weirs constructed below Tieville allowed fish passage into the wetland. Operation of the pumps in 2006 and 2007, when functional, rarely discharged enough water through the outlet to allow fish immigration (Figures III.1.42 and

III.1.43). The isolation of Tieville, coupled with frequent winter kills, limits both the fisheries potential and the benefits of floodplain connectivity. The original concept of the project included the successive bends; Blackbird, Tieville and Decatur. A river connection at upstream Blackbird Bend was expected to supply water to downstream bends. This component of the project is yet to be constructed. The benefit of connecting successive bends into one large complex is unknown. However, an upstream connection to Tieville would likely improve the fish community and reestablish an important link between the river and floodplain.

The design at Decatur and Louisville bends allows for a periodic, passive river connection. The fish communities were dominated by floodplain-using taxa like gizzard shad and centrarchids, similar to the isolated floodplain scours described by Galat (2004b). The presence of channel spawning species that use floodplain water bodies as nursery or adult habitat indicates an exchange of fish with the main channel. The tie channel constructed from the river channel to Decatur provides a gravity flow connection. Galat (2004b) suggested that off-channel water bodies immediately adjacent to the channel would provide greater access by adult riverine fishes and would also provide more beneficial nursery areas. The tie channel that connects Decatur with the river is 2.8 kilometers long and may have diminished use by riverine fishes. The distance to the channel is much shorter at Louisville Bend, and the process that connects to the river is back-filling through a 0.6 kilometer outlet channel. Young of the year channel catfish, sauger, paddlefish and goldeye were rare or absent in both these sites indicating they did not function as nursery areas for some typical native floodplain species.

The backwaters at California Bend and Tyson Island provided continuously connected, zero velocity habitat adjacent to the main channel. Young of the year of all target species except

Asian carp and paddlefish were sampled indicating these areas functioned as either spawning, refuge or nursery habitat for native fishes. The engineering challenge with constructed contiguous backwaters is to minimize sedimentation. Sediment deposition is gradually filling these sites. Deposition at the mouth of these sites has created a sill that is decreasing the range of discharges that provide an open connection and will eventually isolate the backwaters.

Floodplain aquatic habitats were abundant on the pre-developed Missouri River (NRC 2002, Galat 2005) and are necessary to the life history of many native Missouri River fishes (Pflieger 1997). Whitledge et al. (2005) reported that floodplain water bodies are important recruitment sites for big river fishes. The influence of lateral connectivity on the fish community of floodplain water bodies is well documented. Increased connectivity is beneficial to the fish community of floodplain water bodies (Gelwicks 1995, Galat et al. 2004a, Galat et al. 2004b, Whitledge et al. 2005). Junk (2004) described the lateral exchange of water, nutrients and organisms as an integral part of river-floodplain systems, adding that most of the primary and secondary production in large rivers occurs on the floodplain.

The segment of the Missouri River between Sioux City and Omaha is arguably the most challenging segments on the river to create floodplain connectivity. Bed degradation is an obvious obstacle (NRC 2002), and nowhere else on the channelized river is discharge more regulated (Hesse and Mestl 1993, Pegg 2003). The Mitigation Project was established to create and restore native floodplain habitats including wetlands, but projects intended to isolate the floodplain like Tieville are contrary to modern large river ecological theory. Opportunities to create and restore connected floodplain water bodies and riverine habitat in general are limited. Opportunities to restore isolated wetlands on the floodplain are abundant. Isolated wetlands are a

legitimate habitat within the Mitigation Project, but riparian areas should be dedicated to restoring native riverine habitat and promoting floodplain connectivity.

Tables

Table III.1. 1. Total number of samples collected at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Site	Bag seine	Electrofishing	Large fyke net	Gill net	Mini fyke net	Push Trawl	Trammel net
Tieville	14	134	126	64	142	80	11
Decatur	10	130	117	69	116	93	11
Louisville	20	100	70	44	80	47	3
Tyson Island	15	104	91	47	104	80	7
California	15	104	91	47	104	80	7
Total	74	572	495	271	546	380	39

Table III.1. 2. Total number of fish collected at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006.

Common Name	Scientific Name	Tieville	Decatur	Louisville	Tyson Island	California	Total
Bighead carp	*Hypopthalmichthys nobilis*	4	7	12	11	24	58
Black bullhead	*Ameiurus melas*	19430	10	18	10	10	19478
Black crappie	*Pomoxis nigromaculatus*	89	527	22	39	63	740
Bluegill	*Lepomis macrochirus*	19	3909	1353	196	232	5709
Bigmouth buffalo	*Ictiobus cyprinellus*	104	49	15	26	12	206
Bluntnose minnow	*Pimephales notatus*				1		1
Common carp	*Cyprinus carpio*	840	153	83	49	76	1201
Channel catfish	*Ictalurus punctatus*	4	45	40	30	103	222
Emerald shiner	*Notropis atherinoides*	14	18	3	8669	1063	9767
Flathead catfish	*Pylodictus olivaris*		1		6	4	11
Fathead minnow	*Pimephales promelas*	27		560	258	5	850
Freshwater drum	*Aplodinotus grunniens*	1	2404	765	43	33	3246
Goldeye	*Hiodon alosoides*		38		18	290	346
Green sunfish	*Lepomis cyanellus*	33	253	529	15	23	853
Grass carp	*Ctenopharyngodon idella*	4	1	6	1	1	13
Gizzard shad	*Dorosoma cepedianum*	216	961	201	831	1612	3821
Unidentified hybognathus	*Hybognathus spp.*					1	1
Johnny darter	*Etheostoma nigrum*		2				2
Largemouth bass	*Micropterus salmoides*		69		8	11	88
Longnose gar	*Lepisosteus osseus*		1		9	3	13
Northern pike	*Esox lucius*				4		4
Orangespotted sunfish	*Lepomis humilis*	112	28	1423	300	80	1943
Paddlefish	*Polyodon spathula*		13		2	6	21
Quillback	*Carpiodes cyprinus*	12	30	12	64	13	131
Red shiner	*Cyprinella lutrensis*	11	61	2	333	33	440

River carpsucker	*Carpiodes carpio*	15	194	192	236	300	937
River shiner	*Notropis blennius*	21	1047	6	817	66	1957
Slender madtom	*Noturus exilis*		8				8
Spotfin shiner	*Cyprinella spiloptera*	2	6		42	15	65
Sauger	*Sander canadensis*	121	11	24	16	16	188
Shorthead redhorse	*Moxostoma macrolepidotum*		7	2	5	14	28
Skipjack herring	*Alosa chrysochloris*				3	5	8
Smallmouth buffalo	*Ictiobus bubalus*		8	7	5	2	22
Smallmouth bass	*Micropterus dolomieu*				1	1	2
Shortnose gar	*Lepisosteus platostomus*	12	192	100	122	99	525
Sand shiner	*Notropis stramineus*	9	271	2	210	67	559
Silver chub	*Macrhybopsis storeriana*				45	35	80
Tadpole madtom	*Noturus gyrinus*		2	1	1	1	5
Unidentified carpsucker	*Carpiodes spp.*	155					155
Unidentified minnow	*Unidentified Cyprinidae*				59	1	60
Unidentified			3		30	2	35
Unidentified shiner	*Notropis spp.*	4	20		73	1	98
Unidentified sunfish	*Unidentified Centrarchidae*		2	81			83
Walleye	*Sander vitreum*	42	19	44	7	13	125
White Bass	*Morone chrysops*		3		8	14	25
White crappie	*Pomoxis annularis*	20	67	12	90	85	274
White sucker	*Catostomus commersoni*				1	1	2
Yellow bullhead	*Ameiurus natalis*	2	3		1		6
Yellow bass	*Morone mississippiensis*		37	10	69	314	430
Yellow perch	*Perca flavescens*	4	7	1			12
		21327	10487	5526	12764	4750	54854

Table III.1. 3. Total number of fish collected at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2007.

Common Name	Scientific Name	Tieville	Decatur	Louisville	Tyson Island	California	Total
Bighead carp	*Hypopthalmichthys nobilis*	2	5	17	30	15	69
Black bullhead	*Ameiurus melas*	8829	31	112	9	10	8991
Black crappie	*Pomoxis nigromaculatus*	12	386	44	77	111	630
Bluegill	*Lepomis macrochirus*	37	2595	2305	178	111	5226
Bigmouth buffalo	*Ictiobus cyprinellus*	8574	407	157	120	1160	10418
Bluntnose minnow	*Pimephales notatus*				11	5	16
Brassy minnow	*Hybognathus hankinsoni*				1		1
Blue sucker	*Cycleptus elongatus*	6			8	5	19
Common carp	*Cyprinus carpio*	2515	87	254	110	268	3234
Creek chub	*Semotilus atromaculatus*		1	1	1	1	4
Channel catfish	*Ictalurus punctatus*	13	81	194	264	118	670
Emerald shiner	*Notropis atherinoides*	49	24	11	451	1891	2426
Flathead catfish	*Pylodictus olivaris*		3	5	9	10	27
Fathead minnow	*Pimephales promelas*	11	2	4085	25	68	4191
Freshwater drum	*Aplodinotus grunniens*	168	81	137	73	407	866
Goldeye	*Hiodon alosoides*	2	19	1	78	112	212
Golden shiner	*Notemigonus crysoleucas*					1	1
Green sunfish	*Lepomis cyanellus*	24	146	223	14	11	418
Grass carp	*Ctenopharyngodon idella*	3	1	2	9	2	17

Gizzard shad	*Dorosoma cepedianum*	451	6492	213	1114	1834	10104
Johnny darter	*Etheostoma nigrum*	2	18		1		21
Largemouth bass	*Micropterus salmoides*		495	1	5	2	503
Longnose gar	*Lepisosteus osseus*	1	2		9	34	46
Larval fish unidentified		29	404	101	135	686	1355
Northern pike	*Esox lucius*				1	1	2
Orangespotted sunfish	*Lepomis humilis*	223	34	1831	156	87	2331
Paddlefish	*Polyodon spathula*		21			4	25
Quillback	*Carpiodes cyprinus*	10	9	3	13	8	43
Red shiner	*Cyprinella lutrensis*	9	58	112	118	146	443
River carpsucker	*Carpiodes carpio*	99	184	191	1425	1878	3777
River shiner	*Notropis blennius*	77	235	1015	434	753	2514
Slender madtom	*Noturus exilis*	2		2		1	5
Spotfin shiner	*Cyprinella spiloptera*	53	43	39	57	38	230
Sauger	*Sander canadensis*	40	4	37	4	21	106
Shorthead redhorse	*Moxostoma macrolepidotum*	1	5	10	51	85	152
Skipjack herring	*Alosa chrysochloris*	1					1
Speckled chub	*Macrhybopsis aestivalis*				3	8	11
Smallmouth buffalo	*Ictiobus bubalus*	1	41	21	18	19	100
Smallmouth bass	*Micropterus dolomieu*				1		1
Shortnose gar	*Lepisosteus platostomus*	62	1513	40	124	547	2286
Shovelnose sturgeon	*Scaphirhynchus platorynchus*					1	1
Sand shiner	*Notropis stramineus*	51	17	913	216	409	1606
Stonecat	*Noturus flavus*				3		3
Silver chub	*Macrhybopsis storeriana*	1		1	44	132	178
Silver carp	*Hypopthalmichthys molitrix*				2	1	3
Tadpole madtom	*Noturus gyrinus*	1	2	2			5
Unidentified sunfish	*Unidentified Centrarchidae*	6	5	81	14	8	114
Unidentified sucker	*Unidentified Catostomidae*			1490	4	69	1563
Unidentified minnow	*Unidentified Cyprinidae*	2					2
Unidentified lepomis	*Lepomis spp.*					4	4
Unidentified shiner	*Notropis spp.*	3			23		26
Unidentified crappie	*Pomoxis spp.*					20	20
Unidentified percidae	*Unidentified Percidae*					3	3
Walleye	*Sander vitreum*	42	5	15	6	6	74
Western silvery minnow	*Hybognathus argyritis*			6			6
White Bass	*Morone chrysops*	31	11	7	9	45	103
White crappie	*Pomoxis annularis*	6	58	3	26	204	297
White sucker	*Catostomus commersoni*		1	1	3	2	7
Yellow bullhead	*Ameiurus natalis*		20		1	1	22
Yellow bass	*Morone mississippiensis*	169	6	61	12	116	364
Yellow perch	*Perca flavescens*	3	1	2	2	7	15
		21621	13553	13746	5502	11486	65908

Table III.1. 4. Total number of fish collected at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2008.

Common Name	Scientific Name	Tieville	Decatur	Louisville	Tyson Island	California	Total
Bighead carp	*Hypopthalmichthys nobilis*	1	5	11	6	21	44
Black bullhead	*Ameiurus melas*	14567	37	2617	2	4	17227
Black crappie	*Pomoxis nigromaculatus*		132	69	209	11	421
Brook silverside	*Labidesthes sicculus*					1	1
Bluegill	*Lepomis macrochirus*	6	1795	2676	137	63	4677
Bigmouth buffalo	*Ictiobus cyprinellus*	893	124	38	50	71	1176
Bluntnose minnow	*Pimephales notatus*				4	9	13
Brassy minnow	*Hybognathus hankinsoni*	1					1
Blue sucker	*Cycleptus elongatus*	1					1
Common carp	*Cyprinus carpio*	7557	215	90	95	80	8037
Creek chub	*Semotilus atromaculatus*				1		1
Channel catfish	*Ictalurus punctatus*		32	84	68	102	286
Emerald shiner	*Notropis atherinoides*		192	11	423	1490	2116
Flathead catfish	*Pylodictus olivaris*		1		13		14
Fathead minnow	*Pimephales promelas*	1686	108	526	229	608	3157
Freshwater drum	*Aplodinotus grunniens*	5	74	111	154	52	396
Goldeye	*Hiodon alosoides*		23	1	49	49	122
Green sunfish	*Lepomis cyanellus*	29	129	674	16	4	852
Grass carp	*Ctenopharyngodon idella*	1	2				3
Gizzard shad	*Dorosoma cepedianum*	1	961	11	115	542	1630
Johnny darter	*Etheostoma nigrum*		43	1			44
Largemouth bass	*Micropterus salmoides*		98	5	5	1	109
Longnose gar	*Lepisosteus osseus*		3		13	5	21
Northern pike	*Esox lucius*				1		1
Orangespotted sunfish	*Lepomis humilis*	8	13	1216	148	50	1435
Paddlefish	*Polyodon spathula*		6		1	3	10
Quillback	*Carpiodes cyprinus*		14	1		1	16
Red shiner	*Cyprinella lutrensis*	2	119	26	48	225	420
River carpsucker	*Carpiodes carpio*		83	231	448	808	1570
River shiner	*Notropis blennius*	3	176	2	102	300	583
Slender madtom	*Noturus exilis*		2	1			3
Spotfin shiner	*Cyprinella spiloptera*	6	11	12	13	7	49
Sauger	*Sander canadensis*	4	3		3	6	16
Shorthead redhorse	*Moxostoma macrolepidotum*		6	2	42	17	67
Speckled chub	*Macrhybopsis aestivalis*	1			7	5	13
Smallmouth buffalo	*Ictiobus bubalus*	1	3	36	176	128	344
Smallmouth bass	*Micropterus dolomieu*				2		2
Shortnose gar	*Lepisosteus platostomus*	149	315	867	662	367	2360
Shovelnose sturgeon	*Scaphirhynchus platorynchus*		1				1
Sand shiner	*Notropis stramineus*		19	12	59	127	217
Stonecat	*Noturus flavus*				2		2
Silver chub	*Macrhybopsis storeriana*				77	217	294
Silver carp	*Hypopthalmichthys molitrix*			1			1
Tadpole madtom	*Noturus gyrinus*	4	2	1			7
Unidentified sunfish	*Unidentified Centrarchidae*			446	29	15	490
Unidentified minnow	*Unidentified Cyprinidae*	12		510	2	66	590
Unidentified lepomis	*Lepomis spp.*		31		46		77
Walleye	*Sander vitreum*	5	7		8	3	23

White bass	*Morone chrysops*	5	34	6	26	38	109
White crappie	*Pomoxis annularis*		19	6	18	11	54
White sucker	*Catostomus commersoni*		1	5	1		7
Yellow bullhead	*Ameiurus natalis*		9				9
Yellow bass	*Morone mississippiensis*		19			3	22
Yellow perch	*Perca flavescens*	1		2	2	1	6
		24949	4867	10308	3512	5511	49147

Table III.1. 5. Expected species richness by rarefaction for a common number of individuals caught with mini fyke nets (850), large fyke nets (350), experimental gill net (65) and electrofishing (20) at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008. NS = no significant pairwise difference.

Gear	Year	Tieville	Decatur	Louisville	Tyson Island	California	Kruskal-Wallis *H*	P	Kruskal-Wallis All-Pairwise Comparisons Test Alpha 0.1
Mini fyke net	2006	8.69	17.87	14.73	19.96	24.31			
	2007	17.04	17.31	16.58	30.88	28.90	11.83	**0.02**	Tyson > Tieville
	2008	7.42	23.48	15.78	31.80	23.70			
Large fyke net	2006	12.41	11.36	15.09	25.53	20.58			
	2007	9.40	12.92	18.26	20.74	20.41	10.63	**0.01**	Tyson > Tieville
	2008	4.08	18.23	12.32	18.51	16.16			
Gill net	2006	7.11	5.93	11.45	11.84	9.37			
	2007	9.30	11.64	10.54	15.96	11.41	7.87	**0.10**	Tyson > Tieville
	2008	5.00	13.96	9.73	11.43	11.29			
Electro-fishing	2006	4.49	3.69	4.81	6.17	5.05			
	2007	5.68	3.80	7.90	5.32	5.71	8.77	**0.07**	NS
	2008	4.88	3.11	9.68	7.00	10.00			

Table III.1. 6. One tailed Mann-Whitney Rank Test of expected species richness for sites managed with water control structures (Tieville Bend, Decatur Bend, Louisville Bend) and sites with an open river connection (California Bend and Tyson Island) April-September, 2006-2008.

	Mean rank			
Sampling gear	**Open**	**Culverts**	**Z**	**p**
Electrofishing	42	12	**1.71**	**0.09**
Mini fyke net	53	5.1	**3.01**	**<0.01**
Large fyke net	52	2	**2.89**	**<0.01**
Gill net	39	15	1.36	0.18

Table III.1. 7. Simpson Index, Reciprocal of Simpson Index, Shannon-Wiener Index and Brillouin Index and 90% confidence intervals for all fish caught with all gears at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

2006

	Tieville	Decatur	Louisville	Tyson Island	California
Simpson Index	0.16 (0.15-0.16)	0.78 (0.78-0.79)	0.83 (0.82-0.83)	0.52 (0.51-0.52)	0.82 (0.81-0.82)
Reciprocal of Simpson index	1.18 (1.18-1.18)	4.64 (4.54-4.74)	5.77 (5.63-5.90)	2.06 (2.03-2.10)	5.47 (5.23-5.57)
Shannon-Wiener Index	0.64 (0.62-0.66)	2.89 (2.86-2.92)	2.96 (2.93-3.00)	2.05 (2.01-2.09)	3.27 (3.22-3.32)
Brillouin Index	0.64 (0.61-0.66)	2.88 (2.85-2.91)	2.95 (2.91-2.98)	2.04 (2.00-2.08)	3.24 (3.20-3.29)

2007

	Tieville	Decatur	Louisville	Tyson Island	California
Simpson Index	0.66 (0.66-0.66)	0.70 (0.70-0.71)	0.81 (0.81-0.82)	0.86 (0.86-0.87)	0.88 (0.88-0.89)
Reciprocal of Simpson index	2.95 (2.92-2.97)	3.36 (3.30-3.43)	5.30 (5.20-5.40)	7.23 (6.98-7.49)	8.63 (8.47-8.79)
Shanon-Wiener Index	1.98 (1.96-2.00)	2.51 (2.48-2.54)	3.01 (2.97-3.04)	3.61 (3.57-3.66)	3.65 (3.62-3.67)
Brillouin Index	1.98 (1.96-2.00)	2.50 (2.47-2.53)	3.00 (2.98-3.03)	3.59 (3.54-3.63)	3.63 (3.61-3.66)

2008

	Tieville	Decatur	Louisville	Tyson Island	California
Simpson Index	0.56 (0.56-0.57)	0.81 (0.80-0.82)	0.81 (0.80-0.80)	0.91 (0.91-0.91)	0.88 (0.88-0.89)
Reciprocal of Simpson index	2.27 (2.25-3.00)	5.28 (5.09-5.49)	5.12 (5.03-5.21)	11.03 (10.58-11.47)	8.53 (8.26-8.80)
Shanon-Wiener Index	1.49 (1.48-1.51)	3.32 (3.27-3.37)	2.81 (2.78-2.83)	3.99 (3.95-4.03)	3.73 (3.69-3.76)
Brillouin Index	1.49 (1.47-1.50)	3.29 (3.25-3.34)	2.80 (2.77-2.82)	3.95 (3.91-4.00)	3.71 (3.67-3.74)

Table III.1. 8. Kruskal-Wallis One Way AVOVA and All pairwise Comparisons Test of Simpson Index, Reciprocal of Simpson Index, Shannon-Wiener Index and Brillouin Index for Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006- 2008.

	Year	Tieville	Decatur	Louisville	Tyson Island	California	Kruskal-Wallis *H*	Kruskal-Wallis P	Kruskal-Wallis All-Pairwise Comparisons Test Alpha 0.1
Simpson	2006	0.16	0.78	0.83	0.52	0.82	8.14	**0.09**	California > Tieville
	2007	0.66	0.70	0.81	0.86	0.88			
	2008	0.56	0.81	0.81	0.91	0.88			
		Tieville	**Decatur**	**Louisville**	**Tyson Island**	**California**			
Reciprocal of Simpson index	2006	1.18	4.64	5.77	2.06	5.47	8.07	**0.09**	California > Tieville
	2007	2.95	3.36	5.30	7.23	8.63			
	2008	2.27	5.28	5.12	11.03	8.53			
		Tieville	**Decatur**	**Louisville**	**Tyson Island**	**California**			
Shanon-Wiener Index	2006	0.64	2.89	2.96	2.05	3.27	9.07	**0.06**	California > Tieville
	2007	1.98	2.51	3.01	3.61	3.65			
	2008	1.49	3.32	2.81	3.99	3.73			
		Tieville	**Decatur**	**Louisville**	**Tyson Island**	**California**			
Brillouin Index	2006	0.64	2.88	2.95	2.04	3.24	9.07	**0.06**	California > Tieville
	2007	1.98	2.50	3.00	3.59	3.63			
	2008	1.49	3.29	2.80	3.95	3.71			

Table III.1. 9. Kruskal-Wallis One Way AVOVA and All pairwise Comparisons Test of CPUE for select species at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008. NS = no significant pairwise difference.

Species	Life stage	Sampling gear	Year	Kruskal-Wallis One-Way AOV *H*	p	Kruskal-Wallis All-Pairwise Comparisons Test Alpha 0.1
Channel catfish	All	Large fyke	2006	**16.40**	**<0.01**	California > Decatur, Tieville
			2007	**10.36**	**0.03**	California > Tieville
			2008	**12.87**	**0.01**	Louisville > Tieville
Channel catfish	Juvenile	Mini fyke	2006	**12.47**	**0.01**	NS
			2007	**15.60**	**<0.01**	California > Decatur, Tieville
			2008	**12.91**	**0.01**	NS
Crappie	All	Large fyke	2006	**10.00**	**0.04**	Decatur > Tieville
			2007	**11.83**	**0.02**	Decatur > Tieville
			2008	**11.47**	**0.02**	Decatur > Tieville
Crappie	Juvenile	Mini fyke	2006	5.15	0.27	
			2007	5.05	0.28	
			2008	7.00	0.14	
Sauger	All	Large fyke	2006	5.88	0.21	
			2007	**8.22**	**0.08**	NS
			2008	3.53	0.47	
Sauger	Juvenile	Mini fyke	2006	**10.74**	**0.03**	NS
			2007	7.61	0.11	
			2008	2.92	0.57	
Largemouth bass	All	Electro-fishing	2006	**10.60**	**0.03**	NS
			2007	**18.71**	**<0.01**	NS
			2008	**11.81**	**0.02**	NS
Largemouth bass	Juvenile	Mini fyke	2006	**14.36**	**<0.01**	Decatur > Tieville
			2007	**19.57**	**<0.01**	NS
			2008	**11.18**	**0.02**	NS
Bighead carp	All	Gill net	2006	6.17	0.19	
			2007	**15.46**	**<0.01**	Louisville > Tieville
			2008	4.41	0.35	
Paddlefish	All	Gill net	2006	**7.75**	**0.10**	NS
			2007	**8.06**	**0.09**	NS
			2008	6.79	0.15	
Bigmouth buffalo	All	Gill net	2006	3.27	0.51	
			2007	4.59	0.33	
			2008	1.82	0.77	
Bigmouth buffalo	Juvenile	Mini fyke	2006	3.11	0.54	
			2007	2.05	0.73	
			2008	0.83	0.93	

Smallmouth buffalo	All	GN	2006	2.56	0.63	
			2007	7.05	0.13	
			2008	**10.92**	**0.03**	NS
Smallmouth buffalo	Juvenile	Push trawl	2006			
			2007	4.86	0.30	
			2008	6.14	0.19	
River carpsucker	All	Gill net	2006	5.81	0.21	
			2007	1.66	0.80	
			2008	**10.45**	**0.03**	California, Tyson Island > Tieville
River carpsucker	Juvenile	Mini fyke	2006	**19.45**	**<0.01**	Tyson Island > Decatur, Tieville
			2007	**10.21**	**0.04**	NS
			2008	**19.38**	**<0.01**	Tyson Island > Decatur, Tieville
Gizzard shad	All	Gill net	2006	5.33	0.25	
			2007	**8.16**	**0.09**	NS
			2008	4.63	0.33	
Gizzard shad	Juvenile	Mini fyke	2006	3.41	0.49	
			2007	3.84	0.43	
			2008	4.12	0.39	
Goldeye	All	Gill net	2006	6.86	0.14	
			2007	**11.20**	**0.02**	Tyson Island > Tieville
			2008	14.88	**<0.01**	Tyson Island > Tieville
Silver chub	All	Mini fyke	2006	7.38	0.12	
			2007	**22.20**	**<0.01**	Tyson Island > Decatur, Tieville, Louisville
			2008	**8.60**	**0.07**	NS
Minnow-shiner	All	Mini fyke	2006	**9.34**	**0.05**	Louisville > Tieville
			2007	**10.32**	**0.04**	Louisville > Decatur, Tieville
			2008	**3.14**	**0.54**	NS

Table III.1. 10. One tailed Mann-Whitney Rank Test of CPUE for select species at sites managed with water control structures (Tieville Bend, Decatur Bend, Louisville Bend) and sites with an open river connection (California Bend and Tyson Island) April-September, 2006-2008.

			Mean rank			
Species	**Life stage**	**Sampling gear**	**Open**	**Culverts**	**Z**	**p**
Channel catfish	All	Large fyke	49.5	28.2	4.35	**<0.01**
Channel catfish	Juvenile	Mini fyke	57.3	29.4	5.95	**<0.01**
Crappie	All	Large fyke	36.5	36.5	-0.01	0.99
Crappie	Juvenile	Mini fyke	44.5	34.8	1.95	**0.05**
Sauger	All	Large fyke	39.1	37.3	0.37	0.71
Sauger	Juvenile	Mini fyke	38.9	37.4	0.37	0.71
Largemouth bass	All	Electro-fishing	29.3	37.7	2.09	**0.04**
Largemouth bass	Juvenile	Mini fyke	30.5	38.4	1.90	**0.06**
Bighead carp	All	Gill net	35.8	27.9	1.90	**0.06**
Paddlefish	All	Gill net	31.7	27.3	1.19	0.24
Bigmouth buffalo	All	Gill net	24.4	32.9	1.91	**0.06**
Bigmouth buffalo	Juvenile	Mini fyke	40.9	36.3	1.12	0.26
Smallmouth buffalo	All	GN	31.2	27.6	0.94	0.35
Smallmouth buffalo	Juvenile	Push trawl	25.7	18.8	2.62	**<0.01**
River carpsucker	Adult	Gill net	33.9	27.3	1.45	0.15
River carpsucker	Juvenile	Mini fyke	57.3	26.5	6.37	**<0.01**
Gizzard shad	Adult	Gill net	38.9	25.3	3.23	**<0.01**
Gizzard shad	Juvenile	Mini fyke	41.5	35.9	1.18	0.24
Silver chub	All	Mini fyke	56.9	33.5	6.1	**<0.01**
Goldeye	All	Gill net	42.6	23.5	4.59	**<0.01**
Minnow-shiner	All	Mini fyke	42.6	35.3	1.40	0.16

Table III.1. 11. Spearman rank correlation of CPUE of select species and duration of connectivity (number of days of passive connection during the sampling period) at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2008.

Spearman rank correlation Duration of connectivity and CPUE				
Species	**Life stage**	**Sampling gear**	**r**	**p**
Channel catfish	All	Large fyke	0.47	**0.08**
Channel catfish	Juvenile	Mini fyke	0.84	**<0.01**
Crappie	All	Large fyke	0.21	0.43
Crappie	Juvenile	Mini fyke	0.56	**0.03**
Sauger	All	Large fyke	-0.19	0.50
Sauger	Juvenile	Mini fyke	-0.26	0.35
Largemouth bass	All	Electro-fishing	0.08	0.78
Largemouth bass	Juvenile	Mini fyke	0.08	0.78
Bighead carp	All	Gill net	0.36	0.18
Paddlefish	All	Gill net	0.42	0.16
Bigmouth buffalo	All	Gill net	-0.40	0.14
Bigmouth buffalo	Juvenile	Mini fyke	-0.13	0.64
Smallmouth buffalo	All	GN	0.40	0.14
Smallmouth buffalo	Juvenile	Push trawl	0.74	**0.02**
River carpsucker	Adult	Gill net	0.37	0.17
River carpsucker	Juvenile	Mini fyke	0.74	**<0.01**
Gizzard shad	Adult	Gill net	0.64	**0.01**
Gizzard shad	Juvenile	Mini fyke	0.60	**0.02**
Silver chub	All	Mini fyke	0.70	**<0.01**
Goldeye	All	Gill net	0.87	**<0.01**
Minnow-shiner	All	Mini fyke	0.51	**0.05**

Table III.1.12. Catch per unit effort (± 2 se) of channel catfish caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.1 (0.3)	0.0	0.0	0.0	--	0.0	0.0	0.0	0.1 (0.3)	0.3 (0.3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.4 (0.5)	0.2 (0.4)	0.0	3.1 (4.0)	0.2 (0.4)	0.0	0.0	0.8 (1.0)	0.0	0.5 (0.5)	0.6 (1.1)	0.0	0.8 (1.2)	0.0	0.0	0.6 (0.8)	0.0
Louisville	--	--	--	0.0	--	--	--	--	6.4 (3.5)	--	12.8 (8.5)	--	0.4 (0.4)	3.9 (4.7)	2.0 (1.4)	0.8 (1.0)	4.5 (3.7)	3.3 (3.6)
Tyson	--	9.3 (6.8)	5.5 (3.2)	0.7 (0.7)	2.0 (1.8)	0.2 (0.4)	0.8 (1.2)	0.6 (0.5)	0.9 (0.7)	0.0	--	--	0.5 (0.5)	1.3 (1.5)	--	0.3 (0.3)	--	--
California	2.0 (2.2)	3.3 (2.4)	10.4 (7.6)	0.3 (0.5)	2.1 (2.1)	0.2 (0.4)	0.5 (0.7)	0.4 (0.5)	--	0.2 (0.3)	0.1 (0.1)	--	1.1 (1.4)	0.6 (0.8)	--	1.9 (1.7)	2.0 (1.2)	--

Mini fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.1 (0.3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1 (0.3)	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	0.0	0.1 (0.3)	0.8 (1.0)	0.0	0.4 (0.5)	0.4 (0.5)	0.0	0.1 (0.3)	0.0
Tyson	--	16.0 (18.6)	0.6 (0.5)	0.1 (0.3)	1.1 (1.5)	0.6 (0.8)	0.1 (0.3)	0.5 (0.8)	0.0	0.0	--	--	0.9 (0.6)	0.5 (0.5)	0.4 (0.8)	0.1 (0.3)	--	--
California	2.9 (4.7)	1.4 (1.0)	0.6 (0.4)	0.9 (0.6)	0.3 (0.3)	0.2 (0.4)	0.1 (0.3)	0.3 (0.3)	--	0.0	0.1 (0.1)	--	0.0	1.3 (1.5)	0.5 (1.0)	0.3 (0.3)	0.9 (0.7)	--

Push trawl		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	1.9 (3.8)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	1.0 (2.0)	0.0	0.0	0.0	1.9 (2.4)	0.1 (0.3)	0.0	0.9 (1.3)	0.0
Louisville	--	--	--	0.0	0.0	--	4.5 (9.0)	--	0.0	--	0.0	--	0.0	1.6 (2.2)	0.0	0.0	0.0	0.0
Tyson	0.0	0.0	0.3 (0.3)	0.0	0.0	0.0	0.0	2.0 (4.1)	0.0	0.0	--	--	0.0	0.0	0.1 (0.3)	0.0	--	--
California	2.6 (3.5)	0.0	--	1.4 (2.8)	0.0	0.7 (0.6)	1.8 (3.6)	0.0	3.0 (6.0)	0.0	0.0	--	0.0	0.0	--	8.1 (12.2)	--	--

Electrofishing		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	--
Decatur	--	0.0	0.0	--	0.1 (0.2)	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	--	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	--	0.1 (0.3)	--	--	0.1 (0.3)	0.0	--	0.0	0.0	--	0.0	--
California	--	0.2 (0.3)	0.0	--	0.0	0.0	--	0.3 (0.3)	--	--	0.0	0.0	--	1.4 (2.2)	0.0	--	0.0	--

Gill net		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.2 (0.4)	--	--	0.0	0.0	0.0	0.0	0.0	--	0.3 (0.3)	0.0	--	0.3 (0.4)	0.0	0.0	0.2 (0.3)	0.0
Decatur	--	--	1.3 (0.4)		0.5 (0.5)	0.1 (0.2)	0.0	0.0	0.7 (0.6)	0.0	0.0	0.4 (0.7)	--	0.0	0.0	0.3 (0.4)	0.0	0.0
Louisville	--	--	--	--	2.0 (1.8)	--	0.1 (0.2)	--	0.4 (0.4)	--	0.6 (1.2)	--	--	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.4 (0.7)	0.1 (0.1)	--	0.1 (0.3)	0.2 (0.3)	0.0	0.0	--	0.1 (0.2)	--	0.0	--	0.5 (0.6)	0.0	0.0	--	--
California	--	0.0	0.2 (0.3)	--	0.0	0.1 (0.2)	0.1 (0.3)	0.0	0.3 (0.4)	0.0	0.2 (0.3)	0.6 (0.6)	--	0.2 (0.3)	--	0.0	0.0	--

Table III.1.13. Catch per unit effort (± 2 se) of black crappie caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	1.0 (0.8)	0.3 (0.3)	0.0	0.0	0.0	--	0.0	0.6 (0.5)	0.0	0.0	0.1 (0.3)	0.0	1.1 (1.1)	0.0	0.0	6.8 (7.9)	0.1 (0.3)	0.0
Decatur	1.0	9.6 (2.9)	4.2 (4.5)	9.5 (17.0)	2.6 (2.1)	4.8 (5.8)	5.0 (2.8)	10.1 (4.1)	2.5 (2.3)	24.0 (15.8)	17.1 (10.5)	1.1 (0.7)	18.8 (8.6)	6.6 (7.6)	2.3 (1.2)	7.8 (6.4)	2.6 (3.4)	1.2 (1.2)
Louisville	--	--	--	0.5 (1.0)	--	--	--	--	4.2 (3.7)	--	0.4 (0.5)	--	1.4 (1.3)	0.6 (0.6)	2.1 (1.8)	0.8 (0.6)	2.5 (2.6)	3.1 (2.3)
Tyson	--	0.4 (0.4)	0.3 (0.3)	0.3 (0.7)	1.6 (2.2)	1.4 (1.0)	0.2 (0.4)	0.8 (0.6)	5.0 (2.4)	1.2 (0.3)	--	--	0.4 (0.5)	3.5 (1.7)	--	1.8 (1.3)	--	--
California	1.0 (1.4)	1.0 (0.8)	0.3 (0.4)	1.8 (0.5)	0.0	0.8 (0.7)	0.8 (0.6)	0.4 (0.4)	--	1.2 (1.0)	1.8 (1.2)	--	1.0 (0.8)	2.6 (1.4)	--	1.1 (0.7)	1.2 (1.0)	0.0

Mini fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.1 (0.3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1 (0.3)	0.0	0.8 (0.8)	0.1 (0.3)	0.0	2.1 (1.9)	0.0	0.0
Decatur	3.0	1.1 (0.6)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3 (0.4)	0.8 (0.8)	0.5 (0.5)	3.3 (2.7)	0.2 (0.4)	2.3 (1.2)	2.3 (1.4)	0.0	2.4 (3.4)
Louisville	--	--	--	0.0	--	--	--	--	1.2 (1.2)	0.3 (0.7)	0.4 (0.5)	0.0	0.0	0.4 (0.5)	0.0	0.0	1.1 (1.2)	0.0
Tyson	--	0.0	0.0	0.0	0.3 (0.3)	0.0	0.0	0.1 (0.3)	1.0 (0.9)	0.1 (0.3)	--	--	0.0	2.0 (1.2)	0.8 (0.7)	0.0	--	--
California	0.1 (0.3)	0.0	0.1 (0.3)	0.0	0.4 (0.5)	0.0	0.0	0.0	--	0.0	1.0 (0.8)	--	0.0	0.6 (1.0)	0.8 (1.0)	0.0	1.7 (0.8)	--

Push trawl	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	--
Decatur	--	0.0	0.0	--	0.1 (0.1)	0.0	--	0.1 (0.2)	0.1 (0.3)	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0
Tyson	--	0.0	0.0	--	0.5 (1.1)	0.0	--	0.1 (0.3)	--	--	0.1 (0.3)	18.4 (14.7)	--	0.0	0.1 (0.3)	--	0.0	--
California	--	0.0	0.0	--	0.0	0.0	--	0.4 (0.5)	--	--	0.0	0.1 (0.3)	--	0.3 (0.6)	0.0	--	0.1 (0.3)	--

Electrofishing	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	1.1 (2.1)	0.0	0.0	2.3 (3.3)	0.0	0.8 (1.6)	1.4 (2.1)	0.0
Louisville	--	--	--	43.4 (86.8)	0.0	--	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.7 (1.4)	0.0
Tyson	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	--	2.5 (4.9)	0.0	0.0	1.8 (3.6)	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	--	0.0

Gill net	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Decatur	--	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.1 (0.2)	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	--	0.0	--	0.0	--	0.0	--	0.0	--	--	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.1 (0.3)	0.0	--	0.1 (0.1)	0.0	0.0	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	--	--
California	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--	0.0	0.0	--

Table III.1.14. Catch per unit effort (± 2 se) of white crappie caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.3 (0.5)	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0 (1.9)	0.0	0.0
Decatur	0.0	0.4 (0.4)	1.0 (1.1)	0.5 (1.0)	0.4 (0.5)	0.2 (0.4)	0.8 (1.6)	0.4 (0.5)	0.0	0.0	1.3 (2.0)	0.4 (0.6)	0.2 (0.3)	0.4 (0.8)	0.0	0.1 (0.3)	0.6 (0.8)	0.2 (0.4)
Louisville	--	--	--	0.5 (1.0)	--	--	--	--	0.6 (0.8)	--	0.1 (0.3)	--	0.5 (0.5)	0.0	0.0	0.5 (0.5)	0.1 (0.3)	0.4 (0.4)
Tyson	--	0.0	0.0	0.3 (0.7)	0.1 (0.3)	0.0	0.6 (0.5)	0.1 (0.3)	0.0	1.2 (1.5)	--	--	1.3 (0.5)	0.1 (0.3)	--	0.6 (0.5)	--	--
California	1.8 (1.5)	0.5 (0.5)	0.0	0.5 (1.0)	0.0	0.2 (0.4)	0.8 (1.3)	0.5 (0.5)	--	1.7 (1.0)	0.1 (0.1)	--	0.6 (0.5)	0.0	--	2.4 (1.7)	6.3 (2.3)	--

Mini fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	0.0	--	--	--	0.4 (0.6)	0.4 (0.5)	0.0	0.0	0.4 (0.5)	0.0	0.0	0.0	0.0
Decatur	0.0	1.4 (0.8)	0.0	0.0	0.0	0.0	--	--	--	0.8 (1.0)	2.6 (2.1)	1.0 (1.1)	0.0	0.0	0.0	1.3 (1.1)	0.0	0.0
Louisville	--	--	--	0.0	0.0	--	--	--	--	0.7 (1.3)	0.0	0.0	0.0	0.0	0.0	0.0	0.1 (0.3)	0.0
Tyson	--	0.0	0.0	0.0	0.1 (0.3)	0.0	--	--	--	1.3 (1.2)	--	--	0.1 (0.3)	2.3 (3.4)	0.4 (0.8)	0.6 (0.8)	--	--
California	0.1 (0.3)	0.0	0.1 (0.3)	0.3 (0.5)	0.6 (0.8)	0.2 (0.4)	--	--	--	0.0	2.9 (1.9)	--	0.4 (0.5)	4.5 (4.3)	1.3 (1.5)	0.1 (0.3)	7.3 (4.2)	--

Push trawl	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	
Decatur	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	--	0.0	--	--	0.1 (0.3)	1.4 (1.4)	--	0.0	0.1 (0.3)	--	0.0	--
California	--	0.0	0.3 (0.5)	--	0.0	0.0	--	0.0	--	--	0.0	0.1 (0.3)	--	1.0 (0.7)	0.0	--	0.9 (1.5)	--

Electrofishing	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7 (1.4)	0.7 (1.5)	1.3 (2.7)	0.0	0.0	0.0
Louisville	--	--	--	0.0	0.0	--	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	1.9 (3.8)	0.0	--	10.0 (20.1)	--	--

Gill net	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville		0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0
Decatur			0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Louisville					0.0		0.0		0.0		0.0			0.0	0.0	0.0	0.0	0.0
Tyson		0.0	0.0		0.0	0.0	0.0	0.0		0.0		0.0		0.0	0.0	0.1 (0.2)		
California		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.1 (0.2)	0.0	0.0		0.0		0.0	0.1 (0.2)	

Table III.1.15. Catch per unit effort (± 2 se) of sauger caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	2.8 (2.5)	0.3 (0.3)	0.0	0.5 (0.4)	0.0	--	0.2 (0.3)	0.3 (0.3)	0.0	0.0	0.1 (0.3)	0.0	0.3 (0.3)	0.8 (0.3)	0.0	0.3 (0.3)	1.8 (1.2)	0.4 (0.5)
Decatur	3.0	0.1 (0.3)	0.0	0.0	0.0	0.2 (0.4)	0.4 (0.5)	0.1 (0.3)	0.0	0.2 (0.4)	0.0	0.0	0.3 (0.4)	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	--	0.0	--	0.0	0.1 (0.3)	0.0	0.4 (0.5)	4.0 (1.4)	0.0
Tyson		0.0	0.1 (0.3)	0.0	0.1 (0.3)	0.2 (0.4)	0.4 (0.8)	0.1 (0.3)	0.0	0.2 (0.3)	--	--	0.1 (0.3)	0.0	--	0.1 (0.3)	--	--
California	0.0	0.0	0.3 (0.6)	0.5 (0.6)	0.5 (0.5)	0.0	0.0	0.3 (0.3)	--	0.0	0.0	--	0.0	0.3 (0.5)	--	0.4 (0.4)	0.2 (0.3)	--

Mini fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	0.0	7.2 (5.2)	0.3 (0.3)	0.0	2.9 (4.8)	0.1 (0.3)	0.1 (0.3)	0.7 (1.0)	0.5 (0.7)	0.0	2.9 (2.3)	0.8 (1.1)	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5 (0.4)	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1 (0.3)	0.1 (0.3)	--	--	0.1 (0.3)	0.0	0.0	0.4 (0.4)	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3 (0.8)	--	0.0	0.0	--	0.1 (0.3)	0.0	0.0	0.1 (0.3)	0.1 (0.3)	--

Push trawl		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	--	0.0	--	--	--
Decatur	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	--	0.1 (0.3)	--	--	0.0	0.0	--	0.0	0.0	--	0.0	--
California	--	0.0	0.0	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	--

Electrofishing		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	2.6 (3.9)	0.0	0.0	0.0	0.0	0.0	1.1 (2.2)	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	1.1 (2.1)	0.0	0.0	0.0	0.0	0.0	0.0	0.9 (1.9)	0.9 (1.9)	0.0
Louisville	--	--	--	0.0	0.0	--	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.8 (1.6)	0.0
Tyson	2.3 (4.7)	0.0	--	0.0	0.0	0.0	4.0 (7.9)	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	--	--
California	1.5 (3.1)	0.0	--	1.7 (3.4)	0.0	0.0	1.8 (3.6)	3.3 (6.7)	3.2 (6.4)	0.0	0.0	--	1.6 (3.2)	0.0	--	2.1 (4.2)	--	--

Gill net		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.1 (0.2)	0.0	0.0	0.0	0.0		0.0	0.0	--	0.0	0.0	0.0	0.2 (0.3)	0.0
Decatur	--	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.2 (0.3)	0.0	0.0	0.0
Louisville	--	--	--	--	0.0	--	0.0	--	0.0	--	0.0	--	--	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	--	0.1 (0.1)	0.0	0.0	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	--	--
California	--	0.0	0.1 (0.1)	--	0.0	0.1 (0.2)	0.0	0.0	0.1 (0.2)	0.0	0.0	0.0	--	0.0	--	0.0	0.0	--

Table III.1.16. Catch per unit effort (± 2 se) of largemouth bass caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	2.0	0.1 (0.3)	0.0	2.0	0.0	0.0	0.8 (1.6)	0.1 (0.3)	0.1 (0.3)	0.4 (0.5)	0.3 (0.5)	0.3 (0.4)	0.0	0.8 (0.7)	0.5 (0.8)	0.0	0.6 (0.8)	0.8 (1.6)
Louisville	--	--	--	0.0	--	--	--	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.1 (0.3)	0.0	0.0	0.0	0.0	0.0	0.1 (0.3)	0.0	--	--	0.0	0.1 (0.3)	--	0.3 (0.3)	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.3 (0.7)	0.0	--	0.0	0.0	--	0.1 (0.3)	0.0	--	0.0	0.2 (0.3)	--

Mini fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.6 (105.0)	0.0	0.0	2.4 (1.7)	6.4 (2.0)	0.0	2.8 (3.1)	1.3 (1.1)	0.0	0.0	0.2 (0.4)
Louisville	--	--	--	0.0	--	--	--	--	0.0	0.0	0.1 (0.3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.3 (0.5)	0.4 (0.4)	0.3 (0.4)	--	--	0.1 (0.3)	0.1 (0.3)	0.0	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.1 (0.3)	0.0	0.1 (0.3)	0.0	--

Push trawl		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	--
Decatur	--	0.0	0.0	--	0.1 (0.1)	0.0	--	0.5 (0.4)	0.0	--	0.1 (0.3)	0.1 (0.3)	--	0.6 (1.0)	0.6 (0.5)	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0
Tyson	--	0.0	0.0	--	0.1 (0.3)	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	--
California	--	0.0	0.0	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	--

Electrofishing		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	1.8 (3.7)	--	3.4 (5.2)	3.6 (7.2)	2.1 (2.6)	0.8 (1.7)	1.1 (2.1)	3.1 (4.1)	1.3 (2.7)	0.0	5.1 (3.3)	2.5 (3.5)	4.0 (5.4)	4.7 (4.8)	2.5 (3.1)	4.5 (6.3)
Louisville	--	--	--	0.0	0.0	--	0.0	--	1.3 (2.7)	--	0.0	--	0.0	0.0	3.1 (6.2)	0.0	0.0	0.8 (1.6)
Tyson	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	1.8 (3.5)	--	--
California	0.0	0.0	--	1.2 (2.5)	0.0	0.0	1.8 (3.6)	0.0	0.0	1.8 (3.6)	0.0	--	0.0	0.0	--	1.6 (3.1)	0.0	--

Gill net		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	--	--	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Decatur	--	--	0.4 (0.3)	--	0.0	0.0	0.0	0.2 (0.3)	0.1 (0.1)	0.1 (0.2)	0.1 (0.3)	0.0	--	0.1 (0.2)	0.0	0.2 (0.5)	0.0	0.2 (0.3)
Louisville	--	--	--	--	0.0	--	0.0	--	0.0	--	0.0	--	--	0.0	0.0	0.0	0.0	0.2 (0.3)
Tyson	--	0.0	0.0	--	0.0	0.0	0.0	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	--	--
California	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.1 (0.3)	0.0	0.0	0.0	--	0.0	--	0.0	0.0	--

Table III.1.17. Catch per unit effort (± 2 se) of bighead carp caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	--	0.0	--	0.0	0.0	0.4 (0.8)	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.4 (0.8)	0.0	0.0	0.1 (0.3)	0.0	--	--	0.0	0.1 (0.3)	--	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.7 (1.3)	--

Mini fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	0.0	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--

Push trawl	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	--
Decatur	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	--
California	--	0.0	0.0	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	--

Electrofishing	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9 (1.9)	0.0	0.0	0.0	0.0	0.5 (1.0)	0.0
Louisville	--	--	--	21.7 (43.4)	1.3 (2.5)	--	0.0	--	0.0	--	1.0 (1.9)	--	0.0	0.0	0.0	0.9 (1.8)	0.0	0.0
Tyson	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	--	0.0	0.0	0.0	0.0	2.4 (4.8)	0.0	0.0	0.0	--	0.0	0.0	--	0.0	--	--

Gill net	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	0.0	0.0	0.1 (0.2)	0.0	--	0.0	0.0	--	0.0	0.1 (0.2)	0.0	0.0	0.0
Decatur	--	--	0.1 (0.2)	--	0.0	0.0	0.0	0.0	0.2 (0.2)	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	--	2.9 (3.5)	--	0.3 (0.3)	--	0.5 (0.4)	--	0.1 (0.2)	--	--	1.0 (0.2)	0.0	0.1 (0.1)	0.1 (0.3)	0.3 (0.5)
Tyson	--	0.6 (0.4)	0.1 (0.1)	--	0.1 (0.2)	0.2 (0.3)	0.2 (0.4)	0.1 (0.2)	--	0.0	--	0.0	--	0.3 (0.6)	0.0	0.0	--	--
California	--	0.0	0.2 (0.2)	--	0.4 (0.3)	1.7 (1.6)	0.1 (0.2)	0.0	0.0	0.0	0.1 (0.2)	0.0	--	0.0	--	0.5 (0.6)	0.1 (0.2)	--

Table III.1.18. Catch per unit effort (± 2 se) of silver carp caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	--	0.0	--	0.0	0.0	0.1 (0.3)	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--

Mini fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	0.0	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--

Push trawl		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	--
Decatur	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	--
California	--	0.0	0.0	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	--

Electrofishing		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	0.0	--	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	--	--

Gill net		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Decatur	--	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	--	0.0	--	0.0	--	0.0	--	0.0	--	--	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	0.0	0.1 (0.2)	--	0.0	--	0.0	--	0.2 (0.4)	0.0	0.0	--	--
California	--	0.0	0.0	--	0.1 (0.2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--	0.0	0.0	--

Table III.1.19. Catch per unit effort (± 2 se) of paddlefish caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--

Mini fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--

Push trawl		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	--
Decatur	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	--
California	--	0.0	0.0	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	--

Electrofishing		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	--	0.9 (1.7)	0.0	1.5 (2.9)	0.0	0.0	0.0	0.9 (1.8)	0.0	0.0	0.0	0.0	0.7 (1.4)	0.0	0.0
Louisville	--	--	--	0.0	0.0	--	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	--	--

Gill net		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Decatur	--	--	0.0	--	0.1 (0.2)	0.1 (0.2)	0.6 (0.5)	0.6 (0.5)	0.3 (0.4)	0.1 (0.2)	0.0	0.4 (0.4)	--	0.0	0.0	0.0	0.1 (0.2)	0.0
Louisville	--	--	--	--	0.0	--	0.0	--	0.0	--	0.0	--	--	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.1 (0.1)	--	0.0	0.0	0.0	0.0	--	0.1 (0.2)	--	0.0	--	0.0	0.0	0.1 (0.2)	--	--
California	--	0.1 (0.2)	0.1 (0.1)	--	0.0	0.0	0.2 (0.2)	0.3 (0.4)	0.2 (0.3)	0.1 (0.2)	0.1 (0.2)	0.0	--	0.0	--	0.2 (0.3)	0.0	--

Table III.1.20. Catch per unit effort (± 2 se) of bigmouth buffalo caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	1.1	0.0	0.1	--	0.2	2.1	0.1	0.0	0.0	0.3	0.0	0.3	0.1	1.8	0.1	1.1
			(1.4)		(0.3)		(0.3)	(1.5)	(0.3)			(0.3)		(0.3)	(0.3)	(2.2)	(0.3)	(2.3)
Decatur	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.8	0.0	0.1	0.0	0.0	0.2	0.1	0.0	0.0	0.0
					(0.3)	(0.4)			(1.5)		(0.3)			(0.4)	(0.3)			
Louisville	--	--	--	0.0	0.0	--	--	--	0.4	--	0.3	--	0.0	0.0	0.3	0.0	0.1	0.5
									(0.5)		(0.5)				(0.3)		(0.3)	(0.5)
Tyson	--	0.0	1.4	0.0	0.0	0.0	0.2	0.0	0.1	0.0	--	--	0.0	0.4	--	0.0	--	--
			(2.5)				(0.4)		(0.3)					(0.5)				
California	0.0	0.1	0.7	0.0	0.1	0.0	0.0	0.0	--	0.0	0.3	--	0.0	0.0	--	0.0	0.5	--
		(0.3)	(1.1)		(0.3)						(0.3)						(1.0)	

Mini fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	0.0	0.0	883.5	0.0	0.0	1.3	5.3	0.0	0.0	1.6	0.6	0.0	0.0
								(401.5)			(1.9)	(5.2)			(1.7)	(0.5)		
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.9	0.0	0.0	4.7	1.9	0.0	0.0	0.0	0.0	0.0	0.0
								(53.2)			(3.3)	(3.2)						
Louisville	--	--	--	0.0	--	--	--	--	0.0	0.0	1.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
											(0.8)	(4.5)						
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.4	2.4	--	--	0.0	0.3	0.4	0.0	--	--
								(1.0)	(0.8)	(2.2)				(0.5)	(0.5)			
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.6	--	0.0	18.5	--	0.0	2.0	2.8	0.0	0.1	--
								(49.1)			(6.6)			(2.2)	(2.5)		(0.3)	

Push trawl	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	62.1	--	--	7.8	0.0	--	0.0	96.4	--	0.0	0.4	--	0.0	--
					(47.7)			(5.6)				(41.0)			(0.5)			
Decatur	--	0.0	0.0	--	0.0	0.0	--	1.0	0.0	--	0.0	0.8	--	0.0	0.0	--	0.0	0.0
								(1.1)				(2.0)						
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.6	--	--	0.0	0.1	--	0.0	0.0
											(1.1)				(0.3)			
Tyson	--	0.0	0.0	--	0.0	0.0	--	6.1	--	--	6.5	3.8	--	0.0	0.0	--	0.0	--
								(3.7)			(7.7)	(3.3)						
California	--	0.0	0.0	--	0.0	0.0	--	8.5	--	--	37.6	5.4	--	0.0	0.1	--	0.0	--
								(3.4)			(40.6)	(3.1)			(0.3)			

Electrofishing	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	14.2	7.2	--	0.0	16.6	--	16.8	13.5	20.7	0.0	60.9	9.9	0.0	3.3	0.0	0.0	2.2	4.3
	(13.5)	(8.0)			(16.8)		(15.5)	(10.0)	(13.7)		(66.6)	(12.4)		(4.3)			(4.5)	(5.6)
Decatur	2.6	1.1	32.3	--	10.9	3.2	14.1	6.9	8.2	0.0	19.8	7.5	4.9	5.7	5.2	4.7	8.8	4.1
	(5.2)	(2.2)	(40.1)		(13.5)	(6.4)	(19.1)	(9.7)	(6.1)		(25.2)	(13.0)	(4.5)	(7.2)	(7.9)	(5.7)	(10.8)	(5.9)
Louisville	--	--	--	65.1	11.0	--	0.0	--	11.9	--	3.5	--	3.7	0.0	1.7	5.8	2.9	3.4
				(130.1)	(10.0)				(10.0)		(3.5)		(3.9)		(3.4)	(5.0)	(3.8)	(3.1)
Tyson	0.0	0.0	--	0.0	5.1	3.4	1.4	2.7	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
					(10.1)	(6.9)	(2.8)	(5.4)										
California	1.8	0.0	--	3.2	2.3	0.0	0.0	2.1	0.0	0.0	6.1	--	0.0	0.0	--	2.0	0.0	--
	(3.6)			(4.1)	(4.5)			(4.2)			(6.0)					(4.0)		

Gill net	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.6	0.2	--	0.5	1.5	0.2	0.1	0.7	--	0.0	0.2	--	0.2	0.1	0.0	0.0	0.1
		(0.6)	(0.2)		(0.4)	(2.1)	(0.3)	(0.2)	(0.3)			(0.3)		(0.1)	(0.2)			(0.2)
Decatur	--	0.0	6.7	--	0.9	0.2	0.1	0.0	0.2	0.1	0.1	0.2	--	0.1	0.2	0.1	0.0	0.0
			(1.2)		(0.9)	(0.4)	(0.3)		(0.2)	(0.2)	(0.2)	(0.3)		(0.2)	(0.3)	(0.2)		
Louisville	--	--	--	--	0.2	--	0.0	--	0.2	--	0.0	--	--	0.0	0.1	0.0	0.3	0.3
					(0.4)				(0.2)						(0.2)		(0.5)	(0.3)
Tyson	--	0.5	0.0	--	0.6	0.3	0.1	0.3	--	0.0	--	0.0	--	0.0	0.0	0.0	--	--
		(0.6)			(0.1)	(0.4)	(0.2)	(0.4)										
California	--	0.1	0.2	--	0.0	0.5	0.1	0.0	0.0	0.0	0.1	0.0	--	0.0	--	0.0	0.0	--
		(0.2)	(0.3)			(0.5)	(0.2)				(0.2)							

Table III.1.21. Catch per unit effort (± 2 se) of smallmouth buffalo caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.1 (0.3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.2 (0.4)	--	0.0	--	0.0	0.0	0.5 (0.8)	0.0	1.9 (3.2)	1.1 (1.2)
Tyson	--	0.1 (0.3)	0.6 (0.4)	0.0	0.0	0.0	0.2 (0.4)	0.0	0.0	0.0	--	--	0.0	0.1 (0.3)	--	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.5 (0.4)	--

Mini fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1 (0.3)	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	0.0	0.0	1.3 (1.9)	0.0	0.0	0.0	0.0	0.1 (0.3)	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.1 (0.3)	4.0 (6.5)	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.3 (0.5)	6.0 (7.6)	0.0	0.1 (0.3)	--

Push trawl	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	0.1 (0.3)	--	0.0	--
Decatur	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	--	0.4 (0.8)	--	--	0.0	18.4 (8.8)	--	0.0	0.1 (0.3)	--	0.0	--
California	--	0.0	0.0	--	0.0	0.0	--	0.3 (0.3)	--	--	0.8 (0.8)	11.4 (6.5)	--	0.0	0.4 (0.8)	--	0.0	--

Electrofishing	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2 (4.4)	0.0
Decatur	2.6 (5.2)	0.0	0.0	--	0.8 (1.6)	0.0	0.0	0.0	0.0	0.0	3.8 (7.5)	0.0	0.0	1.4 (2.7)	0.0	1.6 (3.1)	0.6 (1.2)	0.0
Louisville	--	--	--	0.0	0.0	--	0.0	--	1.5 (3.1)	--	0.0	--	0.0	0.0	0.0	0.0	3.0 (2.7)	0.6 (1.2)
Tyson	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	3.8 (5.0)	--	--

Gill net	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Decatur	--	--	0.1 (0.2)	--	1.3 (1.5)	0.0	0.0	0.8 (1.3)	0.0	0.0	0.0	0.0	--	0.0	0.0	0.1 (0.2)	0.0	0.2 (0.3)
Louisville	--	--	--	--	0.1 (0.2)	--	0.0	--	0.8 (1.2)	--	0.0	--	--	0.0	0.3 (0.5)	0.0	0.0	0.5 (1.1)
Tyson	--	0.2 (0.3)	0.0	--	0.3 (0.1)	0.0	0.3 (0.4)	0.0	--	0.0	--	0.5 (1.0)	--	0.5 (0.6)	0.2 (0.3)	0.0	--	--
California	--	0.1 (0.2)	0.0	--	0.1 (0.3)	0.1 (0.2)	0.0	0.2 (0.3)	0.0	0.0	0.0	0.5 (1.0)	--	0.0	--	0.0	0.0	--

Table III.1.22. Catch per unit effort (± 2 se) of river carpsucker caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.1	--	0.0	2.3	0.0	0.5	0.3	0.0	0.1	0.6	0.0	0.0	0.3	0.0
					(0.3)			(1.4)		(0.4)	(0.5)		(0.3)	(1.0)			(0.5)	
Decatur	0.0	0.1	0.8	0.0	1.4	0.2	0.2	0.6	0.6	0.0	0.5	1.4	0.5	2.8	0.0	0.5	0.8	0.2
		(0.3)	(1.2)		(1.8)	(0.4)	(0.4)	(0.6)	(0.6)		(0.5)	(2.5)	(0.7)	(5.6)		(0.8)	(1.2)	(0.4)
Louisville	--	--	--	0.5	--	--	--	--	4.0	--	2.5	--	0.6	1.1	12.3	0.1	5.6	7.3
				(1.0)					(2.4)		(1.6)		(0.8)	(1.5)	(16.8)	(0.3)	(5.8)	(4.2)
Tyson	--	26.8	7.5	1.0	6.6	13.2	4.8	7.9	6.5	1.5	0.0	--	0.4	5.9	--	0.3	--	--
		(15.3)	(2.3)	(2.0)	(3.6)	(4.5)	(3.3)	(2.9)	(3.2)	(1.7)			(0.5)	(3.3)		(0.3)		
California	2.8	9.4	15.0	2.8	24.0	6.8	3.3	9.5	--	0.3	1.7	--	1.8	2.6	--	0.5	7.7	--
	(1.9)	(4.2)	(12.1)	(2.5)	(14.0)	(3.7)	(2.9)	(6.3)		(0.4)	(0.8)		(3.0)	(1.6)		(0.5)	(6.0)	

Mini fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	1.3	0.0	0.0	0.1	0.0	0.0	0.0	0.0
								(0.3)			(2.2)			(0.3)				
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
								(0.3)			(2.7)							
Louisville	--	--	--	0.0	--	--	--	--	0.6	0.0	6.6	0.3	0.1	0.0	0.1	0.0	0.0	0.0
									(1.2)		(3.3)	(0.5)	(0.3)		(0.3)			
Tyson	--	6.3	0.8	0.1	0.3	1.2	0.6	0.0	1.3	1.9	--	--	1.0	93.0	17.2	0.3	--	--
		(2.8)	(0.6)	(0.3)	(0.3)	(1.0)	(0.6)		(1.5)	(2.4)			(0.8)	(40.6)	(25.0)	(0.3)		
California	0.4	0.1	0.6	0.5	1.3	0.2	0.0	5.3	--	4.0	30.4	--	0.6	31.6	111.3	0.8	1.7	--
	(0.8)	(0.3)	(0.5)	(0.8)	(1.3)	(0.4)		(6.3)		(4.5)	(25.1)		(1.0)	(26.2)	(81.9)	(0.7)	(0.8)	

Push trawl	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0		--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	--
Decatur	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.4	--	--	0.0	0.0	--	0.0	0.0
											(0.5)							
Tyson	--	0.0	0.4	--	0.1	0.3	--	7.7	--	--	11.6	7.4	--	0.5	2.9	--	2.1	--
			(0.5)		(0.2)	(0.5)		(8.3)			(9.4)	(5.5)		(0.4)	(2.4)		(1.0)	
California	--	0.0	0.0	--	0.0	0.0	--	39.7	--	--	26.4	10.3	--	1.5	4.9	--	0.1	--
								(34.0)			(22.2)	(8.7)		(1.2)	(3.3)		(0.3)	

Electrofishing	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0		0.9	3.2		0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				(1.9)	(6.5)						(3.6)							
Decatur	0.0	0.0	0.0		0.9	3.9	2.0	2.1	0.0	2.0	0.0	0.0	0.8	0.0	0.0	1.1	2.0	0.0
					(1.9)	(4.9)	(4.0)	(2.8)		(4.1)			(1.6)			(2.1)	(3.1)	
Louisville				21.7	11.0		6.8		4.8		0.0		1.8	5.6	8.1	4.0	3.0	0.0
				(43.4)	(4.3)		(7.8)		(4.7)				(2.3)	(5.0)	(8.4)	(5.2)	(3.1)	
Tyson	3.9	2.1		1.4	27.4	31.3	8.0	11.3	3.7	0.0			1.1	5.0		2.1		
	(5.2)	(4.2)		(2.8)	(50.1)	(41.4)	(8.5)	(12.1)	(7.4)				(2.2)	(6.5)		(4.2)		
California	27.1	2.7		6.9	4.5	14.0	23.2	9.7	3.0	0.0	30.1		27.4	3.1		9.7		
	(20.6)	(5.4)		(7.7)	(9.0)	(11.1)	(31.8)	(10.1)	(6.0)		(17.2)		(20.2)	(6.2)		(8.4)		

Gill net	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.9	--	--	0.9	--	0.0	0.5	0.0	--	0.2	0.0	--	1.8	0.0	0.2	0.8	0.0
		(0.3)			(0.6)			(0.7)			(0.2)			(2.5)		(0.3)	(0.6)	
Decatur	--	--	1.3	--	1.9	0.8	2.4	0.8	2.1	1.5	0.5	1.7	--	1.3	0.5	2.0	0.1	0.5
					(1.5)	(0.7)	(0.5)	(0.6)	(1.9)	(1.4)	(0.6)	(1.3)		(1.4)	(0.6)	(1.3)	(0.2)	(0.3)
Louisville	--	--	--	--	4.2	--	1.4	--	2.3	--	1.3	--	--	0.1	0.2	0.4	0.0	1.3
					(2.6)		(2.3)		(1.4)		(1.1)			(0.2)	(0.2)	(0.1)		(1.3)
Tyson	--	0.9	1.2	--	0.7	3.9	2.2	0.8	--	0.8	--	1.1	--	0.4	2.0	0.0	--	--
		(0.5)	(0.3)		(0.9)	(2.0)	(1.3)	(0.7)		(0.8)		(1.5)		(0.8)	(1.0)			
California	--	1.5	1.1	--	2.6	3.6	1.3	0.6	3.0	3.9	0.3	0.7	--	0.5	--	0.6	0.2	--
		(1.0)	(0.6)		(1.0)	(3.1)	(0.6)	(0.5)	(1.5)	(2.4)	(0.2)	(0.8)		(0.6)		(0.7)	(0.4)	

Table III.1.23. Catch per unit effort (± 2 se) of quillback caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3 (0.3)	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.5 (0.5)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.1 (0.3)	--	0.0	--	--
California	0.5 (0.6)	0.4 (0.4)	0.0	0.3 (0.5)	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.1 (0.3)	0.0	--

Mini fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	0.0	0.1 (0.3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.6 (0.6)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.1 (0.3)	0.0	0.0	0.3 (0.3)	--	--
California	0.0	0.0	0.0	0.0	0.1 (0.3)	0.0	0.0	0.0	--	0.0	0.0	--	0.1 (0.3)	0.0	0.0	0.1 (0.3)	0.0	--

Push trawl		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	--
Decatur	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	--
California	--	0.0	0.0	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	--

Electrofishing		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1 (4.2)	0.0
Decatur	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	0.0	--	1.6 (3.2)	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	6.2 (8.1)	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	2.3 (3.1)	2.5 (4.9)	--	0.0	--	--
California	3.1 (6.1)	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	8.8 (8.6)	--	0.0	--	--

Gill net		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.1 (0.2)	0.0	0.2 (0.2)	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Decatur	--	--	0.0	--	0.0	0.8 (0.7)	0.8 (0.4)	0.0	0.2 (0.3)	0.1 (0.2)	0.0	0.0	--	0.4 (0.5)	0.0	0.2 (0.3)	0.1 (0.2)	0.8 (1.2)
Louisville	--	--	--	--	0.0	--	0.1 (0.2)	--	0.0	--	0.1 (0.2)	--	--	0.0	0.0	0.0	0.1 (0.2)	0.1 (0.3)
Tyson	--	0.0	0.0	--	0.0	0.0	0.1 (0.2)	0.2 (0.2)	--	0.0	--	0.0	--	0.0	0.0	0.0	--	--
California	--	0.0	0.0	--	0.1 (0.2)	0.0	0.1 (0.2)	0.0	0.0	0.0	0.0	0.0	--	0.0	--	0.0	0.0	--

Table III.1.24. Catch per unit effort (± 2 se) of fathead minnow caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--

Mini fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.5 (1.0)	4.5 (5.6)	0.9 (1.7)	0.0	4.3 (6.4)	0.7 (0.7)	0.0	25.1 (25.4)	0.0	0.9 (1.0)	6.3 (3.4)	0.0	0.0	24.3 (14.7)	0.1 (0.3)	0.0	30.3 (32.3)
Decatur	0.0	0.3 (0.4)	0.6 (0.5)	0.0	0.0	0.8 (1.2)	0.0	0.0	0.6 (0.6)	0.0	0.0	1.4 (2.0)	0.0	0.0	9.4 (18.2)	0.0	0.0	0.0
Louisville	--	--	--	33.0 (18.9)	--	--	--	--	2.4 (2.6)	54.3 (64.7)	39.9 (36.1)	18.9 (16.7)	18.4 (34.2)	180.6 (359.3)	8.9 (14.4)	13.4 (22.2)	60.9 (105.4)	18.9 (23.0)
Tyson	--	0.6 (0.6)	0.9 (0.8)	0.0	0.0	0.4 (0.8)	0.3 (0.4)	0.1 (0.3)	3.1 (3.3)	0.0	--	--	0.0	1.6 (1.4)	20.8 (13.6)	0.4 (0.5)	--	--
California	0.3 (0.5)	0.0	1.6 (1.0)	0.0	0.0	0.2 (0.4)	0.0	0.4 (0.4)	--	0.0	0.9 (0.5)	--	0.0	2.6 (3.2)	136.0 (202.5)	0.0	0.1 (0.3)	--

Push trawl	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	0.0	5.5 (4.1)	--	0.0	78.5 (55.8)	--	0.0	30.8 (21.2)	--	0.0	--
Decatur	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.3 (1.5)	--	0.0	0.0	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.1 (0.3)	--	226.9 (244.7)	--	--	4.9 (7.8)	17.3 (19.7)	--	0.4 (0.5)	4.6 (4.9)
Tyson	--	0.0	0.1 (0.3)	--	0.0	0.1 (0.3)	--	0.0	--	--	0.0	10.3 (12.2)	--	0.0	0.9 (1.0)	--	0.6 (0.8)	--
California	--	0.0	0.3 (0.3)	--	0.0	0.0	--	0.6 (1.3)	--	--	2.1 (2.2)	3.4 (2.9)	--	0.7 (0.9)	2.6 (2.2)	--	0.0	--

Electrofishing	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.6 (47.1)	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	6.9 (13.8)	1.1 (2.2)	--	0.0	--	1.7 (3.3)	--	10.2 (14.7)	--	0.0	5.8 (4.8)	0.0	1.1 (2.2)	0.0	0.0
Tyson	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	4.8 (6.3)	--	0.0	--	--
California	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7 (5.4)	--	0.0	0.0	--	0.0	--	--

Gill net	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Decatur	--	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	--	0.0	--	0.0	--	0.0	--	0.0	--	--	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	0.0	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	--	--
California	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--	0.0	0.0	--

Table III.1.25. Catch per unit effort (± 2 se) of emerald shiner caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--

Mini fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.1 (0.3)	0.0	0.7 (0.7)	0.0	0.0	0.0	0.1 (0.3)	0.0	0.0	0.0	0.0	0.0	1.8 (3.5)	0.0	0.4 (0.5)	3.8 (4.0)	0.0
Decatur	0.0	0.0	0.0	0.0	0.3 (0.5)	0.0	1.0	0.0	0.0	0.0	0.5 (0.5)	0.0	0.1 (0.3)	0.0	22.4 (31.5)	2.1 (4.3)	0.2 (0.4)	0.0
Louisville	--	--	--	0.5 (0.6)	--	--	--	--	0.0	0.0	0.0	1.5 (1.9)	0.0	0.0	0.0	0.0	0.1 (0.3)	0.0
Tyson	--	12.0 (19.0)	15.1 (26.9)	1.1 (2.0)	1.8 (2.4)	3.5 (4.0)	0.0	0.6 (0.8)	0.6 (0.8)	0.6 (1.1)	--	--	26.5 (31.1)	2.0 (1.7)	2.8 (1.9)	245.8 (346.2)	--	--
California	1.8 (1.8)	3.4 (2.9)	5.4 (3.3)	5.4 (5.0)	0.5 (1.0)	1.8 (1.0)	0.0	0.5 (0.5)	--	1.3 (2.3)	0.0	--	14.9 (21.2)	0.6 (1.3)	3.5 (4.5)	56.4 (60.9)	23.3 (28.4)	--

Push trawl	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.1 (0.1)	--	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	--
Decatur	--	0.0	0.1 (0.3)	--	0.1 (0.1)	0.0	--	0.3 (0.5)	0.0	--	0.1 (0.3)	0.3 (0.3)	--	0.0	1.1 (1.2)	--	0.1 (0.3)	0.1 (0.3)
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.5 (0.8)	--	--	0.0	0.4 (0.5)	--	0.0	0.0
Tyson	--	10.8 (14.4)	2.6 (1.7)	--	0.1 (0.3)	0.9 (0.5)	--	0.1 (0.3)	--	--	0.4 (0.4)	27.6 (24.4)	--	9.2 (6.8)	1.9 (2.0)	--	11.1 (8.6)	--
California	--	28.1 (27.5)	5.4 (3.3)	--	2.2 (1.7)	6.3 (4.1)	--	0.1 (0.3)	--	--	1.4 (1.2)	133.3 (235.5)	--	163.3 (181.4)	32.3 (23.7)	--	12.0 (5.7)	--

Electrofishing	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	1.1 (2.2)	0.0	0.0	1.7 (3.4)	1.8 (3.6)	0.0	0.0	1.9 (3.8)	0.0	0.0	0.0	0.0
Decatur	0.0	2.3 (4.6)	0.0	--	6.7 (8.5)	0.0	2.0 (3.9)	1.0 (2.0)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	5.8 (10.0)	--	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	47.4 (46.8)	38.0 (41.9)	--	18.4 (14.0)	142.4 (260.1)	0.0	0.0	0.0	7.9 (15.8)	0.0	--	--	0.0	19.5 (14.7)	--	23.4 (18.7)	--	--
California	54.9 (25.2)	2.1 (4.2)	--	38.5 (25.5)	2.3 (4.5)	45.4 (51.7)	0.0	2.9 (5.7)	0.0	4.8 (9.6)	0.0	--	0.0	12.5 (25.0)	--	28.9 (23.5)	--	--

Gill net	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Decatur	--	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	--	0.0	--	0.0	--	0.0	--	0.0	--	--	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	0.0	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	--	--
California	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--	0.0	0.0	--

Table III.1.26. Catch per unit effort (± 2 se) of river shiner caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--

Mini fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	3.3 (5.9)	0.3 (0.3)	1.4 (1.6)	3.0 (5.4)	0.0	0.2 (0.3)	1.9 (1.9)	0.1 (0.3)	0.1 (0.3)	0.0	0.0	0.0	0.1 (0.3)	0.0	0.4 (0.5)	0.0	0.0
Decatur	0.0	1.3 (1.2)	14.4 (26.4)	1.0 (1.2)	1.9 (3.2)	0.0	0.0	0.5 (0.5)	0.5 (0.5)	6.2 (8.8)	1.6 (0.8)	0.0	26.0 (23.8)	41.3 (40.0)	2.8 (2.8)	100.6 (116.6)	2.2 (2.2)	15.4 (18.1)
Louisville	--	--	--	0.0	--	--	--	--	0.0	0.0	0.3 (0.5)	0.0	0.0	80.3 (159.9)	0.0	0.0	3.5 (7.0)	0.0
Tyson	--	2.8 (3.8)	15.1 (26.9)	0.4 (0.4)	0.4 (0.5)	2.0 (3.1)	8.3 (11.4)	14.6 (16.4)	0.5 (0.5)	0.0	--	--	13.5 (22.0)	14.4 (10.4)	11.2 (8.1)	9.8 (8.9)	--	--
California	0.0	0.5 (0.5)	16.9 (24.7)	0.1 (0.3)	0.4 (0.5)	2.6 (2.9)	0.3 (0.5)	15.0 (14.0)	--	0.2 (0.3)	1.3 (0.7)	--	1.5 (2.7)	0.9 (1.3)	0.3 (0.5)	5.5 (5.2)	1.0 (0.9)	--

Push trawl		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.1 (0.2)	0.0	--	0.0	--	--	0.1 (0.2)	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	--
Decatur	--	0.0	0.1 (0.3)	--	0.0	0.0	--	0.0	0.0	--	0.1 (0.3)	0.0	--	1.1 (1.6)	0.0	--	0.3 (0.5)	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	37.5 (38.5)	--	--	1.6 (2.7)	0.3 (0.3)	--	0.6 (1.3)	0.0
Tyson	--	0.1 (0.2)	0.1 (0.3)	--	7.7 (8.1)	0.0	--	1.8 (0.8)	--	--	0.8 (1.2)	0.4 (0.5)	--	2.8 (2.0)	0.0	--	6.9 (2.7)	--
California	--	37.0 (68.1)	0.9 (1.0)	--	5.2 (5.3)	0.4 (0.6)	--	4.2 (1.5)	--	--	3.5 (3.3)	0.0	--	4.7 (2.6)	17.6 (33.0)	--	0.8 (0.7)	--

Electrofishing		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	0.0	6.3 (12.6)	0.0	0.0	5.9 (7.7)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	2.3 (4.6)	0.0	--	1.7 (3.4)	0.0	0.0	0.8 (1.5)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6 (1.2)	0.0
Louisville	--	--	--	0.0	0.0	--	0.0	--	0.0	--	23.8 (47.6)	--	0.0	4.7 (7.5)	0.0	0.0	0.8 (1.6)	0.0
Tyson	0.0	0.0	--	0.0	5.1 (10.1)	0.0	0.0	2.7 (5.4)	0.0	0.0	--	--	0.0	56.7 (83.0)	--	0.0	--	--
California	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3 (10.9)	--	2.2 (4.5)	3.3 (6.7)	--	0.0	--	--

Gill net		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Decatur	--	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	--	0.0	--	0.0	--	0.0	--	0.0	--	--	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	0.0	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	--	--
California	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--	0.0	0.0	--

Table III.1.27. Catch per unit effort (± 2 se) of red shiner caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--

Mini fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.3 (0.5)	0.0	0.3 (0.6)	0.0	0.0	1.5 (2.6)	0.0	0.0	0.0	0.0	0.1 (0.3)	0.0	0.0	0.0	0.0	0.0	0.1 (0.3)
Decatur	0.0	0.1 (0.3)	0.2 (0.4)	14.0 (6.4)	0.1 (0.3)	0.0	0.0	4.9 (7.0)	13.1 (14.5)	2.2 (2.5)	1.4 (0.8)	0.4 (0.4)	0.5 (0.8)	1.0 (1.4)	1.0 (1.1)	0.0	0.0	0.0
Louisville	--	--	--	0.3 (0.5)	--	--	--	--	3.4 (3.6)	0.3 (0.7)	0.3 (0.3)	0.0	0.0	11.3 (22.5)	0.0	0.0	0.0	0.4 (0.5)
Tyson	--	0.0	0.9 (1.3)	0.1 (0.3)	0.0	4.8 (4.5)	7.6 (7.3)	12.4 (7.1)	1.4 (1.2)	2.6 (3.4)	--	--	0.1 (0.3)	0.9 (1.3)	0.4 (0.5)	0.6 (0.6)	--	--
California	0.0	0.0	1.8 (0.9)	0.1 (0.3)	0.8 (1.5)	9.0 (4.1)	0.5 (0.5)	15.3 (14.2)	--	2.7 (3.2)	0.1 (0.1)	--	0.1 (0.3)	0.1 (0.3)	1.0 (2.0)	0.1 (0.3)	0.0	--

Push trawl	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	--
Decatur	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.1 (0.3)	--	0.0	0.1 (0.3)	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.4 (0.5)	--	1.3 (1.8)	--	--	0.0	0.1 (0.3)	--	0.1 (0.3)	0.0
Tyson	--	0.0	0.0	--	1.3 (1.2)	0.1 (0.3)	--	0.1 (0.3)	--	--	0.0	0.0	--	0.0	0.4 (0.5)	--	0.0	--
California	--	0.3 (0.7)	0.1 (0.3)	--	0.4 (0.9)	0.1 (0.3)	--	0.8 (0.8)	--	--	0.1 (0.3)	0.3 (0.5)	--	0.3 (0.3)	19.6 (27.9)	--	0.0	--

Electrofishing	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	0.0	8.2 (16.4)	0.0	0.0	3.3 (4.4)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	--	0.8 (1.7)	0.0	0.0	0.0	0.0	0.0	1.2 (2.3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	4.4 (8.8)	--	0.0	--	1.1 (2.2)	--	0.0	--	0.0	1.0 (1.9)	0.0	0.0	0.0	0.0
Tyson	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	3.3 (4.3)	0.0	--	0.0	0.0	0.0	0.0	0.0	3.7 (7.4)	0.0	0.0	--	0.0	0.0	--	0.0	--	--

Gill net	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Decatur	--	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	--	0.0	--	0.0	--	0.0	--	0.0	--	--	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	0.0	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	--	--
California	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--	0.0	0.0	--

Table III.1.28. Catch per unit effort (± 2 se) of spotfin shiner caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--

Mini fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.1 (0.3)	0.0	0.0	0.0	0.8 (1.5)	0.5 (0.8)	0.0	2.5 (3.4)	0.1 (0.3)	0.1 (0.3)	1.5 (2.3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.1 (0.3)	0.0	0.0	0.6 (1.3)	0.4 (0.5)	0.0	3.3 (3.1)	1.0 (1.5)	0.8 (1.1)	0.3 (0.5)	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.4 (0.8)	0.0	0.0	0.0	0.0	2.8 (5.5)	0.0	0.0	0.4 (0.8)	0.0
Tyson	--	0.5 (0.7)	0.6 (0.8)	0.0	0.1 (0.3)	0.8 (0.7)	0.0	6.5 (5.5)	0.4 (0.5)	0.0	--	--	0.8 (0.6)	0.0	0.0	1.3 (1.2)	--	--
California	0.4 (0.8)	0.8 (1.0)	0.4 (0.5)	0.0	0.0	0.6 (0.5)	0.0	0.9 (1.0)	--	0.0	0.3 (0.2)	--	0.6 (1.0)	0.0	0.0	0.8 (0.8)	0.0	--

Push trawl		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.1 (0.2)	--	--	0.0	0.0	--	0.3 (0.5)	0.0	--	0.0	0.0	--	0.0	--
Decatur	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	1.1 (1.8)	--	--	0.0	0.0	--	0.0	0.0
Tyson	--	0.0	0.1 (0.3)	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	--
California	--	0.7 (1.2)	0.0	--	0.5 (0.7)	0.0	--	0.6 (1.0)	--	--	0.0	0.0	--	0.4 (0.8)	0.0	--	0.0	--

Electrofishing		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	0.0	4.9 (6.8)	0.0	0.0	12.7 (13.5)	2.9 (5.8)	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	--	1.7 (3.4)	0.0	0.0	4.4 (4.5)	0.0	0.0	3.2 (4.8)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	1.5 (2.9)	--	0.0	--	1.3 (2.7)	--	1.4 (2.8)	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	3.7 (7.4)	0.0	0.0	--	0.0	0.0	--	0.0	--	--

Gill net		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Decatur	--	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	--	0.0	--	0.0	--	0.0	--	0.0	--	--	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	0.0	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	--	--
California	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--	0.0	0.0	--

Table III.1.29. Catch per unit effort (± 2 se) of sand shiner caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--

Mini fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.3 (0.5)	0.0	0.0	1.6 (1.8)	0.0	0.3 (0.4)	2.8 (3.0)	0.0	0.0	1.4 (1.4)	0.0	0.0	0.1 (0.3)	0.0	0.4 (0.8)	0.0	0.0
Decatur	0.0	0.3 (0.4)	0.0	0.0	0.0	0.0	0.0	0.8 (0.7)	0.9 (1.2)	0.0	1.0 (0.8)	0.4 (0.5)	0.0	0.3 (0.5)	0.9 (0.7)	38.1 (34.2)	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	0.0	1.8 (2.4)	0.3 (0.5)	0.3 (0.5)	93.8 (187.5)	0.0	0.0	1.6 (2.2)	0.0
Tyson	--	2.1 (2.6)	0.8 (1.0)	0.1 (0.3)	0.5 (1.0)	1.8 (1.3)	0.1 (0.3)	5.4 (6.5)	0.1 (0.3)	0.0	--	--	2.0 (1.3)	10.3 (8.0)	7.0 (8.7)	0.9 (1.5)	--	--
California	0.0	9.4 (9.5)	2.4 (2.6)	0.3 (0.3)	0.4 (0.4)	1.2 (1.5)	0.0	2.3 (2.8)	--	0.0	2.1 (1.9)	--	0.0	1.0 (1.7)	1.0 (1.2)	5.9 (6.2)	0.0	--

Push trawl	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	0.2 (0.5)	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	--
Decatur	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.1 (0.3)	--	0.0	0.1 (0.3)	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	15.6 (19.1)	--	--	1.0 (1.8)	0.5 (0.8)	--	0.0	0.1 (0.3)
Tyson	--	0.1 (0.2)	0.0	--	6.6 (8.3)	0.4 (0.5)	--	0.1 (0.3)	--	--	0.0	0.1 (0.3)	--	0.4 (0.5)	0.5 (0.5)	--	0.5 (0.5)	--
California	--	18.8 (34.9)	0.1 (0.3)	--	3.9 (3.4)	0.3 (0.4)	--	0.4 (0.5)	--	--	0.9 (1.3)	7.5 (12.7)	--	1.1 (1.2)	4.4 (3.4)	--	0.1 (0.3)	--

Electrofishing	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	0.0	--	0.0	--	0.0	--	1.3 (2.5)	--	0.0	6.5 (7.7)	0.0	0.0	0.0	0.0
Tyson	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	24.6 (16.3)	--	0.0	--	--
California	18.5 (30.0)	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	2.8 (5.7)	--	0.0	--	--

Gill net	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Decatur	--	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	--	0.0	--	0.0	--	0.0	--	0.0	--	--	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	0.0	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	--	--
California	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--	0.0	0.0	--

Table III.1.30. Catch per unit effort (± 2 se) of silver chub caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--

Mini fyke		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1 (0.3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	1.3 (1.4)	0.8 (1.0)	0.0	1.0 (1.2)	0.0	0.0	0.3 (0.3)	0.0	0.0	--	--	2.0 (1.7)	2.1 (3.0)	4.4 (7.4)	1.1 (1.8)	--	--
California	0.0	0.1 (0.3)	0.0	0.0	0.9 (1.0)	0.0	0.0	0.4 (0.4)	--	0.0	2.6 (0.8)	--	3.6 (3.8)	6.4 (5.3)	29.0 (26.4)	0.6 (0.8)	0.0	--

Push trawl		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	--
Decatur	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0
Tyson	--	0.1 (0.2)	0.3 (0.5)	--	0.0	0.0	--	0.0	--	--	0.3 (0.3)	0.4 (0.5)	--	0.0	5.5 (4.0)	--	0.4 (0.5)	--
California	--	0.7 (0.7)	0.1 (0.3)	--	0.4 (0.5)	0.1 (0.3)	--	0.1 (0.3)	--	--	0.0	4.3 (5.5)	--	0.6 (0.8)	8.1 (3.5)	--	0.0	--

Electrofishing		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	0.0	--	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	0.0	0.0	--	0.0	5.1 (10.1)	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	3.0 (6.0)	--	--
California	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	--	--

Gill net		April			May			June			July			August			September	
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Decatur	--	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	--	0.0	--	0.0	--	0.0	--	0.0	--	--	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	0.0	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	--	--
California	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--	0.0	0.0	--

Table III.1.31. Catch per unit effort (± 2 se) of speckled chub caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--

Mini fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1 (0.3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	0.0	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--

Push trawl	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	--
Decatur	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.9 (1.8)	--	0.4 (0.5)	--
California	--	0.0	0.0	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.3 (0.6)	0.6 (0.8)	--	0.8 (0.6)	--

Electrofishing	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	0.0	--	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	--	--

Gill net	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Decatur	--	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	--	0.0	--	0.0	--	0.0	--	0.0	--	--	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	0.0	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	--	--
California	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	--	0.0	0.0	--

Table III.1.32. Catch per unit effort (± 2 se) of gizzard shad caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.1	0.0	0.7	0.4	--	0.0	0.0	0.0	3.5	0.1	0.0	0.0	0.4	0.0	0.0	0.4	0.0
		(0.3)		(1.3)	(0.8)					(3.3)	(0.3)			(0.8)			(0.8)	
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2
																	(0.4)	(0.4)
Louisville	--	--	--	0.0	--	--	--	--	0.2	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
									(0.4)									
Tyson	--	0.0	0.0	2.0	0.1	0.2	5.6	6.0	0.1	0.0	--	--	0.0	0.4	--	0.3	--	--
				(2.0)	(0.3)	(0.4)	(6.0)	(3.4)	(0.3)					(0.5)		(0.5)		
California	0.0	0.5	0.0	1.3	0.1	0.0	3.2	0.5	--	0.0	0.0	--	0.0	0.0	--	0.0	7.3	--
		(0.5)		(1.9)	(0.3)		(3.5)	(0.5)									(0.5)	

Mini fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	1.6	0.0	0.0	0.3	0.0	0.1	0.0	0.0
								(0.3)			(3.3)			(0.3)		(0.3)		
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	605.0	0.0	4.7	16.0	1.0	3.1	6.5	1.8	0.0	6.2	2.0
								(649.0)		(5.6)	(10.5)	(0.9)	(3.6)	(2.5)	(1.5)		(11.4)	(2.5)
Louisville	--	--	--	0.0	--	--	--	--	0.0	0.0	0.1	1.5	0.1	1.5	0.0	0.0	0.1	0.0
											(0.3)	(1.9)	(0.3)	(3.1)			(0.3)	
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.1	35.0	--	--	0.1	31.9	0.0	1.1	--	--
								(0.7)	(0.3)	(70.0)			(0.3)	(8.0)		(1.0)		
California	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.5	--	0.0	13.6	--	0.4	14.5	9.8	2.0	10.4	--
					(0.3)		(0.3)	(0.7)			(6.8)		(0.5)	(14.9)	(11.0)	(2.0)	(10.6)	

Push trawl	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	13.8	0.0	--	0.1	0.0	--	0.0	0.0	--	0.0	--
								(18.7)			(0.3)							
Decatur	--	0.0	0.4	--	0.0	0.0	--	8.1	2.0	--	5.3	3.9	--	4.4	2.5	--	11.6	9.4
			(0.9)					(8.0)	(4.0)		(6.7)	(4.2)		(2.3)	(2.3)		(15.6)	(12.1)
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.1	--	--	0.0	0.0	--	0.0	0.0
											(0.3)							
Tyson	--	0.1	0.0	--	0.1	0.0	--	5.8	--	--	0.3	12.9	--	1.9	0.0	--	3.2	--
		(0.2)			(0.3)			(3.4)			(0.3)	(18.2)		(1.2)			(1.9)	
California	--	0.0	0.0	--	0.0	0.0	--	15.9	--	--	111.6	50.3	--	14.3	11.1	--	4.8	--
								(7.3)			(72.8)	(96.8)		(7.6)	(12.6)		(2.7)	

Electrofishing	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	9.4	--	0.0	7.4	--	12.1	20.8	0.0	1.9	73.1	0.0	29.0	95.9	2.5	141.9	375.9	0.0
		(7.5)			(10.1)		(4.4)	(29.7)		(3.8)	(34.6)		(16.4)	(36.3)	(4.9)	(67.4)	(316.9)	
Decatur	0.0	4.5	2.0	--	3.4	1.6	121.6	60.0	0.0	19.0	245.4	6.9	65.3	128.4	280.9	248.0	405.1	703.0
		(5.0)	(4.0)		(3.6)	(3.2)	(185.7)	(65.3)		(16.1)	(336.5)	(9.7)	(33.2)	(33.3)	(250.2)	(131.9)	(323.9)	(458.9)
Louisville	--	--	--	6.9	13.3	--	9.2	--	0.2	--	24.1	--	40.6	15.0	0.0	136.1	97.1	0.0
				(13.8)	(11.5)		(7.6)		(0.4)		(30.0)		(24.3)	(8.3)		(37.0)	(74.4)	
Tyson	19.3	1.9	--	29.8	19.5	0.0	12.0	14.5	0.0	30.4	--	--	103.6	281.5	--	118.7	--	--
	(20.1)	(3.7)		(14.4)	(19.2)		(13.0)	(23.2)		(33.0)			(27.4)	(117.2)		(65.4)		
California	1.6	2.2	--	37.1	34.4	19.6	7.6	66.3	3.7	39.1	58.3	--	170.9	337.7	--	432.3	--	--
	(3.1)	(4.4)		(18.4)	(25.3)	(15.6)	(7.9)	(97.0)	(7.4)	(41.9)	(108.3)		(87.7)	(124.7)		(137.0)		

Gill net	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.4	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
					(0.1)													
Decatur	--	--	0.0	--	0.8	0.1	0.0	0.2	0.0	0.0	0.0	0.2	--	0.0	0.0	0.0	0.0	0.0
					(0.6)	(0.2)		(0.3)				(0.3)						
Louisville	--	--	--	--	0.2	--	0.1	--	0.0	--	0.3	--	--	0.1	0.0	0.0	0.1	0.0
					(0.3)		(0.2)				(0.4)			(0.2)			(0.3)	
Tyson	--	0.6	0.5	--	0.2	0.0	0.5	0.6	--	0.3	--	0.0	--	0.1	0.2	0.0	--	--
		(0.7)	(0.6)		(0.1)		(0.3)	(1.2)		(0.3)				(0.3)	(0.3)			
California	--	0.5	0.0	--	1.2	0.3	0.2	0.1	0.0	0.0	0.2	0.0	--	0.0	--	0.2	0.4	--
		(0.4)			(1.2)	(0.5)	(0.2)	(0.3)			(0.2)					(0.3)	(0.5)	

Table III.1.33. Catch per unit effort (± 2 se) of goldeye caught with standard sampling gears fished at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend April-September, 2006-2008.

Large fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1 (0.3)	0.0	0.0	0.0	0.0	0.0	0.1 (0.3)	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.2 (0.4)	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.3 (0.5)	0.0	0.3 (0.3)	0.2 (0.4)	0.0	0.0	1.0 (0.8)	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	1.4 (1.9)	0.0	0.0	0.2 (0.4)	0.0	0.0	--	0.0	0.4 (0.2)	--	0.0	0.0	--	0.0	0.0	--

Mini fyke	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	0.0	0.0	--	--
California	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--

Push trawl	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	--
Decatur	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0	--	0.0	0.0
Louisville	--	--	--	--	--	--	--	--	0.0	--	0.0	--	--	0.0	0.0	--	0.0	0.0
Tyson	--	0.0	0.0	--	0.0	0.0	--	0.0	--	--	0.3 (0.3)	0.0	--	0.0	0.0	--	0.0	--
California	--	0.0	0.0	--	0.0	0.0	--	0.0	--	--	0.4 (0.5)	0.0	--	0.0	0.0	--	0.0	--

Electrofishing	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	0.0	1.7 (3.9)	--	0.0	0.0	--	0.0	0.0	0.0	0.0	1.5 (3.0)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decatur	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0 (2.0)	0.0	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	0.0	0.0	--	0.0	--	0.0	--	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Tyson	2.2 (4.3)	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	0.0	0.0	--	0.0	--	--
California	0.0	0.0	--	6.2 (4.7)	0.0	0.0	0.0	0.0	0.0	0.0	2.0 (4.0)	--	0.0	0.0	--	0.0	--	--

Gill net	April			May			June			July			August			September		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Tieville	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0
Decatur	--	--	1.5 (1.1)	--	0.2 (0.2)	0.0	0.1 (0.3)	0.0	0.1 (0.1)	0.0	0.1 (0.2)	0.7 (1.3)	--	0.0	0.0	0.0	0.0	0.0
Louisville	--	--	--	--	0.0	--	0.0	--	0.0	--	0.1 (0.2)	--	--	0.0	0.0	0.0	0.0	0.0
Tyson	--	0.6 (0.8)	0.9 (0.8)	--	1.1 (0.4)	0.3 (0.7)	0.0	0.1 (0.2)	--	0.5 (0.9)	--	2.6 (1.7)	--	0.5 (0.7)	1.1 (1.0)	0.0	--	--
California	--	0.0	0.5 (0.4)	--	3.3 (2.8)	0.2 (0.4)	0.3 (0.3)	0.0	0.1 (0.2)	0.2 (0.5)	0.0	7.1 (4.6)	--	0.3 (0.4)	--	0.2 (0.4)	0.0	--

Figures

Figure III.1.1. First aerial photo of a nine picture series of the Tieville-Decatur Mitigation Project taken early spring of 2007.

Figure III.1.2. Second aerial photo of a nine picture series of the Tieville-Decatur Mitigation Project taken early spring of 2007.


Figure III.1.3. Third aerial photo of a nine picture series of the Tieville-Decatur Mitigation Project taken early spring of 2007.


Figure III.1.4. Forth aerial photo of a nine picture series of the Tieville-Decatur Mitigation Project taken early spring of 2007.


Figure III.1.5. Fifth aerial photo of a nine picture series of the Tieville-Decatur Mitigation Project taken early spring of 2007.


Figure III.1.6. Sixth aerial photo of a nine picture series of the Tieville-Decatur Mitigation Project taken early spring of 2007.


Figure III.1.7. Seventh aerial photo of a nine picture series of the Tieville-Decatur Mitigation Project taken early spring of 2007.


Figure III.1.8. Eight aerial photo of a nine picture series of the Tieville-Decatur Mitigation Project taken early spring of 2007.

Figure III.1.9. Ninth aerial photo of a nine picture series of the Tieville-Decatur Mitigation Project taken early spring of 2007.

Figure III.1.10. Photo of a weir and culvert below the outlet of the Tieville Bend.


Figure III.1.11. Aerial of the Louisville Bend Mitigation Project.


Figure III.1.12. Aerial photo of the Tyson Island Mitigation Project.

Figure III.1.13. Aerial photo of the California Bend Mitigation Project.

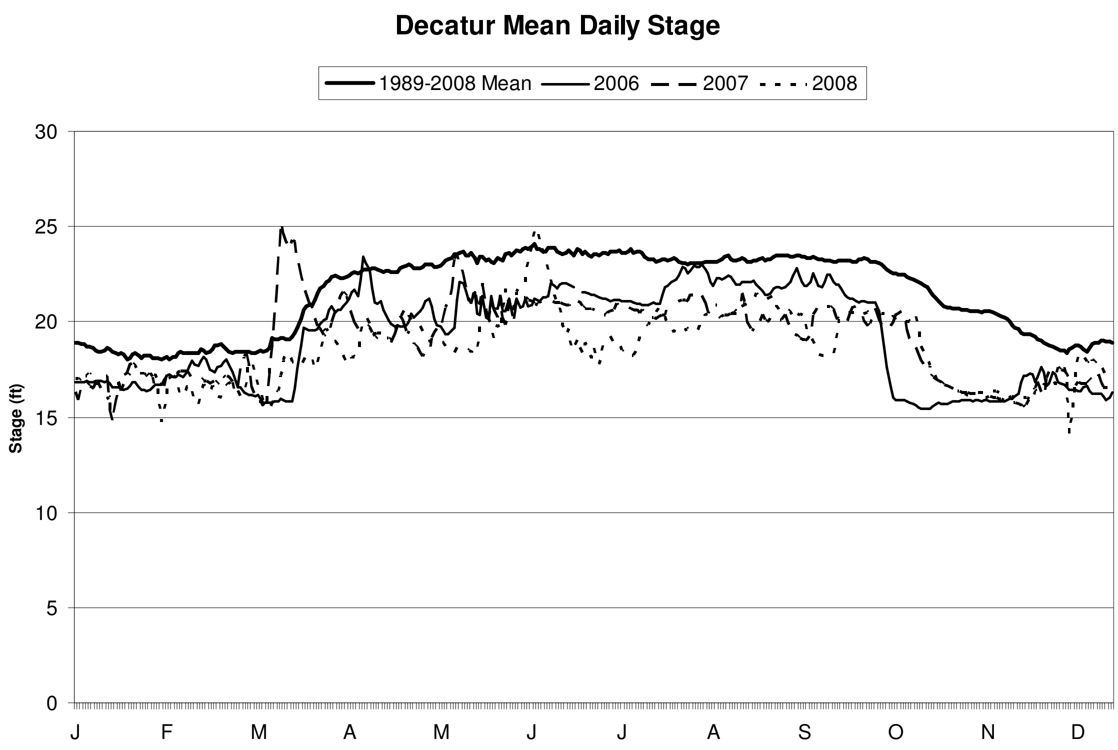


Figure III.1.14. Mean daily river stage for 2006-2008 and mean of mean daily stage for 1989-2008 recorded at the USGS gauging station Decatur, Nebraska

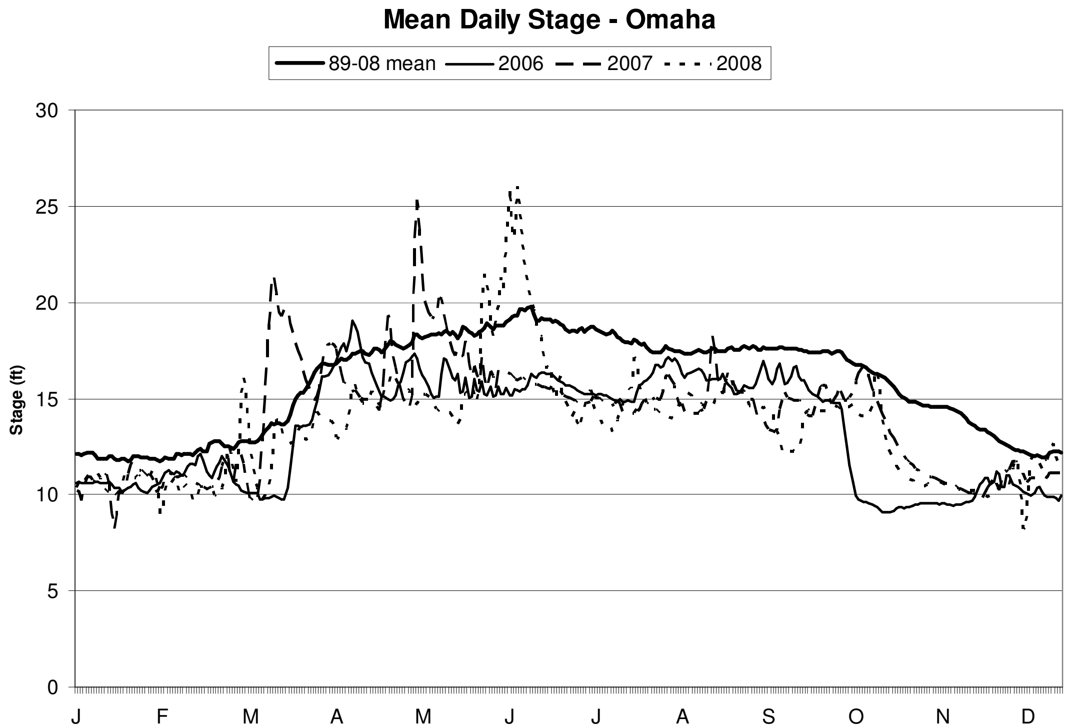


Figure III.1.15. Mean daily river stage for 2006-2008 and mean of mean daily stage for 1989-2008 recorded at the USGS gauging station Omaha, Nebraska

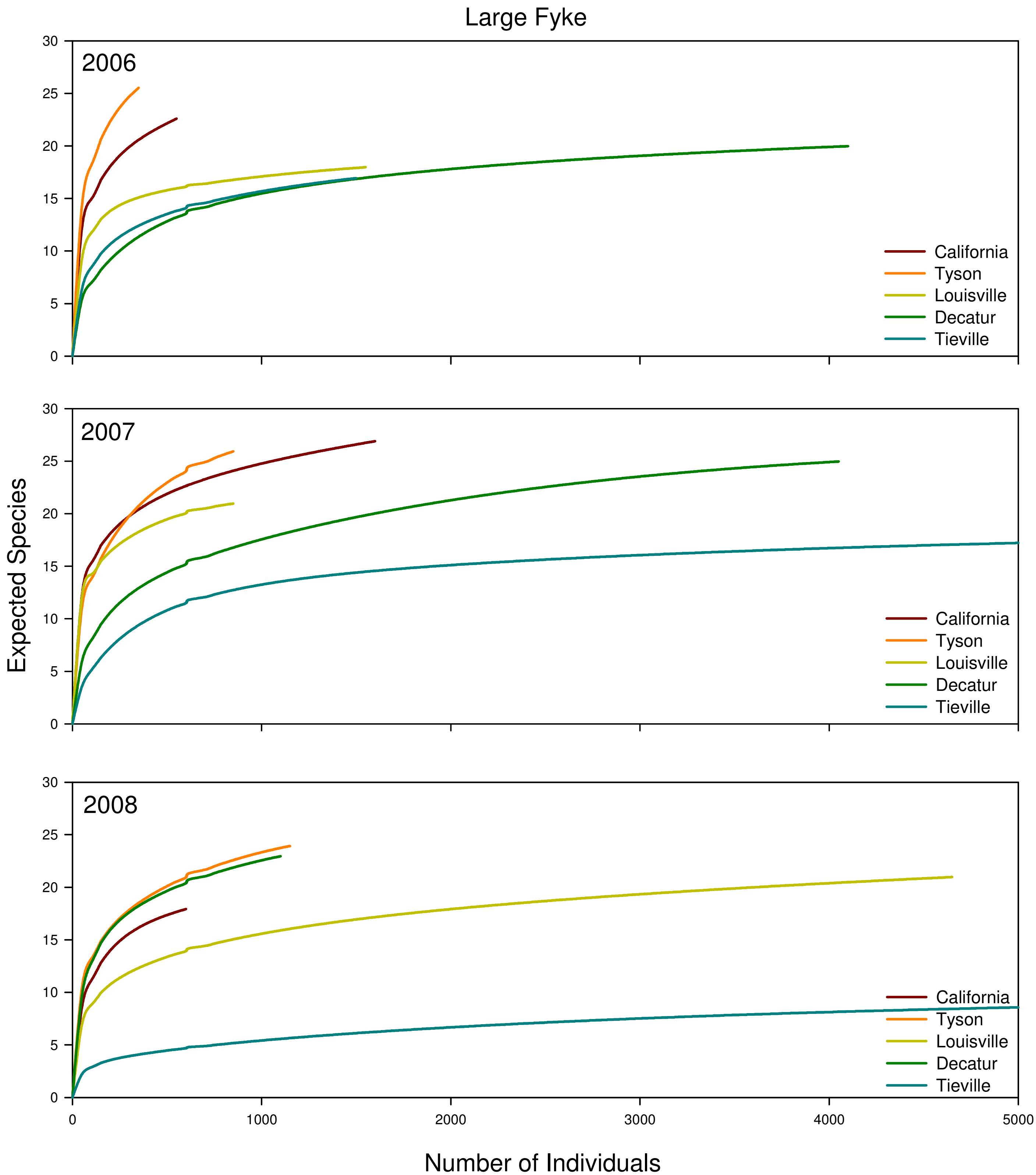


Figure III.1.16. Expected species richness by rarefaction for large fyke net samples at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend, 2006-2008.

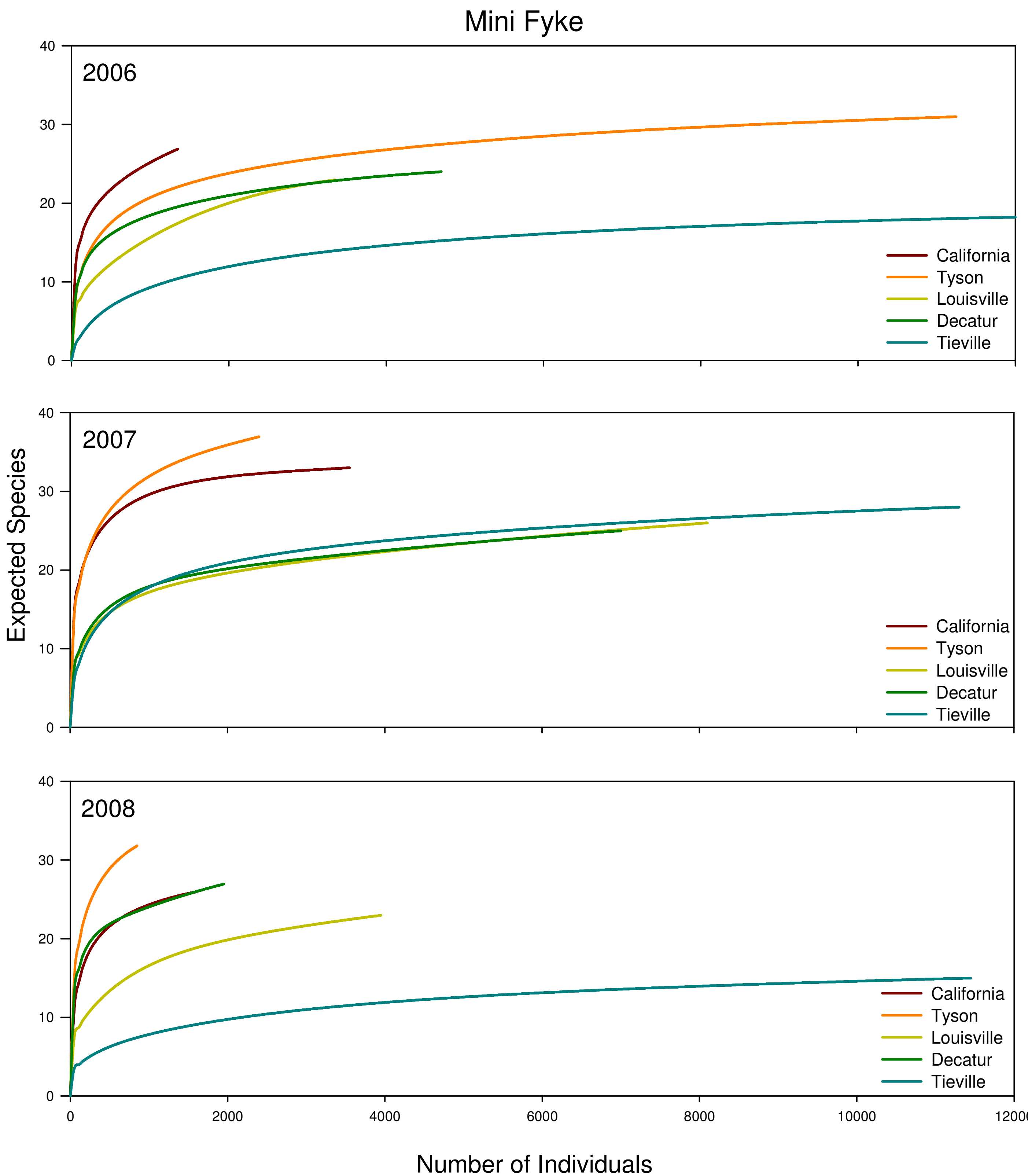


Figure III.1.17. Expected species richness by rarefaction for mini fyke net samples at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend, 2006-2008.

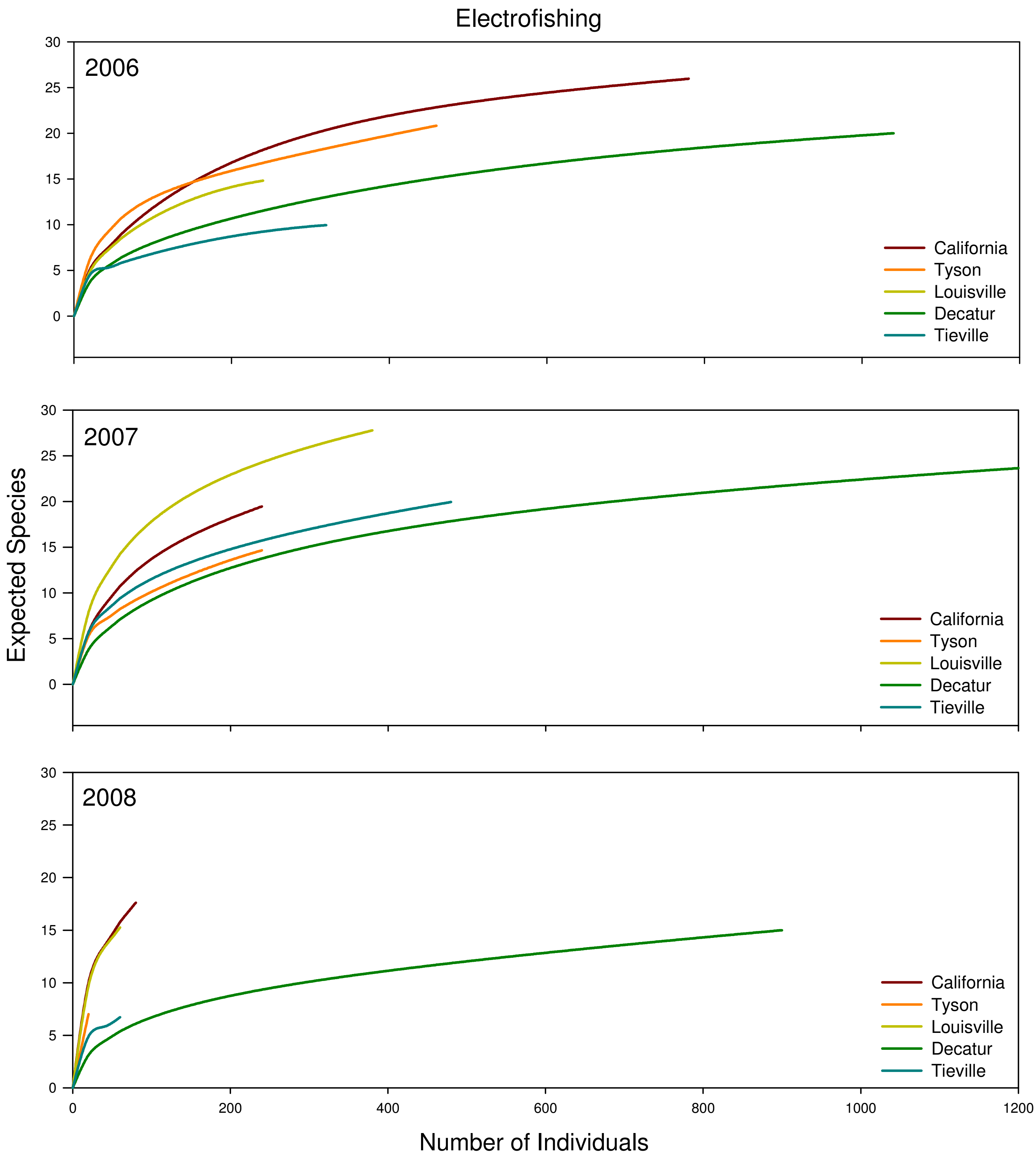


Figure III.1.18. Expected species richness by rarefaction for electrofishing samples at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend, 2006-2008.

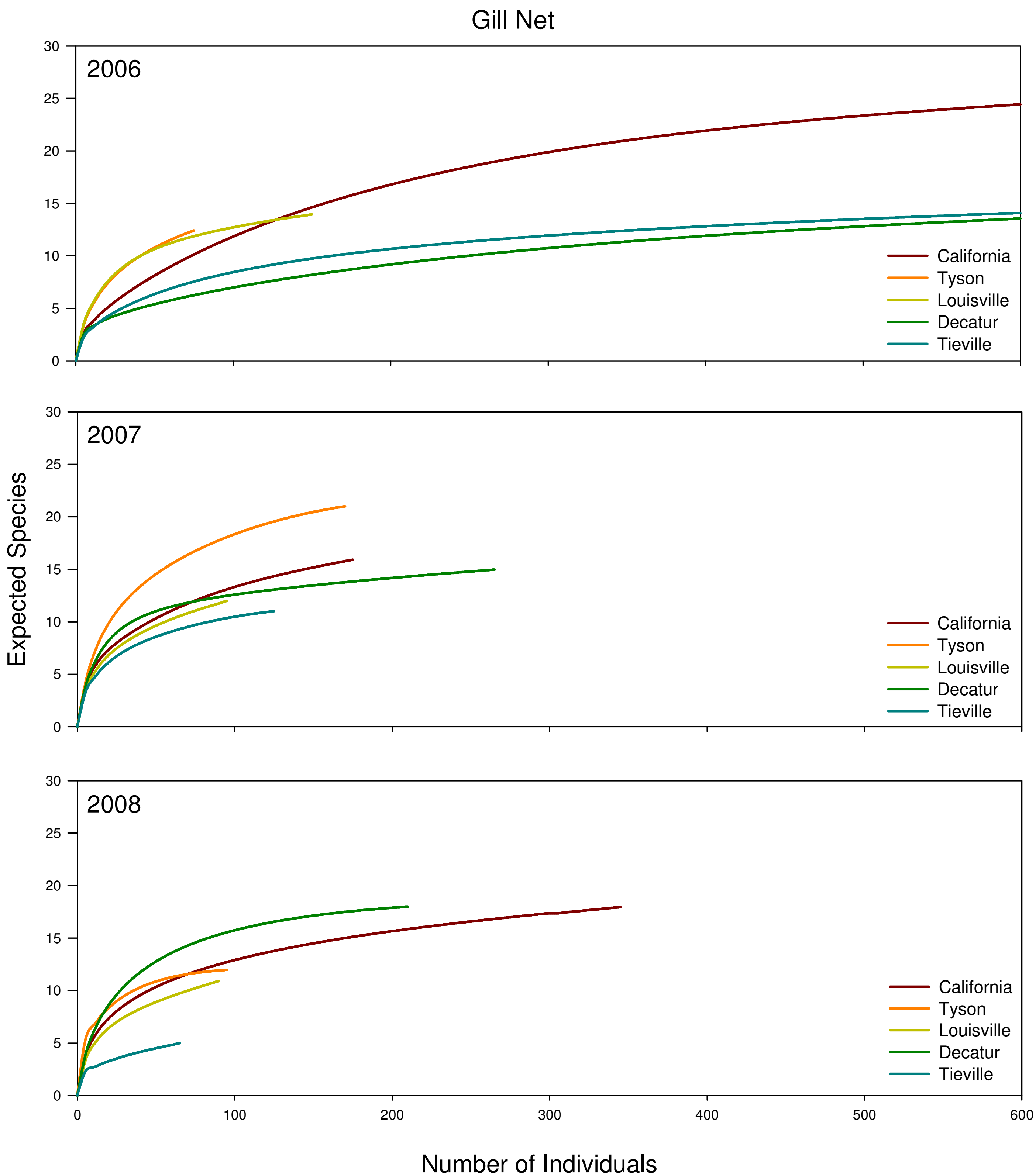


Figure III.1.19. Expected species richness by rarefaction for gill net samples at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend, 2006-2008.

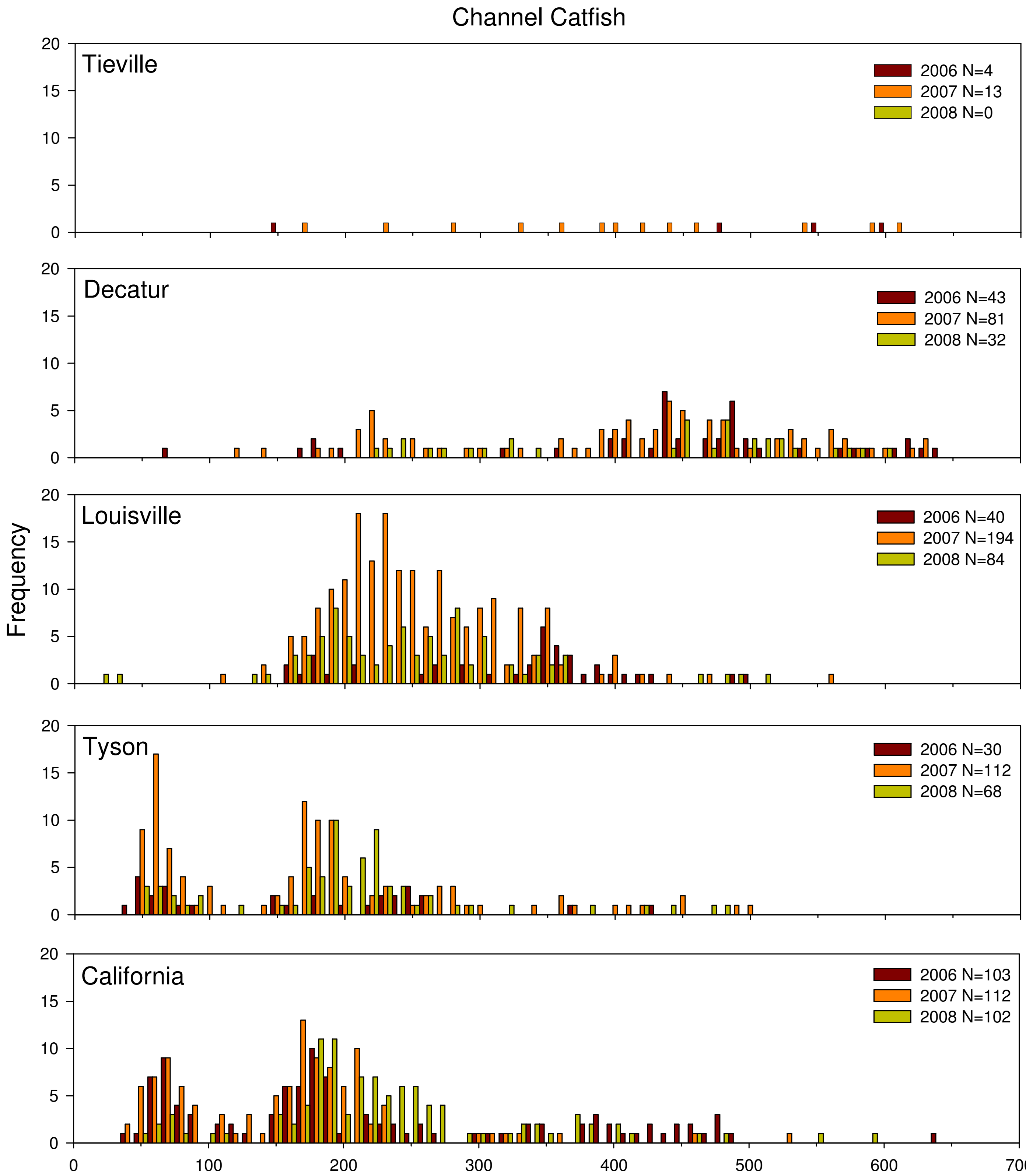


Figure III.1.20. Length frequency histogram for channel catfish caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

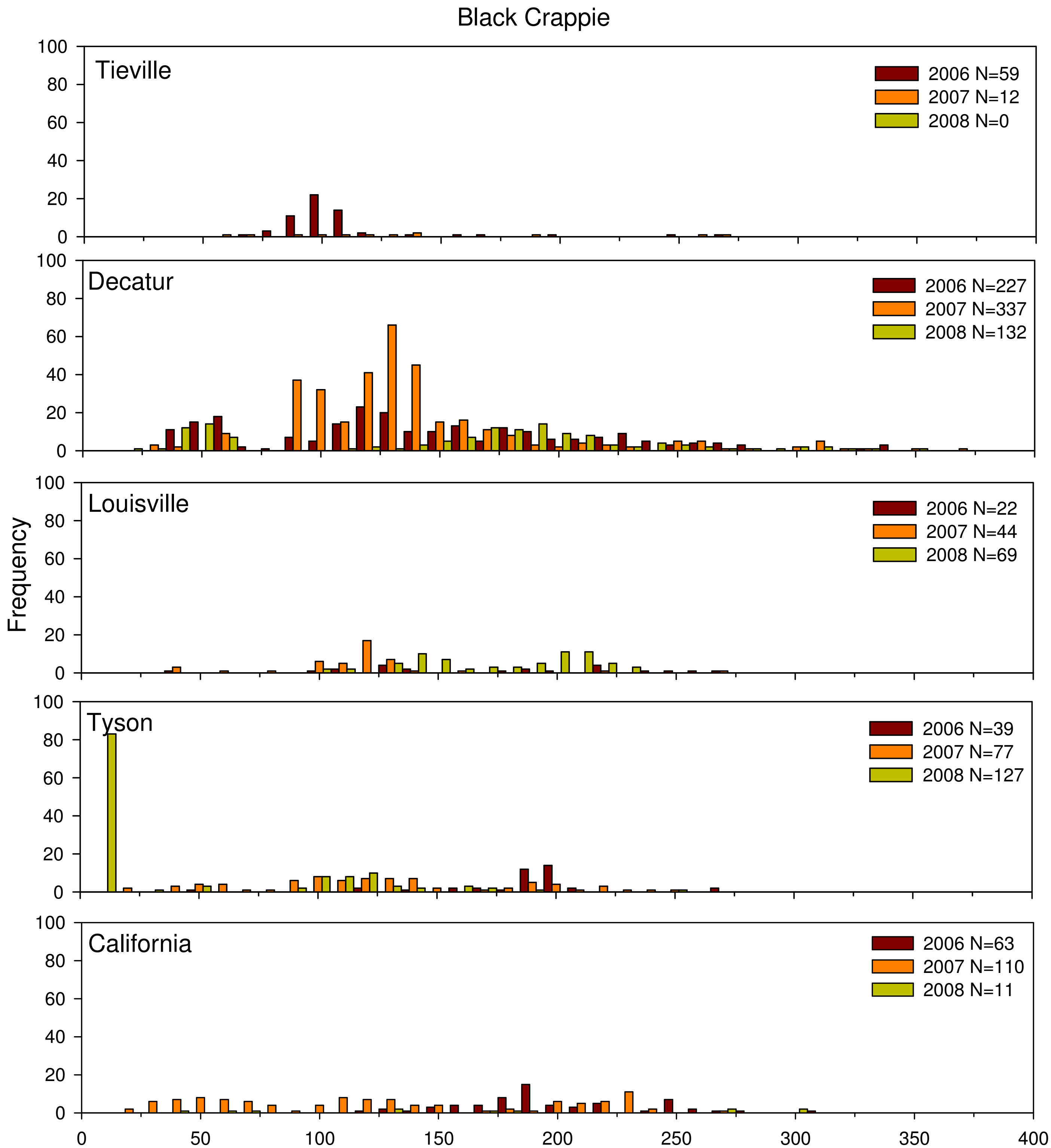


Figure III.1.21. Length frequency histogram for black crappie caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

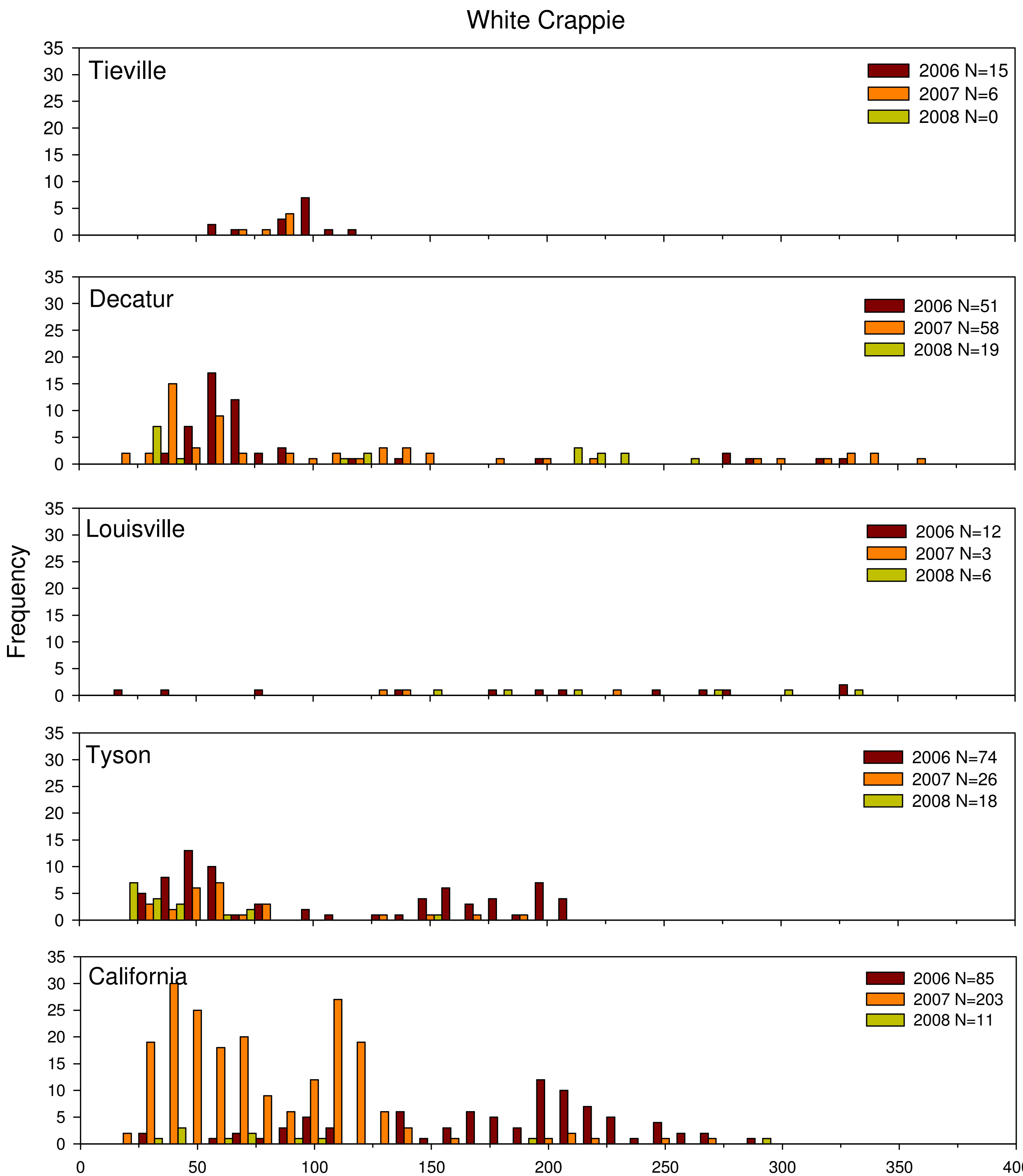


Figure III.1.22. Length frequency histogram for white crappie caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

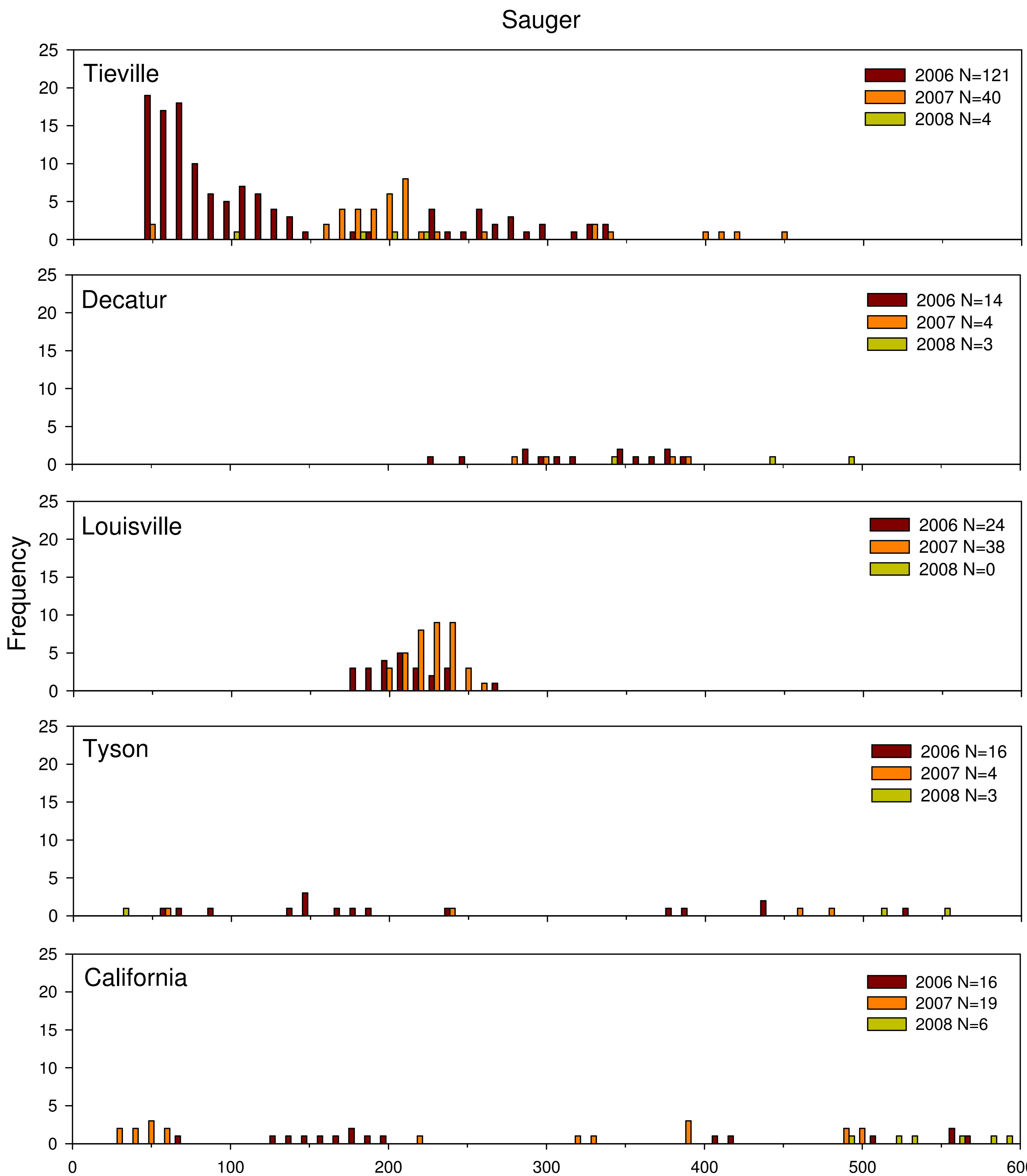


Figure III.1.23. Length frequency histogram for sauger caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

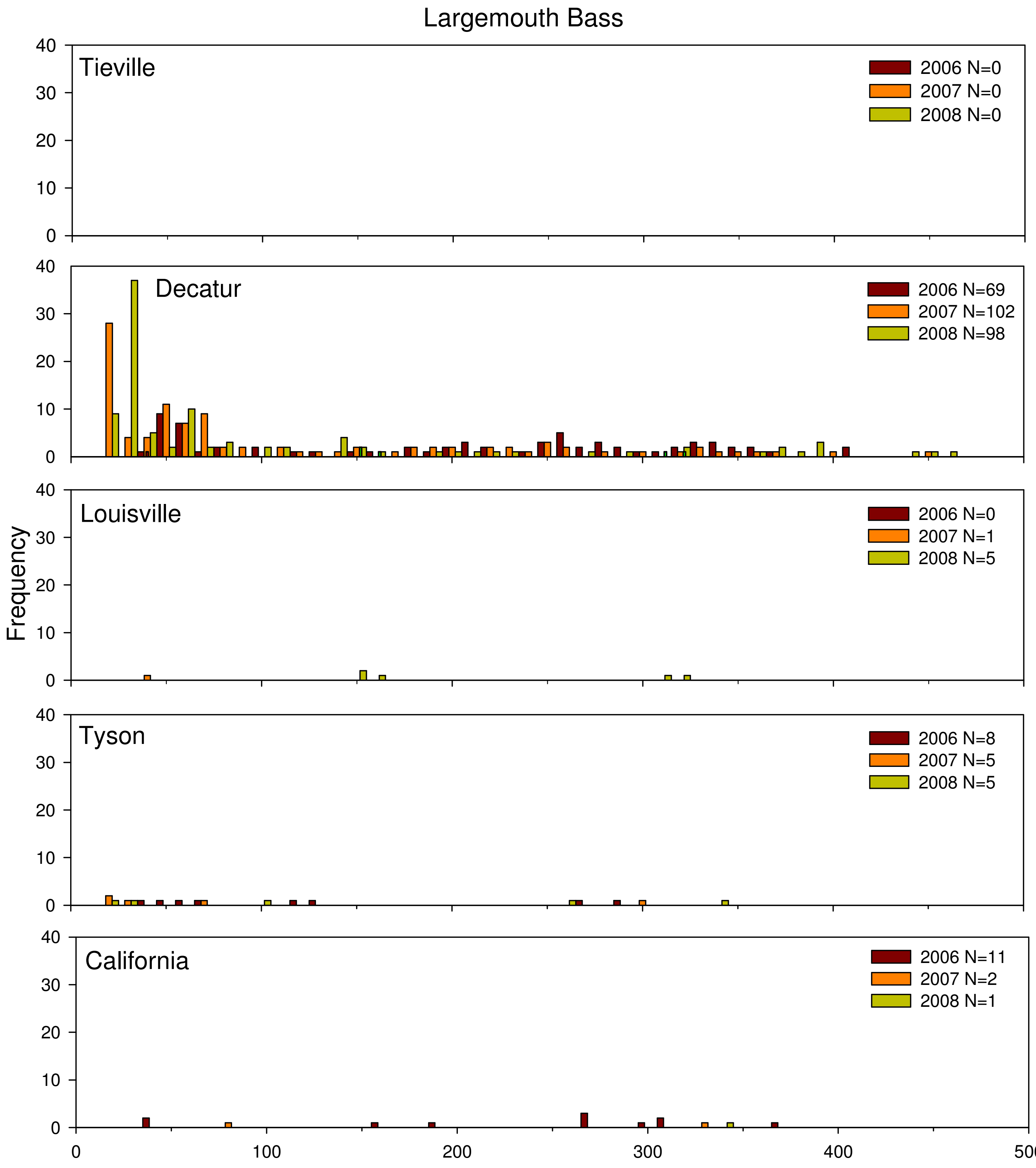


Figure III.1.24. Length frequency histogram for largemouth bass caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

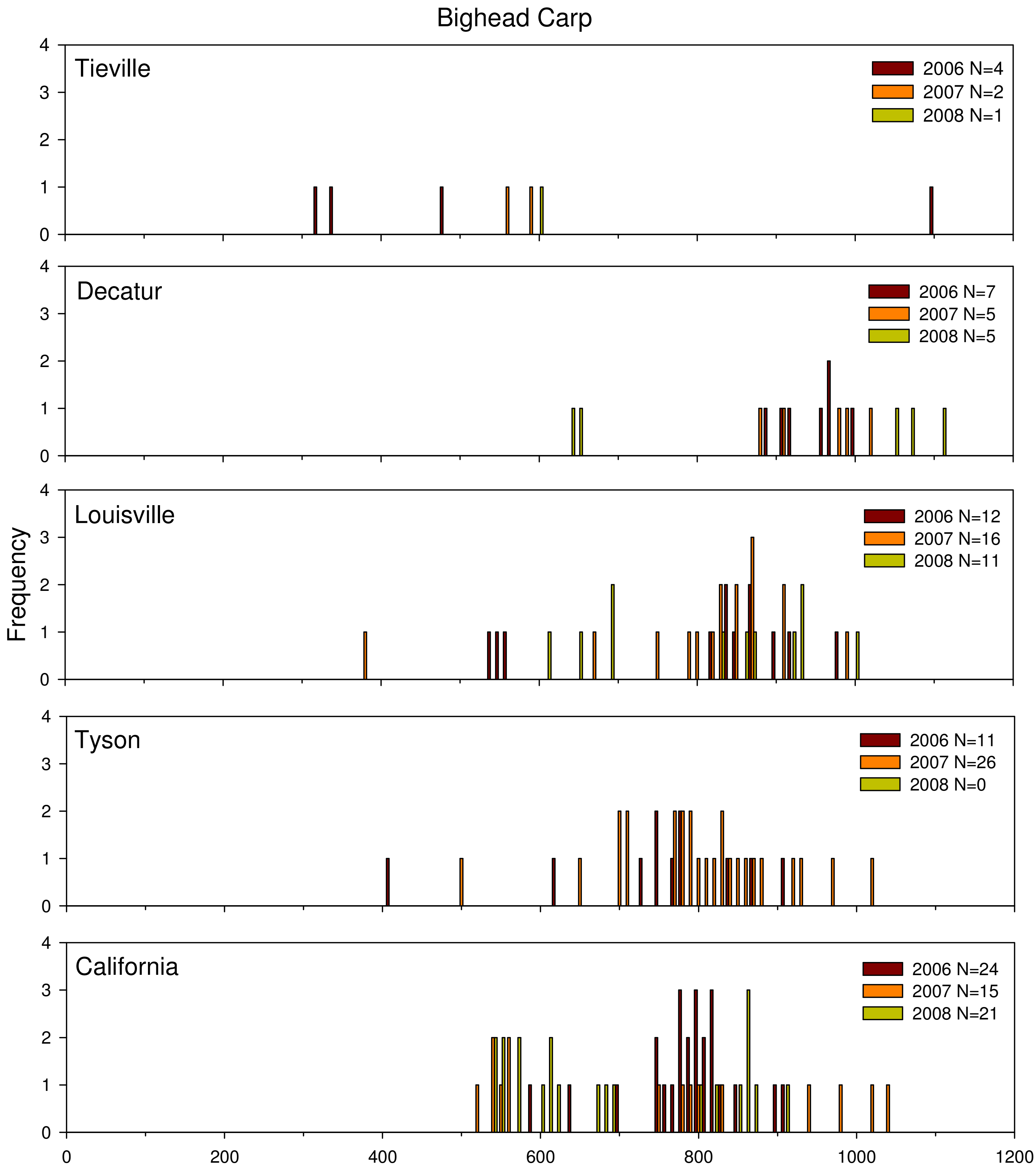


Figure III.1.25. Length frequency histogram for bighead carp caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

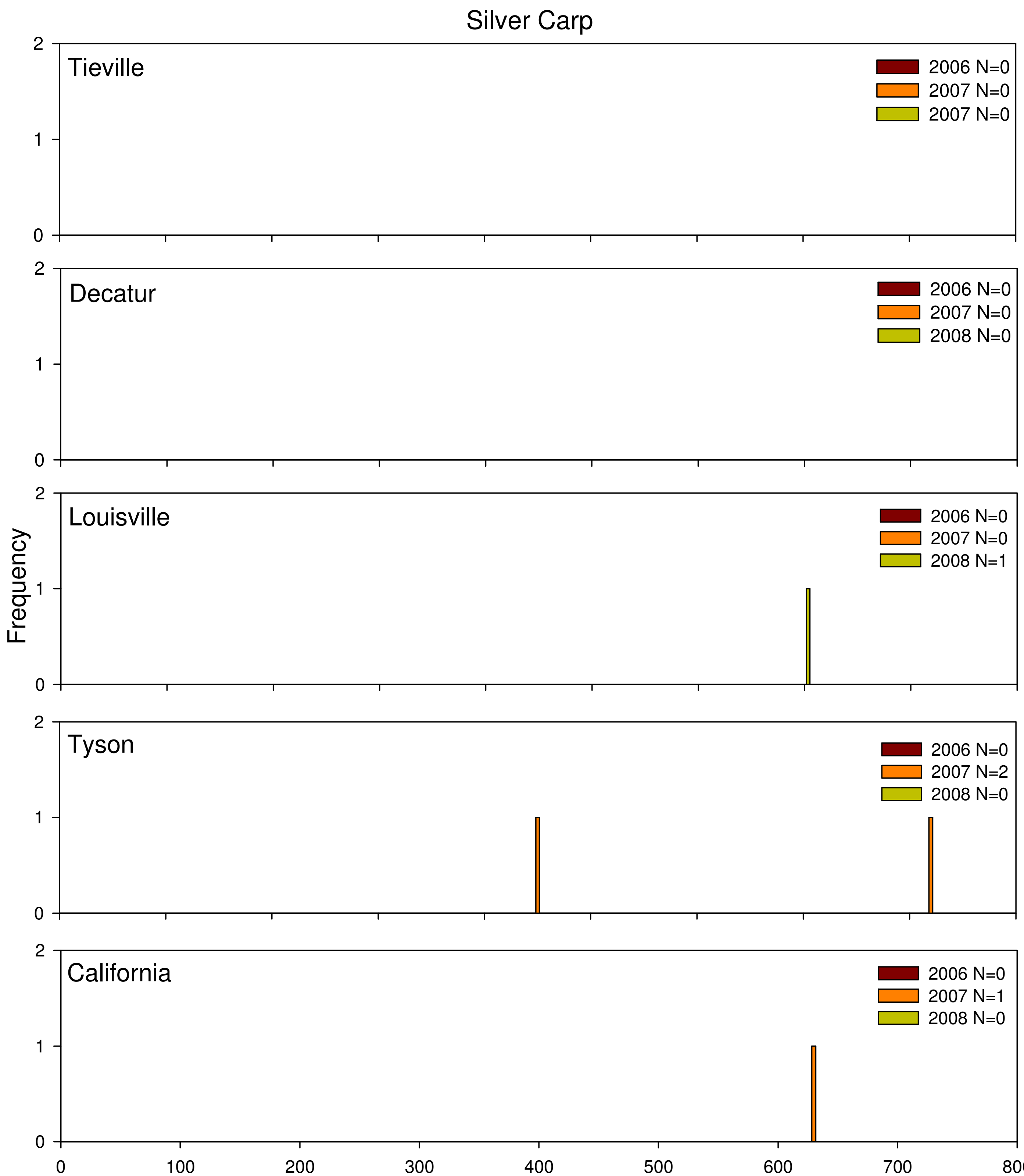


Figure III.1.26. Length frequency histogram for silver carp caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

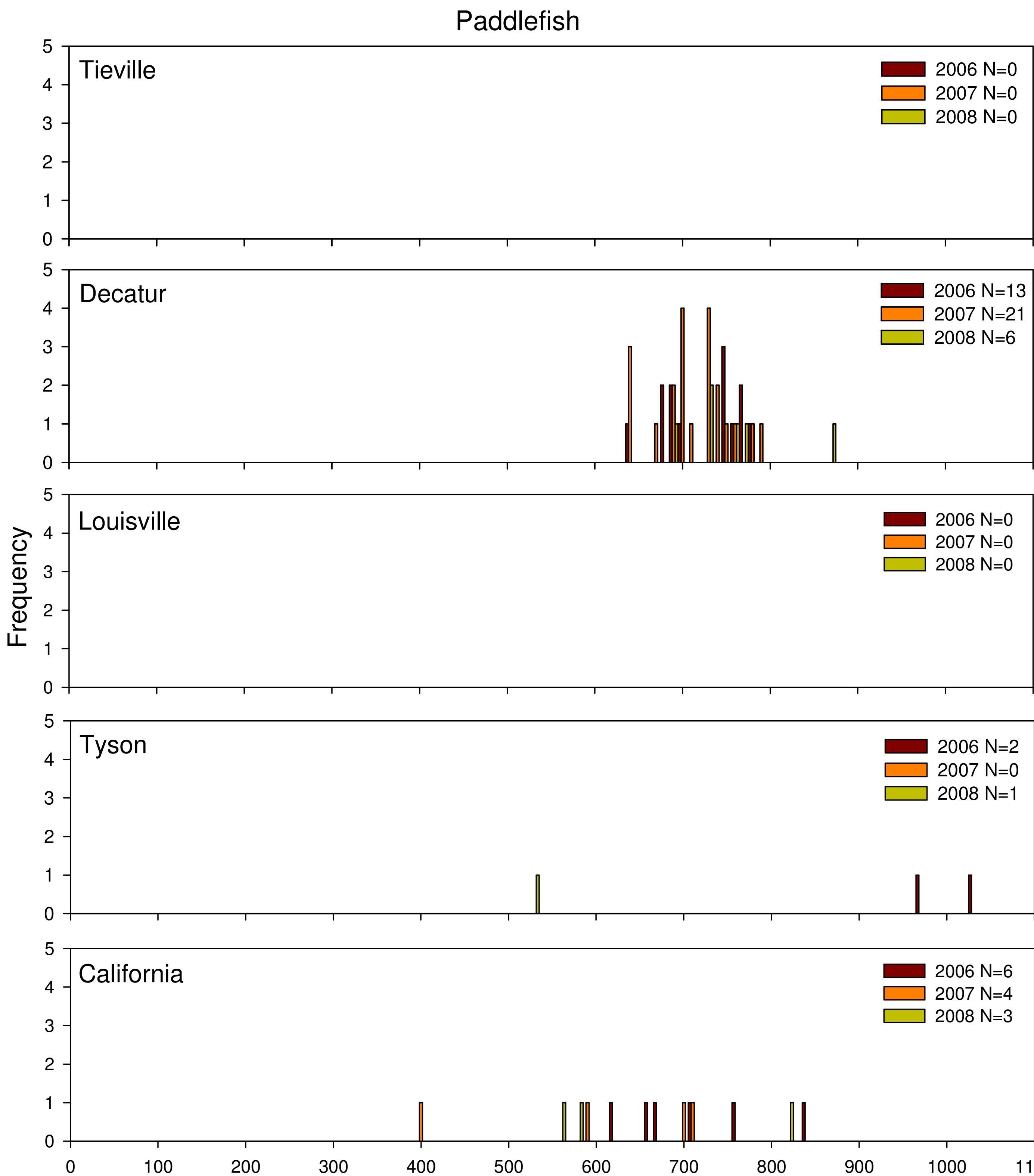


Figure III.1.27. Length frequency histogram for paddlefish caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

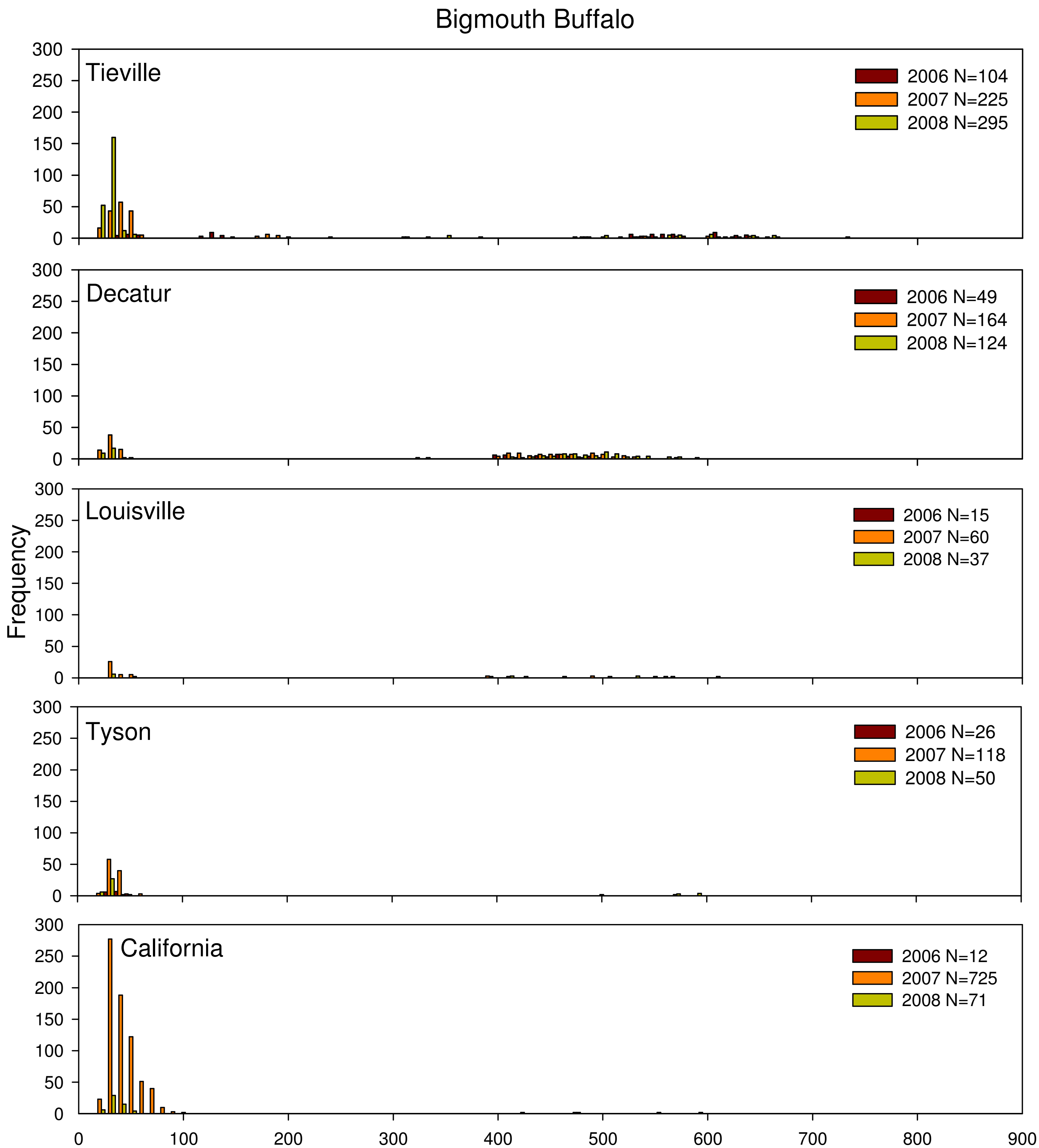


Figure III.1.28. Length frequency histogram for bigmouth buffalo caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

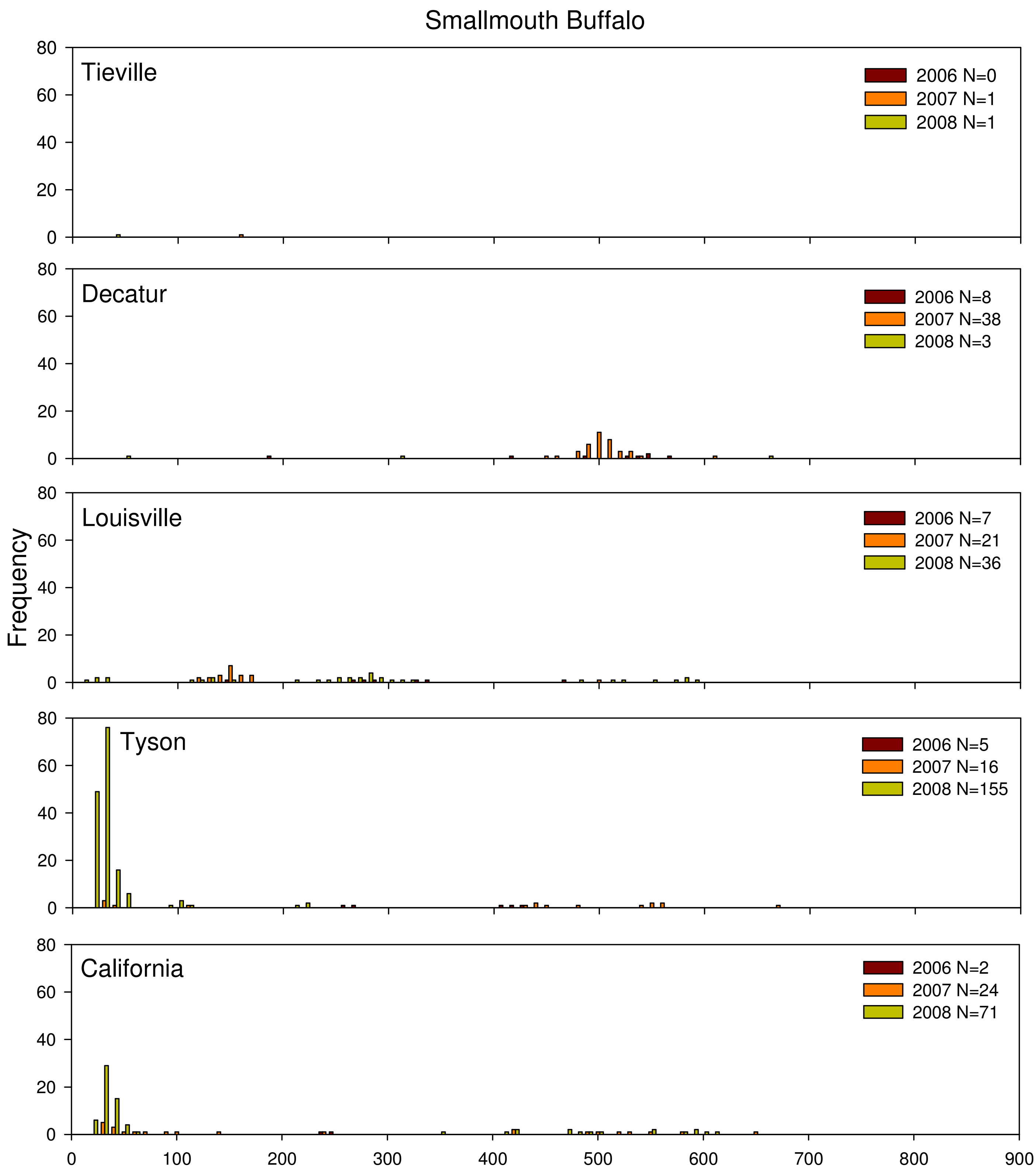


Figure III.1.29. Length frequency histogram for smallmouth buffalo caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

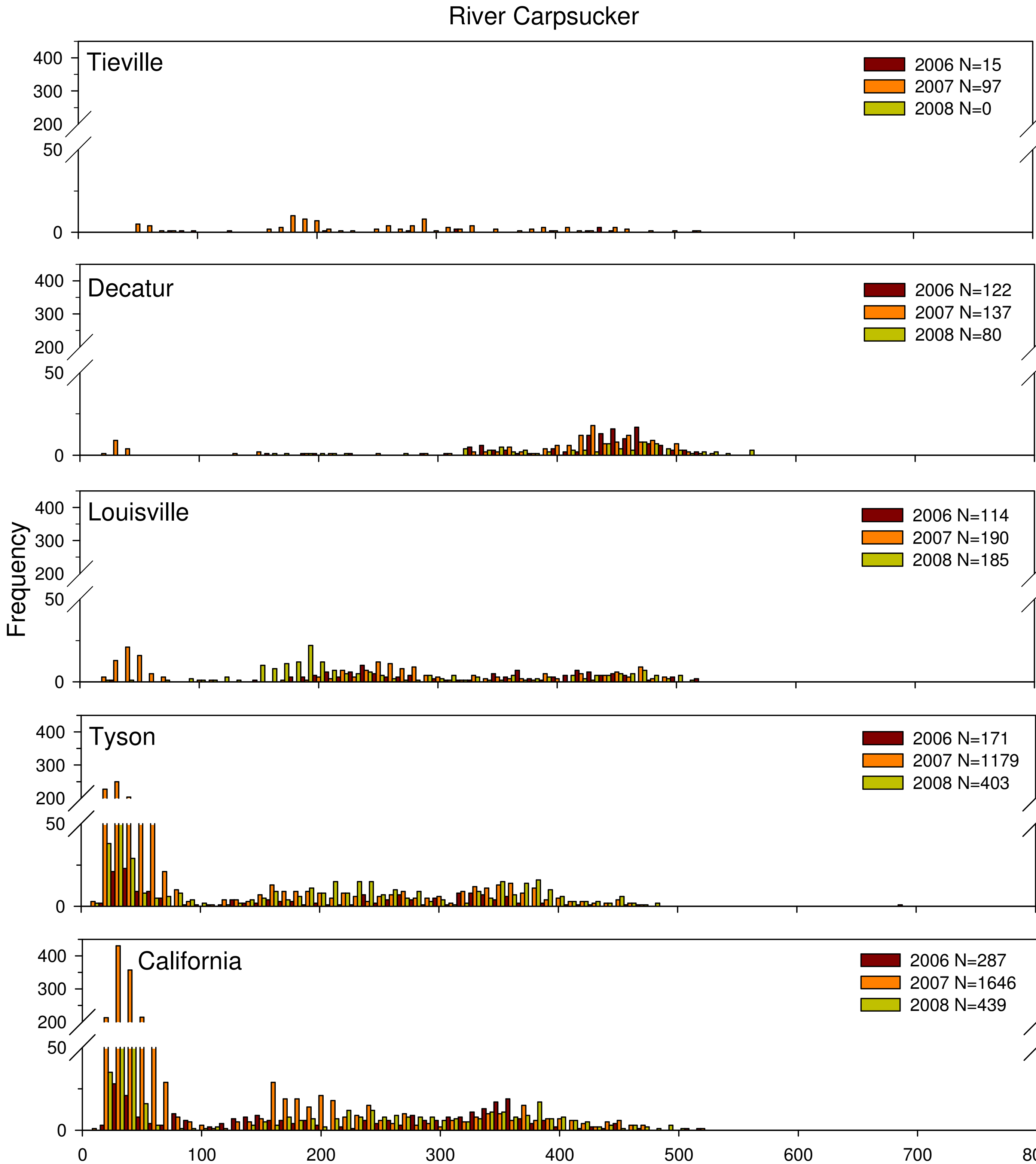


Figure III.1.30. Length frequency histogram for river carpsucker caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

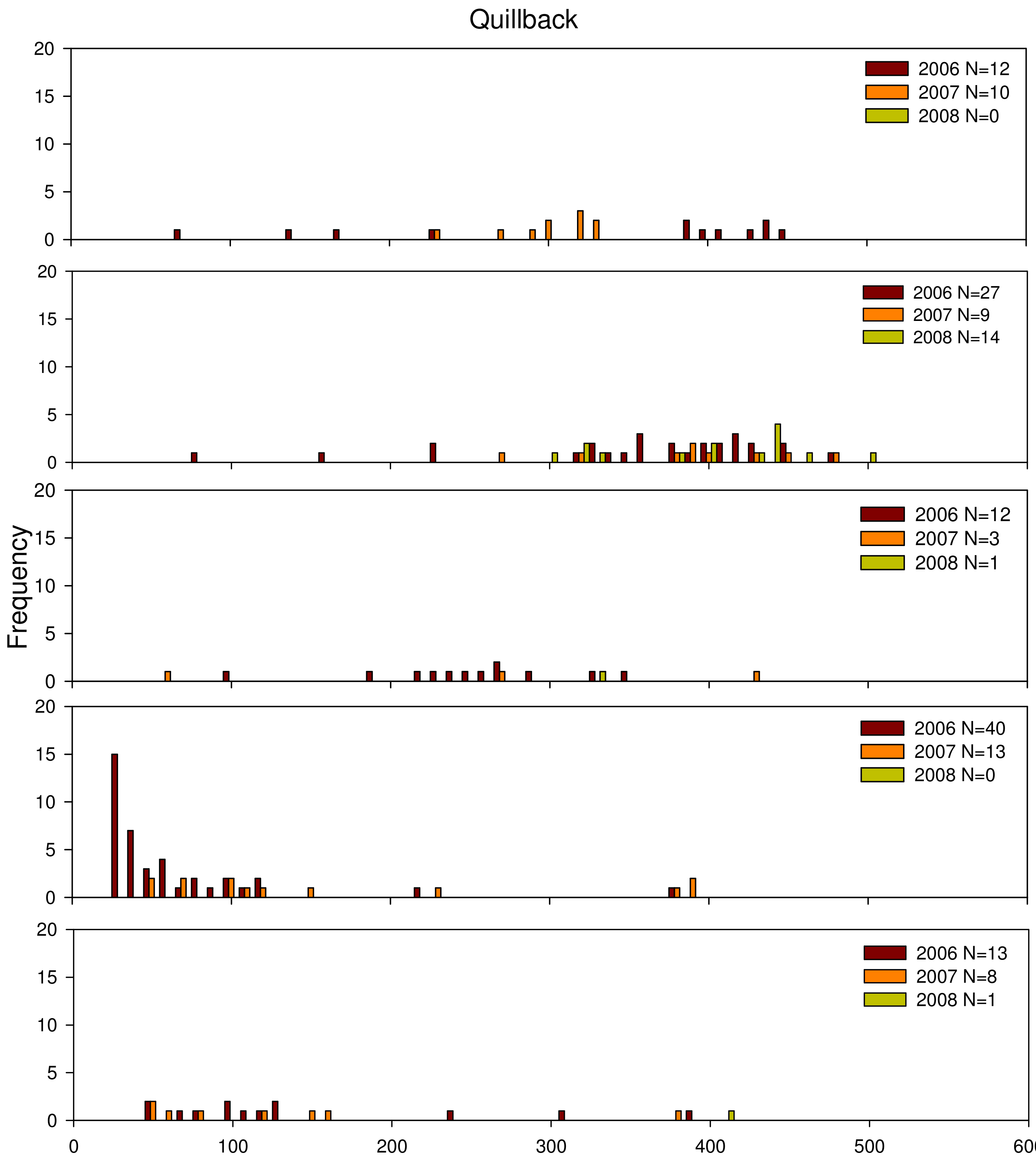


Figure III.1.31. Length frequency histogram for quillback caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

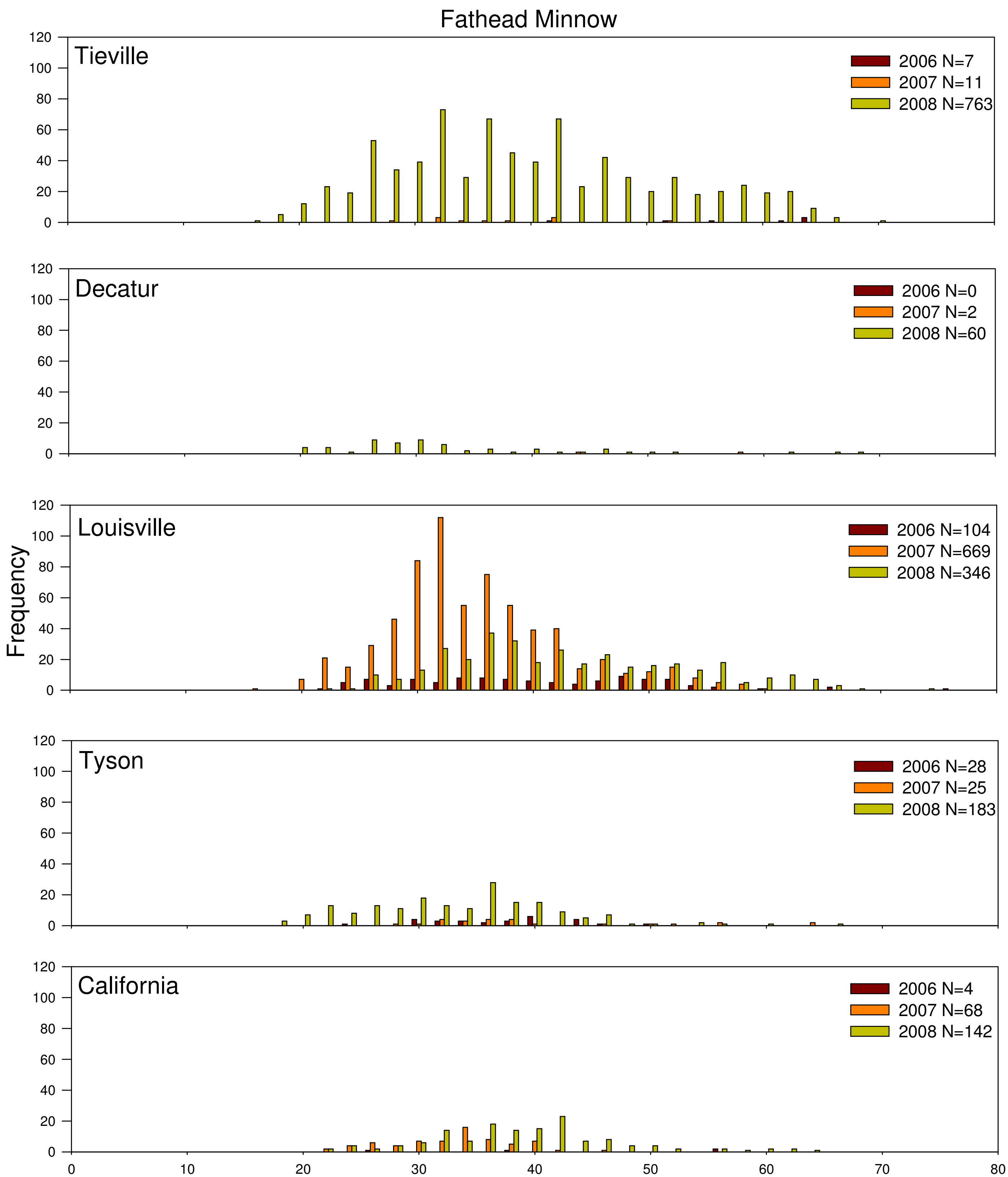


Figure III.1.32. Length frequency histogram for fathead minnow caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

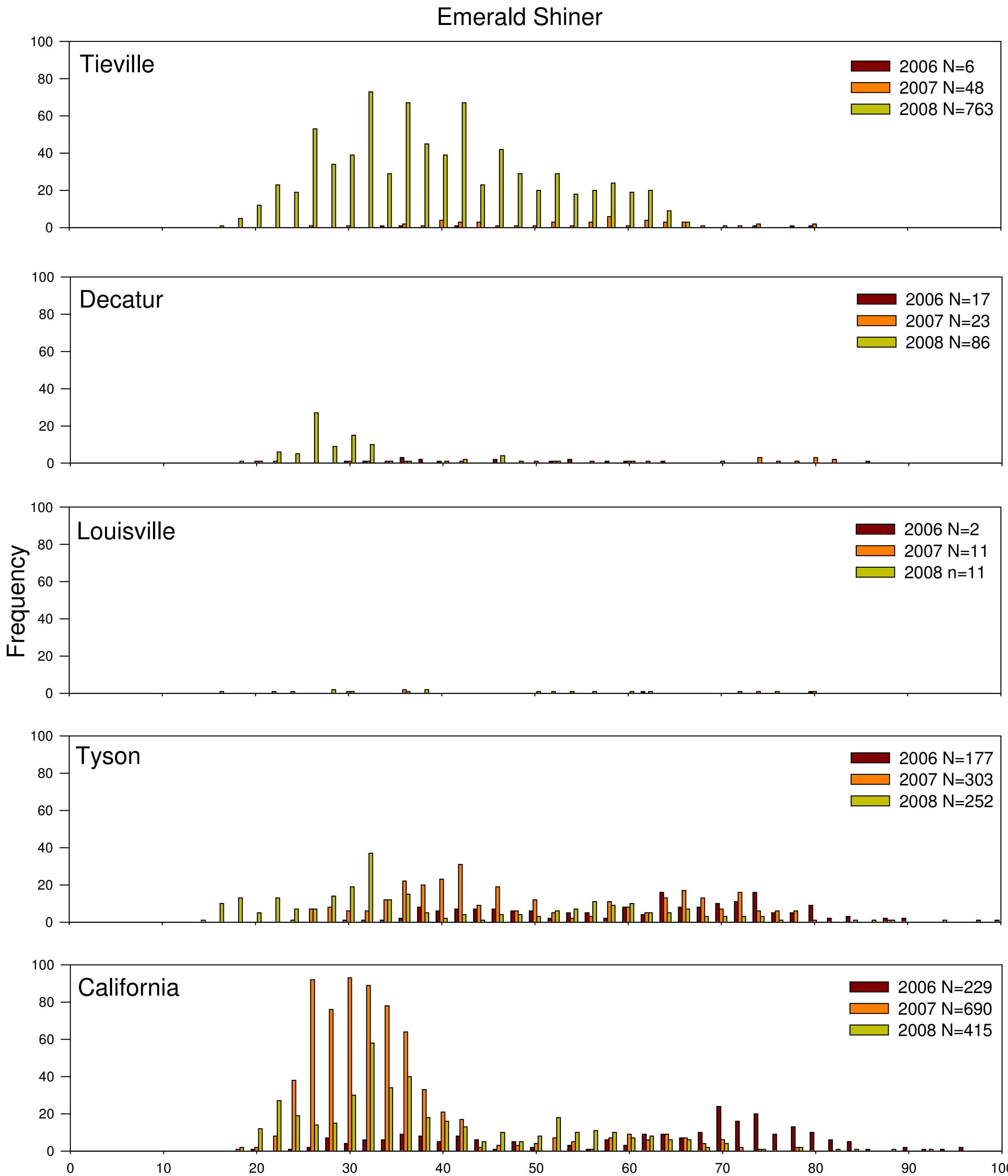


Figure III.1.33. Length frequency histogram for emerald shiner caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

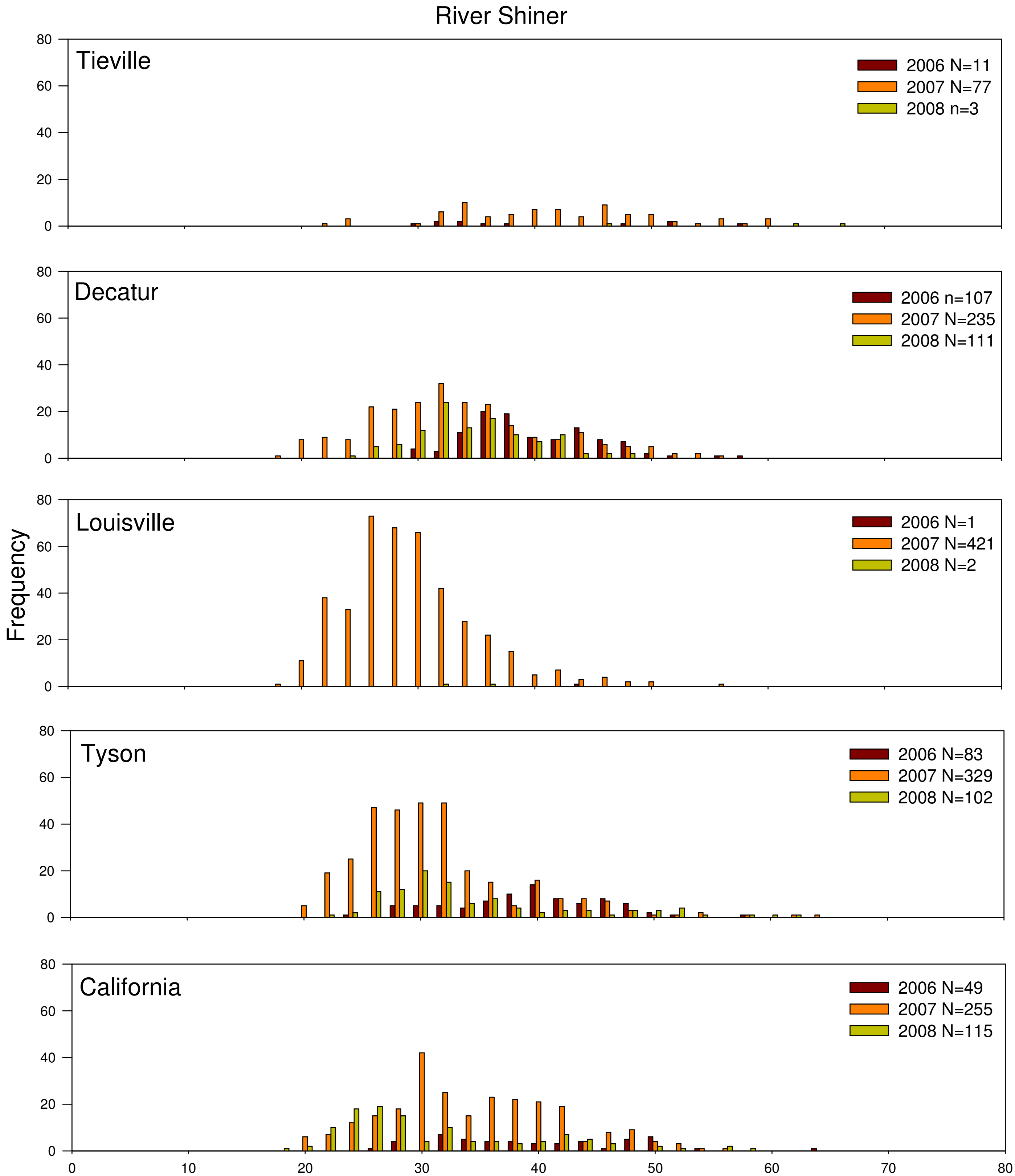


Figure III.1.34. Length frequency histogram for river shiner caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

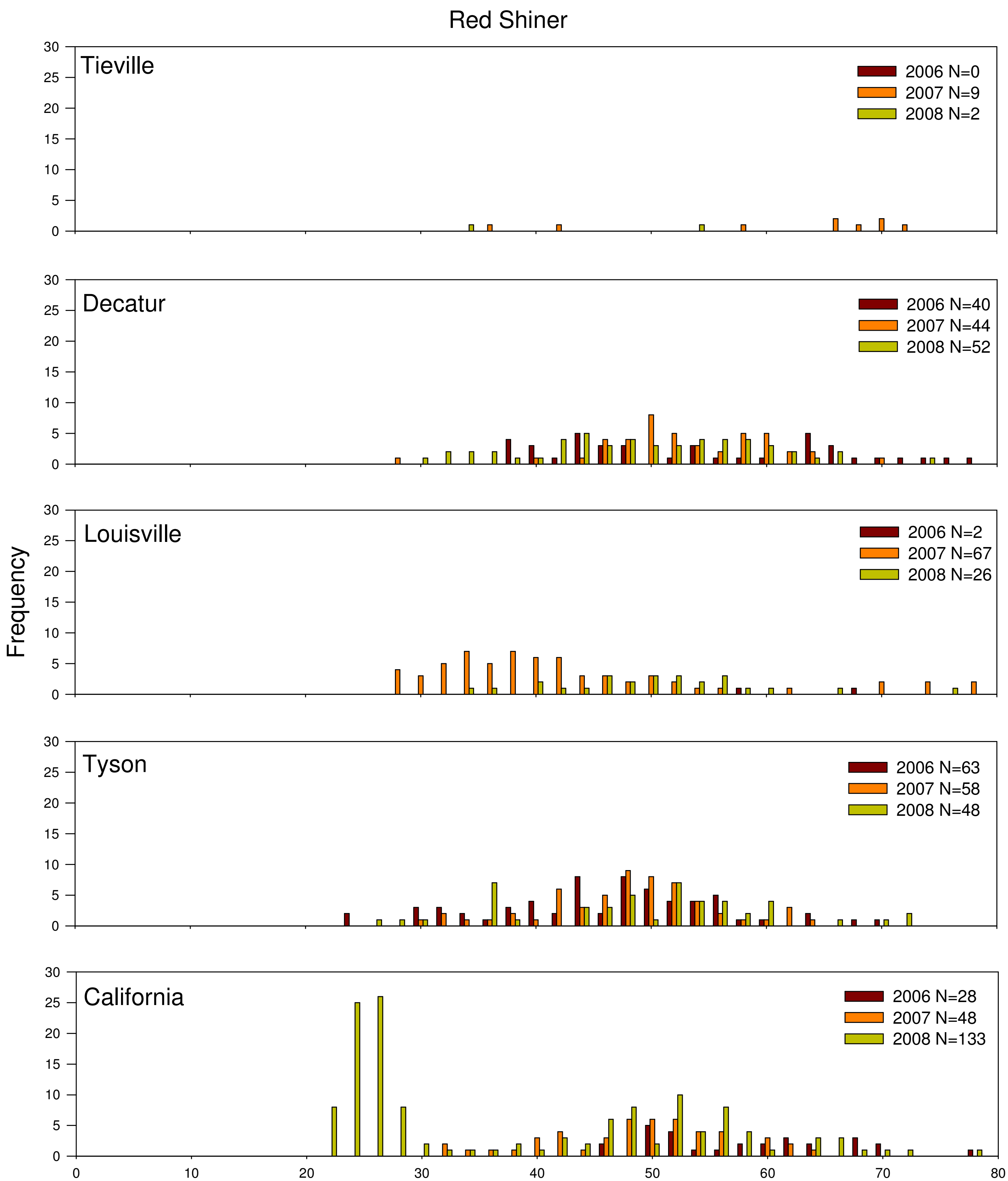


Figure III.1.35. Length frequency histogram for red shiner caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

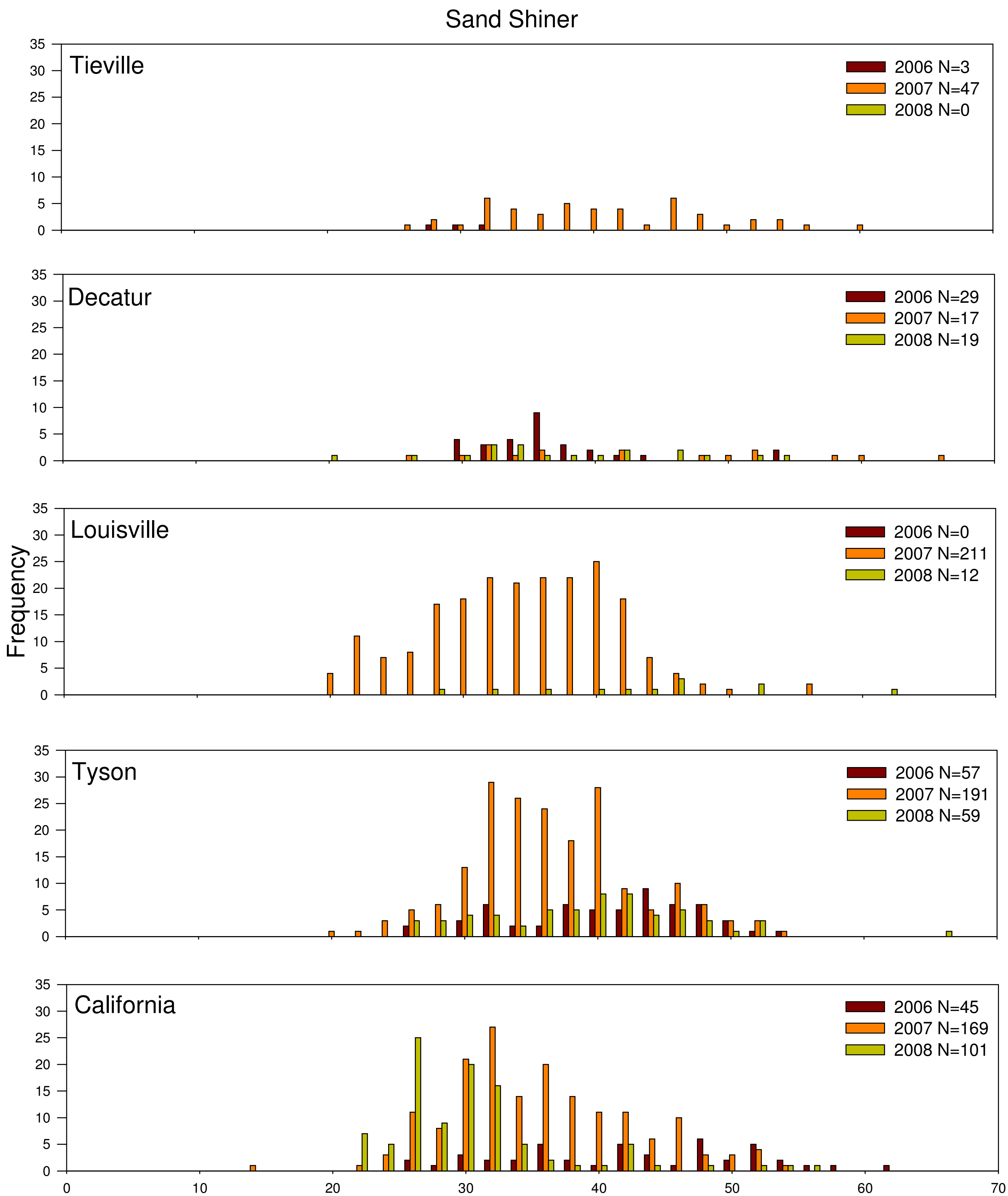


Figure III.1.36. Length frequency histogram for sand shiner caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

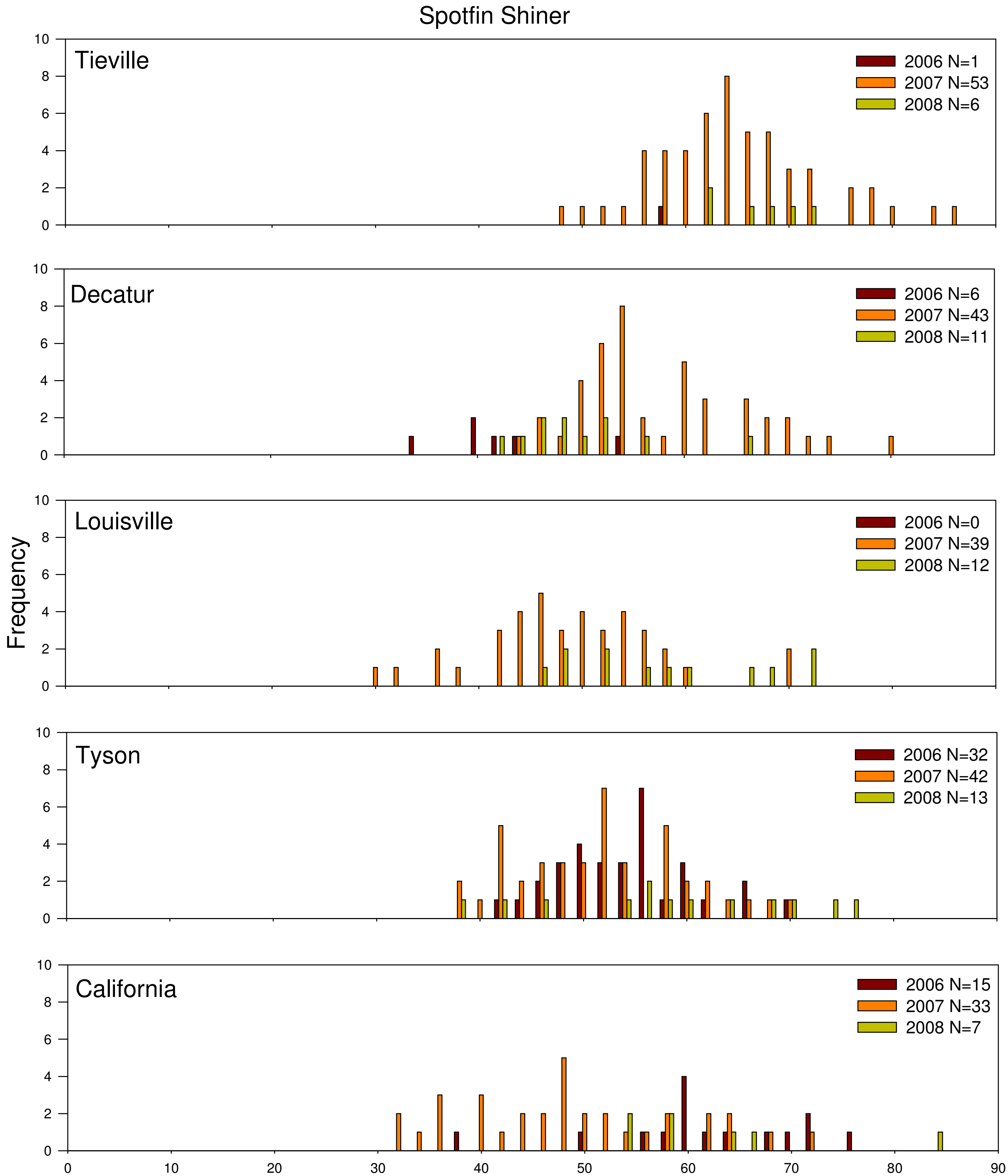


Figure III.1.37. Length frequency histogram for spotfin shiner caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

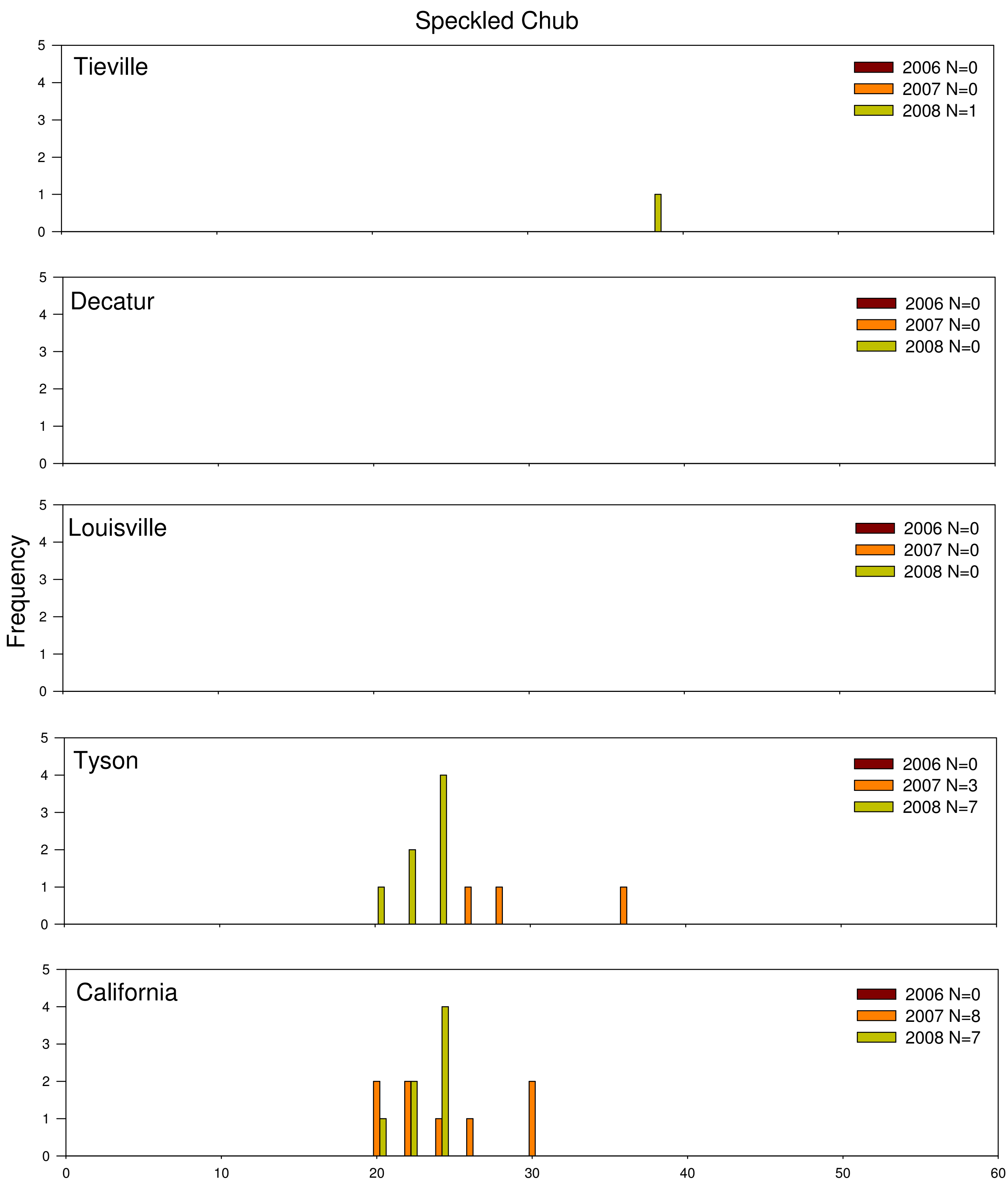


Figure III.1.38. Length frequency histogram for speckled chub caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

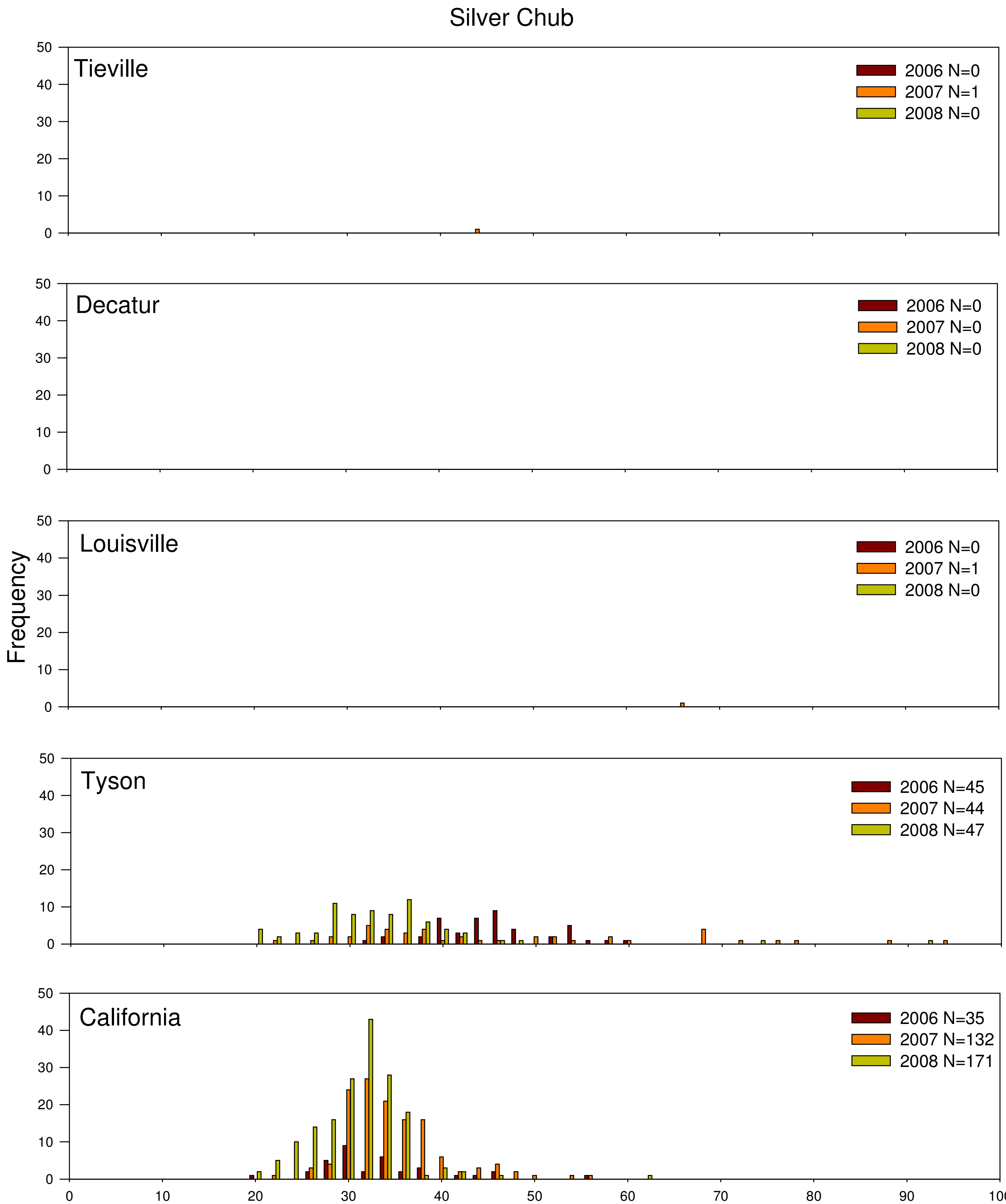


Figure III.1.39. Length frequency histogram for silver chub caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

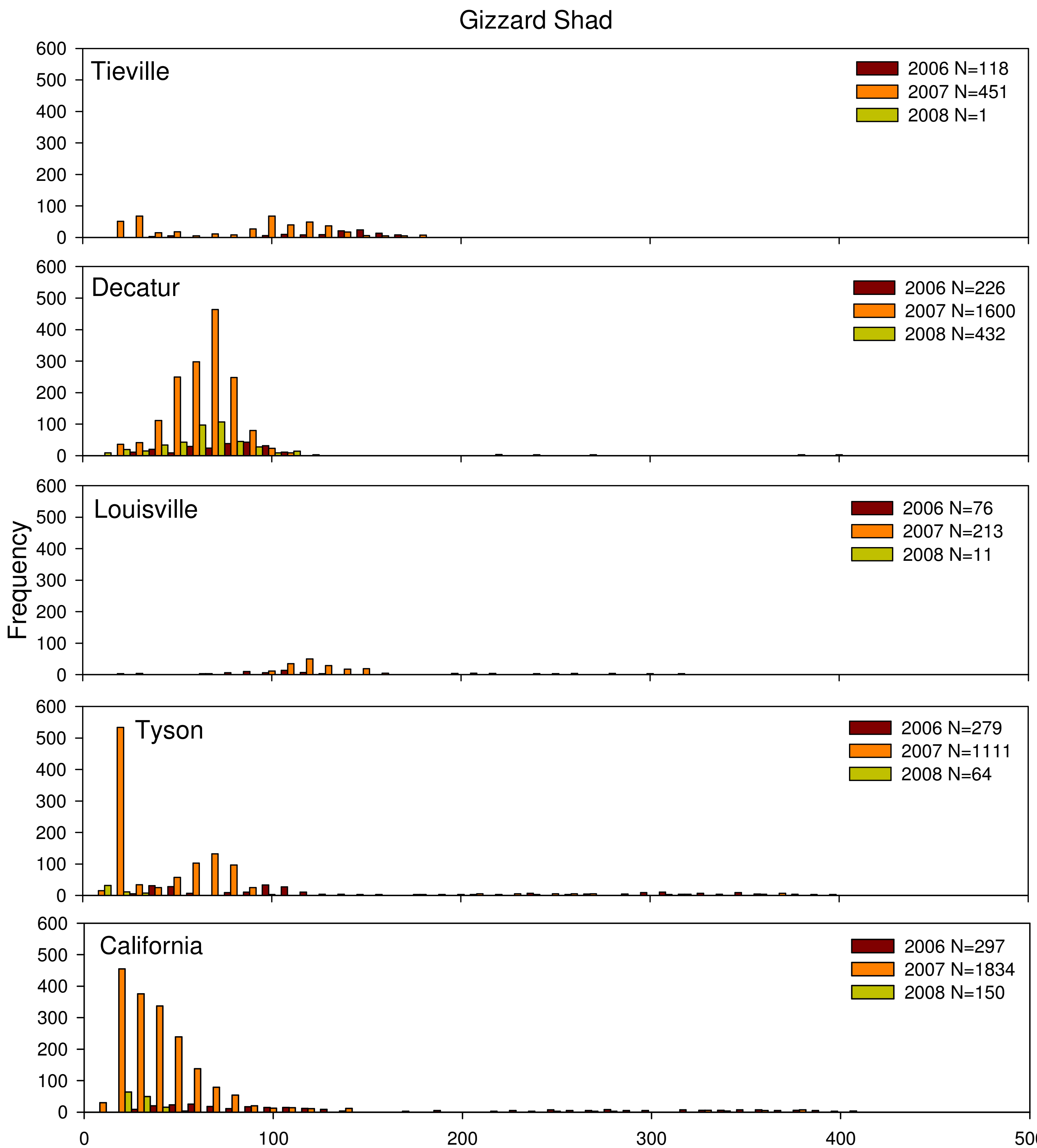


Figure III.1.40. Length frequency histogram for gizzard shad caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

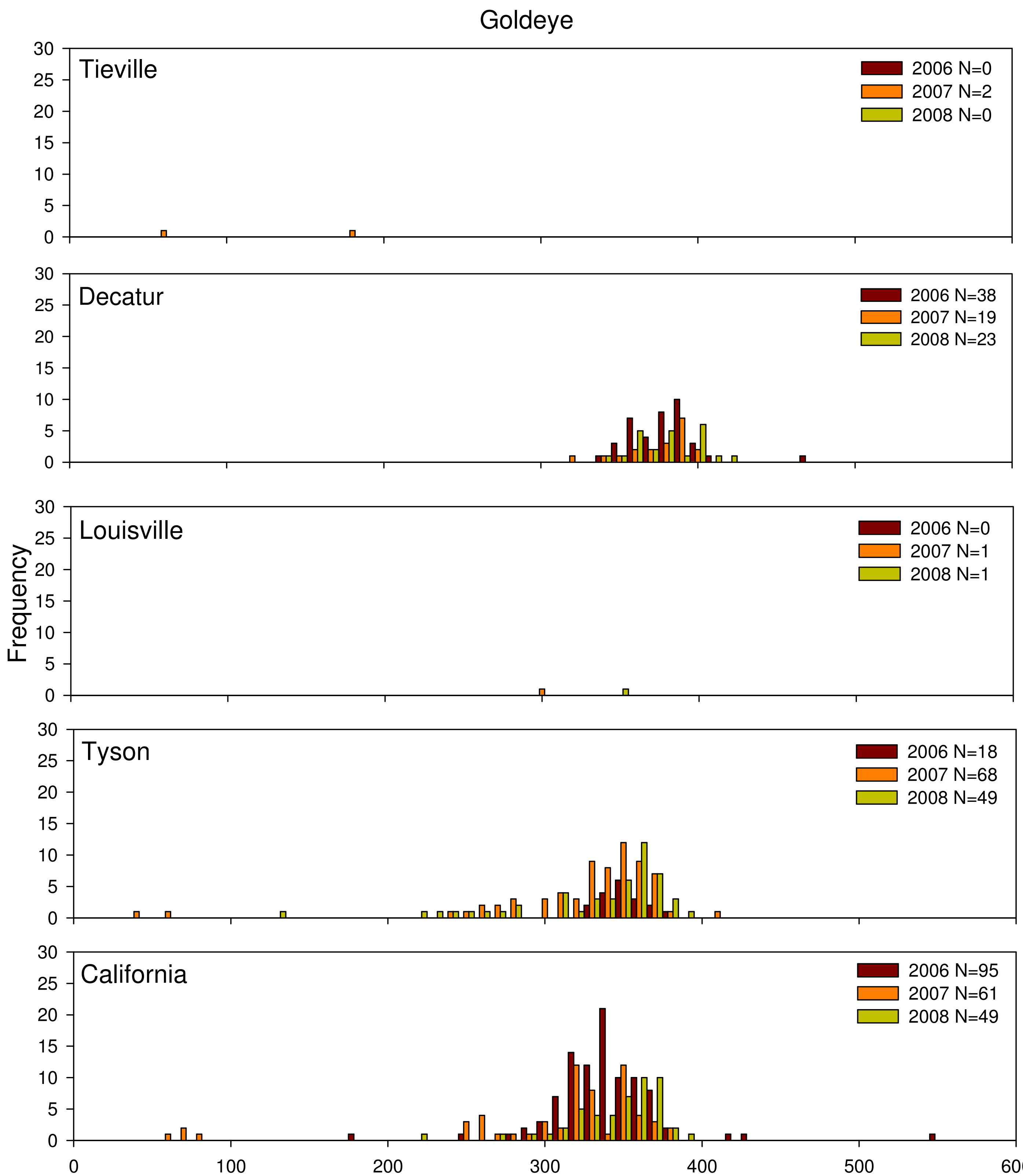
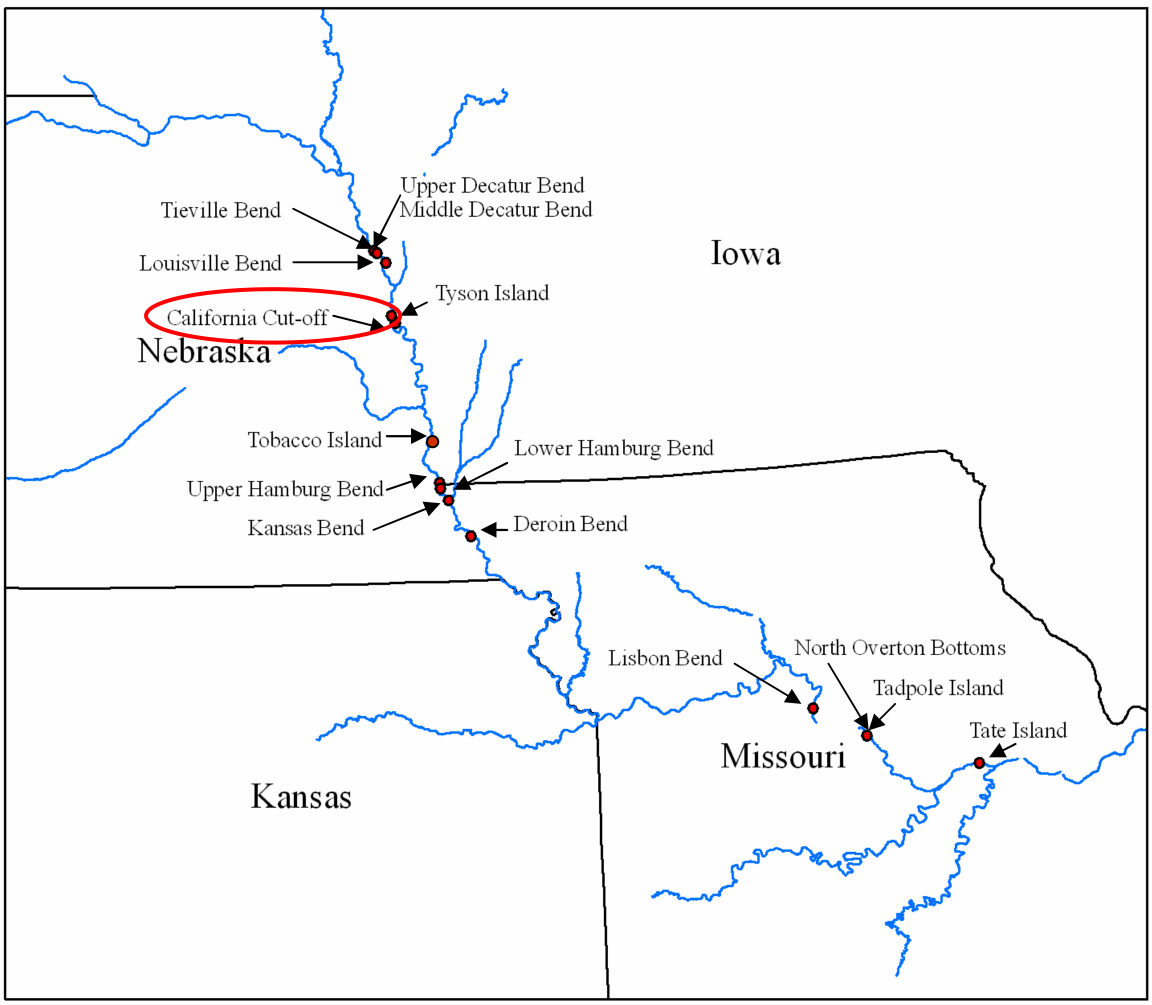


Figure III.1.41. Length frequency histogram for goldeye caught at Tieville Bend, Decatur Bend, Louisville Bend, Tyson Island and California Bend with all gears in 2006-2008.

Figure III.1.42. Photo of the Tieville Bend outlet structure during pump operation to facilitate fish movement.

Figure III.1.43. Photo of the Tieville Bend outlet structure without pump operation to facilitate fish movement.

Section III
Chapter 2
California Cut-off
Iowa



LIST OF TABLES

Table Page

LIST OF FIGURES

Figure .... Page

Figure ....Page

In total 44 identifiable species were caught at California (IA) from 2006 - 2008 (Table III.2.1). Annual species richness at California (IA) changed little during the three years of this study (Table III.2.2) and monthly species richness was similar among years (Figure III.2.1). Species evenness did not differ among years, ranging from 0.76 - 0.82 on a scale from 0 - 1 (Table III.2.2). Species diversity was similar among years, ranging from 2.73 - 2.84 on a scale of 0 - 5 (Shannon's Index) and 0.91 - 0.92 on a scale of 0 - 1 (Simpson's Index). Community assemblage was marginally similar among years (Table III.2.3), ranging from 66 - 71% similar (Morisita's Index).

In total 2,910 fish were caught at California (IA) from 2006 - 2008 (Table III.2.1). Only two fish could not be identified past family. Species that represented greater than 1% of our total catch for this chute, excluding non-target species (e.g. gar, common carp; Table III.2.1) are presented here with analysis, including; proportion of juveniles per species between years (z-test, Table III.2.4), species length frequency distributions between years (Kolmogorov-Smirnov test, Table III.2.5), species mean length between years (t-test, Table III.2.6) and species catch per unit effort (CPUE) by gear between years (Kruskal-Wallis test, Table III.2.7). Juveniles were determined by length (Table I.1.1). Additionally we have reported our monthly CPUE for all species (Table III.2.8). Two additional species of concern are noted, pallid sturgeon and paddlefish.

Pallid Sturgeon

No pallid sturgeon were sampled at California (IA) in 2006 or 2008. One pallid sturgeon was sampled with standard sampling gear at California (IA) in 2007. The pallid

sturgeon was sampled with a 2' hoop net (CPUE = 0.02 fish per net night). The fish was sampled in April, had a fork length of 380 mm and was hatchery spawned.

Shovelnose Sturgeon

In total 23 shovelnose sturgeon (63% juveniles, <540 mm) were sampled with standard sampling gears at California (IA) in 2006. Shovelnose sturgeon were sampled with electrofishing (n = 1, CPUE = 0.32 fish per hour), 4' hoop nets (n = 3, CPUE = 0.06 fish per net night), 2' hoop nets (n = 4, CPUE = 0.13 fish per net night), 8' otter trawls (n = 1, CPUE = 0.04 fish per 100 m trawled) and trammel nets (n = 14, CPUE = 0.84 fish per 125 ft of net drifted 100 m). Mean fork length of shovelnose sturgeon was 528 mm and ranged from 364 to 628 mm.

In total 18 shovelnose sturgeon (89% juveniles, <540 mm) were sampled with standard sampling gears at California (IA) in 2007. Shovelnose sturgeon were sampled with electrofishing (n = 3, CPUE = 1.40 fish per hour), 4' hoop nets (n = 3, CPUE = 0.07 fish per net night), 2' hoop nets (n = 1, CPUE = 0.02 fish per net night) and trammel nets (n = 11, CPUE = 1.04 fish per 125 ft of net drifted 100 m). Monthly catches of shovelnose sturgeon ranged from 2 in June to 9 in September. Mean fork length of shovelnose sturgeon was 531 mm and ranged from 359 to 623 mm.

In total 44 shovelnose sturgeon (68% juveniles, <540 mm) were sampled with standard sampling gears at California (IA) in 2008. Shovelnose sturgeon were sampled with electrofishing (n = 2, CPUE = 0.99 fish per hour), 4' hoop nets (n = 20, CPUE = 0.43 fish per net night), 2' hoop nets (n = 5, CPUE = 0.11 fish per net night), 8' otter trawls (n = 2, CPUE = 0.08 fish per 100 m trawled) and trammel nets (n = 15, CPUE = 1.25 fish per 125 ft of net drifted 100 m). Monthly catches of shovelnose sturgeon

ranged from 1 in April and October to 14 in May. Mean fork length of shovelnose sturgeon was 569 mm and ranged from 382 to 701 mm.

We compared proportion of juveniles between years using a z-test. Shovelnose sturgeon life stage proportions were not significantly different between years (Figure III.2.2, Table III.2.4).

We compared length frequency distributions of shovelnose sturgeon between years using a Kolmogorov-Smirnov test. Shovelnose sturgeon length frequency distributions at California (IA) were not significantly different between years (Figure III.2.3, Table III.2.5). Mean length between years was compared using a t-test. Mean length was significantly different between 2006 and 2008 (Table III.2.6), mean length was higher in 2008.

We compared shovelnose sturgeon CPUE between years using a Kruskal-Wallis test. Shovelnose sturgeon catch rates were not significantly different between years (Table III.2.7).

Paddlefish

No paddlefish were sampled at California (IA) during 2006 or 2007. One paddlefish was sampled in a 4' hoop net (CPUE = 0.02 fish per net night) at California (IA) in September of 2008. The paddlefish measured 842 mm from the front of the eye to the fork of the tail.

Goldeye

In total 49 goldeye (93% juveniles, <356 mm) were sampled with standard gears at California (IA) during 2006. Goldeye were sampled with electrofishing (n = 21, CPUE = 5.51 fish per hour), 4' hoop nets (n = 10, CPUE = 0.20 fish per net night) and trammel nets (n = 18, CPUE = 1.36 fish per 125 ft of net drifted 100 m). Monthly catches of goldeye ranged from 0 in October to 20 in April. Mean total length of goldeye sampled was 303 mm ranging from 162 to 399 mm.

In total 26 goldeye (69% juveniles, <356 mm) were sampled with standard gears at California (IA) during 2007. Goldeye were sampled with electrofishing (n = 5, CPUE = 2.46 fish per hour), 4' hoop nets (n = 14, CPUE = 0.31 fish per net night) and trammel nets (n = 7, CPUE = 0.56 fish per 125 ft of net drifted 100 m). Monthly catches of goldeye ranged from 2 in August and September to 9 in May. Mean total length of goldeye sampled was 339 mm ranging from 203 to 382 mm.

In total 48 goldeye (71% juveniles, <356 mm) were sampled with standard gears at California (IA) during 2008. Goldeye were sampled with electrofishing (n = 11, CPUE = 5.85 fish per hour), 4' hoop nets (n = 25, CPUE = 0.53 fish per net night), 2' hoop nets (n = 2, CPUE = 0.04 fish per net night) and trammel nets (n = 10, CPUE = 0.73 fish per 125 ft of net drifted 100 m). Monthly catches of goldeye ranged from 0 in October to 10 in May. Mean total length of goldeye sampled was 334 mm ranging from 206 to 426 mm.

We compared proportion of juveniles between years using a z-test. Goldeye life stage proportions were significantly different, more juveniles were caught, in 2006 (Figure III.2.4, Table III.2.4)

We compared length frequency distributions of goldeye between years using a Kolmogorov-Smirnov test. Goldeye length frequency distributions at California (IA) were not significantly different between years (Figure III.2.5, Table III.2.5). Mean length between years was compared using a t-test. Mean length was significantly different in 2006 (Table III.2.6). Mean length was lower in 2006 because significantly more juveniles were caught.

We compared goldeye CPUE between years using a Kruskal-Wallis test. Goldeye catch rates were not significantly different between years (Table III.2.7).

Gizzard Shad

In total 46 gizzard shad (94% juveniles, <229 mm) were sampled with standard gears at California (IA) during 2006. All gizzard shad were sampled with electrofishing (CPUE = 16.16 fish per hour). Monthly catches ranged from 0 in October to 23 in September. Mean total length of gizzard shad sampled was 180 mm ranging from 85 to 376 mm.

In total 95 gizzard shad (77% juveniles, <229 mm) were sampled with standard gears at California (IA) during 2007. Gizzard shad were sampled with electrofishing (n = 45, CPUE = 19.80 fish per hour), 4' hoop nets (n = 41, CPUE = 0.91 fish per net night), 2' hoop nets (n = 1, CPUE = 0.02 fish per net night) and push trawls (n = 8, CPUE = 0.35 fish per 100 m trawled). Monthly catches ranged from 2 in May to 43 in April. Mean total length of gizzard shad sampled was 157 mm ranging from 20 to 355 mm.

In total five gizzard shad (80% juveniles, <229 mm) were sampled with standard gears at California (IA) during 2008. Gizzard shad were sampled with electrofishing (n =

4, CPUE = 1.91 fish per hour) and push trawls (n = 1, CPUE = 0.04 fish per 100 m trawled). Monthly catches ranged from 0 in April, June, July and October to 3 in August. Mean total length of gizzard shad sampled was 119 mm ranging from 74 to 252 mm.

We compared proportion of juveniles between years using a z-test. Significantly more juvenile gizzard shad were caught in 2006 than 2007 (Figure III.2.6, Table III.2.4).

We compared length frequency distributions of gizzard shad between years using a Kolmogorov-Smirnov test. Gizzard shad length frequency distributions at California (IA) were significantly different in 2008 (Figure III.2.7, Table III.2.5), only five gizzard shad were caught in 2008. Mean length between years was compared using a t-test. Mean lengths were not significantly different between years (Table III.2.6).

We compared gizzard shad CPUE between years using a Kruskal-Wallis test. Gizzard shad catch rates were significantly higher in 2006 than 2008 for electrofishing (Table III.2.7).

Speckled Chub

Two speckled chubs, one adult and one juvenile, were sampled in an 8' otter trawl (CPUE = 0.05 fish per 100 m trawled) at California (IA) in October 2006. They were 30 and 44 mm in total length, averaging 37 mm.

In total five juvenile speckled chubs were sampled at California (IA) in 2007. Speckled chubs were sampled with push trawls (CPUE = 0.21 fish per 100 m trawled). Monthly speckled chub catches ranged from 0 in April through July and October to 4 in August. Mean length of speckled chubs sampled was 30 mm ranging from 27 to 34 mm.

In total 35 speckled chubs (80% juveniles, <40 mm) were sampled with standard gears at California (IA) in 2008. Speckled chubs were sampled with 8' otter trawls (n = 24, CPUE = 0.87 fish per 100 m trawled) and push trawls (n = 11, CPUE = 0.44 fish per 100 m trawled). Monthly speckled chub catches ranged from 0 in July and August to 19 in September. Mean length of speckled chubs sampled was 35 mm ranging from 22 to 47 mm.

We compared proportion of juveniles between years using a z-test. Speckled chub life stage proportions were not significantly different between years (Figure III.2.8, Table III.2.4).

We compared length frequency distributions of speckled chubs between years using a Kolmogorov-Smirnov test. Speckled chub length frequency distributions at California (IA) were significantly different between 2007 and 2008 (Figure III.2.9, Table III.2.5), smaller fish were caught in 2007. Mean length between years was compared using a t-test. Mean lengths were not significantly different between years (Table III.2.6).

We compared speckled chub CPUE between years using a Kruskal-Wallis test. Speckled chub catch rates were not significantly different between years (Table III.2.7).

Silver Chub

In total 10 silver chubs (93% juveniles, <89 mm) were sampled with standard gears at California (IA) during 2006. Silver chubs were sampled with 8' otter trawls (CPUE = 0.44 fish per 100 m trawled). Monthly catches of silver chubs ranged from 0 in

June to 8 in October. Mean total length of silver chubs was 75 mm ranging from 40 to 96 mm.

In total 88 juvenile silver chubs (<89 mm) were sampled with standard gears at California (IA) during 2007. Silver chubs were sampled with push trawls (CPUE = 3.80 fish per 100 m trawled). Monthly catches of silver chubs ranged from 0 in October to 38 in August. Mean total length of silver chubs was 51 mm ranging from 15 to 84 mm.

In total 101 juvenile silver chubs (<89 mm) were sampled with standard gears at California (IA) during 2008. Silver chubs were sampled with 8' otter trawls (n = 36, CPUE = 1.32 fish per 100 m trawled) and push trawls (n = 65, CPUE = 2.88 fish per 100 m trawled). Monthly catches of silver chubs ranged from 2 in May to 48 in July. Mean total length of silver chubs sampled was 41 mm ranging from 24 to 87 mm.

We compared proportion of juveniles between years using a z-test. Significantly less juvenile silver chubs were caught in 2006 (93%; Figure III.2.10, Table III.2.4), 100% of the catch in 2007 and 2008 was juveniles.

We compared length frequency distributions of silver chubs between years using a Kolmogorov-Smirnov test. Silver chub length frequency distributions at California (IA) were significantly different in 2006 (Figure III.2.11, Table III.2.5), less juvenile and small size fish were caught in 2006. Mean length between years was compared using a t-test. Mean lengths were significantly different between all years (Table III.2.6). Mean length decreased each year.

We compared silver chub CPUE between years using a Kruskal-Wallis test. Silver chub catch rates were not significantly different between years (Table III.2.7).

Red Shiner

No red shiners were sampled in 2006.

In total 29 red shiners (24% juveniles, <46 mm) were sampled with standard gears at California (IA) in 2007. Red shiners were sampled with electrofishing (n = 6, CPUE = 2.45 fish per hour) and push trawls (n = 23, CPUE = 0.98 fish per 100 m trawled). Monthly red shiner catch rates ranged from 0 in April, May and October to 10 in June. Mean total length for red shiners sampled was 55 mm ranging from 40 to 74 mm.

In total 23 red shiners (39% juveniles, <46 mm) were sampled with standard gears at California (IA) in 2008. Red shiners were sampled with electrofishing (n = 2, CPUE = 0.94 fish per hour), 8' otter trawls (n = 2, CPUE = 0.07 fish per 100 m trawled) and push trawls (n = 19, CPUE = 0.85 fish per 100 m trawled). Monthly red shiner catch rates ranged from 0 in October to 13 in July. Mean total length for red shiners sampled was 49 mm ranging from 32 to 69 mm.

We compared proportion of juveniles between years using a z-test. Red shiner life stage proportions were not significantly different between 2007 and 2008 (Figure III.2.12, Table III.2.4).

We compared length frequency distributions of red shiners between years using a Kolmogorov-Smirnov test. Red shiner length frequency distributions at California (IA) were not significantly different between 2007 and 2008 (Figure III.2.13, Table III.2.5). Mean length between years was compared using a t-test. Mean length was significantly longer in 2007 than 2008 (Table III.2.6).

We compared red shiner CPUE between years using a Kruskal-Wallis test. Red shiner catch rates were not significantly different between years (Table III.2.7).

Spotfin Shiner

In total three adult spotfin shiners were sampled with standard gears at California (IA) in 2006. Spotfin shiners were sampled with electrofishing (CPUE = 1.15 fish per hour) and were caught in September. Mean total length was 72 mm and ranged from 67 to 78 mm.

In total 121 spotfin shiners (97% juveniles, <64 mm) were sampled with standard gears at California (IA) in 2007. Spotfin shiners were sampled with electrofishing (n = 18, CPUE = 6.87 fish per hour) and push trawls (n = 103, CPUE = 4.35 fish per 100 m trawled). Monthly catch rates ranged from 0 in April and October to 52 in June. Mean total length was 54 mm and ranged from 28 to 73 mm.

In total 11 spotfin shiners (91% juveniles, <64 mm) were sampled with standard gears at California (IA) in 2008. Spotfin shiners were sampled with push trawls (CPUE = 0.50 fish per 100 m trawled). Monthly catch rates ranged from 0 in May and August thru October to 6 in July. Mean total length was 58 mm and ranged from 47 to 74 mm.

We compared proportion of juveniles between years using a z-test. Spotfin shiner life stage proportions were significantly different in 2006 (Figure III.2.14, Table III.2.4). Three adults were the only spotfin shiners caught in 2006.

We compared length frequency distributions of spotfin shiners between years using a Kolmogorov-Smirnov test. Spotfin shiner length frequency distributions at California (IA) were significantly different between all years (Figure III.2.15, Table III.2.5). Mean length between years was compared using a t-test. Mean length was

significantly higher in 2006 than 2007 (Table III.2.6). Mean length was also higher in 2006 than 2008, although not statistically significant (Table III.2.6, p=0.0490).

We compared spotfin shiner CPUE between years using a Kruskal-Wallis test. Spotfin shiner catch rates were not significantly different between years (Table III.2.7).

Emerald Shiner

In total 54 emerald shiners (94% juveniles, <64 mm) were sampled with standard gears at California (IA) in 2006. Emerald shiners were sampled with electrofishing (CPUE = 20.23 fish per hour). Monthly catch rates ranged from 0 in April, May, August and October to 48 in September. Mean total length was 65 mm and ranged from 38 to 76 mm.

In total 276 emerald shiners (96% juveniles, <64 mm) were sampled with standard gears at California (IA) in 2007. Emerald shiners were sampled with electrofishing (n = 15, CPUE = 7.28 fish per hour) and push trawls (n = 261, CPUE = 10.96 fish per 100 m trawled). Monthly catch rates ranged from 0 in October to 176 in August. Mean total length of emerald shiners at California (IA) was 48 mm and ranged from 24 to 80 mm.

In total 123 emerald shiners (82% juveniles, <64 mm) were sampled with standard gears at California (IA) in 2008. Emerald shiners were sampled with electrofishing (n = 6, CPUE = 2.62 fish per hour), 8' otter trawls (n = 8, CPUE = 0.28 fish per 100 m trawled) and push trawls (n = 109, CPUE = 4.42 fish per 100 m trawled). Monthly catch rates ranged from 7 in October to 42 in May. Mean total length was 60 mm and ranged from 23 to 100 mm.

We compared proportion of juveniles between years using a z-test. Significantly less juvenile emerald shiners were caught in 2008 (Figure III.2.16, Table III.2.4).

We compared length frequency distributions of emerald shiners between years using a Kolmogorov-Smirnov test. Emerald shiner length frequency distributions at California (IA) were significantly different in 2006 (Figure III.2.17, Table III.2.5), fewer small fish were caught in 2006. Mean length between years was compared using a t-test. Emerald shiners in 2007, 96% juveniles, had a significantly lower mean length (Table III.2.6).

We compared emerald shiner CPUE between years using a Kruskal-Wallis test. Emerald shiner catch rates were not significantly different between years (Table III.2.7).

River Shiner

In total 19 river shiners (80% juveniles, <51 mm) were sampled with standard gears at California (IA) during 2006. River shiners were sampled with electrofishing (n = 17, CPUE = 7.38 fish per hour) and 8' otter trawls (n = 2, CPUE = 0.07 fish per 100 m trawled). Monthly catch rates ranged from 0 in April, May, July and October to 16 in September. Mean total length of river shiners was 42 mm ranging from 27 to 76 mm.

In total 127 river shiners (96% juveniles, <51 mm) were sampled with standard gears at California (IA) during 2007. River shiners were sampled with electrofishing (n = 35, CPUE = 14.05 fish per hour) and push trawls (n = 92, CPUE = 3.84 fish per 100 m trawled). Monthly catch rates ranged from 2 in May to 44 in June. Mean total length of river shiners was 37 mm ranging from 18 to 62 mm.

In total 60 river shiners (98% juveniles, <51 mm) were sampled with standard gears at California (IA) during 2008. River shiners were sampled with 8' otter trawls (n = 3, CPUE = 0.13 fish per 100 m trawled) and push trawls (n = 57, CPUE = 2.48 fish per 100 m trawled). Monthly catch rates ranged from 1 in August to 25 in June. Mean total length of river shiners was 34 mm ranging from 21 to 58 mm.

We compared proportion of juveniles between years using a z-test. Proportion on juvenile river shiners was significantly lower in 2006 (Figure III.2.18, Table III.2.4).

We compared length frequency distributions of river shiners between years using a Kolmogorov-Smirnov test. River shiner length frequency distributions at California (IA) were significantly different between 2006 and 2007 (Figure III.2.19, Table III.2.5). Mean length between years was compared using a t-test. Mean length was significantly higher in 2006 (Table III.2.6). More larger, adult fish were caught in 2006.

We compared river shiner CPUE between years using a Kruskal-Wallis test. River shiner catch rates were not significantly different between years (Table III.2.7).

Sand Shiner

No sand shiners were sampled in 2006.

In total 20 sand shiners (60% juveniles, <43 mm) were sampled with standard gears at California (IA) during 2007. Sand shiners were sampled with electrofishing (n = 2, CPUE = 1.00 fish per hour) and push trawls (n = 18, CPUE = 0.80 fish per 100 m trawled). Monthly catch rates ranged from 0 in August and October to 7 in April. Mean total length for sand shiners was 42 mm ranging from 32 to 51 mm.

In total 67 sand shiners (97% juveniles, <43 mm) were sampled with standard gears at California (IA) during 2008. Sand shiners were sampled with 8' otter trawls (n = 3, CPUE = 0.12 fish per 100 m trawled) and push trawls (n = 64, CPUE = 3.00 fish per 100 m trawled). Monthly catch rates ranged from 0 in April, July, and October to 48 in August. Mean total length for sand shiners was 38 mm ranging from 22 to 61 mm.

We compared proportion of juveniles between years using a z-test. Sand shiner life stage proportions were significantly different between 2007 and 2008 (Figure III.2.20, Table III.2.4), significantly more juveniles were caught in 2008.

We compared length frequency distributions of sand shiners between years using a Kolmogorov-Smirnov test. Sand shiner length frequency distributions at California (IA) were not significantly different between 2007 and 2008 (Figure III.2.21, Table III.2.5). Mean length between years was compared using a t-test. Mean length was significantly different between 2007 and 2008 (Table III.2.6), mean length was significantly higher in 2007 when more adults were caught.

We compared sand shiner CPUE between years using a Kruskal-Wallis test. Sand shiner catch rates were not significantly different between years (Table III.2.7).

Fathead Minnow

No fathead minnows were sampled in 2006.

One adult fathead minnow was sampled with standard gears at California (IA) during 2007. The fathead minnow was sampled with a push trawl (CPUE = 0.04 fish per 100 m trawled) during August and was 47 mm long.

In total 14 fathead minnows (93% juveniles, <41 mm) were sampled with standard gears at California (IA) during 2008. Fathead minnows were sampled with push trawls (n = 14, CPUE = 0.57 fish per 100 m trawled) during the month of July. Mean total length for fathead minnows was 34 mm ranging from 28 to 52 mm.

We compared proportion of juveniles between years using a z-test. Fathead minnow life stage portions were significantly different between 2007 and 2008 (Figure III.2.22, Table III.2.4), only one adult fathead minnow was caught in 2007.

We compared length frequency distributions of fathead minnows between years using a Kolmogorov-Smirnov test. Fathead minnow length frequency distributions at California (IA) were not significantly different between 2007 and 2008 (Figure III.2.23, Table III.2.5). Mean length between years was compared using a t-test. Mean length was not significantly different between 2007 and 2008 (Table III.2.6).

We compared fathead minnow CPUE between years using a Kruskal-Wallis test. Fathead minnow catch rates were not significantly different between years (Table III.2.7).

Bighead Carp

Two bighead carp, one adult and one juvenile, were sampled in 2006 with a 4' hoop net (n = 1, CPUE = 0.02 fish per net night) in April and a trammel net (n = 1, CPUE = 0.09 fish per 125 ft of net drifted 100 m) in May. Total length of these fish was 472 and 783 mm, averaging 628 mm.

In total 251 bighead carp (94% juveniles, <625 mm) were sampled with standard gears at California (IA) during 2007. Bighead carp were sampled with 4' hoop nets (n = 249, CPUE = 5.18 fish per net night) and 2' hoop nets (n = 2, CPUE = 0.04 fish per net

night). Monthly catch rates ranged from 0 in April and October to 72 in September. Mean total length of bighead carp sampled was 556 mm ranging from 464 mm to 1 m.

In total five bighead carp (20% juveniles, <625 mm) were sampled with 4' hoop nets (CPUE = 0.11 fish per net night) at California (IA) during July 2008. Mean total length of bighead carp sampled was 670 mm ranging from 608 to 721 mm.

We compared proportion of juveniles between years using a z-test. Significantly more juvenile bighead carp were caught in 2007 (Figure III.2.24, Table III.2.4).

We compared length frequency distributions of bighead carp between years using a Kolmogorov-Smirnov test. Bighead carp length frequency distributions at California (IA) were significantly different between 2007 and 2008 (Figure III.2.25, Table III.2.5). Mean length between years was compared using a t-test. Mean length was significantly lower in 2007 than 2008 (Table III.2.6). Significantly more small fish were caught in 2007.

We compared bighead carp CPUE between years using a Kruskal-Wallis test. Bighead carp catch rates were significantly higher in 2007 than 2008 for 4' hoop nets (Table III.2.7).

River Carpsucker

In total 20 river carpsuckers (75% juveniles, <305 mm) were sampled with standard gears at California (IA) during 2006. River carpsuckers were sampled with electrofishing (n = 19, CPUE = 4.58 fish per hour) and 4' hoop nets (n = 1, CPUE = 0.02 fish per net night). Monthly catch rates ranged from 0 in July and October to 11 in April. Mean total length of river carpsuckers was 304 mm ranging from 134 to 520 mm.

In total 62 river carpsuckers (37% juveniles, <305 mm) were sampled with standard gears at California (IA) during 2007. River carpsuckers were sampled with electrofishing (n = 14, CPUE = 6.02 fish per hour), 4' hoop nets (n = 42, CPUE = 0.93 fish per net night), 2' hoop nets (n = 2, CPUE = 0.05 fish per net night), push trawls (n = 2, CPUE = 0.09 fish per 100 m trawled) and trammel nets (n = 2, CPUE = 0.16 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in October to 23 in July. Mean total length of river carpsuckers was 339 mm ranging from 28 to 521 mm.

In total 81 river carpsuckers (62% juveniles, <305 mm) were sampled with standard gears at California (IA) during 2008. River carpsuckers were sampled with electrofishing (n = 8, CPUE = 4.02 fish per hour), 4' hoop nets (n = 63, CPUE = 1.34 fish per net night), 2' hoop nets (n = 4, CPUE = 0.09 fish per net night), 8' otter trawls (n = 3, CPUE = 0.11 fish per 100 m trawled), push trawls (n = 2, CPUE = 0.08 fish per 100 m trawled) and trammel nets (n = 1, CPUE = 0.21 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in October to 24 in August. Mean total length of river carpsuckers was 355 mm ranging from 36 to 514 mm.

We compared proportion of juveniles between years using a z-test. The proportion of juvenile river carpsuckers was significantly lower in 2007 (Figure III.2.26, Table III.2.4).

We compared length frequency distributions of river carpsuckers between years using a Kolmogorov-Smirnov test. River carpsucker length frequency distributions at California (IA) were significantly different in 2006 (Figure III.2.27, Table III.2.5), fewer small and large fish were caught in 2006. Mean length between years was compared using a t-test. Mean length was not significantly different between years (Table III.2.6).

We compared river carpsucker CPUE between years using a Kruskal-Wallis test. River carpsucker catch rates were significantly lower in 2006 for 4' hoop nets (Table III.2.7).

Blue Sucker

In total 14 blue suckers (9% juveniles, <508 mm) were sampled with standard gears at California (IA) during 2006. Blue suckers were sampled with electrofishing (n = 1, CPUE = 0.42 fish per hour), 4' hoop nets (n = 3, CPUE = 0.06 fish per net night), 2' hoop nets (n = 5, CPUE = 0.16 fish per net night) and trammel nets (n = 5, CPUE = 0.24 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in April, August and October to 7 in July. Mean total length of blue suckers was 567 mm ranging from 356 to 664 mm.

In total 15 blue suckers (20% juveniles, <508 mm) were sampled with standard gears at California (IA) during 2007. Blue suckers were sampled with electrofishing (n = 3, CPUE = 1.53 fish per hour), 4' hoop nets (n = 8, CPUE = 0.18 fish per net night), 2' hoop nets (n = 1, CPUE = 0.02 fish per net night) and trammel nets (n = 3, CPUE = 0.25 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in April, August and October to 5 in July and September. Mean total length of blue suckers sampled in 2007 was 614 mm ranging from 483 to 743 mm.

In total 12 blue suckers (42% juveniles, <508 mm) were sampled with standard gears at California (IA) during 2008. Blue suckers were sampled with electrofishing (n = 1, CPUE = 0.53 fish per hour), 4' hoop nets (n = 5, CPUE = 0.11 fish per net night), push trawls (n = 3, CPUE = 0.14 fish per 100 m trawled) and trammel nets (n = 3, CPUE =

0.23 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in April, May and October to 5 in June and July. Mean total length of blue suckers sampled in 2008 was 476 mm ranging from 26 to 690 mm.

We compared proportion of juveniles between years using a z-test. Blue sucker life stage proportions were significantly different between 2006 and 2008 (Figure III.2.28, Table III.2.4). The proportion of juvenile blue suckers caught increased each year.

We compared length frequency distributions of blue suckers between years using a Kolmogorov-Smirnov test. Blue sucker length frequency distributions at California (IA) were not significantly different between years (Figure III.2.29, Table III.2.5). Mean length between years was compared using a t-test. Mean length was not significantly different between years (Table III.2.6).

We compared blue sucker CPUE between years using a Kruskal-Wallis test. Blue sucker catch rates were significantly different between 2006 and 2008 for 2' hoop nets (Table III.2.7), no blue suckers were caught in 2' hoop nets in 2008.

Bigmouth Buffalo

In total three adult bigmouth buffalo (>381 mm) were sampled with standard gears at California (IA) during 2007. Bigmouth buffalo were sampled with electrofishing (n = 2, CPUE = 0.52 fish per hour) and trammel nets (n = 1, CPUE = 0.05 fish per 125 ft of net drifted 100 m). Bigmouth buffalo were caught in April, July and September. Mean total length of bigmouth buffalo sampled was 575 mm ranging from 495 to 709 mm.

In total 38 bigmouth buffalo (8% juveniles, <381 mm) were sampled with standard gears at California (IA) during 2007. Bigmouth buffalo were sampled with electrofishing (n = 8, CPUE = 3.68 fish per hour), 4' hoop nets (n = 27, CPUE = 0.60 fish per net night), push trawls (n = 2, CPUE = 0.09 fish per 100 m trawled) and trammel nets (n = 1, CPUE = 0.10 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in August and October to 16 in May. Mean total length of bigmouth buffalo sampled was 526 mm ranging from 35 to 892 mm.

In total 22 bigmouth buffalo (45% juveniles, <381 mm) were sampled with standard gears at California (IA) during 2008. Bigmouth buffalo were sampled with electrofishing (n = 1, CPUE = 0.61 fish per hour), 4' hoop nets (n = 11, CPUE = 0.23 fish per net night) and push trawls (n = 10, CPUE = 0.46 fish per 100 m trawled). Monthly catch rates ranged from 0 in April and August thru October to 8 in June. Mean total length of bigmouth buffalo sampled was 327 mm ranging from 14 to 724 mm.

We compared proportion of juveniles between years using a z-test. Bigmouth buffalo life stage proportions were significantly different between 2007 and 2008 (Figure III.2.30, Table III.2.4). Proportion of juvenile bigmouth buffalo caught increased each year.

We compared length frequency distributions of bigmouth buffalo between years using a Kolmogorov-Smirnov test. Bigmouth buffalo length frequency distributions at California (IA) were significantly different between 2006 and 2007 (Figure III.2.31, Table III.2.5), fewer juvenile and small fish were caught in 2006. Mean length between years was compared using a t-test. Mean length was significantly different between 2007 and 2008 (Table III.2.6), mean length decreased each year.

We compared bigmouth buffalo CPUE between years using a Kruskal-Wallis test. Bigmouth buffalo catch rates were significantly different between 2006 and 2007 for 4' hoop nets (Table III.2.7), no bigmouth buffalo were caught in hoop nets in 2006.

Shorthead Redhorse

In total 11 shorthead redhorse (25% juveniles, <229 mm) were sampled with standard gears at California (IA) during 2006. Shorthead redhorse were sampled with electrofishing (n = 8, CPUE = 2.30 fish per hour), 2' hoop nets (n = 3, CPUE = 0.09 fish per net night) and 8' otter trawls (n = 1, CPUE = 0.04 fish per 100 m trawled). Monthly catch rates ranged from 0 in July to 5 in May. Mean total length was 268 mm and ranged from 103 to 357 mm.

In total 42 shorthead redhorse (26% juveniles, <229 mm) were sampled with standard gears at California (IA) during 2007. Shorthead redhorse were sampled with electrofishing (n = 17, CPUE = 8.13 fish per hour), 4' hoop nets (n = 27, CPUE = 0.13 fish per net night), 2' hoop nets (n = 11, CPUE = 0.26 fish per net night), push trawls (n = 5, CPUE = 0.23 fish per 100 m trawled) and trammel nets (n = 2, CPUE = 0.24 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in October to 10 in May. Mean total length was 299 mm and ranged from 70 to 420 mm.

In total 12 shorthead redhorse (42% juveniles, <229 mm) were sampled with standard gears at California (IA) during 2008. Shorthead redhorse were sampled with electrofishing (n = 5, CPUE = 2.50 fish per hour), 2' hoop nets (n = 5, CPUE = 0.10 fish per net night), push trawls (n = 1, CPUE = 0.04 fish per 100 m trawled) and 8' otter trawls (n = 1, CPUE = 0.04 fish per 100 m trawled). Monthly catch rates ranged from 0

in September to 3 in July. Mean total length was 266 mm and ranged from 102 to 407 mm.

We compared proportion of juveniles between years using a z-test. Shorthead redhorse life stage proportions were not significantly different between years (Figure III.2.32, Table III.2.4).

We compared length frequency distributions of shorthead redhorse between years using a Kolmogorov-Smirnov test. Shorthead redhorse length frequency distributions at California (IA) were significantly different between all years (Figure III.2.33, Table III.2.5). Mean length between years was compared using a t-test. Mean length was not significantly different between years (Table III.2.6).

We compared shorthead redhorse CPUE between years using a Kruskal-Wallis test. Shorthead redhorse catch rates were not significantly different between years (Table III.2.7).

Channel Catfish

In total 30 channel catfish (90% juveniles, <305 mm) were sampled with standard gears at California (IA) during 2006. Channel catfish were sampled with electrofishing (n = 3, CPUE = 0.52 fish per hour), 4' hoop nets (n = 3, CPUE = 0.06 fish per net night), 2' hoop nets (n = 13, CPUE = 0.41 fish per net night), 8' otter trawls (n = 10, CPUE = 0.43 fish per 100 m trawled) and trammel nets (n = 1, CPUE = 0.05 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 1 in May and October to 10 in June. Mean total length of channel catfish sampled was 167 mm ranging from 16 to 490 mm.

In total 126 channel catfish (82% juveniles, <305 mm) were sampled with standard gears at California (IA) during 2007. Channel catfish were sampled with electrofishing (n = 4, CPUE = 1.84 fish per hour), 4' hoop nets (n = 15, CPUE = 0.33 fish per net night), 2' hoop nets (n = 23, CPUE = 0.53 fish per net night), push trawls (n = 81, CPUE = 3.39 fish per 100 m trawled) and trammel nets (n = 3, CPUE = 0.21 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in October to 60 in August. Mean total length of channel catfish sampled was 173 mm ranging from 31 to 630 mm.

In total 197 channel catfish (81% juveniles, <305 mm) were sampled with standard gears at California (IA) during 2008. Channel catfish were sampled with 4' hoop nets (n = 32, CPUE = 0.68 fish per net night), 2' hoop nets (n = 49, CPUE = 1.04 fish per net night), 8' otter trawls (n = 68, CPUE = 2.52 fish per 100 m trawled), push trawls (n = 45, CPUE = 1.92 fish per 100 m trawled) and trammel nets (n = 3, CPUE = 0.22 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 5 in July to 61 in April. Mean total length of channel catfish sampled was 196 mm ranging from 19 to 666 mm.

We compared proportion of juveniles between years using a z-test. Channel catfish life stage proportions were not significantly different between years (Figure III.2.34, Table III.2.4).

We compared length frequency distributions of channel catfish between years using a Kolmogorov-Smirnov test. Channel catfish length frequency distributions at California (IA) were significantly different between 2006 and 2007 (Figure III.2.35, Table III.2.5). Mean length between years was compared using a t-test. Mean length was not significantly different between years (Table III.2.6).

We compared channel catfish CPUE between years using a Kruskal-Wallis test. Channel catfish catch rates were significantly lower in 2006 than 2007 for 4' hoop nets and significantly lower in 2006 than 2008 for 8' otter trawls (Table III.2.7).

Flathead Catfish

In total 16 flathead catfish (65% juveniles, <381 mm) were sampled with standard gears at California (IA) during 2006. Flathead catfish were sampled with electrofishing (n = 10, CPUE = 3.16 fish per hour), 4' hoop nets (n = 1, CPUE = 0.02 fish per net night) and 2' hoop nets (n = 5, CPUE = 0.16 fish per net night). Monthly catch rates ranged from 0 in October to 5 in July. Mean total length was 366 mm and ranged from 160 to 495 mm.

In total 23 flathead catfish (71% juveniles, <381 mm) was sampled with standard gears at California (IA) during 2007. Flathead catfish were sampled with electrofishing (n = 2, CPUE = 1.00 fish per hour), 4' hoop nets (n = 10, CPUE = 0.22 fish per net night) and 2' hoop nets (n = 11, CPUE = 0.26 fish per net night). Monthly catch rates ranged from 0 in October to 6 in August. Mean total length was 444 mm and ranged from 241 mm to 1.1 m.

In total 30 flathead catfish (50% juveniles, <381 mm) were sampled with standard gears at California (IA) during 2008. Flathead catfish were sampled with 4' hoop nets (n = 10, CPUE = 0.21 fish per net night), 2' hoop nets (n = 19, CPUE = 0.40 fish per net night) and trammel nets (n = 1, CPUE = 0.07 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in October to 11 in June. Mean total length was 445 mm and ranged from 270 mm to 1.1 m.

We compared proportion of juveniles between years using a z-test. Flathead catfish life stage proportions were not significantly different between years (Figure III.2.36, Table III.2.4).

We compared length frequency distributions of flathead catfish between years using a Kolmogorov-Smirnov test. Flathead catfish length frequency distributions at California (IA) were significantly different between 2006 and 2007 (Figure III.2.37, Table III.2.5), more large fish were caught in 2007. Mean length between years was compared using a t-test. Mean lengths were not significantly different between years (Table III.2.6).

We compared flathead catfish CPUE between years using a Kruskal-Wallis test. Flathead catfish catch rates were significantly lower in 2006 than 2007 for 4' hoop nets (Table III.2.7).

Key Findings

- Some native riverine species appear to be using this chute, including: shovelnose and pallid sturgeon, chub species, blue sucker and catfish species.
- Many pool or backwater associated species were common in this chute, including: shortnose gar, goldeye, gizzard shad, common carp, bighead carp, river carpsucker, bigmouth buffalo, shorthead redhorse and freshwater drum.
- In 2007, 50 times more bighead carp were sampled in this chute than other years.
- Young-of-the-year bigmouth buffalo were sampled in 2007 and 2008.
- Very low numbers of gizzard shad were caught in 2008.
- Flathead catfish were present in sizes targeted by sport fishermen, including some trophy-size fish.

Table III.2.1. Total species caught at California (IA) from 2006 - 2008 and the percent of catch that each species represents. *Indicates a species that was used in analysis. †Indicates a species of note for this chute.

Species	Scientific name	2006	2007	2008	Total	% catch
Pallid sturgeon†	*Scaphirhynchus albus*	0	1	0	1	0.03
Shovelnose sturgeon*	*Scaphirhynchus platorynchus*	23	18	44	85	2.92
Paddlefish†	*Polyodon spathula*	0	0	1	1	0.03
Longnose gar	*Lepisosteus osseus*	3	3	3	9	0.31
Shortnose gar	*Lepisosteus platostomus*	6	11	14	31	1.07
Goldeye*	*Hiodon alosoides*	49	26	48	123	4.23
Gizzard shad*	*Dorosoma cepedianum*	46	95	5	146	5.02
Unidentified minnow	*Cyprinidae*	1	1	0	2	0.07
Speckled chub*	*Macrhybopsis aestivalis*	1	5	35	41	1.41
Sturgeon chub	*Macrhybopsis gelida*	1	0	1	2	0.07
Silver chub*	*Macrhybopsis storeriana*	10	88	101	199	6.84
Creek chub	*Semotilus atromaculatus*	0	0	1	1	0.03
Red shiner*	*Cyprinella lutrensis*	0	29	23	52	1.79
Spotfin shiner*	*Cyprinella spiloptera*	3	121	11	135	4.64
Emerald shiner*	*Notropis atherinoides*	54	276	123	453	15.58
River shiner*	*Notropis blennius*	19	127	60	206	7.08
Sand shiner*	*Notropis stramineus*	0	20	75	95	3.27
Fathead minnow*	*Pimephales notatus*	0	1	14	15	0.52
Grass carp	*Ctenopharyngodon idella*	3	5	0	8	0.28
Common carp	*Cyprinus carpio*	22	22	13	57	1.96
Silver carp	*Hypophthalmicthys molitrix*	0	4	0	4	0.14
Bighead carp*	*Hypophthalmicthys nobilis*	2	251	5	258	8.87
River carpsucker*	*Carpiodes carpio*	20	67	81	168	5.78
Quillback	*Carpiodes cyprinus*	0	3	0	3	0.10
Blue sucker*	*Cycleptus elongatus*	14	15	12	41	1.41
Smallmouth buffalo	*Ictiobus bubalus*	3	5	0	8	0.28
Bigmouth buffalo*	*Ictiobus cyprinellus*	3	38	22	63	2.17
Shorthead redhorse*	*Moxostoma macrolepidotum*	11	42	12	65	2.24
Channel catfish*	*Ictalurus punctatus*	30	131	197	358	12.31
Flathead catfish*	*Pylodictis olivaris*	15	24	30	69	2.37
Stonecat	*Noturus flavus*	2	0	2	4	0.14

Table III.2.1 continued. Total species caught at California (IA) from 2006 - 2008 and the percent of catch that each species represents. *Indicates a species that was used in analysis. †Indicates a species of note for this chute.

Species	Scientific name	2006	2007	2008	Total	% catch
Brook silverside	*Labidesthes sicculus*	0	0	1	1	0.03
White bass	*Morone chrysops*	1	14	1	16	0.55
Yellow bass	*Morone mississippiensis*	0	7	1	8	0.28
Green sunfish	*Lepomis cyanellus*	1	1	1	3	0.10
Orangespotted sunfish	*Lepomis humilis*	1	1	1	3	0.10
Bluegill	*Lepomis macrochirus*	2	7	1	10	0.34
Smallmouth bass	*Micropterus dolomieu*	1	0	0	1	0.03
White crappie	*Pomoxis annularis*	1	3	0	4	0.14
Black crappie	*Pomoxis nigromaculatus*	5	2	1	8	0.28
Yellow perch	*Perca flavescens*	0	0	1	1	0.03
Sauger	*Stizostedion canadense*	5	5	3	13	0.45
Walleye	*Stizostedion vitreum*	1	1	3	5	0.17
Freshwater drum	*Aplodinotus grunniens*	33	37	64	134	4.61

Table III.2.2. Species richness (S), species evenness (E), Shannon's diversity index (H) and Simpson's diversity index (D) for California (IA) from 2006 - 2008.

Year	S	E	H	D
2006	32	0.820	2.842	0.9203
2007	36	0.768	2.753	0.9102
2008	36	0.762	2.731	0.9088

Table III.2.3. Community assemblage similarity, using Morisita's index, for California (IA) between years (2006 - 2008).

Year	**2006 v 2007**	**2006 v 2008**	**2007 v 2008**
Morisita's Index	0.6632	0.7128	0.6705

Table III.2.4. Results for analysis of life stage proportions at California (IA) from 2006 - 2008. A z-test was used to determine differences in proportions of juveniles of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold. Analysis was not preformed, all fish caught from both years were juveniles (NA*). Analyses were not preformed, no fish were caught in 2006 (NA†).

	2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**Z**	**p-value**	**Z**	**p-value**	**Z**	**p-value**
Shovelnose sturgeon	-1.92	0.0548	-0.47	0.6384	1.69	0.0910
Goldeye	**3.00**	**0.0026**	**3.16**	**0.0016**	-0.14	0.8886
Gizzard shad	**2.72**	**0.0066**	1.21	0.2262	-0.16	0.8728
Speckled chub	-1.71	0.0872	-1.00	0.3174	1.10	0.2714
Silver chub	**-2.52**	**0.0118**	**-2.70**	**0.0070**	NA*	NA*
Red shiner	NA†	NA†	NA†	NA†	-1.16	0.2460
Spotfin shiner	**-7.17**	**<0.0001**	**-3.09**	**0.0020**	0.96	0.3370
Emerald shiner	-0.52	0.6030	**2.17**	**0.0300**	**4.66**	**<0.0001**
River shiner	**-2.79**	**0.0052**	**-2.93**	**0.0034**	-0.82	0.4122
Sand shiner	NA†	NA†	NA†	NA†	**-4.83**	**<0.0001**
Fathead minnow	NA†	NA†	NA†	NA†	**-2.64**	**0.0082**
Bighead carp	**-11.22**	**<0.0001**	0.79	0.4296	**14.28**	**<0.0001**
River carpsucker	**2.97**	**0.0030**	1.11	0.2670	**-2.96**	**0.0030**
Blue sucker	-0.95	0.3422	**-2.24**	**0.0250**	-1.23	0.2186
Bigmouth buffalo	-0.58	0.5620	-1.72	0.0854	**-3.40**	**0.0006**
Shorthead redhorse	-0.08	0.9362	-0.87	0.3844	-1.04	0.2984
Channel catfish	1.27	0.2040	1.58	0.1140	0.39	0.6966
Flathead catfish	-0.42	0.6744	0.97	0.3320	1.55	0.1212

Table III.2.5. Results for analysis of length frequency distribution at California (IA) from 2006 - 2008. A Kolmogorov-Smirnov test was used to determine differences in length frequency distribution of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold. Analyses could not be performed (NA); no fish were caught in 2006.

	2006 v 2007		2006 v 2008		2007 v 2008	
Species	**D**	**p-value**	**D**	**p-value**	**D**	**p-value**
Shovelnose sturgeon	0.50	0.1308	0.29	0.6672	0.43	0.2343
Goldeye	0.50	0.1972	0.32	0.6639	0.30	0.8186
Gizzard shad	0.31	0.4594	**0.93**	**0.0094**	**1.00**	**0.0033**
Speckled chub	1.00	0.1389	1.00	0.0678	**1.00**	**0.0057**
Silver chub	**0.91**	**<0.0001**	**0.88**	**<0.0001**	0.38	0.0735
Red shiner	NA	NA	NA	NA	0.53	0.0451
Spotfin shiner	**1.00**	**0.0102**	**1.00**	**0.0198**	**0.86**	**0.0001**
Emerald shiner	**0.63**	**0.0010**	**0.62**	**0.0007**	0.22	0.4598
River shiner	**0.64**	**0.0015**	0.38	0.2263	0.27	0.4961
Sand shiner	NA	NA	NA	NA	0.54	0.0754
Fathead minnow	NA	NA	NA	NA	1.00	0.3581
Bighead carp	1.00	0.0536	1.00	0.1389	**0.89**	**0.0101**
River carpsucker	**0.67**	**0.0016**	**0.70**	**0.0009**	0.35	0.1625
Blue sucker	0.56	0.1074	0.70	0.0763	0.58	0.2335
Bigmouth buffalo	**1.00**	**0.0135**	0.88	0.0708	0.37	0.4845
Shorthead redhorse	**0.71**	**0.0275**	**0.78**	**0.0257**	**0.71**	**0.0075**
Channel catfish	**0.54**	**0.0034**	0.41	0.0493	0.26	0.3355
Flathead catfish	**0.64**	**0.0096**	0.36	0.3820	0.36	0.3338

Table III.2.6. Results for analysis of species mean length at California (IA) from 2006 - 2008. A t-test was used to determine differences in mean length of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold. Analyses could not be performed (NA); no fish were caught in 2006.

	2006 v 2007		2006 v 2008		2007 v 2008	
Species	**t**	**p-value**	**t**	**p-value**	**t**	**p-value**
Shovelnose sturgeon	-0.13	0.8944	**-2.41**	**0.0183**	-2.07	0.0420
Goldeye	**-2.92**	**0.0042**	**-2.98**	**0.0035**	0.42	0.6722
Gizzard shad	1.45	0.1483	1.56	0.1217	1.01	0.3163
Speckled chub	1.63	0.1102	0.52	0.6091	-2.08	0.0445
Silver chub	**6.66**	**<0.0001**	**9.54**	**<0.0001**	**5.45**	**<0.0001**
Red shiner	NA	NA	NA	NA	**2.58**	**0.0129**
Spotfin shiner	**2.86**	**0.0049**	1.99	0.0490	-1.20	0.2336
Emerald shiner	**5.97**	**<0.0001**	1.74	0.0836	**-7.00**	**<0.0001**
River shiner	**2.16**	**0.0319**	**3.00**	**0.0031**	1.62	0.1061
Sand shiner	NA	NA	NA	NA	**2.76**	**0.0070**
Fathead minnow	NA	NA	NA	NA	2.21	0.0456
Bighead carp	1.66	0.0986	-0.85	0.3977	**-4.17**	**<0.0001**
River carpsucker	-1.53	0.1276	-1.79	0.0502	-0.61	0.5427
Blue sucker	-0.77	0.4462	1.42	0.1624	2.19	0.0351
Bigmouth buffalo	0.35	0.7286	1.86	0.0673	**3.50**	**0.0009**
Shorthead redhorse	-1.00	0.3204	0.05	0.9608	1.10	0.2758
Channel catfish	-0.81	0.4171	-1.31	0.1899	-0.60	0.5464
Flathead catfish	-1.28	0.2043	-1.49	0.1420	-0.17	0.8665

Table III.2.7. Results for analysis of species catch per unit effort (CPUE) at California (IA) from 2006 - 2008. Effort for each gear is defined as: electrofishing (EFS), fish caught per hour; 4' hoop nets (HNS), fish caught per net night; 2' hoop nets (SHNS), fish caught per net night; push trawls (POT02S), fish caught per 100 m trawled; 8' otter trawls (OT8S), fish caught per 100 m trawled and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Push trawl was not used in 2006. A Kruskal-Wallis test was used to determine differences in CPUE of a species by gear between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

		2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**Gear**	**$\chi2$**	**p-value**	**$\chi2$**	**p-value**	**$\chi2$**	**p-value**
Shovelnose sturgeon	**EFS**	0.02	0.9020	0.07	0.7865	0.00	1.0000
	HNS	0.75	0.3865	0.27	0.6008	1.53	0.2155
	OT8S			0.49	0.4860		
	POT02S					0.00	1.0000
	SHNS	1.41	0.2357	0.13	0.7176	0.71	0.4005
	TN	1.12	0.2894	0.00	1.0000	0.94	0.3333
Goldeye	**EFS**	2.23	0.1351	0.08	0.7837	1.80	0.1801
	HNS	1.52	0.2173	4.17	0.0412	2.70	0.1006
	SHNS	0.00	1.0000	1.50	0.2207	2.20	0.1380
	TN	1.09	0.2971	0.41	0.5218	0.92	0.3367
Gizzard shad	**EFS**	1.26	0.2623	**5.74**	**0.0166**	1.96	0.1611
	HNS	2.18	0.1396	0.00	1.0000	2.18	0.1396
	POT02S					1.53	0.2155
	SHNS	0.67	0.4142	0.00	1.0000	1.00	0.3173
Speckled chub	**OT8S**			1.61	0.2045		
	POT02S					0.51	0.4751
Silver chub	**OT8S**			1.26	0.2622		
	POT02S					1.26	0.2615
Red shiner	**EFS**	3.58	0.0585	1.20	0.2733	0.72	0.3976
	OT8S			0.83	0.3613		
	POT02S					0.10	0.7462
Spotfin shiner	**EFS**	1.53	0.2155	0.83	0.3613	3.03	0.0816
	POT02S					2.40	0.1215
Emerald shiner	**EFS**	0.11	0.7398	0.15	0.7017	0.87	0.3501
	OT8S			1.83	0.1757		
	POT02S					0.03	0.8728
River shiner	**EFS**	0.04	0.8489	1.83	0.1757	1.83	0.1757
	POT02S					0.92	0.3367
Sand shiner	**EFS**	1.00	0.3173	0.00	1.0000	0.83	0.3613
	OT8S			1.83	0.1757		
	POT02S					0.42	0.5189
Fathead minnow	**POT02S**					1.56	0.2110

Species	Gear	2006 v 2007		2006 v 2008		2007 v 2008	
		χ2	p-value	χ2	p-value	χ2	p-value
Bighead carp	**HNS**	6.14	0.0132	0.02	0.9020	**6.14**	**0.0132**
	SHNS	0.67	0.4142	0.00	1.0000	1.00	0.3173
	TN	1.00	0.3173	1.00	0.3173	0.00	1.0000
River carpsucker	**EFS**	0.10	0.7471	1.66	0.1971	0.31	0.5751
	HNS	**6.14**	**0.0132**	**6.14**	**0.0132**	0.16	0.6884
	OT8S			1.83	0.1757		
	SHNS	0.67	0.4142	1.50	0.2207	0.41	0.5233
	TN	1.00	0.3173	1.00	0.3173	0.02	0.9020
Blue sucker	**EFS**	0.71	0.4005	0.07	0.7865	0.49	0.4860
	HNS	0.64	0.4227	0.00	1.0000	0.48	0.4907
	POT02S					1.00	0.3173
	SHNS	3.35	0.0673	**5.63**	**0.0177**	1.00	0.3173
	TN	0.15	0.7032	0.00	1.0000	0.00	1.0000
Bigmouth buffalo	**EFS**	1.15	0.2840	0.05	0.8164	1.12	0.2904
	HNS	**5.23**	**0.0222**	3.58	0.0585	0.56	0.4541
	POT02S					0.15	0.7024
	TN	0.02	0.9020	1.00	0.3173	1.00	0.3173
Shorthead redhorse	**EFS**	2.60	0.1068	1.22	0.2689	3.69	0.0547
	HNS	3.67	0.0555	0.00	1.0000	3.67	0.0555
	OT8S			0.00	1.0000		
	POT02S					0.71	0.4005
	SHNS	1.77	0.1840	0.13	0.7176	2.24	0.1343
	TN	1.00	0.3173	0.00	1.0000	1.00	0.3173
Channel catfish	**EFS**	1.05	0.3051	1.83	0.1757	4.47	0.0345
	HNS	**6.50**	**0.0108**	4.03	0.0447	0.03	0.8705
	OT8S			**5.66**	**0.0174**		
	POT02S					0.23	0.6285
	SHNS	0.42	0.5186	0.42	0.5186	0.95	0.3298
	TN	0.02	0.9020	0.74	0.3912	0.74	0.3912
Flathead catfish	**EFS**	2.37	0.1240	4.47	0.0345	1.83	0.1757
	HNS	**5.43**	**0.0198**	3.87	0.0490	0.01	0.9343
	OT8S			0.00	1.0000		
	POT02S					0.00	1.0000
	SHNS	0.58	0.4457	1.18	0.2775	0.65	0.4201
	TN	0.00	1.0000	1.00	0.3173	1.00	0.3173

Table III.2.8. Species monthly catch per unit effort (± 2 SE) at California (IA) from 2006 - 2008. Effort for each gear is defined as: electrofishing (EFS), fish caught per hour; 4' hoop nets (HNS), fish caught per net night; 2' hoop nets (SHNS), fish caught per net night; push trawls (POT02S), fish caught per 100 m trawled; 8' otter trawls (OT8S), fish caught per 100 m trawled; trammel nets (TN), fish caught per 125 ft of net drifted 100 m and 8' beam trawls (BT8W) a wild gear, fish caught per 100 m trawled. Push trawl was not used in 2006. Otter trawls were not used in 2007. Beam trawls were only used in 2006.

Species	Gear	March	April			May			June			July			August			September			October		
		2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Pallid Sturgeon	**SHNS**			0.14 (0.29)																			
Shovelnose sturgeon	**EFS**										4.97 (9.94)				1.69 (3.39)				15.43 (30.86)				
	HNS						0.38 (0.53)	1.25 (1.80)	0.13 (0.25)		1.13 (1.28)	0.13 (0.25)		0.13 (0.25)	0.13 (0.25)								
	SHNS							0.38 (0.37)		0.13 (0.25)		0.38 (0.53)			0.13 (0.25)		0.25 (0.33)						
	TN				1.25 (2.50)	0.53 (1.05)		0.34 (0.68)	3.79 (2.32)	0.43 (0.86)	0.45 (0.89)	0.92 (1.08)		3.14 (2.16)	0.55 (0.77)	3.42 (3.98)	0.89 (1.77)	2.70 (2.80)	2.12 (2.50)	1.41 (1.83)			
	OT8S										0.20 (0.41)										0.19 (0.38)		0.25 (0.50)
Paddlefish	**HNS**																			0.14 (0.29)			
Longnose gar	**EFS**														1.81 (3.63)								
	HNS						0.13 (0.25)							0.13 (0.25)									
	SHNS						0.25 (0.50)																
	TN														0.35 (0.47)					0.89 (1.04)			
Shortnose gar	**EFS**					3.53 (4.12)	4.68 (5.46)		2.16 (4.32)	4.72 (5.60)			1.62 (3.24)	4.80 (5.56)	3.51 (4.06)	2.87 (5.73)	2.73 (5.45)						
	HNS		0.10 (0.20)	0.13 (0.25)			0.13 (0.25)	0.13 (0.25)						0.38 (0.53)			0.13 (0.25)						
	SHNS						0.13 (0.25)	0.13 (0.25)						0.25 (0.50)		0.13 (0.25)	0.13 (0.25)			0.14 (0.29)			
	TN				0.43 (0.87)														0.41 (0.81)				
Goldeye	**EFS**		14.48		2.50 (5.00)	9.76 (8.88)	10.16 (1.29)	11.27 (13.08)	5.28 (6.58)	2.75 (5.50)	12.76 (5.05)	2.54 (5.07)			7.75 (10.31)		2.73 (5.45)						
	HNS	0.75 (0.33)	0.60 (0.80)	0.25 (0.50)			0.25 (0.50)	0.63 (0.53)		0.25 (0.50)		0.13 (0.25)	0.63 (0.53)	0.50 (0.53)		0.25 (0.33)	0.63 (0.53)	0.38 (0.75)	0.13 (0.25)	0.71 (0.95)			
	SHNS	0.13 (0.25)															0.13 (0.25)						
	TN		2.89 (2.55)	0.80 (1.60)	0.99 (1.16)	1.41 (1.98)	1.11 (0.75)	0.40 (0.80)		0.43 (0.86)	0.83 (0.95)	1.22 (1.63)	0.69 (1.39)	0.82 (1.63)	0.67 (0.75)		0.44 (0.87)	0.52 (1.04)	0.41 (0.81)	0.94 (1.08)			

		April			May			June			July			August			September			October		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Gizzard shad	**EFS**	20.69	5.00 (5.78)		3.44 (4.05)	2.89 (5.79)	2.17 (4.35)	6.76 (8.38)			7.85 (5.24)	2.09 (4.19)		9.81 (7.98)	15.29 (15.97)	7.36 (10.29)	51.81 (14.37)	182.02 (261.18)				
	HNS		5.00 (2.36)			0.13 (0.25)																
	SHNS		0.14 (0.29)																			
	POT02S								0.75 (1.50)			1.08 (1.12)			0.25 (0.50)				0.26 (0.52)			
Unidentified minnow	**OT8S**													0.13 (0.26)								
Speckled chub	**POT02S**			0.75 (1.50)			1.14 (1.51)			0.74 (1.03)					1.00 (1.07)			0.25 (0.50)				
	OT8S			0.30 (0.61)															3.95 (5.51)	0.20 (0.41)		0.85 (1.71)
	BT8W				0.20 (0.41)																	
Sturgeon chub	**OT8S**										0.24 (0.48)					0.21 (0.42)						
Silver chub	**POT02S**		0.34 (0.68)	1.00 (1.07)		4.26 (6.87)	0.44 (0.88)		2.34 (3.67)	1.33 (1.41)		3.50 (4.33)	12.97 (11.72)		9.50 (9.37)	1.00 (1.07)		2.63 (2.72)	0.53 (0.69)			
	OT8S			0.30 (0.61)							0.24 (0.48)			0.13 (0.26)		1.88 (3.21)			2.47 (2.95)	1.66 (0.78)		3.03 (5.41)
	BT8W	0.67 (0.91)			0.18 (0.37)																	
Creek chub	**POT02S**									0.30 (0.61)												
Red shiner	**EFS**								2.28 (4.57)			7.42 (6.10)	4.72 (9.45)		3.15 (6.29)							
	POT02S			0.50 (0.65)			0.25 (0.50)		2.43 (1.66)	0.55 (0.73)		1.00 (2.00)	3.02 (2.09)		0.25 (0.50)	0.50 (1.00)		2.07 (1.87)	0.25 (0.50)			
	OT8S															0.42 (0.83)						
Spotfin shiner	**EFS**								26.10 (23.99)			8.98 (8.81)			6.13 (7.08)		6.92 (4.63)					
	POT02S			0.25 (0.50)		0.30 (0.60)			9.89 (8.38)	1.04 (1.09)		8.39 (9.52)	1.73 (1.82)		7.00 (8.75)			0.50 (1.00)				

Species	Gear	April			May			June			July			August			September			October		
		2006	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Emerald shiner	**EFS**			4.88 (9.76)		5.47 (6.33)		9.22 (13.88)	12.36 (14.44)	2.49 (4.97)	5.07 (10.14)				21.03 (34.18)	5.72 (11.44)	107.10 (91.19)	5.04 (10.08)				
	POT02S		3.93 (3.86)	5.75 (3.89)		5.02 (4.61)	9.81 (8.04)		0.99 (1.48)	2.96 (1.91)		0.50 (0.65)	2.17 (2.32)		42.25 (27.74)	1.85 (1.68)		11.69 (5.48)	4.01 (4.06)			
	OT8S															0.21 (0.42)						1.50 (2.99)
River shiner	**EFS**							1.70 (3.40)	69.03 (86.47)			4.72 (5.53)					37.07 (29.81)					
	POT02S		2.02 (2.67)	0.98 (1.06)		0.50 (1.00)	4.21 (3.94)		2.89 (2.81)	6.68 (5.65)		5.33 (8.23)	1.43 (2.34)		3.50 (3.36)	0.25 (0.50)		8.58 (10.77)	1.36 (1.42)			
	OT8S													0.32 (0.39)								0.75 (0.96)
	BT8W				0.20 (0.41)																	
Sand shiner	**EFS**											5.26 (10.53)										
	POT02S		2.02 (2.67)			1.16 (1.98)	2.20 (2.00)		0.48 (0.63)	0.79 (0.78)		0.33 (0.66)				13.50 (16.92)		0.71 (0.70)	1.53 (1.68)			
	OT8S															0.21 (0.42)			0.46 (0.53)			
Fathead minnow	**POT02S**			0.25 (0.50)									2.91 (5.14)		0.25 (0.50)	0.25 (0.50)						
Grass carp	**EFS**	2.07	2.41 (4.83)		3.92 (7.84)																	
	HNS								0.13 (0.25)			0.13 (0.25)			0.25 (0.50)							
Common carp	**EFS**	12.41	4.92 (5.70)	7.48 (4.99)	1.96 (3.92)	8.37 (10.99)	5.23 (10.47)	8.00 (5.74)	1.97 (3.94)		7.79 (9.78)	20.81 (11.07)	7.31 (4.92)	11.38 (13.62)	2.87 (5.73)	1.91 (3.81)	4.73 (5.47)	5.04 (10.08)				
	HNS						0.25 (0.33)						0.13 (0.25)					0.13 (0.25)				
	SHNS									0.13 (0.25)		0.13 (0.25)						0.25 (0.33)				
	BT8W				0.20 (0.41)																	
Silver carp	**HNS**											0.50 (0.76)										

Species	Gear	March	April			May			June			July			August			September			October		
		2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Bighead carp	**HNS**		0.10 (0.20)				2.38 (4.21)			6.50 (4.97)			12.13 (5.08)	0.63 (1.00)		1.13 (1.16)			9.00 (7.74)				
	SHNS						0.25 (0.50)																
	TN					0.44 (0.88)																	
River carpsucker	**EFS**		20.69	4.68 (9.35)	15.17 (16.72)	3.92 (7.84)	7.90 (10.92)	2.62 (5.23)	4.14 (4.94)	7.12 (4.97)			11.91 (3.94)	2.30 (4.59)	4.00 (4.72)			6.81 (4.58)					
	HNS	1.13 (1.03)	0.10 (0.20)	1.38 (0.84)						0.63 (0.65)	1.50 (3.00)		2.75 (2.72)	2.50 (2.07)		0.75 (0.98)	2.63 (4.97)		0.38 (0.53)	0.14 (0.29)			
	SHNS	0.25 (0.33)									0.25 (0.50)					0.25 (0.33)							
	POT02S				0.25 (0.50)											0.25 (0.50)	0.25 (0.50)		0.25 (0.50)				
	TN				1.25 (2.50)														0.91 (1.81)				
	OT8S				0.26 (0.51)												0.42 (0.83)						
Quillback	**HNS**									0.13 (0.25)						0.25 (0.50)							
Blue sucker	**EFS**									2.87 (5.73)				2.65 (5.31)				2.19 (4.38)	10.29 (20.57)				
	HNS					0.13 (0.25)	0.13 (0.25)		0.13 (0.25)	0.13 (0.25)	0.25 (0.50)	0.13 (0.25)	0.63 (0.84)	0.38 (0.75)					0.13 (0.25)				
	SHNS								0.13 (0.25)	0.13 (0.25)		0.38 (0.75)						0.13 (0.25)					
	POT02S										0.83 (1.20)												
	TN									0.56 (1.13)		1.22 (1.63)		0.44 (0.87)			0.44 (0.89)	1.08 (1.08)	0.86 (0.99)	0.48 (0.96)			
Smallmouth buffalo	**EFS**						5.79 (11.58)					5.13 (5.92)											
	HNS		0.10 (0.20)							0.13 (0.25)			0.13 (0.25)						0.13 (0.25)				
Bigmouth buffalo	**EFS**		2.07	10.07 (8.46)			2.89 (5.79)				3.04 (6.08)		6.35 (4.54)					2.19 (4.38)					
	HNS	0.63 (0.65)		0.88 (1.75)			1.88 (3.75)	0.50 (0.65)					0.13 (0.25)	0.25 (0.50)					0.50 (0.76)				
	POT02S									0.25 (0.50)	1.90 (2.35)		0.25 (0.50)	0.83 (0.82)									
	TN			0.76 (1.53)								0.39 (0.78)											

Species	Gear	March	April			May			June			July			August			September			October		
		2008	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Shorthead redhorse	**EFS**		2.07	5.17 (10.34)	2.44 (4.88)	7.41 (8.59)	13.83 (14.75)		1.88 (3.76)	7.12 (4.97)	5.01 (10.03)		6.34 (7.52)	2.51 (5.01)			2.53 (5.06)	2.43 (4.86)	20.47 (20.77)				
	HNS									0.25 (0.33)						0.25 (0.33)			0.25 (0.33)				
	SHNS	0.25 (0.33)					0.38 (0.53)	0.13 (0.25)		0.50 (0.38)			0.25 (0.33)	0.25 (0.33)	0.38 (0.53)	0.25 (0.33)			0.13 (0.25)				
	POT02S						0.58 (0.75)	0.25 (0.49)								0.75 (1.05)							
	TN												1.39 (2.78)										
	OT8S																				0.20 (0.40)		0.23 (0.45)
Channel catfish	**EFS**		4.14	2.34 (4.68)									1.62 (3.24)		1.69 (3.39)	3.17 (6.34)			5.04 (10.08)				
	HNS	2.38 (2.93)		0.50 (0.53)		0.13 (0.25)	0.13 (0.25)			0.25 (0.33)	0.25 (0.33)	0.25 (0.50)	0.88 (0.96)	0.25 (0.33)		0.38 (0.75)	1.00 (1.25)		0.25 (0.50)	0.14 (0.29)			
	SHNS	5.25 (8.00)		0.86 (0.92)				0.25 (0.33)	0.25 (0.33)	0.50 (0.53)		0.88 (0.80)	0.50 (0.53)	0.13 (0.25)	0.13 (0.25)	0.88 (0.59)	0.50 (0.53)	0.38 (0.53)	0.38 (0.75)				
	POT02S			0.62 (0.82)	3.50 (2.48)		0.83 (0.81)	3.60 (2.22)		2.85 (3.57)	4.14 (4.93)			0.28 (0.56)		12.25 (9.39)			3.64 (3.41)				
	TN				0.55 (1.11)			0.40 (0.80)						0.36 (0.72)				0.57 (1.14)	1.22 (2.44)				
	OT8S				3.87 (1.82)			1.48 (1.88)	1.59 (1.54)		0.29 (0.58)						3.59 (3.76)	0.23 (0.45)		3.92 (4.36)	0.20 (0.40)		2.34 (0.88)
	BT8W		2.29 (2.10)			3.62 (4.87)																	
Flathead catfish	**EFS**		4.14									5.25 (6.07)	2.09 (4.19)		7.14 (10.27)	3.17 (6.34)		2.43 (4.86)					
	HNS			0.25 (0.33)		0.13 (0.25)	0.38 (0.37)			0.38 (0.37)	0.38 (0.37)		0.13 (0.25)	0.25 (0.33)		0.13 (0.25)	0.38 (0.37)			0.29 (0.57)			
	SHNS						0.25 (0.33)	0.63 (0.53)	0.25 (0.33)	0.13 (0.25)	1.00 (0.76)	0.38 (0.37)	0.50 (0.76)	0.25 (0.33)		0.50 (0.38)	0.38 (0.53)		0.13 (0.25)	0.14 (0.29)			
	TN				0.43 (0.87)																		
	BT8W					0.19 (0.39)																	
Stonecat	**OT8S**							0.21 (0.42)	0.22 (0.43)						0.13 (0.26)		0.22 (0.43)						
	BT8W		0.43 (0.55)			0.38 (0.44)																	
Brook silverside	**POT02S**				0.25 (0.50)																		

		April			May			June			July			August			September			October		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
White bass	**EFS**													1.81 (3.63)								
	HNS		1.00 (1.25)																0.14 (0.29)			
	SHNS														0.13 (0.25)			0.25 (0.33)				
	POT02S								0.37 (0.74)													
	TN																	0.91 (1.81)				
Yellow bass	**HNS**																		0.14 (0.29)			
	SHNS																	0.50 (0.76)				
	TN																	1.36 (2.72)				
Green sunfish	**EFS**								2.28 (4.57)								2.19 (4.38)					
	POT02S												0.33 (0.66)									
Orangespotted sunfish	**EFS**						2.62 (5.23)	2.16 (4.32)														
	POT02S																	0.22 (0.45)				
Bluegill	**EFS**											2.63 (5.26)		2.30 (4.60)			2.19 (4.38)					
	SHNS														0.50 (0.38)			0.13 (0.25)				
	POT02S									0.30 (0.61)								0.25 (0.50)				
Smallmouth bass	**SHNS**													0.13 (0.25)								
White crappie	**HNS**											0.38 (0.75)										
	SHNS																0.13 (0.25)					
Black crappie	**HNS**	0.20 (0.27)													0.13 (0.25)			0.13 (0.25)				
	SHNS													0.38 (0.53)		0.13 (0.25)						

		March	April			May			June			July			August			September			October		
Species	**Gear**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Yellow perch	**POT02S**										0.25 (0.49)												
Sauger	**EFS**							2.17 (4.35)	1.70 (3.40)									2.07 (4.15)					
	HNS	0.13 (0.25)								0.13 (0.25)									0.25 (0.50)				
	SHNS														0.13 (0.25)								
	POT02S									0.25 (0.50)				0.25 (0.50)		0.25 (0.50)							
	OT8S								0.20 (0.40)			0.24 (0.48)											
Walleye	**HNS**	0.25 (0.33)					0.13 (0.25)																
	SHNS											0.13 (0.25)		0.13 (0.25)									
Freshwater drum	**EFS**		6.21	2.34 (4.68)		1.96 (3.92)		5.19 (6.15)					1.62 (3.24)	2.36 (4.72)			2.38 (4.76)	4.15 (8.29)	5.04 (10.08)				
	HNS	0.13 (0.25)	0.10 (0.20)				0.13 (0.25)			0.25 (0.50)	0.50 (0.53)		0.63 (0.65)	0.38 (0.53)		0.13 (0.25)	0.38 (0.53)	0.13 (0.25)					
	SHNS						0.13 (0.25)				0.25 (0.33)		0.25 (0.33)	0.25 (0.33)	0.13 (0.25)			0.25 (0.33)					
	POT02S									2.19 (2.62)			1.00 (1.31)	10.08 (6.77)		1.75 (2.06)			0.50 (1.00)	0.25 (0.50)			
	TN				0.98 (1.15)																		
	OT8S								4.04 (5.83)			0.25 (0.51)					0.63 (0.80)						0.46 (0.54)

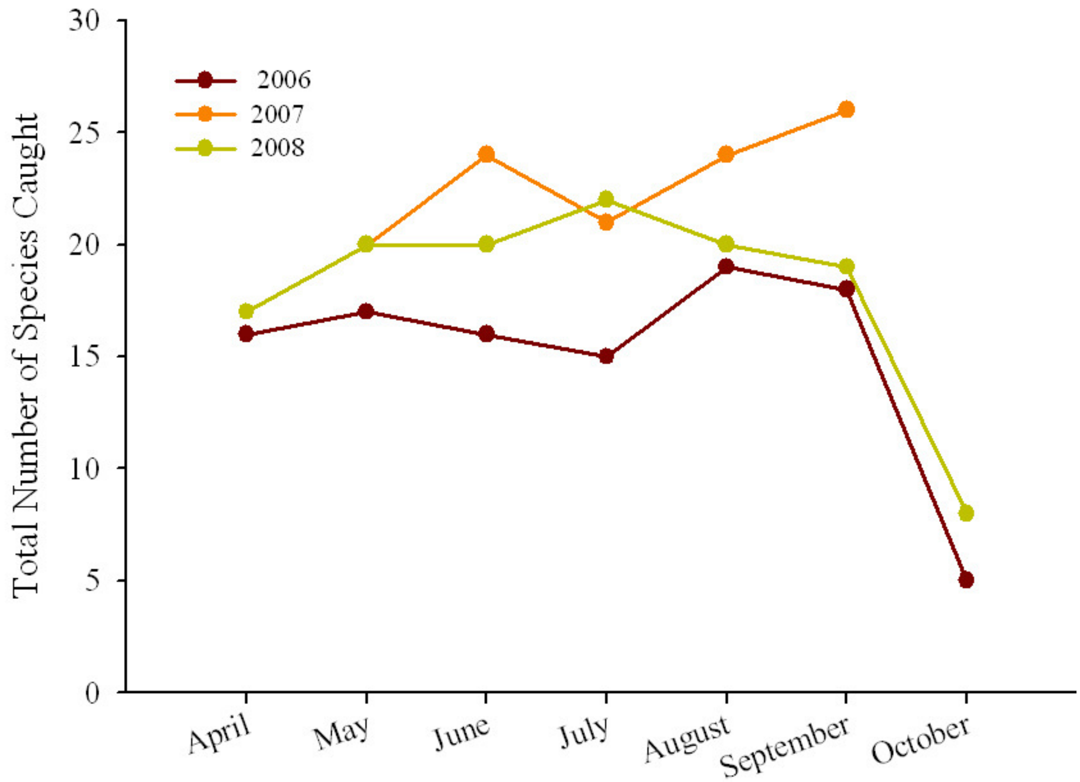


Figure III.2.1. Monthly species richness for California (IA) from 2006 - 2008.

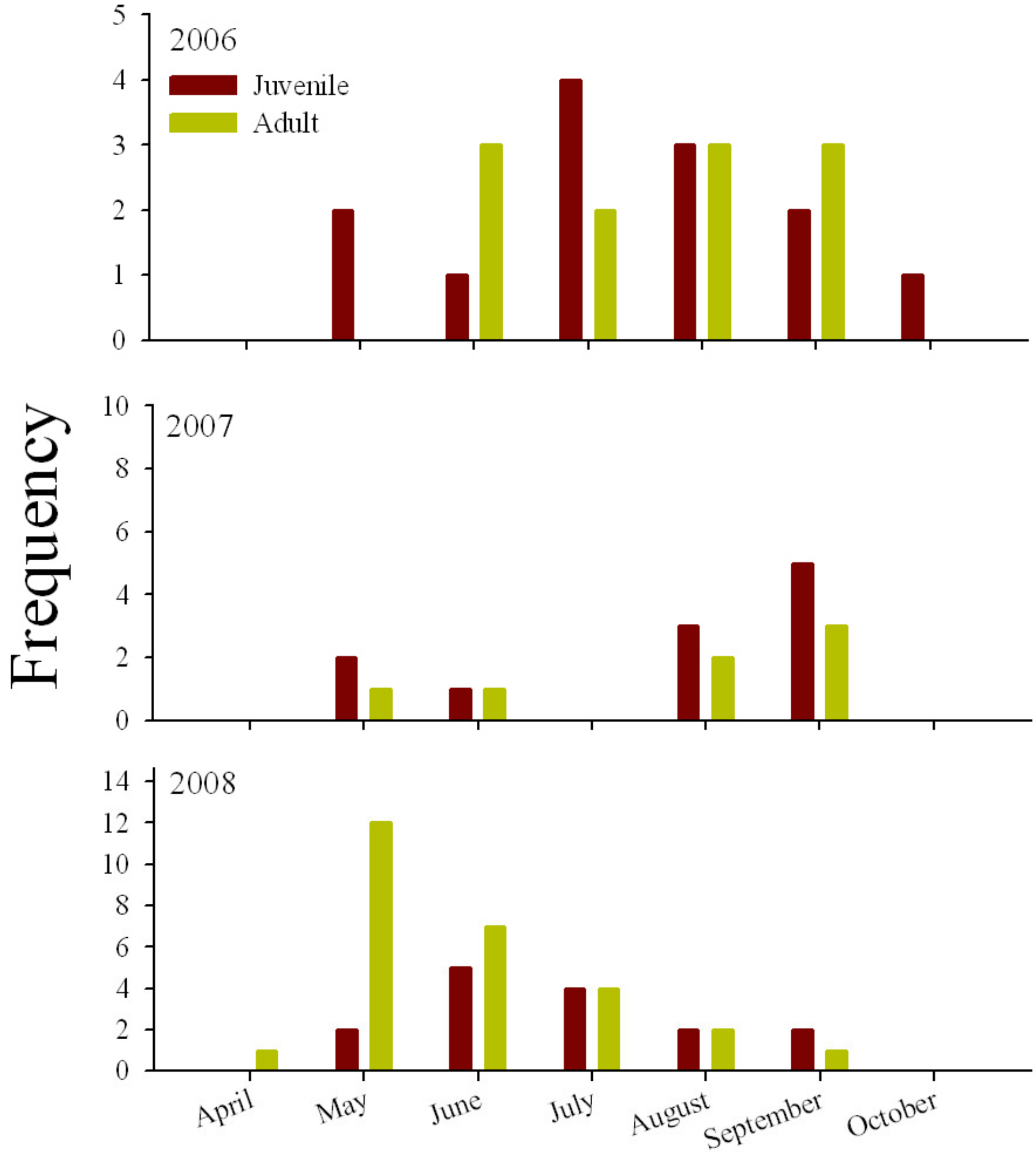


Figure III.2.2. Monthly frequency of juvenile (<540 mm) and adult (≥540 mm) shovelnose sturgeon caught at California (IA) from 2006 - 2008. Please note differences in scale of frequency.

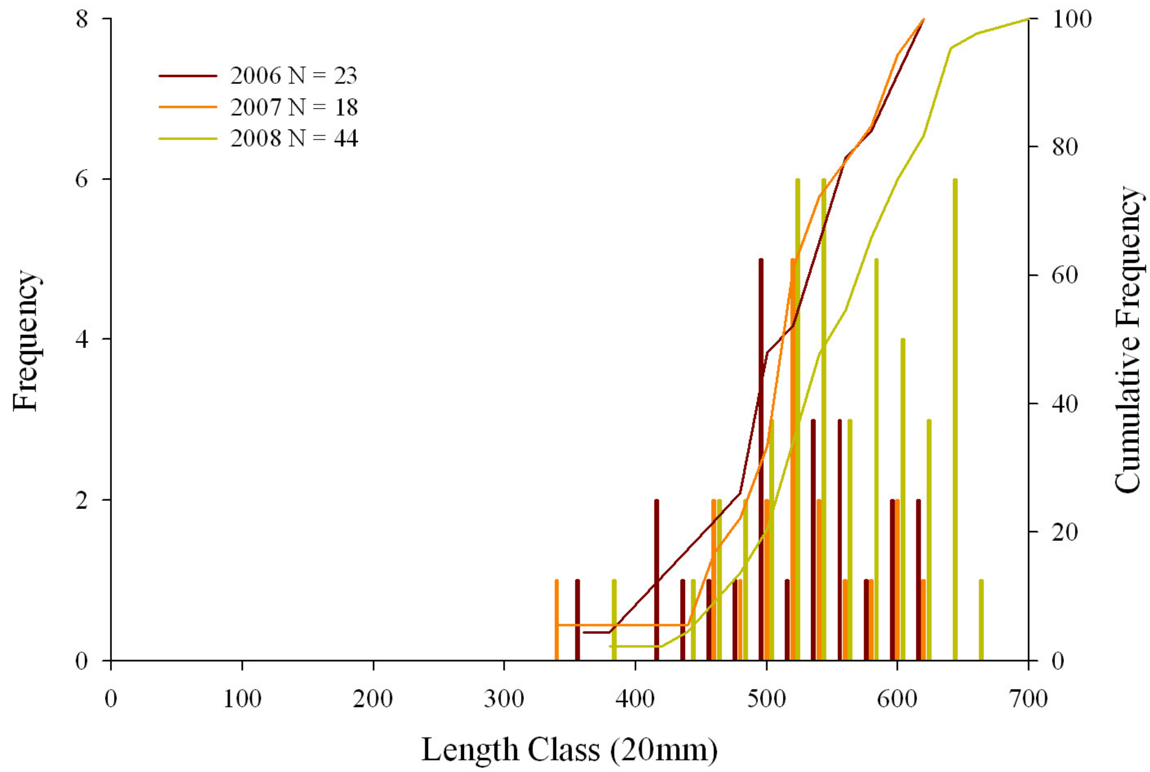


Figure III.2.3. Length frequency distributions and cumulative frequencies for measured shovelnose sturgeon (N) at California (IA) from 2006 - 2008.

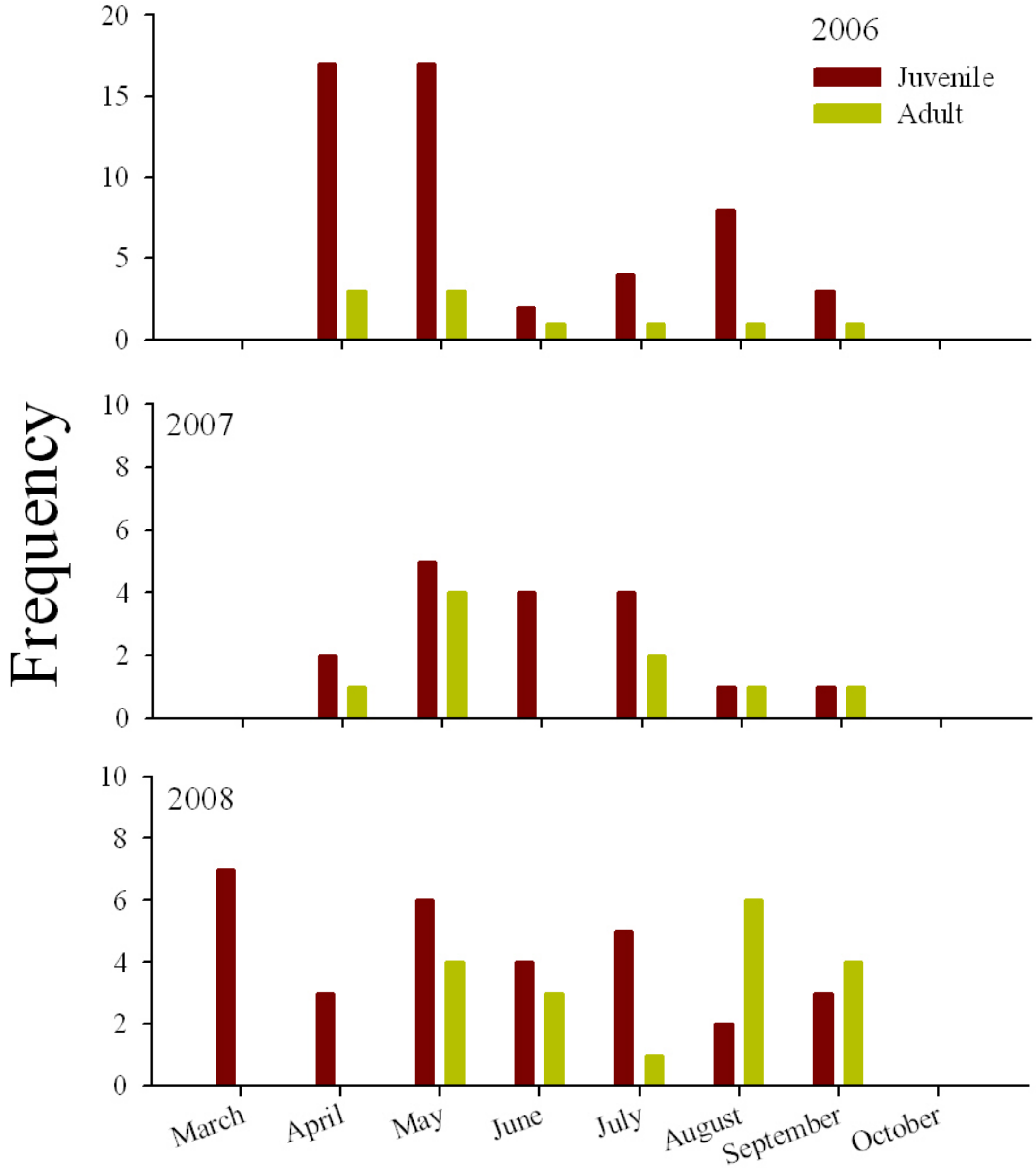


Figure III.2.4. Monthly frequency of juvenile (<356 mm) and adult (≥356 mm) goldeye caught at California (IA) from 2006 - 2008. Please note differences in scale of frequency.

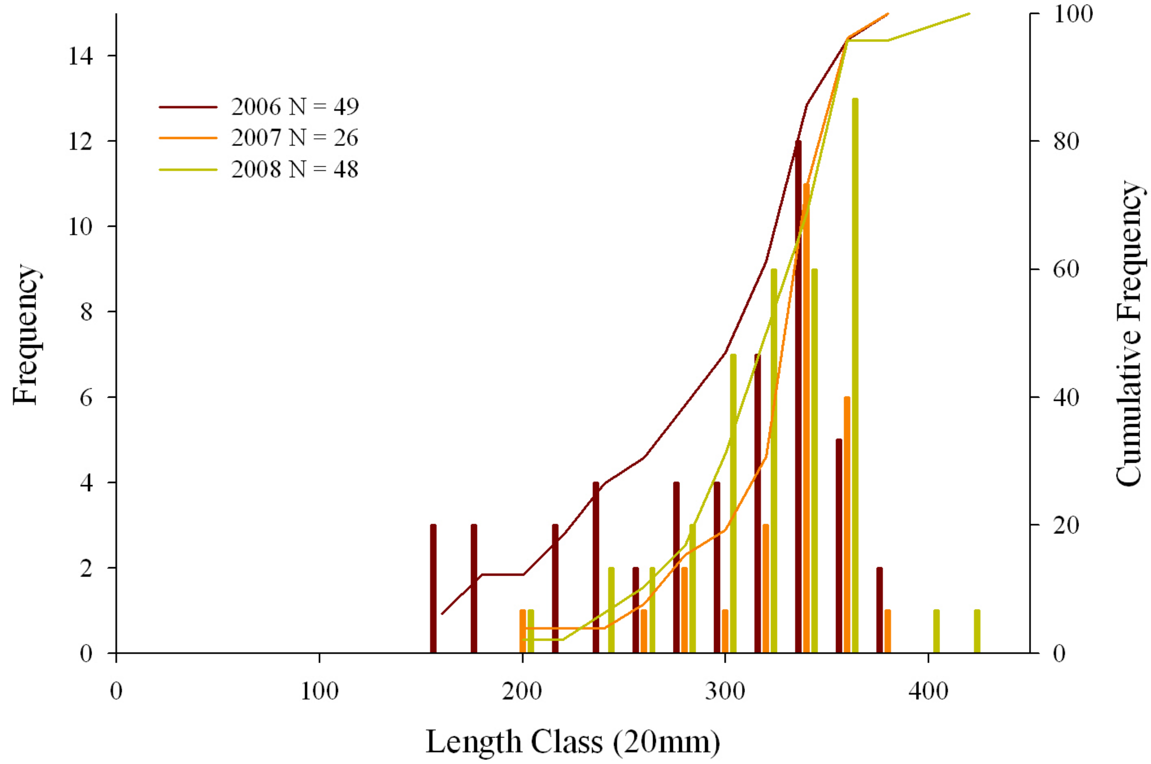


Figure III.2.5. Length frequency distributions and cumulative frequencies for measured goldeye (N) at California (IA) from 2006 - 2008.

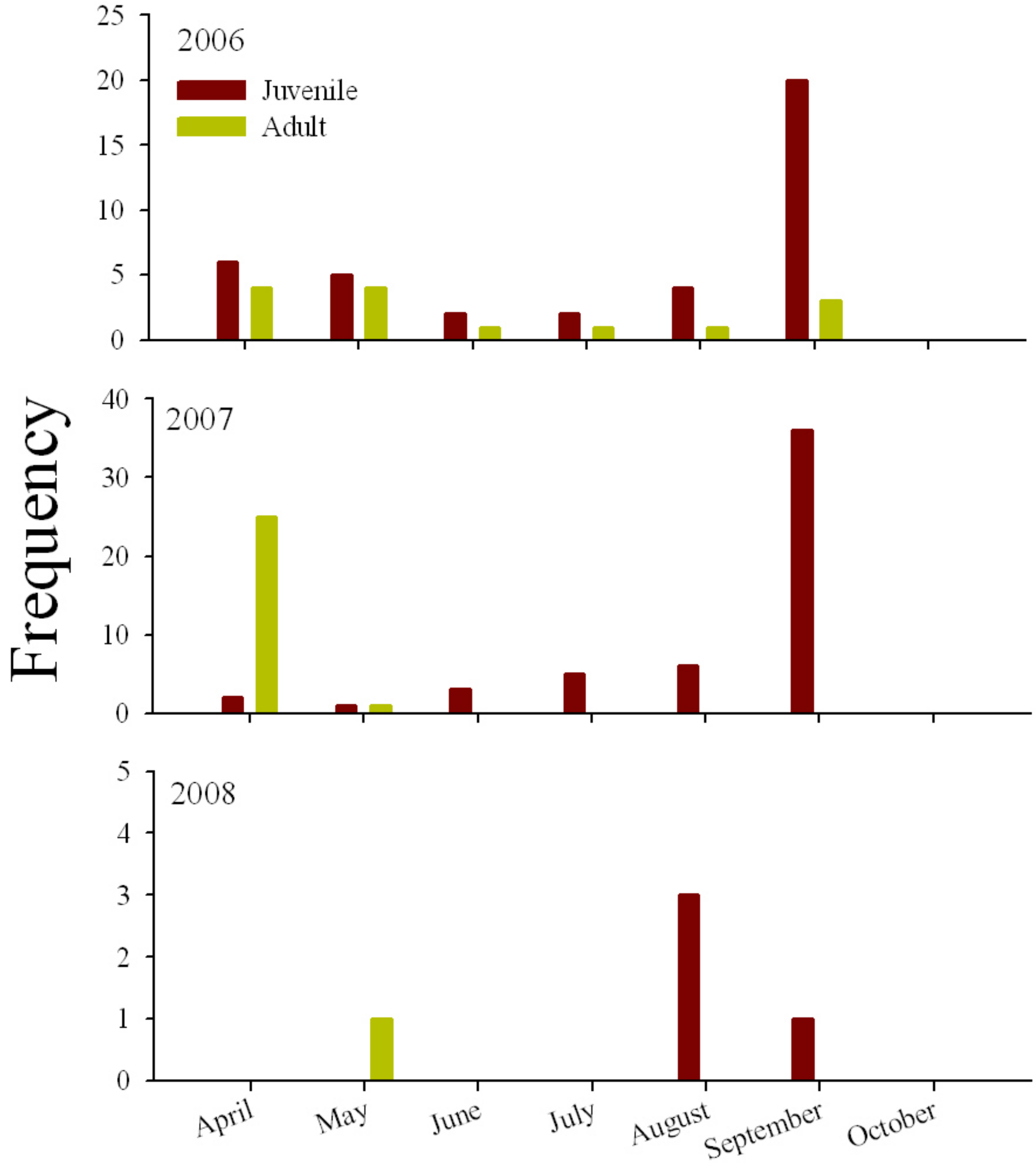


Figure III.2.6. Monthly frequency of juvenile (<229 mm) and adult (≥229 mm) gizzard shad caught at California (IA) from 2006 - 2008. Please note differences in scale of frequency.

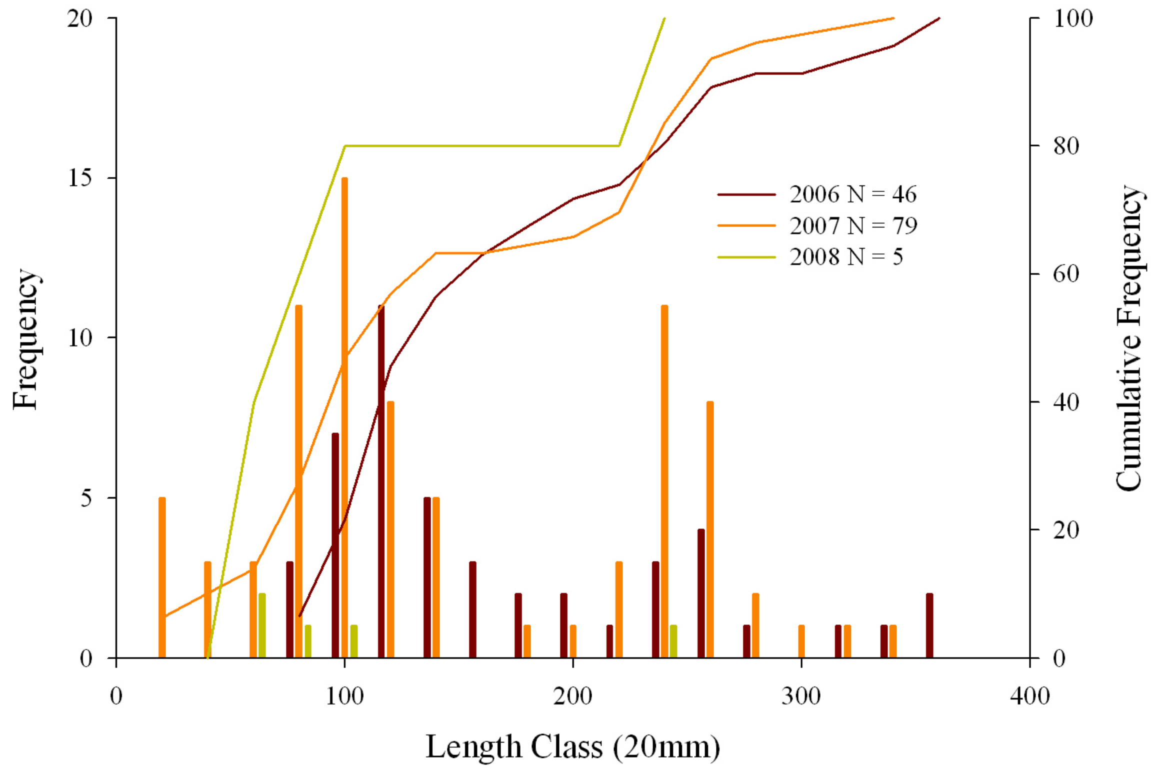


Figure III.2.7. Length frequency distributions and cumulative frequencies for measured gizzard shad (N) at California (IA) from 2006 - 2008.

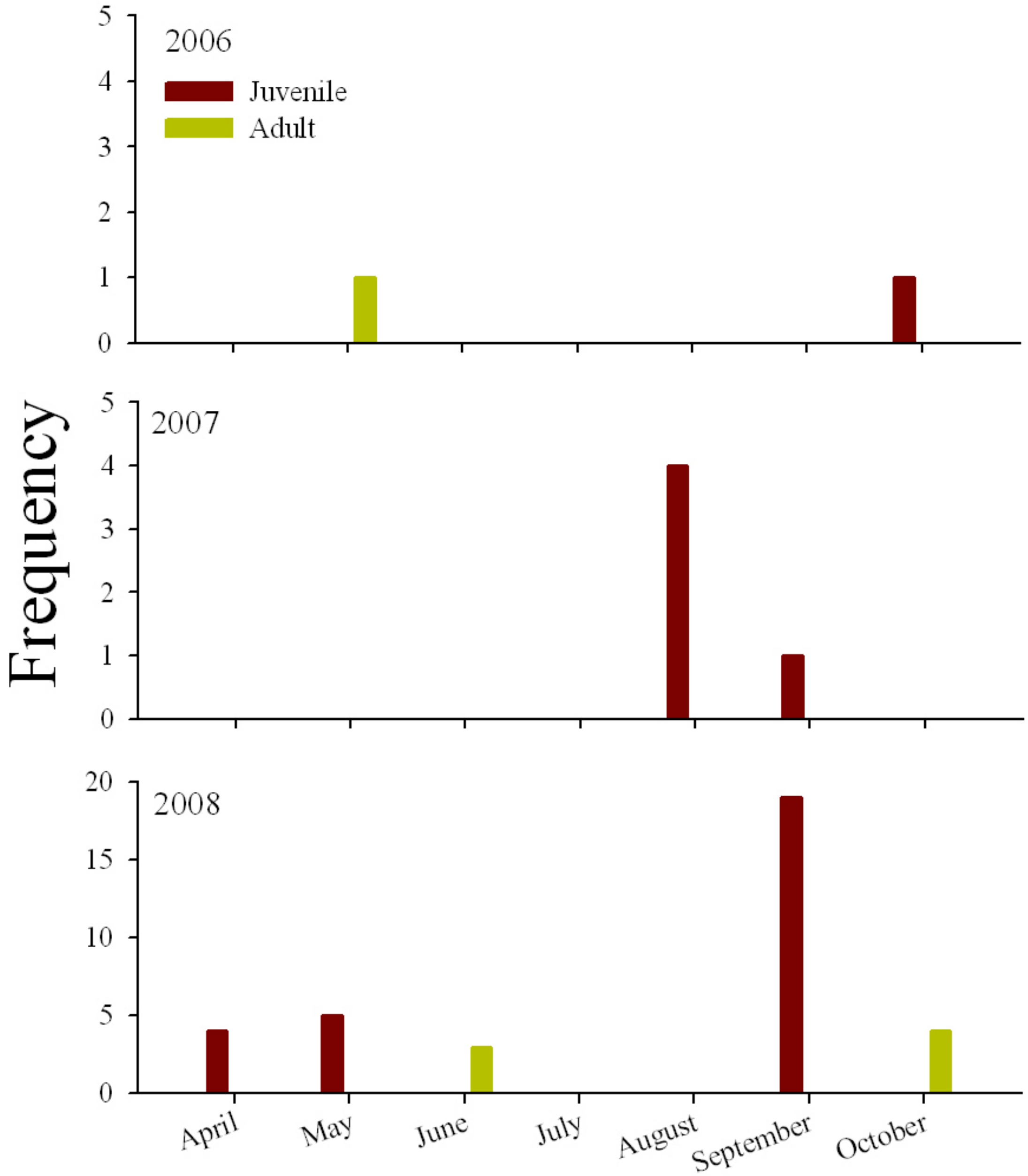


Figure III.2.8. Monthly frequency of juvenile (<40 mm) and adult (≥40 mm) speckled chubs caught at California (IA) from 2006 - 2008. Please note differences in scale of frequency.

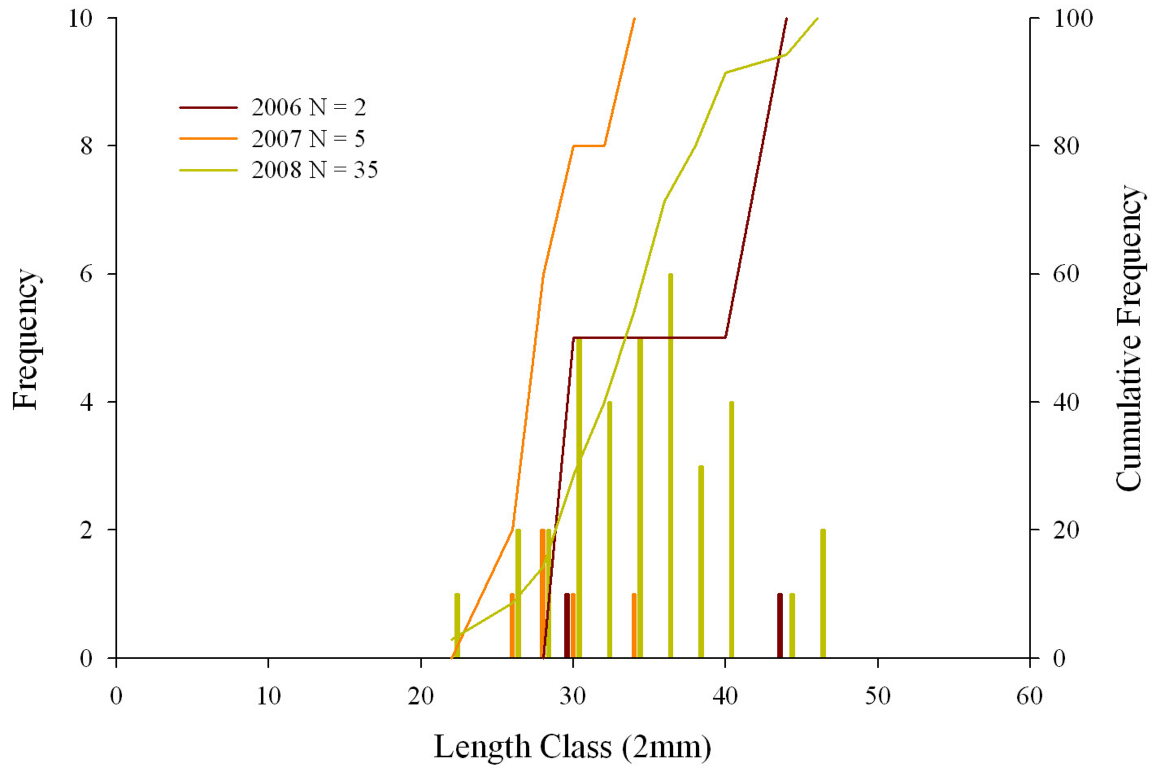


Figure III.2.9. Length frequency distributions and cumulative frequencies for measured speckled chubs (N) at California (IA) from 2006 - 2008.

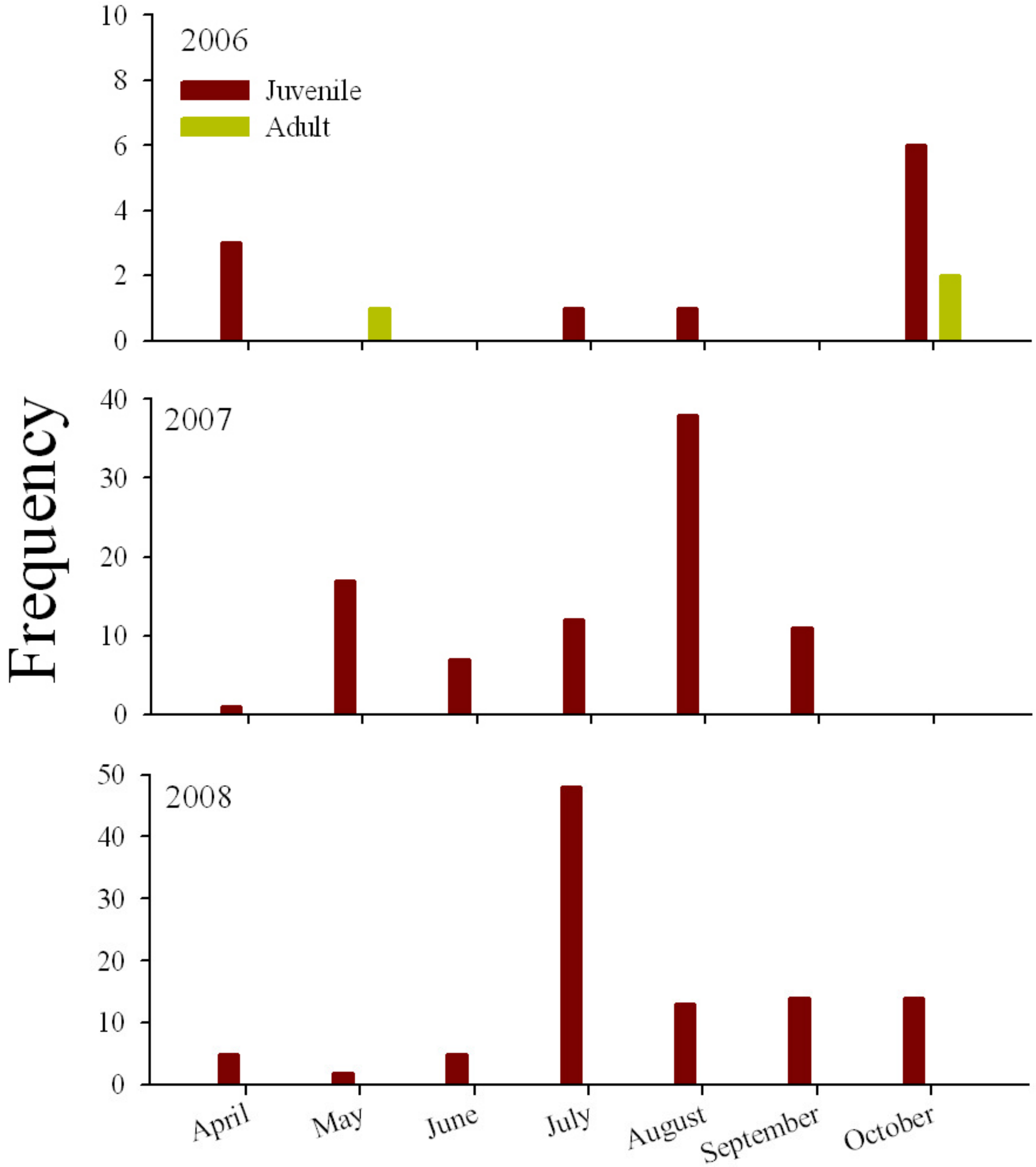


Figure III.2.10. Monthly frequency of juvenile (<89 mm) and adult (≥89 mm) silver chubs caught at California (IA) from 2006 - 2008. Please note differences in scale of frequency.

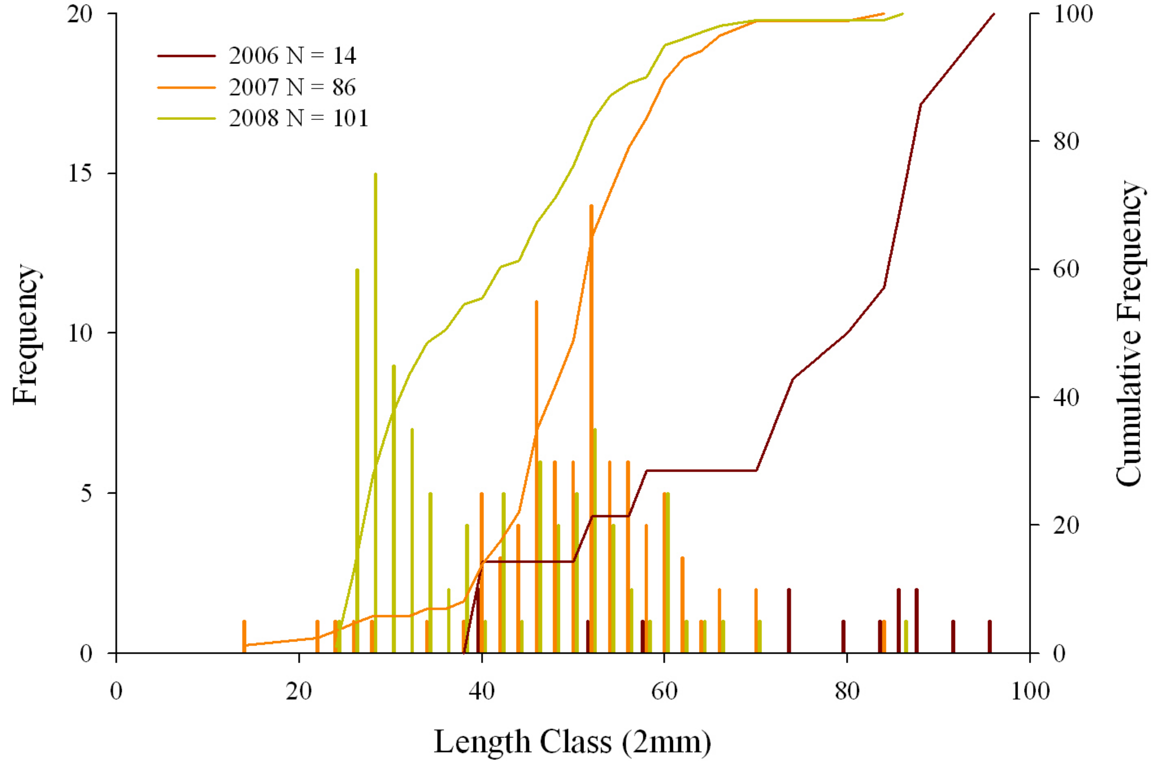


Figure III.2.11. Length frequency distributions and cumulative frequencies for measured silver chubs (N) at California (IA) from 2006 - 2008.

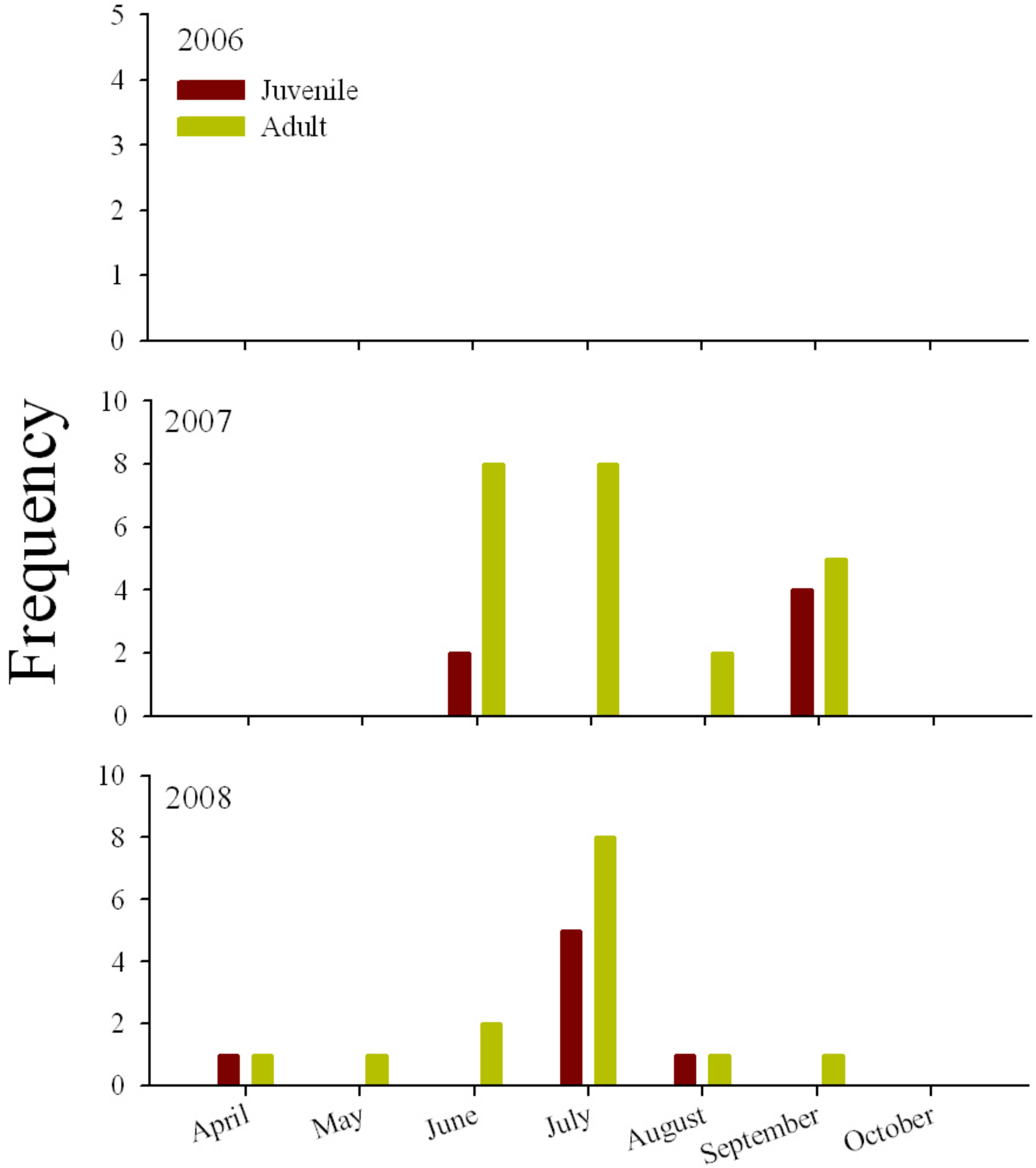


Figure III.2.12. Monthly frequency of juvenile (<46 mm) and adult (≥46 mm) red shiners caught at California (IA) from 2006 - 2008.

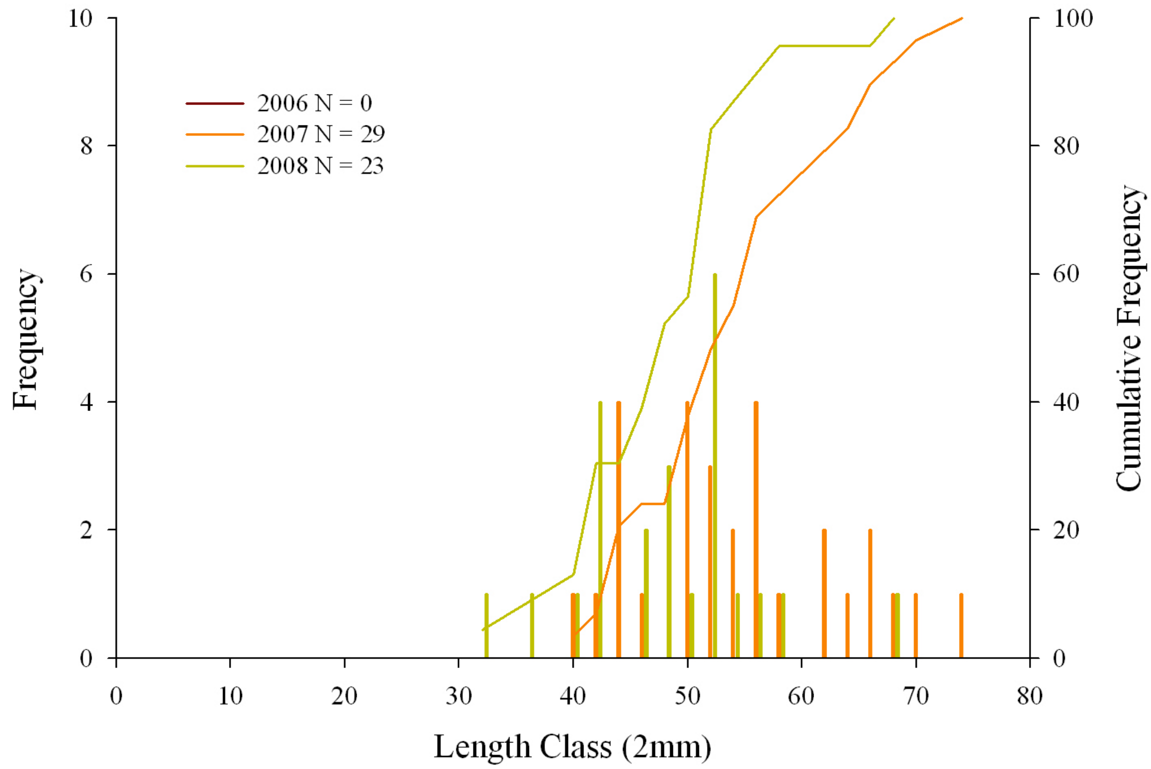


Figure III.2.13. Length frequency distributions and cumulative frequencies for measured red shiners (N) at California (IA) from 2006 - 2008.

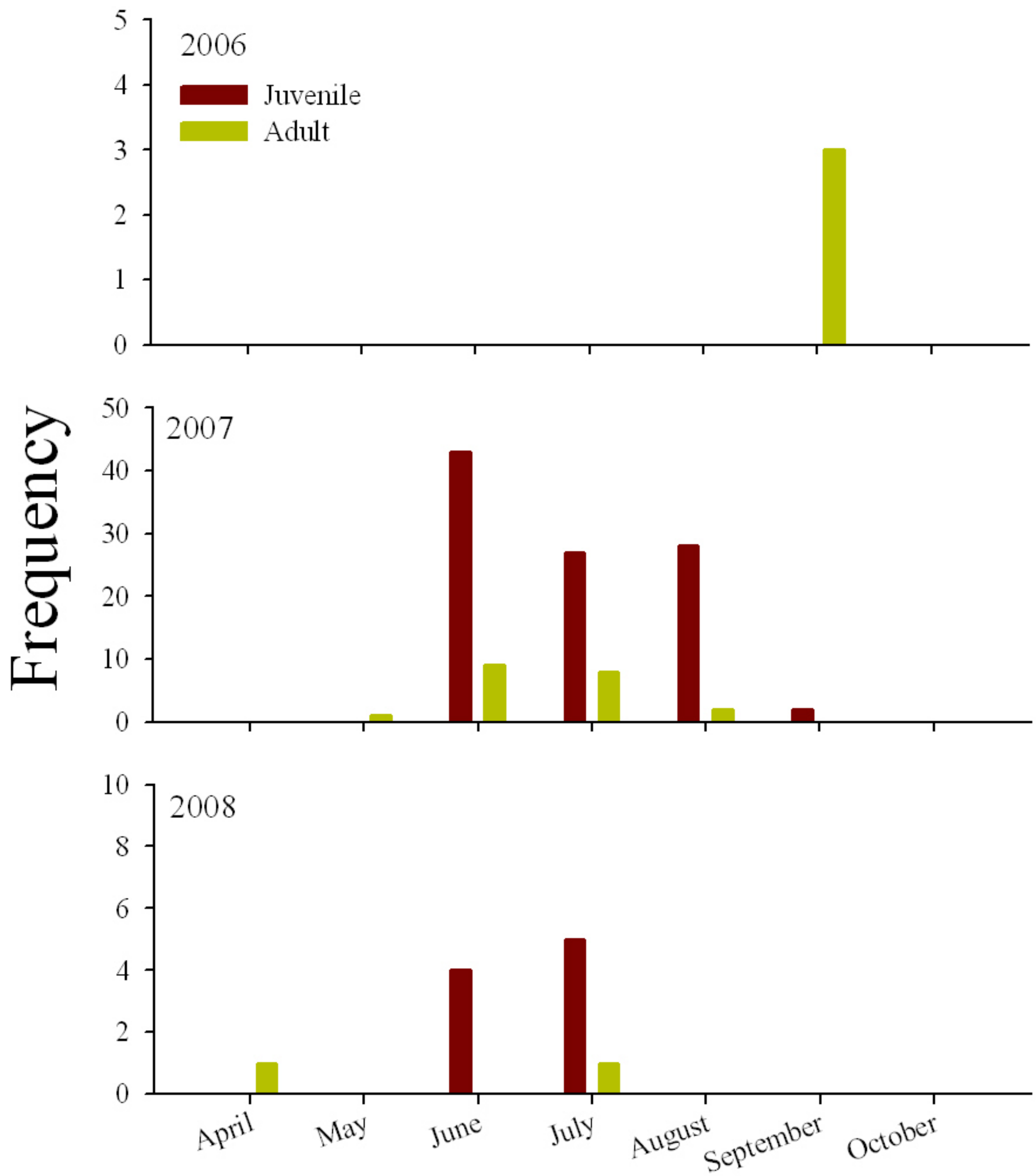


Figure III.2.14. Monthly frequency of juvenile (<64 mm) and adult (≥64 mm) spotfin shiners caught at California (IA) from 2006 - 2008. Please note differences in scale of frequency.

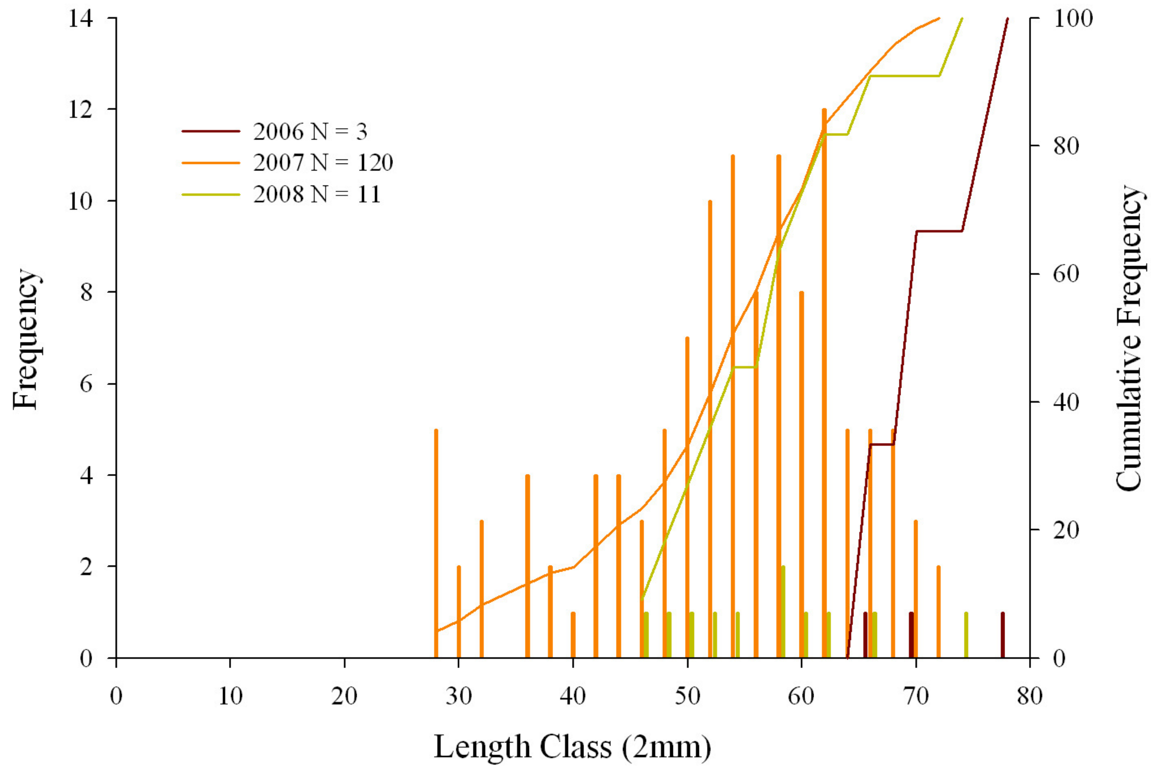


Figure III.2.15. Length frequency distributions and cumulative frequencies for measured spotfin shiners (N) at California (IA) from 2006 - 2008.

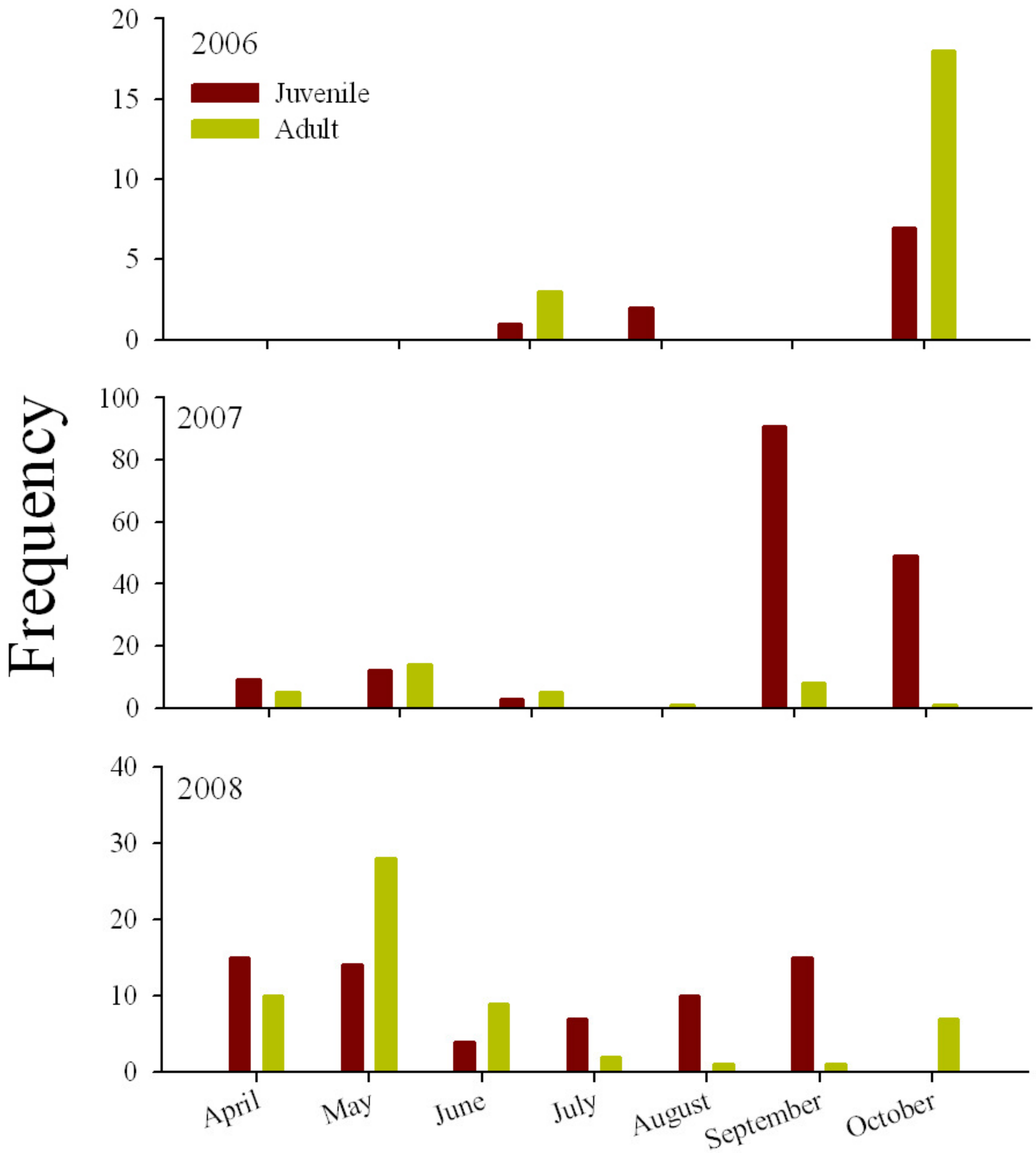


Figure III.2.16. Monthly frequency of juvenile (<64 mm) and adult (≥64 mm) emerald shiners caught at California (IA) from 2006 - 2008. Please note differences in scale of frequency.

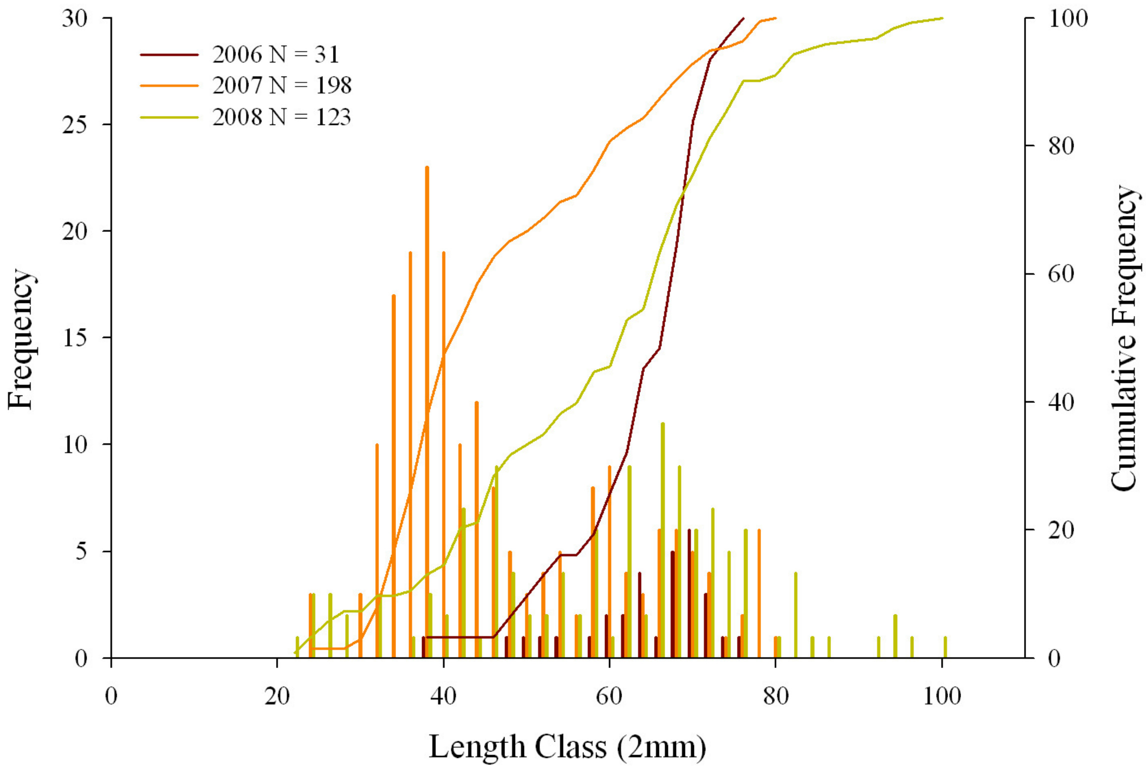


Figure III.2.17. Length frequency distributions and cumulative frequencies for measured emerald shiners (N) at California (IA) from 2006 - 2008.

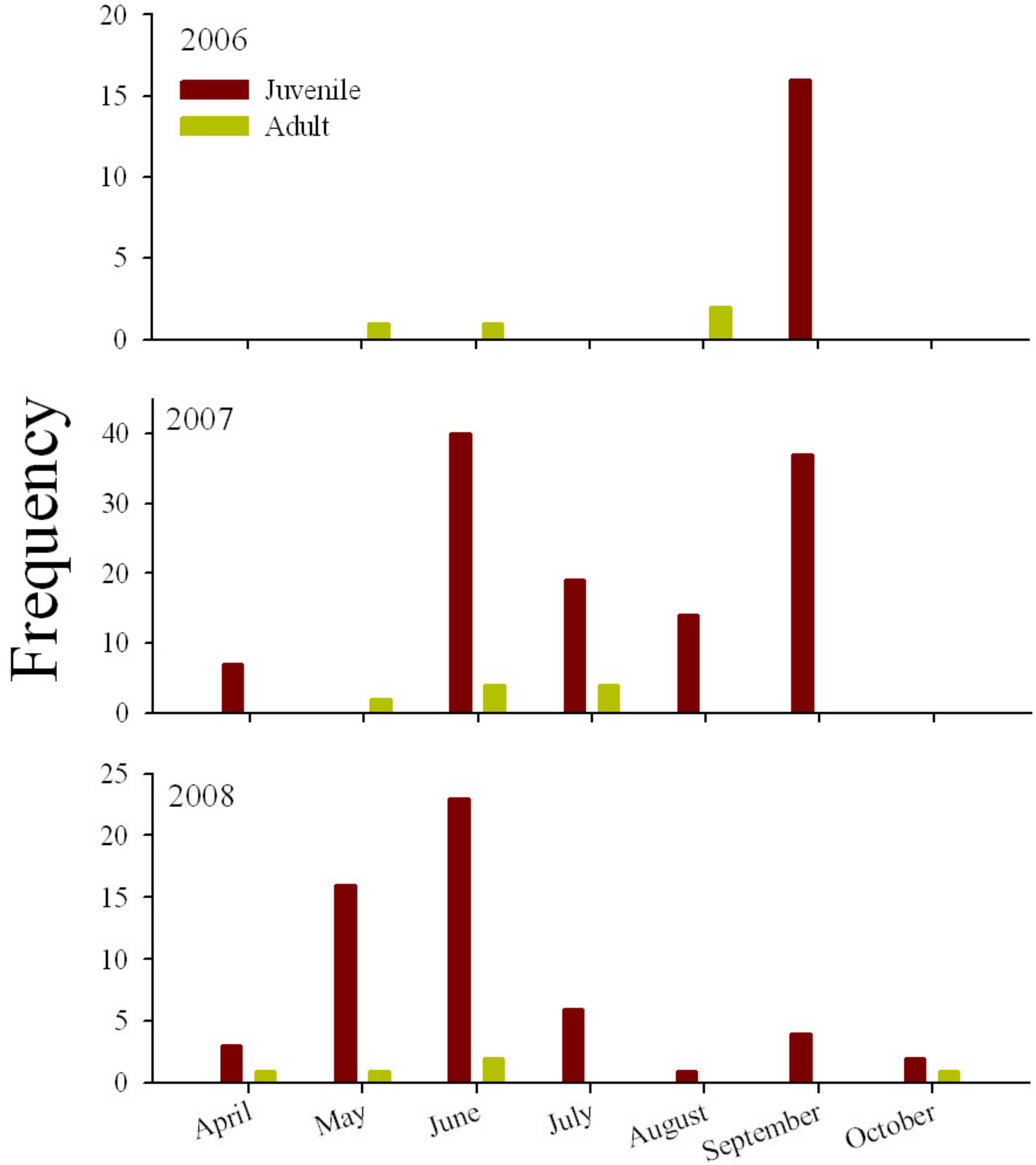


Figure III.2.18. Monthly frequency of juvenile (<51 mm) and adult (≥51 mm) river shiners caught at California (IA) from 2006 - 2008. Please note differences in scale of frequency.

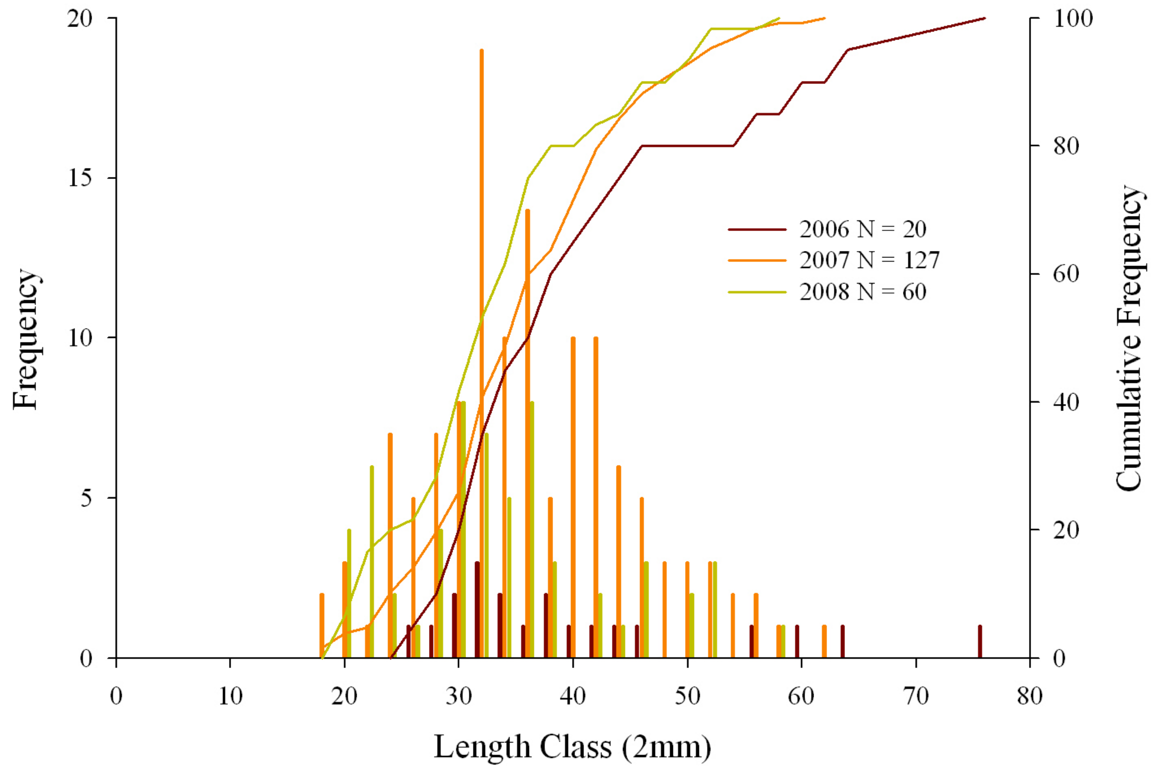


Figure III.2.19. Length frequency distributions and cumulative frequencies for measured river shiners (N) at California (IA) from 2006 - 2008.

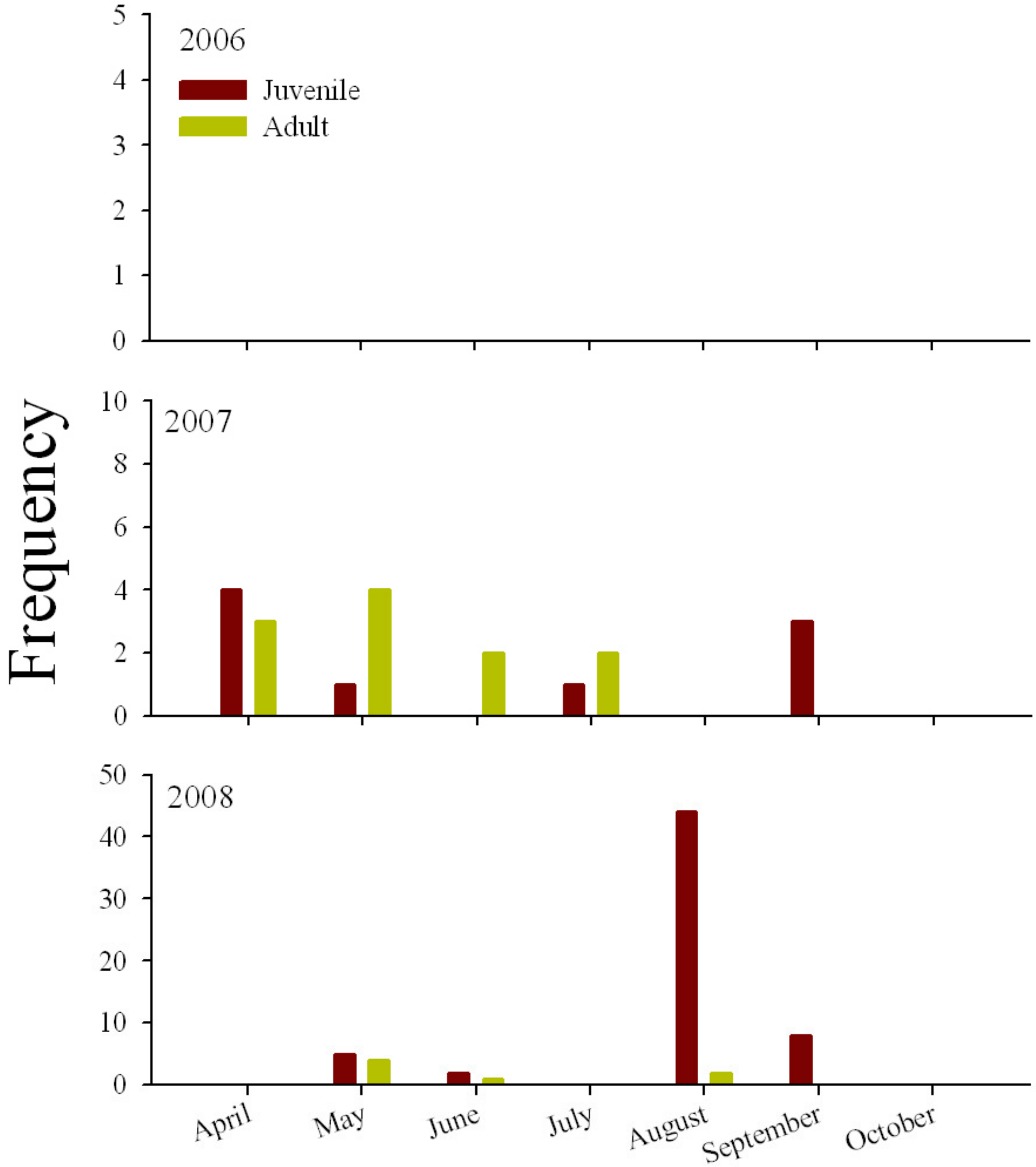


Figure III.2.20. Monthly frequency of juvenile (<43 mm) and adult (≥43 mm) sand shiners caught at California (IA) from 2006 - 2008. Please note differences in scale of frequency.

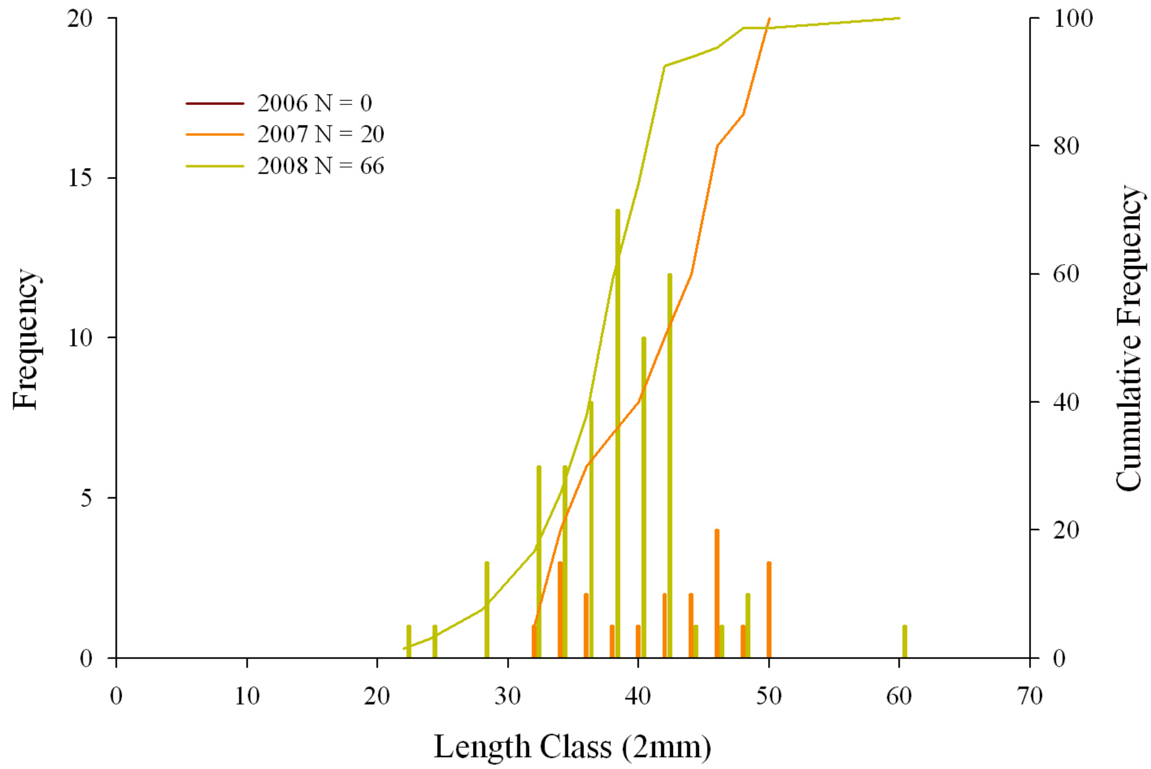


Figure III.2.21. Length frequency distributions and cumulative frequencies for measured sand shiners (N) at California (IA) from 2006 - 2008.

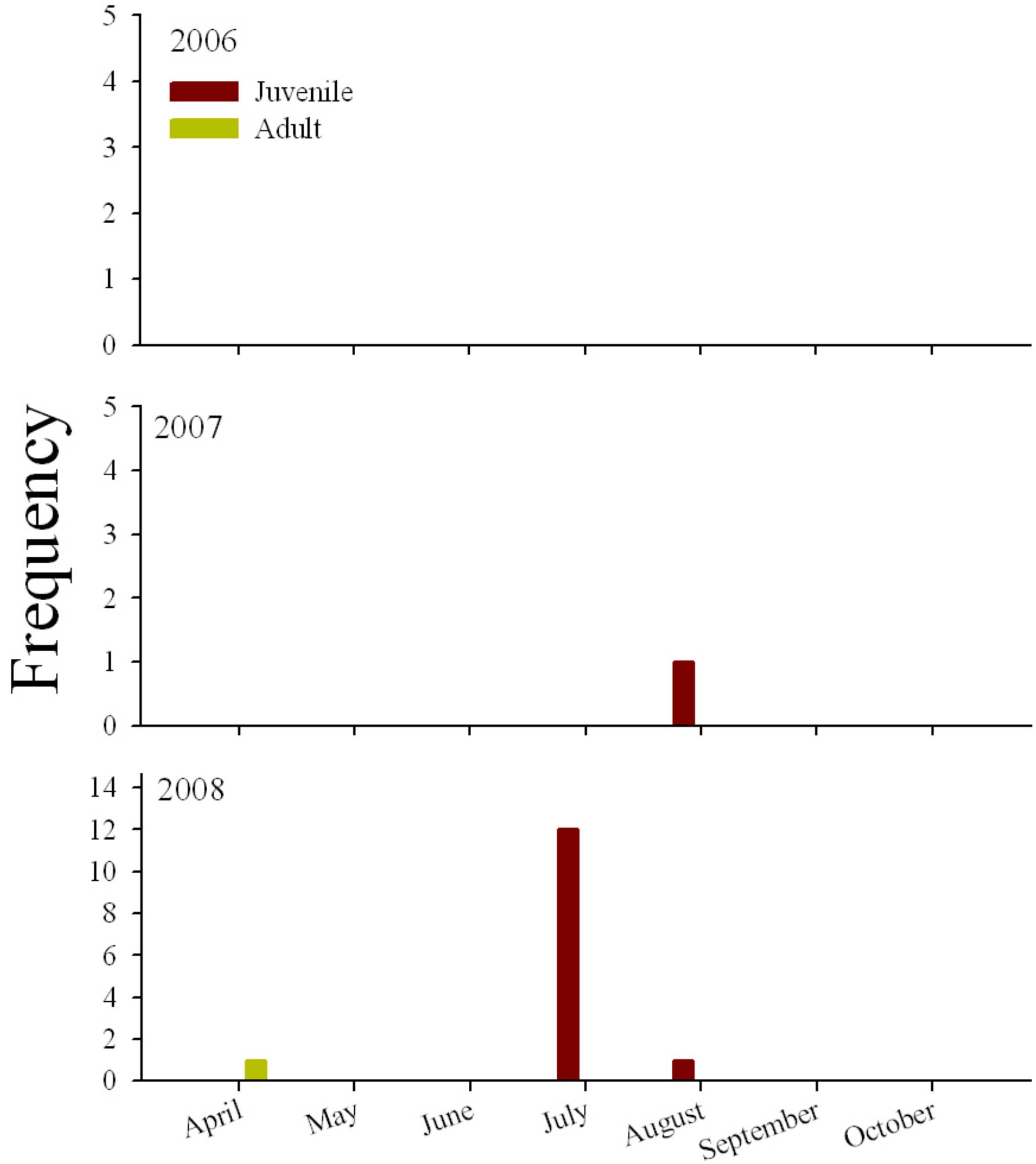


Figure III.2.22. Monthly frequency of juvenile (<41 mm) and adult (≥41 mm) fathead minnows caught at California (IA) from 2006 - 2008. Please note differences in scale of frequency.

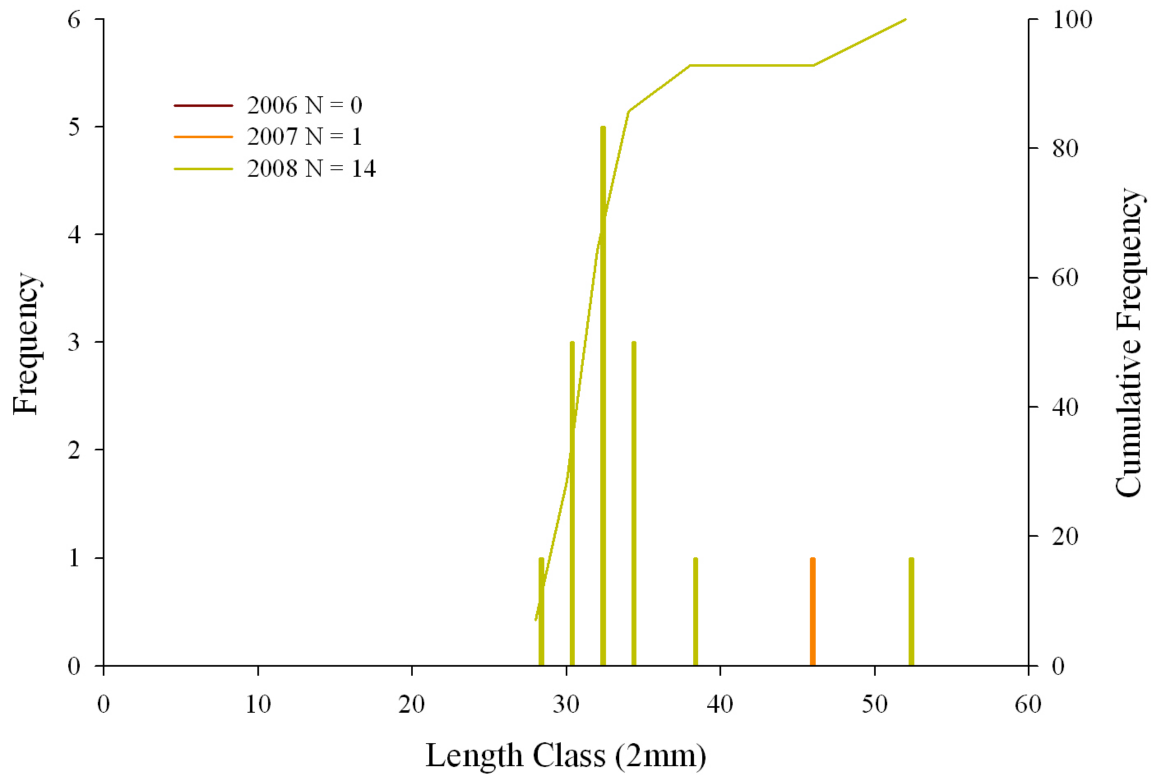


Figure III.2.23. Length frequency distributions and cumulative frequencies for measured fathead minnows (N) at California (IA) from 2006 - 2008.

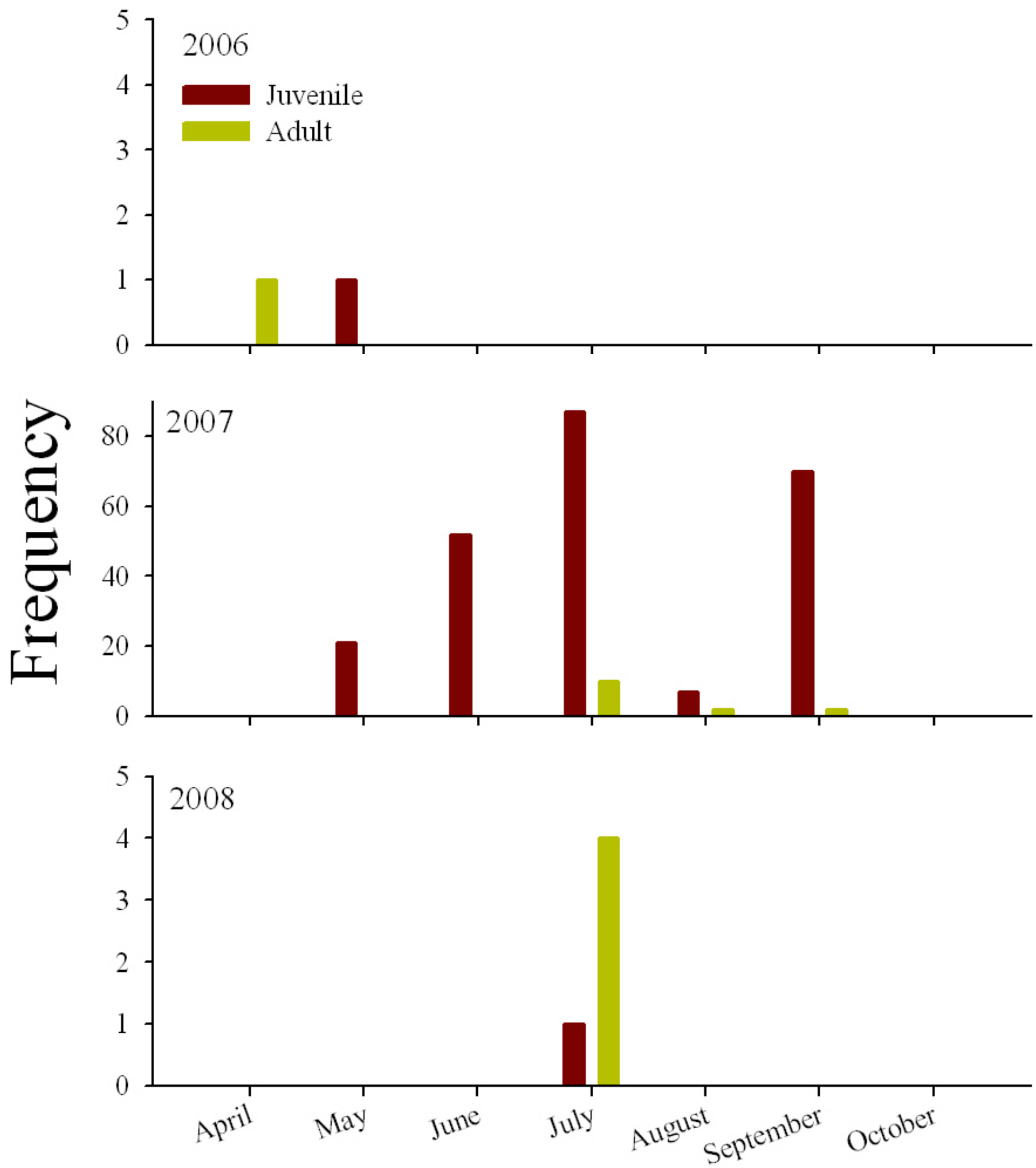


Figure III.2.24. Monthly frequency of juvenile (<625 mm) and adult (≥625 mm) bighead carp caught at California (IA) from 2006 - 2008. Please note differences in scale of frequency.

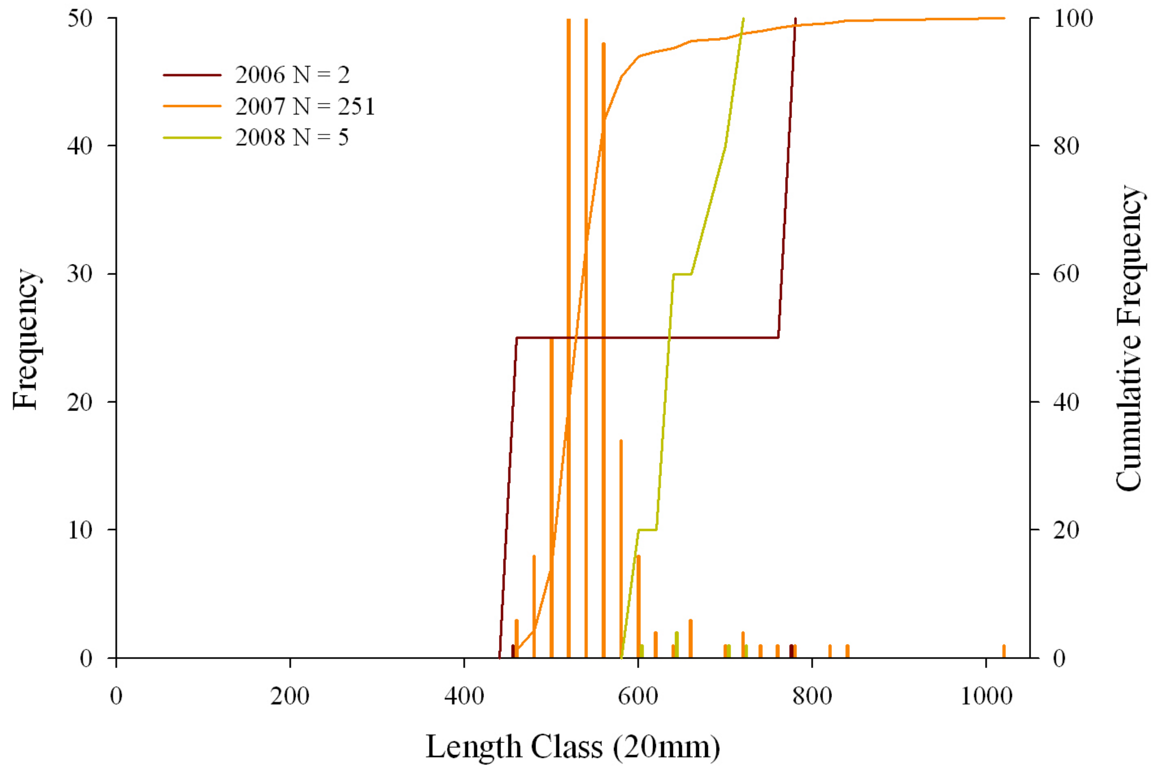


Figure III.2.25. Length frequency distributions and cumulative frequencies for measured bighead carp (N) at California (IA) from 2006 - 2008.

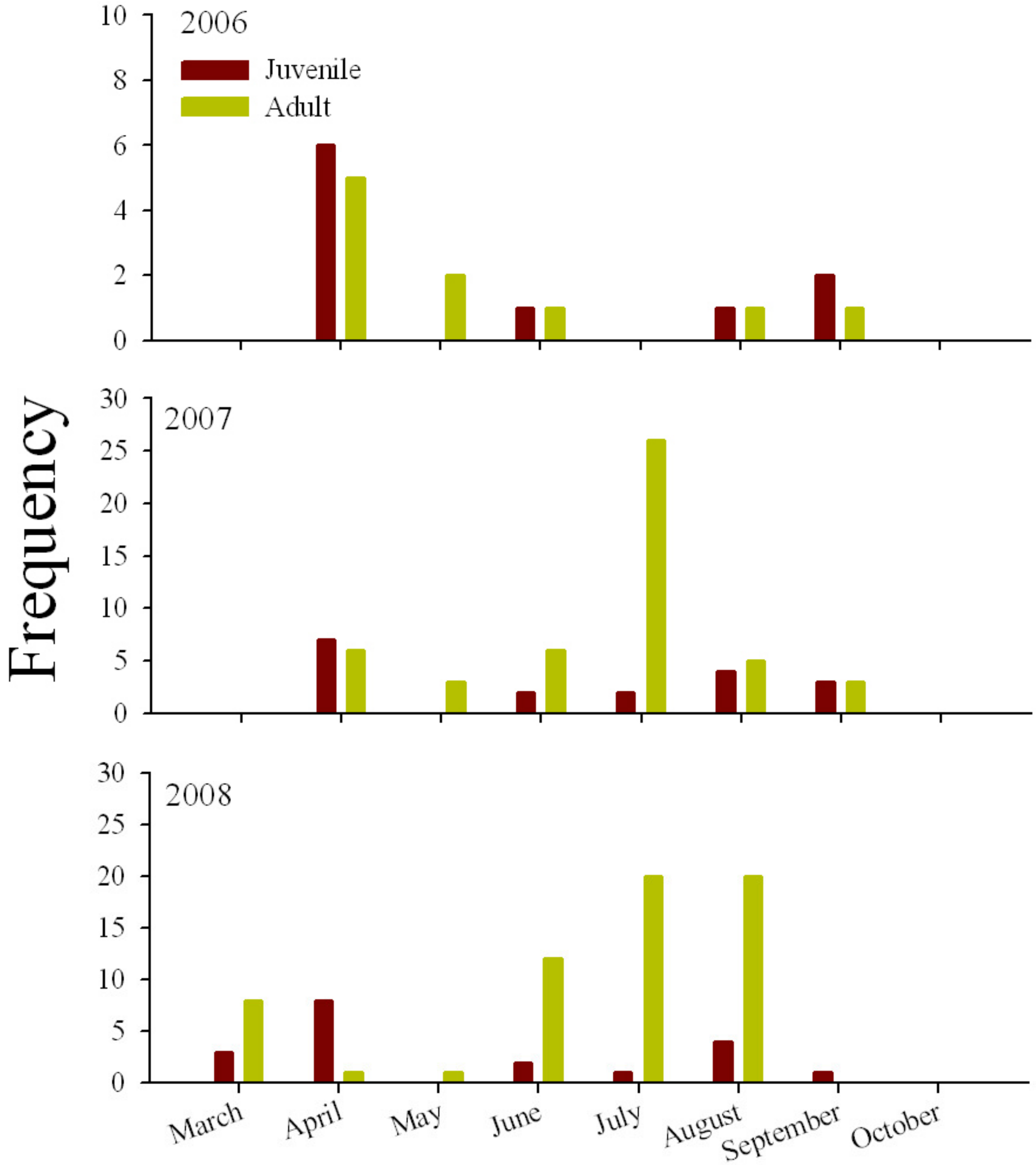


Figure III.2.26. Monthly frequency of juvenile (<305 mm) and adult (≥305 mm) river carpsuckers caught at California (IA) from 2006 - 2008. Please note differences in scale of frequency.

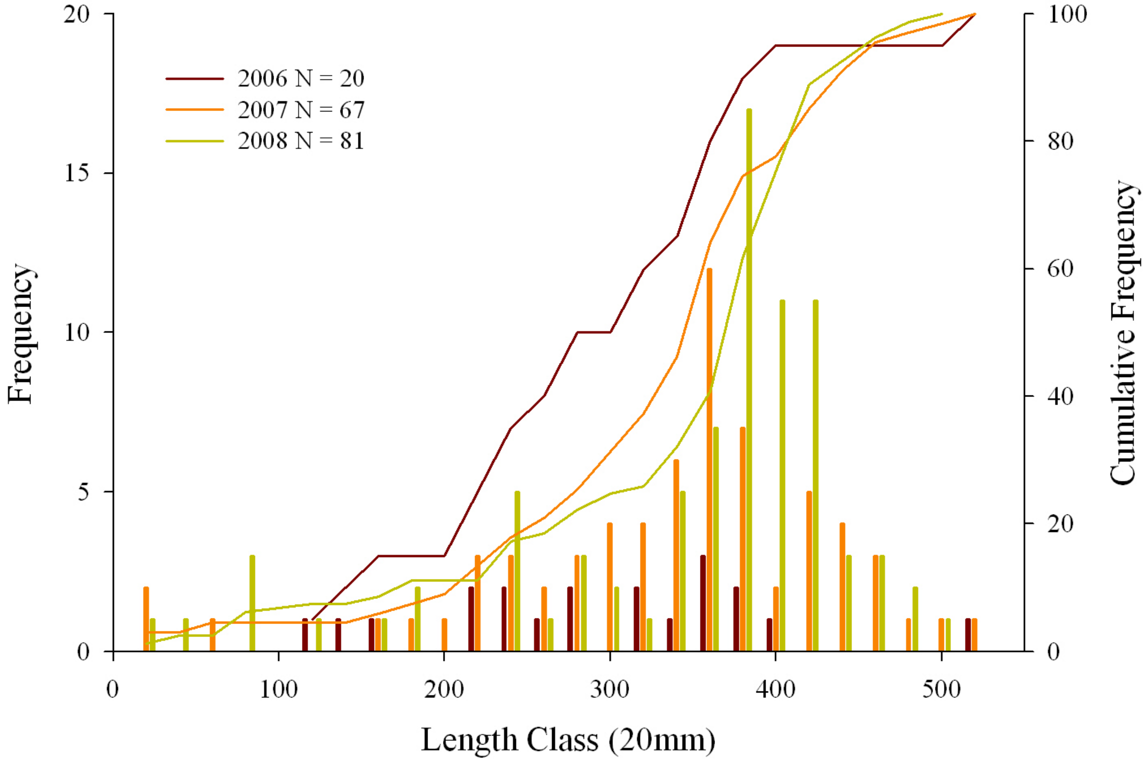


Figure III.2.27. Length frequency distributions and cumulative frequencies for measured river carpsuckers (N) at California (IA) from 2006 - 2008.

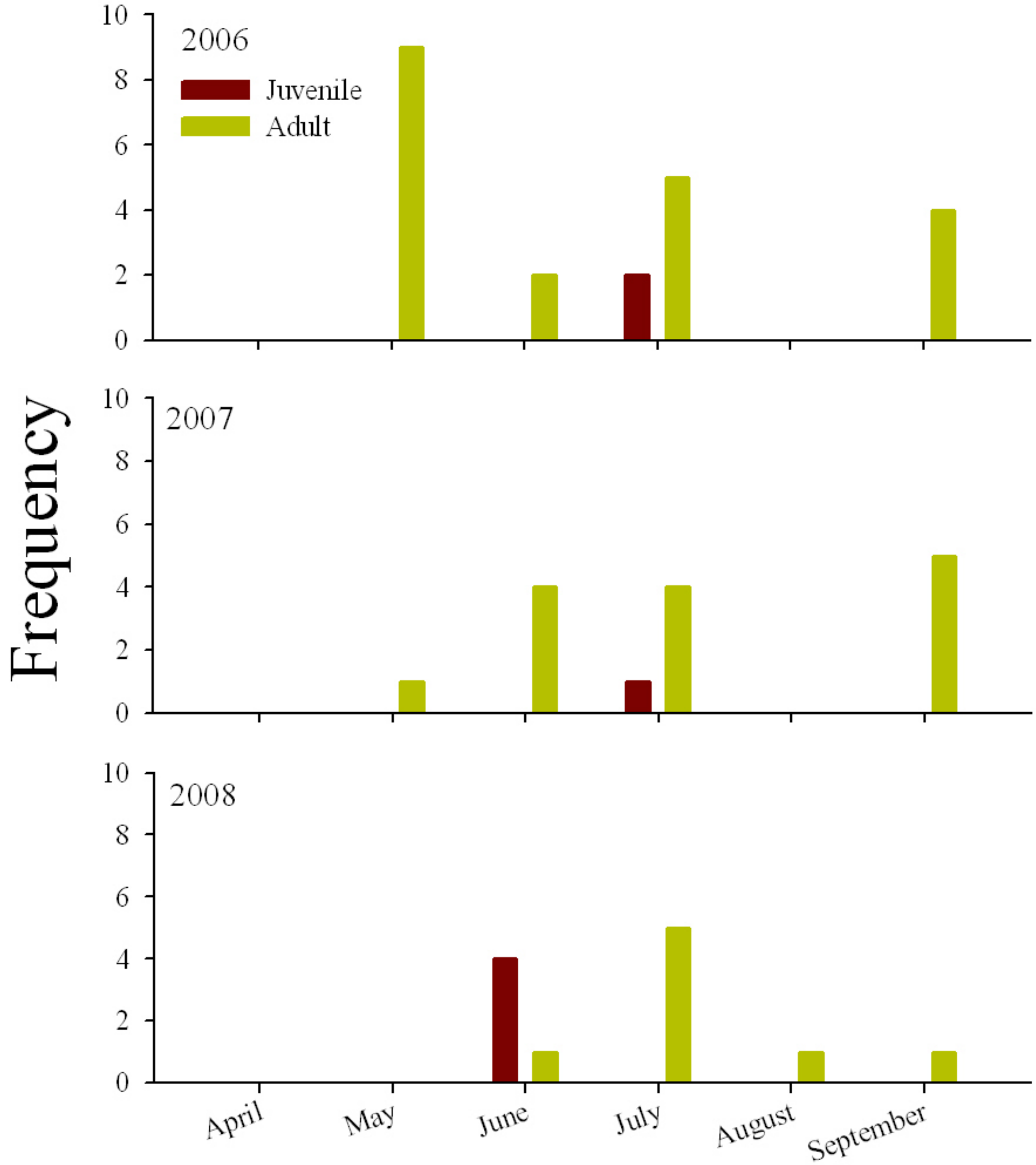


Figure III.2.28. Monthly frequency of juvenile (<508 mm) and adult (≥508 mm) blue suckers caught at California (IA) from 2006 - 2008.

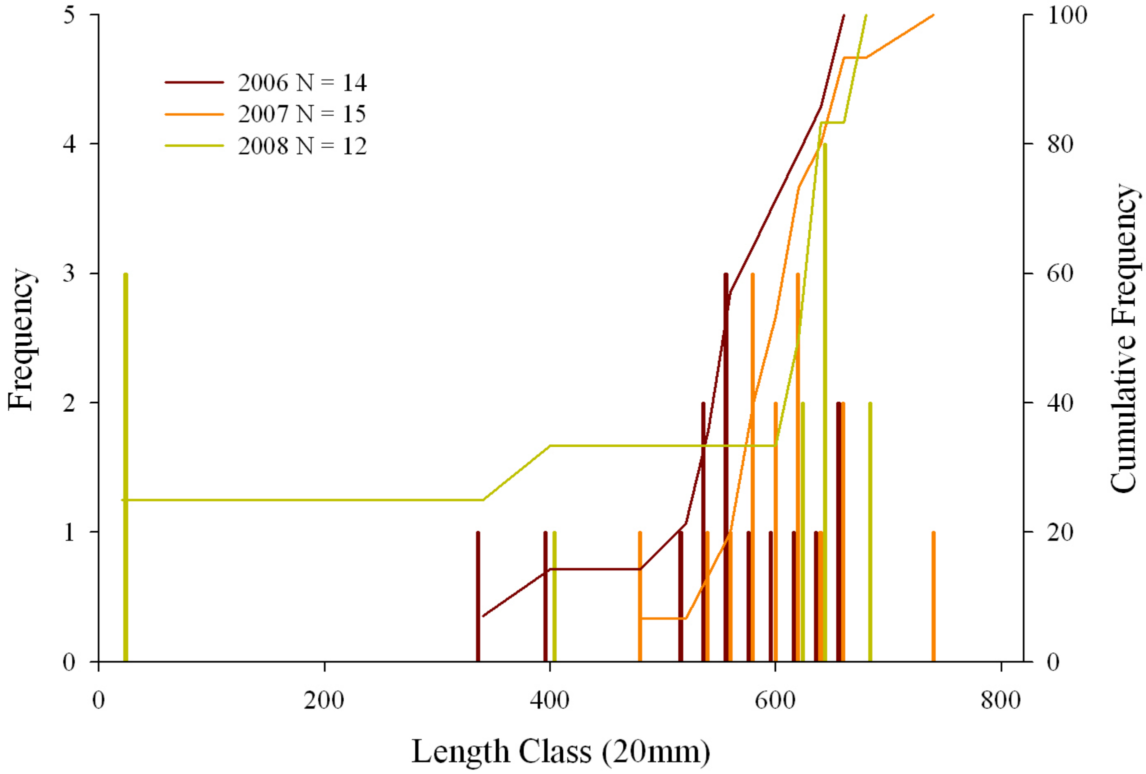


Figure III.2.29. Length frequency distributions and cumulative frequencies for measured blue suckers (N) at California (IA) from 2006 - 2008.

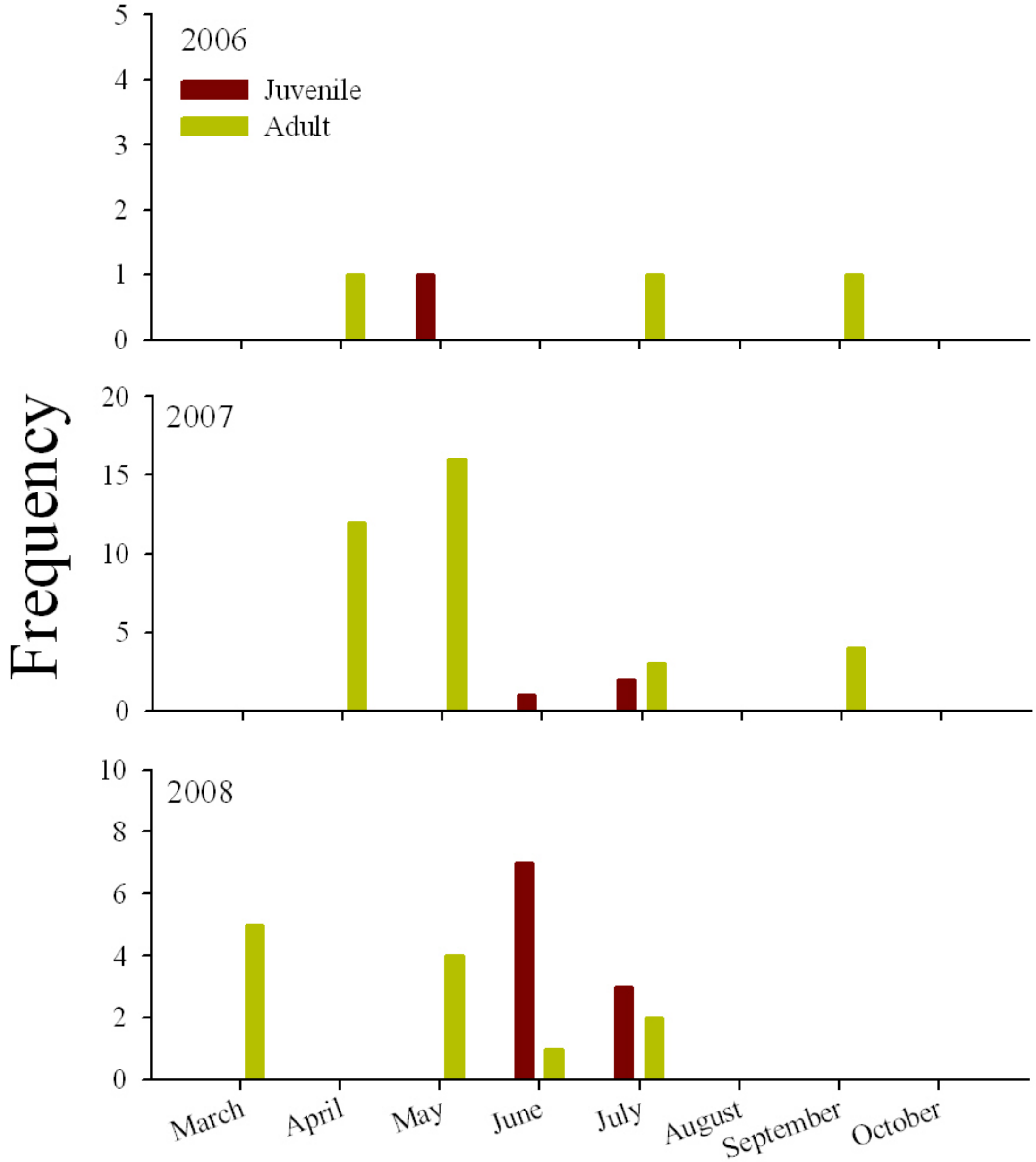


Figure III.2.30. Monthly frequency of juvenile (<381 mm) and adult (≥381 mm) bigmouth buffalo caught at California (IA) from 2006 - 2008. Please note differences in scale of frequency.

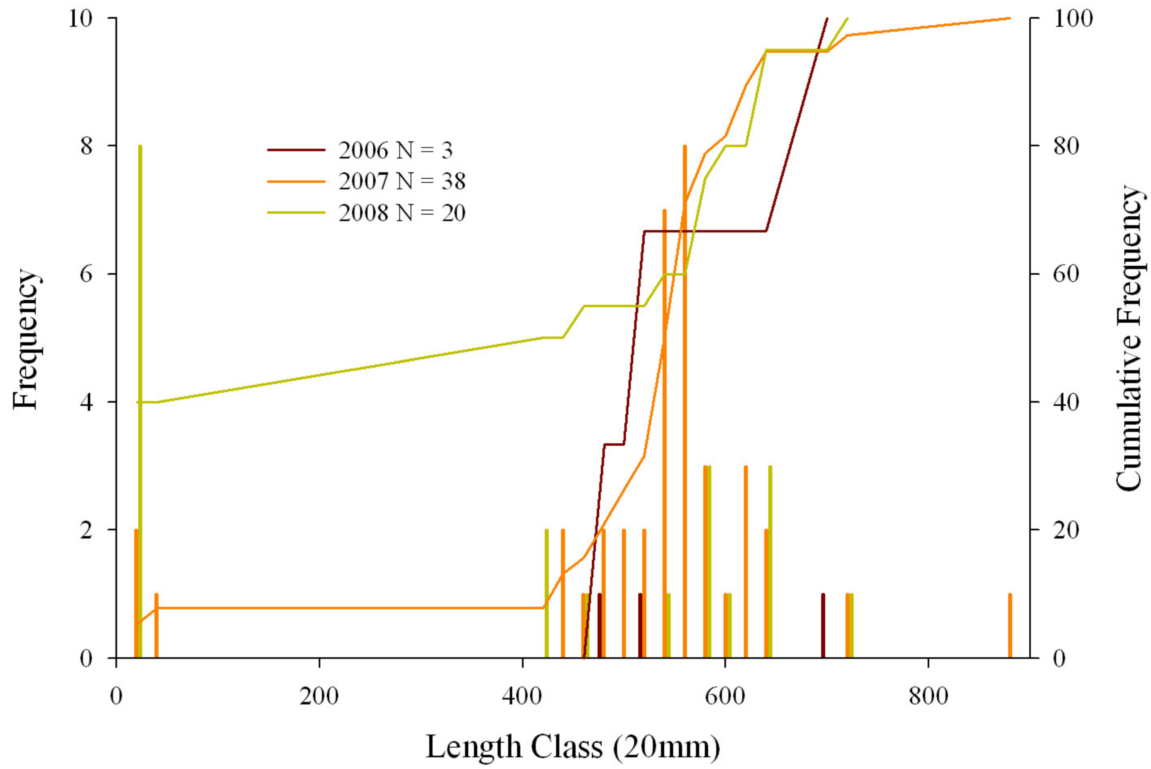


Figure III.2.31. Length frequency distributions and cumulative frequencies for measured bigmouth buffalo (N) at California (IA) from 2006 - 2008.

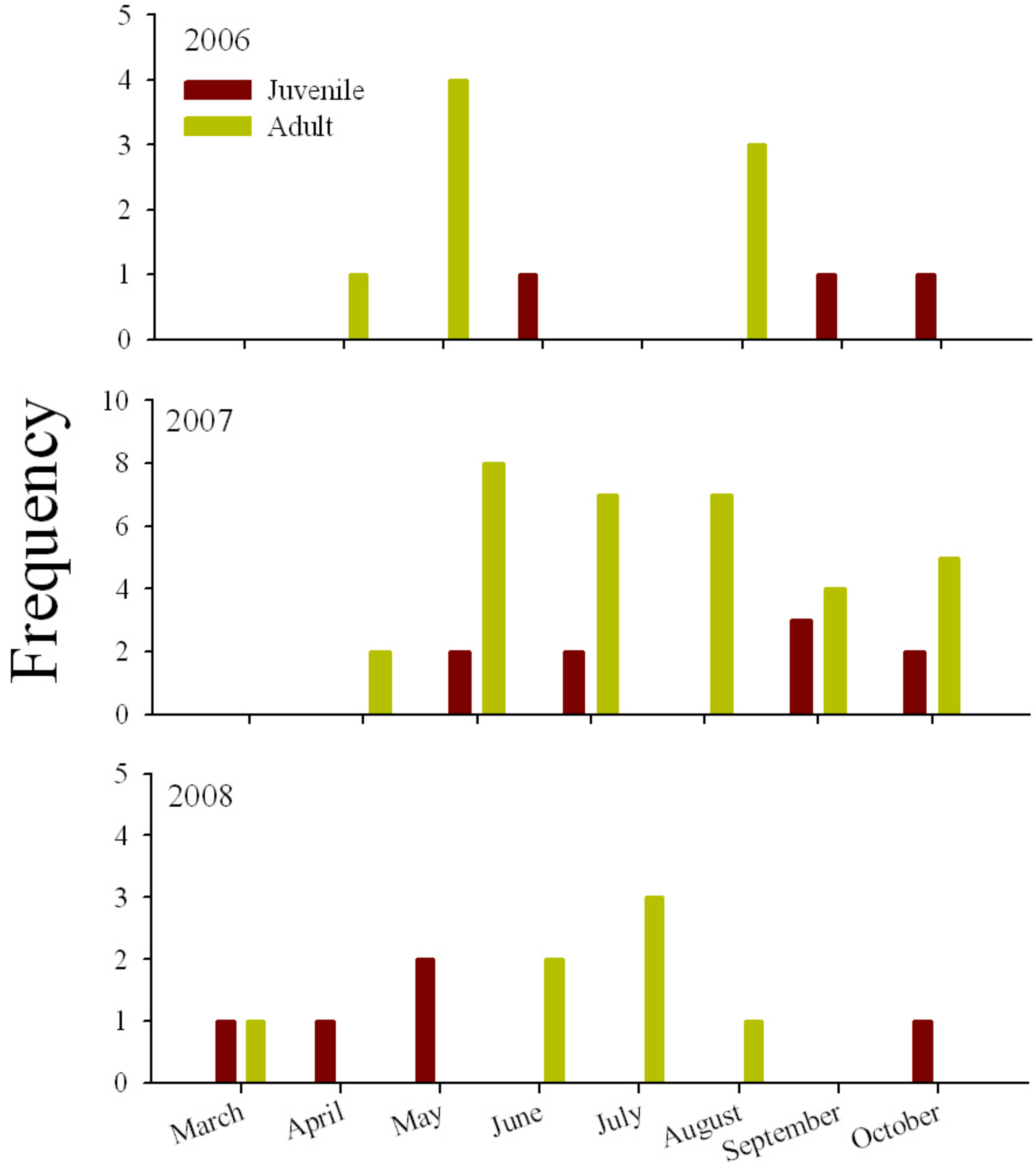


Figure III.2.32. Monthly frequency of juvenile (<229 mm) and adult (≥229 mm) shorthead redhorse caught at California (IA) from 2006 - 2008. Please note differences in scale of frequency.

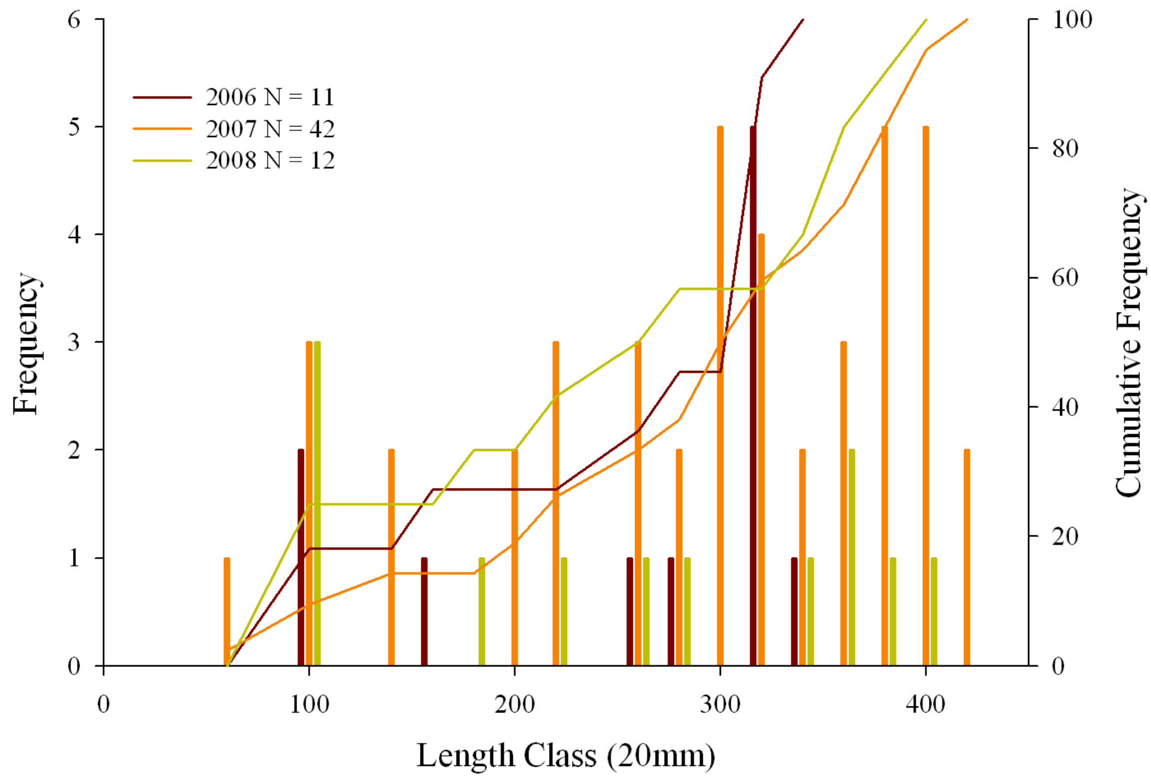


Figure III.2.33. Length frequency distributions and cumulative frequencies for measured shorthead redhorse (N) at California (IA) from 2006 - 2008.

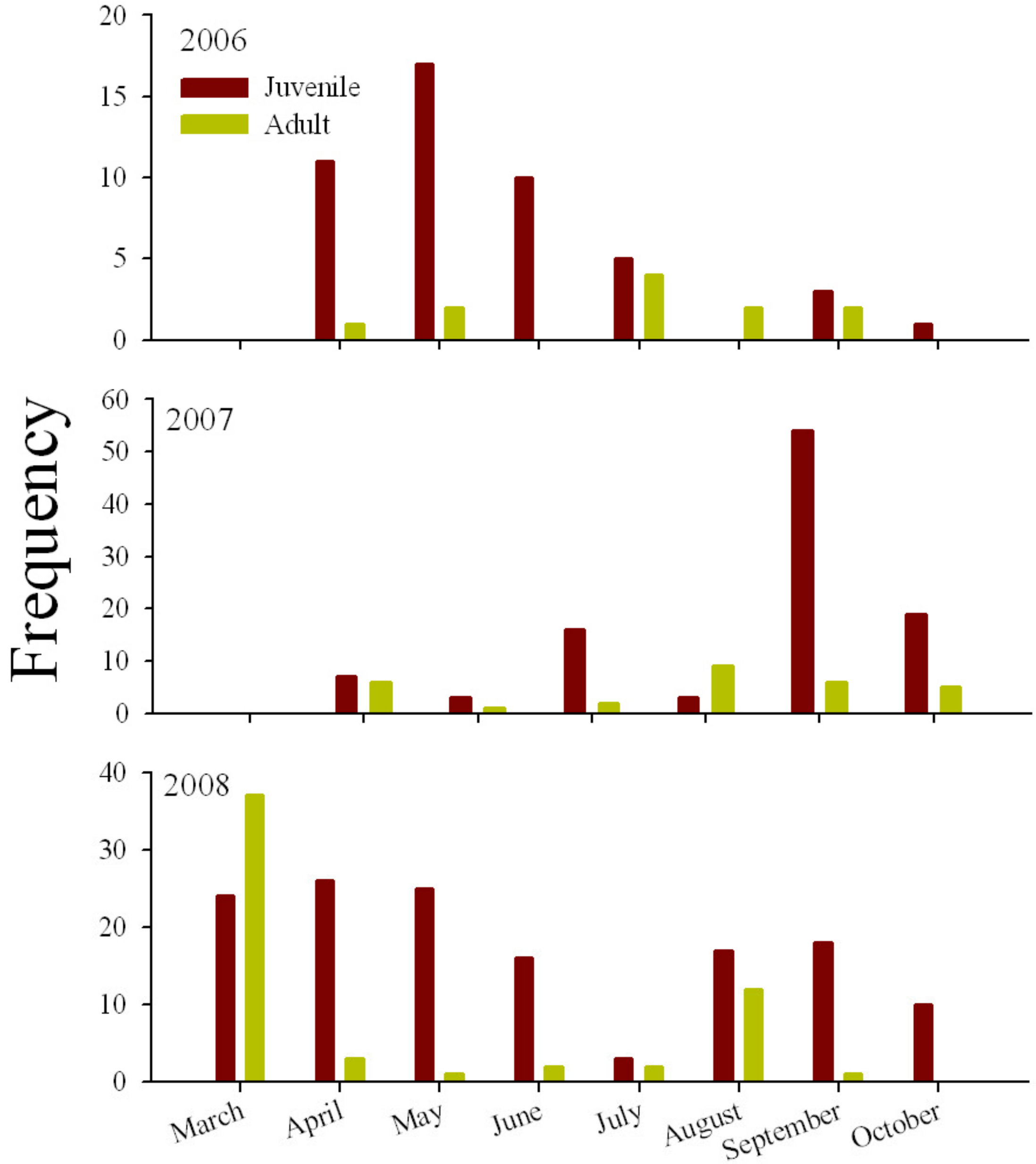


Figure III.2.34. Monthly frequency of juvenile (<305 mm) and adult (≥305 mm) channel catfish caught at California (IA) from 2006 - 2008. Please note differences in scale of frequency.

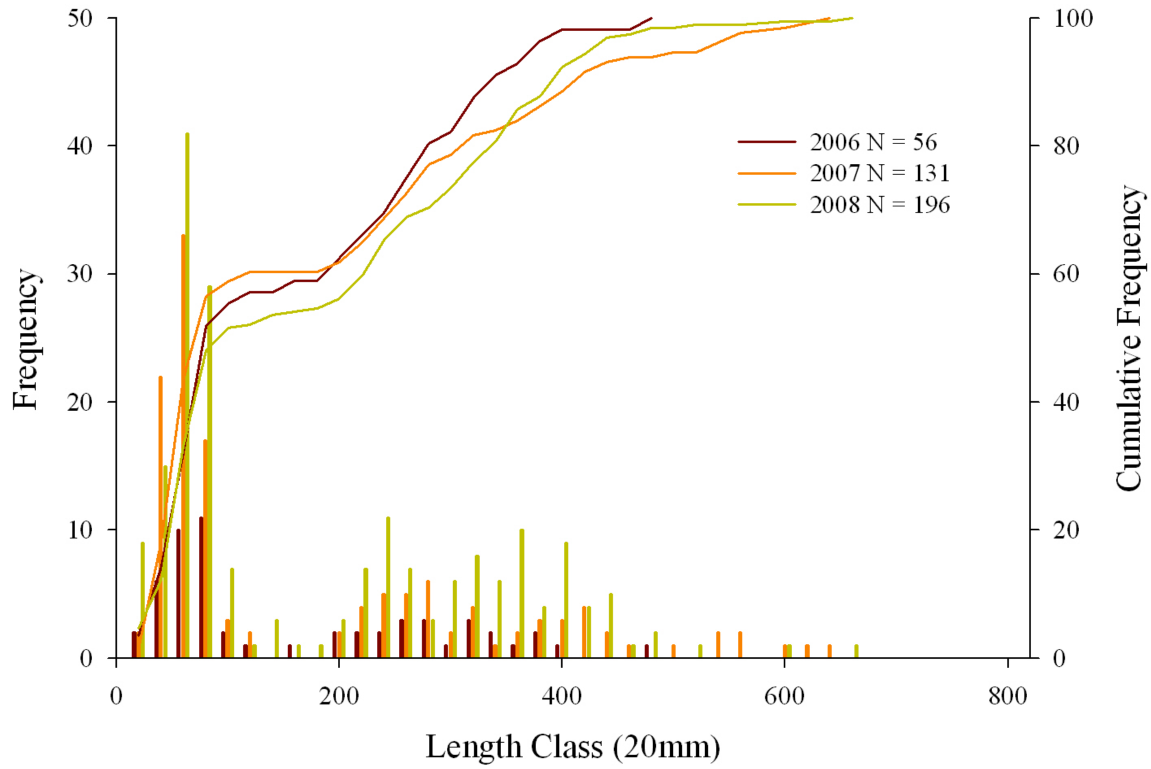


Figure III.2.35. Length frequency distributions and cumulative frequencies for measured channel catfish (N) at California (IA) from 2006 - 2008.

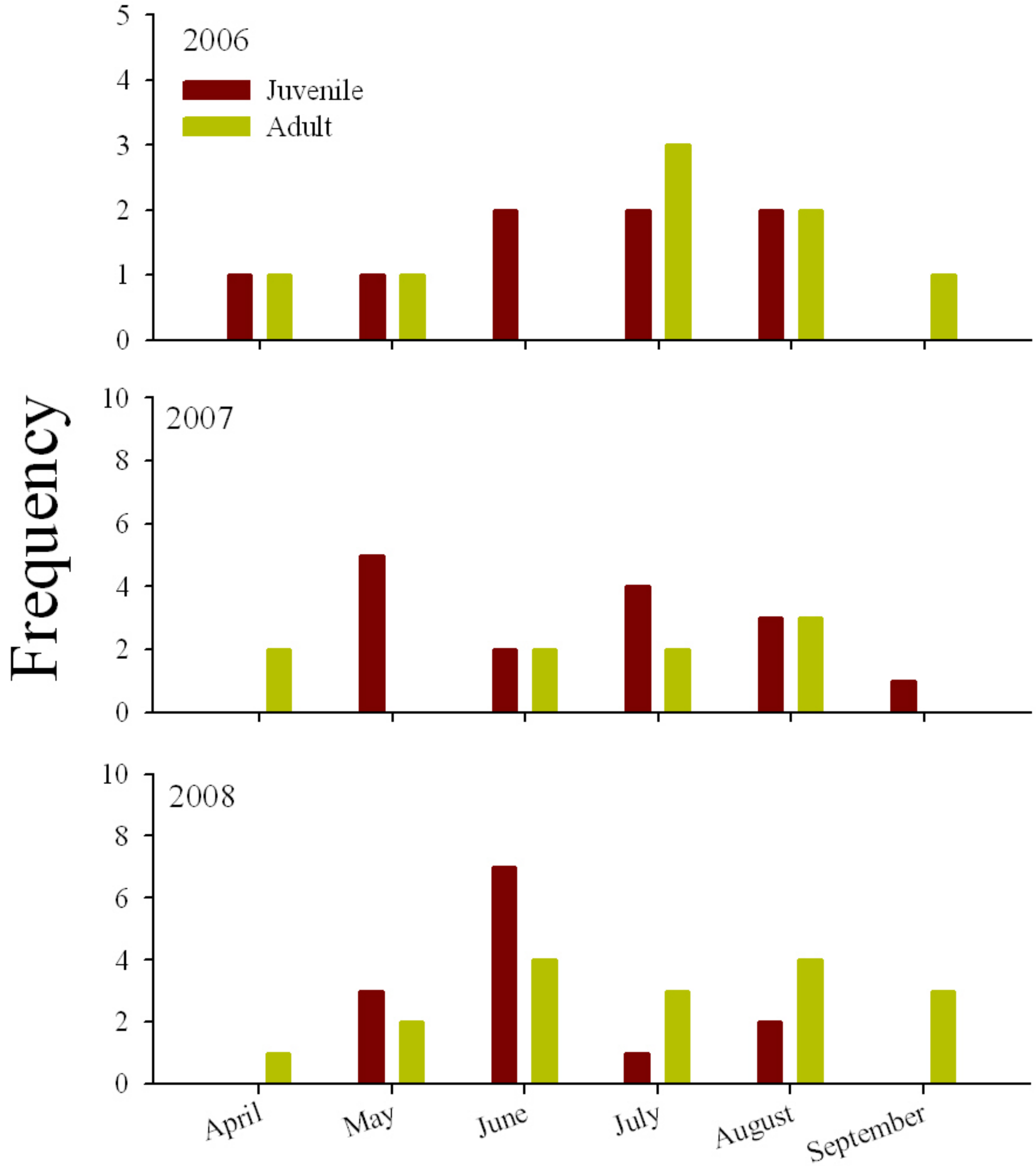


Figure III.2.36. Monthly frequency of juvenile (<381 mm) and adult (≥381 mm) flathead catfish caught at California (IA) from 2006 - 2008. Please note differences in scale of frequency.

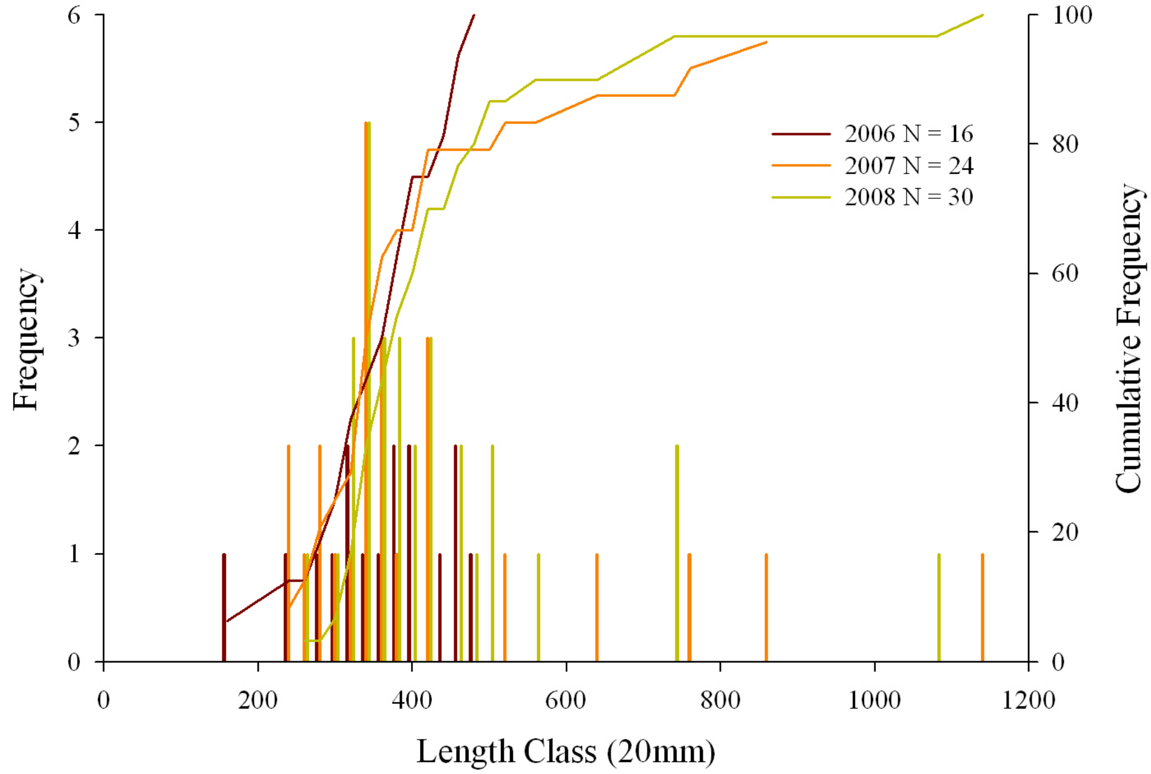
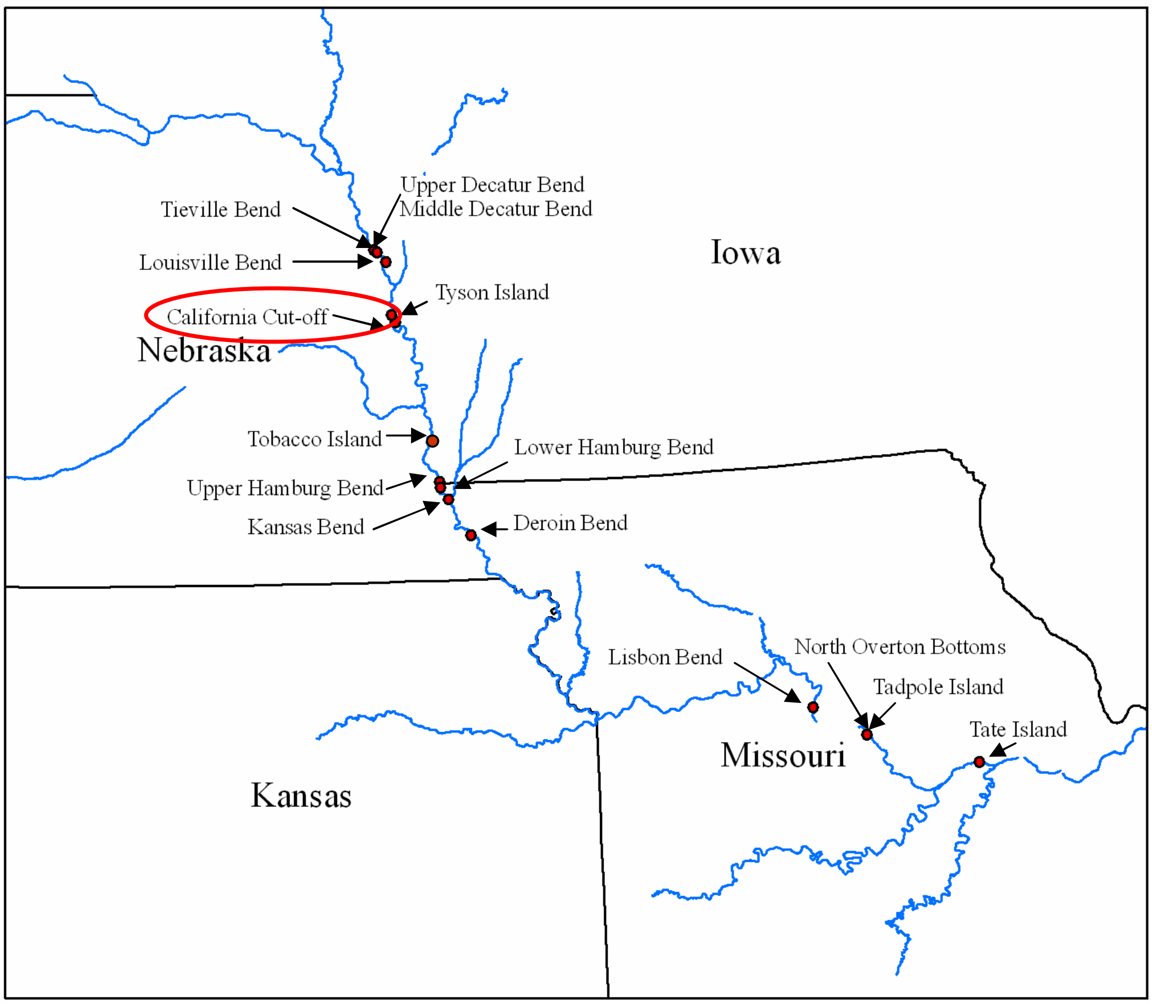


Figure III.2.37. Length frequency distributions and cumulative frequencies for measured flathead catfish (N) at California (IA) from 2006 - 2008.

Section III
Chapter 3
California Cut-off
Nebraska



LIST OF TABLES

LIST OF FIGURES

Figure Page

Figure ....Page

In total 63 identifiable species were caught at California (NE) from 2006 - 2008 (Table III.3.1). Annual species richness changed little at California (NE) during the three years of this study (Table III.3.2), there were however, monthly variations in species richness (Figure III.3.1). Species evenness did not differ among years, ranging from 0.72 - 0.74 on a scale from 0 - 1. Species diversity was similar among years, ranging from 2.77 - 2.87 on a scale of 0 - 5 (Shannon's Index) and 0.91 - 0.92 on a scale of 0 - 1 (Simpson's Index). Community assemblage similarity was not different between years (Table III.3.3), ranging from 82 - 90% similar (Morisita's Index), 2007 and 2008 were the most similar at 90%.

In total 16,078 fish were caught at California (NE) from 2006 - 2008 (Table III.3.1). In total 176 fish could not be identified past family; all unidentified fish were juveniles, usually young of the year. Species that represented greater than 1% of our total catch for this chute, excluding non-target species (e.g. gar, common carp; Table III.3.1) are presented here with analysis, including; proportion of juveniles to adults per species between years (z-test, Table III.3.4), species length frequency distributions between years (Kolmogorov-Smirnov test, Table III.3.5), species mean length between years (t-test, Table III.3.6) and species catch per unit effort (CPUE) by gear between years (Kruskal-Wallis test, Table III.3.7). Juveniles were determined by length (Table I.1.1). Additionally we have reported our monthly CPUE for all species (Table III.3.8). Two additional species of concern are noted, pallid sturgeon and paddlefish.

Pallid Sturgeon

No pallid sturgeon were sampled during 2006.

Three pallid sturgeon were sampled with wild sampling gear at California (NE) during 2007. Pallid sturgeon were sampled with set-lines (n = 2, CPUE = 0.04 fish per set) and hook and line (n = 1, CPUE = NA). Two pallid sturgeon were caught in March and one in April. Mean fork length for pallid sturgeon was 414 mm and ranged from 395 to 425 mm.

Seven pallid sturgeon were sampled with standard sampling gear at California (NE) during 2008. Pallid sturgeon were sampled with 16' otter trawls (n = 1, CPUE = 0.02 fish per 100 m trawled) and trammel nets (n = 6, CPUE = 0.06 fish per 125 ft of net drifted 100 m). Monthly pallid sturgeon catch rates ranged from 2 in May to 5 in June. Mean fork length for pallid sturgeon was 426 mm and ranged from 295 to 676 mm.

All pallid sturgeon caught at California (NE) were hatchery reared fish. One of the pallid sturgeon caught in June 2008 was determined with genetic analysis to be a hybrid sturgeon.

Shovelnose Sturgeon

In total 100 shovelnose sturgeon (61% juveniles, <540 mm) were sampled with standard sampling gears at California (NE) during 2006. Shovelnose sturgeon were sampled with 16' otter trawls (n = 18, CPUE = 0.23 fish per 100 m trawled), 8' otter trawls (n = 6, CPUE = 0.10 fish per 100 m trawled), 4' hoop nets (n = 7, CPUE = 0.13 fish per net night), 2' hoop nets (n = 1, CPUE = 0.02 fish per net night), trammel nets (n = 20, CPUE = 0.54 fish per 125 ft of net drifted 100 m) and electrofishing (n = 48, CPUE

= 8.83 fish per hour). Monthly catches of shovelnose sturgeon ranged from 5 in October to 31 in April. Mean fork length for shovelnose sturgeon was 533 mm ranging from 48 to 657 mm.

In total 201 shovelnose sturgeon (78% juveniles, <540 mm) were sampled with standard sampling gears at California (NE) during 2007. Shovelnose sturgeon were sampled with 16' otter trawls (n = 16, CPUE = 0.21 fish per 100 m trawled), 8' otter trawls (n = 6, CPUE = 0.24 fish per 100 m trawled), 4' hoop nets (n = 55, CPUE = 1.15 fish per net night), 2' hoop nets (n = 14, CPUE = 0.28 fish per net night), trammel nets (n = 72, CPUE = 0.47 fish per 125 ft of net drifted 100 m), electrofishing (n = 37, CPUE = 5.95 fish per hour) and push trawls (n = 1, CPUE = 0.02 fish per 100 m trawled). Monthly catches of shovelnose sturgeon ranged from 15 in October to 63 in May. Mean fork length for shovelnose sturgeon was 528 mm ranging from 209 to 679 mm.

In total 168 shovelnose sturgeon (77% juveniles, <540 mm) were sampled with standard sampling gears at California (NE) during 2008. Shovelnose sturgeon were sampled with 16' otter trawls (n = 15, CPUE = 0.27 fish per 100 m trawled), 8' otter trawls (n = 4, CPUE = 0.08 fish per 100 m trawled), electrofishing (n = 28, CPUE = 4.77 fish per hour), 4' hoop nets (n = 18, CPUE = 0.34 fish per net night), 2' hoop nets (n = 5, CPUE = 0.09 fish per net night), trammel nets (n = 67, CPUE = 1.44 fish per 125 ft of net drifted 100 m) and push trawls (n = 3, CPUE = 0.07 fish per 100 m trawled). Monthly catches of shovelnose sturgeon ranged from 3 in October to 102 in June. Mean fork length for shovelnose sturgeon was 531 mm ranging from 83 to 660 mm.

We compared proportion of juveniles between years using a z-test. Shovelnose sturgeon life stage proportions were significantly different in 2006, a greater proportion of adults was caught in 2006 (Figure III.3.2, Table III.3.4).

We compared length frequency distributions of shovelnose sturgeon between years using a Kolmogorov-Smirnov test. Shovelnose sturgeon length frequency distributions at California (NE) were not significantly different between years (Figure III.3.3, Table III.3.5). Mean length between years was compared using a t-test. Mean lengths were not significantly different between years (Table III.3.6).

We compared shovelnose sturgeon CPUE between years using a Kruskal-Wallis test. Shovelnose sturgeon catch rates between 2006 and 2007 were significantly different for 2’ and 4’ hoop nets and trammel nets (Table III.3.7).

Paddlefish

No paddlefish were sampled at California (NE) during 2006.

One paddlefish was sampled in a 4’ hoop net (CPUE = 0.02 fish per net night) at California (NE) in August of 2007. The paddlefish measured 662 mm from the front of the eye to the fork of the tail.

One paddlefish was sampled electrofishing (CPUE = 0.18 fish per hour) at California (NE) in May of 2008. The paddlefish measured 786 mm from the front of the eye to the fork of the tail.

Goldeye

In total 88 goldeye (98% juveniles, <356 mm) were sampled with standard gears at California (NE) during 2006. Goldeye were sampled with electrofishing (n = 49, CPUE = 8.76 fish per hour), 4' hoop nets (n = 32, CPUE = 0.60 fish per net night) and trammel nets (n = 7, CPUE = 0.21 fish per 125 ft of net drifted 100 m). Monthly catches of goldeye ranged from 2 in September to 27 in May. Mean total length of goldeye sampled was 329 mm ranging from 175 to 389 mm.

In total 102 goldeye (90% juveniles, <356 mm) were sampled with standard gears at California (NE) during 2007. Goldeye were sampled with electrofishing (n = 55, CPUE = 9.77 fish per hour), 4' hoop nets (n = 8, CPUE = 0.17 fish per net night), 16' otter trawls (n = 2, CPUE = 0.03 fish per 100 m trawled) and trammel nets (n = 37, CPUE = 0.73 fish per 125 ft of net drifted 100 m). Monthly catches of goldeye ranged from 7 in July to 32 in April. Mean total length of goldeye sampled was 328 mm ranging from 99 to 406 mm.

In total 127 goldeye (86% juveniles, <356 mm) were sampled with standard gears at California (NE) during 2008. Goldeye were sampled with electrofishing (n = 87, CPUE = 15.84 fish per hour), 4' hoop nets (n = 15, CPUE = 0.28 fish per net night) and trammel nets (n = 25, CPUE = 0.42 fish per 125 ft of net drifted 100 m). Monthly catches of goldeye ranged from 5 in September to 29 in July. Mean total length of goldeye sampled was 334 mm ranging from 172 to 399 mm.

We compared proportion of juveniles between years using a z-test. The proportion of juvenile goldeye caught was significantly higher in 2006 (Figure III.3.4, Table III.3.4).

We compared length frequency distributions of goldeye between years using a Kolmogorov-Smirnov test. Goldeye length frequency distributions at California (NE) were not significantly different between years (Figure III.3.5, Table III.3.5). Mean length between years was compared using a t-test. Mean lengths were not significantly different between years (Table III.3.6).

We compared goldeye CPUE between years using a Kruskal-Wallis test. Goldeye catch rates were not significantly different between years (Table III.3.7).

Gizzard Shad

In total 259 gizzard shad (96% juveniles, <229 mm) were sampled with standard gears at California (NE) during 2006. Gizzard shad were sampled with bag seines (n = 16, CPUE = 1.22 fish per 100 m^2), electrofishing (n = 206, CPUE = 34.37 fish per hour), mini-fyke nets (n = 28, CPUE = 1.08 fish per net night) and 16' otter trawls (n = 9, CPUE = 0.09 fish per 100 m trawled). Monthly catches ranged from 2 in April to 145 in September. Mean total length of gizzard shad sampled was 152 mm ranging from 61 to 415 mm.

In total 311 gizzard shad (99% juveniles, <229 mm) were sampled with standard gears at California (NE) during 2007. Gizzard shad were sampled with electrofishing (n = 181, CPUE = 30.75 fish per hour), push trawls (n = 1, CPUE = 0.05 fish per 100 m trawled), 16' otter trawls (n = 2, CPUE = 0.03 fish per 100 m trawled) and mini-fyke nets (n = 127, CPUE = 4.23 fish per net night). Monthly catches ranged from 1 in May to 209 in September. Mean total length of gizzard shad sampled was 115 mm ranging from 28 to 375 mm.

In total 86 gizzard shad (98% juveniles, <229 mm) were sampled with standard gears at California (NE) during 2008. Gizzard shad were sampled with electrofishing (n = 54, CPUE = 10.62 fish per hour), push trawls (n = 17, CPUE = 0.47 fish per 100 m trawled), 16' otter trawls (n = 2, CPUE = 0.05 fish per 100 m trawled) and mini-fyke nets (n = 13, CPUE = 0.45 fish per net night). Monthly catches ranged from 0 in June to 48 in October. Mean total length of gizzard shad sampled was 102 mm ranging from 33 to 346 mm.

We compared proportion of juveniles between years using a z-test. The proportion of juvenile gizzard shad caught was significantly higher in 2006 than 2007 (Figure III.3.6, Table III.3.4).

We compared length frequency distributions of gizzard shad between years using a Kolmogorov-Smirnov test. Gizzard shad length frequency distributions at California (NE) were not significantly different between years (Figure III.3.7, Table III.3.5). Mean length between years was compared using a t-test. Mean length was significantly higher in 2006 (Table III.3.6), mean length decreased each year.

We compared gizzard shad CPUE between years using a Kruskal-Wallis test. Gizzard shad catch rates were not significantly different between years (Table III.3.7).

Speckled Chub

In total 59 speckled chubs (88% juveniles, <40 mm) were sampled with standard gears at California (NE) in 2006. Speckled chubs were sampled with 16' otter trawls (n = 11, CPUE = 0.15 fish per 100 m trawled), 8' otter trawls (n = 47, CPUE = 0.78 fish per 100 m trawled) and bag seines (n = 1, CPUE = 0.08 fish per 100 m^2). Monthly speckled

chub catches ranged from 0 in August to 38 in October. Mean length of speckled chubs sampled was 36 mm ranging from 25 to 63 mm.

In total 101 speckled chubs (78% juveniles, <40 mm) were sampled with standard gears at California (NE) in 2007. Speckled chubs were sampled with 16' otter trawls (n = 30, CPUE = 0.44 fish per 100 m trawled), 8' otter trawls (n = 35, CPUE = 0.63 fish per 100 m trawled), push trawls (n = 35, CPUE = 1.32 fish per 100 m trawled) and mini-fyke nets (n = 1, CPUE = 0.03 fish per net night). Monthly speckled chub catches ranged from 5 in May to 51 in October. Mean length of speckled chubs sampled was 38 mm ranging from 20 to 62 mm.

In total 92 speckled chubs (82% juveniles, <40 mm) were sampled with standard gears at California (NE) in 2008. Speckled chubs were sampled with 16' otter trawls (n = 17, CPUE = 0.30 fish per 100 m trawled), 8' otter trawls (n = 50, CPUE = 1.08 fish per 100 m trawled) and push trawls (n = 25, CPUE = 0.55 fish per 100 m trawled). Monthly speckled chub catches ranged from 0 in July and August to 32 in April. Mean length of speckled chubs sampled was 39 mm ranging from 24 to 55 mm.

We compared proportion of juveniles between years using a z-test. Speckled chub life stage proportions were not significantly different between years (Figure III.3.8, Table III.3.4).

We compared length frequency distributions of speckled chubs between years using a Kolmogorov-Smirnov test. Speckled chub length frequency distributions at California (NE) were not significantly different between years (Figure III.3.9, Table III.3.5). Mean length between years was compared using a t-test. Mean lengths were not significantly different between years (Table III.3.6).

We compared speckled chub CPUE between years using a Kruskal-Wallis test. Speckled chub catch rates were not significantly different between years (Table III.3.7).

Silver Chub

In total 486 silver chubs (97% juveniles, <89 mm) were sampled with standard gears at California (NE) during 2006. Silver chubs were sampled with bag seines (n = 91, CPUE = 6.86 fish per 100 m^2), electrofishing (n = 13, CPUE = 1.80 fish per hour), mini-fyke nets (n = 131, CPUE = 5.04 fish per net night), 16' otter trawls (n = 173, CPUE = 2.11 fish per 100 m trawled), 8' otter trawls (n = 75, CPUE = 1.25 fish per 100 m trawled) and 2' hoop nets (n = 3, CPUE = 0.06 fish per net night). Monthly catches of silver chubs ranged from 2 in June to 138 in August. Mean total length of silver chubs sampled was 64 mm ranging from 22 to 159 mm.

In total 445 silver chubs (96% juveniles, <89 mm) were sampled with standard gears at California (NE) during 2007. Silver chubs were sampled with electrofishing (n = 14 , CPUE = 2.76 fish per hour), mini-fyke nets (n = 54, CPUE = 1.80 fish per net night), 16' otter trawls (n = 189, CPUE = 2.64 fish per 100 m), 8' otter trawls (n = 65, CPUE = 1.06 fish per 100 m trawled), 2' hoop nets (n = 7, CPUE = 0.15 fish per net night) and push trawls (n = 116, CPUE = 5.22 fish per 100 m trawled). Monthly catches of silver chubs ranged from 16 in May and June to 205 in April. Mean total length of silver chubs sampled was 68 mm ranging from 18 to 135 mm.

In total 838 silver chubs (99.9% juveniles, <89 mm) were sampled with standard gears at California (NE) during 2008. Silver chubs were sampled with electrofishing (n = 4, CPUE = 0.68 fish per hour), mini-fyke nets (n = 53, CPUE = 1.83 fish per net night),

16’ otter trawls (n = 63, CPUE = 1.23 fish per 100 m trawled), 8’ otter trawls (n = 224, CPUE = 4.75 fish per 100 m trawled) and push trawls (n = 494, CPUE = 12.33 fish per 100 m trawled). Monthly catches of silver chubs ranged from 9 in May to 234 in September. Mean total length of silver chubs sampled was 51 mm ranging from 17 to 131 mm.

We compared proportion of juveniles between years using a z-test. The proportion of juvenile silver chubs was significantly higher in 2008 (Figure III.3.10, Table III.3.4).

We compared length frequency distributions of silver chubs between years using a Kolmogorov-Smirnov test. Silver chub length frequency distributions at California (NE) were significantly different between 2006 and 2008 (Figure III.3.11, Table III.3.5), more small fish were caught in 2008 and more large fish were caught in 2006. Mean length between years was compared using a t-test. Mean lengths were significantly different between all years (Table III.3.6), mean lengths were highest in 2007, lowest in 2008.

We compared silver chub CPUE between years using a Kruskal-Wallis test. Silver chub catch rates were not significantly different between years (Table III.3.7).

Red Shiner

In total 746 red shiners (92% juveniles, <46 mm) were sampled with standard gears at California (NE) in 2006. Red shiners were sampled with bag seines (n = 21, CPUE = 1.56 fish per 100 m^2), electrofishing (n = 8, CPUE = 1.30 fish per hour), mini-fyke nets (n = 709, CPUE = 27.27 fish per net night), 16’ otter trawls (n = 7, CPUE =

0.08 fish per 100 m trawled) and 8' otter trawls (n = 1, CPUE = 0.02 fish per 100 m trawled). Monthly red shiner catch at California (NE) ranged from 4 in April to 422 in June. Mean total length for red shiners sampled was 53 mm ranging from 28 to 93 mm.

In total 251 red shiners (81% juveniles, <46 mm) were sampled with standard gears at California (NE) in 2007. Red shiners were sampled with electrofishing (n = 26, CPUE = 4.22 fish per hour), mini-fyke nets (n = 213, CPUE = 7.10 fish per net night) and push trawls (n = 12, CPUE = 0.38 fish per 100 m trawled). Monthly red shiner catch rates ranged from 7 in April to 107 in June. Mean total length for red shiners sampled was 49 mm ranging from 22 to 83 mm.

In total 86 red shiners (70% juveniles, <46 mm) were sampled with standard gears at California (NE) in 2008. Red shiners were sampled with electrofishing (n = 2, CPUE = 0.34 fish per hour), mini-fyke nets (n = 59, CPUE = 2.03 fish per net night), 8' otter trawls (n = 1, CPUE = 0.02 fish per 100 m trawled) and push trawls (n = 24, CPUE = 0.56 fish per 100 m trawled). Monthly red shiner catch rates ranged from 2 in October to 24 in July. Mean total length for red shiners sampled was 48 mm ranging from 18 to 82 mm.

We compared proportion of juveniles between years using a z-test. Red shiner life stage proportions were significantly different for all years (Figure III.3.12, Table III.3.4), the number of juveniles caught decreased each year.

We compared length frequency distributions of red shiners between years using a Kolmogorov-Smirnov test. Red shiner length frequency distributions at California (NE) were not significantly different between years (Figure III.3.13, Table III.3.5). Mean

length between years was compared using a t-test. Mean length was significantly higher in 2006 (Table III.3.6), many large red shiners were caught in 2006.

We compared red shiner CPUE between years using a Kruskal-Wallis test. Red shiner catch rates were significantly higher in 2006 than 2008 for mini-fyke nets (Table III.3.7), mini fyke net catch rates decreased yearly.

Emerald Shiner

In total 1,040 emerald shiners (92% juveniles, <64 mm) were sampled with standard gears at California (NE) in 2006. Emerald shiners were sampled with bag seines (n = 148, CPUE = 11.83 fish per 100 m^2), electrofishing (n = 160, CPUE = 29.16 fish per hour), mini-fyke nets (n = 723, CPUE = 27.81 fish per net night), 16' otter trawls (n = 6, CPUE = 0.07 fish per 100 m trawled) and 8' otter trawls (n = 3, CPUE = 0.05 fish per 100 m trawled). Monthly catches ranged from 7 in June to 462 in April. Mean total length of emerald shiners was 65 mm and ranged from 26 to 105 mm.

In total 616 emerald shiners (93% juveniles, <64 mm) were sampled with standard gears at California (NE) in 2007. Emerald shiners were sampled with electrofishing (n = 135, CPUE = 22.55 fish per hour), mini-fyke nets (n = 415, CPUE = 13.83 fish per net night), 8' otter trawls (n = 4, CPUE = 0.06 fish per 100 m trawled), push trawls (n = 61, CPUE = 2.5 fish per 100 m trawled) and 2' hoop nets (n = 1, CPUE = 0.02 fish per net night). Monthly catch rates ranged from 7 in July to 192 in April. Mean total length of emerald shiners was 60 mm and ranged from 24 to 97 mm.

In total 1,182 emerald shiners (94% juveniles, <64 mm) were sampled with standard gears at California (NE) in 2008. Emerald shiners were sampled with

electrofishing (n = 73, CPUE = 13.27 fish per hour), mini-fyke nets (n = 912, CPUE = 30.81 fish per net night), 16' otter trawls (n = 5, CPUE = 0.09 fish per 100 m trawled), 8' otter trawls (n = 27, CPUE = 0.73 fish per 100 m trawled) and push trawls (n = 165, CPUE = 4.99 fish per 100 m trawled). Monthly catch rates ranged from 28 in August to 117 in April. Mean total length for emerald shiners sampled was 63 mm ranging from 21 to 102 mm.

We compared proportion of juveniles between years using a z-test. Emerald shiner life stage proportions were not significantly different between years (Figure III.3.14, Table III.3.4).

We compared length frequency distributions of emerald shiners between years using a Kolmogorov-Smirnov test. Emerald shiner length frequency distributions were not significantly different between years (Figure III.3.15, Table III.3.5). Mean length between years was compared using a t-test. Mean length was significantly lower in 2007 (Table III.3.6).

We compared emerald shiner CPUE between years using a Kruskal-Wallis test. Emerald shiner catch rates were not significantly different between years (Table III.3.7).

River Shiner

In total 963 river shiners (99% juveniles, <51 mm) were sampled with standard gears at California (NE) during 2006. River shiners were sampled with bag seines (n = 17, CPUE = 1.13 fish per 100 m^2), electrofishing (n = 10, CPUE = 1.83 fish per hour), mini-fyke nets (n = 932, CPUE = 35.85 fish per net night), 16' otter trawls (n = 3, CPUE = 0.04 fish per 100 m trawled) and 8' otter trawls (n = 1, CPUE = 0.02 fish per 100 m

trawled). Monthly catches ranged from 10 in May to 625 in August. Mean total length of river shiners was 42 mm ranging from 29 to 132 mm.

In total 438 river shiners (98% juveniles, <51 mm) were sampled with standard gears at California (NE) during 2007. River shiners were sampled with electrofishing (n = 11, CPUE = 1.83 fish per hour), mini-fyke nets (n = 408, CPUE = 13.60 fish per net night), 8' otter trawls (n = 2, CPUE = 0.03 fish per 100 m trawled) and push trawls (n = 17, CPUE = 0.74 fish per 100 m trawled). Monthly catch rates ranged from 2 in July to 252 in June. Mean total length of river shiners was 39 mm ranging from 24 to 78 mm.

In total 715 river shiners (99% juveniles, <51 mm) were sampled with standard gears at California (NE) during 2008. River shiners were sampled with electrofishing (n = 2, CPUE = 0.32 fish per hour), mini-fyke nets (n = 441, CPUE = 15.21 fish per net night), 8' otter trawls (n = 4, CPUE = 0.09 fish per 100 m trawled) and push trawls (n = 268, CPUE = 7.37 fish per 100 m trawled). Monthly catch rates ranged from 21 in July to 107 in May. Mean total length of river shiners was 34 mm ranging from 10 to 64 mm.

We compared proportion of juveniles between years using a z-test. River shiner life stage proportions were significantly different between 2007 and 2008 (Figure III.3.16, Table III.3.4), less juveniles were caught in 2007.

We compared length frequency distributions of river shiners between years using a Kolmogorov-Smirnov test. River shiner length frequency distributions at California (NE) were not significantly different between years (Figure III.3.17, Table III.3.5). Mean length between years was compared using a t-test. Mean lengths were significantly different between all years, with the mean length declining yearly (Table III.3.6).

We compared river shiner CPUE between years using a Kruskal-Wallis test. River shiner catch rates were significantly different between years for push trawls (Table III.3.7), push trawl catch rates were much higher in 2008.

Sand Shiner

In total 562 sand shiners (96% juveniles, <43 mm) were sampled with standard gears at California (NE) during 2006. Sand shiners were sampled with bag seines (n = 29, CPUE = 1.97 fish per 100 m^2), electrofishing (n = 7, CPUE = 1.07 fish per hour), mini-fyke nets (n = 520, CPUE = 20.00 fish per net night), 16' otter trawls (n = 4, CPUE = 0.04 fish per 100 m trawled) and 8' otter trawls (n = 2, CPUE = 0.04 fish per 100 m trawled). Monthly catches ranged from 3 in May to 335 in August. Mean total length for sand shiners was 39 mm ranging from 21 to 61 mm.

In total 190 sand shiners (94% juveniles, <43 mm) were sampled with standard gears at California (NE) during 2007. Sand shiners were sampled with electrofishing (n = 4, CPUE = 0.67 fish per hour), mini-fyke nets (n = 169, CPUE = 5.63 fish per net night), 16' otter trawls (n = 3, CPUE = 0.06 fish per 100 m trawled), 8' otter trawls (n = 2, CPUE = 0.03 fish per 100 m trawled) and push trawls (n = 12, CPUE = 0.54 fish per 100 m trawled). Monthly catch rates ranged from 4 in July to 63 in October. Mean total length for sand shiners was 41 mm ranging from 22 to 68 mm.

In total 206 sand shiners (98% juveniles, <43 mm) were sampled with standard gears at California (NE) during 2008. Sand shiners were sampled with electrofishing (n = 1, CPUE = 0.26 fish per hour), mini-fyke nets (n = 91, CPUE = 3.14 fish per net night), 16' otter trawls (n = 1, CPUE = 0.02 fish per 100 m trawled), 8' otter trawls (n = 3,

CPUE = 0.06 fish per 100 m trawled) and push trawls (n = 110, CPUE = 3.19 fish per 100 m trawled). Monthly catch rates ranged from 3 in July to 61 in May. Mean total length for sand shiners was 37 mm ranging from 19 to 60 mm.

We compared proportion of juveniles between years using a z-test. Sand shiner life stage proportions were not significantly different between years (Figure III.3.18, Table III.3.4).

We compared length frequency distributions of sand shiners between years using a Kolmogorov-Smirnov test. Sand shiner length frequency distributions at California (NE) were not significantly different between years (Figure III.3.19, Table III.3.5). Mean length between years was compared using a t-test. Mean length was significantly lower in 2008 (Table III.3.6).

We compared sand shiner CPUE between years using a Kruskal-Wallis test. Sand shiner catch rates were not significantly different between years (Table III.3.7).

Fathead Minnow

In total 26 fathead minnows (15% juveniles, <41 mm) were sampled with standard gears at California (NE) during 2006. Fathead minnows were sampled with bag seines (n = 1, CPUE = 0.08 fish per 100 m^2) and mini-fyke nets (n = 25, CPUE = 0.96 fish per net night). Monthly catches ranged from 0 in July and October to 15 in May. Mean total length of fathead minnows was 50 mm ranging from 31 to 68 mm.

In total 10 fathead minnows (80% juveniles, <41 mm) were sampled with standard gears at California (NE) during 2007. Fathead minnows were sampled with mini-fyke nets (n = 10, CPUE = 0.33 fish per net night). Monthly catch rates ranged

from 0 in May, August and October to 4 in June and September. Mean total length of fathead minnows was 38 mm ranging from 26 to 56 mm.

In total 56 fathead minnows (86% juveniles, <41 mm) were sampled with standard gears at California (NE) during 2008. Fathead minnows were sampled with electrofishing (n = 1, CPUE = 0.21 fish per hour), mini-fyke nets (n = 51, CPUE = 1.76 fish per net night) and push trawls (n = 4, CPUE = 0.17 fish per 100 m trawled). Monthly catch rates ranged from 0 in October to 28 in July. Mean total length of fathead minnows was 40 mm ranging from 25 to 80 mm.

We compared proportion of juveniles between years using a z-test. The proportion of juvenile fathead minnows was significantly lower in 2006 (Figure III.3. 20, Table III.3. 4).

We compared length frequency distributions of fathead minnows between years using a Kolmogorov-Smirnov test. Fathead minnow length frequency distributions at California (NE) were significantly different between all years (Figure III.3.21, Table III.3.5). Mean length between years was compared using a t-test. Mean length was significantly higher in 2006 (Table III.3.6), corresponding with the large proportion of adults caught.

We compared fathead minnow CPUE between years using a Kruskal-Wallis test. Fathead minnow catch rates were not significantly different between years (Table III.3.7).

River Carpsucker

In total 190 river carpsuckers (90% juveniles, <305 mm) were sampled with standard gears at California (NE) during 2006. River carpsuckers were sampled with bag

seines (n = 120, CPUE = 9.29 fish per 100 m^2), electrofishing (n = 43, CPUE = 7.55 fish per hour), 4' hoop nets (n = 4, CPUE = 0.08 fish per net night), mini-fyke nets (n = 21, CPUE = 0.81 fish per net night) and 16' otter trawls (n = 2, CPUE = 0.02 fish per 100 m trawled). Monthly river carpsucker catches at California (NE) ranged from 9 in June to 67 in July. Mean total length of river carpsuckers was 114 mm ranging from 18 to 491 mm.

In total 76 river carpsuckers (88% juveniles, <305 mm) were sampled with standard gears at California (NE) during 2007. River carpsuckers were sampled with electrofishing (n = 49, CPUE = 8.30 fish per hour), 4' hoop nets (n = 3, CPUE = 0.06 fish per net night), mini-fyke nets (n = 17, CPUE = 0.57 fish per net night), 16' otter trawls (n = 2, CPUE = 0.02 fish per 100 m trawled), 8' otter trawls (n = 1, CPUE = 0.01 fish per 100 m trawled), push trawls (n = 3, CPUE = 0.20 fish per 100 m trawled) and trammel nets (n = 1, CPUE = 0.01 fish per 125 ft of net drifted 100 m). Monthly catch rates at California (NE) ranged from 4 in April to 15 in June and July. Mean total length of river carpsuckers was 209 mm ranging from 31 to 807 mm.

In total 270 river carpsuckers (94% juveniles, <305 mm) were sampled with standard gears at California (NE) during 2008. River carpsuckers were sampled with electrofishing (n = 69, CPUE = 13.40 fish per hour), 4' hoop nets (n = 10, CPUE = 0.19 fish per net night), mini-fyke nets (n = 96, CPUE = 3.31 fish per net night), 16' otter trawls (n = 7, CPUE = 0.13 fish per 100 m trawled), 8' otter trawls (n = 2, CPUE = 0.05 fish per 100 m trawled), push trawls (n = 82, CPUE = 2.35 fish per 100 m trawled) and trammel nets (n = 4, CPUE = 0.10 fish per 125 ft of net drifted 100 m). Monthly catch

rates at California (NE) ranged from 12 in June to 65 in July. Mean total length of river carpsuckers was 119 mm ranging from 21 to 525 mm.

We compared proportion of juveniles between years using a z-test. River carpsucker life stage proportions were not significantly different between years (Figure III.3.22, Table III.3.4).

We compared length frequency distributions of river carpsuckers between years using a Kolmogorov-Smirnov test. River carpsucker length frequency distributions at California (NE) were not significantly different between years (Figure III.3.23, Table III.3.5). Mean length between years was compared using a t-test. Mean length was significantly higher in 2007 (Table III.3.6).

We compared river carpsuker CPUE between years using a Kruskal-Wallis test. River carpsucker catch rates were significantly different between 2006 and 2008 for trammel nets; trammel net catch increased each year, no river carpsuckers were caught in trammel nets in 2006. Catch rates were significantly lower in 2007 than 2008 for mini-fyke nets and push trawls (Table III.3.7).

Blue Sucker

In total 104 blue suckers (34% juveniles, <508 mm) were sampled with standard gears at California (NE) during 2006. Blue suckers were sampled with electrofishing (n = 29, CPUE = 5.03 fish per hour), 4’ hoop nets (n = 43, CPUE = 0.81 fish per net night), 16’ otter trawls (n = 15, CPUE = 0.18 fish per 100 m trawled), 8’ otter trawls (n = 2, CPUE = 0.03 fish per 100 m trawled), 2’ hoop nets (n = 2, CPUE = 0.04 fish per net night) and trammel nets (n = 13, CPUE = 0.24 fish per 125 ft of net drifted 100 m).

Monthly blue sucker catches ranged from 1 in April to 41 in October. Mean total length of blue suckers sampled in 2006 was 564 mm ranging from 95 to 820 mm.

In total 65 blue suckers (20% juveniles, <508 mm) were sampled with standard gears at California (NE) during 2007. Blue suckers were sampled with electrofishing (n = 28, CPUE = 4.97 fish per hour), 4' hoop nets (n = 29, CPUE = 0.60 fish per net night), mini-fyke nets (n = 2, CPUE = 0.07 fish per net night), 16' otter trawls (n = 3, CPUE = 0.04 fish per 100 m trawled) and trammel nets (n = 3, CPUE = 0.12 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 2 in April, August to 16 in October. Mean total length of blue suckers sampled in 2007 was 591 mm ranging from 45 to 790 mm.

In total 32 blue suckers (9% juveniles, <508 mm) were sampled with standard gears at California (NE) during 2008. Blue suckers were sampled with electrofishing (n = 23, CPUE = 4.24 fish per hour), 4' hoop nets (n = 2, CPUE = 0.04 fish per net night) and trammel nets (n = 7, CPUE = 0.09 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 1 in April, August and September to 12 in October. Mean total length of blue suckers sampled in 2008 was 617 mm ranging from 501 to 711 mm.

The number of blue suckers caught in California (NE) significantly decreased over the three years of this study (Linear regression, $p = 0.0306$). We compared proportion of juveniles between years using a z-test. Blue sucker juvenile proportions were significantly higher in 2006 than 2008 (Figure III.3.24, Table III.3.4); the proportion of juvenile blue suckers caught decreased each year.

We compared length frequency distributions of blue suckers between years using a Kolmogorov-Smirnov test. Blue sucker length frequency distributions at California

(NE) were significantly different in 2008 (Figure III.3.25, Table III.3.5), very few small or large fish were caught in 2008. Mean length between years was compared using a t-test. Mean lengths were not significantly different between years (Table III.3.6).

We compared blue sucker CPUE between years using a Kruskal-Wallis test. Blue sucker catch rates were significantly higher in 2006 than 2008 for 16' otter trawls, 16' otter trawl catch decreased each year, blue suckers were not caught in 16' trawls in 2008. Catch rates for 4' hoop nets were significantly lower in 2007 than 2008 and decreased yearly (Table III.3.7).

Smallmouth Buffalo

In total nine smallmouth buffalo (18% juveniles, <381 mm) were sampled with standard gears at California (NE) during 2006. Smallmouth buffalo were sampled with electrofishing (n = 6, CPUE = 1.00 fish per hour) and 4' hoop nets (n = 3, CPUE = 0.06 fish per net night). Monthly catch rates ranged from 0 in April and August to 3 in May and October. Mean total length was 444 mm ranging from 54 to 693 mm.

In total 61 smallmouth buffalo (87% juveniles, <381 mm) were sampled in standard gears at California (NE) during 2007. Smallmouth buffalo were sampled with electrofishing (n = 3, CPUE = 0.63 fish per hour), 4' hoop nets (n = 1, CPUE = 0.02 fish per net night), mini-fyke nets (n = 48, CPUE = 1.60 fish per net night), 16' otter trawls (n = 3, CPUE = 0.04 fish per 100 m trawled), 8' otter trawls (n = 2, CPUE = 0.03 fish per 100 m trawled) and trammel nets (n = 4, CPUE = 0.07 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in June to 46 in July. Mean total length was 109 mm and ranged from 21 to 621 mm.

In total 24 smallmouth buffalo (63% juveniles, <381 mm) were sampled with standard gears at California (NE) during 2008. Smallmouth buffalo were sampled with electrofishing (n = 5, CPUE = 0.78 fish per hour), 4' hoop nets (n = 1, CPUE = 0.02 fish per net night), mini-fyke nets (n = 10, CPUE = 0.43 fish per net night), 8' otter trawls (n = 1, CPUE = 0.02 fish per 100 m trawled), push trawls (n = 4, CPUE = 0.06 fish per 100 m trawled) and trammel nets (n = 3, CPUE = 0.03 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in April and October to 7 in August. Mean total length was 213 mm ranging from 26 to 588 mm.

We compared proportion of juveniles between years using a z-test. Smallmouth buffalo life stage proportions were significantly different between all years (Figure III.3.26, Table III.3.4), with 2007 having the most juveniles, 2006 the least.

We compared length frequency distributions of smallmouth buffalo between years using a Kolmogorov-Smirnov test. Smallmouth buffalo length frequency distributions at California (NE) were significantly different in 2006 (Figure III.3.27, Table III.3.5), large numbers of young of the year smallmouth buffalo were caught in 2007 and 2008 but not in 2006. Mean length between years was compared using a t-test. Mean lengths were significantly different between all years (Table III.3.6), due to different catches of juvenile fish.

We compared smallmouth buffalo CPUE between years using a Kruskal-Wallis test. Smallmouth buffalo catch rates were not significantly different between years (Table III.3.7).

Bigmouth Buffalo

In total two adult bigmouth buffalo were sampled with standard gears at California (NE) during 2006. Bigmouth buffalo were sampled with electrofishing (n = 1, CPUE = 0.19 fish per hour) and 4' hoop nets (n = 1, CPUE = 0.02 fish per net night). One bigmouth buffalo was sampled in April and one in October. The total lengths of bigmouth buffalo sampled were 453 mm and 603 mm, averaging 528 mm.

In total 83 bigmouth buffalo (94% juveniles, <381 mm) were sampled with standard gears at California (NE) during 2007. Bigmouth buffalo were sampled with electrofishing (n = 4, CPUE = 0.70 fish per hour), 4' hoop nets (n = 1, CPUE = 0.02 fish per net night) and mini-fyke nets (n = 78, CPUE = 2.60 fish per net night). Monthly catch rates ranged from 0 in September and October to 63 in July. Mean total length of bigmouth buffalo sampled was 81 mm ranging from 30 to 682 mm.

In total five bigmouth buffalo (20% juveniles, <381 mm) were sampled with standard gears at California (NE) during 2008. Bigmouth buffalo were sampled with electrofishing (n = 2, CPUE = 0.35 fish per hour), push trawls (n = 1, CPUE = 0.05 fish per 100 m trawled) and trammel nets (n = 2, CPUE = 0.04 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in April, August thru October to 2 in May and June. Mean total length of bigmouth buffalo sampled was 455 mm ranging from 43 to 615 mm.

We compared proportion of juveniles between years using a z-test. The proportion of juvenile bigmouth buffalo was significantly higher in 2007 (Figure III.3.28, Table III.3.4).

We compared length frequency distributions of bigmouth buffalo between years using a Kolmogorov-Smirnov test. Bigmouth buffalo length frequency distributions at

California (NE) were significantly different between 2006 and 2008 (Figure III.3.29, Table III.3.5), however only two fish were caught in 2006 and five in 2008. Mean length between years was compared using a t-test. Mean length was significantly shorter in 2007 (Table III.3.6), corresponding with an increased juvenile catch.

We compared bigmouth buffalo CPUE between years using a Kruskal-Wallis test. Bigmouth buffalo catch rates were not significantly different between years (Table III.3.7).

Shorthead Redhorse

In total 79 shorthead redhorse (59% juveniles, <229 mm) were sampled with standard gears at California (NE) during 2006. Shorthead redhorse were sampled with bag seines (n = 1, CPUE = 0.08 fish per 100 m^2), electrofishing (n = 46, CPUE = 8.19 fish per hour), 4' hoop nets (n = 3, CPUE = 0.06 fish per net night), mini-fyke nets (n = 8, CPUE = 0.31 fish per net night), 16' otter trawls (n = 16, CPUE = 0.23 fish per 100 m trawled), 8' otter trawls (n = 2, CPUE = 0.03 fish per 100 m trawled) and trammel nets (n = 3, CPUE = 0.09 fish per 125 ft of net drifted 100 m). Monthly catches ranged from 4 in April and August to 25 in May. Mean total length was 228 mm and ranged from 31 to 555 mm.

In total 119 shorthead redhorse (55% juveniles, <229 mm) were sampled with standard gears at California (NE) during 2007. Shorthead redhorse were sampled with electrofishing (n = 60, CPUE = 9.94 fish per hour), 4' hoop nets (n = 9, CPUE = 0.19 fish per net night), 2' hoop nets (n = 4, CPUE = 0.08 fish per net night), mini-fyke nets (n = 5, CPUE = 0.17 fish per net night), 16' otter trawls (n = 10, CPUE = 0.19 fish per 100 m

trawled), 8' otter trawls (n = 7, CPUE = 0.12 fish per 100 m trawled), push trawls (n = 14, CPUE = 0.51 fish per 100 m trawled) and trammel nets (n = 10, CPUE = 0.17 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 11 in April, May and July to 25 in October. Mean total length was 254 mm and ranged from 64 to 435 mm.

In total 114 shorthead redhorse (45% juveniles, <229 mm) were sampled with standard gears at California (NE) during 2008. Shorthead redhorse were sampled with electrofishing (n = 59, CPUE = 9.90 fish per hour), 4' hoop nets (n = 4, CPUE = 0.07 fish per net night), 2' hoop nets (n = 1, CPUE = 0.02 fish per net night), mini-fyke nets (n = 5, CPUE = 0.15 fish per net night), 16' otter trawls (n = 5, CPUE = 0.11 fish per 100 m trawled), 8' otter trawls (n = 5, CPUE = 0.11 fish per 100 m trawled), push trawls (n = 12, CPUE = 0.33 fish per 100 m trawled) and trammel nets (n = 23, CPUE = 0.35 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 4 in October to 44 in July. Mean total length was 262 mm and ranged from 23 to 459 mm.

We compared proportion of juveniles between years using a z-test. Shorthead redhorse life stage proportions were not significantly different between years (Figure III.3.30, Table III.3.4).

We compared length frequency distributions of shorthead redhorse between years using a Kolmogorov-Smirnov test. Shorthead redhorse length frequency distributions at California (NE) were not significantly different between years (Figure III.3.31, Table III.3.5). Mean length between years was compared using a t-test. Mean lengths were not significantly different between years (Table III.3.6).

We compared shorthead redhorse CPUE between years using a Kruskal-Wallis test. Shorthead redhorse catch rates were not significantly different between years (Table III.3.7).

Channel Catfish

In total 384 channel catfish (97% juveniles, <305 mm) were sampled with standard gears at California (NE) during 2006. Channel catfish were sampled with bag seines (n = 15, CPUE = 0.58 fish per 100 m^2), electrofishing (n = 12, CPUE = 1.86 fish per hour), 4’ hoop nets (n = 15, CPUE = 0.28 fish per net night), 2’ hoop nets (n = 33, CPUE = 0.61 fish per net night), mini-fyke nets (n = 38, CPUE = 1.46 fish per net night), 16’ otter trawls (n = 223, CPUE = 3.71 fish per 100 m trawled), 8’ otter trawls (n = 43, CPUE = 0.72 fish per 100 m trawled) and trammel nets (n = 5, CPUE = 0.14 fish per 125 ft of net drifted 100 m). Monthly channel catfish catches ranged from 17 in July to 293 in May. Mean total length of channel catfish sampled was 131 mm ranging from 32 to 590 mm.

In total 823 channel catfish (97% juveniles, <305 mm) were sampled with standard gears at California (NE) during 2007. Channel catfish were sampled with electrofishing (n = 17, CPUE = 2.93 fish per hour), 4’ hoop nets (n = 20, CPUE = 0.42 fish per net night), 2’ hoop nets (n = 35, CPUE = 0.73 fish per net night), mini-fyke nets (n = 128, CPUE = 4.27 fish per net night), 16’ otter trawls (n = 210, CPUE = 3.32 fish per 100 m trawled), 8’ otter trawls (n = 152, CPUE = 0.72 fish per 100 m trawled), push trawls (n = 247, CPUE = 9.75 fish per 100 m trawled) and trammel nets (n = 14, CPUE = 0.26 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 11 in May to

319 in October. Mean total length of channel catfish sampled was 101 mm ranging from 16 to 935 mm.

In total 765 channel catfish (97% juveniles, <305 mm) were sampled with standard gears at California (NE) during 2008. Channel catfish were sampled with electrofishing (n = 16, CPUE = 3.33 fish per hour), 4’ hoop nets (n = 14, CPUE = 0.26 fish per net night), 2’ hoop nets (n = 18, CPUE = 0.34 fish per net night), mini-fyke nets (n = 58, CPUE = 2.00 fish per net night), 16’ otter trawls (n = 93, CPUE = 1.87 fish per 100 m trawled), 8’ otter trawls (n = 196, CPUE = 3.93 fish per 100 m trawled), push trawls (n = 353, CPUE = 8.32 fish per 100 m trawled) and trammel nets (n = 17, CPUE = 0.29 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 36 in April to 148 in October. Mean total length of channel catfish sampled was 91 mm ranging from 19 to 735 mm.

We compared proportion of juveniles between years using a z-test. Channel catfish life stage proportions were not significantly different between years (Figure III.3.32, Table III.3.4).

We compared length frequency distributions of channel catfish between years using a Kolmogorov-Smirnov test. Channel catfish length frequency distributions at California (NE) were not significantly different between years (Figure III.3.33, Table III.3.5). Mean length between years was compared using a t-test. Mean lengths were significantly different between all years (Table III.3.6); mean length decreased yearly.

We compared channel catfish CPUE between years using a Kruskal-Wallis test. Channel catfish catch rates were not significantly different between years (Table III.3.7).

Flathead Catfish

In total 36 flathead catfish (68% juveniles, <381 mm) were sampled with standard gears at California (NE) during 2006. Flathead catfish were sampled with electrofishing (n = 10, CPUE = 1.92 fish per hour), 4' hoop nets (n = 7, CPUE = 0.13 fish per net night), 2' hoop nets (n = 15, CPUE = 0. 28 fish per net night) and 16' otter trawls (n = 4, CPUE = 0.07 fish per 100 m trawled). Monthly catches of flathead catfish ranged from 0 in April to 14 in July. Mean total length was 376 mm and ranged from 142 to 800 mm.

In total 63 flathead catfish (86% juveniles, <381 mm) were sampled with standard gears at California (NE) during 2007. Flathead catfish were sampled with electrofishing (n = 18, CPUE = 3.05 fish per hour), 4' hoop nets (n = 11, CPUE = 0.23 fish per net night), 2' hoop nets (n = 30, CPUE = 0.63 fish per net night), 16' otter trawls (n = 3, CPUE = 0.04 fish per 100 m trawled) and 8' otter trawls (n = 1, CPUE = 0.01 fish per 100 m trawled). Monthly catch rates ranged from 1 in April to 16 in July. Mean total length was 374 mm and ranged from 96 mm to 1.3 m.

In total 57 flathead catfish (67% juveniles, <381 mm) were sampled with standard gears at California (NE) during 2008. Flathead catfish were sampled with electrofishing (n = 9, CPUE = 1.58 fish per hour), 4' hoop nets (n = 19, CPUE = 0.35 fish per net night), 2' hoop nets (n = 21, CPUE = 0.38 fish per net night), 16' otter trawls (n = 1, CPUE = 0.02 fish per 100 m trawled), 8' otter trawls (n = 3, CPUE = 0.06 fish per 100 m trawled), push trawls (n = 1, CPUE = 0.02 fish per 100 m trawled) and trammel nets (n = 3, CPUE = 0.04 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in April to 20 in July. Mean total length was 431 mm and ranged from 199 mm to 1.1 m.

We compared proportion of juveniles between years using a z-test. The proportion of juvenile flathead catfish was significantly higher in 2007 (Figure III.3.34, Table III.3.4).

We compared length frequency distributions of flathead catfish between years using a Kolmogorov-Smirnov test. Flathead catfish length frequency distributions at California (NE) were significantly different between 2007 and 2008 (Figure III.3.35, Table III.3.5), more small flathead catfish were caught in 2007. Mean length between years was compared using a t-test. Mean lengths were not significantly different between years (Table III.3.6).

We compared flathead catfish CPUE between years using a Kruskal-Wallis test. Flathead catfish catch rates were not significantly different between years (Table III.3.7).

Sauger

In total 31 sauger (74% juveniles, <229 mm) were sampled with standard gears at California (NE) during 2006. Sauger were sampled with bag seines (n = 2, CPUE = 0.16 fish per 100 m^2), electrofishing (n = 11, CPUE = 1.95 fish per hour), 4' hoop nets (n = 6, CPUE = 0.11 fish per net night), mini-fyke nets (n = 7, CPUE = 0.27 fish per net night) and 16'otter trawls (n = 5, CPUE = 0.06 fish per 100 m trawled). Monthly catches of sauger ranged from 1 in April to 15 in June. Mean total length of sauger sampled was 252 mm ranging from 29 to 619 mm.

In total 31 sauger (48% juveniles, <229 mm) were sampled with standard gears at California (NE) during 2007. Sauger were sampled with electrofishing (n = 15, CPUE = 2.72 fish per hour), 4' hoop nets (n = 1, CPUE = 0.02 fish per net night), mini-fyke nets

(n = 3, CPUE = 0.10 fish per net night), 16' otter trawls (n = 2, CPUE = 0.02 fish per 100 m trawled), push trawls (n = 2, CPUE = 0.04 fish per 100 m trawled) and trammel nets (n = 8, CPUE = 0.12 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in August to 12 in June. Mean total length of sauger sampled was 303 mm ranging from 22 to 576 mm.

In total 25 sauger (52% juveniles, <229 mm) were sampled with standard gears at California (NE) during 2008. Sauger were sampled with electrofishing (n = 8, CPUE = 1.42 fish per hour), 4' hoop nets (n = 1, CPUE = 0.02 fish per net night), mini-fyke nets (n = 4, CPUE = 0.14 fish per net night), 16' otter trawls (n = 2, CPUE = 0.04 fish per 100 m trawled), 8' otter trawls (n = 2, CPUE = 0.03 fish per 100 m trawled), push trawls (n = 4, CPUE = 0.10 fish per 100 m trawled) and trammel nets (n = 4, CPUE = 0.04 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in April and August to 20 in July. Mean total length of sauger sampled was 263 mm ranging from 38 to 597 mm.

We compared proportion of juveniles between years using a z-test. Sauger life stage proportions were significantly different between 2006 and 2007 (Figure III.3.36, Table III.3.4), more juveniles were caught in 2006.

We compared length frequency distributions of sauger between years using a Kolmogorov-Smirnov test. Sauger length frequency distributions at California (NE) were significantly different in 2007, when more large adults were caught (Figure III.3.37, Table III.3.5). Mean length between years was compared using a t-test. Mean lengths were significantly different between 2006 and 2007 (Table III.3.6), mean length was higher in 2007.

We compared sauger CPUE between years using a Kruskal-Wallis test. Sauger catch rates were significantly different between 2006 and 2007 for trammel nets (Table III.3.7); no sauger were caught in trammel nets in 2006.

Key Findings

- Many native riverine species appear to be using this chute, including: shovelnose and pallid sturgeon, chub species, blue sucker and catfish species.
- Many pool or backwater associated species were also common in this chute, including: goldeye, gizzard shad, common carp, river carpsucker, shorthead redhorse and freshwater drum.
- Young of the year shovelnose sturgeon were caught in 2006 and 2008. Young of the year sauger were caught in 2006. Young of the year smallmouth buffalo were caught in 2007 and 2008. Young of the year bigmouth buffalo were caught in 2008. Young of the year buffalo were caught in large numbers.
- Blue sucker numbers significantly decreased over the three years of this study. More juvenile blue suckers were sampled in 2006 and 2007 than 2008.
- More juvenile river carpsuckers were caught in 2006 and 2008 than 2007.
- Almost twice as many silver chubs were caught in 2008 compared to 2006 and 2007.
- Red shiner numbers decreased over the three years of this study.
- Gizzard shad numbers were low in 2008.
- Channel and flathead catfish and sauger were present in sizes targeted by sport fisherman including several trophy-size flathead and channel catfish.

Table III.3.1. Total species caught at California (NE) from 2006 - 2008 and the percent of catch that each species represents. *Indicates a species that was used in analysis. †Indicates a species of note for this chute.

Species	**Scientific name**	**2006**	**2007**	**2008**	**Total**	**% catch**
Pallid sturgeon†	*Scaphirhynchus albus*	0	0	7	7	0.04
Shovelnose sturgeon*	*Scaphirhynchus platorynchus*	99	201	168	468	2.94
Paddlefish†	*Polyodon spathula*	0	1	1	2	0.01
Longnose gar	*Lepisosteus osseus*	3	16	10	29	0.18
Shortnose gar	*Lepisosteus platostomus*	22	28	52	102	0.64
Goldeye*	*Hiodon alosoides*	88	102	127	317	1.99
Mooneye	*Hiodon tergisus*	0	2	0	2	0.01
Unidentified herring	*Clupeidae*	0	11	0	11	0.07
Skipjack herring	*Alosa chrysochloris*	0	2	1	3	0.02
Gizzard shad*	*Dorosoma cepedianum*	259	311	86	656	4.12
Unidentified minnow	*Cyprinidae*	10	116	15	141	0.89
Central stoneroller	*Campostoma anomalum*	0	0	1	1	0.01
Speckled chub*	*Macrhybopsis aestivalis*	59	101	92	252	1.58
Sturgeon chub	*Macrhybopsis gelida*	3	1	7	11	0.07
Silver chub*	*Macrhybopsis storeriana*	486	445	838	1769	11.12
Red shiner*	*Cyprinella lutrensis*	746	251	86	1083	6.81
Spotfin shiner	*Cyprinella spiloptera*	2	70	41	113	0.71
Emerald shiner*	*Notropis atherinoides*	1040	616	1182	2838	17.83
River shiner*	*Notropis blennius*	963	438	715	2116	13.30
Blacknose shiner	*Notropis heterolepis*	4	0	0	4	0.03
Sand shiner*	*Notropis stramineus*	562	190	206	958	6.02
Bluntnose minnow	*Pimephales notatus*	7	7	18	32	0.20
Fathead minnow*	*Pimephales promelas*	26	10	56	92	0.58
Grass carp	*Ctenopharyngodon idella*	7	10	3	20	0.13
Common carp	*Cyprinus carpio*	39	68	79	186	1.17
Silver carp	*Hypophthalmicthys molitrix*	1	0	0	1	0.01
Bighead carp	*Hypophthalmicthys nobilis*	0	8	1	9	0.06
Unidentified sucker	*Catostomidae*	0	7	7	14	0.09
River carpsucker*	*Carpiodes carpio*	190	76	270	536	3.37
Quillback	*Carpiodes cyprinus*	5	0	2	7	0.04
White sucker	*Catostomus commersoni*	2	3	8	13	0.08
Blue sucker*	*Cycleptus elongatus*	104	65	32	201	1.26

Table III.3.1 continued. Total species caught at California (NE) from 2006 - 2008 and the percent of catch that each species represents. *Indicates a species that was used in analysis. †Indicates a species of note for this chute.

Species	Scientific name	2006	2007	2008	Total	% catch
Smallmouth buffalo*	*Ictiobus bubalus*	10	61	24	95	0.60
Bigmouth buffalo*	*Ictiobus cyprinellus*	2	83	5	90	0.57
Black buffalo	*Ictiobus niger*	0	1	0	1	0.01
Shorthead redhorse*	*Moxostoma macrolepidotum*	79	119	114	312	1.96
Unidentified bullhead	*Ameiurus*	0	1	0	1	0.01
Black bullhead	*Ameiurus melas*	0	1	0	1	0.01
Yellow bullhead	*Ameiurus natalis*	0	0	1	1	0.01
Brown bullhead	*Ameiurus nebulosus*	0	0	2	2	0.01
Blue catfish	*Ictalurus furcatus*	0	1	0	1	0.01
Channel catfish*	*Ictalurus punctatus*	384	823	765	1972	12.39
Flathead catfish*	*Pylodictis olivaris*	36	63	57	156	0.98
Stonecat	*Noturus flavus*	26	8	10	44	0.28
Brook silverside	*Labidesthes sicculus*	0	5	17	22	0.14
White perch	*Morone Americana*	1	0	0	1	0.01
White bass	*Morone chrysops*	19	20	40	79	0.50
Unidentified sunfish	*Centrarchidae*	1	8	0	9	0.06
Green sunfish	*Lepomis cyanellus*	49	14	9	72	0.45
Pumpkinseed sunfish	*Lepomis gibbosus*	2	0	0	2	0.01
Orangespotted sunfish	*Lepomis humilis*	54	12	16	82	0.52
Bluegill	*Lepomis macrochirus*	1	17	27	45	0.28
Redear sunfish	*Lepomis microlophus*	1	0	0	1	0.01
Smallmouth bass	*Micropterus dolomieu*	5	5	5	15	0.09
Largemouth bass	*Micropterus salmoides*	1	14	6	21	0.13
White crappie	*Pomoxis annularis*	8	4	3	15	0.09
Black crappie	*Pomoxis nigromaculatus*	3	2	1	6	0.04
Johnny darter	*Etheostoma nigrum*	1	1	4	6	0.04
Yellow perch	*Perca flavescens*	0	1	0	1	0.01
Sauger*	*Stizostedion canadense*	31	31	25	87	0.55
Saugeye	*S. vitreum x S. canadense*	1	1	0	2	0.01
Walleye	*Stizostedion vitreum*	5	2	5	12	0.08
Freshwater drum	*Aplodinotus grunniens*	72	189	666	927	5.83

Table III.3.2. Species richness (S), species evenness (E), Shannon's diversity index (H) and Simpson's diversity index (D) for California (NE) from 2006 - 2008.

Year	S	E	H	D
2006	46	0.731	2.799	0.9152
2007	49	0.736	2.866	0.9124
2008	48	0.716	2.773	0.9086

Table III.3.3. Community assemblage similarity, using Morisita's index, for California (NE) between years (2006 - 2008).

Year	2006 v 2007	2006 v 2008	2007 v 2008
Morisita's Index	0.8265	0.8204	0.8965

Table III.3.4. Results for analysis of life stage proportions at California (NE) from 2006 - 2008. A z-test was used to determine differences in proportions of juveniles and adults of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

	2006 v 2007		2006 v 2008		2007 v 2008	
Species	**Z**	**p-value**	**Z**	**p-value**	**Z**	**p-value**
Shovelnose sturgeon	**-3.13**	**0.0018**	**-2.75**	**0.0060**	0.25	0.8026
Goldeye	**3.13**	**0.0018**	**4.50**	**<0.0001**	1.03	0.3030
Gizzard shad	**-2.81**	**0.0050**	-0.77	0.4412	1.38	0.1676
Speckled chub	1.55	0.1212	1.04	0.2984	-0.57	0.5686
Silver chub	0.99	0.3222	**-4.59**	**<0.0001**	**-5.54**	**<0.0001**
Red shiner	**4.80**	**<0.0001**	**6.47**	**<0.0001**	**2.24**	**0.0250**
Emerald shiner	-0.48	0.6312	-1.35	0.1770	-0.66	0.5092
River shiner	1.31	0.1902	-1.57	0.1164	**-2.59**	**0.0096**
Sand shiner	1.21	0.2262	-1.25	0.2112	-2.00	0.0456
Fathead minnow	**-3.68**	**0.0002**	**-6.15**	**<0.0001**	-0.46	0.6456
River carpsucker	0.55	0.5824	-1.35	0.1770	-1.62	0.1052
Blue sucker	1.94	0.0524	**2.69**	**0.0072**	1.33	0.1836
Smallmouth buffalo	**-4.94**	**<0.0001**	**-2.44**	**0.0146**	**2.53**	**0.0114**
Bigmouth buffalo	**-4.78**	**<0.0001**	-0.68	0.4966	**5.30**	**<0.0001**
Shorthead redhorse	0.52	0.6030	2.02	0.0434	1.64	0.1010
Channel catfish	0.02	0.9840	-0.12	0.9044	-0.15	0.8808
Flathead catfish	**-2.13**	**0.0332**	0.17	0.8650	**2.46**	**0.0138**
Sauger	**2.28**	**0.0226**	1.86	0.0628	-0.27	0.7872

Table III.3.5. Results for analysis of length frequency distribution at California (NE) from 2006 - 2008. A Kolmogorov-Smirnov test was used to determine differences in length frequency distribution of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

	2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**D**	**p-value**	**D**	**p-value**	**D**	**p-value**
Shovelnose sturgeon	0.45	0.0583	0.27	0.4531	0.22	0.8316
Goldeye	0.40	0.2923	0.28	0.6582	0.25	0.8849
Gizzard shad	0.29	0.4540	0.49	0.0789	0.43	0.1631
Speckled chub	0.16	0.9819	0.24	0.7145	0.25	0.6994
Silver chub	0.22	0.1751	**0.30**	**0.0219**	0.20	0.3127
Red shiner	0.26	0.2402	0.18	0.8044	0.24	0.4173
Emerald shiner	0.22	0.3364	0.16	0.7358	0.20	0.4579
River shiner	0.20	0.7647	0.21	0.7015	0.13	0.9920
Sand shiner	0.23	0.6505	0.19	0.8716	0.22	0.7278
Fathead minnow	**0.75**	**0.0050**	**0.79**	**0.0018**	**0.58**	**0.0059**
River carpsucker	0.38	0.0775	0.41	0.0429	0.21	0.7308
Blue sucker	0.36	0.1192	**0.69**	**0.0045**	**0.73**	**0.0007**
Smallmouth buffalo	**0.83**	**0.0077**	**0.75**	**0.0138**	0.57	0.2421
Bigmouth buffalo	0.88	0.1725	**0.88**	**0.0180**	1.00	0.1148
Shorthead redhorse	0.22	0.7038	0.20	0.8291	0.14	0.9829
Channel catfish	0.35	0.0509	0.35	0.0552	0.20	0.6878
Flathead catfish	0.41	0.1010	0.41	0.0504	**0.55**	**0.0099**
Sauger	**0.53**	**0.0197**	0.44	0.1147	**0.53**	**0.0270**

Table III.3.6. Results for analysis of species mean length at California (NE) from 2006 - 2008. A t-test was used to determine differences in mean length of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

	2006 v 2007		2006 v 2008		2007 v 2008	
Species	**t**	**p-value**	**t**	**p-value**	**t**	**p-value**
Shovelnose sturgeon	0.60	0.5513	0.26	0.7952	-0.30	0.7025
Goldeye	0.17	0.8633	-0.79	0.4329	-1.01	0.3313
Gizzard shad	**5.61**	**<0.0001**	**5.70**	**<0.0001**	1.51	0.1319
Speckled chub	-0.80	0.4273	-1.37	0.1713	-0.07	0.5066
Silver chub	**-2.85**	**0.0045**	**11.23**	**<0.0001**	**13.26**	**<0.0001**
Red shiner	**2.30**	**0.0217**	**2.36**	**0.0183**	0.61	0.5450
Emerald shiner	**4.61**	**<0.0001**	1.68	0.0924	**-2.88**	**0.0041**
River shiner	**4.38**	**<0.0001**	**11.93**	**<0.0001**	**6.23**	**<0.0001**
Sand shiner	-1.98	0.0477	**3.00**	**0.0029**	**4.76**	**<0.0001**
Fathead minnow	**2.79**	**0.0064**	**3.50**	**0.0007**	-0.61	0.5433
River carpsucker	**-5.85**	**<0.0001**	-0.46	0.6446	**5.80**	**<0.0001**
Blue sucker	-1.17	0.2438	-1.76	0.0806	-0.79	0.4317
Smallmouth buffalo	**5.08**	**<0.0001**	**3.18**	**0.0020**	**-2.23**	**0.0283**
Bigmouth buffalo	**4.64**	**<0.0001**	0.65	0.5195	**-6.02**	**<0.0001**
Shorthead redhorse	-1.66	0.0973	-2.09	0.0376	-0.48	0.6294
Channel catfish	**3.88**	**0.0001**	**5.70**	**<0.0001**	**2.25**	**0.0244**
Flathead catfish	0.07	0.9481	-1.40	0.1641	-1.70	0.0906
Sauger	**-2.67**	**0.0088**	-1.65	0.1030	0.79	0.4297

Table III.3.7. Results for analysis of species catch per unit effort (CPUE) at California (NE) from 2006 - 2008. Effort for each gear is defined as: electrofishing (EFS), fish caught per hour; 4' hoop nets (HNS), fish caught per net night; 2' hoop nets (SHNS), fish caught per net night; mini-fyke nets (MFS), fish caught per net night; push trawls (POT02S), fish caught per 100 m trawled; 8' otter trawls (OT8S), fish caught per 100 m trawled; 16' otter trawls (OT16S), fish caught per 100 m trawled and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Push trawl was not used in 2006. A Kruskal-Wallis test was used to determine differences in CPUE of a species by gear between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

		2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**Gear**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**
Shovelnose sturgeon	**EFS**	1.00	0.3173	2.56	0.1093	2.04	0.1531
	HNS	**5.14**	**0.0234**	0.08	0.7769	3.28	0.0702
	OT16S	0.07	0.7961	2.14	0.1435	0.72	0.3959
	OT8S	0.01	0.9279	0.15	0.6991	0.45	0.5028
	POT02S					1.10	0.2951
	SHNS	**5.14**	**0.0234**	0.51	0.4760	2.26	0.1329
	TN	**5.04**	**0.0247**	3.96	0.0467	1.47	0.2248
Goldeye	**EFS**	0.02	0.8864	1.26	0.2623	1.00	0.3173
	HNS	2.61	0.1059	1.21	0.2710	1.11	0.2925
	OT16S	2.15	0.1422	0.00	1.0000	2.15	0.1422
	TN	2.57	0.1087	1.54	0.2144	0.00	0.9490
Gizzard shad	**EFS**	0.00	1.0000	2.11	0.1467	1.18	0.2773
	MFS	0.45	0.5028	0.50	0.4792	0.00	0.9456
	OT16S	0.39	0.5338	0.00	1.0000	0.39	0.5338
	POT02S					0.46	0.4989
Speckled chub	**MFS**	1.00	0.3173	0.00	1.0000	1.00	0.3173
	OT16S	0.00	0.9470	0.56	0.4530	0.27	0.6022
	OT8S	0.37	0.5440	0.55	0.4569	1.60	0.2064
	POT02S					0.19	0.6593
Silver chub	**EFS**	0.63	0.4256	0.59	0.4418	2.31	0.1283
	MFS	0.20	0.6544	0.50	0.4773	1.19	0.2759
	OT16S	1.80	0.1797	0.49	0.4822	1.18	0.2774
	OT8S	0.16	0.6847	2.38	0.1229	1.47	0.2248
	POT02S					1.00	0.3173

Table III.3.7 continued. Results for analysis of species catch per unit effort (CPUE) at California (NE) from 2006 - 2008. Effort for each gear is defined as: electrofishing (EFS), fish caught per hour; 4' hoop nets (HNS), fish caught per net night; 2' hoop nets (SHNS), fish caught per net night; mini-fyke nets (MFS), fish caught per net night; push trawls (POT02S), fish caught per 100 m trawled; 8' otter trawls (OT8S), fish caught per 100 m trawled; 16' otter trawls (OT16S), fish caught per 100 m trawled and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Push trawl was not used in 2006. A Kruskal-Wallis test was used to determine differences in CPUE of a species by gear between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

		2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**Gear**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**
Red shiner	**EFS**	1.38	0.2398	0.80	0.3720	3.82	0.0508
	MFS	1.80	0.1797	**5.91**	**0.0151**	0.15	0.7012
	OT16S	3.49	0.0619	3.49	0.0619	0.00	1.0000
	OT8S	1.40	0.2367	0.02	0.9007	1.00	0.3173
	POT02S					1.06	0.3036
Emerald shiner	**EFS**			0.03	0.8728	0.02	0.8864
	MFS	0.15	0.7012	0.15	0.7012		
	OT16S	3.49	0.0619	0.23	0.6330	5.02	0.0250
	OT8S	0.56	0.4556	0.20	0.6507	1.44	0.2300
	POT02S					2.48	0.1156
River shiner	**EFS**	1.06	0.3036	4.66	0.0309	0.42	0.5147
	MFS	0.00	0.9491	0.59	0.4428	0.15	0.7012
	OT16S	1.00	0.3173	1.00	0.3173	0.00	1.0000
	OT8S	0.10	0.7492	1.13	0.2879	0.94	0.3331
	POT02S					**5.96**	**0.0146**
Sand shiner	**EFS**	0.10	0.7561	1.10	0.2947	0.76	0.3830
	MFS	0.00	1.0000	0.26	0.6089	1.33	0.2496
	OT16S	0.77	0.3787	0.77	0.3787	0.01	0.9165
	OT8S	0.02	0.9007	0.02	0.9007	0.01	0.9165
	POT02S					3.49	0.0618
Fathead minnow	**EFS**	0.00	1.0000	1.00	0.3173	1.17	0.2801
	MFS	1.11	0.2930	0.81	0.3674	3.30	0.0692
	POT02S					4.38	0.0363

Table III.3.7 continued. Results for analysis of species catch per unit effort (CPUE) at California (NE) from 2006 - 2008. Effort for each gear is defined as: electrofishing (EFS), fish caught per hour; 4' hoop nets (HNS), fish caught per net night; 2' hoop nets (SHNS), fish caught per net night; mini-fyke nets (MFS), fish caught per net night; push trawls (POT02S), fish caught per 100 m trawled; 8' otter trawls (OT8S), fish caught per 100 m trawled; 16' otter trawls (OT16S), fish caught per 100 m trawled and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Push trawl was not used in 2006. A Kruskal-Wallis test was used to determine differences in CPUE of a species by gear between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

		2006 v 2007		2006 v 2008		2007 v 2008	
Species	**Gear**	**$\chi2$**	**p-value**	**$\chi2$**	**p-value**	**$\chi2$**	**p-value**
River carpsucker	**EFS**	0.18	0.6682	1.64	0.2002	2.04	0.1531
	HNS	0.01	0.9361	0.98	0.3213	0.98	0.3213
	MFS	1.34	0.2465	2.80	0.0945	**5.41**	**0.0200**
	OT16S	0.03	0.8728	2.42	0.1196	2.42	0.1196
	OT8S	0.71	0.3980	0.71	0.3980	0.01	0.9165
	POT02S					**6.24**	**0.0125**
	TN	1.00	0.3173	**5.02**	**0.0250**	3.46	0.0627
Blue sucker	**EFS**	0.02	0.8864	0.32	0.5745	0.33	0.5677
	HNS	0.04	0.8470	4.50	0.0340	**7.11**	**0.0077**
	MFS	1.00	0.3173	0.00	1.0000	1.00	0.3173
	OT16S	3.65	0.0561	**6.79**	**0.0092**	1.00	0.3173
	OT8S	1.40	0.2367	1.40	0.2367	0.00	1.0000
	SHNS	2.17	0.1410	2.17	0.1410	0.00	1.0000
	TN	1.77	0.1835	1.35	0.2449	0.18	0.6712
Smallmouth buffalo	**EFS**	0.80	0.3703	0.07	0.7976	0.32	0.5686
	HNS	0.93	0.3352	0.93	0.3352	0.00	1.0000
	MFS	2.15	0.1422	3.49	0.0619	0.05	0.8232
	OT16S	3.49	0.0619	0.00	1.0000	3.49	0.0619
	OT8S	1.56	0.2119	0.71	0.3980	0.39	0.5338
	POT02S					0.86	0.3545
	SHNS	0.00	1.0000	0.00	1.0000	0.00	1.0000
	TN	3.49	0.0619	1.00	0.3173	1.44	0.2300
Bigmouth buffalo	**EFS**	1.10	0.2951	0.18	0.6742	0.66	0.4154
	HNS	0.01	0.9165	1.00	0.3173	1.00	0.3173
	MFS	2.15	0.1422	0.00	1.0000	2.15	0.1422
	POT02S					0.86	0.3545
	TN	0.00	1.0000	2.15	0.1422	2.15	0.1422

Table III.3.7 continued. Results for analysis of species catch per unit effort (CPUE) at California (NE) from 2006 - 2008. Effort for each gear is defined as: electrofishing (EFS), fish caught per hour; 4' hoop nets (HNS), fish caught per net night; 2' hoop nets (SHNS), fish caught per net night; mini-fyke nets (MFS), fish caught per net night; push trawls (POT02S), fish caught per 100 m trawled; 8' otter trawls (OT8S), fish caught per 100 m trawled; 16' otter trawls (OT16S), fish caught per 100 m trawled and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Push trawl was not used in 2006. A Kruskal-Wallis test was used to determine differences in CPUE of a species by gear between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

		2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**Gear**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**
Shorthead redhorse	**EFS**	0.18	0.6682	0.07	0.7976	0.33	0.5686
	HNS	3.76	0.0524	6.93	0.3352	0.00	1.0000
	MFS	0.47	0.4918	3.49	0.0619	0.05	0.8232
	OT16S	0.36	0.5495	0.00	1.0000	3.49	0.0619
	OT8S	0.76	0.3845	0.71	0.3980	0.39	0.5338
	POT02S					0.86	0.3545
	SHNS	3.49	0.0619	0.00	1.0000	0.00	1.0000
	TN	0.01	0.9436	1.00	0.3173	1.44	0.2300
Channel catfish	**EFS**	0.19	0.6665	0.10	0.7466	0.05	0.8299
	HNS	0.02	0.8966	0.02	0.8967	0.02	0.8971
	MFS	1.18	0.2769	0.00	0.9485	0.59	0.4423
	OT16S	0.00	0.9490	0.92	0.3379	0.10	0.7491
	OT8S	2.38	0.1229	2.38	0.1229	0.20	0.6547
	POT02S					0.02	0.8864
	SHNS	0.04	0.8477	1.81	0.1783	1.81	0.1783
	TN	0.72	0.3956	1.84	0.1749	1.18	0.2774
Flathead catfish	**EFS**	0.54	0.4625	0.25	0.6184	0.34	0.5623
	HNS	0.04	0.8437	0.11	0.7430	0.02	0.8937
	MFS	0.00	1.0000	0.00	1.0000	0.00	1.0000
	OT16S	0.27	0.6022	1.08	0.2982	0.39	0.5338
	OT8S	0.71	0.3980	1.56	0.2119	0.64	0.4237
	POT02S					0.86	0.3545
	SHNS	2.00	0.1571	0.21	0.6470	1.51	0.2191
	TN	0.00	1.0000	2.15	0.1422	2.15	0.1422
Sauger	**EFS**	0.19	0.6593	0.00	1.0000	0.52	0.4689
	HNS	2.69	0.1009	3.20	0.0735	0.01	0.9165
	MFS	3.14	0.0765	2.66	0.1032	0.01	0.9165
	OT16S	0.10	0.7489	0.20	0.6567	0.20	0.6567
	OT8S	0.00	1.0000	0.71	0.3980	1.00	0.3173
	TN	**5.02**	**0.0250**	1.00	0.3173	2.00	0.1572

Table III.3.8. Species monthly catch per unit effort (± 2 SE) at California (NE) from 2006 - 2008. Effort for each gear is defined as: electrofishing (EFS), fish caught per hour; 4’ hoop nets (HNS), fish caught per net night; 2’ hoop nets (SHNS), fish caught per net night; mini-fyke nets (MFS), fish caught per net night; push trawls (POT02S), fish caught per 100 m trawled; 8’ otter trawls (OT8S), fish caught per 100 m trawled; 16’ otter trawls (OT16S), fish caught per 100 m trawled; trammel nets (TN), fish caught per 125 ft of net drifted 100 m; set lines (SLW) a wild gear, fish caught per set night and 8’ beam trawls (BT8W) a wild gear, fish caught per 100 m trawled. Push trawl was not used in 2006. Set lines were used in 2007 and 2008, but caught no fish in 2008. Beam trawl was only used in 2006.

Species	Gear	March	April			May			June			July			August			September			October		
		2007	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Pallid sturgeon	**SLW**	0.04 (0.07)		0.06 (0.13)																			
	TN							0.08 (0.15)			0.25 (0.27)												
	OT16S							0.09 (0.18)															
Shovelnose sturgeon	**EFS**		10.64 (9.32)	3.76 (7.52)	2.11 (4.22)	5.01 (3.97)	8.10 (7.68)	2.95 (2.89)	15.43 (14.63)	3.69 (4.15)	14.20 (10.23)	8.18 (9.36)	6.17 (5.13)	5.10 (2.69)		5.04 (3.90)	3.18 (6.36)	6.67 (5.58)	9.41 (6.81)		2.99 (3.94)	4.71 (4.48)	
	HNS			1.33 (1.61)			4.71 (5.01)		0.43 (0.59)	0.33 (0.42)	1.86 (2.02)		0.13 (0.25)	0.13 (0.25)	0.38 (0.37)	0.86 (0.68)	0.50 (0.76)		0.43 (0.40)		0.13 (0.25)	0.29 (0.57)	
	SHNS			0.38 (0.75)			1.00 (1.38)				0.50 (0.76)		0.14 (0.29)	0.13 (0.25)		0.25 (0.33)		0.13 (0.25)				0.13 (0.25)	
	POT02S									0.10 (0.20)	0.16 (0.32)			0.06 (0.13)						0.21 (0.42)			
	SLW	0.14 (0.16)																					
	TN		2.58 (2.51)	1.84 (2.16)	0.96 (0.92)		1.03 (0.87)	1.48 (1.37)	0.26 (0.52)	1.43 (1.28)	3.28 (2.88)		1.50 (1.29)	1.61 (1.21)	0.74 (0.91)	1.58 (1.88)	0.66 (0.43)		1.82 (0.83)	0.72 (0.73)	0.13 (0.25)	1.18 (0.84)	0.33 (0.46)
	OT16S		0.16 (0.20)	0.69 (0.59)		0.63 (0.58)	0.35 (0.46)		0.35 (0.47)	0.15 (0.29)	1.21 (1.00)	0.27 (0.36)	0.41 (0.32)	0.17 (0.33)	0.07 (0.15)			0.16 (0.22)					
	OT8S			0.24 (0.47)			0.27 (0.35)		0.34 (0.34)	0.24 (0.31)	0.25 (0.24)				0.15 (0.20)		0.22 (0.43)						
	BT8W		0.07 (0.14)																				
Paddlefish	**EFS**							0.99 (1.99)															
	HNS															0.14 (0.29)							
Longnose gar	**EFS**									0.89 (1.78)	2.88 (3.98)		1.07 (2.15)	4.29 (3.14)		2.15 (2.81)			2.01 (4.03)			3.20 (4.65)	
	HNS								0.14 (0.29)												0.13 (0.25)		
	SHNS																		0.14 (0.29)				
	MFS									0.20 (0.40)		0.25 (0.50)	0.50 (0.58)										
	POT02S										0.19 (0.38)												
	TN							0.11 (0.22)									0.10 (0.19)					0.17 (0.34)	
	OT16S																		0.11 (0.22)				
	OT8S															0.14 (0.28)							

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Shortnose gar	**EFS**		5.00 (10.00)	6.10 (6.25)	14.35 (10.29)	2.13 (2.75)	1.33 (2.66)		1.57 (3.14)	5.71 (3.75)	1.02 (2.04)		0.88 (1.76)		0.94 (1.87)	1.14 (2.27)	0.92 (1.85)	0.98 (1.97)			1.17 (2.34)	1.05 (2.11)
	HNS											0.13 (0.25)	0.25 (0.33)			0.13 (0.25)			0.13 (0.25)	0.13 (0.25)		0.13 (0.25)
	SHNS										0.13 (0.25)		0.13 (0.25)								0.13 (0.25)	
	MFS		1.25 (1.26)	0.20 (0.40)	1.00 (1.15)	2.00 (2.83)				5.75 (10.84)	0.25 (0.50)					0.67 (0.67)	0.25 (0.50)	0.25 (0.50)				
	POT02S																		0.25 (0.34)			
	TN						0.11 (0.22)		0.09 (0.18)							0.09 (0.17)		0.08 (0.17)				
Goldeye	**EFS**	15.95 (17.31)	31.09 (15.29)	28.45 (25.54)	18.65 (17.22)	14.13 (9.24)	13.69 (3.79)	5.87 (7.16)	3.79 (4.98)	22.55 (11.75)	5.79 (5.00)	8.24 (4.89)	20.08 (7.74)		5.63 (7.27)	5.76 (4.47)	1.14 (2.27)	3.24 (3.06)		5.46 (5.83)	11.03 (17.08)	3.83 (5.61)
	HNS				1.14 (1.19)		0.43 (0.59)	1.71 (1.84)			0.63 (0.53)	0.25 (0.33)	0.25 (0.33)	0.50 (0.38)	0.29 (0.37)	0.50 (0.76)	0.13 (0.25)	0.14 (0.29)	0.25 (0.33)	0.25 (0.33)	0.43 (0.59)	0.50 (0.38)
	TN		1.96 (1.59)		0.58 (0.83)	0.13 (0.26)	0.77 (0.87)	0.20 (0.40)	0.25 (0.50)		0.44 (0.59)	0.35 (0.50)	0.53 (0.48)		1.76 (1.97)	0.78 (0.76)		0.52 (0.57)	0.42 (0.54)	0.25 (0.51)	0.41 (0.39)	0.57 (1.14)
	OT16S		0.10 (0.19)									0.14 (0.29)										
Mooneye	**EFS**											2.11 (2.73)										
Unidentified herring	**MFS**											2.75 (5.50)										
Skipjack herring	**POT02S**								0.24 (0.36)													
	TN																					0.08 (0.16)
Gizzard shad	**EFS**	1.80 (2.39)	37.78 (28.03)		20.93 (11.87)	1.00 (2.00)	3.29 (4.77)	27.16 (17.23)	2.64 (3.54)		1.09 (2.18)				31.87 (12.04)	5.55 (5.67)	126.59 (198.06)	113.76 (40.43)		19.64 (16.41)	24.61 (18.66)	57.42 (36.63)
	MFS			0.20 (0.40)								6.50 (10.50)	1.20 (1.17)	0.75 (0.96)		1.33 (2.67)		24.75 (49.50)	0.50 (0.58)	6.25 (12.50)	0.40 (0.80)	
	POT02S												2.65 (3.82)			0.26 (0.52)					0.23 (0.45)	
	OT16S				0.58 (1.17)												0.10 (0.20)		0.17 (0.33)		0.18 (0.37)	0.24 (0.47)
Unidentified minnow	**MFS**		1.25 (2.50)			0.75 (1.50)	0.25 (0.50)		0.20 (0.40)		1.00 (2.00)	25.00 (39.38)	0.40 (0.80)	0.50 (0.58)	0.25 (0.50)			0.25 (0.50)				
	POT02S		1.36 (1.89)							0.29 (0.37)					0.33 (0.67)	1.17 (1.37)		0.41 (0.81)	0.55 (0.61)			
	OT8S							0.09 (0.19)														

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Emerald shiner	**EFS**	10.45 (8.78)	10.14 (15.83)	14.93 (7.32)	5.69 (4.57)	5.44 (7.07)	31.07 (11.20)	2.72 (3.54)	8.09 (5.49)	9.08 (8.05)	5.94 (3.51)	4.44 (6.72)	12.93 (5.59)		27.47 (26.33)		86.13 (65.20)	40.28 (44.53)		51.36 (33.79)	59.28 (37.21)	11.62 (15.79)
	SHNS																	0.14 (0.29)				
	MFS	108.25 (203.87)	46.50 (61.93)	48.80 (68.36)	12.33 (20.80)	32.00 (49.01)	154.25 (284.57)	1.00 (1.15)	0.60 (0.49)	4.25 (7.85)	0.50 (1.00)	0.50 (1.00)	2.60 (2.80)	30.00 (50.67)	3.75 (2.63)	2.00 (2.00)	18.25 (13.00)	15.25 (7.27)	3.25 (5.85)	13.75 (14.57)	4.00 (7.01)	0.50 (0.58)
	POT02S			9.54 (18.05)			1.65 (2.74)			10.71 (13.60)		0.27 (0.53)	3.89 (3.97)		6.94 (13.89)	4.56 (4.32)		7.32 (14.63)	1.60 (1.69)		0.37 (0.50)	2.99 (1.95)
	OT16S			0.15 (0.31)						0.15 (0.29)			0.16 (0.32)	0.15 (0.30)			0.15 (0.30)		0.17 (0.33)	0.19 (0.24)		
	OT8S			0.80 (1.60)										0.08 (0.16)			0.15 (0.30)	0.50 (1.00)	4.20 (4.95)			0.10 (0.19)
River shiner	**EFS**	1.80 (2.38)			4.91 (7.76)			1.02 (2.04)	1.08 (2.16)		2.04 (4.08)		0.89 (1.79)					1.99 (2.59)		1.30 (2.59)	9.96 (5.19)	1.14 (2.28)
	MFS	1.50 (2.38)	20.50 (16.78)	19.20 (14.72)	1.00 (2.00)	8.75 (11.70)	69.75 (111.70)	2.00 (4.00)	50.20 (88.66)	0.25 (0.50)	2.25 (1.89)	0.25 (0.50)	3.80 (3.25)	156.00 (263.68)	4.75 (3.77)	1.00 (2.00)	40.25 (41.36)	3.00 (2.45)	10.75 (10.78)	30.75 (32.16)	1.60 (2.73)	
	POT02S		0.36 (0.71)	7.35 (14.22)			14.93 (21.16)			9.77 (9.08)			0.13 (0.25)		1.74 (3.47)	5.83 (3.66)		2.44 (4.88)	2.10 (2.13)			15.43 (13.85)
	OT16S				0.32 (0.41)																	
	OT8S			0.20 (0.40)								0.07 (0.13)		0.08 (0.16)				0.13 (0.25)	0.17 (0.33)			0.20 (0.41)
Sand shiner	**EFS**	1.33 (1.75)							1.08 (2.16)		4.08 (8.16)						0.87 (1.75)	0.98 (1.97)			2.47 (3.33)	1.62 (3.24)
	MFS	0.25 (0.50)	8.00 (15.34)	4.20 (2.56)	0.33 (0.67)	5.50 (11.00)	6.25 (8.02)		4.40 (3.38)	1.50 (1.91)	7.00 (7.02)	0.75 (0.96)	0.60 (0.80)	82.75 (89.78)	3.75 (5.68)	11.00 (15.53)	31.75 (57.52)	3.50 (2.89)	0.75 (0.50)	8.00 (9.49)	12.20 (12.92)	
	POT02S			3.25 (6.49)			13.12 (17.03)		0.10 (0.20)	5.15 (5.40)		0.38 (0.77)			0.97 (1.23)	1.60 (1.19)		1.82 (3.20)	1.12 (1.10)			1.67 (2.82)
	OT16S			0.15 (0.31)	0.15 (0.29)			0.07 (0.14)	0.41 (0.59)		0.08 (0.16)											
	OT8S			0.50 (0.60)				0.20 (0.39)										0.25 (0.50)				
Bluntnose minnow	**MFS**						0.25 (0.50)		0.60 (0.80)	0.75 (1.50)		1.00 (1.15)	1.60 (2.73)	1.75 (3.50)								
	POT02S						0.24 (0.47)			0.62 (0.95)			0.28 (0.56)									
Fathead minnow	**EFS**			1.35 (2.70)																		
	MFS	0.50 (1.00)	0.25 (0.50)	1.80 (3.12)	4.67 (6.36)		2.00 (3.37)	1.33 (2.67)	0.80 (1.17)	0.25 (0.50)		0.25 (0.50)	5.40 (3.67)	1.00 (1.41)		1.33 (1.76)	0.25 (0.50)	1.00 (1.41)	0.50 (0.58)			
	POT02S			0.65 (1.30)									0.20 (0.40)			0.18 (0.36)			0.10 (0.21)			

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Grass carp	**EFS**			2.54 (3.29)	4.64 (5.30)	1.33 (2.66)			1.07 (2.13)		1.11 (2.23)						0.92 (1.85)	1.97 (3.93)			1.74 (3.48)	
	HNS														0.29 (0.57)							
	POT02S									0.19 (0.38)												
	TN		0.26 (0.35)								0.18 (0.36)											
Common carp	**EFS**	8.45 (7.80)	5.21 (6.47)	8.10 (9.45)	2.28 (3.00)	1.23 (2.45)	15.44 (8.92)	7.14 (5.76)	11.28 (6.86)	8.11 (9.63)	8.29 (7.73)	11.34 (10.57)	14.30 (10.08)		12.39 (5.74)	6.11 (5.63)	8.28 (6.95)	4.04 (2.88)		5.41 (5.75)	8.48 (6.52)	4.78 (6.61)
	HNS		0.17 (0.33)			0.14 (0.29)	0.29 (0.37)			1.00 (0.98)			0.13 (0.25)									0.13 (0.25)
	SHNS									0.13 (0.25)												
	MFS								0.60 (1.20)			1.50 (1.29)	1.20 (1.94)			0.33 (0.67)					0.20 (0.40)	
	POT02S								0.29 (0.39)							0.18 (0.36)						
	TN		0.10 (0.19)	0.30 (0.60)	0.19 (0.38)	0.31 (0.41)							0.21 (0.28)			0.14 (0.28)						
	OT16S	0.07 (0.14)																				
	OT8S												0.13 (0.25)									
	BT8W	0.08 (0.15)																				
Silver carp	**TN**	0.32 (0.64)																				
Bighead carp	**HNS**		0.17 (0.33)				0.14 (0.29)					0.13 (0.25)			0.86 (0.92)							
Unidentified sucker	**MFS**			0.20 (0.40)								1.75 (3.50)				2.00 (4.00)						
River carpsucker	**EFS**	5.36 (3.93)	3.33 (6.67)	10.86 (7.05)	5.45 (6.24)	6.66 (6.87)	18.71 (9.60)	2.50 (3.30)	11.57 (8.69)	8.01 (7.62)	3.29 (3.22)	10.08 (7.86)	18.70 (13.36)		7.63 (7.83)		15.12 (7.87)	5.04 (7.81)		11.80 (6.13)	10.28 (9.40)	24.16 (24.11)
	HNS	0.14 (0.29)					0.57 (0.86)					0.25 (0.33)	0.50 (0.65)			0.13 (0.25)		0.14 (0.29)		0.38 (0.75)		0.13 (0.25)
	MFS	1.00 (1.41)	0.25 (0.50)	1.80 (3.12)	2.00 (3.06)	1.75 (2.22)	6.00 (12.00)	0.33 (0.67)	0.60 (1.20)	0.25 (0.50)	1.00 (0.82)		7.20 (8.70)	0.75 (1.50)	0.25 (0.50)	5.00 (6.43)	0.75 (0.96)	0.25 (0.50)	2.00 (2.16)		0.80 (1.17)	0.75 (1.50)
	POT02S			4.78 (3.68)			0.30 (0.61)			0.33 (0.44)			0.61 (0.96)			7.90 (7.17)		1.22 (2.44)	1.91 (1.37)			0.33 (0.48)
	TN			0.30 (0.60)			0.17 (0.33)					0.09 (0.19)	0.12 (0.25)			0.14 (0.28)						
	OT16S		0.10 (0.20)	0.48 (0.59)							0.08 (0.16)	0.08 (0.16)	0.32 (0.64)	0.07 (0.14)					0.17 (0.33)			0.14 (0.27)
	OT8S											0.07 (0.13)				0.43 (0.87)						

		April			May			June			July			August			September			October		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Quillback	**EFS**	3.34 (3.52)																				
	MFS	0.25 (0.50)		0.40 (0.49)																		
	TN																			0.14 (0.28)		
White sucker	**HNS**																0.13 (0.25)					
	MFS													0.25 (0.50)	0.25 (0.50)	1.33 (1.33)						
	POT02S															0.56 (0.76)						0.20 (0.41)
	OT16S														0.15 (0.29)							
	OT8S														0.17 (0.33)							
Blue sucker	**EFS**		3.69 (4.26)	1.19 (2.39)	3.00 (4.11)	2.45 (3.16)	5.89 (7.84)	7.32 (4.10)	3.07 (4.27)	4.61 (6.09)	2.23 (4.46)	2.59 (3.50)	1.92 (2.49)		10.28 (10.64)		8.73 (8.20)	4.29 (6.34)		10.48 (10.52)	7.86 (4.13)	11.51 (10.39)
	HNS					0.57 (0.40)		0.29 (0.37)	0.17 (0.33)		0.75 (0.73)	1.25 (1.45)	0.13 (0.25)	1.13 (1.98)	0.14 (0.29)	0.13 (0.25)	0.75 (0.82)	0.57 (0.59)		2.50 (1.89)	1.29 (1.94)	
	SHNS													0.13 (0.25)			0.13 (0.25)					
	MFS								0.40 (0.80)													
	TN	0.16 (0.31)			0.23 (0.46)			0.26 (0.52)	0.57 (1.14)	0.06 (0.11)	0.16 (0.32)		0.23 (0.22)				0.15 (0.20)	0.26 (0.35)	0.25 (0.51)	0.66 (0.47)		0.16 (0.32)
	OT16S							0.14 (0.18)	0.30 (0.39)		0.10 (0.20)			0.29 (0.29)			0.39 (0.79)			0.32 (0.42)		
	OT8S													0.16 (0.21)								
	BT8W				0.07 (0.14)																	
Smallmouth buffalo	**EFS**				2.25 (2.99)	2.22 (2.88)	0.89 (1.78)	1.48 (2.96)		0.93 (1.86)			2.87 (2.71)		1.86 (3.71)					2.27 (2.97)		
	HNS				0.14 (0.29)		0.14 (0.29)										0.13 (0.25)			0.13 (0.25)	0.14 (0.29)	
	MFS											10.75 (12.09)	0.40 (0.80)			2.33 (3.71)		1.25 (1.50)	0.25 (0.50)			
	POT02S																		0.42 (0.65)			
	TN		0.12 (0.24)			0.19 (0.25)				0.17 (0.34)		0.19 (0.39)										
	OT16S											0.08 (0.16)			0.07 (0.13)			0.13 (0.25)				
	OT8S											0.09 (0.19)	0.11 (0.23)					0.13 (0.25)				

		April			May			June			July			August			September			October		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Bigmouth buffalo	**EFS**		1.67 (3.33)			2.33 (3.05)	0.99 (1.99)			0.93 (1.86)					1.21 (2.42)					1.25 (2.50)		
	HNS	0.14 (0.29)	0.17 (0.33)																			
	MFS								3.00 (2.97)			15.75 (14.86)										
	POT02S												0.28 (0.56)									
	TN						0.11 (0.22)			0.08 (0.17)												
Black buffalo	**MFS**								0.20 (0.40)													
Shorthead redhorse	**EFS**	2.43 (2.43)	3.62 (7.24)	2.54 (3.29)	15.98 (8.61)	2.23 (2.89)	8.29 (5.22)	6.88 (9.39)	12.32 (5.59)	23.39 (9.55)	9.23 (7.83)	6.40 (3.70)	21.74 (8.31)		16.23 (18.02)	1.06 (2.12)	4.48 (6.85)	12.18 (4.60)		11.42 (7.25)	12.50 (5.77)	2.36 (4.73)
	HNS							0.14 (0.29)	0.17 (0.33)	0.14 (0.29)		0.25 (0.50)	0.38 (0.37)	0.13 (0.25)	0.29 (0.37)			0.29 (0.37)		0.13 (0.25)	0.29 (0.57)	
	SHNS								0.20 (0.40)	0.13 (0.25)					0.25 (0.50)			0.14 (0.29)				
	MFS		0.75 (0.96)			0.25 (0.50)				0.25 (0.50)	0.50 (0.58)		0.80 (0.98)	0.25 (0.50)	0.25 (0.50)		0.50 (0.58)			0.75 (1.50)		
	POT02S			0.20 (0.41)					0.10 (0.20)	0.83 (0.85)			0.56 (1.11)		1.00 (1.37)			0.70 (0.71)	0.72 (1.24)		0.92 (1.31)	
	TN	0.15 (0.30)	0.18 (0.23)	0.72 (0.70)	0.18 (0.36)	0.78 (0.67)	0.37 (0.51)			0.10 (0.13)	0.28 (0.56)		1.15 (0.65)			0.09 (0.17)					0.13 (0.27)	
	OT16S		0.50 (1.00)		1.08 (0.83)		0.19 (0.38)	0.14 (0.28)	0.23 (0.30)	0.08 (0.16)		0.30 (0.39)					0.53 (0.76)	0.18 (0.36)	0.17 (0.33)		0.17 (0.35)	0.29 (0.37)
	OT8S		0.40 (0.48)			0.07 (0.15)								0.15 (0.30)		0.79 (0.92)					0.46 (0.69)	
	BT8W				0.07 (0.14)																	
Unidentified bullhead	**MFS**											0.25 (0.50)										
Black bullhead	**MFS**		0.25 (0.50)																			
Yellow bullhead	**MFS**			0.20 (0.40)																		
Brown bullhead	**MFS**																		0.50 (1.00)			
Blue catfish	**HNS**																	0.14 (0.29)				

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Channel catfish	**EFS**	3.43 (3.55)	1.88 (3.76)	0.93 (1.86)	3.20 (3.19)		6.38 (5.55)	1.22 (2.45)	1.08 (2.16)	0.93 (1.86)		2.99 (4.09)	2.86 (2.71)		3.09 (2.95)		3.20 (4.66)	5.44 (6.48)			5.87 (9.43)	8.80 (11.90)
	HNS		1.67 (2.17)	0.57 (0.86)	0.71 (0.57)		0.14 (0.29)	0.71 (0.84)	0.67 (1.33)	0.14 (0.29)	0.13 (0.25)	0.50 (0.53)		0.13 (0.25)	0.29 (0.37)	0.13 (0.25)	0.25 (0.50)		0.25 (0.50)	0.13 (0.25)		0.63 (0.53)
	SHNS	1.00 (0.76)	2.00 (1.69)	0.29 (0.57)	1.13 (1.49)	0.29 (0.57)	0.57 (0.86)	0.25 (0.33)	0.40 (0.49)	0.13 (0.25)	0.63 (0.37)	0.57 (0.40)	0.50 (0.53)	0.75 (0.73)	0.63 (0.75)	0.50 (0.38)	0.13 (0.25)		0.14 (0.29)	0.33 (0.67)	0.75 (0.82)	0.25 (0.33)
	MFS	3.25 (1.71)	2.50 (2.38)	0.20 (0.40)	2.33 (3.71)	1.50 (0.58)	0.75 (0.96)	0.33 (0.67)	0.60 (0.80)	0.75 (0.50)	0.75 (1.50)	0.25 (0.50)	0.40 (0.49)	0.75 (0.96)	7.00 (2.94)	4.33 (3.71)	0.50 (0.58)	4.00 (3.74)	2.00 (2.31)	2.25 (2.87)	12.80 (9.35)	7.00 (10.13)
	POT02S		2.00 (4.00)	2.52 (1.74)			6.89 (2.08)		0.47 (0.38)	26.90 (20.44)		13.47 (9.71)	0.32 (0.41)		2.72 (3.29)	3.96 (3.77)		21.44 (14.40)	14.98 (11.59)		15.69 (7.59)	2.42 (3.17)
	TN	0.47 (0.66)	0.41 (0.52)	0.30 (0.60)		0.13 (0.25)	0.55 (0.82)	0.20 (0.40)	0.08 (0.17)	0.11 (0.15)		0.13 (0.25)	0.58 (0.63)	0.36 (0.71)		0.14 (0.28)		0.08 (0.17)	0.19 (0.37)		1.01 (0.42)	0.10 (0.20)
	OT16S	5.89 (9.18)	4.09 (3.26)	2.02 (3.21)	18.19 (17.33)		1.38 (0.96)	0.68 (0.69)	3.74 (2.08)	0.32 (0.42)	0.20 (0.26)	5.61 (5.06)	1.81 (1.67)	0.32 (0.32)		4.61 (4.87)	1.16 (1.07)	0.99 (0.88)	1.93 (0.70)	1.29 (0.88)	7.95 (5.56)	2.30 (2.54)
	OT8S		2.39 (0.94)	0.94 (1.49)		0.15 (0.31)	1.21 (1.66)	1.36 (0.99)	0.32 (0.41)	0.07 (0.14)	0.31 (0.32)	1.17 (0.93)	2.03 (2.09)	0.29 (0.58)	2.02 (1.94)	11.36 (11.46)		3.60 (2.71)	4.94 (3.33)	1.64 (1.55)	8.44 (5.10)	7.31 (6.25)
	BT8W	0.30 (0.22)			11.97 (8.78)																	
Flathead catfish	**EFS**				1.05 (2.10)		0.82 (1.65)		4.39 (4.89)		9.15 (5.99)	3.96 (4.06)	1.83 (2.36)		8.27 (7.04)	5.65 (4.38)	1.08 (2.15)	0.98 (1.97)			1.60 (3.21)	1.18 (2.36)
	HNS				0.29 (0.37)	0.71 (0.72)	0.14 (0.29)	0.14 (0.29)		0.43 (0.40)	0.25 (0.33)	0.50 (0.53)	1.63 (1.36)	0.13 (0.25)		0.25 (0.33)		0.14 (0.29)		0.13 (0.25)	0.14 (0.29)	
	SHNS					1.14 (0.81)		0.88 (0.96)	0.60 (0.49)	1.13 (0.80)	0.38 (0.37)	0.86 (0.52)	0.63 (0.53)	0.38 (0.37)	0.63 (0.53)	0.50 (0.65)	0.13 (0.25)	1.00 (0.87)	0.43 (0.59)	0.17 (0.33)	0.13 (0.25)	
	POT02S																		0.13 (0.25)			
	TN						0.22 (0.44)															0.08 (0.16)
	OT16S				0.33 (0.44)						0.08 (0.16)	0.16 (0.32)		0.11 (0.21)							0.09 (0.18)	0.13 (0.27)
	OT8S		0.14 (0.28)																0.20 (0.40)			0.23 (0.46)
Stonecat	**MFS**						0.25 (0.50)			0.25 (0.50)												
	POT02S								0.27 (0.42)	0.14 (0.29)											0.15 (0.29)	
	OT16S	1.25 (1.76)	0.25 (0.50)		1.67 (1.42)					0.24 (0.22)												
	OT8S		0.14 (0.28)							0.17 (0.34)						0.28 (0.33)					0.25 (0.50)	
	BT8W	1.80 (1.44)			0.81 (0.38)																	
Brook Silverside	**MFS**		0.75 (1.50)	0.20 (0.40)		0.50 (0.58)	1.25 (1.89)						0.20 (0.40)			0.33 (0.67)						
	POT02S												1.25 (1.32)									

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
White Perch	**OT16S**										0.07 (0.15)											
White bass	**EFS**			1.06 (2.11)			1.86 (2.44)	1.12 (2.23)					0.88 (1.76)		2.75 (5.50)		2.01 (2.66)	3.90 (4.09)		1.22 (2.43)	1.74 (3.48)	2.76 (3.64)
	HNS					0.14 (0.29)																
	MFS								0.20 (0.40)		1.00 (1.41)	1.25 (1.50)	3.60 (2.87)	0.25 (0.50)	1.00 (1.41)	1.67 (1.33)	0.50 (1.00)			0.75 (0.50)	0.20 (0.40)	
	POT02S												0.54 (0.95)			0.52 (0.69)			0.09 (0.19)			
	TN						0.12 (0.23)															
	OT16S												0.32 (0.37)				0.08 (0.15)				0.09 (0.17)	
	OT8S										0.08 (0.15)		0.11 (0.23)									
Unidentified sunfish	**MFS**								0.40 (0.49)			1.50 (1.29)		0.25 (0.50)								
Green sunfish	**EFS**	0.65 (1.31)																				
	SHNS							0.13 (0.25)														
	MFS		0.75 (0.96)		0.67 (1.33)		0.25 (0.50)	2.33 (3.71)	0.40 (0.80)	0.25 (0.50)				4.25 (5.97)			0.50 (1.00)	1.75 (2.87)	0.25 (0.50)	3.25 (6.50)	0.40 (0.49)	
	POT02S									0.94 (1.02)												0.12 (0.24)
	OT8S															0.15 (0.30)						
Pumpkinseed sunfish	**MFS**													0.25 (0.50)								
Orangespotted sunfish	**EFS**	0.65 (1.31)				1.22 (2.44)	0.97 (1.94)														0.87 (1.73)	
	MFS	0.25 (0.50)	0.25 (0.50)		1.00 (2.00)	0.25 (0.50)	0.25 (0.50)	0.67 (0.67)	0.20 (0.40)		0.50 (1.00)		0.60 (0.80)	0.25 (0.50)	0.25 (0.50)	0.33 (0.67)	1.25 (0.96)	1.00 (2.00)	0.50 (1.00)	5.00 (8.68)	0.20 (0.40)	
	POT02S									0.49 (0.67)					0.17 (0.35)				0.15 (0.29)			0.48 (0.95)
	OT16S	0.08 (0.16)																				
Bluegill	**EFS**												2.07 (2.67)		1.21 (2.42)							
	SHNS														0.38 (0.75)							
	MFS					0.50 (0.58)	0.25 (0.50)		0.20 (0.40)	0.50 (0.58)		0.50 (0.58)	0.20 (0.40)		0.25 (0.50)	1.33 (1.76)	0.25 (0.50)	1.25 (0.96)	0.25 (0.50)		0.20 (0.40)	0.25 (0.50)
	POT02S						0.30 (0.61)			0.30 (0.39)			0.13 (0.25)		0.22 (0.44)							0.22 (0.44)
	OT16S												0.17 (0.33)			0.40 (0.80)						
	OT8S												0.13 (0.25)			0.69 (0.87)						

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Redear sunfish	**TN**													0.36 (0.71)								
Smallmouth bass	**EFS**										1.21 (2.43)	1.84 (2.38)	1.92 (2.49)		2.79 (3.87)	1.06 (2.12)	0.87 (1.75)					
	SHNS												0.13 (0.25)	0.25 (0.33)								
	MFS										0.25 (0.50)		0.20 (0.40)									
	TN																	0.07 (0.14)				
Largemouth bass	**EFS**	0.79 (1.58)																				
	MFS								2.60 (5.20)				1.20 (0.98)					0.25 (0.50)				
White crappie	**MFS**										0.25 (0.50)	0.75 (0.96)	0.60 (1.20)				1.75 (2.36)				0.20 (0.40)	
Black crappie	**EFS**	0.79 (1.58)																				
	MFS	0.25 (0.50)				0.25 (0.50)												0.25 (0.50)		0.25 (0.50)		
	OT16S															0.19 (0.38)						
Johnny darter	**MFS**													0.25 (0.50)								
	POT02S															0.22 (0.43)		0.19 (0.38)	0.29 (0.59)			0.12 (0.24)
Yellow perch	**MFS**					0.25 (0.50)																
Sauger	**EFS**				4.02 (4.19)	2.55 (3.30)	1.08 (2.17)		6.17 (6.91)	1.84 (2.41)		1.12 (2.25)	4.44 (3.22)				4.12 (4.45)	4.38 (4.62)		3.76 (3.55)	2.77 (3.57)	1.14 (2.28)
	HNS	0.14 (0.29)			0.29 (0.37)									0.13 (0.25)				0.14 (0.29)	0.13 (0.25)	0.25 (0.33)		
	MFS				0.33 (0.67)			0.67 (1.33)	0.60 (1.20)		0.50 (0.58)		0.80 (1.17)				0.25 (0.50)			0.25 (0.50)		
	POT02S								0.17 (0.23)				0.59 (0.68)									
	TN		0.10 (0.19)									0.19 (0.37)	0.27 (0.40)					0.40 (0.32)			0.13 (0.27)	
	OT16S								0.08 (0.16)			0.08 (0.16)	0.32 (0.64)	0.15 (0.30)						0.26 (0.24)		
	OT8S												0.24 (0.28)									
Saugeye	**EFS**				1.26 (2.51)																	
	MFS					0.25 (0.50)																

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Walleye	**EFS**				0.95 (1.90)				0.79 (1.57)	0.93 (1.86)							2.23 (2.93)					1.18 (2.36)
	HNS												0.13 (0.25)									
	TN											0.13 (0.25)	0.08 (0.16)			0.10 (0.19)						
	OT16S																0.08 (0.15)					
	OT8S										0.08 (0.15)											
Freshwater drum	**EFS**	1.19 (1.57)	18.12 (7.29)	2.12 (2.77)	1.90 (3.81)	1.00 (2.00)	11.80 (5.80)	4.13 (5.99)	2.08 (4.17)	5.78 (3.79)			3.98 (4.00)		12.16 (6.28)		6.96 (5.93)	7.47 (7.87)		13.48 (9.84)	19.64 (9.16)	14.58 (8.87)
	HNS					0.86 (0.92)		0.14 (0.29)		0.14 (0.29)			0.13 (0.25)	0.13 (0.25)	0.14 (0.29)	0.25 (0.33)	0.25 (0.33)	0.14 (0.29)	0.25 (0.33)		0.14 (0.29)	
	SHNS									0.13 (0.25)			0.38 (0.53)			0.25 (0.33)	0.75 (0.73)	0.14 (0.29)		0.50 (0.68)	0.13 (0.25)	
	MFS		0.25 (0.50)				0.25 (0.50)			0.75 (0.50)		14.00 (8.60)	41.00 (60.17)	0.25 (0.50)		3.67 (4.06)	0.25 (0.50)	0.50 (1.00)	0.25 (0.50)	0.25 (0.50)	0.40 (0.49)	0.50 (1.00)
	POT02S			0.11 (0.23)					0.30 (0.41)	0.32 (0.63)		0.38 (0.77)	1.51 (1.18)		0.22 (0.44)	0.17 (0.35)			0.21 (0.42)		0.45 (0.91)	0.57 (1.14)
	TN			0.30 (0.60)				0.20 (0.40)													0.16 (0.32)	
	OT16S			0.32 (0.37)				0.07 (0.14)				2.53 (2.41)	29.60 (13.01)	0.11 (0.21)		2.41 (3.81)	0.49 (0.75)	0.18 (0.36)	0.33 (0.67)	0.07 (0.14)	1.46 (1.20)	0.37 (0.48)
	OT8S			0.15 (0.31)				0.57 (0.74)			0.08 (0.15)	0.58 (0.58)	17.22 (13.95)	0.14 (0.29)		5.45 (5.22)			0.17 (0.33)		1.84 (1.56)	
Unidentified larval fish	**MFS**												0.60 (0.80)									

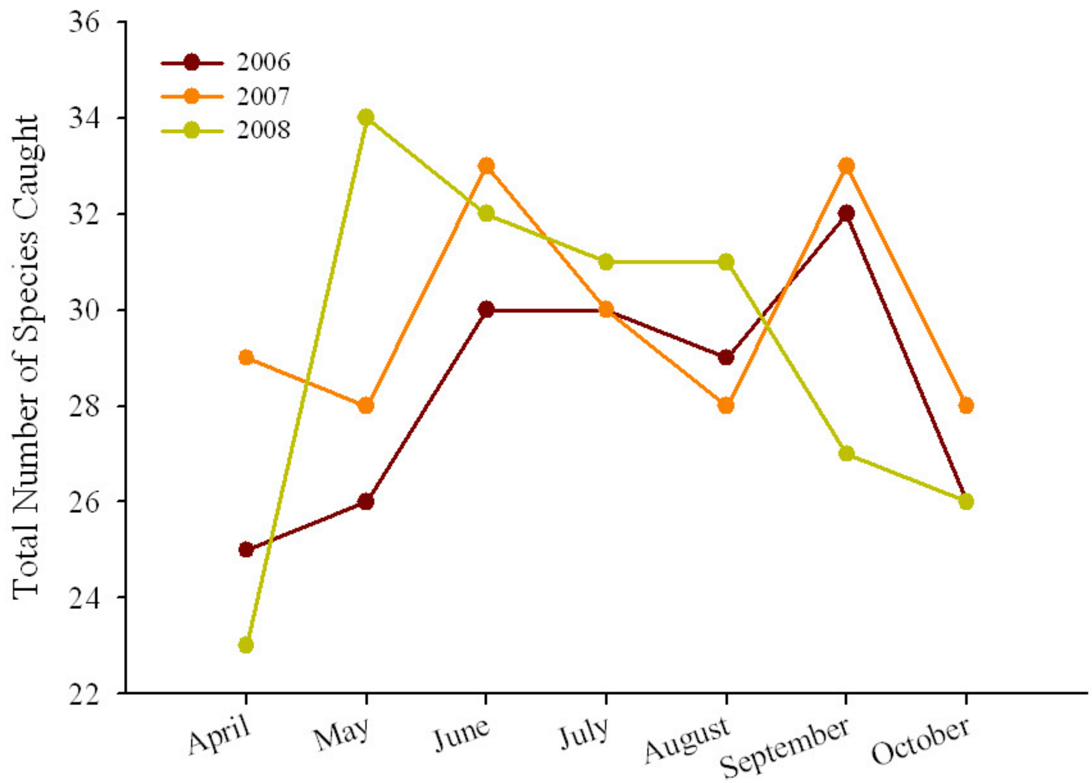


Figure III.3.1. Monthly species richness for California (NE) from 2006 - 2008.

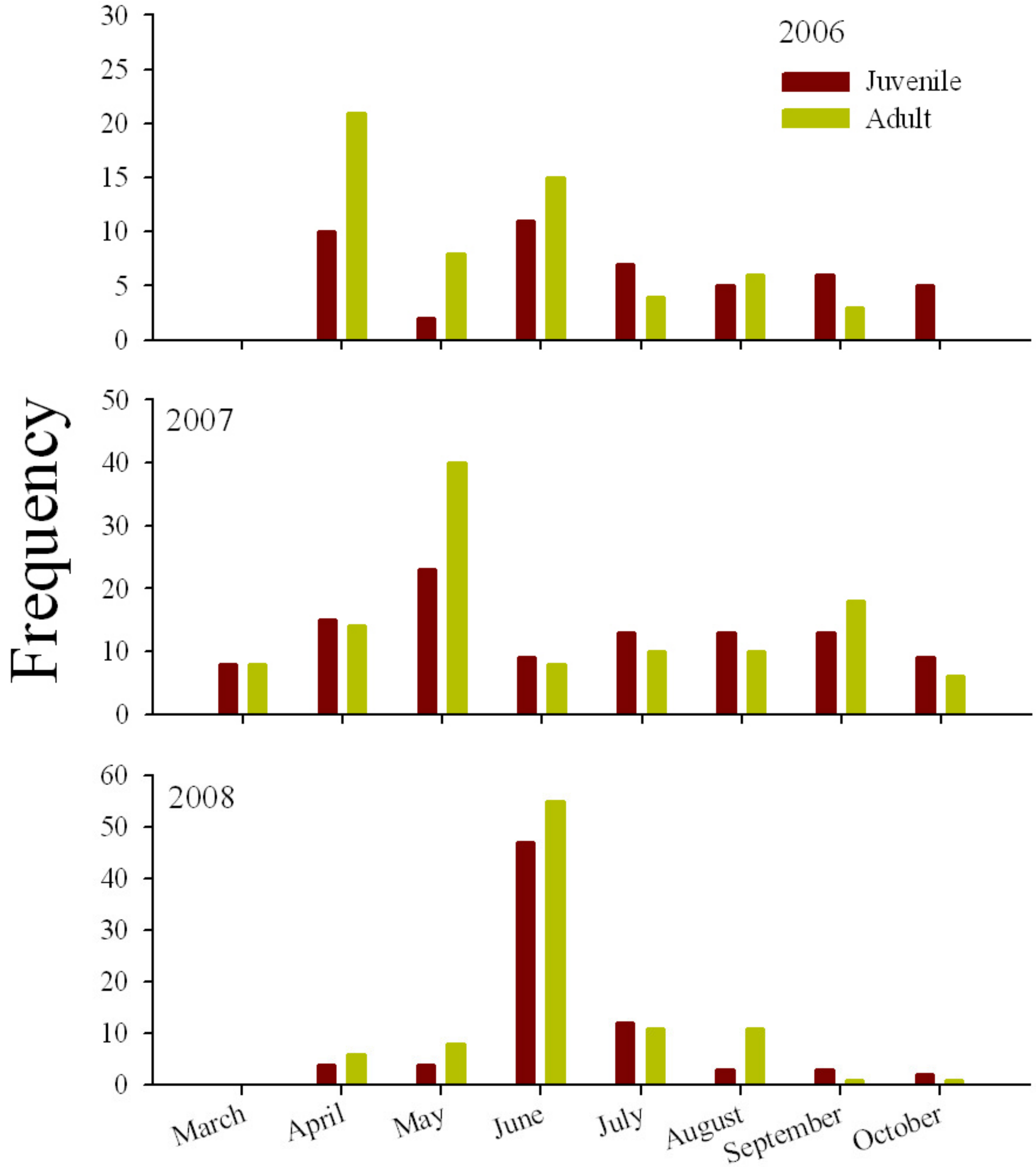


Figure III.3.2. Monthly frequency of juvenile (<540 mm) and adult (≥540 mm) shovelnose sturgeon caught at California (NE) from 2006 - 2008. Please note differences in scale of frequency.

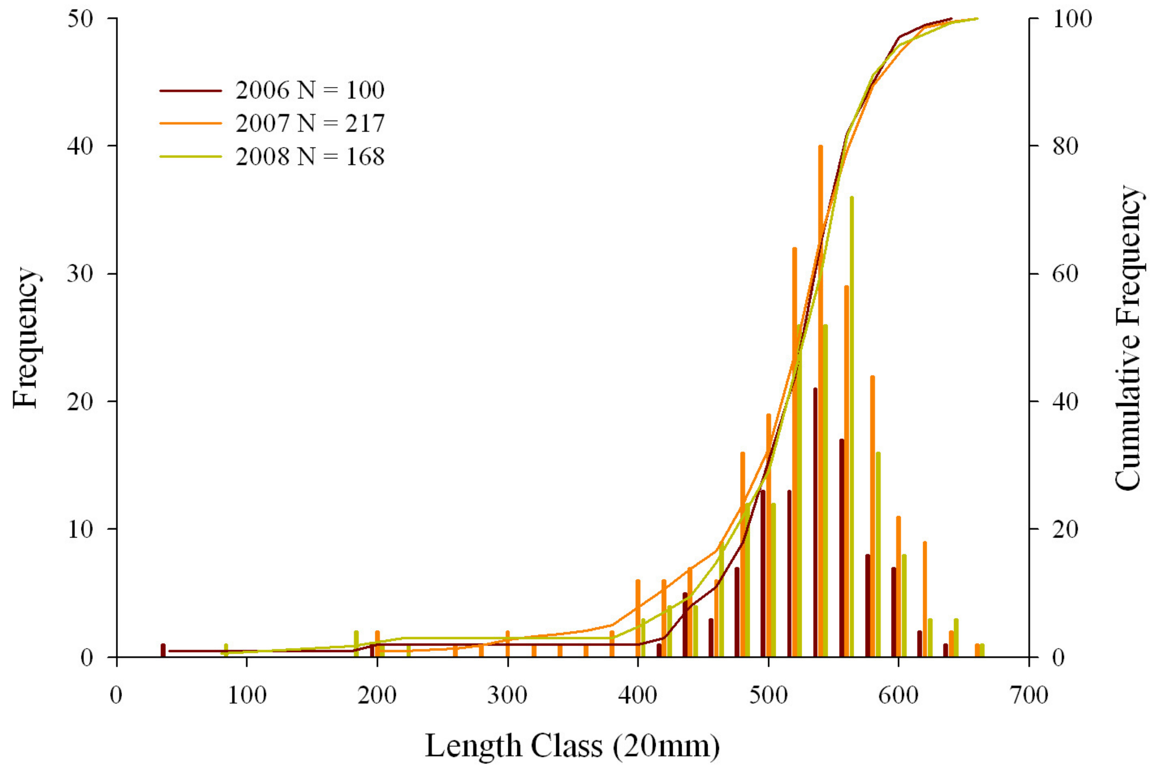


Figure III.3.3. Length frequency distributions and cumulative frequencies for measured shovelnose sturgeon (N) at California (NE) from 2006 - 2008.

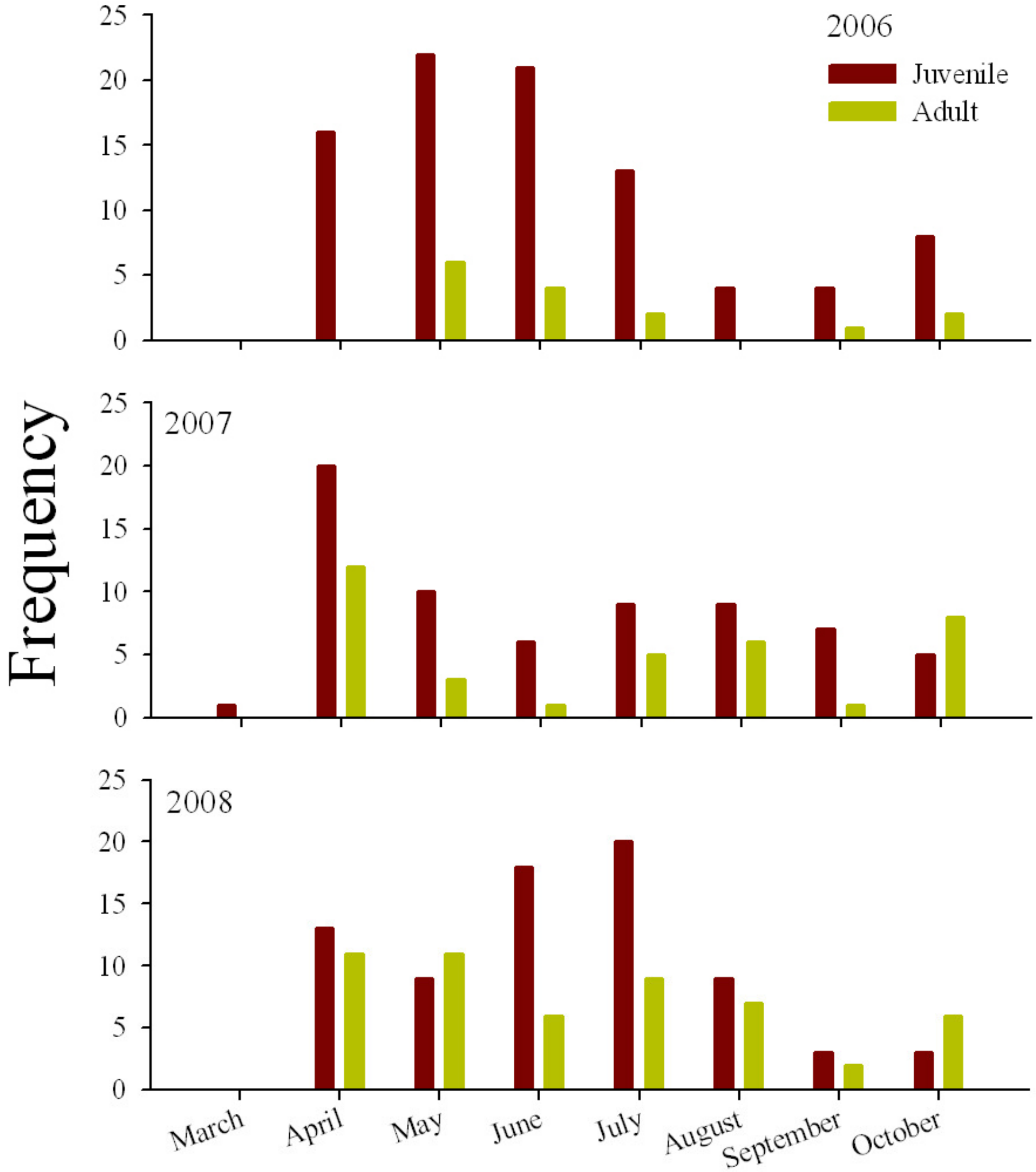


Figure III.3.4. Monthly frequency of juvenile (<356 mm) and adult (≥356 mm) goldeye caught at California (NE) from 2006 - 2008.

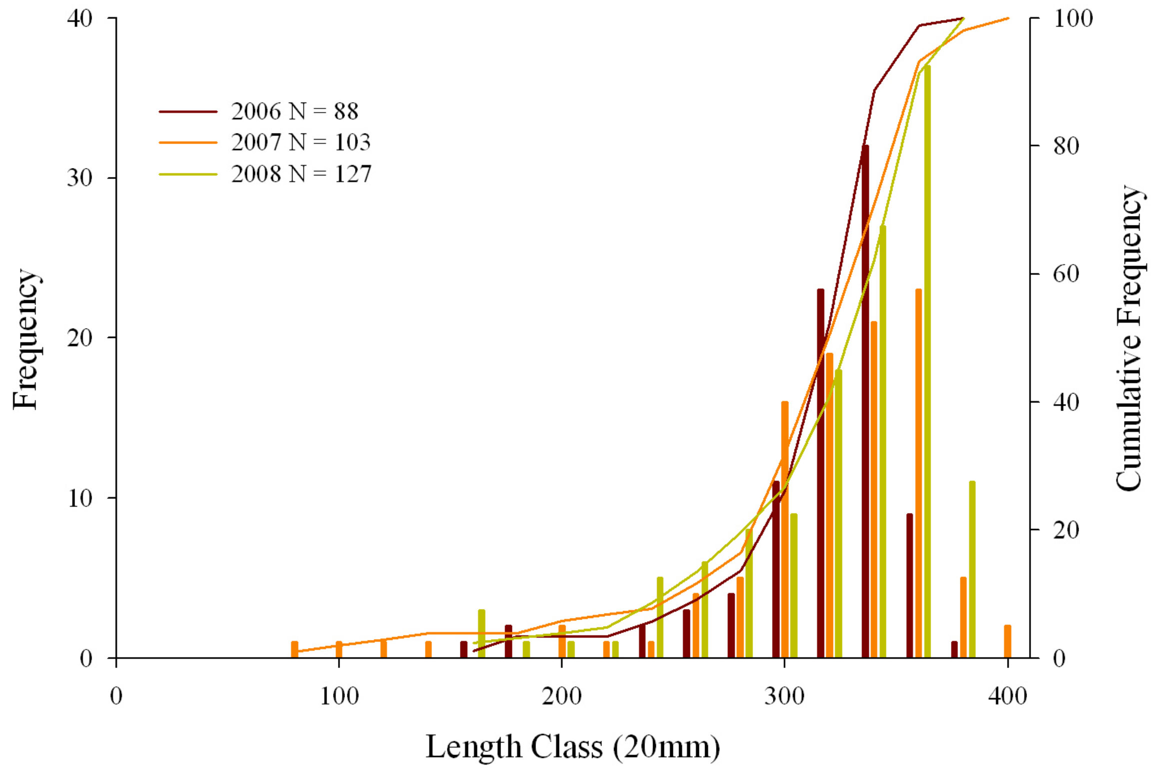


Figure III.3.5. Length frequency distributions and cumulative frequencies for measured goldeye (N) at California (NE) from 2006 - 2008.

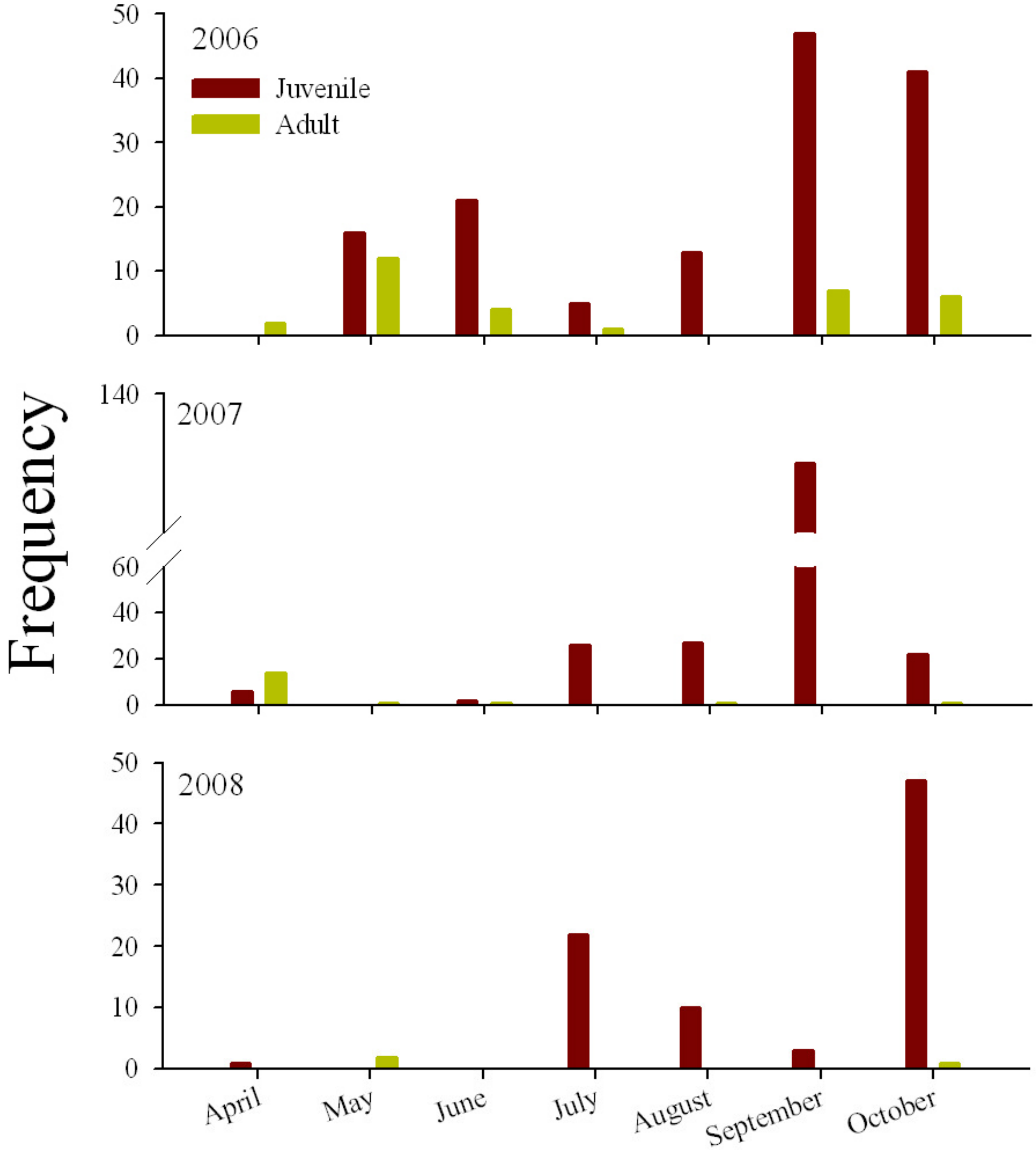


Figure III.3.6. Monthly frequency of juvenile (<229 mm) and adult (≥229 mm) gizzard shad caught at California (NE) from 2006 - 2008. Please note differences in scale of frequency.

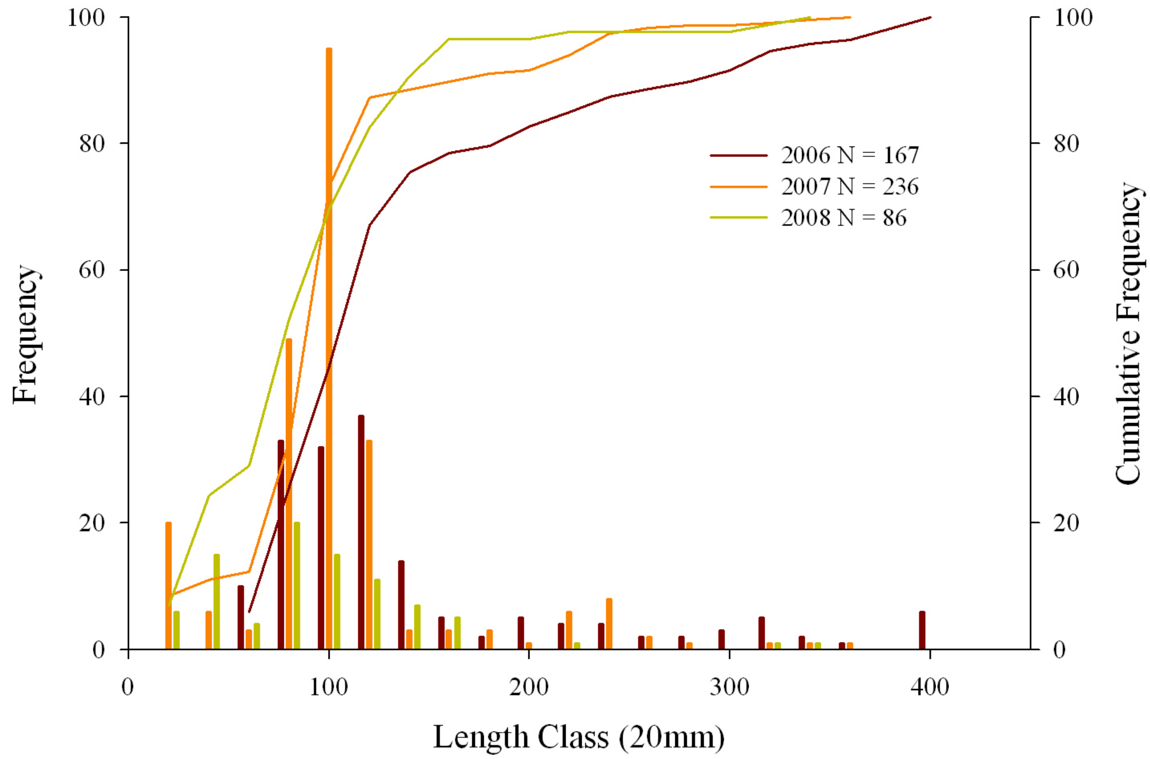


Figure III.3.7. Length frequency distributions and cumulative frequencies for measured gizzard shad (N) at California (NE) from 2006 - 2008.

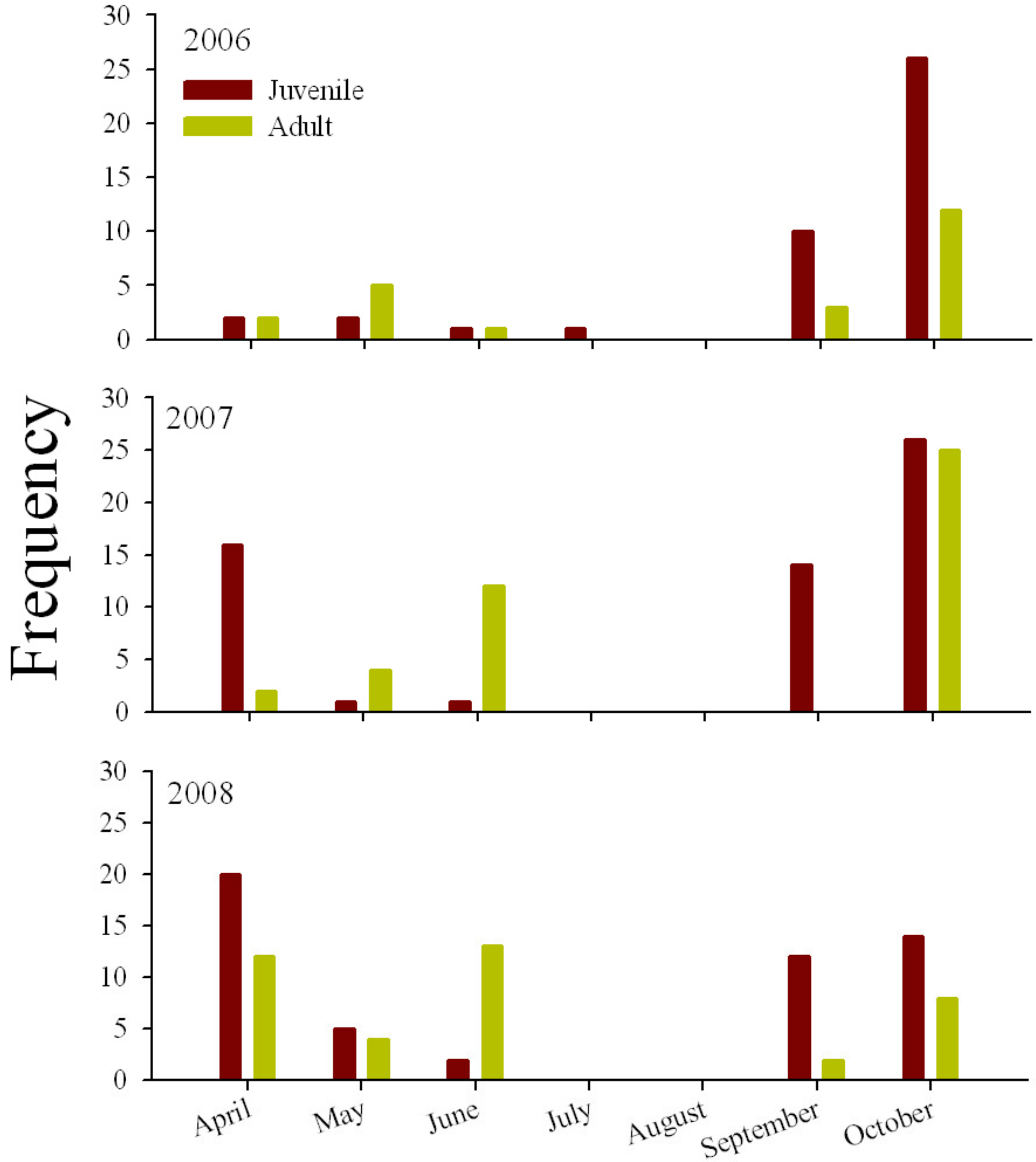


Figure III.3.8. Monthly frequency of juvenile (<40 mm) and adult (≥40 mm) speckled chubs caught at California (NE) from 2006 - 2008.

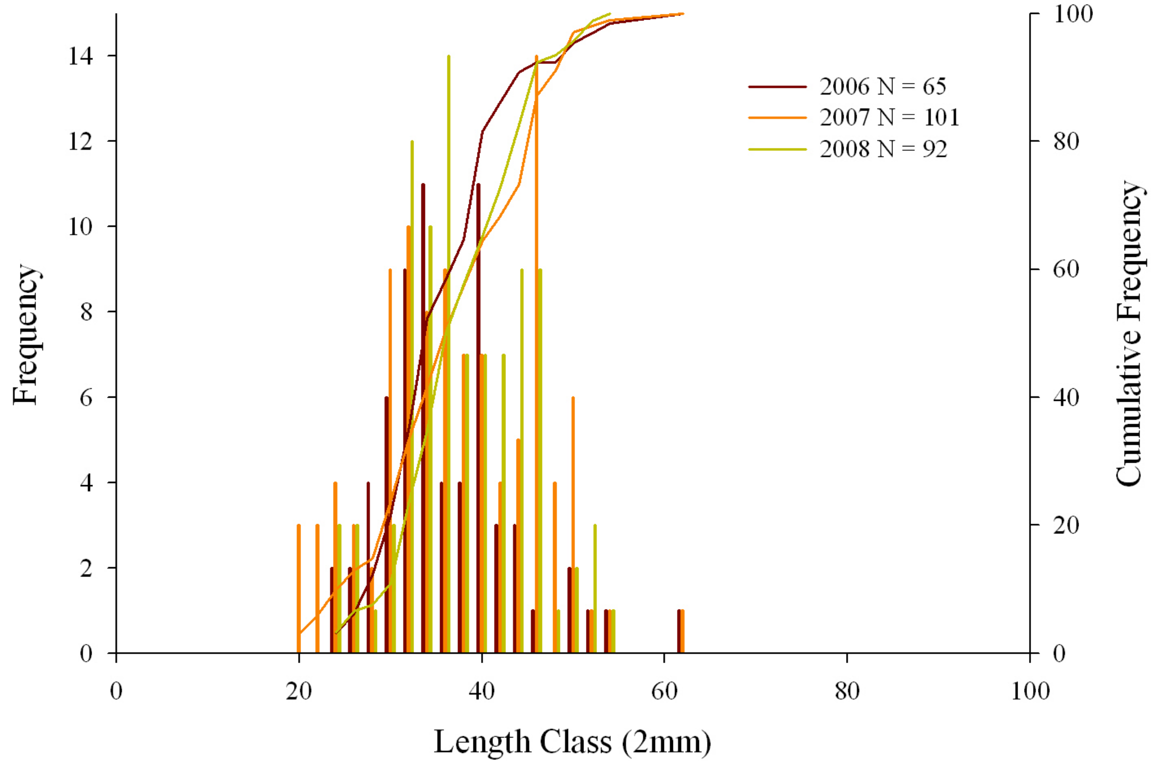


Figure III.3.9. Length frequency distributions and cumulative frequencies for measured speckled chubs (N) at California (NE) from 2006 - 2008.

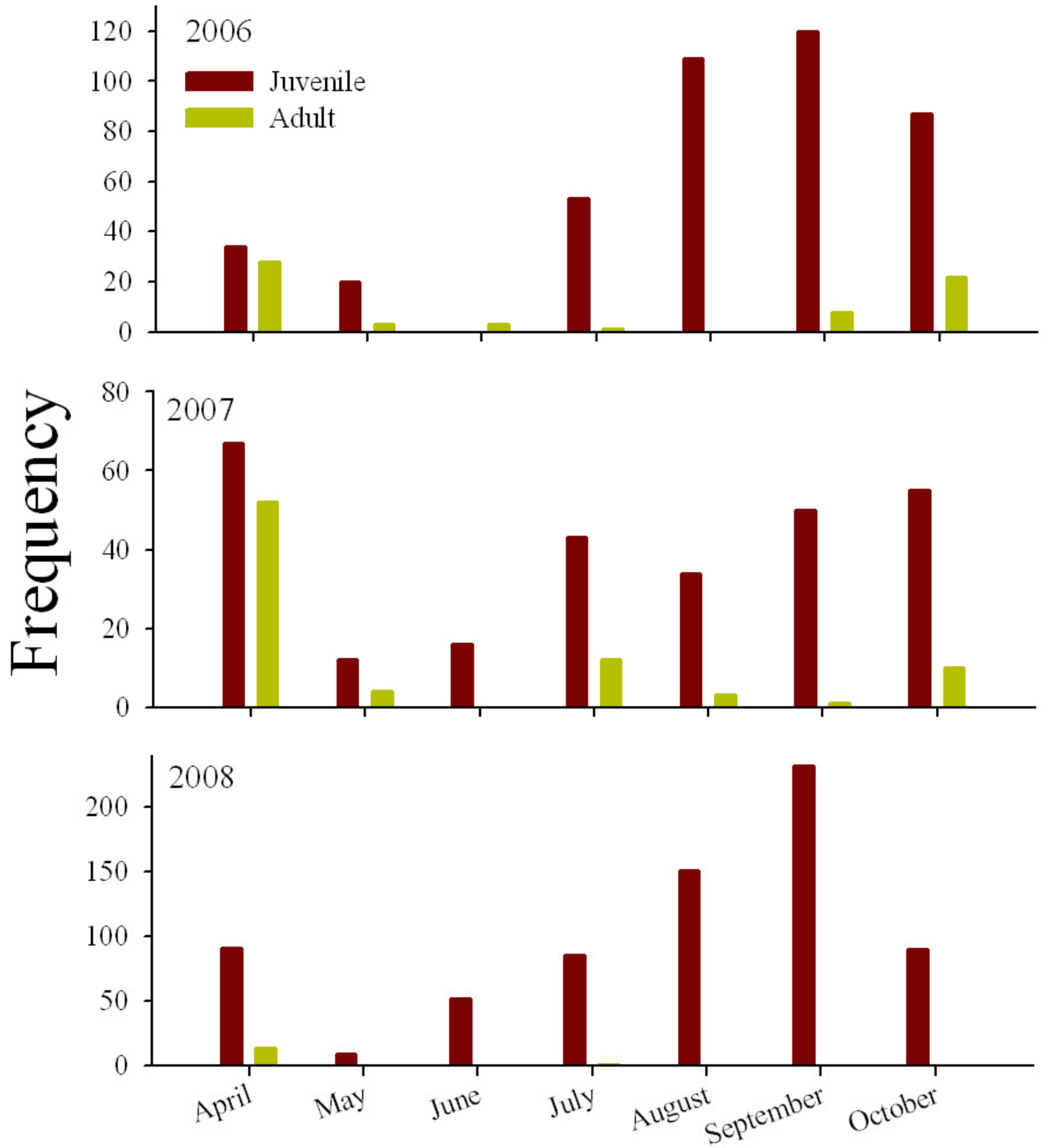


Figure III.3.10. Monthly frequency of juvenile (<89 mm) and adult (≥89 mm) silver chubs caught at California (NE) from 2006 - 2008. Please note differences in scale of frequency.

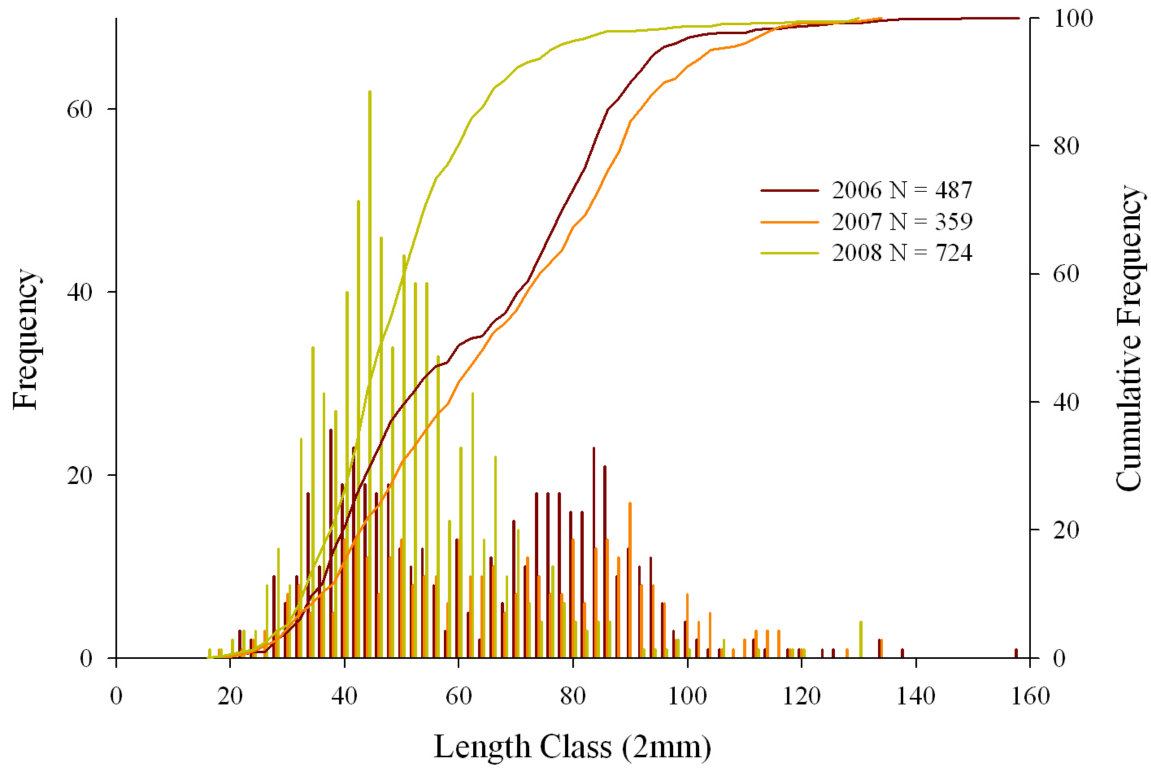


Figure III.3.11. Length frequency distributions and cumulative frequencies for measured silver chubs (N) at California (NE) from 2006 - 2008.

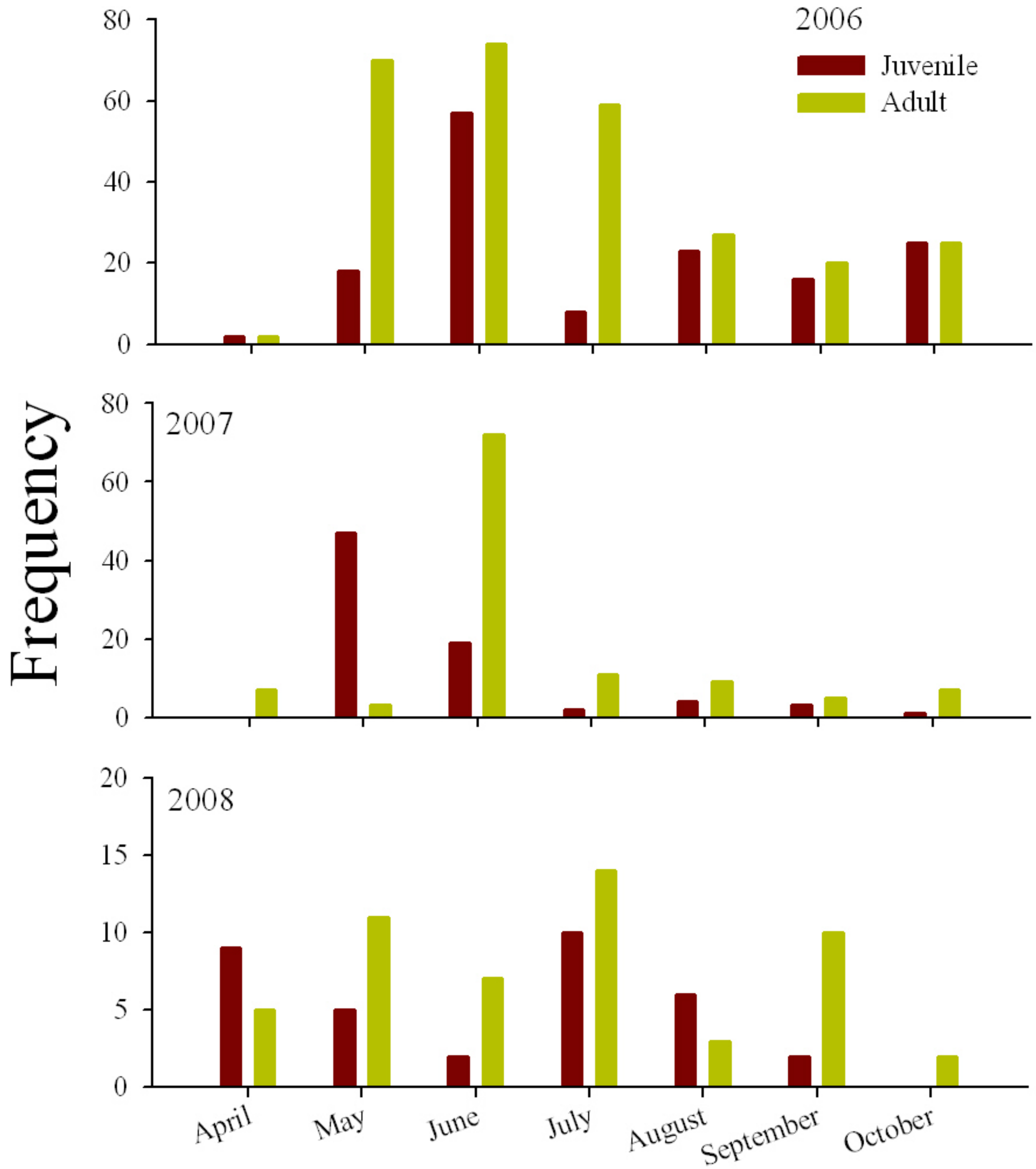


Figure III.3.12. Monthly frequency of juvenile (<46 mm) and adult (≥46 mm) red shiners caught at California (NE) from 2006 - 2008. Please note differences in scale of frequency.

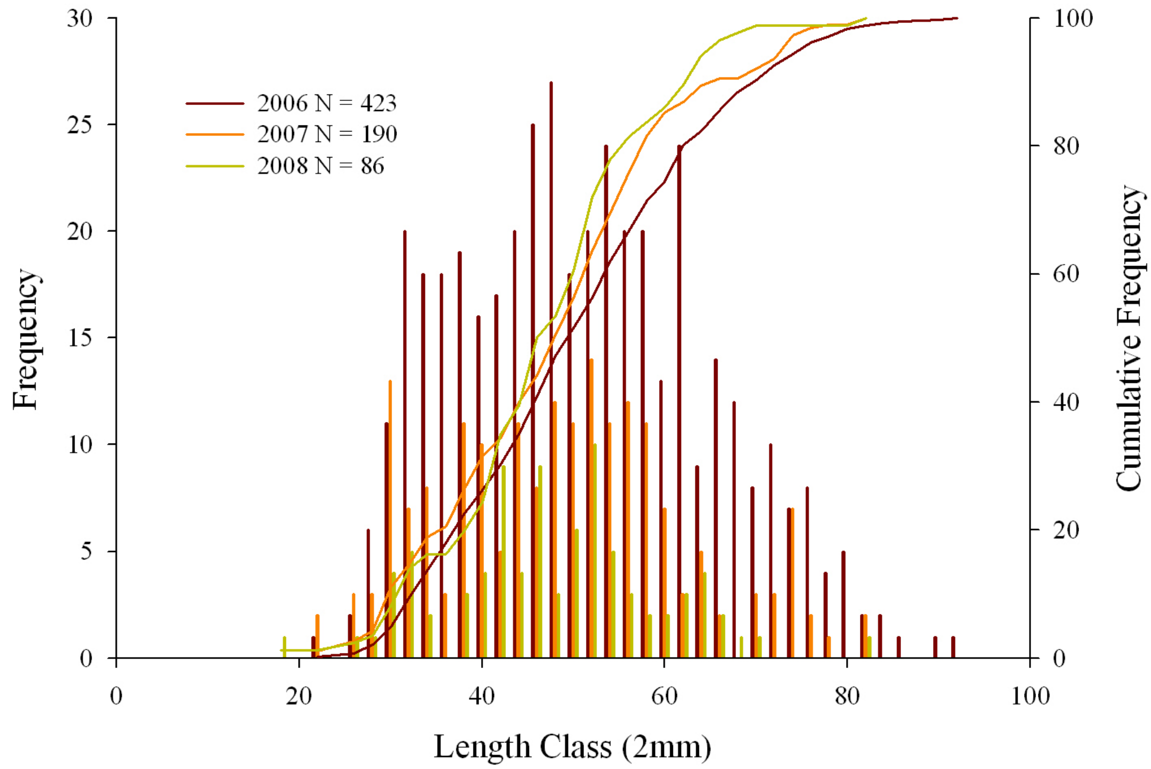


Figure III.3.13. Length frequency distributions and cumulative frequencies for measured red shiners (N) at California (NE) from 2006 - 2008.

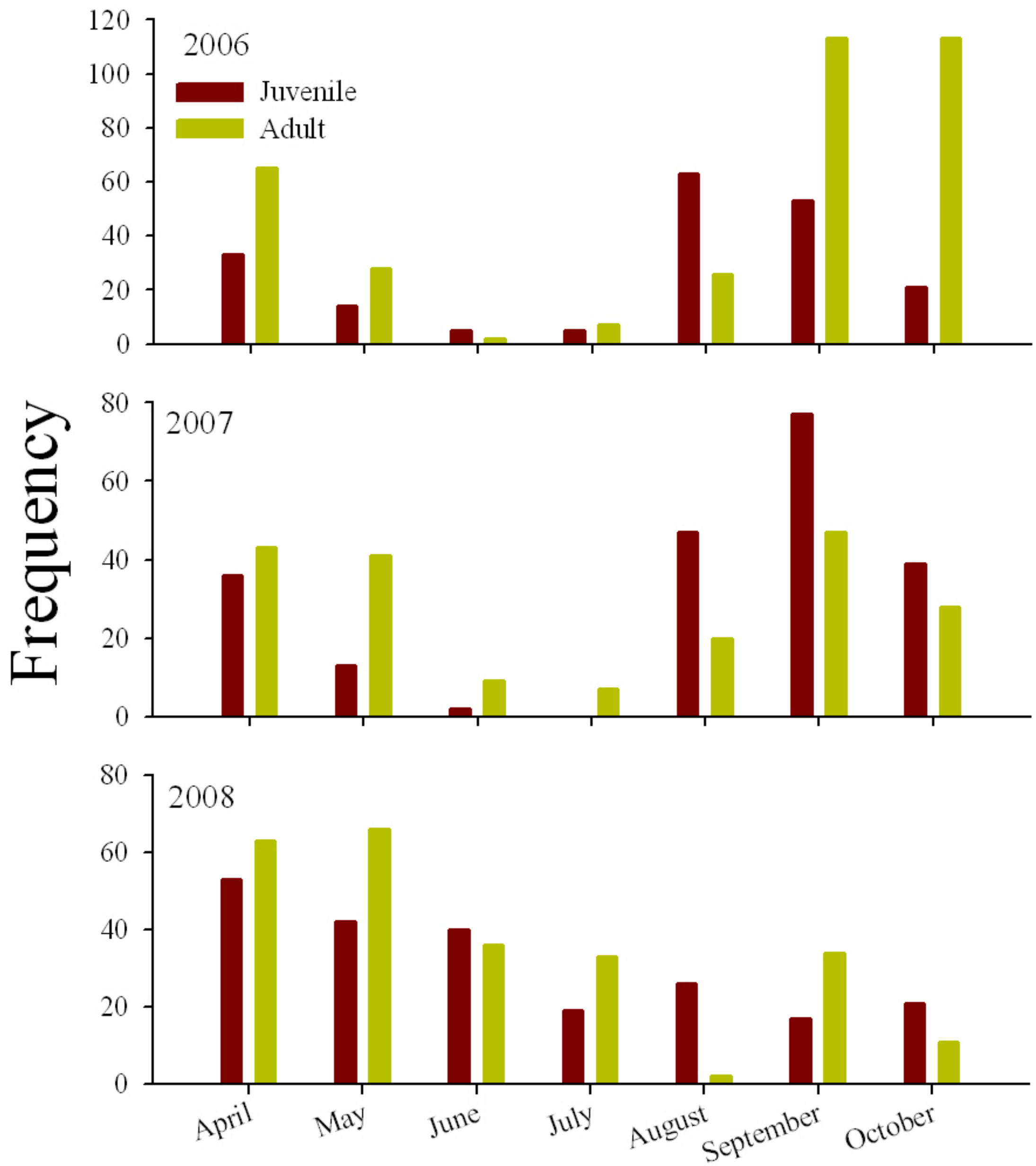


Figure III.3.14. Monthly frequency of juvenile (<64 mm) and adult (≥64 mm) emerald shiners caught at California (NE) from 2006 - 2008. Please note differences in scale of frequency.

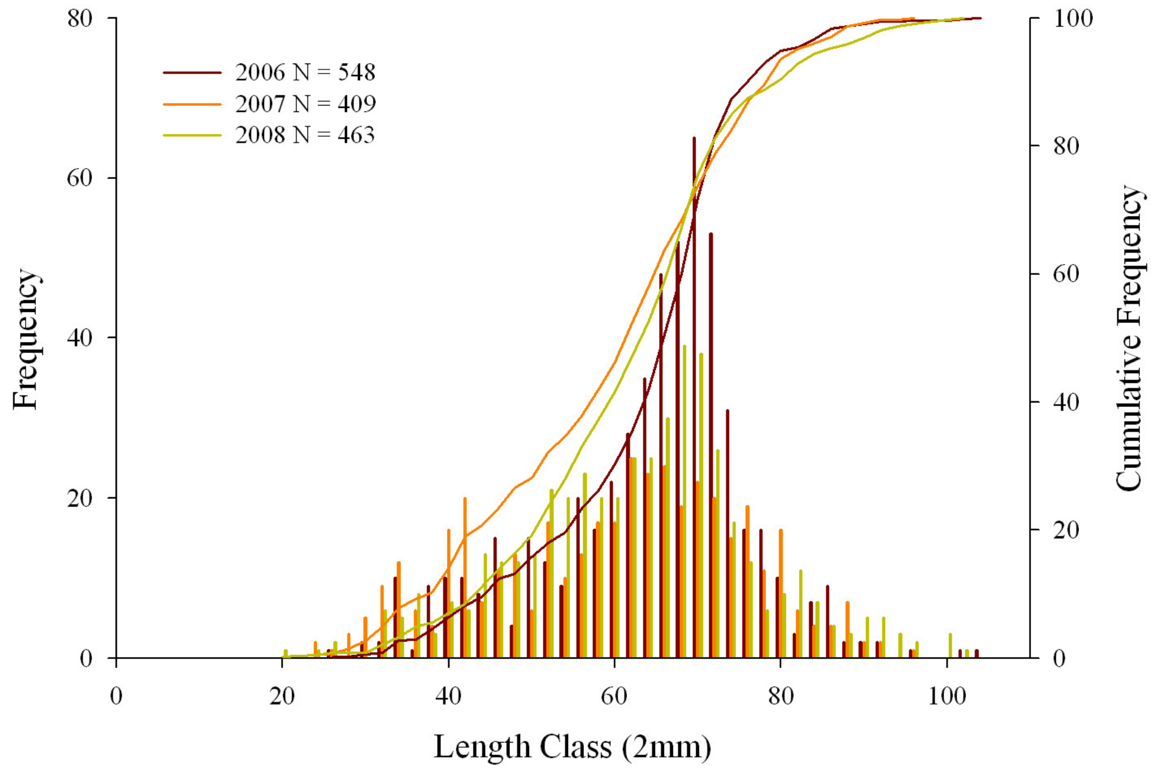


Figure III.3.15. Length frequency distributions and cumulative frequencies for measured emerald shiners (N) at California (NE) from 2006 - 2008.

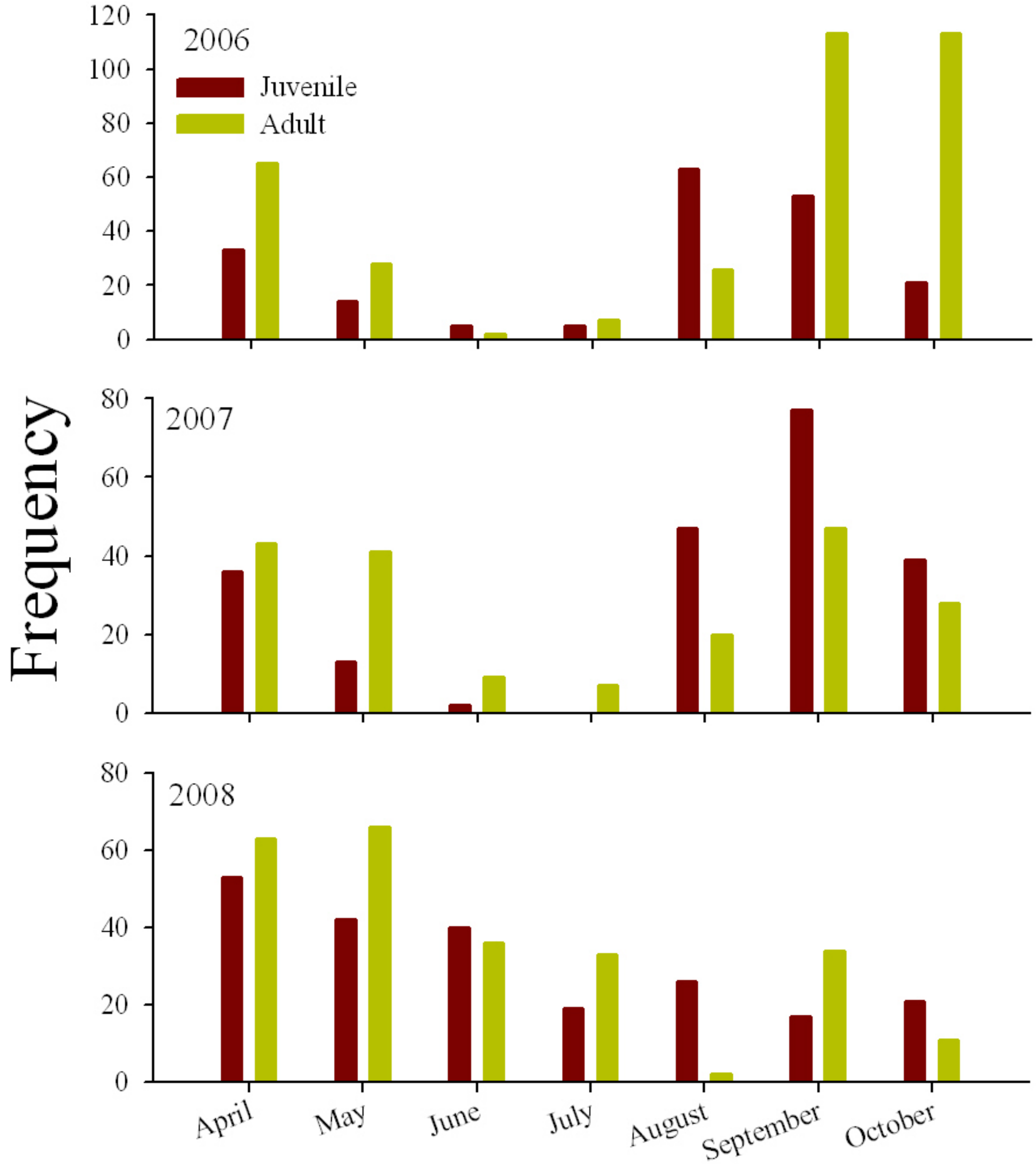


Figure III.3.16. Monthly frequency of juvenile (<51 mm) and adult (≥51 mm) river shiners caught at California (NE) from 2006 - 2008. Please note differences in scale of frequency.

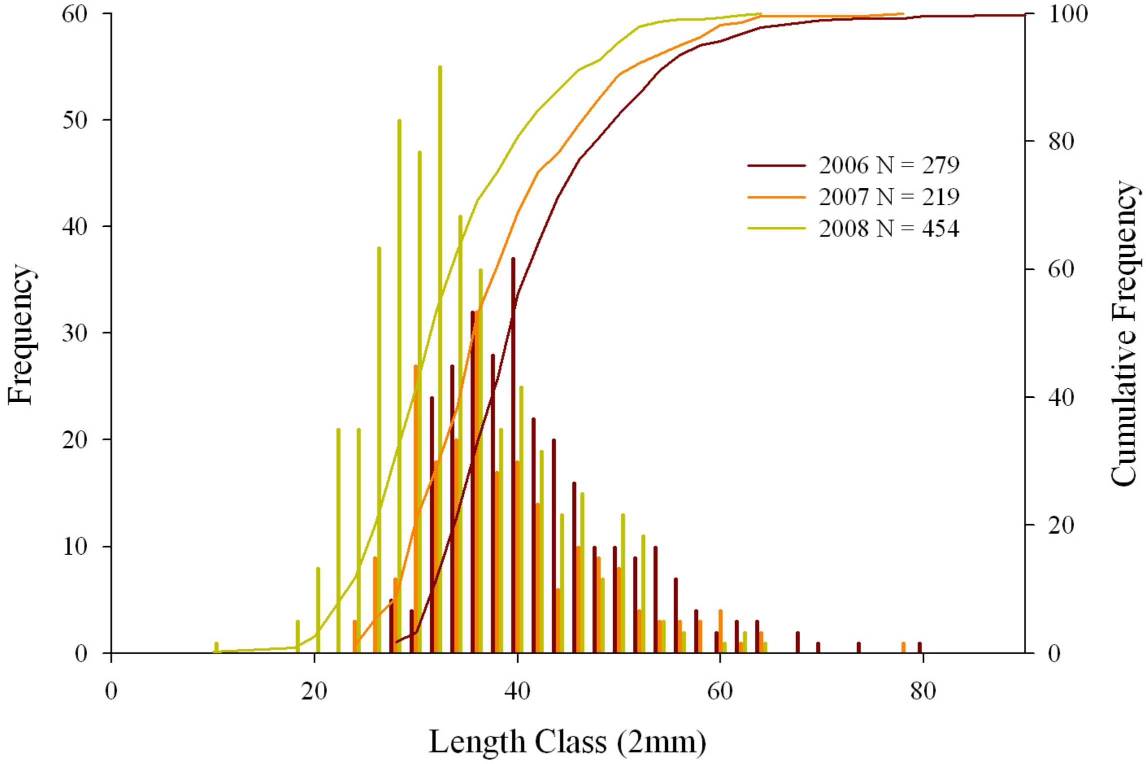


Figure III.3.17. Length frequency distributions and cumulative frequencies for measured river shiners (N) at California (NE) from 2006 - 2008.

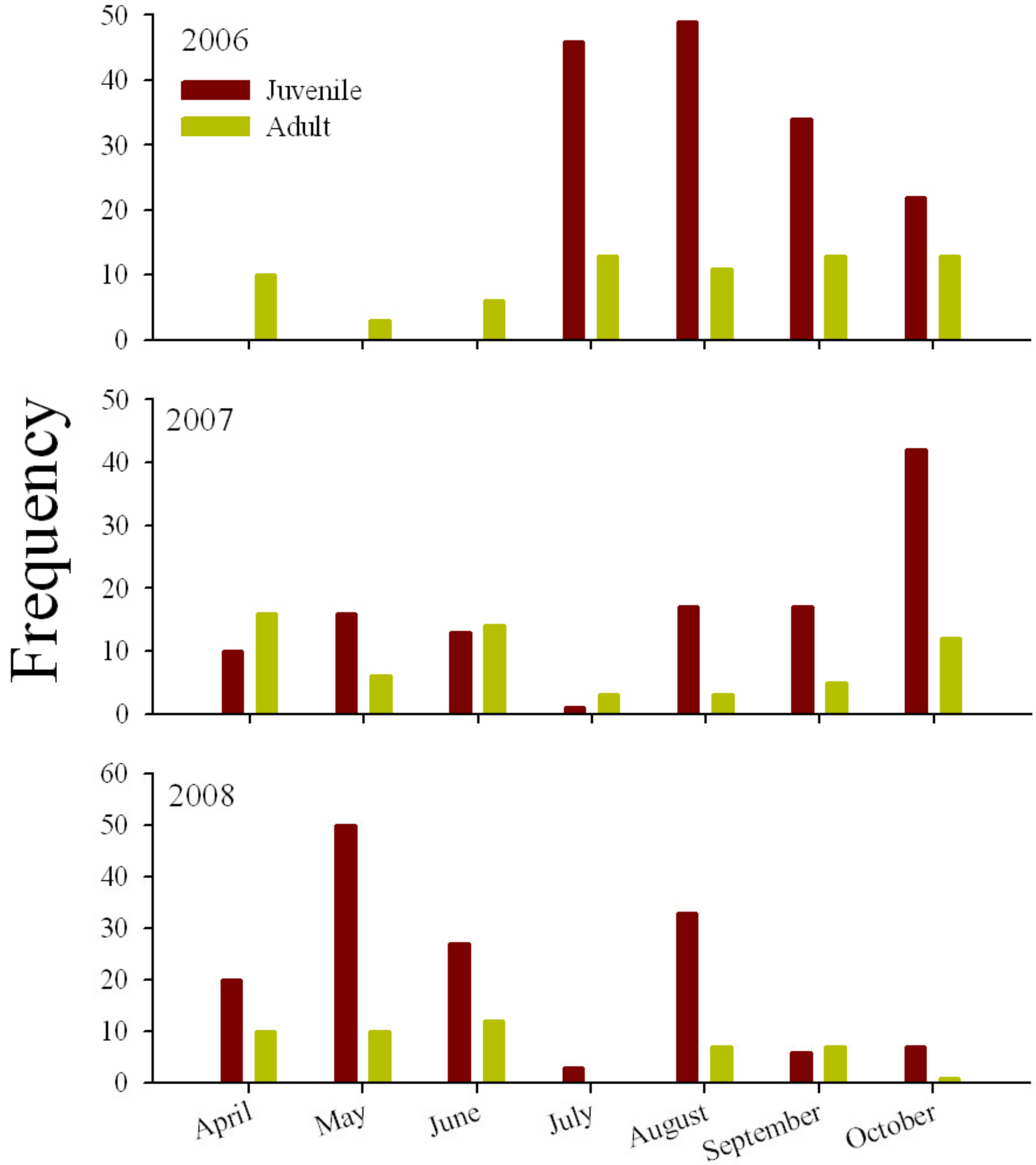


Figure III.3.18. Monthly frequency of juvenile (<43 mm) and adult (≥43 mm) sand shiners caught at California (NE) from 2006 - 2008. Please note differences in scale of frequency.

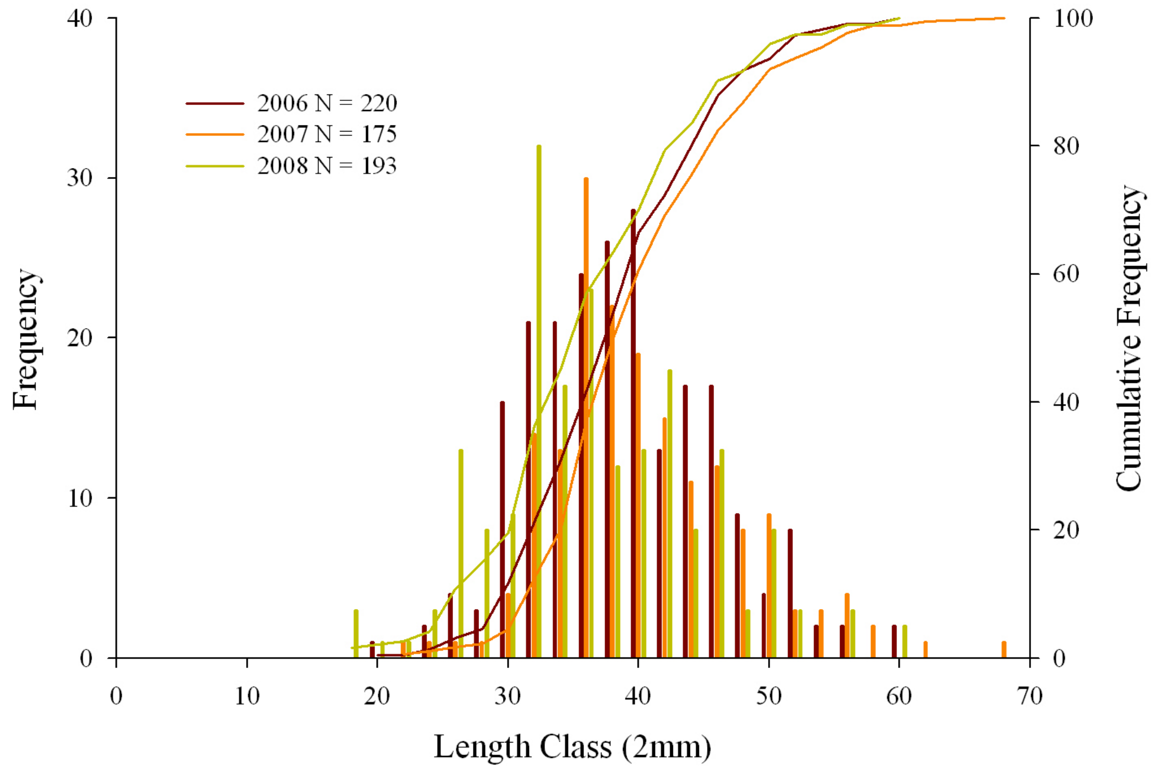


Figure III.3.19. Length frequency distributions and cumulative frequencies for measured sand shiners (N) at California (NE) from 2006 - 2008.

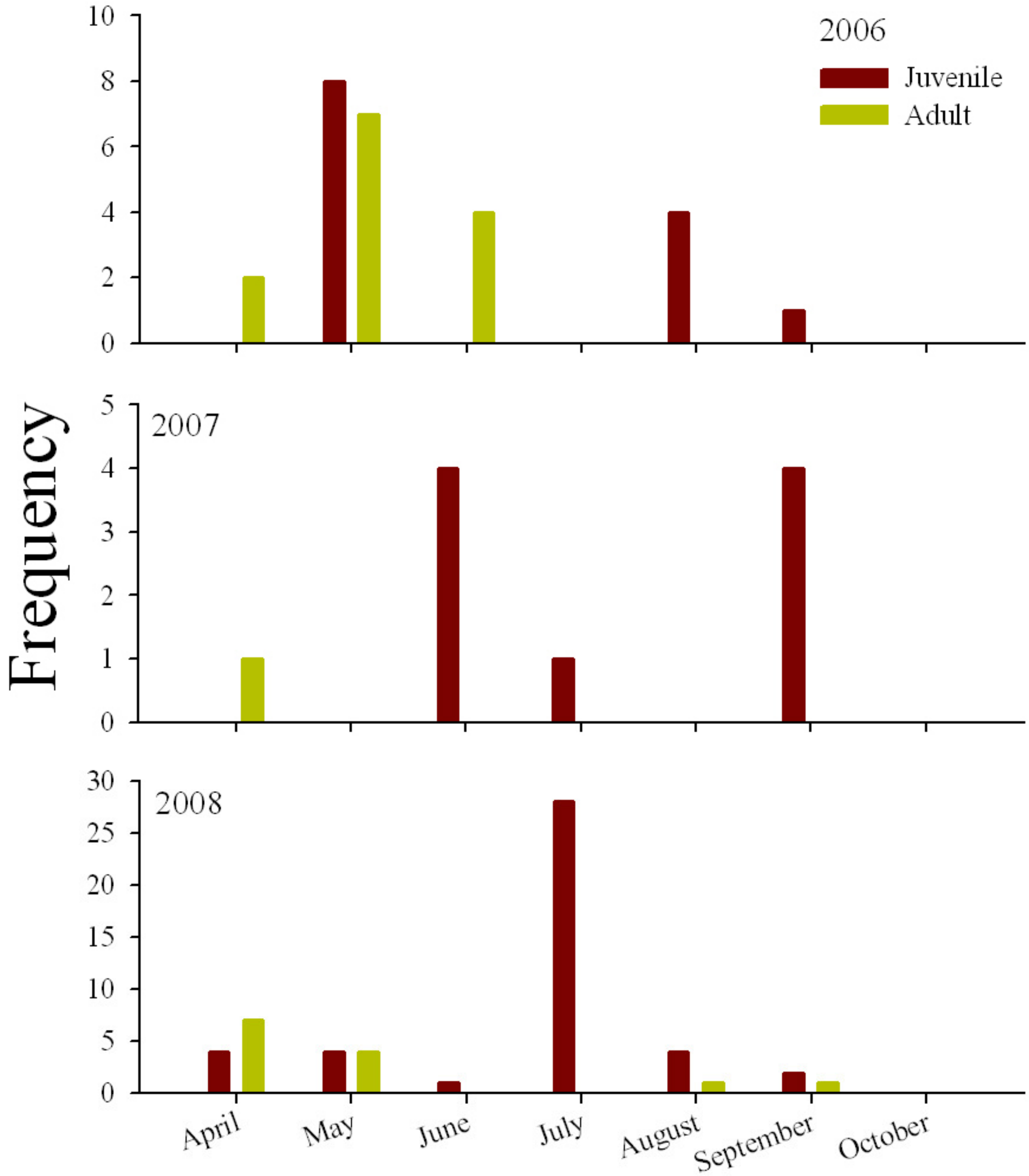


Figure III.3.20. Monthly frequency of juvenile (<41 mm) and adult (≥41 mm) fathead minnows caught at California (NE) from 2006 - 2008. Please note differences in scale of frequency.

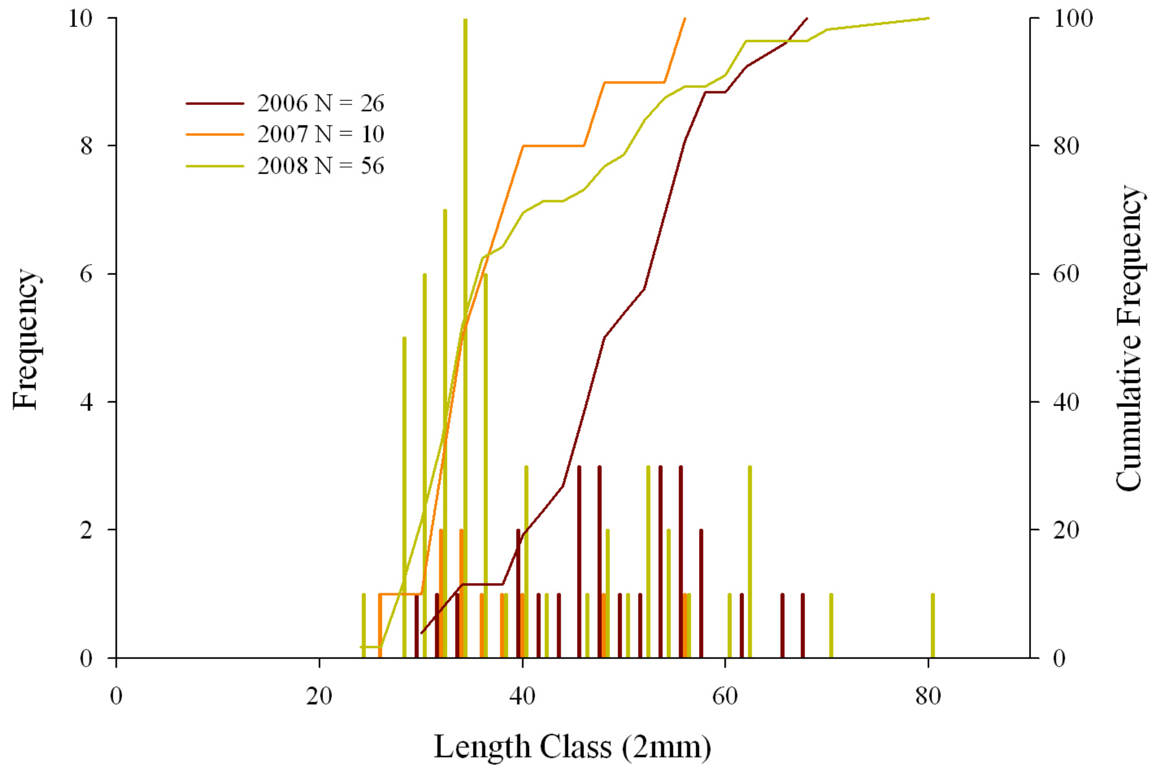


Figure III.3.21. Length frequency distributions and cumulative frequencies for measured fathead minnows (N) at California (NE) from 2006 - 2008.

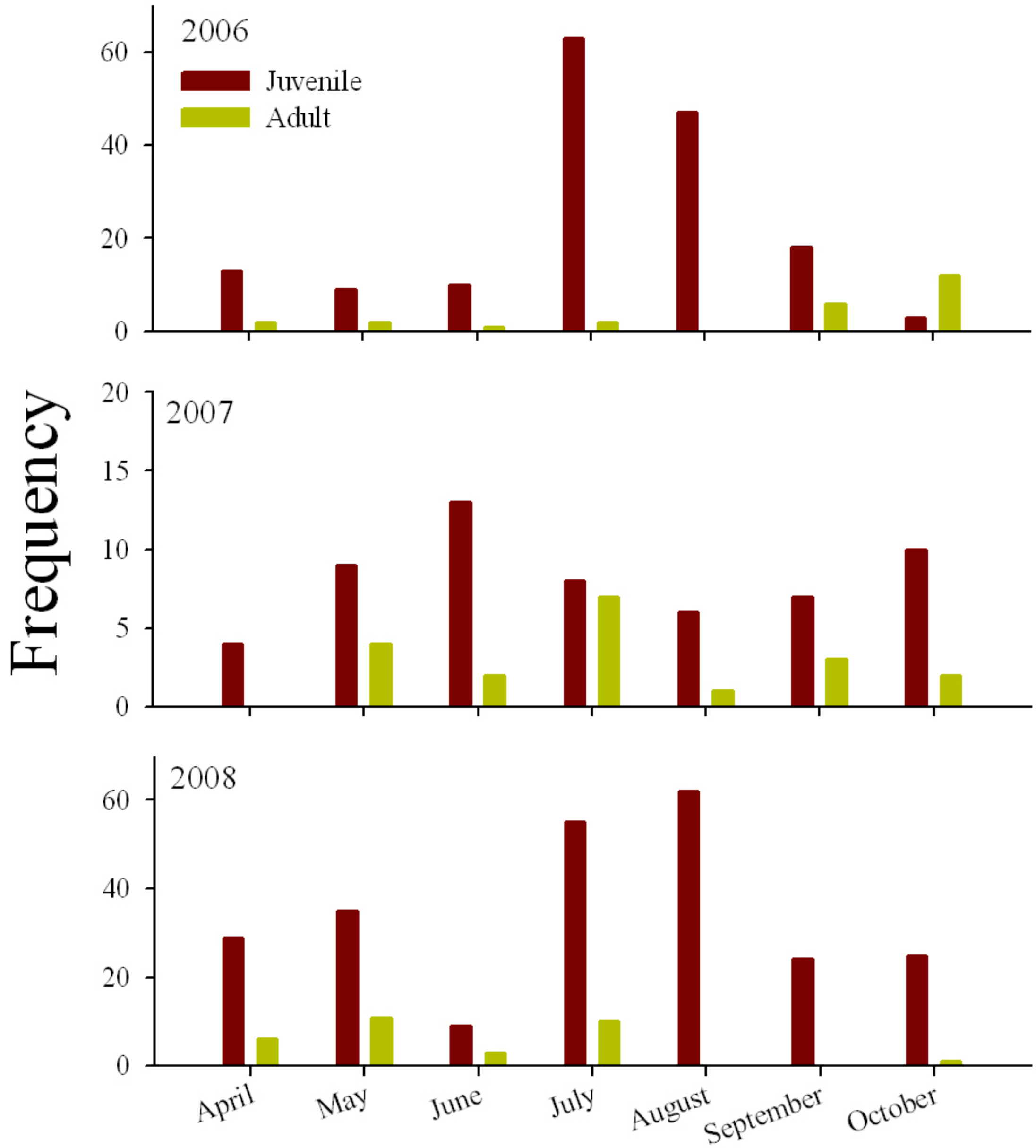


Figure III.3.22. Monthly frequency of juvenile (<305 mm) and adult (≥305 mm) river carpsuckers caught at California (NE) from 2006 - 2008. Please note differences in scale of frequency.

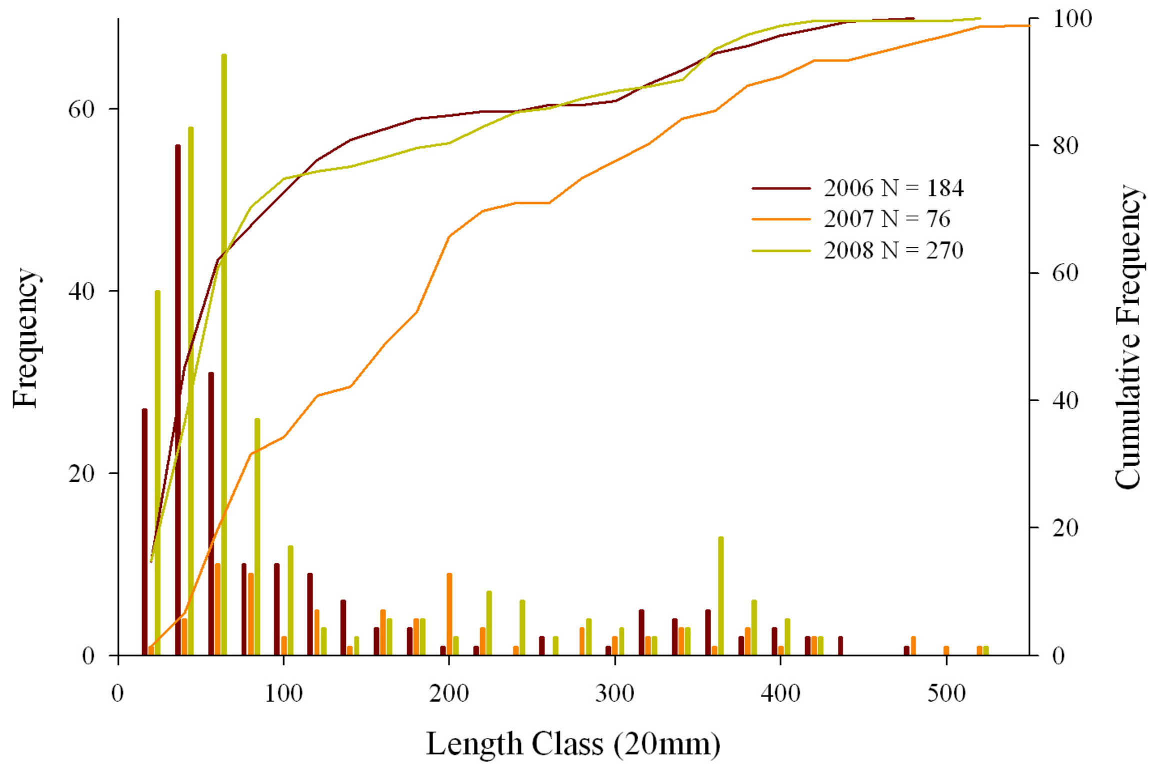


Figure III.3.23. Length frequency distributions and cumulative frequencies for measured river carpsuckers (N) at California (NE) from 2006 - 2008.

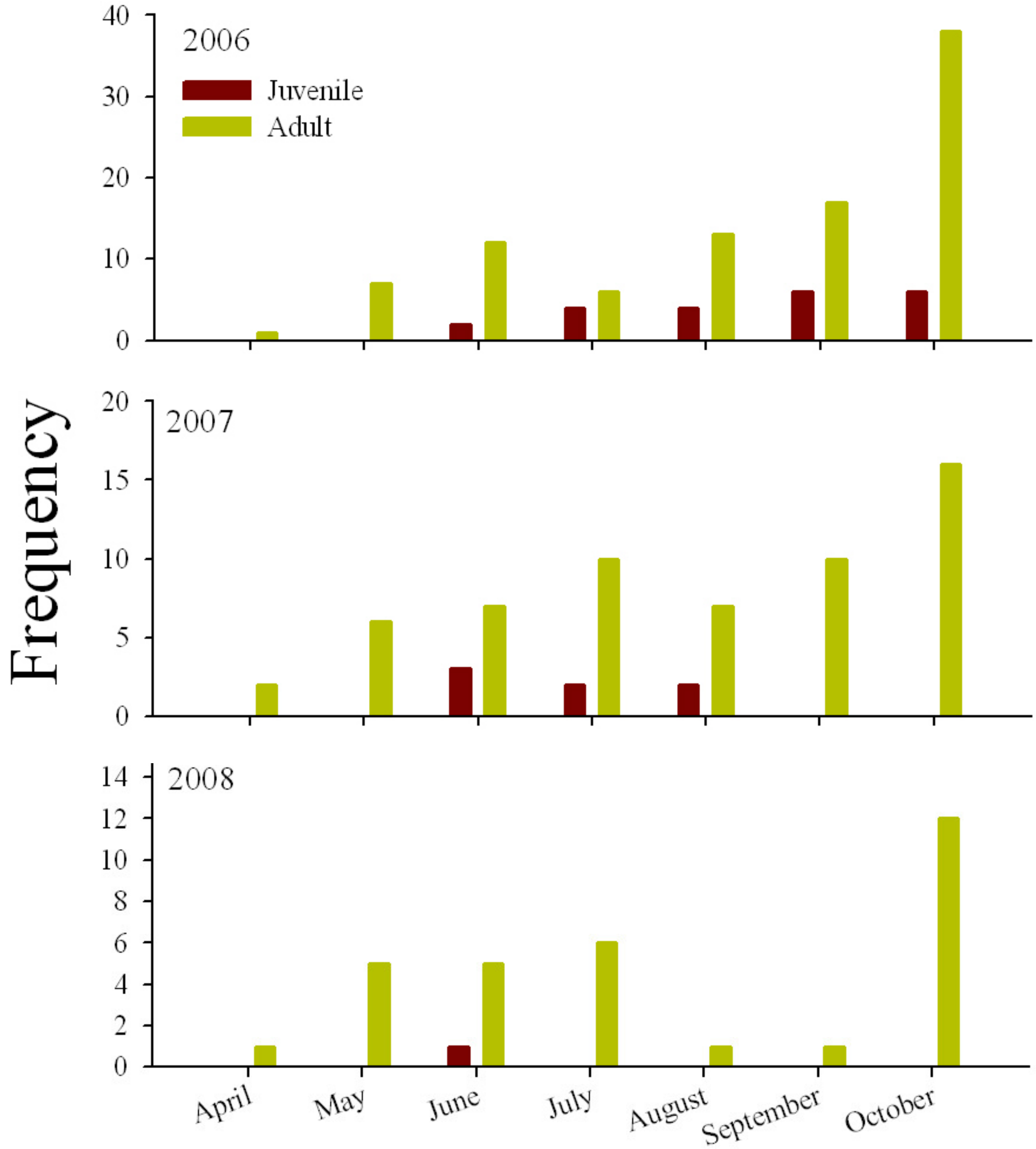


Figure III.3.24. Monthly frequency of juvenile (<508 mm) and adult (≥508 mm) blue suckers caught at California (NE) from 2006 - 2008. Please note differences in scale of frequency.

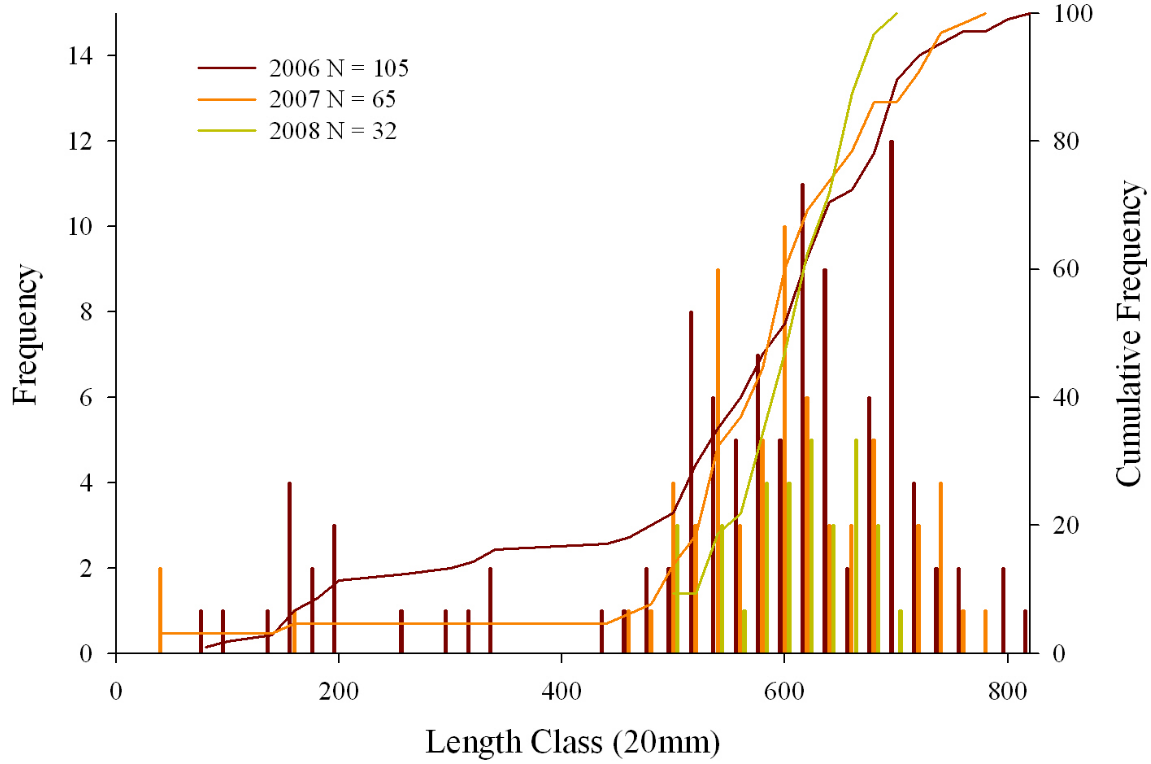


Figure III.3.25. Length frequency distributions and cumulative frequencies for measured blue suckers (N) at California (NE) from 2006 - 2008.

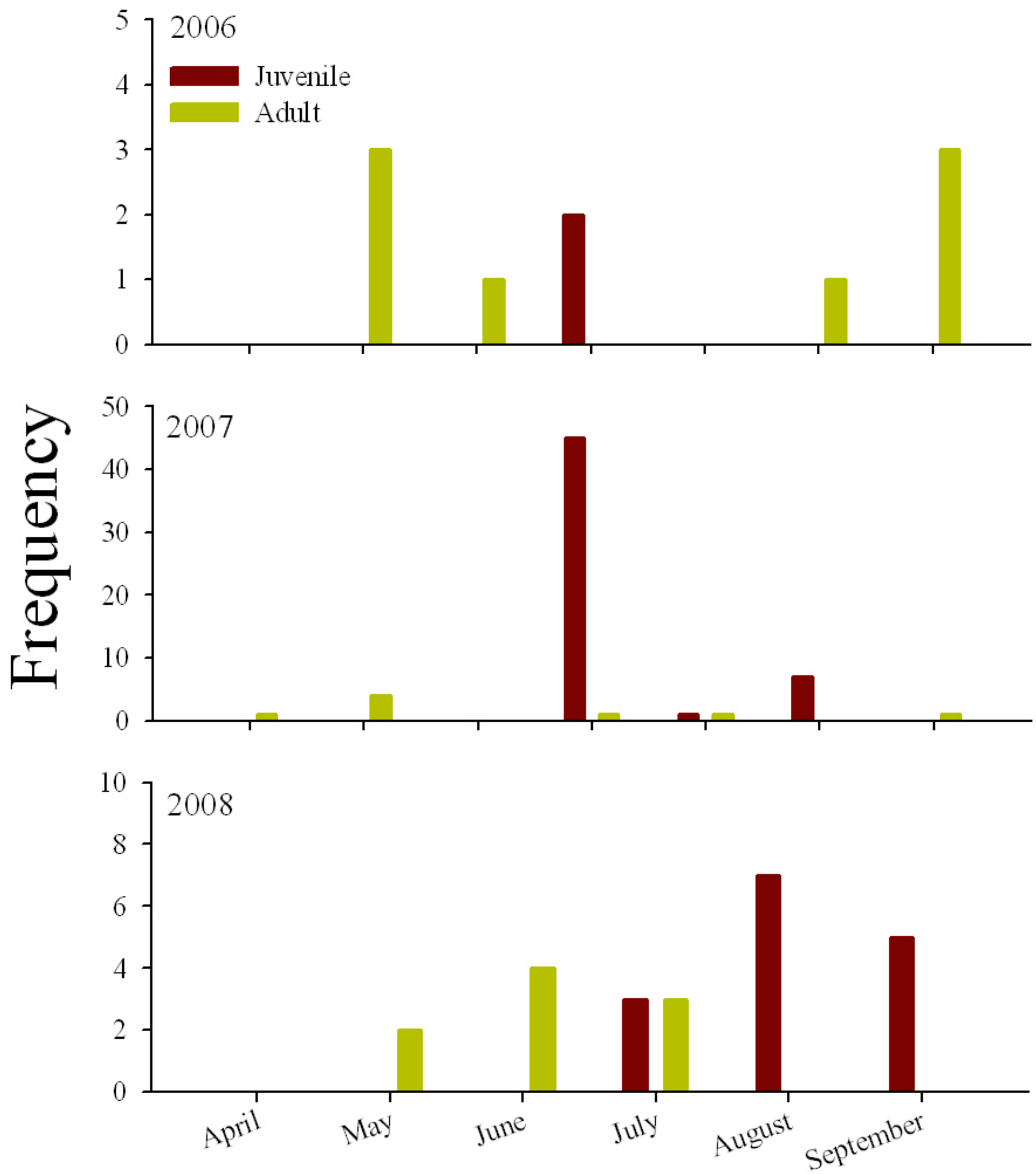


Figure III.3.26. Monthly frequency of juvenile (<381 mm) and adult (≥381 mm) smallmouth buffalo caught at California (NE) from 2006 - 2008. Please note differences in scale of frequency.

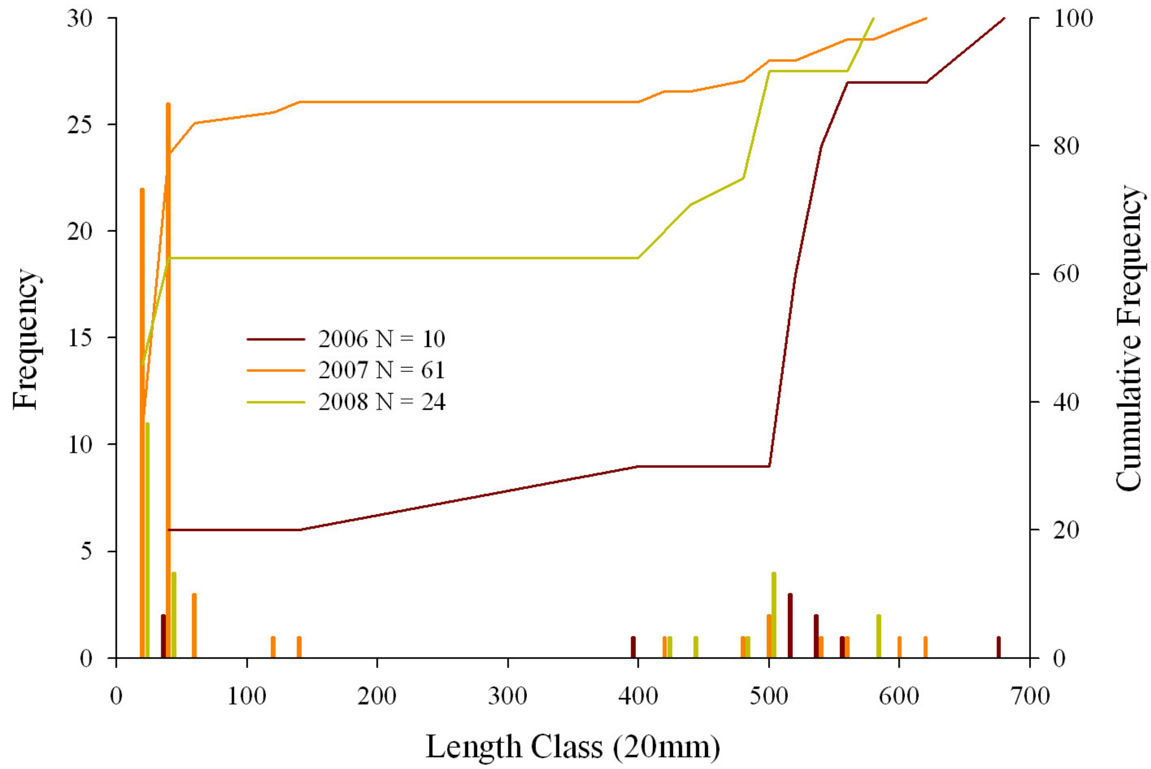


Figure III.3.27. Length frequency distributions and cumulative frequencies for measured smallmouth buffalo (N) at California (NE) from 2006 - 2008.

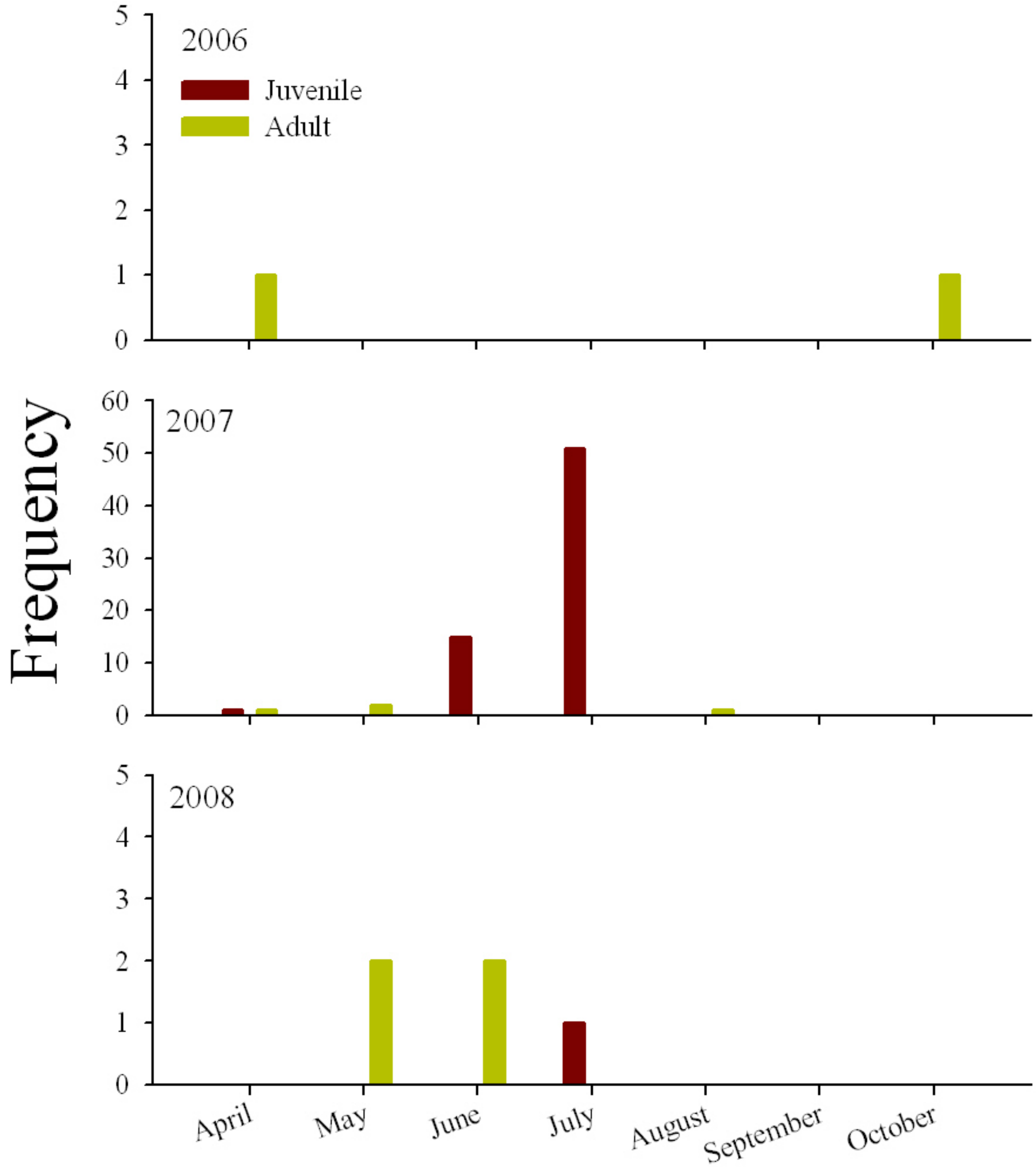


Figure III.3.28. Monthly frequency of juvenile (<381 mm) and adult (≥381 mm) bigmouth buffalo caught at California (NE) from 2006 - 2008. Please note differences in scale of frequency.

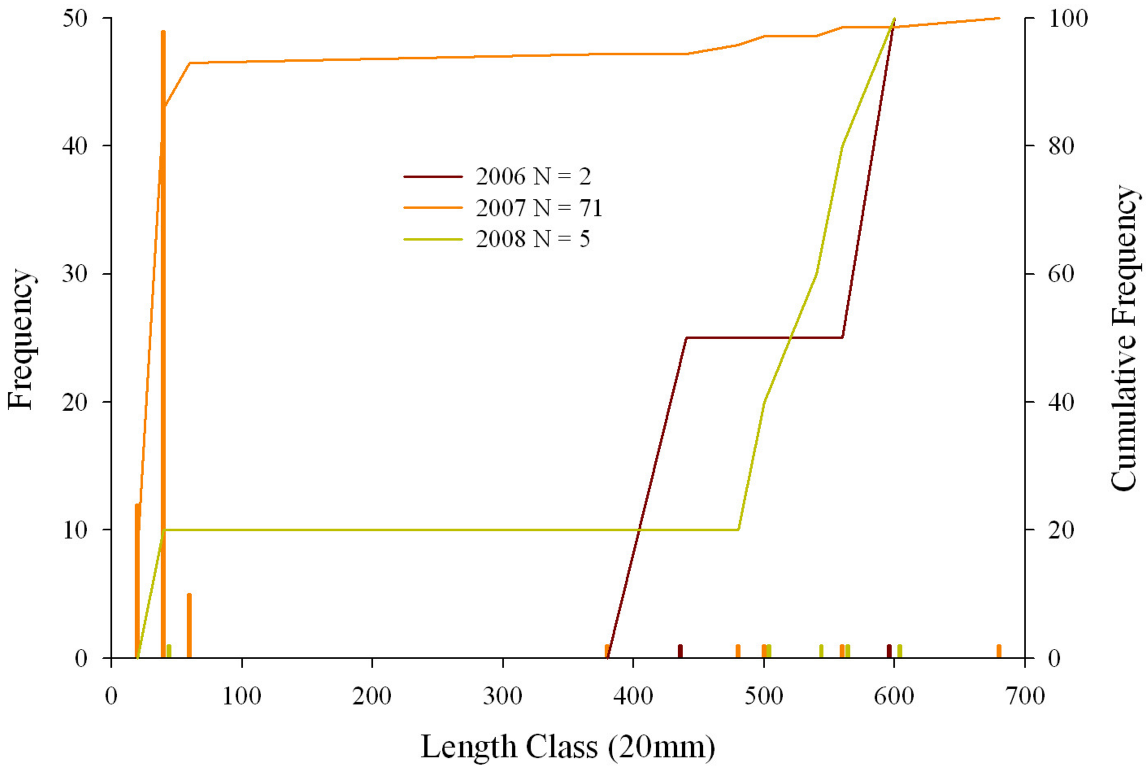


Figure III.3.29. Length frequency distributions and cumulative frequencies for measured bigmouth buffalo (N) at California (NE) from 2006 - 2008.

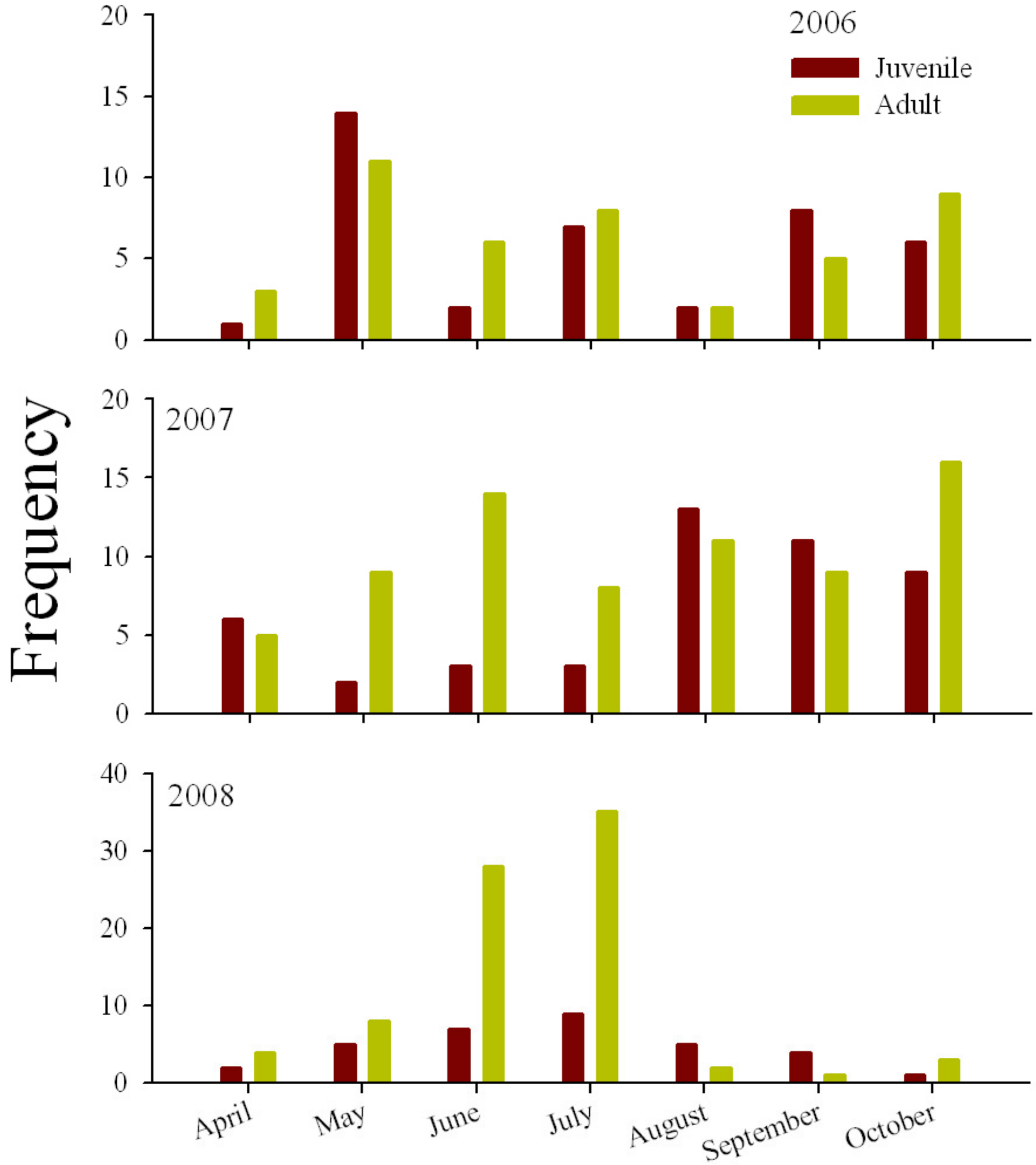


Figure III.3.30. Monthly frequency of juvenile (<229 mm) and adult (≥229 mm) shorthead redhorse caught at California (NE) from 2006 - 2008. Please note differences in scale of frequency.

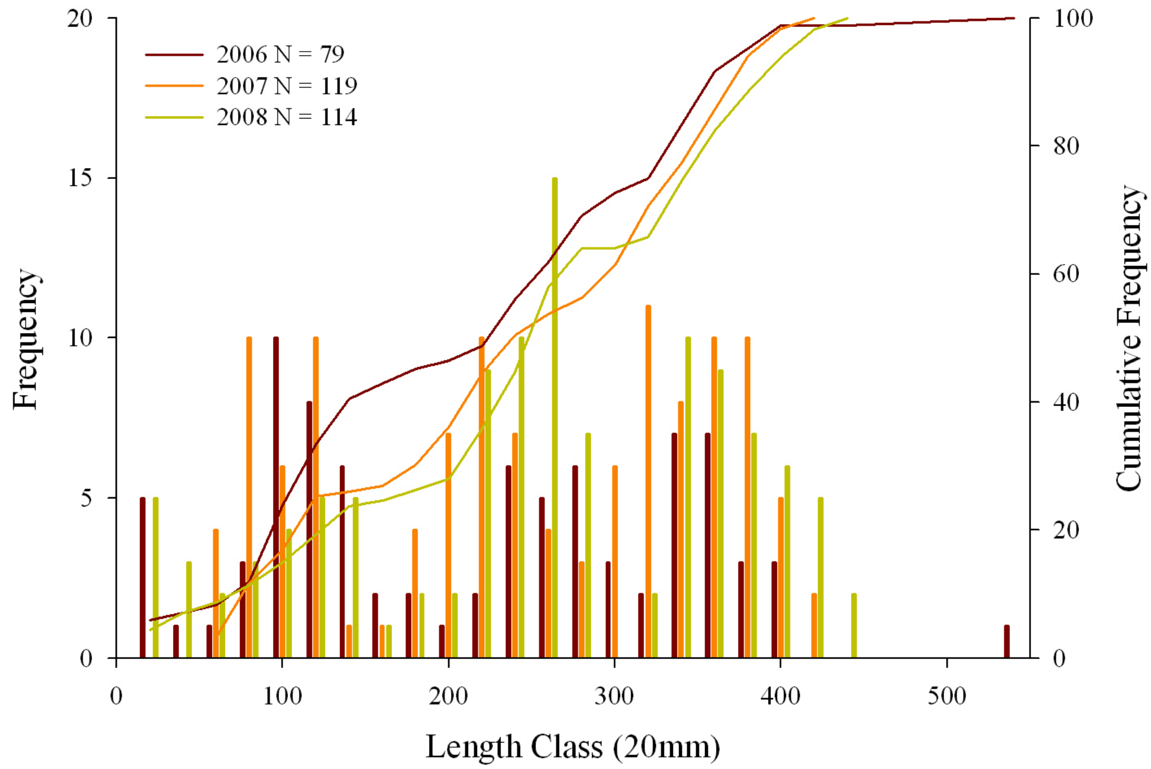


Figure III.3.31. Length frequency distributions and cumulative frequencies for measured shorthead redhorse (N) at California (NE) from 2006 - 2008.

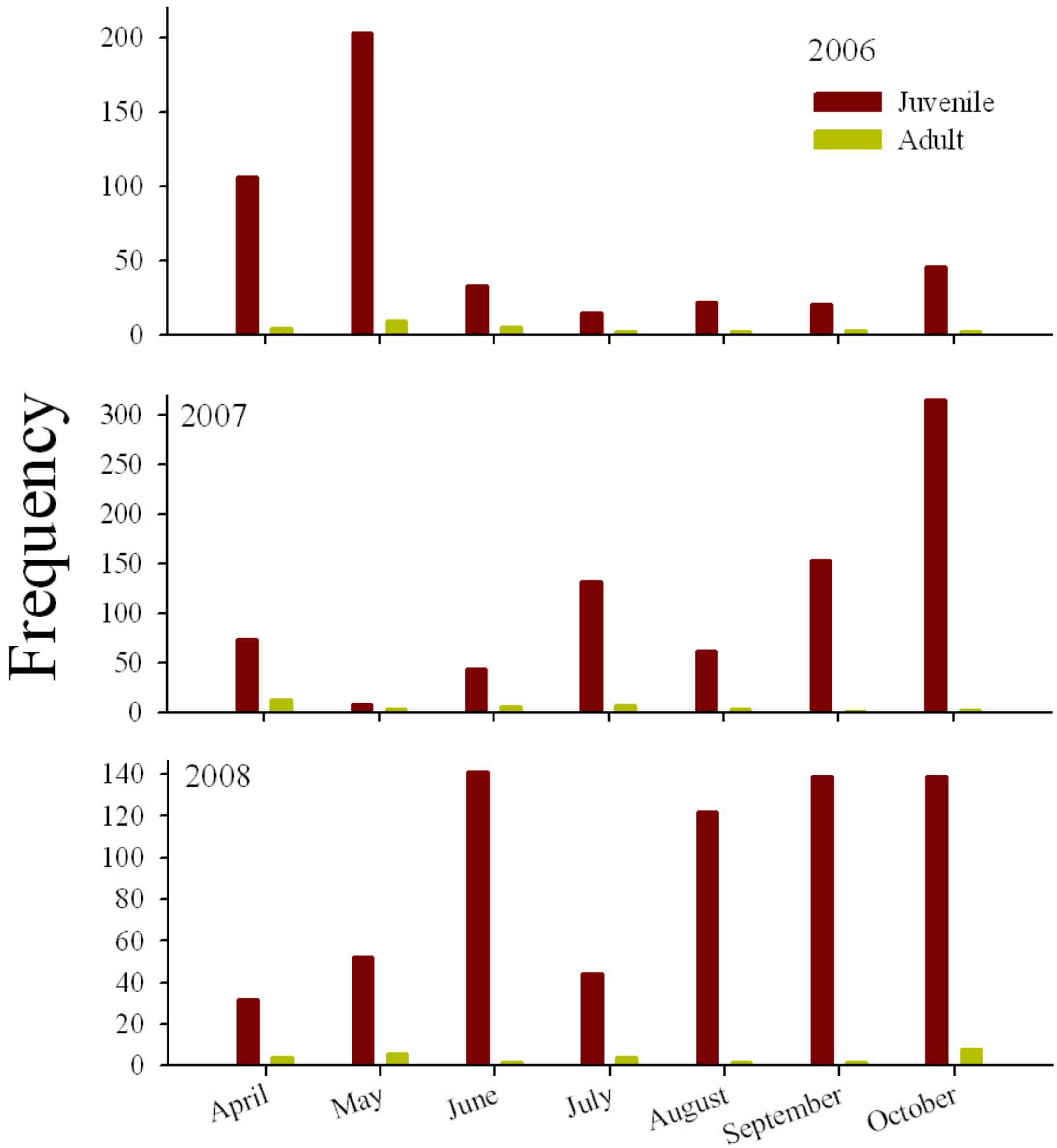


Figure III.3.32. Monthly frequency of juvenile (<305 mm) and adult (≥305 mm) channel catfish caught at California (NE) from 2006 - 2008. Please note differences in scale of frequency.

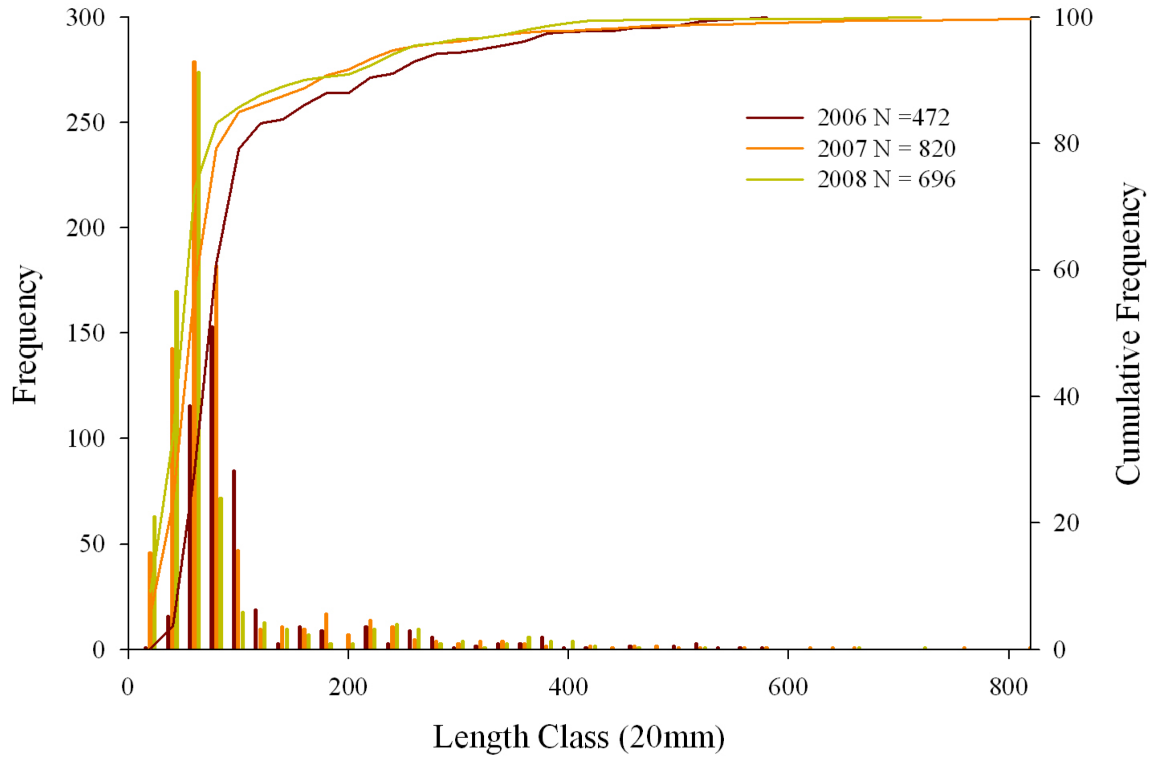


Figure III.3.33. Length frequency distributions and cumulative frequencies for measured channel catfish (N) at California (NE) from 2006 - 2008.

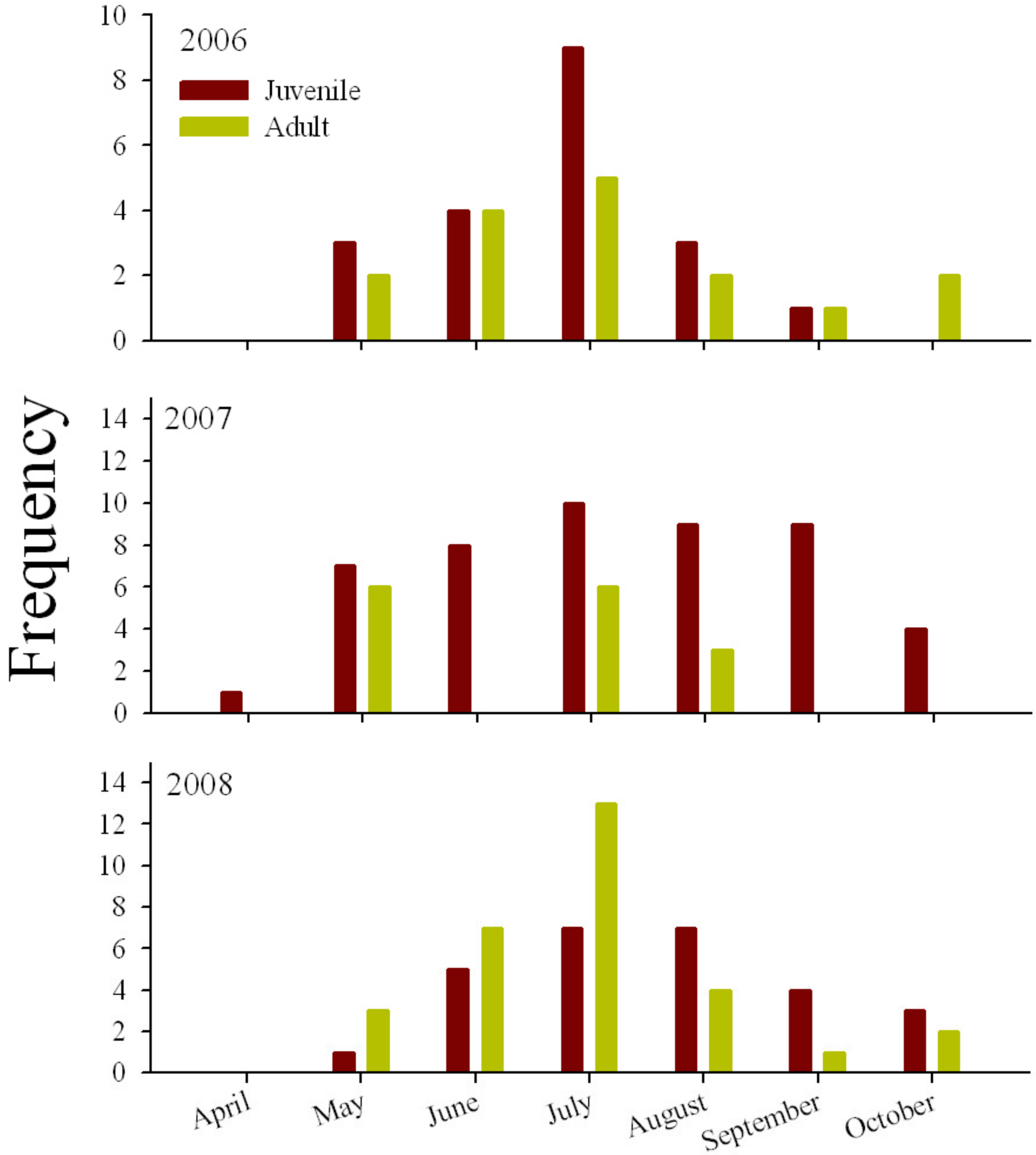


Figure III.3.34. Monthly frequency of juvenile (<381 mm) and adult (≥381 mm) flathead catfish caught at California (NE) from 2006 - 2008. Please note differences in scale of frequency.

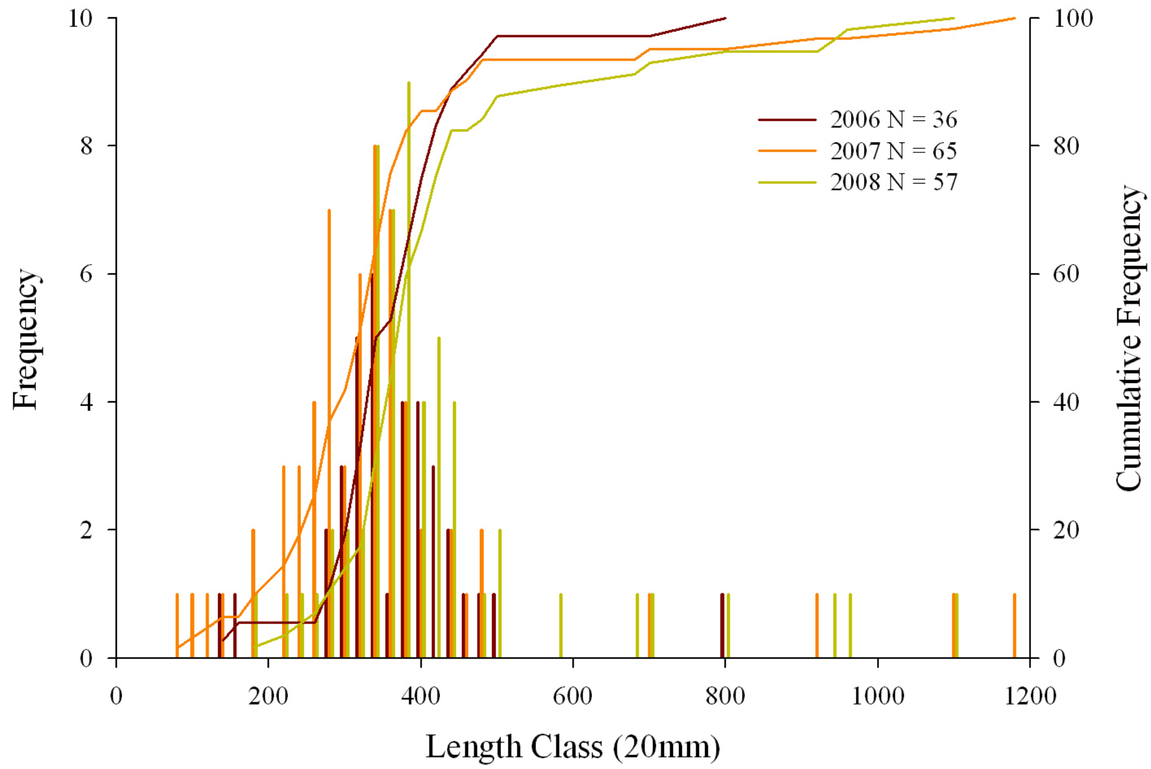


Figure III.3.35. Length frequency distributions and cumulative frequencies for measured flathead catfish (N) at California (NE) from 2006 - 2008.

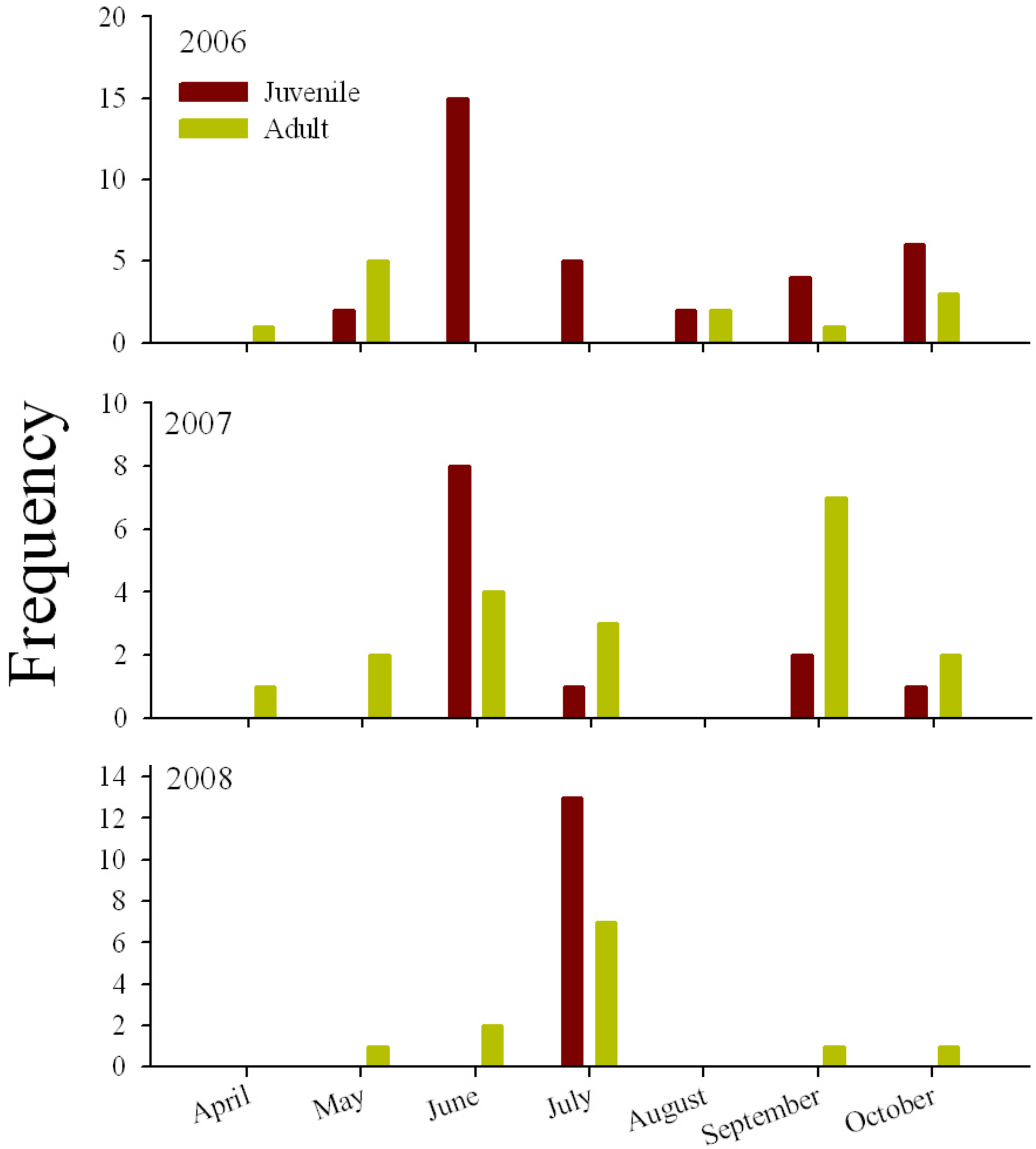


Figure III.3.36. Monthly frequency of juvenile (<229 mm) and adult (≥229 mm) sauger caught at California (NE) from 2006 - 2008. Please note differences in scale of frequency.

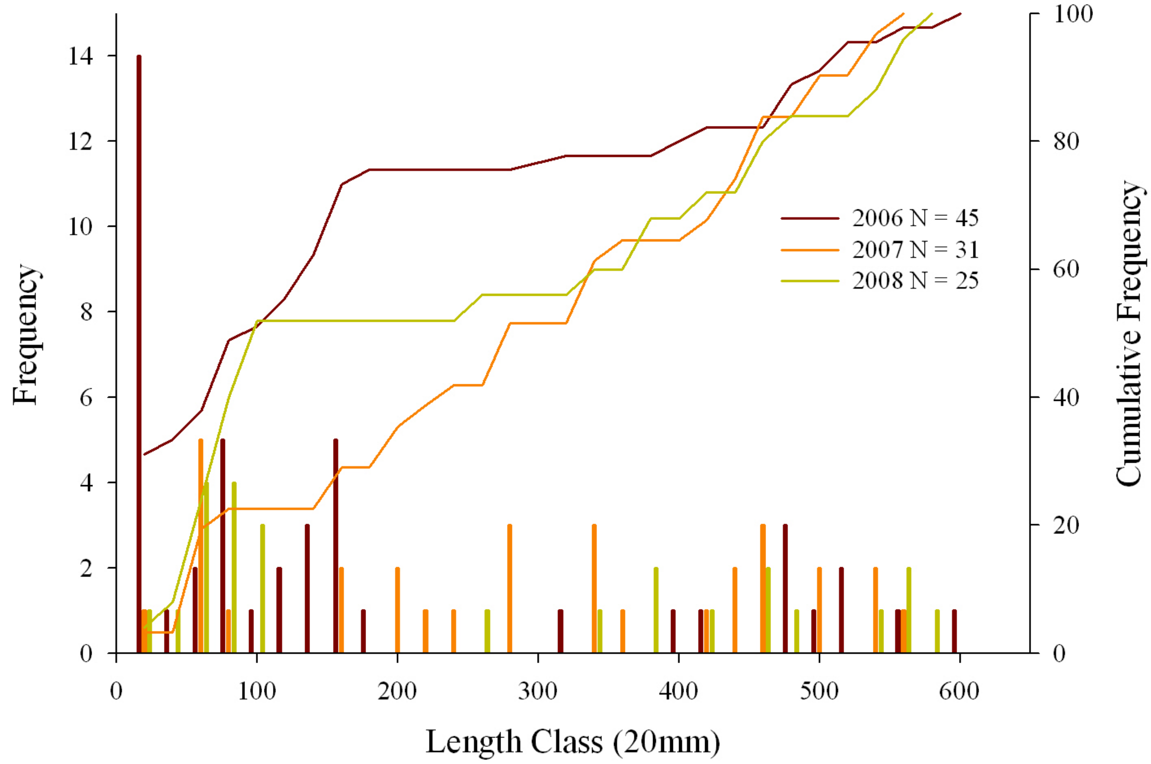


Figure III.3.37. Length frequency distributions and cumulative frequencies for measured sauger (N) at California (NE) from 2006 - 2008.

FINAL REPORT

Missouri River Fish and Wildlife Mitigation Program

Fish Community Monitoring and Habitat Assessment of Off-channel Mitigation Sites

Section III Biological Monitoring (Chapters 4-8)

Tieville-Decatur Bend[1], Louisville Bend[1], Tyson Island[1], California Cut-Off[1,2], Tobacco Island[2], Upper and Lower Hamburg Bend[2,3], Kansas Bend[2,3], Deroin Bend[2,3], Lisbon Bottom[4], North Overton Bottoms[4], Tadpole Island[4] and Tate Island[4]

Prepared for the U.S. Army Corps of Engineers

By:

[1]Van Sterner and Royce Bowman
[2]Brandon Eder, Sabrina Negus and Gerald Mestl
[3]Kasey Whiteman, Darrick Garner and Vince Travnichek
[4]Joshua Schloesser, Joseph McMullen and Tracy Hill

April 2009

[1]Van Sterner and Royce Bowman
Contract number –
Iowa Department of Natural Resources
607 10th St
Onawa, Iowa 51040

[2]Brandon Eder, Sabrina Negus and Gerald Mestl
Contract number – W9128F-05-P-0171
Nebraska Game and Parks Commission
Missouri River Program – Fisheries Division
2200 North 33rd Street
Lincoln, NE 68503

[3]Kasey Whiteman, Darrick Garner and Vince Travnichek
Contract number – W912DQ-07-D-0001
Missouri Department of Conservation
Nodaway Valley CA
21999 Hwy B
Maitland, MO 64466

[4]Joshua Schloesser, Joseph McMullen and Tracy Hill
Contract number - W59XQG83460940
U.S. Fish and Wildlife Service
Columbia National Fish & Wildlife Conservation Office
101 Park DeVille Drive, Suite A
Columbia, MO 65203-0057

Executive Summary

The Missouri River has been developed for flood control, commercial navigation, irrigation, fish and wildlife conservation, municipal water supply, water quality control and hydropower production through a series of congressional acts. However, prior to development, the lower Missouri River was characterized by a highly sinuous to braided channel with abundant log jams, sand bars, secondary channels and cut-off channels. Construction of the Bank Stabilization and Navigation Project (BSNP) converted the lower Missouri River into a narrow, self scouring channel. The active channel downstream of Sioux City, Iowa was as wide as 1.8 km before river modification, but is now confined to a 91.4 m channel. Total river and floodplain habitat altered or destroyed by the BSNP is estimated at 211,246 hectares.

The Missouri River Fish and Wildlife Mitigation Project (Mitigation Project) was established to restore fish and wildlife habitat lost by the construction, operation and maintenance of the BSNP. The Water Resources Development Act of 1986 authorized the United States Army Corps of Engineers (COE) to acquire and develop habitat on 12,100 hectares of non public lands and the development of 7,365 hectares of habitat on existing public lands to mitigate habitat losses. The Water Resources Development Act of 1999 authorized an additional 48,016 hectares to the program. The Final Supplemental Environmental Impact Statement (FSEIS) for the expanded Mitigation Project was issued in March of 2003, and it included a preferred alternative proposing the creation of additional shallow water habitat (defined as areas less than 1.5 m deep with a current velocity of less than 0.76 m/s). The preferred action in the FSEIS for the expanded

Mitigation Project included creation of 2,833 to 8,094 hectares of shallow water habitat (SWH).

In 2005, the Iowa Department of Natural Resources, Nebraska Game and Parks Commission (NGPC), Missouri Department of Conservation and U.S. Fish and Wildlife Service, Columbia Fisheries Resource Office (renamed to Columbia National Fish and Wildlife Conservation Office) were contracted by the COE to monitor and evaluate fish communities of select off-channel aquatic habitat sites that were constructed through the Mitigation Project. Additionally, the NGPC was contracted to collect physical habitat information from the secondary channels that were selected for biological monitoring in the upper channelized section above Kansas City. Sixteen sites selected for monitoring covered a range of aquatic habitats including backwaters and secondary channels with varying levels of engineering and development. Sites from upstream to downstream included Tieville-Decatur Bend (two backwaters), Louisville Bend (backwater), Tyson Island (backwater), California Bend (chute on the Nebraska bank and a chute with connected backwater on the Iowa bank), Tobacco Island (chute), Upper and Lower Hamburg Bends (one chute each), Kansas Bend (two small chutes, treated as one), Deroin Bend (chute), Lisbon Bottom (natural chute), North Overton Bottoms (chute), Tadpole Island (chute) and Tate Island (chute). The study was designed to include three field sampling seasons, but due to delays implementing contracts in 2005 another complete year of sampling was added. Thus, fish community monitoring and habitat assessment of off-channel mitigation sites began in April, 2006 and concluded in October, 2008. The objective of this project was to determine biological performance and functionality of chutes and backwaters and to compare chutes and backwaters in an effort to identify

designs most beneficial to native Missouri River fish species. Additionally, this project was designed to help determine if additional modifications are needed at existing mitigation sites, if existing designs are providing a range of habitats, if these habitats are of value to the biological diversity of the Missouri River and if these habitats are of specific value to species of concern or importance, such as pallid sturgeon.

Chutes and backwaters were sampled monthly from April thru October 2006 – 2008. Each chute was divided into 16 sampling segments, and eight segments were randomly chosen without replacement each month for each gear type used. The standard gears used for this project include; trammel nets, large and small otter trawls, push trawls, bag seines, electrofishing, large and small diameter hoop nets and mini-fyke nets. Additional gears used only in backwaters include experimental gill nets and large frame trap nets. Set lines and hook and line were used as wild gears (gears in addition to those required for standard sampling), these gears were used to target pallid sturgeon.

Chutes and backwaters provided habitat for different fish communities. Chutes were found to have more riverine species while these species were lacking in backwaters. Contiguous backwaters had greater species diversity and richness than those that were impounded. This connection to the river allowed species to access these areas that they otherwise could not have.

Chutes separated themselves out geographically. The available fish community in the main channel affected the fish community in the chutes. Chutes that were located farther up the Missouri River tended to benefit different species than those on the lower end of the river. Therefore, the benefit of a chute to the overall fish community probably depended on if the chute provided something different than what was already found in the

main channel. Also more diverse fish communities were found in the older constructed and natural chutes. This is probably due to the greater habitat diversity these chutes have developed compared to the younger chutes.

Overall, the fish communities in most sites were dominated by juveniles of most species. The habitat that has been developed via chutes and backwaters therefore are functioning as refuges for smaller fish. This is a valuable asset to the fish communities in the Missouri River. Currently little is known if these juveniles are spawned or drifted into the chutes and backwaters. It is also unknown if these juveniles are able to move out of the chutes and backwaters and into the main channel.

Predictive models indicated that chutes had different probabilities of presence for target species. In general, chutes that were relatively longer, wider, shallower and had greater sinuosity were more likely to have target species present. Conversely, chutes that were short, had low width to depth ratios and low sinuosity were less likely to have target species present.

Important predictor variables for species presence were year (85% of species models), water depth (80%), turbidity (65%), water temperature (60%), month (60%) and water velocity (50%). A year effect, likely related to river discharge, for many species supports the need for multiple year assessment programs. Water depth and, to some extent, water velocity were recognized as two variables that can be manipulated by river engineers and we found that the selected range of depths and velocities varied by species, which was expected with a diverse fish community. Many juvenile and small-bodied fishes utilized shallow water habitats (<1.0 m) over a broad range of water velocities (0.0-1.0 m/s), but large-bodied fishes tended to orient towards relatively deeper water. Therefore, creating

shallow water habitats with a range of velocities would likely benefit many juvenile native species.

Mitigation Project designs are providing a range of habitats. Backwater habitats are creating a habitat not currently available in most reaches of the Missouri River. Different backwater designs do not appear to be creating different habitats from each other; however, backwaters can only be used by riverine fish if they are connected to the river. All chutes are providing some habitat diversity, however, some chutes, including; California (NE), Upper Hamburg, Lisbon and Tate contain more habitat diversity, and therefore, are providing much needed habitat complexity to that reach of the river.

Backwater and chute habitats appear to be beneficial to the biodiversity of the Missouri River system; however, it is important to note that different reaches of the river have different needs. The highly modified middle Missouri River, from Sioux City, IA to Kansas City, MO has very little habitat diversity available within the main channel and many different habitats may be necessary to restore the healthy function of the river system. While the lower Missouri River has greater habitat diversity within the main channel, there are still habitats that may be limited, such as habitat diverse chutes (e.g., Lisbon or Tate) or backwaters that may be needed to restore a fully functioning river.

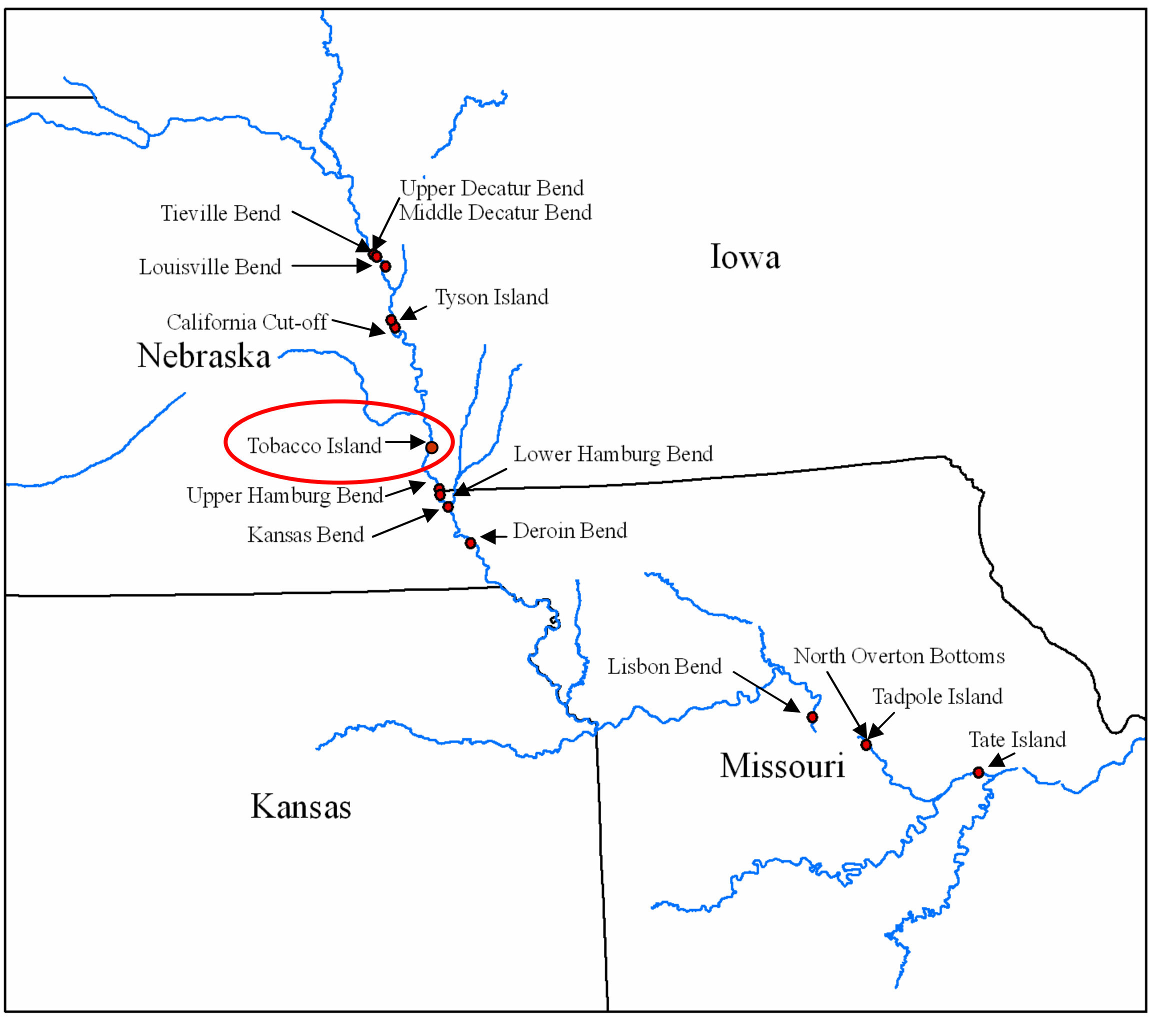
General Recommendations

- Promote natural side channel creation on suitable public lands. Allowing the river to naturally create side channel habitat may provide the most suitable habitat for riverine fish.
- We recommend constructing chutes that allow for floodplain connectivity, encourage natural river processes and maintain greater complexities of habitats (i.e. high width to depth ratios, diverse substrates, diverse depths, diverse velocities, shallow sandbars, woody debris and vegetated sandbars)
- Construction of longer chutes should receive higher priority than short chutes
- If a short chute must be built, build width, sinuosity and habitat diversity (deep scour holes, bar features and large woody debris).
- Promote channel movement through the use of structures or large woody debris.
- Soil type should be an important consideration in chute design, sites with clay or compacted soils need to be built to finished width or with wider pilot channels to hasten evolution.
- Slope banks when possible to allow large woody debris to accumulate in chutes rather than on high banks.
- Promote capture of large woody debris to increase habitat diversity and secondary productivity.
- Avoid designing chute entrances that may block upstream migration of fish (e.g., high sills or constricted entrances with high velocities and turbulence).
- Evaluate entrance structures to determine if certain life stages of some species (e.g., young of the year sturgeon) are being excluded from entering the chute.
- Avoid designs that promote sedimentation at chute entrances; keep entrances open so desired flows can be achieved.
- If a chute is intended to widen with increased main channel discharge, avoid designs where velocities decrease as main channel discharges increase such as at California (IA) and Kansas (upper).
- Use pilings, like those at Tate chute, instead of rip rap to create water control structures. Using pilings, as opposed to rock structures, may increase the permeability of water structures at varying levels of the water column, particularly the benthos.
- Include tie-channels and braids in chute designs to increase the amount of shallow, slow moving water at sites and provide more area that is in contact with the main channel.
- Design tie-channels, braids and connected backwaters to limit sedimentation.
- Tie channels can be used to direct flows to lower portions of the chute, allowing the upper portions to act more like backwater habitat.

- Create side channel habitat by building islands as opposed to digging channels, as was the case with Tate Island chute.
- Consider reopening existing, naturally formed side channels that are presently cut off from regular flows; there are at least 13 historic chutes that may be considered on the lower Missouri River.
- Contiguous dredged backwaters (such as Tyson Island and California (IA)) are recommended over impounded (disconnected) wetlands (such as Tieville, Louisville and Decatur). Contiguous sites provide connectivity that allows fish access to spawning and nursery habitat. Pumping did not provide accessible floodplain fish habitat.
- Backwaters should maintain a consistent, direct river connection. Open river connections are preferred over water control structures (culverts).
- Connectivity introduces sediment that will eventually fill backwaters. Siltation must be addressed by mechanical removal or improved backwater design.
- Backwaters of the upper channelized river become dewatered and isolated during winter discharges, backwaters should maintain adequate depth to prevent winter fish kills (approximately 3 m deep from December through February)
- Continued monitoring of chutes and backwaters would allow the determination of the rate at which the chute or backwater is evolving, the level of functionality that they can attain, value each chute has to different species, and how future manipulations affect the habitat and fish community.
- The variation in fish abundances seen among the three years of sampling indicates that a long term monitoring effort would be needed to detect population trends in chutes or backwaters. Furthermore, fish data from the chutes and backwaters should be compared to data from the main channel to determine how the chutes and backwaters are functioning with respect to main channel fish use.

TABLE OF CONTENTS

Section III
Chapter 4
Tobacco Island
Nebraska



LIST OF TABLES

LIST OF FIGURES

Figure Page

In total 58 identifiable species were caught at Tobacco Island from 2006 - 2008 (Table III.4.1). Annual species richness at Tobacco Island changed little during the three years of this study (Table III.4.2) however, monthly species richness did vary (Figure III.4.1). Species evenness did not differ among years, ranging from 0.74 - 0.75 on a scale from 0 - 1. Species diversity was similar among years, ranging from 2.8 - 3.0 on a scale of 0 - 5 (Shannon's Index) and 0.91 - 0.92 on a scale of 0 - 1 (Simpson's Index). Community assemblage was different in 2006, using Morisita's Index, with approximately 54% similarity to the other years (Table III.4.3). Community assemblage was not different between 2007 and 2008 (93% similar).

In total 24,829 fish were caught at Tobacco Island from 2006 - 2008 (Table III.4.1). In total 438 fish could not be identified past family; all unidentified fish were juveniles, usually young of the year. Species that represented greater than 1% of our total catch for this chute, excluding non-target species (e.g. gar, common carp; Table III.4.1) are presented here with analysis, including; proportion of juveniles to adults per species between years (z-test, Table III.4.4), species length frequency distributions between years (Kolmogorov-Smirnov test, Table III.4.5), species mean length between years (t-test, Table III.4.6) and analysis of species catch per unit effort (CPUE) by gear between years (Kruskal-Wallis test, Table III.4.7). Juveniles were determined by length (Table I.1.1). Additionally we have reported our monthly CPUE for all species (Table III.4.8). Two additional species of concern are noted, pallid sturgeon and blue suckers.

Pallid Sturgeon

No pallid sturgeon were sampled with standard gears during 2006.

Two pallid sturgeon were sampled with standard sampling gear and one pallid sturgeon was sampled with wild sampling gear at Tobacco Island during 2007. Pallid sturgeon were sampled with electrofishing* (n = 1), trammel nets (n = 1) and set-lines (n = 1, wild gear). Pallid sturgeon were caught in April (n = 1), July (n = 1) and August (n = 1). Mean fork length for pallid sturgeon was 409 mm and ranged from 375 to 467 mm.

Four pallid sturgeon were sampled with standard sampling gear during 2008. Pallid sturgeon were sampled with electrofishing* (n = 2), trammel nets (n = 1) and 4' hoop nets (n = 1). Pallid sturgeon were caught in April (n = 2), July (n = 1) and August (n = 1). Mean fork length for pallid sturgeon was 556 mm and ranged from 491 to 668 mm.

All pallid sturgeon caught at Tobacco Island were hatchery reared fish. One fish caught in 2007 was deemed a hybrid sturgeon based on morphological features.

* Note: pallid sturgeon are incidental catch while electrofishing, they are not a targeted species.

Shovelnose Sturgeon

In total 64 shovelnose sturgeon (75% juveniles, <540 mm) were sampled with standard sampling gears at Tobacco Island during 2006. Sturgeon were sampled with trammel nets (n = 7, CPUE = 0.84 fish per 125 ft of net drifted 100 m), 4' hoop nets (n = 9, CPUE = 0.20 fish per net night), 2' hoop nets (n = 1, CPUE = 0.02 fish per net night)

and electrofishing (n = 47, CPUE = 8.67 fish per hour). Monthly catches of shovelnose sturgeon ranged from 0 in July to 36 in April. Mean fork length for shovelnose sturgeon was 519 mm and ranged from 232 to 685 mm.

In total 286 shovelnose sturgeon (83% juveniles, <540 mm) were sampled with standard sampling gears at Tobacco Island during 2007, an additional 11 shovelnose sturgeon were caught using setlines, a wild gear, (CPUE = 0.34 fish per set night). Sturgeon were sampled with trammel nets (n = 155, CPUE = 6.44 fish per 125 ft of net drifted 100 m), 4' hoop nets (n = 28, CPUE = 0.53 fish per net night), 2' hoop nets (n = 8, CPUE = 0.14 fish per net night), electrofishing (n = 91, CPUE = 13.14 fish per hour) and push trawls (n = 4, CPUE = 0.13 fish per 100 m trawled). Monthly catches of shovelnose sturgeon ranged from 21 in July to 66 in September. Mean fork length for shovelnose sturgeon was 495 mm and ranged from 130 to 648 mm.

In total 529 shovelnose sturgeon (92% juveniles, <540 mm) were sampled with standard sampling gears at Tobacco Island during 2008 and four shovelnose sturgeon were caught using setlines (a wild gear; CPUE = 0.15 fish per set night). Sturgeon were sampled with trammel nets (n = 264, CPUE = 8.02 fish per 125 ft of net drifted 100 m), 4' hoop nets (n = 96, CPUE = 1.85 fish per net night), 2' hoop nets (n = 40, CPUE = 0.71 fish per net night), electrofishing (n = 128, CPUE = 22.03 fish per hour) and push trawsl (n = 1, CPUE = 0.03 fish per 100 m trawled). Monthly catches of shovelnose sturgeon ranged from 3 in October to 211 in July. Mean fork length for shovelnose sturgeon was 523 mm and ranged from 33 to 685 mm.

Shovelnose sturgeon caught at Tobacco Island significantly increased over the three years of this study (Linear Regression, $p = 0.0166$). We compared proportion of

juveniles between years using a z-test. The proportion of juvenile shovelnose sturgeon was significantly higher in 2008 (Figure III.4.2, Table III.4.4), the number of juveniles caught increased each year.

We compared length frequency distributions of shovelnose sturgeon between years using a Kolmogorov-Smirnov test. Shovelnose sturgeon length frequency distributions at Tobacco Island were different between 2007 and 2008, when fewer small fish were collected, with no difference between 2006 and 2007 or between 2006 and 2008 (Figure III.4.3, Table III.4.5). Mean length between years was compared using a t-test. Mean lengths were significantly different only between 2007 and 2008 (Table III.4.6), mean length was highest in 2008.

We compared shovelnose sturgeon CPUE between years using a Kruskal-Wallis test. Catch rates in 2' hoop nets were significantly lower in 2006 than 2008 (Table III.4.7), 2' hoop net catch rates decreased each year.

Goldeye

In total 122 goldeye (96% juveniles, <356 mm) were sampled with standard gears at Tobacco Island during 2006. Goldeye were sampled with electrofishing (n = 114, CPUE = 21.22 fish per hour), 4' hoop nets (n = 1, CPUE = 0.02 fish per net night) and trammel nets (n = 7, CPUE = 0.72 fish per 125 ft of net drifted 100 m). Monthly catches of goldeye ranged from 0 in July to 91 in April. Mean total length of goldeye sampled was 253 mm ranging from 75 to 394 mm.

In total 70 goldeye (79% juveniles, <356 mm) were sampled with standard gears at Tobacco Island during 2007. Goldeye were sampled with electrofishing (n = 52,

CPUE = 8.02 fish per hour), 4' hoop nets (n = 6, CPUE = 0.11 fish per net night) and trammel nets (n = 12, CPUE = 0.57 fish per 125 ft of net drifted 100 m). Monthly catches of goldeye ranged from 6 in June and July to 15 in April and September. Mean total length of goldeye sampled was 328 mm ranging from 135 to 592 mm.

In total 149 goldeye (95% juveniles, <356 mm) were sampled with standard gears at Tobacco Island during 2008. Goldeye were sampled with electrofishing (n = 110, CPUE = 19.72 fish per hour), 4' hoop nets (n = 7, CPUE = 0.13 fish per net night) and trammel nets (n = 32, CPUE = 1.10 fish per 125 ft of net drifted 100 m). Monthly catches of goldeye ranged from 1 in September to 71 in April. Mean total length of goldeye sampled was 296 mm ranging from 80 to 574 mm.

We compared proportion of juveniles between years using a z-test. The proportion of juvenile goldeye was significantly lower in 2007 (Figure III.4.4, Table III.4.4).

We compared length frequency distributions of goldeye from all years using a Kolmogorov-Smirnov test. Goldeye length frequency distributions at Tobacco Island were not different between years (Figure III.4.5, Table III.4.5). Mean length between years was compared using a t-test. Mean lengths were significantly different between all years (Table III.4.6); mean length was highest in 2007, lowest in 2006.

We compared goldeye CPUE between years using a Kruskal-Wallis test. No catch rates were significantly different between years (Table III.4.7).

Gizzard Shad

In total 362 gizzard shad (99% juveniles, <229 mm) were sampled with standard gears at Tobacco Island during 2006. Gizzard shad were sampled with bag seines (n = 18, CPUE = 1.33 fish per 100 m^2), electrofishing (n = 205, CPUE = 38.42 fish per hour), mini-fyke nets (n = 138, CPUE = 7.26 fish per net night) and trammel nets (n = 1, CPUE = 0.07 fish per 125 ft of net drifted 100 m). Monthly catches ranged from 5 in April to 197 in August. Mean total length of gizzard shad sampled was 140 mm ranging from 20 to 444 mm.

In total 299 gizzard shad (99% juveniles, <229 mm) were sampled with standard gears at Tobacco Island during 2007. Gizzard shad were sampled with electrofishing (n = 189, CPUE = 23.73 fish per hour), mini-fyke nets (n = 96, CPUE = 3.43 fish per net night), trammel nets (n = 1, CPUE = 0.06 fish per 125 ft of net drifted 100 m) and push trawls (n = 13, CPUE = 0.047 fish per 100 m trawled). Monthly catches ranged from 3 in May to 125 in July. Mean total length of gizzard shad sampled was 92 mm ranging from 28 to 400 mm.

In total 159 gizzard shad (99% juveniles, <229 mm) were sampled with standard gears at Tobacco Island during 2008. Gizzard shad were sampled with electrofishing (n = 5, CPUE = 0.86 fish per hour), mini-fyke nets (n = 80, CPUE = 2.96 fish per net night) and push trawls (n = 74, CPUE = 2.01 fish per 100 m trawled). Monthly catches ranged from 0 in May to 76 in August. Mean total length of gizzard shad sampled was 57 mm ranging from 23 to 303 mm.

We compared proportion of juveniles between years using a z-test. Gizzard shad life stage proportions were not significantly different between years (Figure III.4.6, Table III.4.4).

We compared length frequency distributions of gizzard shad from all years using a Kolmogorov-Smirnov test. Gizzard shad length frequency distributions at Tobacco Island were not different between years (Figure III.4.7, Table III.4.5). Mean length between years was compared using a t-test. Mean lengths were significantly different between all years, decreasing yearly (Table III.4.6).

We compared gizzard shad CPUE between years using a Kruskal-Wallis test. Electrofishing catch rates were significantly higher in 2006 than 2008, decreasing yearly (Table III.4.7).

Speckled Chub

One juvenile speckled chub was sampled with standard gears at Tobacco Island during 2006. The speckled chub was sampled with a mini-fyke net (CPUE = 0.05) in May and measured 34 mm.

In total 74 speckled chubs (89% juveniles, <40 mm) were sampled with standard gears at Tobacco Island during 2007. Speckled chubs were sampled with mini-fyke nets (n = 3, CPUE = 0.11 fish per net night) and push trawls (n = 71, CPUE = 2.40 fish per 100 m trawled). Monthly speckled chub catches ranged from 5 in July to 20 in October. Mean length of speckled chubs sampled was 34 mm ranging from 18 to 55 mm.

In total 67 speckled chubs (82% juveniles, <40 mm) were sampled with standard gears at Tobacco Island during 2008. Speckled chubs were sampled with mini-fyke nets (n = 1, CPUE = 0.04 fish per net night) and push trawls (n = 66, CPUE = 1.59 fish per 100 m trawled). Monthly speckled chub catches ranged from 0 in July through September to 42 in October. Mean length of speckled chubs sampled was 40 mm ranging from 24 to 54 mm.

We compared proportion of juveniles between years using a z-test. Speckled chub life stage proportions were not significantly different between years (Figure III.4.8, Table III.4.4).

We compared length frequency distributions of speckled chubs from all years using a Kolmogorov-Smirnov test. Speckled chub length frequency distributions at Tobacco Island were not different between years (Figure III.4.9, Table III.4.5). Mean length between years was compared using a t-test. Mean lengths were significantly different between 2007 and 2008 (Table III.4.6), mean length was highest in 2008.

We compared speckled chub CPUE between years using a Kruskal-Wallis test. There were no significant differences in catch rates (Table III.4.7).

Silver Chub

In total 104 silver chubs (98% juveniles, <89 mm) were sampled with standard gears at Tobacco Island during 2006. Silver chubs were sampled with bag seines (n = 24, CPUE = 1.77 fish per 100 m^2), electrofishing (n = 17, CPUE = 3.29 fish per hour) and mini-fyke nets (n = 63, CPUE = 3.32 fish per net night). Monthly catches of silver chubs ranged from 2 in May and September to 68 in August. Mean total length of silver chubs sampled was 57 mm ranging from 25 to 120 mm.

In total 255 silver chubs (99.6% juveniles, <89 mm) were sampled with standard gears at Tobacco Island during 2007. Silver chubs were sampled with electrofishing (n = 2, CPUE = 0.26 fish per hour), mini-fyke nets (n = 34, CPUE = 1.21 fish per net night) and push trawls (n = 219, CPUE = 7.22 fish per 100 m trawled). Monthly catches of

silver chubs ranged from 12 in April to 141 in May. Mean total length of silver chubs sampled was 42 mm ranging from 12 to 92 mm.

In total 368 silver chubs (99.7% juveniles, <89 mm) were sampled with standard gears at Tobacco Island during 2008. Silver chubs were sampled with electrofishing (n = 2, CPUE = 0.33 fish per hour), mini-fyke nets (n = 69, CPUE = 2.56 fish per net night) and push trawls (n = 297, CPUE = 7.83 fish per 100 m trawled). Monthly catches of silver chubs ranged from 3 in April to 169 in July. Mean total length of silver chubs sampled was 40 mm ranging from 15 to 120 mm.

We compared proportion of juveniles between years using a z-test. Silver chub life stage proportions were not significantly different between years (Figure III.4.10, Table III.4.4).

We compared length frequency distributions of silver chubs from all years using a Kolmogorov-Smirnov test. Silver chub length frequency distributions at Tobacco Island were not different between years (Figure III.4.11, Table III.4.5). Mean length between years was compared using a t-test. Mean length was significantly higher in 2006 (Table III.4.6), mean length decreased each year.

We compared silver chub CPUE between years using a Kruskal-Wallis test. Electrofishing catch rates significantly decreased between 2006 and 2007 (Table III.4.7).

Red Shiner

In total 167 red shiners (84% juveniles, <46 mm) were sampled with standard gears at Tobacco Island in 2006. Red shiners were sampled with bag seines (n = 16, CPUE = 1.39 fish per 100 m^2), electrofishing (n = 53, CPUE = 10.99 fish per hour) and mini-fyke nets (n = 98, CPUE = 5.16 fish per net night). Monthly red shiner catches at

Tobacco Island ranged from 3 in June to 50 in September. Mean total length for red shiners was 47 mm ranging from 28 to 82 mm.

In total 1,106 red shiners (98% juveniles, <46 mm) were sampled with standard gears at Tobacco Island in 2007. Red shiners were sampled with electrofishing (n = 25, CPUE = 4.38 fish per hour), mini-fyke nets (n = 1,017, CPUE = 36.32 fish per net night) and push trawls (n = 64, CPUE = 2.00 fish per 100 m trawled). Monthly red shiner catch rates ranged from 11 in August to 709 in October. Mean total length for red shiners was 44 mm ranging from 26 to 68 mm.

In total 355 red shiners (98% juveniles, <46 mm) were sampled with standard gears at Tobacco Island in 2008. Red shiners were sampled with electrofishing (n = 5, CPUE = 0.77 fish per hour), mini-fyke nets (n = 210, CPUE = 7.78 fish per net night) and push trawls (n = 140, CPUE = 3.24 fish per 100 m trawled). Monthly red shiner catch rates ranged from 5 in May to 66 in September. Mean total length for red shiners was 42 mm ranging from 22 to 71 mm.

We compared proportion of juveniles between years using a z-test. The proportion of juvenile red shiners was significantly lower in 2006 (Figure III.4.12, Table III.4.4).

We compared length frequency distributions of red shiners from all years using a Kolmogorov-Smirnov test. Red shiner length frequency distributions at Tobacco Island were not different between years (Figure III.4.13, Table III.4.5). Mean length between years was compared using a t-test. Mean length was significantly lower in 2008 (Table III.4.6); mean length decreased each year.

We compared red shiner CPUE between years using a Kruskal-Wallis test. There were no significant differences in catch rates between years (Table III.4.7).

Emerald Shiner

In total 704 emerald shiners (96% juveniles, <64 mm) were sampled with standard gears at Tobacco Island in 2006. Emerald shiners were sampled with bag seines (n = 24, CPUE = 1.9 fish per 100 m^2), electrofishing (n = 228, CPUE = 40.73 fish per hour) and mini-fyke nets (n = 452, CPUE = 23.79 fish per net night). Monthly catches ranged from 0 in June to 197 in August. Mean total length of emerald shiners was 58 mm ranging from 27 to 94 mm.

In total 818 emerald shiners (98% juveniles, <64 mm) were sampled with standard gears at Tobacco Island in 2007. Emerald shiners were sampled with electrofishing (n = 47, CPUE = 9.21 fish per hour), mini-fyke nets (n = 759, CPUE = 27.11 fish per net night) and push trawls (n = 12, CPUE = 0.44 fish per 100 m trawled). Monthly catch rates ranged from 2 in June to 461 in October. Mean total length of emerald shiners was 59 mm ranging from 19 to 93 mm.

In total 588 emerald shiners (98% juveniles, <64 mm) were sampled with standard gears at Tobacco Island in 2008. Emerald shiners were sampled with electrofishing (n = 36, CPUE = 5.81 fish per hour), mini-fyke nets (n = 277, CPUE = 12.04 fish per net night) and push trawls (n = 275, CPUE = 7.78 fish per 100 m trawled). Monthly catch rates ranged from 16 in June to 92 in April and October. Mean total length for emerald shiners was 54 mm ranging from 15 to 113 mm.

We compared proportion of juveniles between years using a z-test. Emerald shiner life stage proportions were not significantly different between years (Figure III.4.14, Table III.4.4).

We compared length frequency distributions of emerald shiners from all years using a Kolmogorov-Smirnov test. Emerald shiner length frequency distributions at Tobacco Island were not different between years (Figure III.4.15, Table III.4.5). Mean length between years was compared using a t-test. Mean length was significantly lower in 2008 (Table III.4.6).

We compared emerald shiner CPUE between years using a Kruskal-Wallis test. Emerald shiner push trawl catch rates were significantly higher in 2008 (Table III.4.7).

River Shiner

In total 220 river shiners (95% juveniles, <51 mm) were sampled with standard gears at Tobacco Island during 2006. River shiners were sampled with bag seines (n = 7, CPUE = 0.56 fish per 100 m^2), electrofishing (n = 25, CPUE = 5.65 fish per hour) and mini-fyke nets (n = 188, CPUE = 9.89 fish per net night). Monthly catches ranged from 0 in April and May to 68 in October. Mean total length of river shiners was 39 mm ranging from 18 to 77 mm.

In total 4,019 river shiners (99.98% juveniles, <51 mm) were sampled with standard gears at Tobacco Island during 2007. River shiners were sampled with electrofishing (n = 51, CPUE = 10.25 fish per hour), mini-fyke nets (n = 3,734, CPUE = 133.36 fish per net night) and push trawls (n = 234, CPUE = 8.11 fish per 100 m

trawled). Monthly catch rates ranged from 33 in July to 1,745 in October. Mean total length of river shiners was 36 mm ranging from 19 to 70 mm.

In total 2,661 river shiners (99.96% juveniles, <51 mm) were sampled with standard gears at Tobacco Island during 2008. River shiners were sampled with electrofishing (n = 14, CPUE = 2.15 fish per hour), mini-fyke nets (n = 830, CPUE = 30.74 fish per net night) and push trawls (n = 1,817, CPUE = 39.26 fish per 100 m trawled). Monthly catch rates ranged from 39 in July to 237 in October. Mean total length of river shiners was 32 mm ranging from 13 to 73 mm.

We compared proportion of juveniles between years using a z-test. The proportion of juvenile river shiners was significantly lower in 2006 (Figure III.4.16, Table III.4.4).

We compared length frequency distributions of river shiners from all years using a Kolmogorov-Smirnov test. River shiner length frequency distributions at Tobacco Island were not significantly different between years (Figure III.4.17, Table III.4.5). Mean length between years was compared using a t-test. Mean lengths were significantly different in all years, decreasing yearly (Table III.4.6).

We compared river shiner CPUE between years using a Kruskal-Wallis test. River shiner mini-fyke catch rates were very significantly lower in 2006 than 2007. Push trawl catch rates were significantly lower in 2007 than 2008 (Table III.4.7).

Sand Shiner

In total 421 sand shiners (99% juveniles, <43 mm) were sampled with standard gears at Tobacco Island during 2006. Sand shiners were sampled with bag seines (n = 22, CPUE = 2.21 fish per 100 m^2), electrofishing (n = 11, CPUE = 1.97 fish per hour) and

mini-fyke nets (n = 388, CPUE = 20.42 fish per net night). Monthly catches ranged from 3 in April and June to 283 in May. Mean total length for sand shiners was 37 mm ranging from 27 to 74 mm.

In total 1,671 sand shiners (99.6% juveniles, <43 mm) were sampled with standard gears at Tobacco Island during 2007. Sand shiners were sampled with mini-fyke nets (n = 1,545, CPUE = 55.18 fish per net night) and push trawls (n = 126, CPUE = 4.09 fish per 100 m trawled). Monthly catch rates ranged from 14 in August to 1,039 in April. Mean total length for sand shiners was 39 mm ranging from 19 to 61 mm.

In total 410 sand shiners (97% juveniles, <43 mm) were sampled with standard gears at Tobacco Island during 2008. Sand shiners were sampled with electrofishing (n = 4, CPUE = 0.62 fish per hour), mini-fyke nets (n = 203, CPUE = 7.52 fish per net night) and push trawls (n = 203, CPUE = 6.65 fish per 100 m trawled). Monthly catch rates ranged from 7 in July to 118 in April. Mean total length for sand shiners was 38 mm ranging from 21 to 62 mm.

We compared proportion of juveniles between years using a z-test. The proportion of juvenile sand shiners was significantly higher in 2007 than 2008 (Figure III.4.18, Table III.4.4).

We compared length frequency distributions of sand shiners from all years using a Kolmogorov-Smirnov test. Sand shiner length frequency distributions at Tobacco Island were not different between years (Figure III.4.19, Table III.4.5). Mean length between years was compared using a t-test. Mean length was significantly lower in 2006 than 2007 (Table III.4.6).

We compared sand shiner CPUE between years using a Kruskal-Wallis test. Sand shiner catch rates were not significantly different between years (Table III.4.7).

Fathead Minnow

In total 35 fathead minnows (82% juveniles, <41 mm) were sampled with standard gears at Tobacco Island during 2006. Fathead minnows were sampled with bag seines (n = 9, CPUE = 0.76 fish per 100 m^2) and mini-fyke nets (n = 26, CPUE = 1.37 fish per net night). Fathead minnows were only sampled in April (n = 17) and May (n = 18) at Tobacco Island. Mean total length of fathead minnows was 40 mm ranging from 32 to 60 mm.

In total 84 fathead minnows (95% juveniles, <41 mm) were sampled with standard gears at Tobacco Island during 2007. Fathead minnows were sampled with electrofishing (n = 1, CPUE = 0.12 fish per hour), mini-fyke nets (n = 81, CPUE = 2.89 fish per net night) and push trawls (n = 2, CPUE = 0.08 fish per 100 m trawled). Monthly catch rates ranged from 0 in May and June to 73 in August. Mean total length of fathead minnows was 34 mm ranging from 20 to 62 mm.

In total 10 fathead minnows (70% juveniles, <41 mm) were sampled with standard gears at Tobacco Island during 2008. Fathead minnows were sampled with mini-fyke nets (n = 9, CPUE = 0.37 fish per net night) and push trawls (n = 1, CPUE = 0.06 fish per 100 m trawled). Monthly catch rates ranged from 0 in May, September and October to 5 in July. Mean total length of fathead minnows was 38 mm ranging from 22 to 68 mm.

We compared proportion of juveniles between years using a z-test. The proportion of juvenile fathead minnows was significantly higher in 2007 (Figure III.4.20, Table III.4.4).

We compared length frequency distributions of fathead minnows from all years using a Kolmogorov-Smirnov test. Fathead minnow length frequency distributions at Tobacco Island were significantly different between 2006 and 2008 (Figure III.4.21, Table III.4.5), less small fish were caught in 2006. Mean length between years was compared using a t-test. Mean length was significantly lower in 2006 than 2007 (Table III.4.6).

We compared fathead minnow CPUE between years using a Kruskal-Wallis test. Fathead minnow catch rates were not significantly different between years (Table III.4.7).

River Carpsucker

In total 400 river carpsuckers (95% juveniles, <305 mm) were sampled with standard gears at Tobacco Island during 2006. River carpsuckers were sampled with bag seines (n = 152, CPUE = 11.95 fish per 100 m^2), electrofishing (n = 126, CPUE = 22.25 fish per hour), 4' hoop nets (n = 12, CPUE = 0.27 fish per net night), mini-fyke nets (n = 109, CPUE = 5.74 fish per net night) and trammel nets (n = 1, CPUE = 0.07 fish per 125 ft of net drifted 100 m). Monthly catches of river carpsuckers ranged from 28 in May to 83 in April. Mean total length of river carpsuckers was 98 mm ranging from 14 to 520 mm.

In total 193 river carpsuckers (92% juveniles, <305 mm) were sampled with standard gears at Tobacco Island during 2007. River carpsuckers were sampled with electrofishing (n = 100, CPUE = 16.87 fish per hour), 4' hoop nets (n = 17, CPUE = 0.32

fish per net night), mini-fyke nets (n = 53, CPUE = 1.89 fish per net night), push trawls (n = 19, CPUE = 0.65 fish per 100 m trawled) and trammel nets (n = 4, CPUE = 0.18 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 8 in October to 44 in August. Mean total length of river carpsuckers was 189 mm ranging from 30 to 555 mm.

In total 188 river carpsuckers (89% juveniles, <305 mm) were sampled with standard gears at Tobacco Island during 2008. River carpsuckers were sampled with electrofishing (n = 24, CPUE = 3.75 fish per hour), 4' hoop nets (n = 9, CPUE = 0.17 fish per net night), 2' hoop nets (n = 1, CPUE = 0.02 fish per net night), mini-fyke nets (n = 76, CPUE = 2.81 fish per net night), push trawls (n = 75, CPUE = 2.07 fish per 100 m trawled) and trammel nets (n = 3, CPUE = 0.11 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 7 in June and October to 68 in July. Mean total length of river carpsuckers was 106 mm ranging from 18 to 550 mm.

We compared proportion of juveniles between years using a z-test. The proportion of juvenile river carpsuckers was significantly higher in 2006 than 2008 (Figure III.4.22, Table III.4.4).

We compared length frequency distributions of river carpsuckers from all years using a Kolmogorov-Smirnov test. River carpsucker length frequency distributions at Tobacco Island were significantly different between 2006 and 2007 (Figure III.4.23, Table III.4.5), more small fish were caught in 2006. Mean length between years was compared using a t-test. Mean lengths were significantly higher in 2007 (Table III.4.6).

We compared river carpsucker CPUE between years using a Kruskal-Wallis test. River carpsucker catch rates were not significantly different between years (Table III.4.7).

Blue Sucker

In total 24 blue suckers (42% juveniles, <508 mm) were sampled with standard gears at Tobacco Island during 2006. Blue suckers were sampled with electrofishing (n = 20, CPUE = 3.75 fish per hour), 4' hoop nets (n = 3, CPUE = 0.07 fish per net night) and trammel nets (n = 1, CPUE = 0.29 fish per 125 ft of net drifted 100 m). Monthly blue sucker catches ranged from 0 in April and July to 10 in August. Mean total length of blue suckers sampled in 2006 was 533 mm ranging from 145 to 757 mm.

In total 45 adult blue suckers (>508 mm) were sampled with standard gears at Tobacco Island during 2007. Blue suckers were sampled with electrofishing (n = 32, CPUE = 4.62 fish per hour), 4' hoop nets (n = 4, CPUE = 0.08 fish per net night) and trammel nets (n = 9, CPUE = 0.44 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in April to 22 in June. Mean total length of blue suckers sampled was 630 mm ranging from 514 to 712 mm.

In total 44 blue suckers (34% juveniles, <508 mm) were sampled with standard gears at Tobacco Island during 2008, including thirteen young of the year, which were caught in a mini-fyke net set in flooded terrestrial vegetation in June. Blue suckers were sampled with electrofishing (n = 14, CPUE = 2.21 fish per hour), 4' hoop nets (n = 5, CPUE = 0.10 fish per net night), mini-fyke nets (n = 15, CPUE = 0.56 fish per net night) and trammel nets (n = 10, CPUE = 0.32 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in April and September to 20 in June. Mean total length of blue suckers sampled in 2008 was 434 mm ranging from 20 to 803 mm.

Smallmouth buffalo

In total six smallmouth buffalo (0.17% juveniles, <381 mm) were sampled with standard gears at Tobacco Island during 2006. Smallmouth buffalo were sampled with electrofishing (n = 5, CPUE = 0.44 fish per hour) and 4’ hoop nets (n = 1, CPUE = 0.03 fish per net night). All fish were caught in August. Mean total length of smallmouth buffalo sampled in 2006 was 456 mm ranging from 52 to 648 mm.

In total 571 smallmouth buffalo (99.6% juveniles, <381 mm) were sampled in standard gears at Tobacco Island during 2007. Smallmouth buffalo were sampled with electrofishing (n = 18, CPUE = 2.15 fish per hour), 4’ hoop nets (n = 1, CPUE = 0.02 fish per net night), mini-fyke nets (n = 515, CPUE = 18.39 fish per net night) and push trawls (n = 37, CPUE = 1.27 fish per 100 m trawled). Monthly catch rates ranged from 0 in April and May to 428 in June. Mean total length was 61 mm ranging from 26 to 672 mm.

In total 63 smallmouth buffalo (83% juveniles, <381 mm) were sampled with standard gears at Tobacco Island during 2008. Smallmouth buffalo were sampled with electrofishing (n = 7, CPUE = 1.16 fish per hour), 4’ hoop nets (n = 3, CPUE = 0.05 fish per net night), mini-fyke nets (n = 46, CPUE = 1.51 fish per net night), push trawls (n = 5, CPUE = 0.09 fish per 100 m trawled) and trammel nets (n = 2, CPUE = 0.05 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in September to 31 in July. Mean total length was 138 mm ranging from 22 to 631 mm.

We compared proportion of juveniles between years using a z-test. Smallmouth buffalo life stage proportions were significantly different between all years, 2007 had the highest juvenile catch, 2006 the lowest (Figure III.4.26, Table III.4.4).

We compared length frequency distributions of smallmouth buffalo from all years using a Kolmogorov-Smirnov test. Smallmouth buffalo length frequency distributions at Tobacco Island were not different between years (Figure III.4.27, Table III.4.5). Mean length between years was compared using a t-test. Mean lengths were significantly different in all years (Table III.4.6), corresponding with juvenile catch, 2007 had the smallest mean length, 2006 the largest.

We compared smallmouth buffalo CPUE between years using a Kruskal-Wallis test. Smallmouth buffalo catch rates were significantly lower in 2006 than 2007 for mini-fyke nets (Table III.4.7); no smallmouth buffalo were caught in mini fyke nets in 2006.

Bigmouth Buffalo

One adult bigmouth buffalo was sampled with standard gears at Tobacco Island during 2006 with a 4' hoop net (n = 1, CPUE = 0.02 fish per net night) during the month of August. The fish was 715 mm in total length.

In total 168 bigmouth buffalo (95% juveniles, <381 mm) were sampled with standard gears at Tobacco Island during 2007. Bigmouth buffalo were sampled with electrofishing (n = 6, CPUE = 0.76 fish per hour), 4' hoop nets (n = 2, CPUE = 0.04 fish per net night), mini-fyke nets (n = 149, CPUE = 5.32 fish per net night) and push trawls (n = 11, CPUE = 0.37 fish per 100 m trawled). Monthly catch rates ranged from 0 in September to 111 in July. Mean total length of bigmouth buffalo sampled in 2007 was 85 mm ranging from 30 to 658 mm.

In total 56 bigmouth buffalo (82% juveniles, <381 mm) were sampled with standard gears at Tobacco Island during 2008. Bigmouth buffalo were sampled with electrofishing (n = 9, CPUE = 1.57 fish per hour), mini-fyke nets (n = 22, CPUE = 0.81

fish per net night), push trawls (n = 24, CPUE = 0.61 fish per 100 m trawled) and trammel nets (n = 1, CPUE = 0.02 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 0 in September and October to 30 in June. Mean total length of bigmouth buffalo sampled in 2007 was 127 mm ranging from 21 to 690 mm.

We compared proportion of juveniles between years using a z-test. The proportion of juvenile bigmouth buffalo was significantly higher in 2007 (Figure III.4.28, Table III.4.4).

We compared length frequency distributions of bigmouth buffalo from all years using a Kolmogorov-Smirnov test. Bigmouth buffalo length frequency distributions at Tobacco Island were not different between years (Figure III.4.29, Table III.4.5). Mean length between years was compared using a t-test. Mean length was significantly higher in 2006 when only one large adult bigmouth buffalo was caught (Table III.4.6).

We compared bigmouth buffalo CPUE between years using a Kruskal-Wallis test. Bigmouth buffalo catch rates were significantly lower in 2006 than 2008 for electrofishing (Table III.4.7); electrofishing catch rates increased yearly, no bigmouth buffalo were caught electrofishing in 2006.

Channel Catfish

In total 255 channel catfish (67% juveniles, <305 mm) were sampled with standard gears at Tobacco Island during 2006. Channel catfish were sampled with bag seines (n = 30, CPUE = 1.41 fish per 100 m^2), electrofishing (n = 24, CPUE = 4.58 fish per hour), 4' hoop nets (n = 88, CPUE = 1.96 fish per net night), mini-fyke nets (n = 56, CPUE = 2.95 fish per net night), 2' hoop nets (n = 56, CPUE = 1.04 fish per net night) and trammel nets (n = 1, CPUE = 0.27 fish per 125 ft of net drifted 100 m). Monthly

catches of channel catfish ranged from 12 in June to 173 in April. Mean total length of channel catfish sampled was 277 mm ranging from 43 to 672 mm.

In total 708 channel catfish (89% juveniles, <305 mm) were sampled with standard gears at Tobacco Island during 2007. Channel catfish were sampled with electrofishing (n = 30, CPUE = 4.43 fish per hour), 4' hoop nets (n = 62, CPUE = 1.17 fish per net night), 2' hoop nets (n = 27, CPUE = 0.48 fish per net night), mini-fyke nets (n = 148, CPUE = 5.29 fish per net night), push trawls (n = 433, CPUE = 14.69 fish per 100 m trawled) and trammel nets (n = 8, CPUE = 0.31 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 21 in May to 206 in September. Mean total length of channel catfish sampled was 143 mm ranging from 15 to 762 mm.

In total 954 channel catfish (90% juveniles, <305 mm) were sampled with standard gears at Tobacco Island during 2008. Channel catfish were sampled with electrofishing (n = 15, CPUE = 2.40 fish per hour), 4' hoop nets (n = 87, CPUE = 1.67 fish per net night), 2' hoop nets (n = 55, CPUE = 0.98 fish per net night), mini-fyke nets (n = 141, CPUE = 5.22 fish per net night), push trawls (n = 648, CPUE = 16.09 fish per 100 m trawled) and trammel nets (n = 8, CPUE = 0.21 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 27 in September to 209 in April. Mean total length of channel catfish sampled was 120 mm ranging from 16 to 791 mm.

We compared proportion of juveniles between years using a z-test. The proportion of juvenile channel catfish was significantly lower in 2006 (Figure III.4.30, Table III.4.4).

We compared length frequency distributions of channel catfish from all years using a Kolmogorov-Smirnov test. Channel catfish length frequency distributions at

Tobacco Island were significantly different in 2007 (Figure III.4.31, Table III.4.5). Mean length between years was compared using a t-test. Mean lengths were significantly different between all years, decreasing yearly (Table III.4.6).

We compared channel catfish CPUE between years using a Kruskal-Wallis test. Channel catfish catch rates were not significantly different between years (Table III.4.7).

Flathead Catfish

In total 63 flathead catfish (79% juveniles, <381 mm) were sampled with standard gears at Tobacco Island during 2006. Flathead catfish were sampled with electrofishing (n = 24, CPUE = 4.77 fish per hour), 4’ hoop nets (n = 16, CPUE = 0.36 fish per net night) and 2’ hoop nets (n = 23, CPUE = 0.43 fish per net night). Monthly catches ranged from 0 in April to 30 in August. Mean total length was 407 mm and ranged from 178 mm to 1.1 m.

In total 150 flathead catfish (73% juveniles, <381 mm) were sampled with standard gears at Tobacco Island during 2007. Flathead catfish were sampled with electrofishing (n = 50, CPUE = 7.70 fish per hour), 4’ hoop nets (n = 36, CPUE = 0.68 fish per net night), 2’ hoop nets (n = 55, CPUE = 0.98 fish per net night), mini-fyke nets (n = 1, CPUE = 0.04 fish per net night), push trawls (n = 1, CPUE = 0.04 fish per 100 m trawled) and trammel nets (n = 7, CPUE = 0.26 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 6 in April to 39 in June. Mean total length was 365 mm and ranged from 172 mm to 1.1 m.

In total 156 flathead catfish (67% juveniles, <381 mm) were sampled with standard gears at Tobacco Island during 2008. Flathead catfish were sampled with

electrofishing (n = 30, CPUE = 4.58 fish per hour), 4' hoop nets (n = 44, CPUE = 0.84 fish per net night), 2' hoop nets (n = 4, CPUE = 1.32 fish per net night), push trawls (n = 74, CPUE = 0.08 fish per 100 m trawled) and trammel nets (n = 4, CPUE = 0.10 fish per 125 ft of net drifted 100 m). Monthly catch rates ranged from 3 in September to 71 in June. Mean total length was 423 mm and ranged from 19 mm to 1.3 m.

We compared proportion of juveniles between years using a z-test. Flathead catfish life stage proportions were not significantly different between years (Figure III.4.32, Table III.4.4).

We compared length frequency distributions of flathead catfish from all years using a Kolmogorov-Smirnov test. Flathead catfish length frequency distributions at Tobacco Island were significantly different between 2007 and 2008 (Figure III.4.33, Table III.4.5), more small fish were caught in 2007. Mean length between years was compared using a t-test. Mean lengths were significantly lower in 2007 than 2008 (Table III.4.6).

We compared flathead catfish CPUE between years using a Kruskal-Wallis test. Flathead catfish catch rates were not significantly different between years (Table III.4.7).

Key Findings

- Many native riverine species appear to be using this chute, including: shovelnose and pallid sturgeon, chub species, blue sucker and catfish species.
- Many pool or backwater associated species were also common in this chute, including: shortnose gar, gizzard shad, common carp, river carpsucker, buffalo species, bluegill and freshwater drum.
- Young of the year blue suckers were caught in flooded terrestrial vegetation in 2008.

- Young of the year shovelnose sturgeon and smallmouth and bigmouth buffalo were caught in 2007 and 2008. Young of the year buffalo were caught in large numbers.
- Young of the year blue catfish were caught in 2008.
- Silver and sturgeon chub catches increased yearly, speckled chub catch was much lower in 2006 compared to 2007 and 2008.
- Shovelnose sturgeon numbers significantly increased over the three years of this study.
- Fish community assemblage was different in 2006 from other years.
- Fish catches for red and river shiners, juvenile channel catfish and flathead catfish were low in 2006.
- Channel and flathead catfish were present in sizes targeted by sport fisherman including several trophy-size catfish.

Table III.4.1. Total species caught at Tobacco Island from 2006 - 2008 and the percent of catch that each species represents. *Indicates a species that was used in analysis. †Indicates a species of note for this chute.

Species	Scientific name	2006	2007	2008	Total	% catch
Pallid sturgeon†	*Scaphirhynchus albus*	0	2	4	6	0.02
Hybrid sturgeon	*S. platorynchus x S. albus*	0	1	0	1	0.00
Shovelnose sturgeon*	*Scaphirhynchus platorynchus*	64	286	529	879	3.54
Longnose gar	*Lepisosteus osseus*	10	29	23	62	0.25
Shortnose gar	*Lepisosteus platostomus*	39	135	92	266	1.07
Goldeye*	*Hiodon alosoides*	122	70	149	341	1.37
Unidentified herring	*Clupeidae*	0	20	0	20	0.08
Skipjack herring	*Alosa chrysochloris*	2	1	1	4	0.02
Gizzard shad*	*Dorosoma cepedianum*	362	299	159	820	3.30
Unidentified minnow	*Cyprinidae*	25	66	232	323	1.30
Speckled chub*	*Macrhybopsis aestivalis*	1	74	67	142	0.57
Sturgeon chub	*Macrhybopsis gelida*	0	7	52	59	0.24
Silver chub*	*Macrhybopsis storeriana*	104	255	368	727	2.97
Red shiner*	*Cyprinella lutrensis*	167	1106	355	1628	6.65
Spotfin shiner	*Cyprinella spiloptera*	2	34	11	47	0.19
Emerald shiner*	*Notropis atherinoides*	704	818	588	2110	8.62
River shiner*	*Notropis blennius*	220	4019	2661	6900	28.20
Spottail shiner	*Notropis hudsonius*	0	1	0	1	0.00
Sand shiner*	*Notropis stramineus*	421	1671	410	2502	10.23
Bluntnose minnow	*Pimephales notatus*	8	2	29	39	0.16
Fathead minnow*	*Pimephales promelas*	35	84	10	129	0.53
Goldfish	*Carassius auratus*	0	1	0	1	0.00
Grass carp	*Ctenopharyngodon idella*	10	14	7	31	0.13
Common carp	*Cyprinus carpio*	149	166	627	942	3.85
Bighead carp	*Hypophthalmicthys nobilis*	4	1	1	6	0.02
Unidentified sucker	*Catostomidae*	12	0	0	12	0.05
River carpsucker*	*Carpiodes carpio*	400	193	188	781	3.19
Quillback	*Carpiodes cyprinus*	1	3	1	5	0.02
Blue sucker†	*Cycleptus elongatus*	24	45	44	113	0.46
Unidentified buffalo	*Ictiobus*	0	56	0	56	0.23
Smallmouth buffalo*	*Ictiobus bubalus*	6	571	63	640	2.62
Bigmouth buffalo*	*Ictiobus cyprinellus*	1	168	56	225	0.92
Shorthead redhorse	*Moxostoma macrolepidotum*	12	8	4	24	0.10

Table III.4.1 continued. Total species caught at Tobacco Island from 2006 - 2008 and the percent of catch that each species represents. *Indicates a species that was used in analysis. †Indicates a species of note for this chute.

Species	Scientific name	2006	2007	2008	Total	% catch
Black bullhead	*Ameiurus melas*	0	1	0	1	0.00
Yellow bullhead	*Ameiurus natalis*	0	1	0	1	0.00
Blue catfish	*Ictalurus furcatus*	7	1	72	80	0.33
Channel catfish*	*Ictalurus punctatus*	255	708	954	1917	7.83
Flathead catfish*	*Pylodictis olivaris*	63	150	156	369	1.51
Stonecat	*Noturus flavus*	0	5	1	6	0.02
Unidentified killifish	*Cyprinodontidae*	0	1	0	1	0.00
Plains topminnow	*Fundulus sciadicus*	2	0	0	2	0.01
Western mosquitofish	*Gambusia affinis*	4	5	3	12	0.05
Brook silverside	*Labidesthes sicculus*	1	18	54	73	0.30
Brook stickleback	*Culaea inconstans*	0	0	2	2	0.01
Unidentified bass	*Percichythidae*	0	25	0	25	0.10
White bass	*Morone chrysops*	35	97	43	175	0.72
Yellow bass	*Morone mississippiensis*	1	1	1	3	0.01
Striped bass	*Morone saxatilis*	0	0	1	1	0.00
Wiper	*M. chrysops x M. saxatilis*	0	1	0	1	0.00
Unidentified sunfish	*Centrarchidae*	0	1	0	1	0.00
Green sunfish	*Lepomis cyanellus*	43	1	10	54	0.22
Orangespotted sunfish	*Lepomis humilis*	2	4	1	7	0.03
Bluegill	*Lepomis macrochirus*	7	640	213	860	3.51
Smallmouth bass	*Micropterus dolomieu*	0	33	0	33	0.13
Spotted bass	*Micropterus punctulatus*	0	1	0	1	0.00
Largemouth bass	*Micropterus salmoides*	0	2	62	64	0.26
White crappie	*Pomoxis annularis*	12	6	33	51	0.21
Black crappie	*Pomoxis nigromaculatus*	0	5	6	11	0.04
Johnny darter	*Etheostoma nigrum*	0	0	2	2	0.01
Yellow perch	*Perca flavescens*	0	0	1	1	0.00
Sauger	*Stizostedion canadense*	5	8	4	17	0.07
Saugeye	*S. vitreum x S. canadense*	0	3	0	3	0.01
Walleye	*Stizostedion vitreum*	2	1	0	3	0.01
Freshwater drum	*Aplodinotus grunniens*	140	600	468	1208	4.94

Table III.4.2. Species richness (S), species evenness (E), Shannon's diversity index (H) and Simpson's diversity index (D) for Tobacco Island from 2006 - 2008.

Year	S	E	H	D
2006	43	0.744	2.799	0.9203
2007	51	0.752	2.955	0.9124
2008	47	0.742	2.859	0.9166

Table III.4.3. Morisita's similarity index, for Tobacco Island between years (2006 - 2008).

Year	2006 v 2007	2006 v 2008	2007 v 2008
Morisita's Index	0.5477	0.5437	0.9248

Table III.4.4. Results for analysis of life stage proportions at Tobacco Island from 2006 - 2008. A z-test was used to determine differences in proportions of juveniles and adults of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

	2006 v 2007		2006 v 2008		2007 v 2008	
Species	Z	p-value	Z	p-value	Z	p-value
Shovelnose sturgeon	-1.40	0.1616	**-4.22**	**<0.0001**	**-3.97**	**<0.0001**
Goldeye	**3.82**	**0.0002**	0.12	0.9044	**-3.84**	**0.0002**
Gizzard shad	0.67	0.5028	-0.22	0.8258	-0.70	0.4840
Speckled chub	0.35	0.7264	0.47	0.6384	1.21	0.2262
Silver chub	-1.37	0.1706	-1.79	0.0734	-0.26	0.7948
Red shiner	**-8.80**	**<0.0001**	**-6.07**	**<0.0001**	-0.01	0.9920
Emerald shiner	-2.03	0.0424	-1.32	0.1868	0.54	0.5892
River shiner	**-14.09**	**<0.0001**	**-11.44**	**<0.0001**	0.29	0.7718
Sand shiner	-1.33	0.1836	2.09	0.0366	**4.78**	**<0.0001**
Fathead minnow	**-2.38**	**0.0174**	0.84	0.4010	**2.87**	**0.0042**
River carpsucker	1.58	0.1140	**2.55**	**0.0108**	0.78	0.4354
Smallmouth buffalo	**-18.47**	**<0.0001**	**-3.65**	**0.0001**	**9.09**	**<0.0001**
Bigmouth buffalo	**-4.00**	**<0.0001**	-2.06	0.0394	**2.91**	**0.0036**
Channel catfish	**-8.15**	**<0.0001**	**-9.36**	**<0.0001**	-0.69	0.4902
Flathead catfish	0.94	0.3472	2.04	0.0414	1.27	0.2040

Table III.4.5. Results for analysis of length frequency distribution at Tobacco Island from 2006 - 2008. A Kolmogorov-Smirnov test was used to determine differences in length frequency distribution of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

	2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**D**	**p-value**	**D**	**p-value**	**D**	**p-value**
Shovelnose sturgeon	0.42	0.0393	0.26	0.3695	**0.46**	**0.0232**
Goldeye	0.16	0.9930	0.20	0.9433	0.19	0.9553
Gizzard shad	0.33	0.3542	0.38	0.5095	0.38	0.3814
Speckled chub	1.00	0.3056	0.17	0.9835	1.00	0.3081
Silver chub	0.28	0.1220	0.19	0.5050	0.27	0.1630
Red shiner	0.19	0.7892	0.09	1.0000	0.23	0.5301
Emerald shiner	0.14	0.8788	0.20	0.4736	0.21	0.4127
River shiner	0.21	0.6941	0.20	0.7191	0.27	0.2966
Sand shiner	0.18	0.9361	0.14	0.9867	0.16	0.9732
Fathead minnow	0.30	0.6162	**0.79**	**0.0015**	0.58	0.0489
River carpsucker	**0.42**	**0.0322**	0.35	0.1386	0.41	0.0659
Smallmouth buffalo	0.78	0.0409	0.56	0.1243	0.78	0.0409
Bigmouth buffalo	1.00	0.3364	0.50	0.1972	1.00	0.3185
Channel catfish	**0.43**	**0.0050**	0.18	0.6325	**0.52**	**0.0002**
Flathead catfish	0.30	0.2256	0.29	0.1755	**0.45**	**0.0092**

Table III.4.6. Results for analysis of species mean length at Tobacco Island from 2006 - 2008. A t-test was used to determine differences in mean length of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

	2006 v 2007		2006 v 2008		2007 v 2008	
Species	**t**	**p-value**	**t**	**p-value**	**t**	**p-value**
Shovelnose sturgeon	1.99	0.0464	-0.32	0.7486	**-4.38**	**<0.0001**
Goldeye	**-7.07**	**<0.0001**	**-4.96**	**<0.0001**	**3.13**	**0.0019**
Gizzard shad	**7.45**	**<0.0001**	**11.09**	**<0.0001**	**4.48**	**<0.0001**
Speckled chub	0.06	0.9519	-0.85	0.3993	**-5.37**	**<0.0001**
Silver chub	**7.55**	**<0.0001**	**9.11**	**<0.0001**	0.93	0.3539
Red shiner	1.85	0.0642	**3.69**	**0.0002**	**2.35**	**0.0193**
Emerald shiner	-0.51	0.6111	**5.36**	**<0.0001**	**5.34**	**<0.0001**
River shiner	**4.52**	**<0.0001**	**10.74**	**<0.0001**	**9.53**	**<0.0001**
Sand shiner	**-2.97**	**0.0031**	-1.26	0.2073	1.84	0.0662
Fathead minnow	**3.32**	**0.0012**	0.55	0.5862	-1.47	0.1439
River carpsucker	**-8.54**	**<0.0001**	-0.75	0.4539	**6.65**	**<0.0001**
Smallmouth buffalo	**7.07**	**<0.0001**	**5.53**	**<0.0001**	**-3.89**	**<0.0001**
Bigmouth buffalo	**3.60**	**0.0004**	**3.34**	**0.0010**	-1.48	0.1417
Channel catfish	**8.98**	**<0.0001**	**11.85**	**<0.0001**	**2.79**	**0.0054**
Flathead catfish	1.86	0.0642	-0.68	0.4942	**-3.33**	**0.0010**

Table III.4.7. Results for analysis of species catch per unit effort (CPUE) at Tobacco Island from 2006 - 2008. Effort for each gear is defined as: electrofishing (EFS), fish caught per hour; 4' hoop nets (HNS), fish caught per net night; 2' hoop nets (SHNS), fish caught per net night; mini-fyke nets (MFS), fish caught per net night; push trawls (POT02S), fish caught per 100 m trawled and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Push trawl was not used in 2006. A Kruskal-Wallis test was used to determine differences in CPUE of a species by gear between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

		2006 v 2007		2006 v 2008		2007 v 2008	
Species	**Gear**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**
Shovelnose sturgeon	**EFS**	2.26	0.1329	4.27	0.0388	1.48	0.2232
	HNS	1.14	0.2862	4.65	0.0311	1.82	0.1773
	POT02S					1.49	0.2219
	SHNS	1.65	0.1996	**4.86**	**0.0274**	1.45	0.2285
	TN	4.12	0.0424	4.12	0.0424	0.33	0.5653
Goldeye	**EFS**	1.21	0.2721	1.20	0.2737	1.11	0.2912
	HNS	1.65	0.1996	3.20	0.0735	0.07	0.7847
	TN	0.68	0.4085	0.11	0.7449	0.82	0.3658
Gizzard shad	**EFS**	1.47	0.2248	**7.18**	**0.0074**	3.81	0.0509
	MFS	0.81	0.3673	0.30	0.5861	0.21	0.6474
	POT02S					0.09	0.7638
	TN	0.02	0.9007	1.40	0.2367	1.00	0.3173
Speckled chub	**MFS**	0.01	0.9093	0.05	0.8203	0.01	0.9165
	POT02S					2.50	0.1141
Silver chub	**EFS**	**4.81**	**0.0283**	3.13	0.0770	0.56	0.4556
	MFS	0.02	0.8845	0.01	0.9422	0.07	0.7959
	POT02S					0.08	0.7751
Red shiner	**EFS**	0.20	0.6511	3.31	0.0687	2.71	0.0996
	MFS	1.65	0.1985	0.08	0.7748	1.19	0.2753
	POT02S					0.51	0.4751
Emerald shiner	**EFS**	0.50	0.4803	0.16	0.6847	0.17	0.6842
	MFS	0.18	0.6682	1.65	0.1985	0.69	0.4062
	POT02S					**7.39**	**0.0066**
River shiner	**EFS**	1.49	0.2228	0.06	0.8062	1.48	0.2232
	MFS	**5.24**	**0.0221**	1.31	0.2518	1.48	0.2243
	POT02S					**4.59**	**0.0321**
Sand shiner	**EFS**	3.49	0.0619	0.76	0.3845	1.40	0.2367
	MFS	0.02	0.8864	1.00	0.3166	2.16	0.1413
	POT02S					0.18	0.6682
Fathead minnow	**EFS**	1.00	0.3173	0.00	1.0000	0.71	0.3980
	MFS	0.56	0.4525	0.02	0.8766	0.21	0.6466
	POT02S					0.05	0.8203

Table III.4.7 continued. Results for analysis of species catch per unit effort (CPUE) at Tobacco Island from 2006 - 2008. Effort for each gear is defined as: electrofishing (EFS), fish caught per hour; 4' hoop nets (HNS), fish caught per net night; 2' hoop nets (SHNS), fish caught per net night; mini-fyke nets (MFS), fish caught per net night; push trawls (POT02S), fish caught per 100 m trawled and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Push trawl was not used in 2006. A Kruskal-Wallis test was used to determine differences in CPUE of a species by gear between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

		2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**Gear**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**
River carpsucker	**HNS**	0.54	0.4645	0.04	0.8415	0.27	0.6028
	MFS	1.85	0.1735	0.73	0.3914	0.15	0.6999
	POT02S					0.33	0.5677
	SHNS	0.00	1.0000	1.00	0.3173	1.00	0.3173
	TN	0.46	0.4988	0.23	0.6290	0.01	0.9436
Smallmouth buffalo	**EFS**	0.79	0.3751	0.19	0.6647	0.18	0.6738
	HNS	0.01	0.9165	0.39	0.5338	0.51	0.4760
	MFS	**5.97**	**0.0146**	1.86	0.1730	2.05	0.1519
	POT02S					0.12	0.7271
	SHNS	0.00	1.0000	0.00	1.0000	0.00	1.0000
	TN	0.00	1.0000	0.71	0.3980	1.00	0.3173
Bigmouth buffalo	**EFS**	3.49	0.0619	**7.32**	**0.0068**	2.05	0.1523
	HNS	0.51	0.4760	1.00	0.3173	2.15	0.1422
	MFS	4.40	0.0359	1.86	0.1730	0.98	0.3213
	POT02S					0.34	0.5622
	TN	0.00	1.0000	0.71	0.3980	1.00	0.3173
Channel catfish	**EFS**	0.69	0.4057	1.91	0.1675	0.17	0.6826
	HNS	0.10	0.7491	0.02	0.8982	0.00	1.0000
	MFS	0.63	0.4282	0.52	0.4726	0.15	0.7009
	POT02S					0.02	0.8864
	SHNS	3.47	0.0625	1.81	0.1783	0.00	1.0000
	TN	0.66	0.4151	0.66	0.4151	0.02	0.8942
Flathead catfish	**EFS**	0.50	0.4803	0.06	0.8062	0.32	0.5698
	HNS	0.60	0.4382	1.21	0.2716	0.20	0.6540
	MFS	0.86	0.3545	0.00	1.0000	1.00	0.3173
	POT02S					0.76	0.3830
	SHNS	3.72	0.0537	1.34	0.2470	0.42	0.5187
	TN	3.73	0.0533	1.56	0.2119	1.28	0.2576

Table III.4.8. Species monthly catch per unit effort (± 2 SE) at Tobacco Island from 2006 - 2008. Effort for each gear is defined as: electrofishing (EFS), fish caught per hour; 4' hoop nets (HNS), fish caught per net night; 2' hoop nets (SHNS), fish caught per net night; mini-fyke nets (MFS), fish caught per net night; push trawls (POT02S), fish caught per 100 m trawled; trammel nets (TN), fish caught per 125 ft of net drifted 100 m and set lines (SLW) a wild gear, fish caught per set night. Push trawl was not used in 2006. Set lines were not used in 2006.

		March	April			May			June			July			August			September			October		
Species	**Gear**	**2007**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Pallid sturgeon	**SLW**	0.04 (0.07)		0.06 (0.13)																			
	TN							0.08 (0.15)			0.25 (0.27)												
	OT16S							0.09 (0.18)															
Shovelnose sturgeon	**EFS**		10.64 (9.32)	3.76 (7.52)	2.11 (4.22)	5.01 (3.97)	8.10 (7.68)	2.95 (2.89)	15.43 (14.63)	3.69 (4.15)	14.20 (10.23)	8.18 (9.36)	6.17 (5.13)	5.10 (2.69)		5.04 (3.90)	3.18 (6.36)	6.67 (5.58)	9.41 (6.81)		2.99 (3.94)	4.71 (4.48)	
	HNS			1.33 (1.61)			4.71 (5.01)		0.43 (0.59)	0.33 (0.42)	1.86 (2.02)		0.13 (0.25)	0.13 (0.25)	0.38 (0.37)	0.86 (0.68)	0.50 (0.76)		0.43 (0.40)		0.13 (0.25)	0.29 (0.57)	
	SHNS			0.38 (0.75)			1.00 (1.38)				0.50 (0.76)		0.14 (0.29)	0.13 (0.25)		0.25 (0.33)		0.13 (0.25)				0.13 (0.25)	
	POT02S									0.10 (0.20)	0.16 (0.32)			0.06 (0.13)						0.21 (0.42)			
	SLW	0.14 (0.16)																					
	TN		2.58 (2.51)	1.84 (2.16)	0.96 (0.92)		1.03 (0.87)	1.48 (1.37)	0.26 (0.52)	1.43 (1.28)	3.28 (2.88)		1.50 (1.29)	1.61 (1.21)	0.74 (0.91)	1.58 (1.88)	0.66 (0.43)		1.82 (0.83)	0.72 (0.73)	0.13 (0.25)	1.18 (0.84)	0.33 (0.46)
	OT16S		0.16 (0.20)	0.69 (0.59)		0.63 (0.58)	0.35 (0.46)		0.35 (0.47)	0.15 (0.29)	1.21 (1.00)	0.27 (0.36)	0.41 (0.32)	0.17 (0.33)	0.07 (0.15)			0.16 (0.22)					
	OT8S			0.24 (0.47)			0.27 (0.35)		0.34 (0.34)	0.24 (0.31)	0.25 (0.24)				0.15 (0.20)		0.22 (0.43)						
	BT8W		0.07 (0.14)																				
Paddlefish	**EFS**							0.99 (1.99)															
	HNS															0.14 (0.29)							
Longnose gar	**EFS**									0.89 (1.78)	2.88 (3.98)		1.07 (2.15)	4.29 (3.14)		2.15 (2.81)			2.01 (4.03)			3.20 (4.65)	
	HNS								0.14 (0.29)												0.13 (0.25)		
	SHNS																		0.14 (0.29)				
	MFS									0.20 (0.40)		0.25 (0.50)	0.50 (0.58)										
	POT02S										0.19 (0.38)												
	TN							0.11 (0.22)									0.10 (0.19)					0.17 (0.34)	
	OT16S																		0.11 (0.22)				
	OT8S															0.14 (0.28)							

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Shortnose gar	**EFS**		5.00 (10.00)	6.10 (6.25)	14.35 (10.29)	2.13 (2.75)	1.33 (2.66)		1.57 (3.14)	5.71 (3.75)	1.02 (2.04)		0.88 (1.76)		0.94 (1.87)	1.14 (2.27)	0.92 (1.85)	0.98 (1.97)			1.17 (2.34)	1.05 (2.11)
	HNS											0.13 (0.25)	0.25 (0.33)			0.13 (0.25)			0.13 (0.25)	0.13 (0.25)		0.13 (0.25)
	SHNS										0.13 (0.25)		0.13 (0.25)								0.13 (0.25)	
	MFS		1.25 (1.26)	0.20 (0.40)	1.00 (1.15)	2.00 (2.83)				5.75 (10.84)	0.25 (0.50)					0.67 (0.67)	0.25 (0.50)	0.25 (0.50)				
	POT02S																		0.25 (0.34)			
	TN						0.11 (0.22)		0.09 (0.18)							0.09 (0.17)		0.08 (0.17)				
Goldeye	**EFS**	15.95 (17.31)	31.09 (15.29)	28.45 (25.54)	18.65 (17.22)	14.13 (9.24)	13.69 (3.79)	5.87 (7.16)	3.79 (4.98)	22.55 (11.75)	5.79 (5.00)	8.24 (4.89)	20.08 (7.74)		5.63 (7.27)	5.76 (4.47)	1.14 (2.27)	3.24 (3.06)		5.46 (5.83)	11.03 (17.08)	3.83 (5.61)
	HNS				1.14 (1.19)		0.43 (0.59)	1.71 (1.84)			0.63 (0.53)	0.25 (0.33)	0.25 (0.33)	0.50 (0.38)	0.29 (0.37)	0.50 (0.76)	0.13 (0.25)	0.14 (0.29)	0.25 (0.33)	0.25 (0.33)	0.43 (0.59)	0.50 (0.38)
	TN		1.96 (1.59)		0.58 (0.83)	0.13 (0.26)	0.77 (0.87)	0.20 (0.40)	0.25 (0.50)		0.44 (0.59)	0.35 (0.50)	0.53 (0.48)		1.76 (1.97)	0.78 (0.76)		0.52 (0.57)	0.42 (0.54)	0.25 (0.51)	0.41 (0.39)	0.57 (1.14)
	OT16S		0.10 (0.19)									0.14 (0.29)										
Mooneye	**EFS**											2.11 (2.73)										
Unidentified herring	**MFS**											2.75 (5.50)										
Skipjack herring	**POT02S**								0.24 (0.36)													
	TN																					0.08 (0.16)
Gizzard shad	**EFS**	1.80 (2.39)	37.78 (28.03)		20.93 (11.87)	1.00 (2.00)	3.29 (4.77)	27.16 (17.23)	2.64 (3.54)		1.09 (2.18)				31.87 (12.04)	5.55 (5.67)	126.59 (198.06)	113.76 (40.43)		19.64 (16.41)	24.61 (18.66)	57.42 (36.63)
	MFS			0.20 (0.40)								6.50 (10.50)	1.20 (1.17)	0.75 (0.96)		1.33 (2.67)		24.75 (49.50)	0.50 (0.58)	6.25 (12.50)	0.40 (0.80)	
	POT02S												2.65 (3.82)			0.26 (0.52)					0.23 (0.45)	
	OT16S				0.58 (1.17)												0.10 (0.20)		0.17 (0.33)		0.18 (0.37)	0.24 (0.47)
Unidentified minnow	**MFS**		1.25 (2.50)			0.75 (1.50)	0.25 (0.50)		0.20 (0.40)		1.00 (2.00)	25.00 (39.38)	0.40 (0.80)	0.50 (0.58)	0.25 (0.50)			0.25 (0.50)				
	POT02S		1.36 (1.89)							0.29 (0.37)					0.33 (0.67)	1.17 (1.37)		0.41 (0.81)	0.55 (0.61)			
	OT8S							0.09 (0.19)														

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Speckled chub	**MFS**								0.20 (0.40)													
	POT02S		3.55 (4.46)	0.22 (0.44)			1.18 (1.82)			0.75 (0.76)								2.78 (2.14)	0.59 (0.93)		2.08 (2.55)	1.37 (1.46)
	OT16S	0.25 (0.50)	1.10 (1.05)	1.38 (2.76)	0.35 (0.38)				1.30 (1.06)	0.65 (0.80)	0.11 (0.22)						0.23 (0.46)			0.09 (0.18)	0.81 (1.05)	
	OT8S			3.77 (1.38)		0.40 (0.32)	0.84 (1.11)	0.10 (0.19)	0.09 (0.19)	0.15 (0.30)							0.79 (0.53)		1.64 (2.32)	3.03 (1.42)	3.38 (1.77)	1.50 (1.36)
	BT8W	0.09 (0.18)			0.29 (0.43)																	
Sturgeon chub	**POT02S**																		0.59 (0.93)			
	OT8S						0.14 (0.29)	0.29 (0.40)										0.13 (0.25)				
Silver chub	**EFS**	5.39 (3.57)	3.78 (7.56)		2.28 (3.01)	1.22 (2.44)	1.78 (3.56)		0.79 (1.57)			1.12 (2.25)	1.03 (2.06)		3.08 (4.10)		2.93 (2.89)				10.84 (10.95)	1.18 (2.36)
	SHNS	0.38 (0.37)	0.88 (0.88)																			
	MFS	1.00 (1.41)	4.00 (7.35)			1.75 (1.50)			1.40 (1.50)	0.75 (0.96)	5.00 (6.22)	3.25 (2.06)	2.40 (2.06)	15.50 (12.77)	0.75 (0.96)	10.67 (9.40)	9.25 (10.37)	1.25 (0.96)	1.25 (1.50)	2.00 (0.82)	0.60 (0.49)	0.25 (0.50)
	POT02S		0.71 (1.43)	7.25 (6.66)			0.71 (1.41)		0.40 (0.60)	6.36 (4.57)		7.38 (7.29)	9.95 (7.52)		4.30 (4.80)	23.50 (23.97)		9.01 (9.33)	26.77 (11.90)		8.14 (7.95)	6.70 (6.58)
	OT16S	2.12 (1.09)	19.37 (23.48)	3.84 (6.06)	1.99 (1.69)	0.33 (0.33)	0.40 (0.39)	0.07 (0.14)	0.15 (0.19)	0.58 (0.63)	1.30 (1.11)	1.44 (1.54)	0.80 (1.21)	0.54 (0.42)	0.07 (0.13)		5.71 (4.23)	0.36 (0.71)	2.17 (2.27)	2.99 (2.59)	0.18 (0.23)	1.60 (1.16)
	OT8S		2.93 (2.09)	10.43 (3.94)		0.34 (0.35)	0.13 (0.25)	0.10 (0.20)	0.19 (0.37)	0.42 (0.34)	0.30 (0.45)	0.09 (0.19)	0.34 (0.68)	0.37 (0.37)	1.69 (3.01)	6.40 (6.08)	0.31 (0.47)	1.35 (1.65)	14.69 (13.44)	5.16 (3.11)	1.83 (2.12)	4.37 (4.06)
	BT8W	1.43 (0.73)			0.50 (0.85)																	
Red shiner	**EFS**				3.05 (6.11)			4.26 (6.18)	9.76 (7.24)	0.85 (1.70)		1.92 (2.49)			6.23 (7.94)			2.89 (4.12)		0.97 (1.94)	5.75 (4.18)	1.18 (2.36)
	MFS	0.50 (1.00)	1.75 (2.87)	2.80 (2.04)	28.33 (24.50)	23.75 (27.79)	3.00 (3.37)	123.33 (218.67)	17.60 (13.47)	0.50 (1.00)	13.25 (7.93)	2.75 (3.10)	3.80 (3.06)	13.50 (13.38)	1.25 (1.50)	1.33 (1.76)	17.25 (29.84)	1.00 (0.82)	1.75 (2.06)	19.00 (26.17)	0.60 (1.20)	0.25 (0.50)
	POT02S						0.94 (1.37)		1.04 (0.64)	0.96 (0.83)			0.63 (1.25)		0.51 (0.69)	1.01 (0.79)		0.41 (0.81)	0.51 (0.44)			
	OT16S	0.16 (0.20)												0.31 (0.32)						0.09 (0.18)		
	OT8S													0.08 (0.16)					0.20 (0.40)			
Spotfin shiner	**EFS**						1.08 (2.17)		5.52 (4.82)			1.12 (2.25)			3.36 (4.89)			1.76 (3.53)			4.33 (8.66)	
	MFS			0.60 (0.49)			2.75 (5.50)			0.50 (1.00)		4.75 (3.20)	0.80 (0.75)		1.00 (1.41)	0.67 (0.67)		2.00 (1.83)	0.50 (1.00)		3.20 (3.87)	
	POT02S									2.42 (1.08)		0.21 (0.43)	0.08 (0.16)					0.22 (0.44)	0.32 (0.32)			
	OT8S											0.28 (0.57)						0.13 (0.25)				

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Emerald shiner	**EFS**	10.45 (8.78)	10.14 (15.83)	14.93 (7.32)	5.69 (4.57)	5.44 (7.07)	31.07 (11.20)	2.72 (3.54)	8.09 (5.49)	9.08 (8.05)	5.94 (3.51)	4.44 (6.72)	12.93 (5.59)		27.47 (26.33)		86.13 (65.20)	40.28 (44.53)		51.36 (33.79)	59.28 (37.21)	11.62 (15.79)
	SHNS																	0.14 (0.29)				
	MFS	108.25 (203.87)	46.50 (61.93)	48.80 (68.36)	12.33 (20.80)	32.00 (49.01)	154.25 (284.57)	1.00 (1.15)	0.60 (0.49)	4.25 (7.85)	0.50 (1.00)	0.50 (1.00)	2.60 (2.80)	30.00 (50.67)	3.75 (2.63)	2.00 (2.00)	18.25 (13.00)	15.25 (7.27)	3.25 (5.85)	13.75 (14.57)	4.00 (7.01)	0.50 (0.58)
	POT02S			9.54 (18.05)			1.65 (2.74)			10.71 (13.60)		0.27 (0.53)	3.89 (3.97)		6.94 (13.89)	4.56 (4.32)		7.32 (14.63)	1.60 (1.69)		0.37 (0.50)	2.99 (1.95)
	OT16S			0.15 (0.31)						0.15 (0.29)			0.16 (0.32)	0.15 (0.30)			0.15 (0.30)		0.17 (0.33)	0.19 (0.24)		
	OT8S			0.80 (1.60)										0.08 (0.16)			0.15 (0.30)	0.50 (1.00)	4.20 (4.95)			0.10 (0.19)
River shiner	**EFS**	1.80 (2.38)			4.91 (7.76)			1.02 (2.04)	1.08 (2.16)		2.04 (4.08)		0.89 (1.79)					1.99 (2.59)		1.30 (2.59)	9.96 (5.19)	1.14 (2.28)
	MFS	1.50 (2.38)	20.50 (16.78)	19.20 (14.72)	1.00 (2.00)	8.75 (11.70)	69.75 (111.70)	2.00 (4.00)	50.20 (88.66)	0.25 (0.50)	2.25 (1.89)	0.25 (0.50)	3.80 (3.25)	156.00 (263.68)	4.75 (3.77)	1.00 (2.00)	40.25 (41.36)	3.00 (2.45)	10.75 (10.78)	30.75 (32.16)	1.60 (2.73)	
	POT02S		0.36 (0.71)	7.35 (14.22)			14.93 (21.16)			9.77 (9.08)			0.13 (0.25)		1.74 (3.47)	5.83 (3.66)		2.44 (4.88)	2.10 (2.13)			15.43 (13.85)
	OT16S				0.32 (0.41)																	
	OT8S			0.20 (0.40)								0.07 (0.13)		0.08 (0.16)				0.13 (0.25)	0.17 (0.33)			0.20 (0.41)
Sand shiner	**EFS**	1.33 (1.75)							1.08 (2.16)		4.08 (8.16)						0.87 (1.75)	0.98 (1.97)			2.47 (3.33)	1.62 (3.24)
	MFS	0.25 (0.50)	8.00 (15.34)	4.20 (2.56)	0.33 (0.67)	5.50 (11.00)	6.25 (8.02)		4.40 (3.38)	1.50 (1.91)	7.00 (7.02)	0.75 (0.96)	0.60 (0.80)	82.75 (89.78)	3.75 (5.68)	11.00 (15.53)	31.75 (57.52)	3.50 (2.89)	0.75 (0.50)	8.00 (9.49)	12.20 (12.92)	
	POT02S			3.25 (6.49)			13.12 (17.03)		0.10 (0.20)	5.15 (5.40)		0.38 (0.77)			0.97 (1.23)	1.60 (1.19)		1.82 (3.20)	1.12 (1.10)			1.67 (2.82)
	OT16S			0.15 (0.31)	0.15 (0.29)			0.07 (0.14)	0.41 (0.59)		0.08 (0.16)											
	OT8S			0.50 (0.60)				0.20 (0.39)										0.25 (0.50)				
Bluntnose minnow	**MFS**						0.25 (0.50)		0.60 (0.80)	0.75 (1.50)		1.00 (1.15)	1.60 (2.73)	1.75 (3.50)								
	POT02S						0.24 (0.47)			0.62 (0.95)			0.28 (0.56)									
Fathead minnow	**EFS**			1.35 (2.70)																		
	MFS	0.50 (1.00)	0.25 (0.50)	1.80 (3.12)	4.67 (6.36)		2.00 (3.37)	1.33 (2.67)	0.80 (1.17)	0.25 (0.50)		0.25 (0.50)	5.40 (3.67)	1.00 (1.41)		1.33 (1.76)	0.25 (0.50)	1.00 (1.41)	0.50 (0.58)			
	POT02S			0.65 (1.30)									0.20 (0.40)			0.18 (0.36)			0.10 (0.21)			

Species	Gear	April 2006	April 2007	April 2008	May 2006	May 2007	May 2008	June 2006	June 2007	June 2008	July 2006	July 2007	July 2008	August 2006	August 2007	August 2008	September 2006	September 2007	September 2008	October 2006	October 2007	October 2008
Grass carp	**EFS**			2.54 (3.29)	4.64 (5.30)	1.33 (2.66)			1.07 (2.13)		1.11 (2.23)						0.92 (1.85)	1.97 (3.93)			1.74 (3.48)	
	HNS														0.29 (0.57)							
	POT02S									0.19 (0.38)												
	TN		0.26 (0.35)								0.18 (0.36)											
Common carp	**EFS**	8.45 (7.80)	5.21 (6.47)	8.10 (9.45)	2.28 (3.00)	1.23 (2.45)	15.44 (8.92)	7.14 (5.76)	11.28 (6.86)	8.11 (9.63)	8.29 (7.73)	11.34 (10.57)	14.30 (10.08)		12.39 (5.74)	6.11 (5.63)	8.28 (6.95)	4.04 (2.88)		5.41 (5.75)	8.48 (6.52)	4.78 (6.61)
	HNS		0.17 (0.33)			0.14 (0.29)	0.29 (0.37)			1.00 (0.98)			0.13 (0.25)									0.13 (0.25)
	SHNS									0.13 (0.25)												
	MFS								0.60 (1.20)			1.50 (1.29)	1.20 (1.94)			0.33 (0.67)					0.20 (0.40)	
	POT02S								0.29 (0.39)							0.18 (0.36)						
	TN		0.10 (0.19)	0.30 (0.60)	0.19 (0.38)	0.31 (0.41)							0.21 (0.28)			0.14 (0.28)						
	OT16S	0.07 (0.14)																				
	OT8S												0.13 (0.25)									
	BT8W	0.08 (0.15)																				
Silver carp	**TN**	0.32 (0.64)																				
Bighead carp	**HNS**		0.17 (0.33)				0.14 (0.29)					0.13 (0.25)			0.86 (0.92)							
Unidentified sucker	**MFS**			0.20 (0.40)								1.75 (3.50)				2.00 (4.00)						
River carpsucker	**EFS**	5.36 (3.93)	3.33 (6.67)	10.86 (7.05)	5.45 (6.24)	6.66 (6.87)	18.71 (9.60)	2.50 (3.30)	11.57 (8.69)	8.01 (7.62)	3.29 (3.22)	10.08 (7.86)	18.70 (13.36)		7.63 (7.83)		15.12 (7.87)	5.04 (7.81)		11.80 (6.13)	10.28 (9.40)	24.16 (24.11)
	HNS	0.14 (0.29)					0.57 (0.86)					0.25 (0.33)	0.50 (0.65)			0.13 (0.25)		0.14 (0.29)		0.38 (0.75)		0.13 (0.25)
	MFS	1.00 (1.41)	0.25 (0.50)	1.80 (3.12)	2.00 (3.06)	1.75 (2.22)	6.00 (12.00)	0.33 (0.67)	0.60 (1.20)	0.25 (0.50)	1.00 (0.82)		7.20 (8.70)	0.75 (1.50)	0.25 (0.50)	5.00 (6.43)	0.75 (0.96)	0.25 (0.50)	2.00 (2.16)		0.80 (1.17)	0.75 (1.50)
	POT02S			4.78 (3.68)			0.30 (0.61)			0.33 (0.44)			0.61 (0.96)			7.90 (7.17)		1.22 (2.44)	1.91 (1.37)			0.33 (0.48)
	TN			0.30 (0.60)			0.17 (0.33)					0.09 (0.19)	0.12 (0.25)			0.14 (0.28)						
	OT16S		0.10 (0.20)	0.48 (0.59)							0.08 (0.16)	0.08 (0.16)	0.32 (0.64)	0.07 (0.14)					0.17 (0.33)			0.14 (0.27)
	OT8S											0.07 (0.13)				0.43 (0.87)						

		April			May			June			July			August			September			October		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Quillback	**EFS**	3.34 (3.52)																				
	MFS	0.25 (0.50)		0.40 (0.49)																		
	TN																			0.14 (0.28)		
White sucker	**HNS**																0.13 (0.25)					
	MFS													0.25 (0.50)	0.25 (0.50)	1.33 (1.33)						
	POT02S															0.56 (0.76)						0.20 (0.41)
	OT16S														0.15 (0.29)							
	OT8S														0.17 (0.33)							
Blue sucker	**EFS**		3.69 (4.26)	1.19 (2.39)	3.00 (4.11)	2.45 (3.16)	5.89 (7.84)	7.32 (4.10)	3.07 (4.27)	4.61 (6.09)	2.23 (4.46)	2.59 (3.50)	1.92 (2.49)		10.28 (10.64)		8.73 (8.20)	4.29 (6.34)		10.48 (10.52)	7.86 (4.13)	11.51 (10.39)
	HNS					0.57 (0.40)		0.29 (0.37)	0.17 (0.33)		0.75 (0.73)	1.25 (1.45)	0.13 (0.25)	1.13 (1.98)	0.14 (0.29)	0.13 (0.25)	0.75 (0.82)	0.57 (0.59)		2.50 (1.89)	1.29 (1.94)	
	SHNS													0.13 (0.25)			0.13 (0.25)					
	MFS								0.40 (0.80)													
	TN	0.16 (0.31)			0.23 (0.46)			0.26 (0.52)	0.57 (1.14)	0.06 (0.11)	0.16 (0.32)		0.23 (0.22)				0.15 (0.20)	0.26 (0.35)	0.25 (0.51)	0.66 (0.47)		0.16 (0.32)
	OT16S							0.14 (0.18)	0.30 (0.39)		0.10 (0.20)			0.29 (0.29)			0.39 (0.79)			0.32 (0.42)		
	OT8S													0.16 (0.21)								
	BT8W				0.07 (0.14)																	
Smallmouth buffalo	**EFS**				2.25 (2.99)	2.22 (2.88)	0.89 (1.78)	1.48 (2.96)		0.93 (1.86)			2.87 (2.71)		1.86 (3.71)					2.27 (2.97)		
	HNS				0.14 (0.29)		0.14 (0.29)										0.13 (0.25)			0.13 (0.25)	0.14 (0.29)	
	MFS											10.75 (12.09)	0.40 (0.80)			2.33 (3.71)		1.25 (1.50)	0.25 (0.50)			
	POT02S																		0.42 (0.65)			
	TN		0.12 (0.24)			0.19 (0.25)				0.17 (0.34)		0.19 (0.39)										
	OT16S											0.08 (0.16)			0.07 (0.13)			0.13 (0.25)				
	OT8S											0.09 (0.19)	0.11 (0.23)					0.13 (0.25)				

Species	Gear	April			May			June			July			August			September			October		
		2006	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Bigmouth buffalo	**EFS**		1.67 (3.33)			2.33 (3.05)	0.99 (1.99)			0.93 (1.86)					1.21 (2.42)					1.25 (2.50)		
	HNS	0.14 (0.29)	0.17 (0.33)																			
	MFS								3.00 (2.97)			15.75 (14.86)										
	POT02S												0.28 (0.56)									
	TN						0.11 (0.22)			0.08 (0.17)												
Black buffalo	**MFS**								0.20 (0.40)													
Shorthead redhorse	**EFS**	2.43 (2.43)	3.62 (7.24)	2.54 (3.29)	15.98 (8.61)	2.23 (2.89)	8.29 (5.22)	6.88 (9.39)	12.32 (5.59)	23.39 (9.55)	9.23 (7.83)	6.40 (3.70)	21.74 (8.31)		16.23 (18.02)	1.06 (2.12)	4.48 (6.85)	12.18 (4.60)		11.42 (7.25)	12.50 (5.77)	2.36 (4.73)
	HNS							0.14 (0.29)	0.17 (0.33)	0.14 (0.29)		0.25 (0.50)	0.38 (0.37)	0.13 (0.25)	0.29 (0.37)			0.29 (0.37)		0.13 (0.25)	0.29 (0.57)	
	SHNS								0.20 (0.40)	0.13 (0.25)					0.25 (0.50)			0.14 (0.29)				
	MFS		0.75 (0.96)			0.25 (0.50)				0.25 (0.50)	0.50 (0.58)		0.80 (0.98)	0.25 (0.50)	0.25 (0.50)		0.50 (0.58)			0.75 (1.50)		
	POT02S			0.20 (0.41)					0.10 (0.20)	0.83 (0.85)			0.56 (1.11)		1.00 (1.37)			0.70 (0.71)	0.72 (1.24)		0.92 (1.31)	
	TN	0.15 (0.30)	0.18 (0.23)	0.72 (0.70)	0.18 (0.36)	0.78 (0.67)	0.37 (0.51)			0.10 (0.13)	0.28 (0.56)		1.15 (0.65)			0.09 (0.17)					0.13 (0.27)	
	OT16S		0.50 (1.00)		1.08 (0.83)		0.19 (0.38)	0.14 (0.28)	0.23 (0.30)	0.08 (0.16)		0.30 (0.39)					0.53 (0.76)	0.18 (0.36)	0.17 (0.33)		0.17 (0.35)	0.29 (0.37)
	OT8S		0.40 (0.48)			0.07 (0.15)								0.15 (0.30)		0.79 (0.92)					0.46 (0.69)	
	BT8W				0.07 (0.14)																	
Unidentified bullhead	**MFS**											0.25 (0.50)										
Black bullhead	**MFS**		0.25 (0.50)																			
Yellow bullhead	**MFS**			0.20 (0.40)																		
Brown bullhead	**MFS**																		0.50 (1.00)			
Blue catfish	**HNS**																	0.14 (0.29)				

Species	Gear	April 2006	April 2007	April 2008	May 2006	May 2007	May 2008	June 2006	June 2007	June 2008	July 2006	July 2007	July 2008	August 2006	August 2007	August 2008	September 2006	September 2007	September 2008	October 2006	October 2007	October 2008
Channel catfish	**EFS**	3.43 (3.55)	1.88 (3.76)	0.93 (1.86)	3.20 (3.19)		6.38 (5.55)	1.22 (2.45)	1.08 (2.16)	0.93 (1.86)		2.99 (4.09)	2.86 (2.71)		3.09 (2.95)		3.20 (4.66)	5.44 (6.48)			5.87 (9.43)	8.80 (11.90)
	HNS		1.67 (2.17)	0.57 (0.86)	0.71 (0.57)		0.14 (0.29)	0.71 (0.84)	0.67 (1.33)	0.14 (0.29)	0.13 (0.25)	0.50 (0.53)		0.13 (0.25)	0.29 (0.37)	0.13 (0.25)	0.25 (0.50)		0.25 (0.50)	0.13 (0.25)		0.63 (0.53)
	SHNS	1.00 (0.76)	2.00 (1.69)	0.29 (0.57)	1.13 (1.49)	0.29 (0.57)	0.57 (0.86)	0.25 (0.33)	0.40 (0.49)	0.13 (0.25)	0.63 (0.37)	0.57 (0.40)	0.50 (0.53)	0.75 (0.73)	0.63 (0.75)	0.50 (0.38)	0.13 (0.25)		0.14 (0.29)	0.33 (0.67)	0.75 (0.82)	0.25 (0.33)
	MFS	3.25 (1.71)	2.50 (2.38)	0.20 (0.40)	2.33 (3.71)	1.50 (0.58)	0.75 (0.96)	0.33 (0.67)	0.60 (0.80)	0.75 (0.50)	0.75 (1.50)	0.25 (0.50)	0.40 (0.49)	0.75 (0.96)	7.00 (2.94)	4.33 (3.71)	0.50 (0.58)	4.00 (3.74)	2.00 (2.31)	2.25 (2.87)	12.80 (9.35)	7.00 (10.13)
	POT02S		2.00 (4.00)	2.52 (1.74)			6.89 (2.08)		0.47 (0.38)	26.90 (20.44)		13.47 (9.71)	0.32 (0.41)		2.72 (3.29)	3.96 (3.77)		21.44 (14.40)	14.98 (11.59)		15.69 (7.59)	2.42 (3.17)
	TN	0.47 (0.66)	0.41 (0.52)	0.30 (0.60)		0.13 (0.25)	0.55 (0.82)	0.20 (0.40)	0.08 (0.17)	0.11 (0.15)		0.13 (0.25)	0.58 (0.63)	0.36 (0.71)		0.14 (0.28)		0.08 (0.17)	0.19 (0.37)		1.01 (0.42)	0.10 (0.20)
	OT16S	5.89 (9.18)	4.09 (3.26)	2.02 (3.21)	18.19 (17.33)		1.38 (0.96)	0.68 (0.69)	3.74 (2.08)	0.32 (0.42)	0.20 (0.26)	5.61 (5.06)	1.81 (1.67)	0.32 (0.32)		4.61 (4.87)	1.16 (1.07)	0.99 (0.88)	1.93 (0.70)	1.29 (0.88)	7.95 (5.56)	2.30 (2.54)
	OT8S		2.39 (0.94)	0.94 (1.49)		0.15 (0.31)	1.21 (1.66)	1.36 (0.99)	0.32 (0.41)	0.07 (0.14)	0.31 (0.32)	1.17 (0.93)	2.03 (2.09)	0.29 (0.58)	2.02 (1.94)	11.36 (11.46)		3.60 (2.71)	4.94 (3.33)	1.64 (1.55)	8.44 (5.10)	7.31 (6.25)
	BT8W	0.30 (0.22)			11.97 (8.78)																	
Flathead catfish	**EFS**				1.05 (2.10)		0.82 (1.65)		4.39 (4.89)		9.15 (5.99)	3.96 (4.06)	1.83 (2.36)		8.27 (7.04)	5.65 (4.38)	1.08 (2.15)	0.98 (1.97)			1.60 (3.21)	1.18 (2.36)
	HNS				0.29 (0.37)	0.71 (0.72)	0.14 (0.29)	0.14 (0.29)		0.43 (0.40)	0.25 (0.33)	0.50 (0.53)	1.63 (1.36)	0.13 (0.25)		0.25 (0.33)		0.14 (0.29)		0.13 (0.25)	0.14 (0.29)	
	SHNS					1.14 (0.81)		0.88 (0.96)	0.60 (0.49)	1.13 (0.80)	0.38 (0.37)	0.86 (0.52)	0.63 (0.53)	0.38 (0.37)	0.63 (0.53)	0.50 (0.65)	0.13 (0.25)	1.00 (0.87)	0.43 (0.59)	0.17 (0.33)	0.13 (0.25)	
	POT02S																		0.13 (0.25)			
	TN						0.22 (0.44)															0.08 (0.16)
	OT16S				0.33 (0.44)						0.08 (0.16)	0.16 (0.32)		0.11 (0.21)							0.09 (0.18)	0.13 (0.27)
	OT8S		0.14 (0.28)																0.20 (0.40)			0.23 (0.46)
Stonecat	**MFS**						0.25 (0.50)			0.25 (0.50)												
	POT02S								0.27 (0.42)	0.14 (0.29)											0.15 (0.29)	
	OT16S	1.25 (1.76)	0.25 (0.50)		1.67 (1.42)					0.24 (0.22)												
	OT8S		0.14 (0.28)							0.17 (0.34)						0.28 (0.33)					0.25 (0.50)	
	BT8W	1.80 (1.44)			0.81 (0.38)																	
Brook Silverside	**MFS**		0.75 (1.50)	0.20 (0.40)		0.50 (0.58)	1.25 (1.89)						0.20 (0.40)			0.33 (0.67)						
	POT02S												1.25 (1.32)									

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
White Perch	**OT16S**										0.07 (0.15)											
White bass	**EFS**			1.06 (2.11)			1.86 (2.44)	1.12 (2.23)					0.88 (1.76)		2.75 (5.50)		2.01 (2.66)	3.90 (4.09)		1.22 (2.43)	1.74 (3.48)	2.76 (3.64)
	HNS					0.14 (0.29)																
	MFS								0.20 (0.40)		1.00 (1.41)	1.25 (1.50)	3.60 (2.87)	0.25 (0.50)	1.00 (1.41)	1.67 (1.33)	0.50 (1.00)			0.75 (0.50)	0.20 (0.40)	
	POT02S												0.54 (0.95)			0.52 (0.69)			0.09 (0.19)			
	TN						0.12 (0.23)															
	OT16S												0.32 (0.37)				0.08 (0.15)				0.09 (0.17)	
	OT8S										0.08 (0.15)		0.11 (0.23)									
Unidentified sunfish	**MFS**								0.40 (0.49)			1.50 (1.29)		0.25 (0.50)								
Green sunfish	**EFS**	0.65 (1.31)																				
	SHNS							0.13 (0.25)														
	MFS		0.75 (0.96)		0.67 (1.33)		0.25 (0.50)	2.33 (3.71)	0.40 (0.80)	0.25 (0.50)				4.25 (5.97)			0.50 (1.00)	1.75 (2.87)	0.25 (0.50)	3.25 (6.50)	0.40 (0.49)	
	POT02S									0.94 (1.02)												0.12 (0.24)
	OT8S															0.15 (0.30)						
Pumkinseed sunfish	**MFS**													0.25 (0.50)								
Orangespotted sunfish	**EFS**	0.65 (1.31)				1.22 (2.44)	0.97 (1.94)														0.87 (1.73)	
	MFS	0.25 (0.50)	0.25 (0.50)		1.00 (2.00)	0.25 (0.50)	0.25 (0.50)	0.67 (0.67)	0.20 (0.40)		0.50 (1.00)		0.60 (0.80)	0.25 (0.50)	0.25 (0.50)	0.33 (0.67)	1.25 (0.96)	1.00 (2.00)	0.50 (1.00)	5.00 (8.68)	0.20 (0.40)	
	POT02S									0.49 (0.67)					0.17 (0.35)				0.15 (0.29)			0.48 (0.95)
	OT16S	0.08 (0.16)																				
Bluegill	**EFS**												2.07 (2.67)		1.21 (2.42)							
	SHNS														0.38 (0.75)							
	MFS					0.50 (0.58)	0.25 (0.50)		0.20 (0.40)	0.50 (0.58)		0.50 (0.58)	0.20 (0.40)		0.25 (0.50)	1.33 (1.76)	0.25 (0.50)	1.25 (0.96)	0.25 (0.50)		0.20 (0.40)	0.25 (0.50)
	POT02S						0.30 (0.61)			0.30 (0.39)			0.13 (0.25)		0.22 (0.44)							0.22 (0.44)
	OT16S												0.17 (0.33)			0.40 (0.80)						
	OT8S												0.13 (0.25)			0.69 (0.87)						

		April			May			June			July			August			September			October		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Redear sunfish	**TN**													0.36 (0.71)								
Smallmouth bass	**EFS**										1.21 (2.43)	1.84 (2.38)	1.92 (2.49)		2.79 (3.87)	1.06 (2.12)	0.87 (1.75)					
	SHNS												0.13 (0.25)	0.25 (0.33)								
	MFS										0.25 (0.50)		0.20 (0.40)									
	TN																	0.07 (0.14)				
Largemouth bass	**EFS**	0.79 (1.58)																				
	MFS								2.60 (5.20)				1.20 (0.98)					0.25 (0.50)				
White crappie	**MFS**										0.25 (0.50)	0.75 (0.96)	0.60 (1.20)				1.75 (2.36)				0.20 (0.40)	
Black crappie	**EFS**	0.79 (1.58)																				
	MFS	0.25 (0.50)				0.25 (0.50)												0.25 (0.50)		0.25 (0.50)		
	OT16S															0.19 (0.38)						
Johnny darter	**MFS**													0.25 (0.50)								
	POT02S															0.22 (0.43)		0.19 (0.38)	0.29 (0.59)			0.12 (0.24)
Yellow perch	**MFS**					0.25 (0.50)																
Sauger	**EFS**				4.02 (4.19)	2.55 (3.30)	1.08 (2.17)		6.17 (6.91)	1.84 (2.41)		1.12 (2.25)	4.44 (3.22)				4.12 (4.45)	4.38 (4.62)		3.76 (3.55)	2.77 (3.57)	1.14 (2.28)
	HNS	0.14 (0.29)			0.29 (0.37)									0.13 (0.25)				0.14 (0.29)	0.13 (0.25)	0.25 (0.33)		
	MFS				0.33 (0.67)			0.67 (1.33)	0.60 (1.20)		0.50 (0.58)		0.80 (1.17)				0.25 (0.50)			0.25 (0.50)		
	POT02S								0.17 (0.23)				0.59 (0.68)									
	TN		0.10 (0.19)									0.19 (0.37)	0.27 (0.40)					0.40 (0.32)			0.13 (0.27)	
	OT16S								0.08 (0.16)			0.08 (0.16)	0.32 (0.64)	0.15 (0.30)						0.26 (0.24)		
	OT8S												0.24 (0.28)									
Saugeye	**EFS**				1.26 (2.51)																	
	MFS					0.25 (0.50)																

Species	Gear	April 2006	April 2007	April 2008	May 2006	May 2007	May 2008	June 2006	June 2007	June 2008	July 2006	July 2007	July 2008	August 2006	August 2007	August 2008	September 2006	September 2007	September 2008	October 2006	October 2007	October 2008
Walleye	**EFS**				0.95 (1.90)				0.79 (1.57)	0.93 (1.86)							2.23 (2.93)					1.18 (2.36)
	HNS												0.13 (0.25)									
	TN											0.13 (0.25)	0.08 (0.16)			0.10 (0.19)						
	OT16S																0.08 (0.15)					
	OT8S										0.08 (0.15)											
Freshwater drum	**EFS**	1.19 (1.57)	18.12 (7.29)	2.12 (2.77)	1.90 (3.81)	1.00 (2.00)	11.80 (5.80)	4.13 (5.99)	2.08 (4.17)	5.78 (3.79)			3.98 (4.00)		12.16 (6.28)		6.96 (5.93)	7.47 (7.87)		13.48 (9.84)	19.64 (9.16)	14.58 (8.87)
	HNS					0.86 (0.92)		0.14 (0.29)		0.14 (0.29)			0.13 (0.25)	0.13 (0.25)	0.14 (0.29)	0.25 (0.33)	0.25 (0.33)	0.14 (0.29)	0.25 (0.33)		0.14 (0.29)	
	SHNS									0.13 (0.25)			0.38 (0.53)			0.25 (0.33)	0.75 (0.73)	0.14 (0.29)		0.50 (0.68)	0.13 (0.25)	
	MFS		0.25 (0.50)				0.25 (0.50)			0.75 (0.50)		14.00 (8.60)	41.00 (60.17)	0.25 (0.50)		3.67 (4.06)	0.25 (0.50)	0.50 (1.00)	0.25 (0.50)	0.25 (0.50)	0.40 (0.49)	0.50 (1.00)
	POT02S			0.11 (0.23)					0.30 (0.41)	0.32 (0.63)		0.38 (0.77)	1.51 (1.18)		0.22 (0.44)	0.17 (0.35)			0.21 (0.42)		0.45 (0.91)	0.57 (1.14)
	TN			0.30 (0.60)				0.20 (0.40)													0.16 (0.32)	
	OT16S			0.32 (0.37)				0.07 (0.14)				2.53 (2.41)	29.60 (13.01)	0.11 (0.21)		2.41 (3.81)	0.49 (0.75)	0.18 (0.36)	0.33 (0.67)	0.07 (0.14)	1.46 (1.20)	0.37 (0.48)
	OT8S			0.15 (0.31)				0.57 (0.74)			0.08 (0.15)	0.58 (0.58)	17.22 (13.95)	0.14 (0.29)		5.45 (5.22)			0.17 (0.33)		1.84 (1.56)	
Unidentified larval fish	**MFS**												0.60 (0.80)									

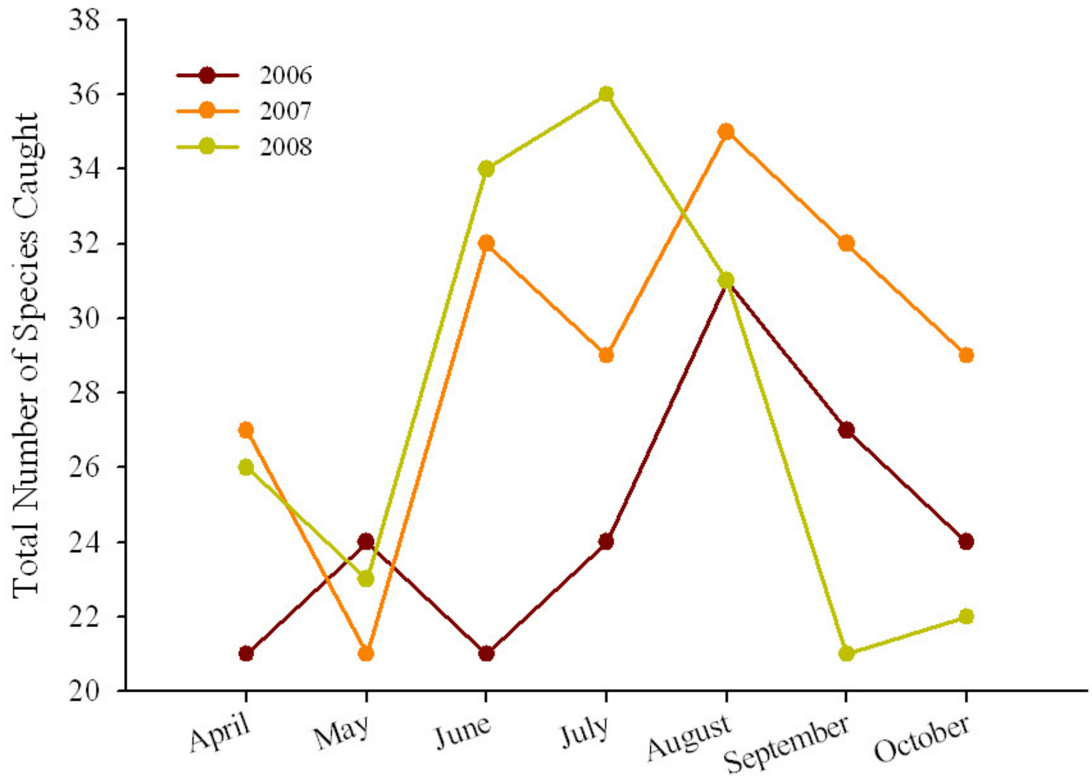


Figure III.4.1. Monthly species richness for Tobacco Island from 2006 - 2008.

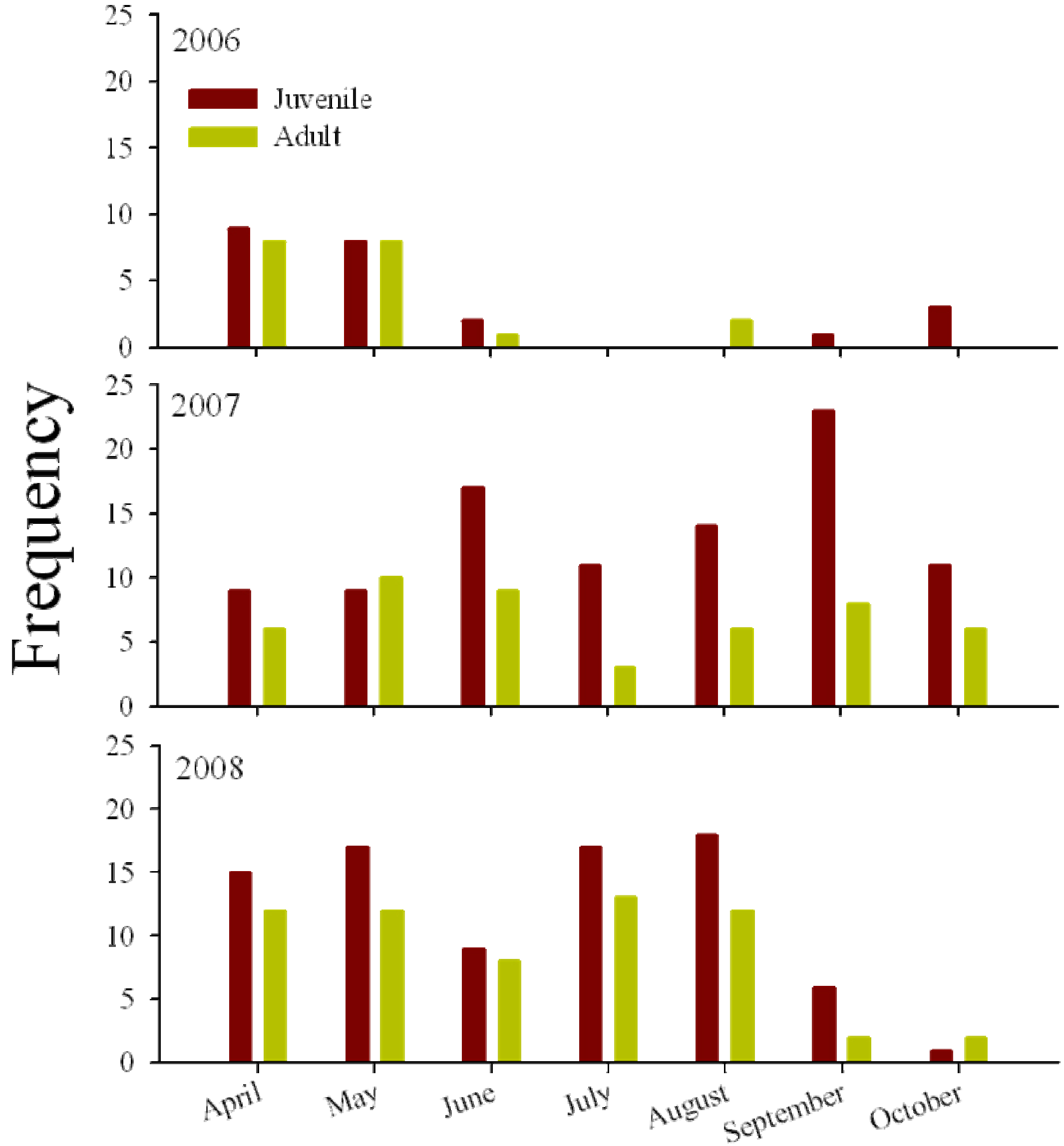


Figure III.4.2. Monthly frequency of juvenile (<540 mm) and adult (≥540 mm) shovelnose sturgeon caught at Tobacco Island from 2006 - 2008.

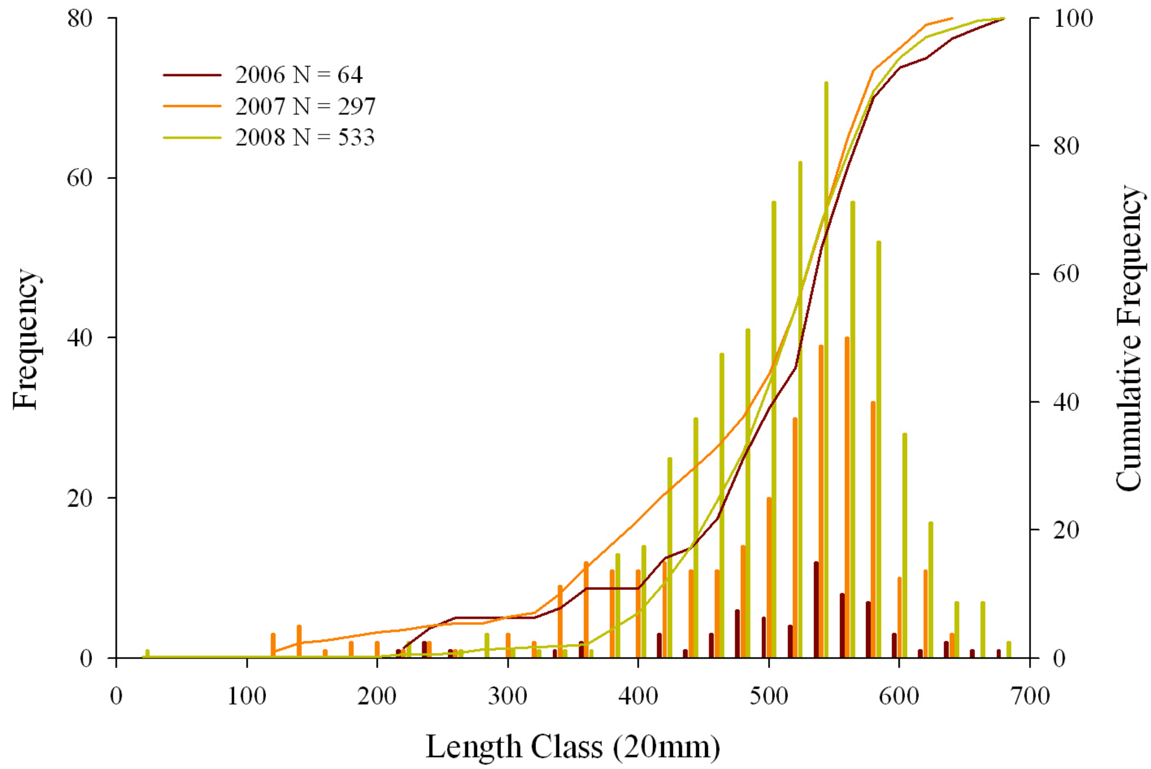


Figure III.4.3. Length frequency distributions and cumulative frequencies for measured shovelnose sturgeon (N) at Tobacco Island from 2006 - 2008.

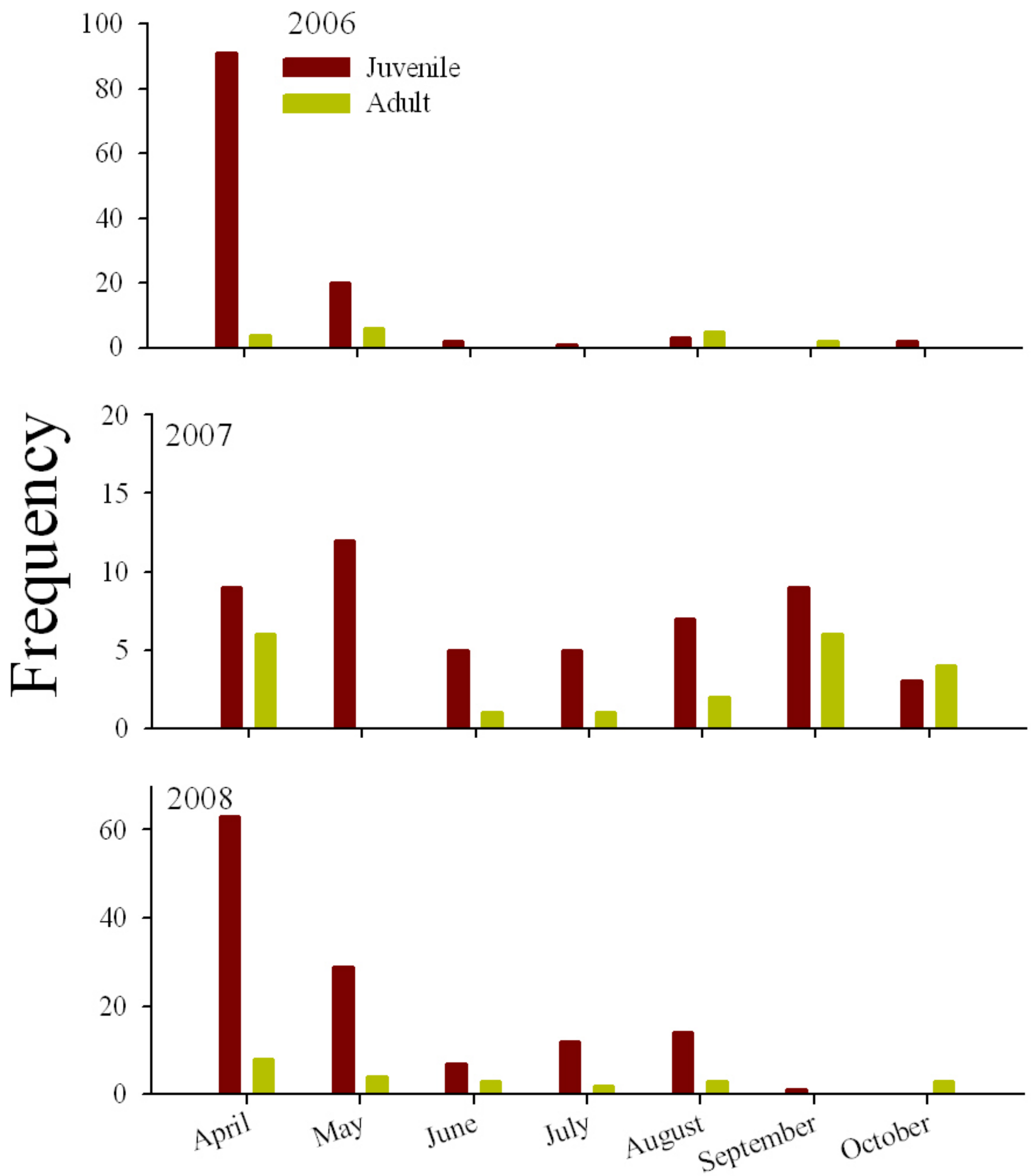


Figure III.4.4. Monthly frequency of juvenile (<356 mm) and adult (≥356 mm) goldeye caught at Tobacco Island from 2006 - 2008. Please note differences in scale of frequency.

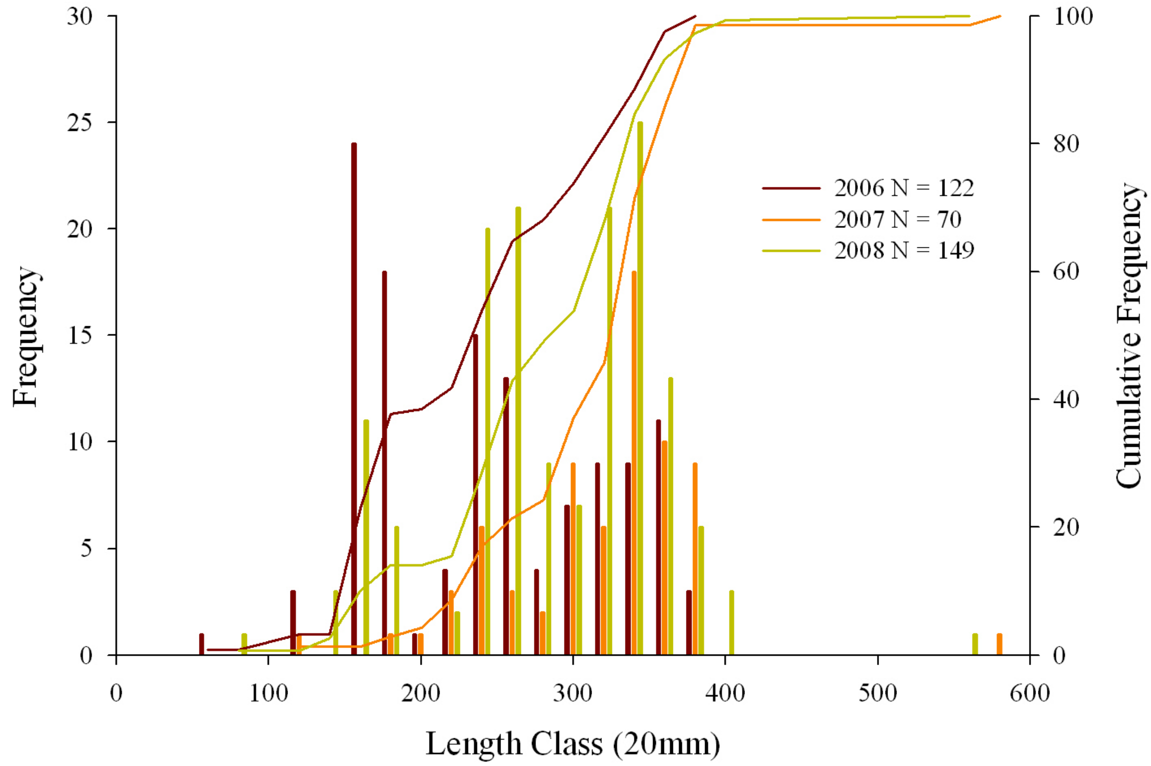


Figure III.4.5. Length frequency distributions and cumulative frequencies for measured goldeye (N) at Tobacco Island from 2006 - 2008.

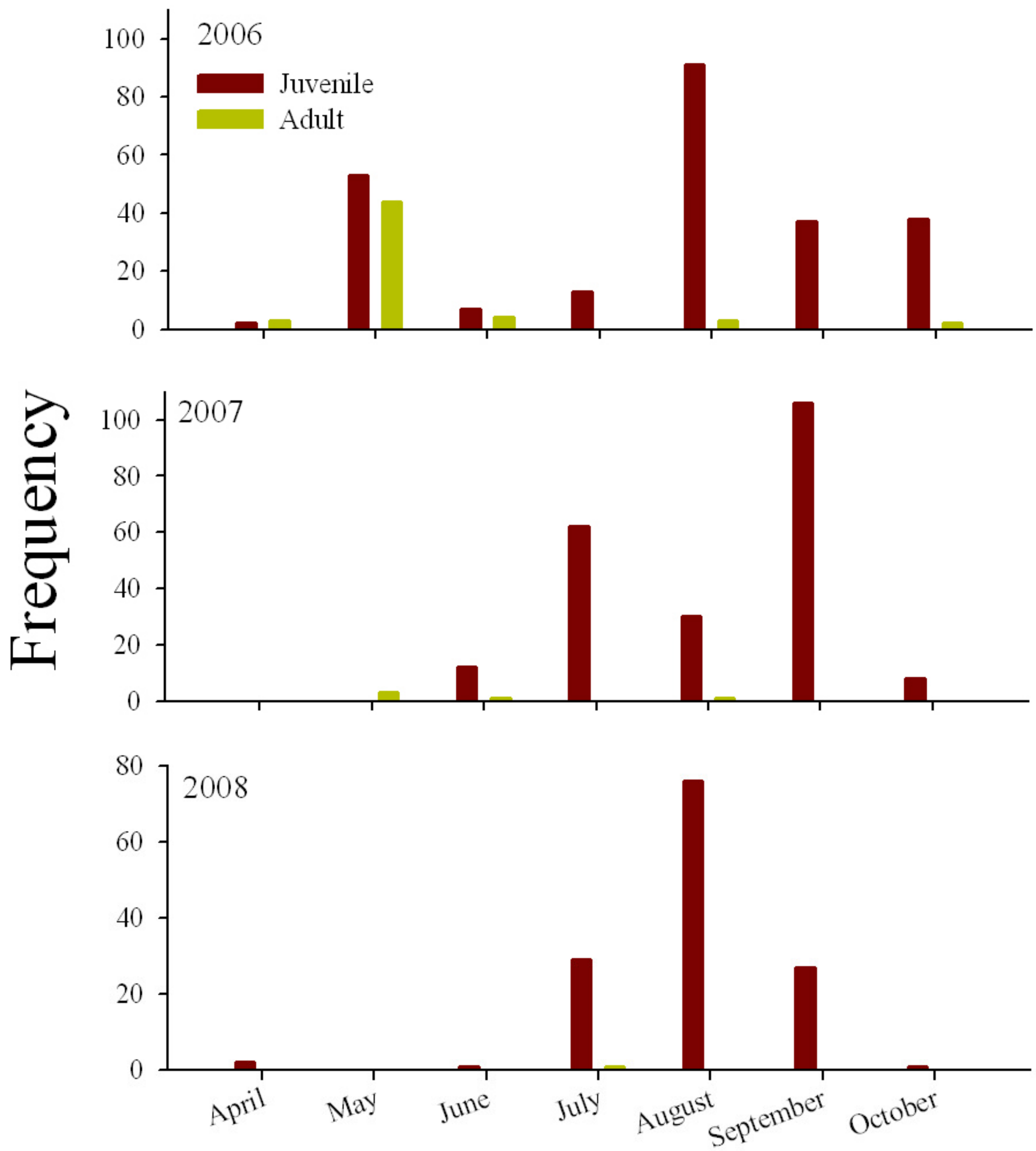


Figure III.4.6. Monthly frequency of juvenile (<229 mm) and adult (≥229 mm) gizzard shad caught at Tobacco Island from 2006 - 2008. Please note differences in scale of frequency.

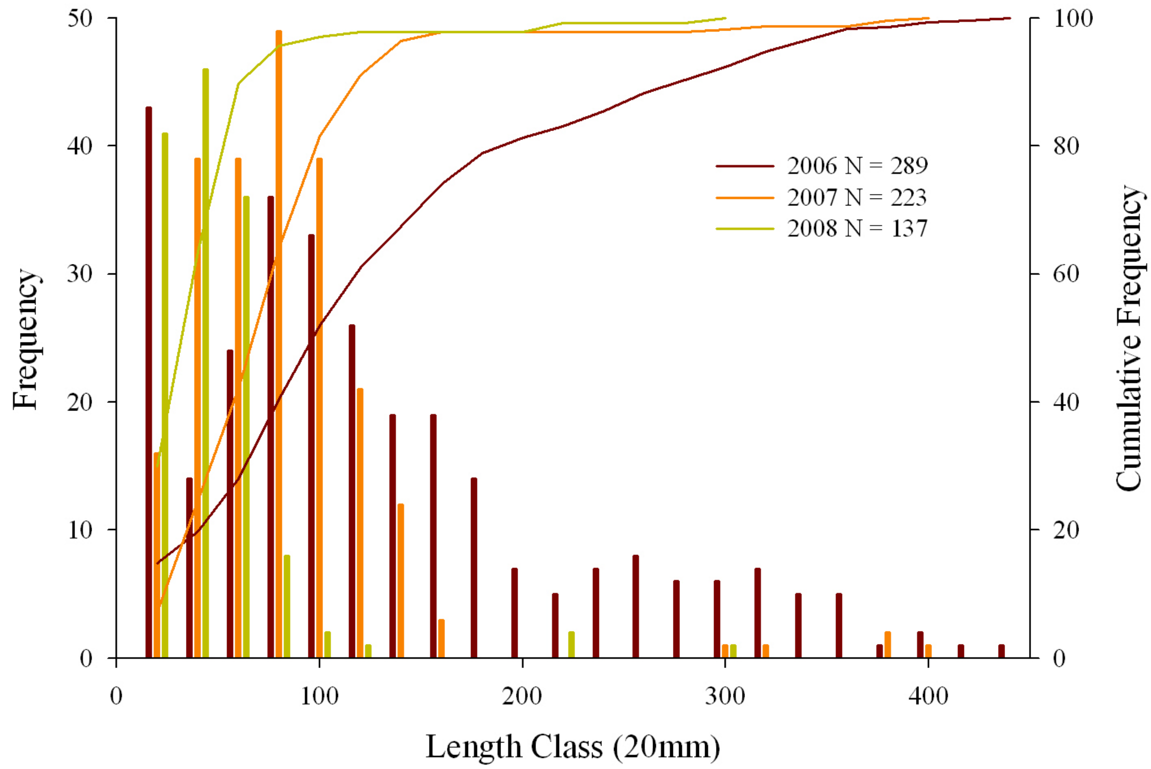


Figure III.4.7. Length frequency distributions and cumulative frequencies for measured gizzard shad (N) at Tobacco Island from 2006 - 2008.

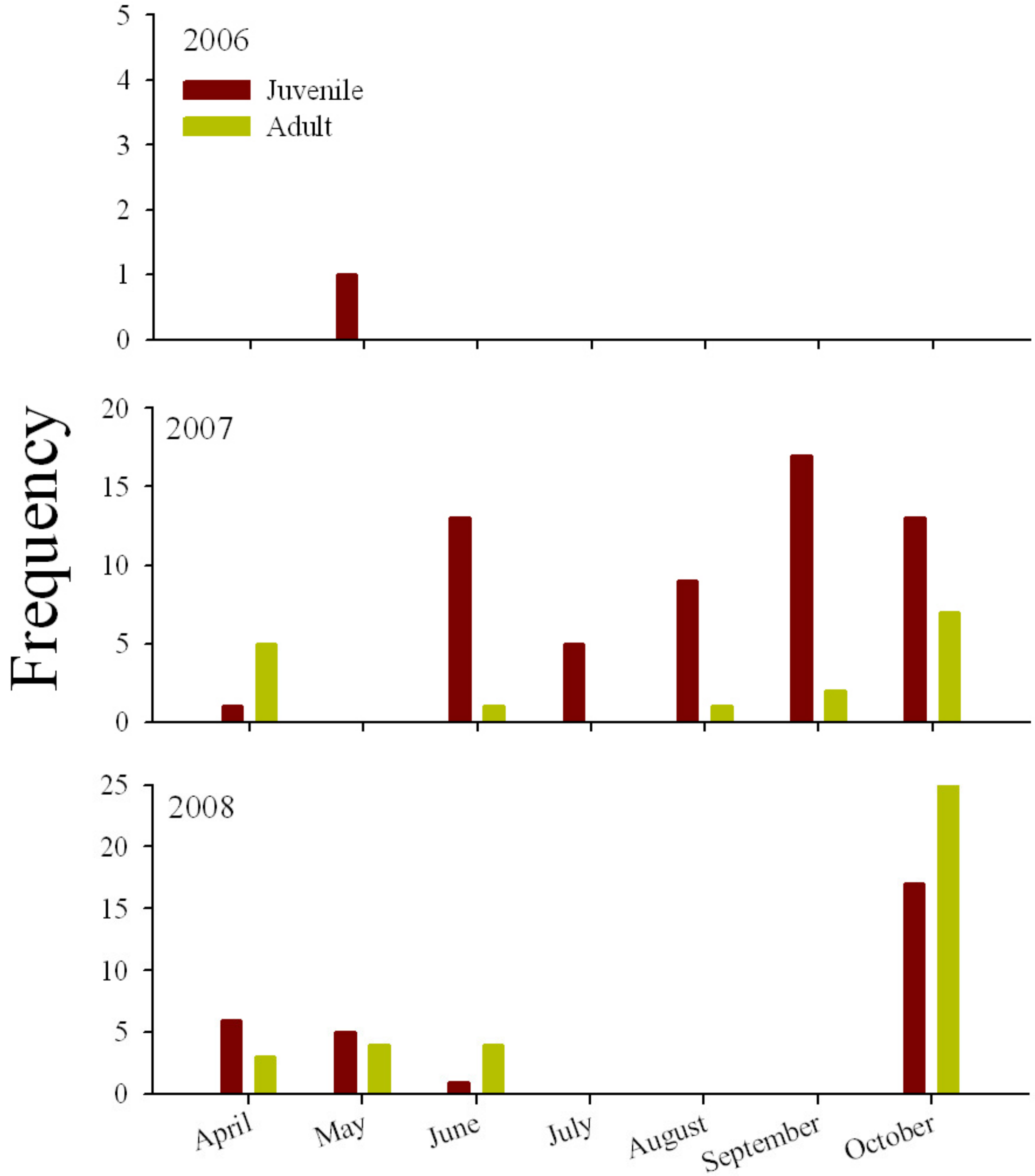


Figure III.4.8. Monthly frequency of juvenile (<40 mm) and adult (≥40 mm) speckled chubs caught at Tobacco Island from 2006 - 2008. Please note differences in scale of frequency.

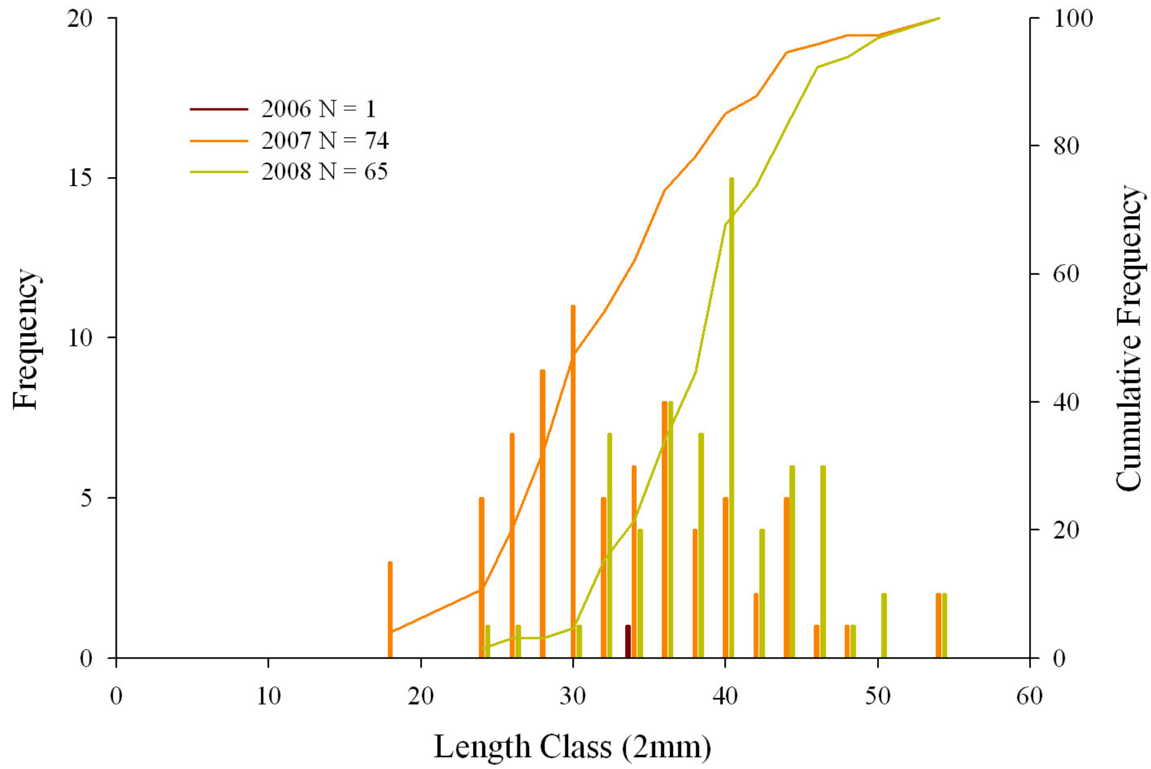


Figure III.4.9. Length frequency distributions and cumulative frequencies for measured speckled chubs (N) at Tobacco Island from 2006 - 2008.

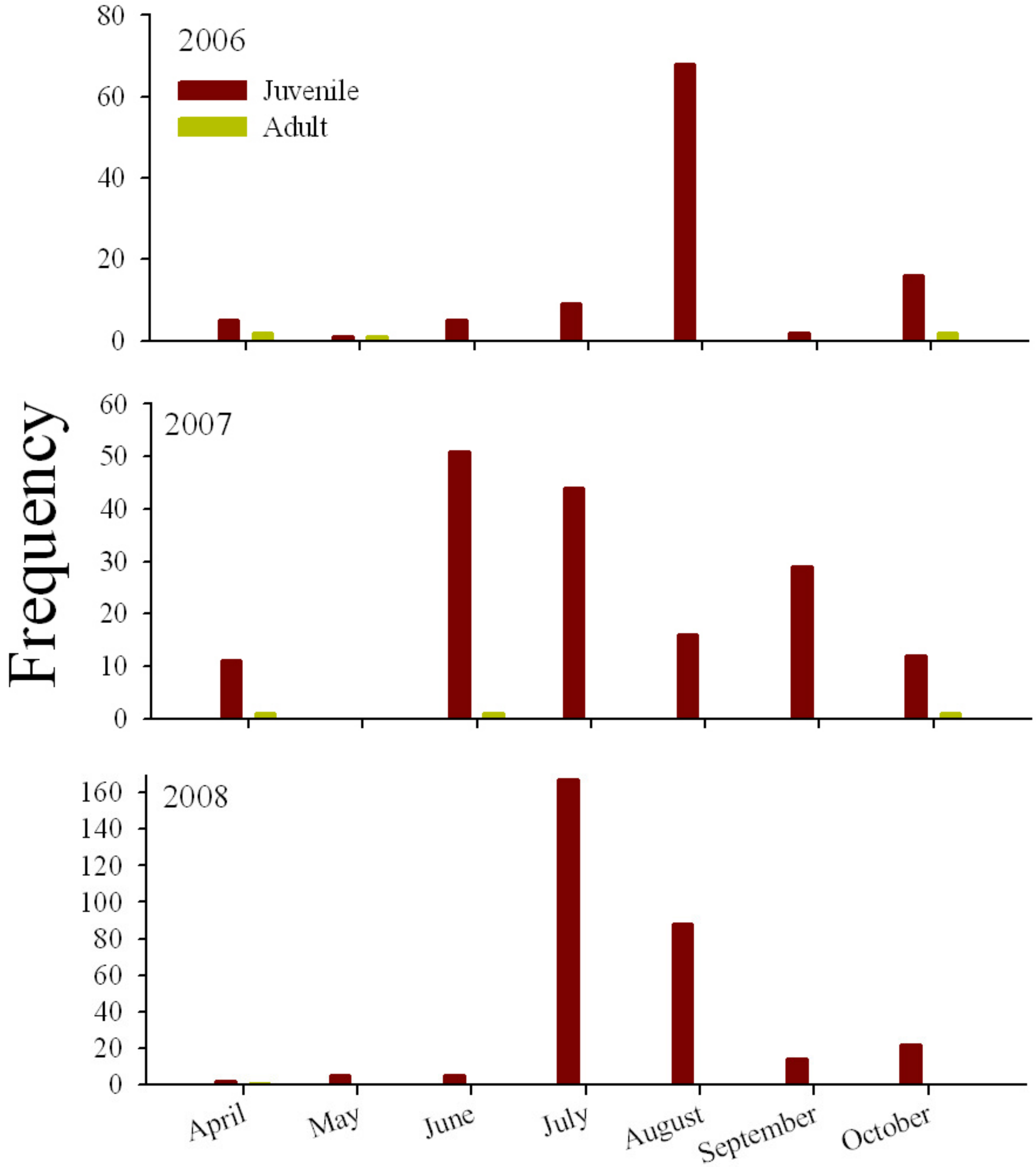


Figure III.4.10. Monthly frequency of juvenile (<89 mm) and adult (≥89 mm) silver chubs caught at Tobacco Island from 2006 - 2008. Please note differences in scale of frequency.

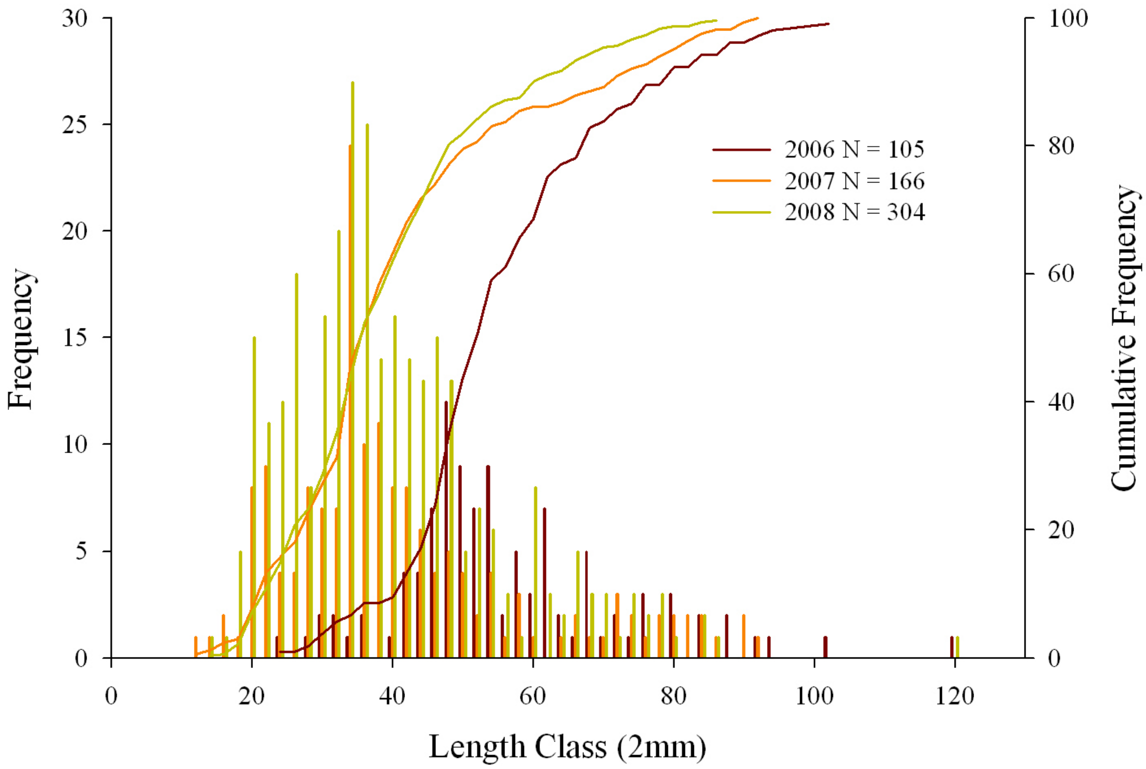


Figure III.4.11. Length frequency distributions and cumulative frequencies for measured silver chubs (N) at Tobacco Island from 2006 - 2008.

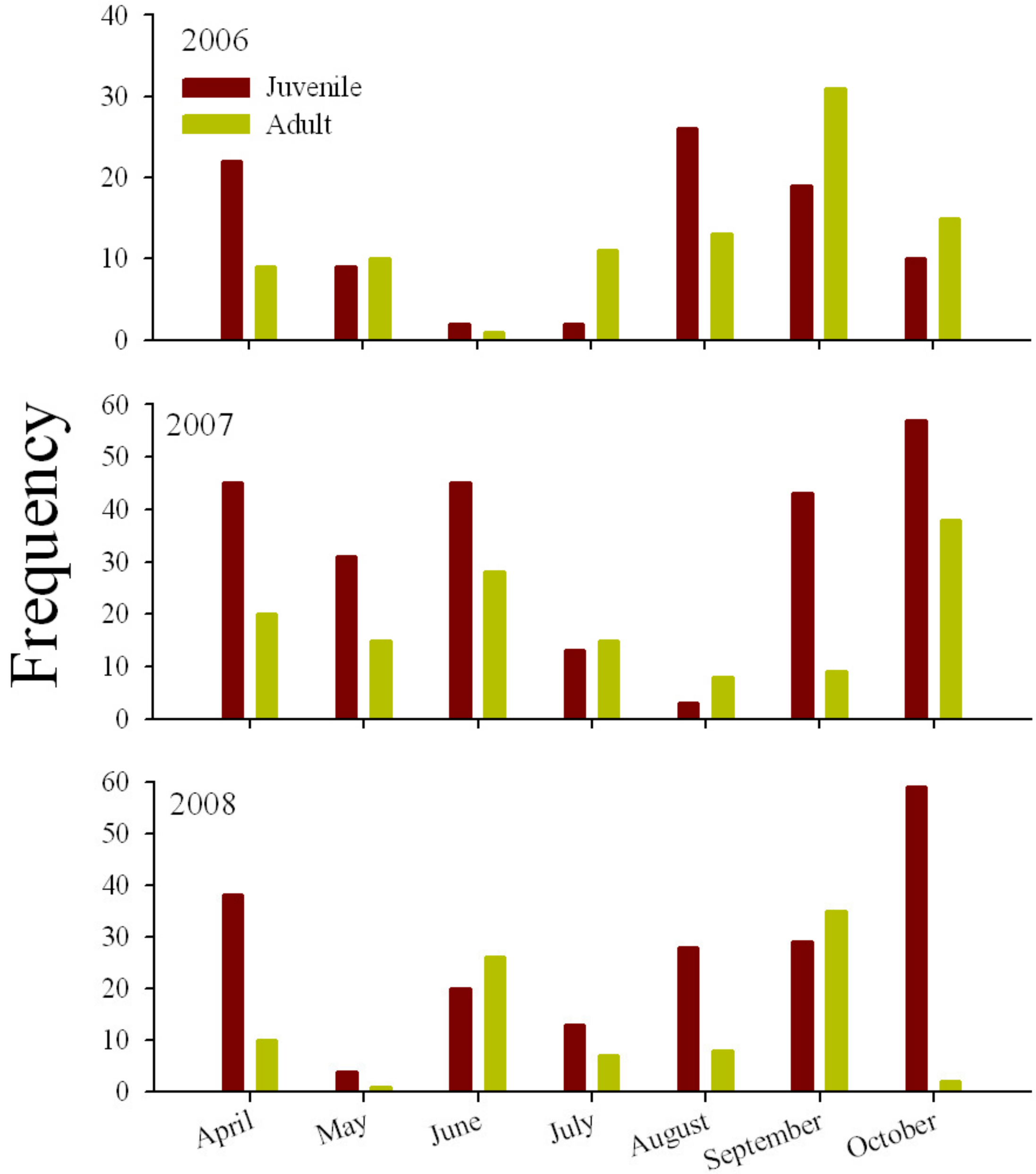


Figure III.4.12. Monthly frequency of juvenile (<46 mm) and adult (≥46 mm) red shiners caught at Tobacco Island from 2006 - 2008. Please note differences in scale of frequency.

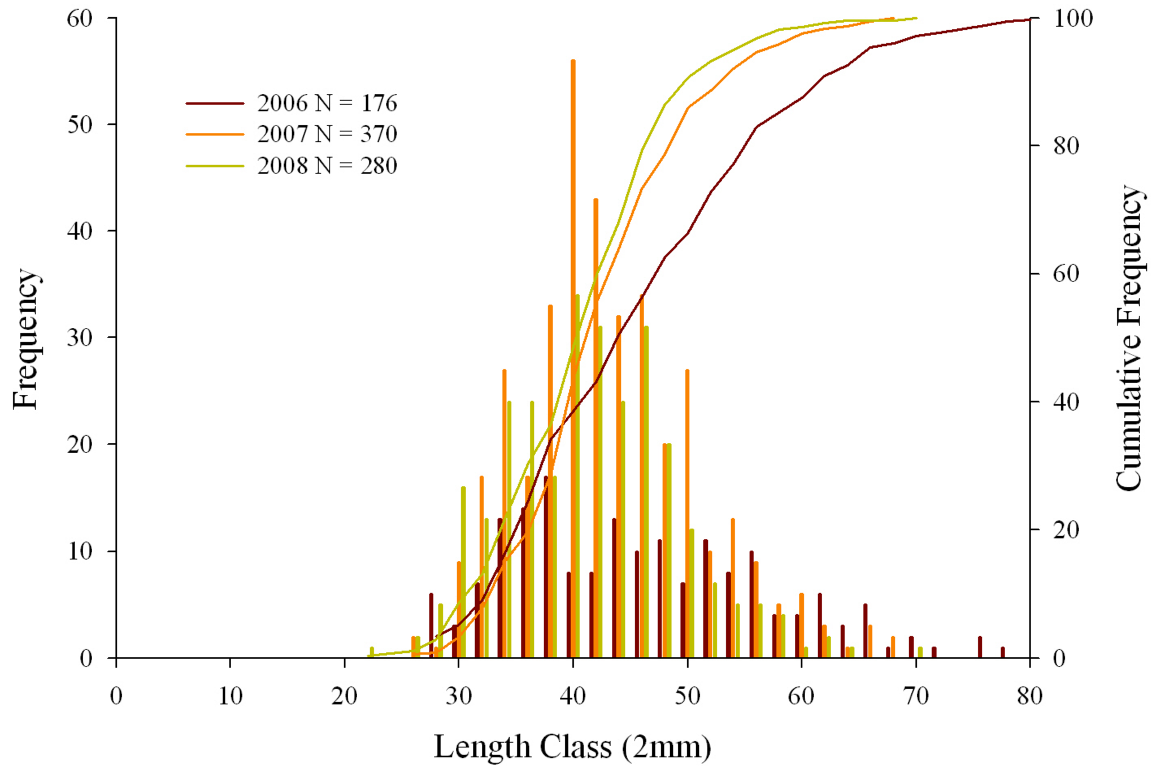


Figure III.4.13. Length frequency distributions and cumulative frequencies for measured red shiners (N) at Tobacco Island from 2006 - 2008.

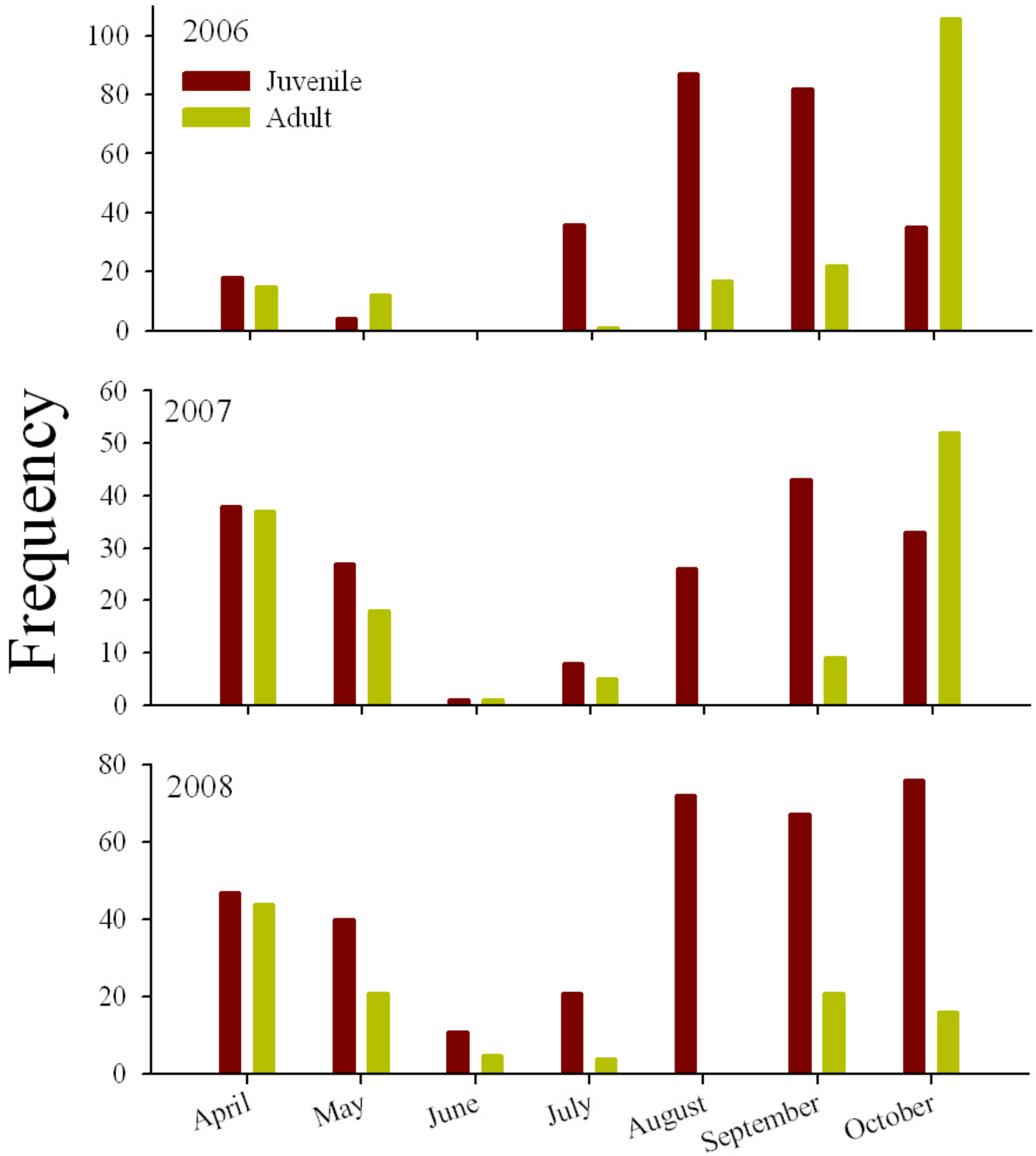


Figure III.4.14. Monthly frequency of juvenile (<64 mm) and adult (≥64 mm) emerald shiners caught at Tobacco Island from 2006 - 2008. Please note differences in scale of frequency.

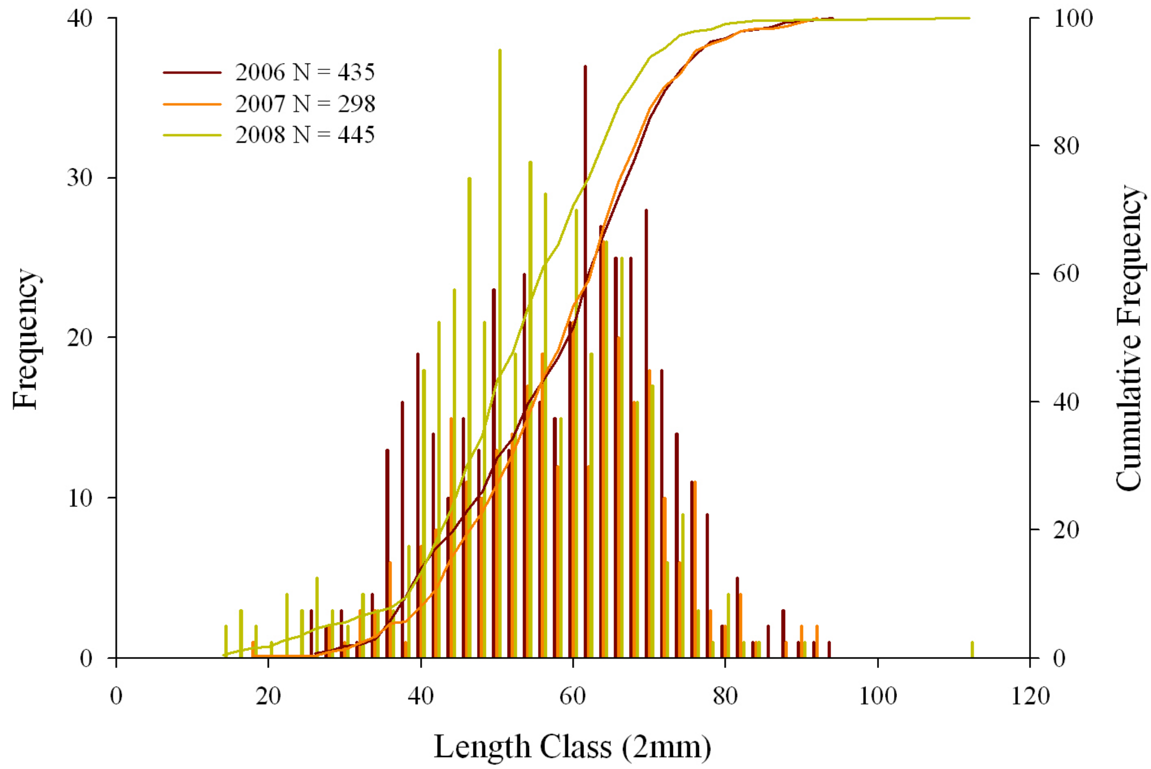


Figure III.4.15. Length frequency distributions and cumulative frequencies for measured emerald shiners (N) at Tobacco Island from 2006 - 2008.

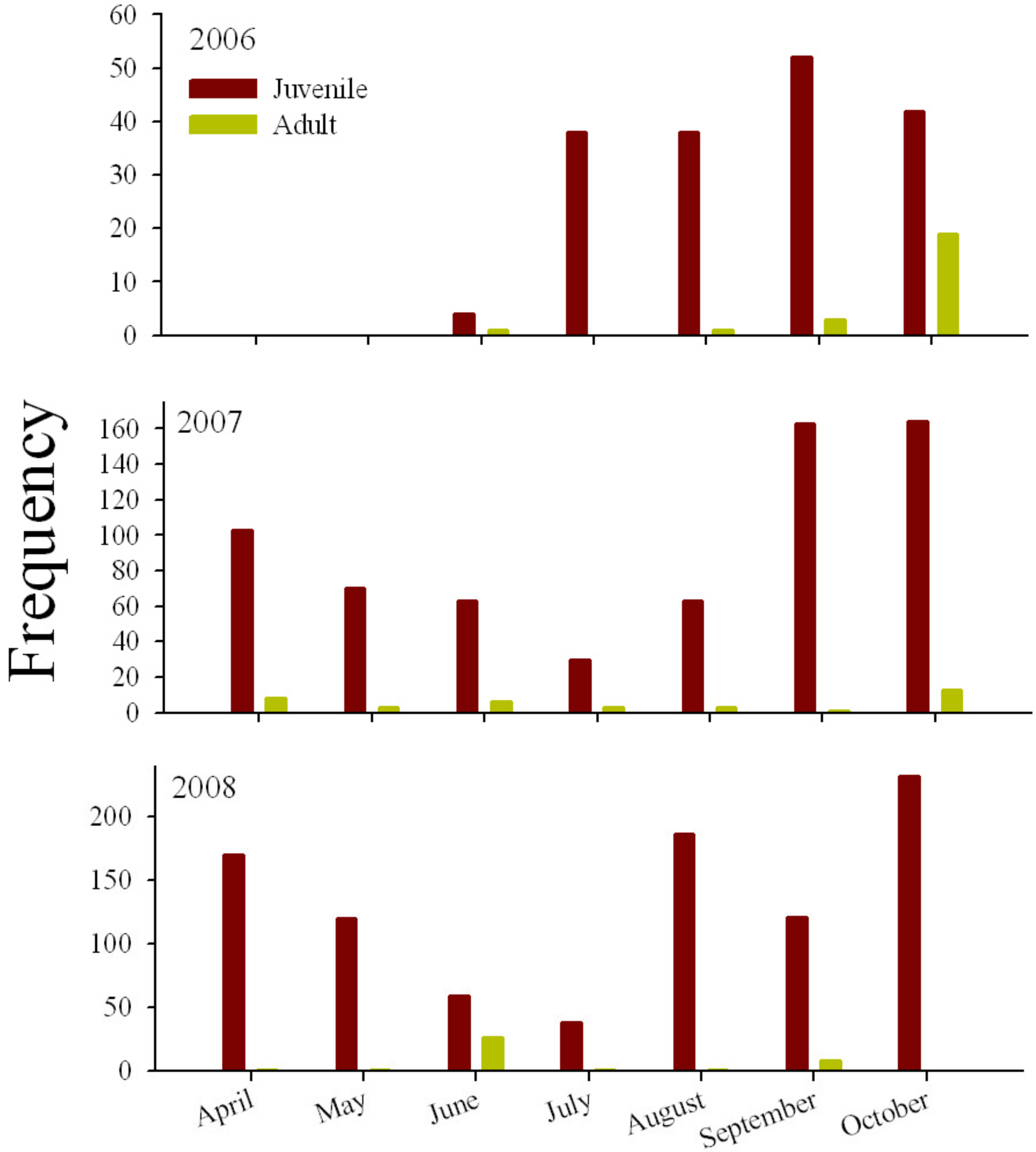


Figure III.4.16. Monthly frequency of juvenile (<51 mm) and adult (≥51 mm) river shiners caught at Tobacco Island from 2006 - 2008. Please note differences in scale of frequency.

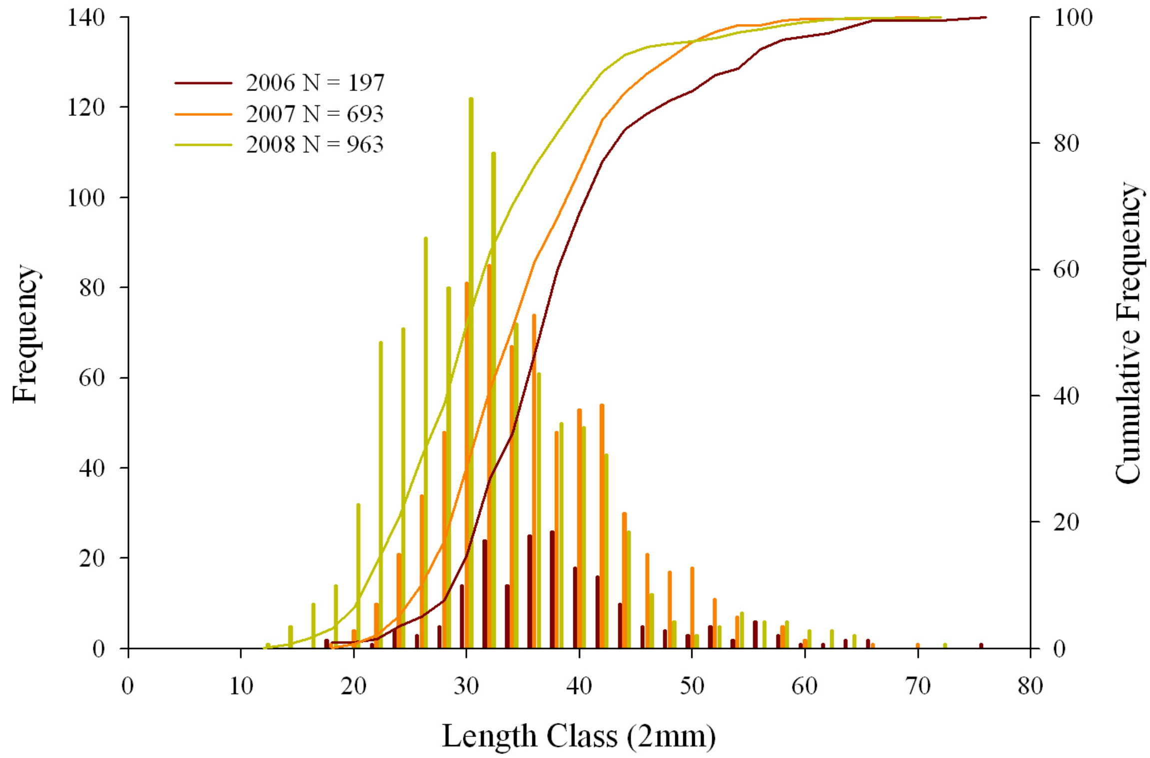


Figure III.4.17. Length frequency distributions and cumulative frequencies for measured river shiners (N) at Tobacco Island from 2006 - 2008.

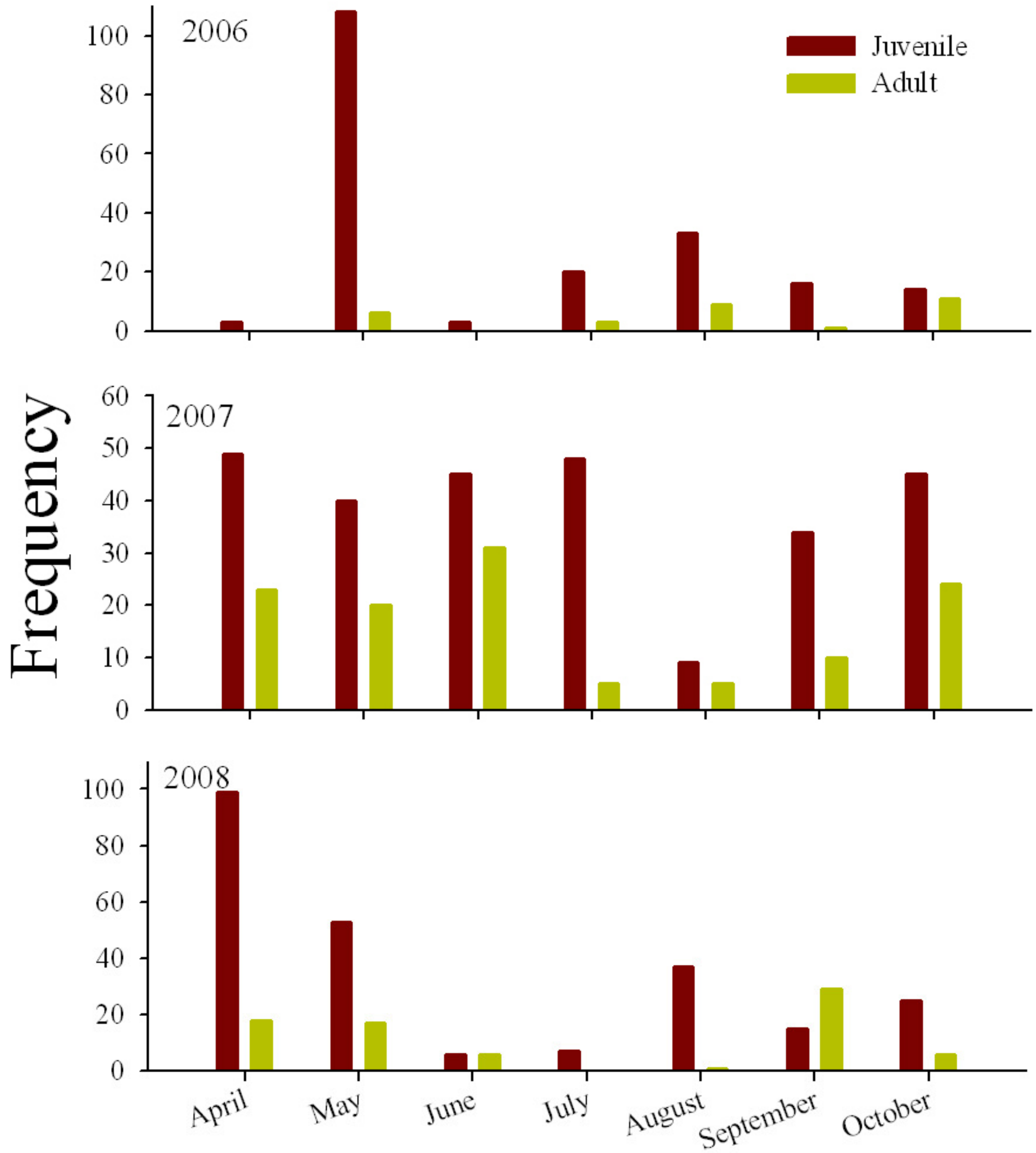


Figure III.4.18. Monthly frequency of juvenile (<43 mm) and adult (≥43 mm) sand shiners caught at Tobacco Island from 2006 - 2008. Please note differences in scale of frequency.

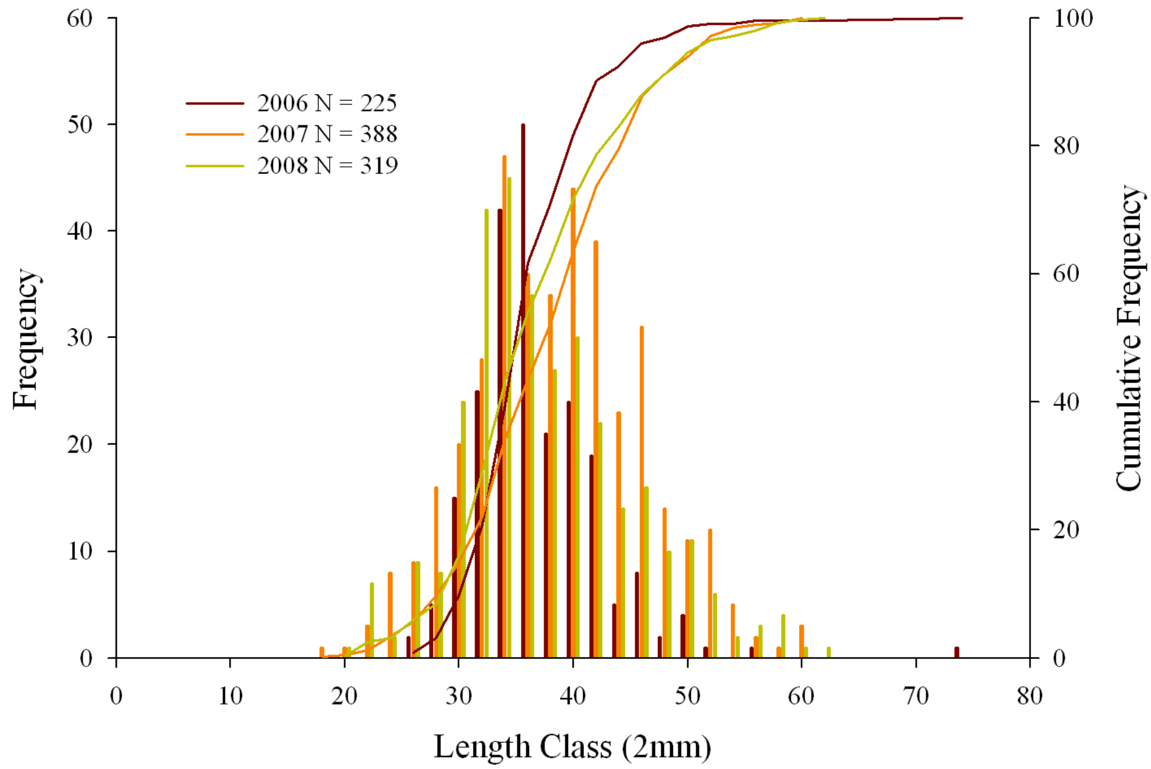


Figure III.4.19. Length frequency distributions and cumulative frequencies for measured sand shiners (N) at Tobacco Island from 2006 - 2008.

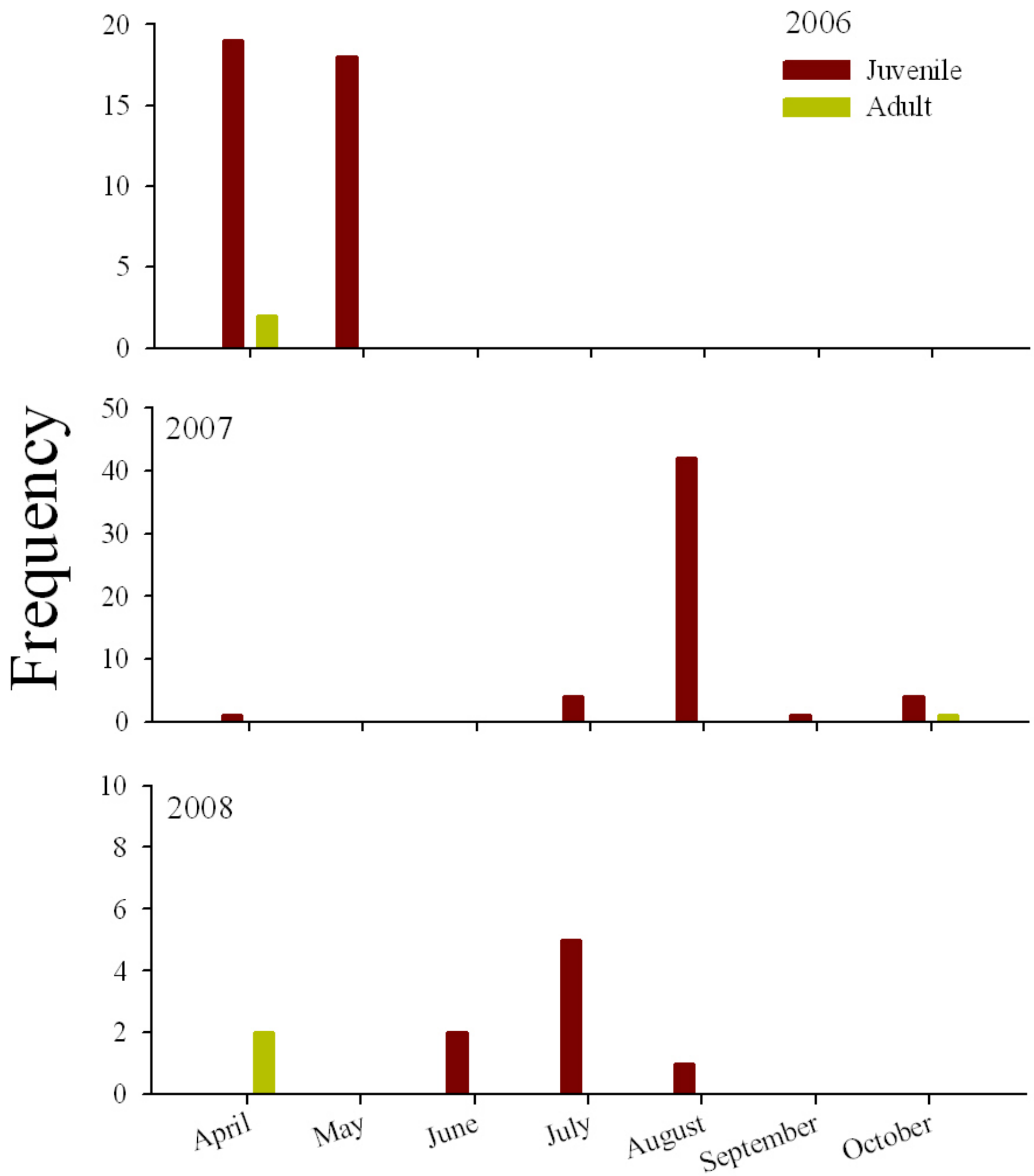


Figure III.4.20. Monthly frequency of juvenile (<41 mm) and adult (≥41 mm) fathead minnows caught at Tobacco Island from 2006 - 2008. Please note differences in scale of frequency.

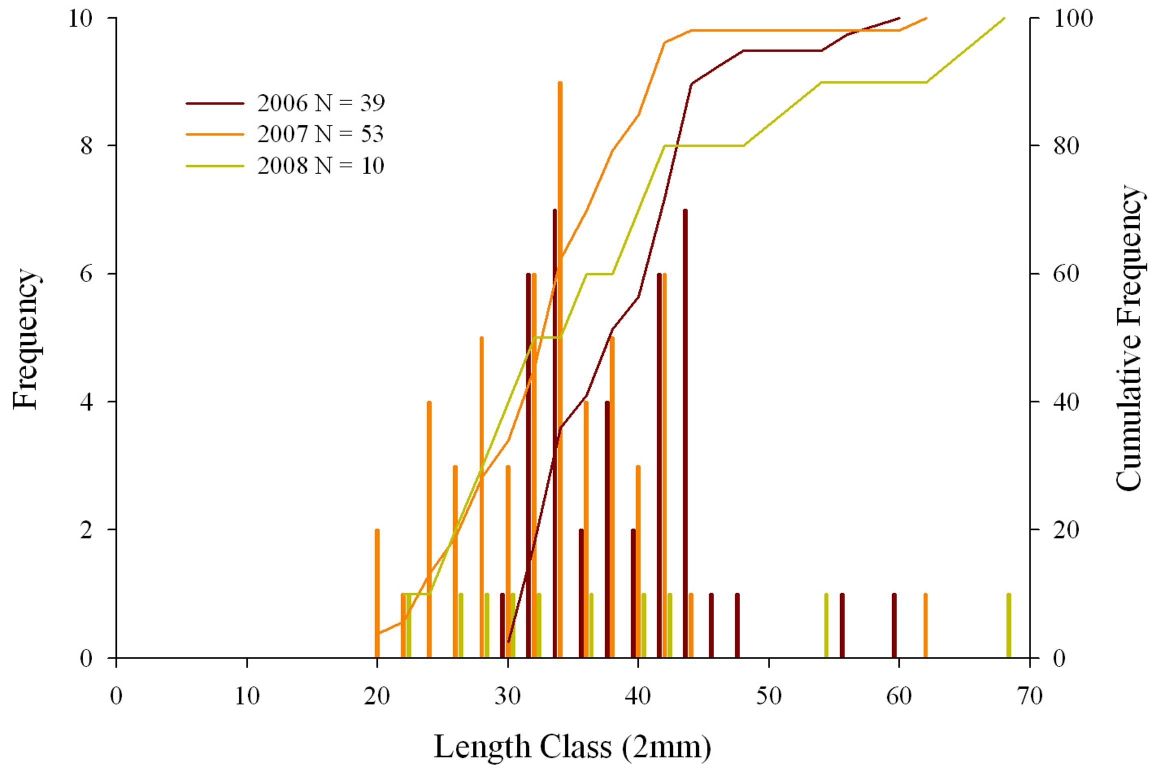


Figure III.4.21. Length frequency distributions and cumulative frequencies for measured fathead minnows (N) at Tobacco Island from 2006 - 2008.

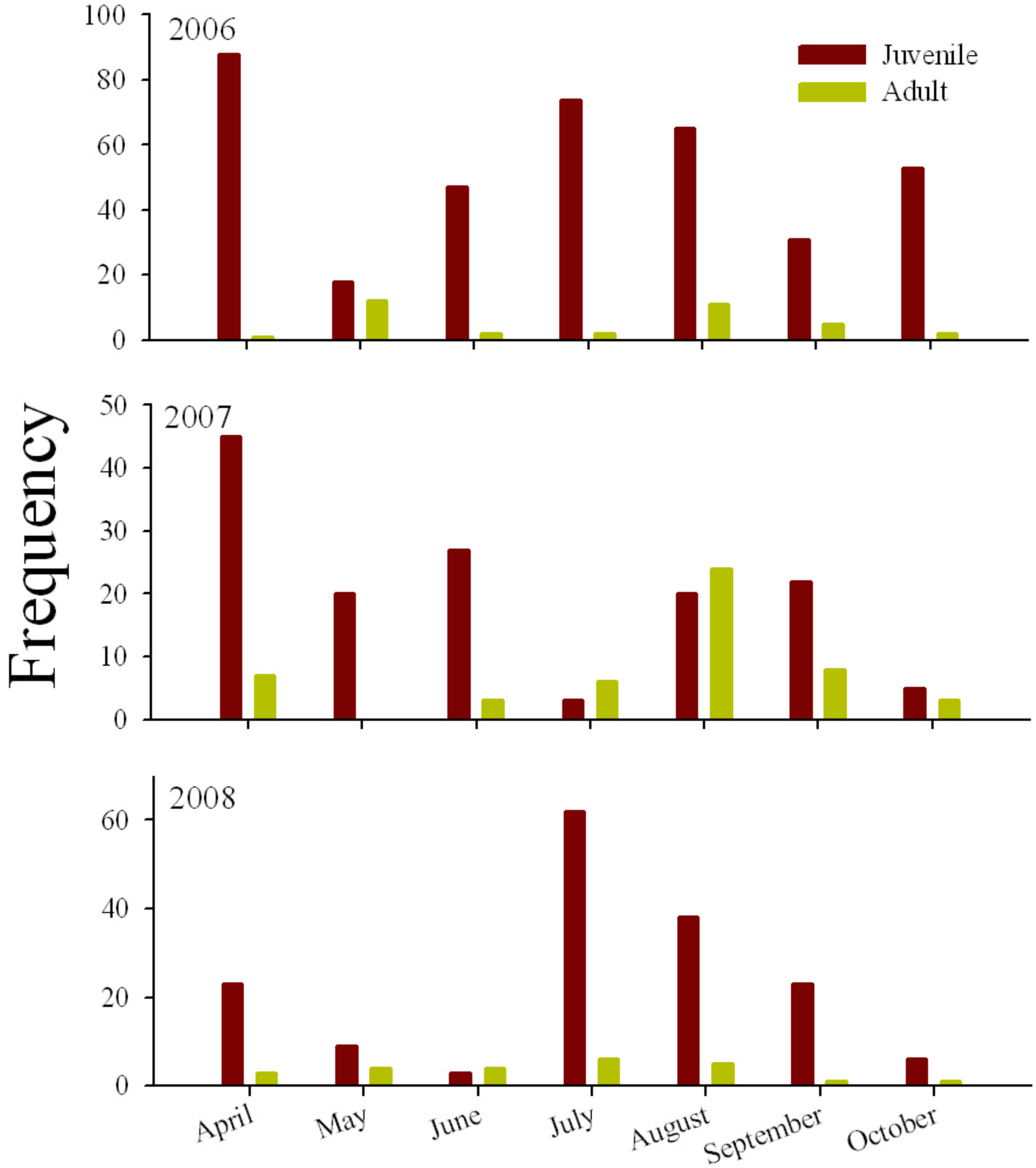


Figure III.4.22. Monthly frequency of juvenile (<305 mm) and adult (≥305 mm) river carpsuckers caught at Tobacco Island from 2006 - 2008. Please note differences in scale of frequency.

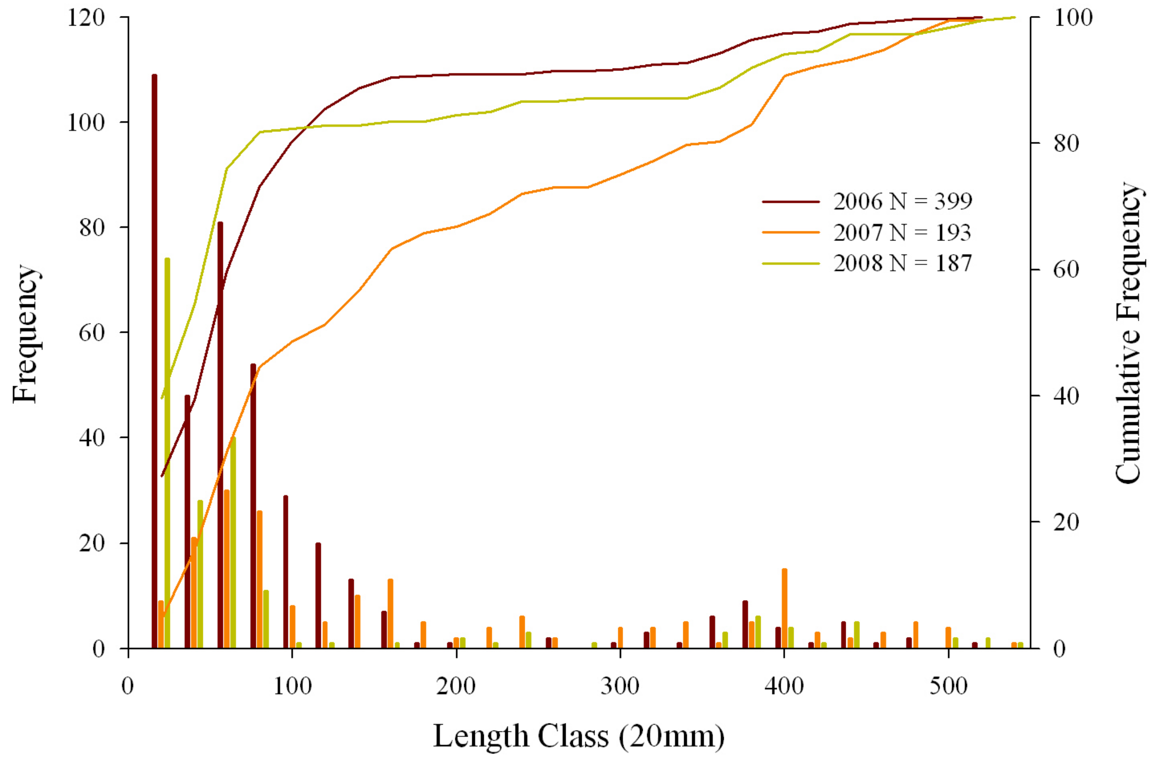


Figure III.4.23. Length frequency distributions and cumulative frequencies for measured river carpsuckers (N) at Tobacco Island from 2006 - 2008.

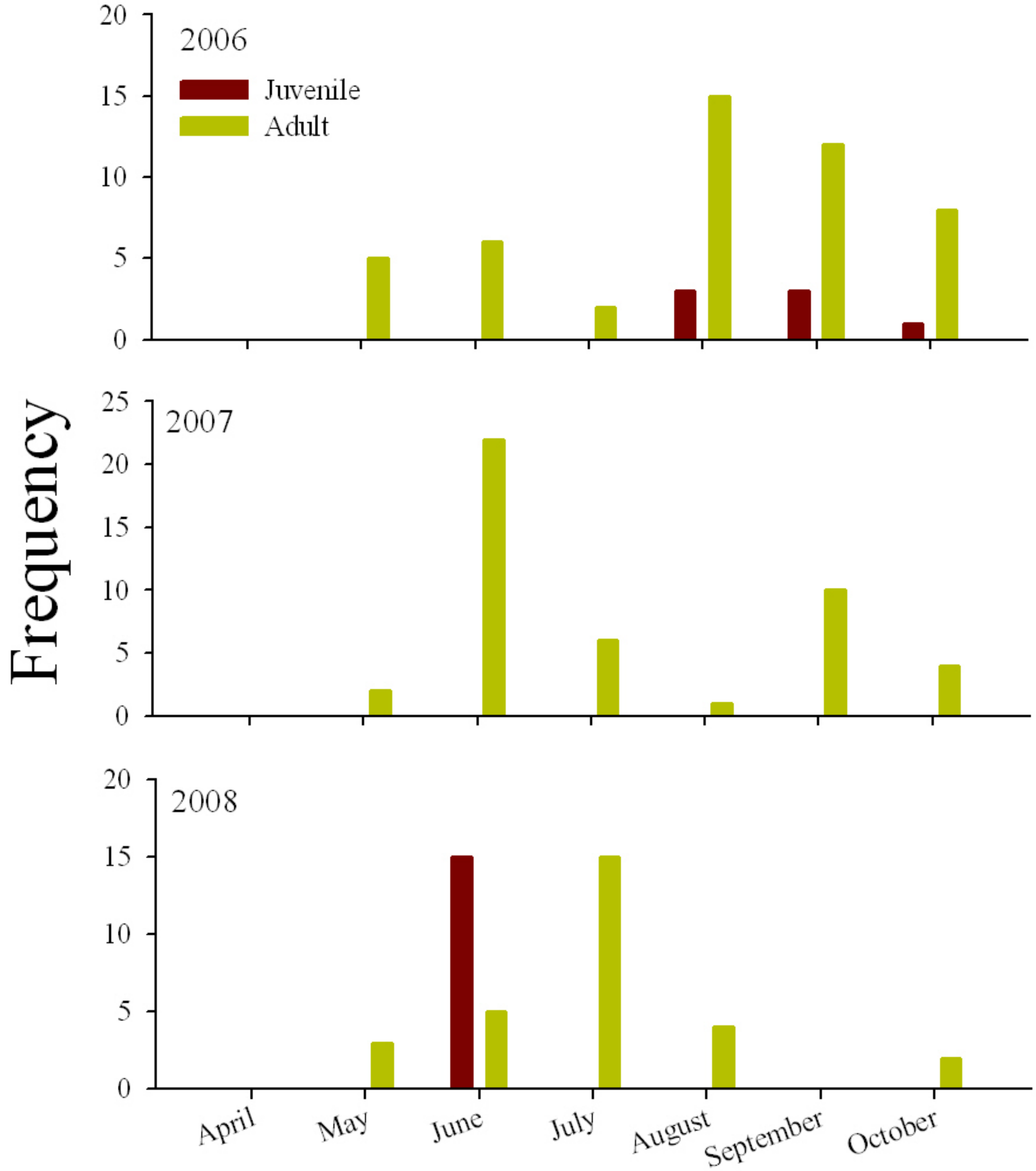


Figure III.4.24. Monthly frequency of juvenile (<508 mm) and adult (≥508 mm) blue suckers caught at Tobacco Island from 2006 - 2008. Please note differences in scale of frequency.

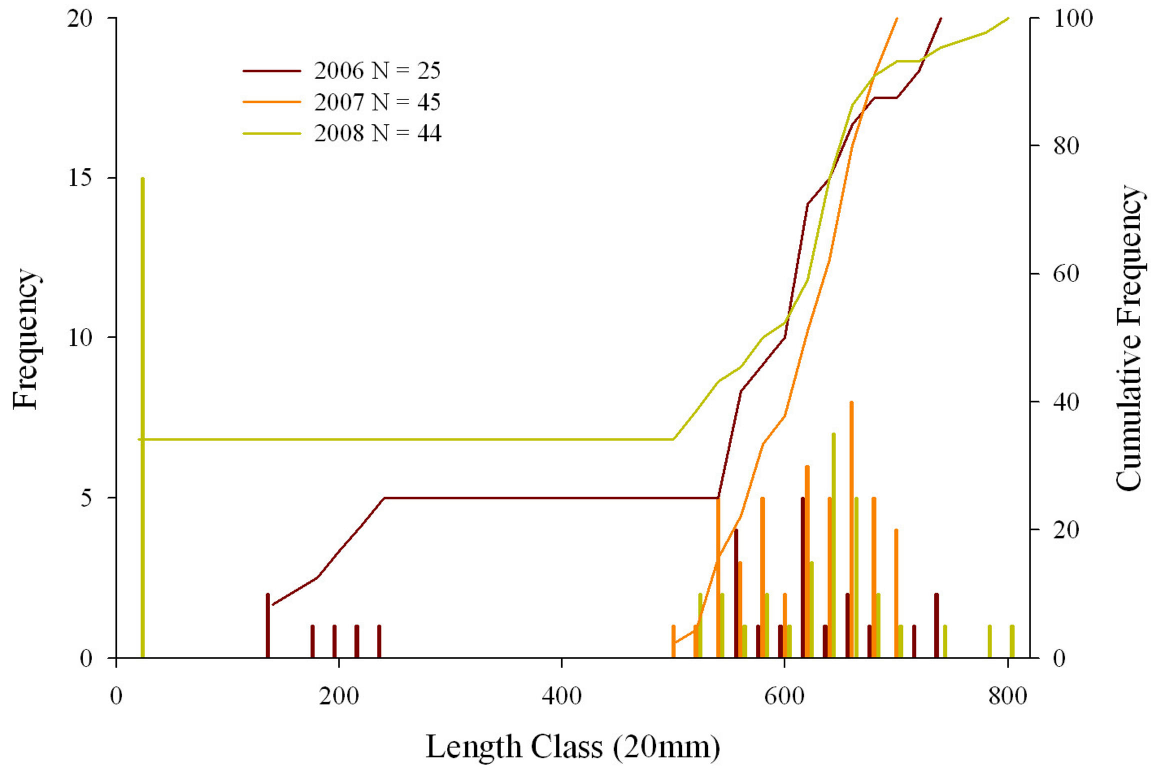


Figure III.4.25. Length frequency distributions and cumulative frequencies for measured blue suckers (N) at Tobacco Island from 2006 - 2008.

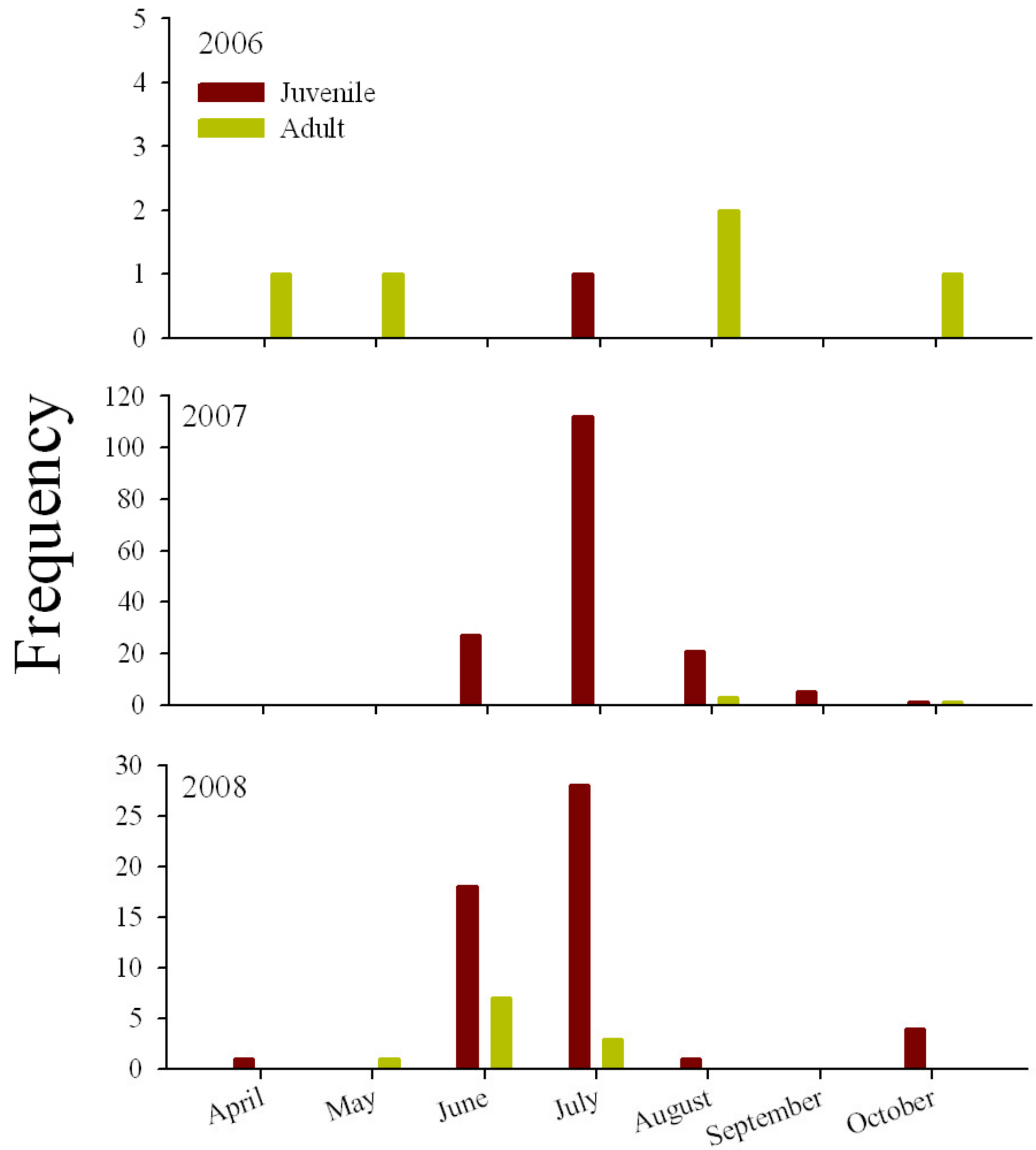


Figure III.4.26. Monthly frequency of juvenile (<381 mm) and adult (≥381 mm) smallmouth buffalo caught at Tobacco Island from 2006 - 2008. Please note differences in scale of frequency.

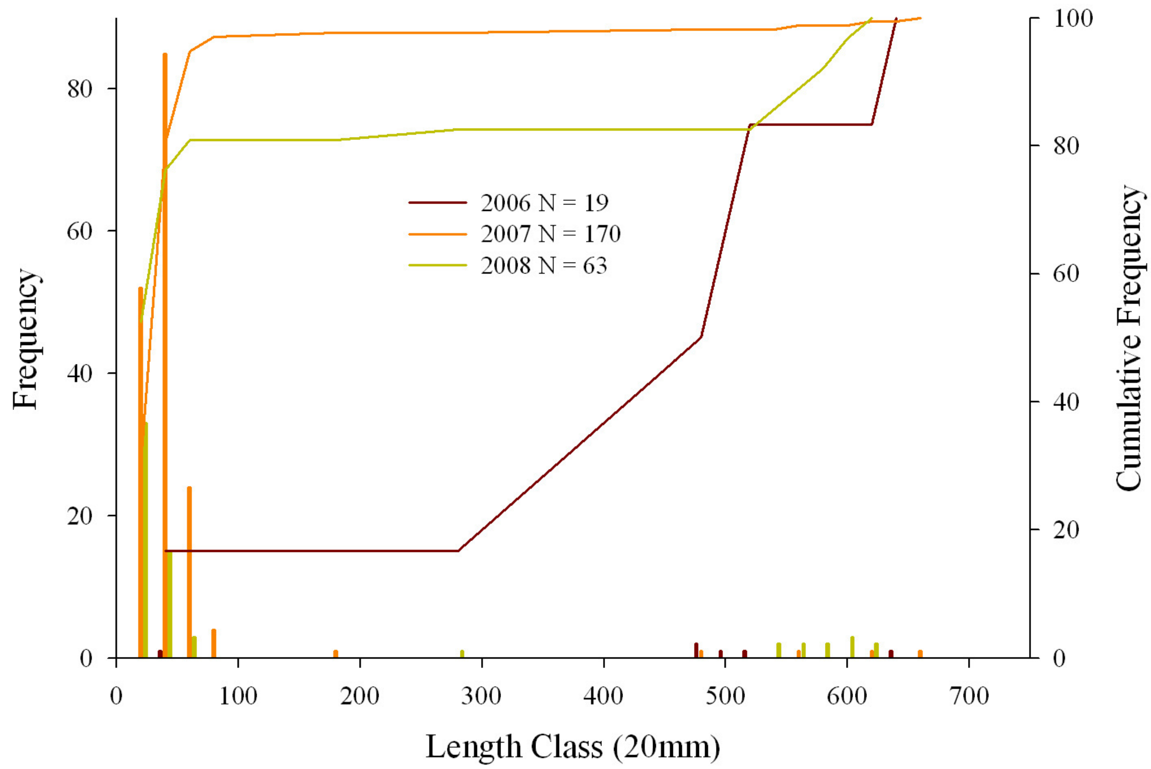


Figure III.4.27. Length frequency distributions and cumulative frequencies for measured smallmouth buffalo (N) at Tobacco Island from 2006 - 2008.

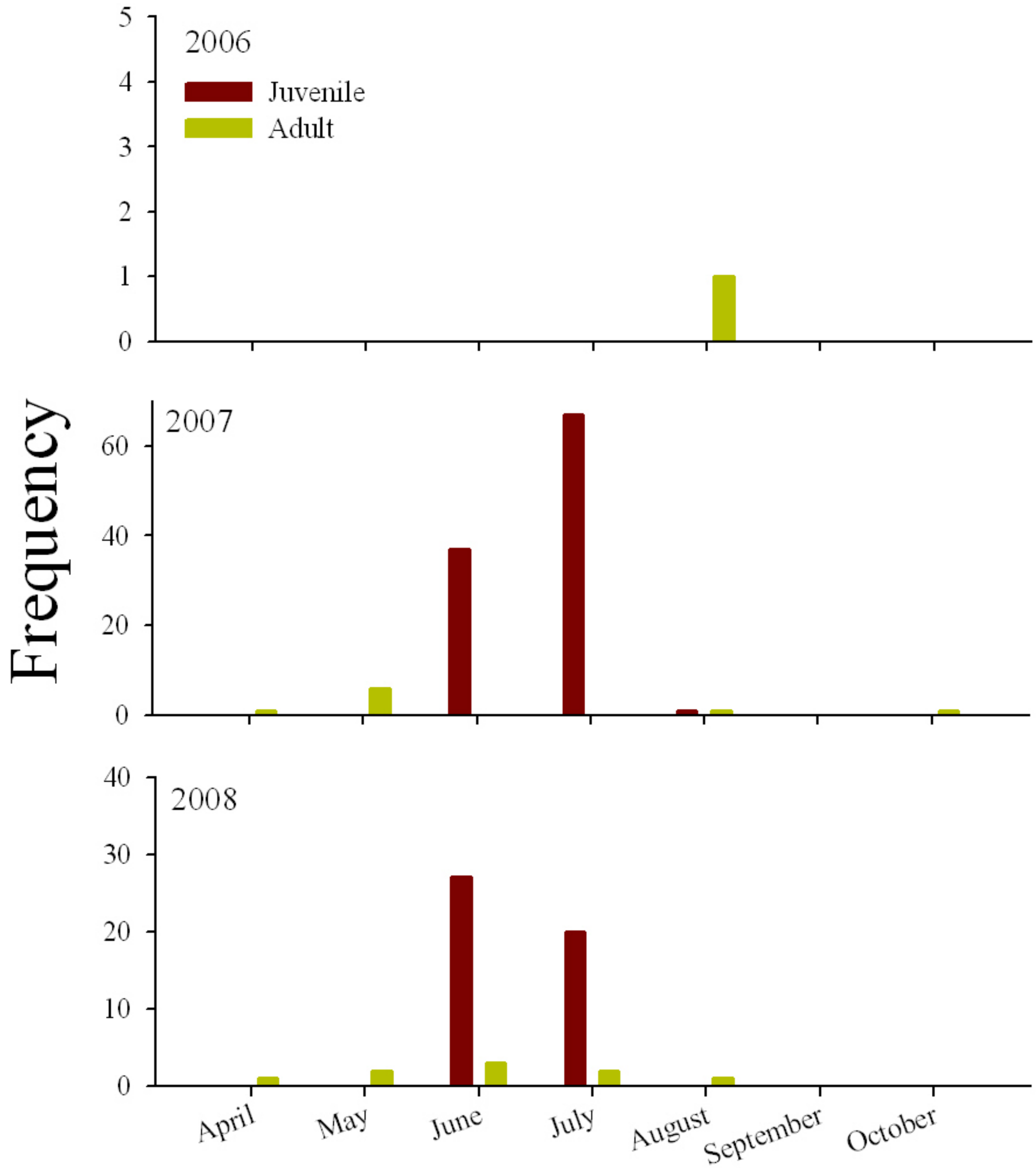


Figure III.4.28. Monthly frequency of juvenile (<381 mm) and adult (≥381 mm) bigmouth buffalo caught at Tobacco Island from 2006 - 2008. Please note differences in scale of frequency.

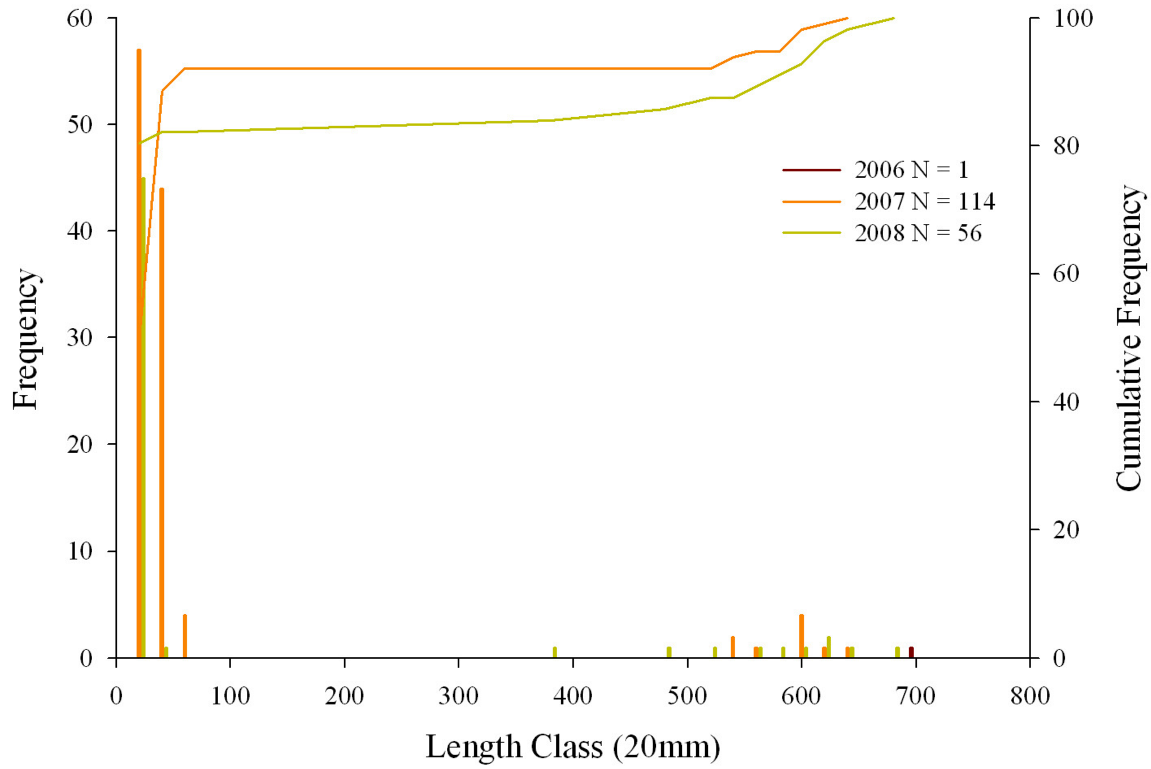


Figure III.4.29. Length frequency distributions and cumulative frequencies for measured bigmouth buffalo (N) at Tobacco Island from 2006 - 2008.

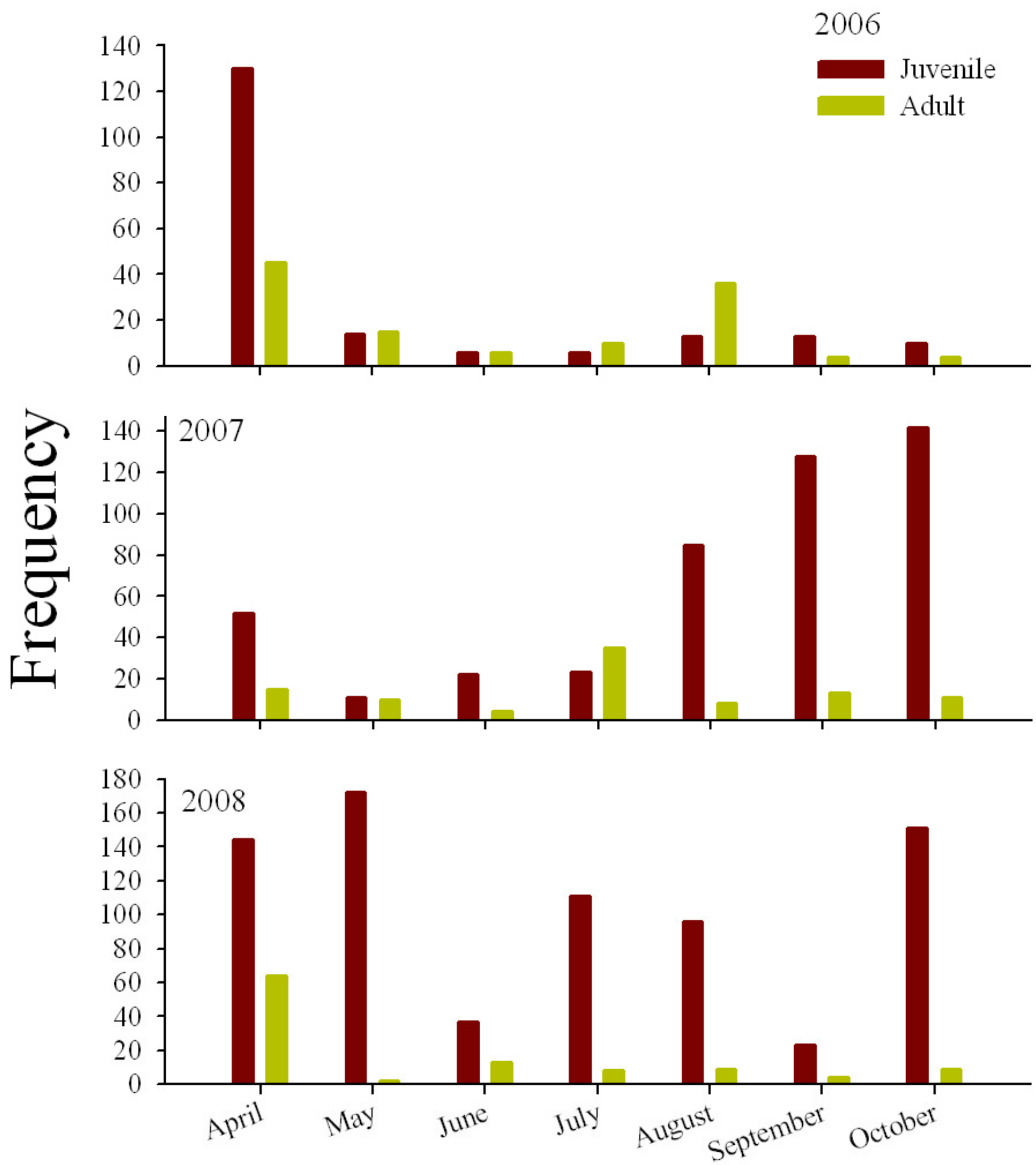


Figure III.4.30. Monthly frequency of juvenile (<305 mm) and adult (≥305 mm) channel catfish caught at Tobacco Island from 2006 - 2008. Please note differences in scale of frequency.

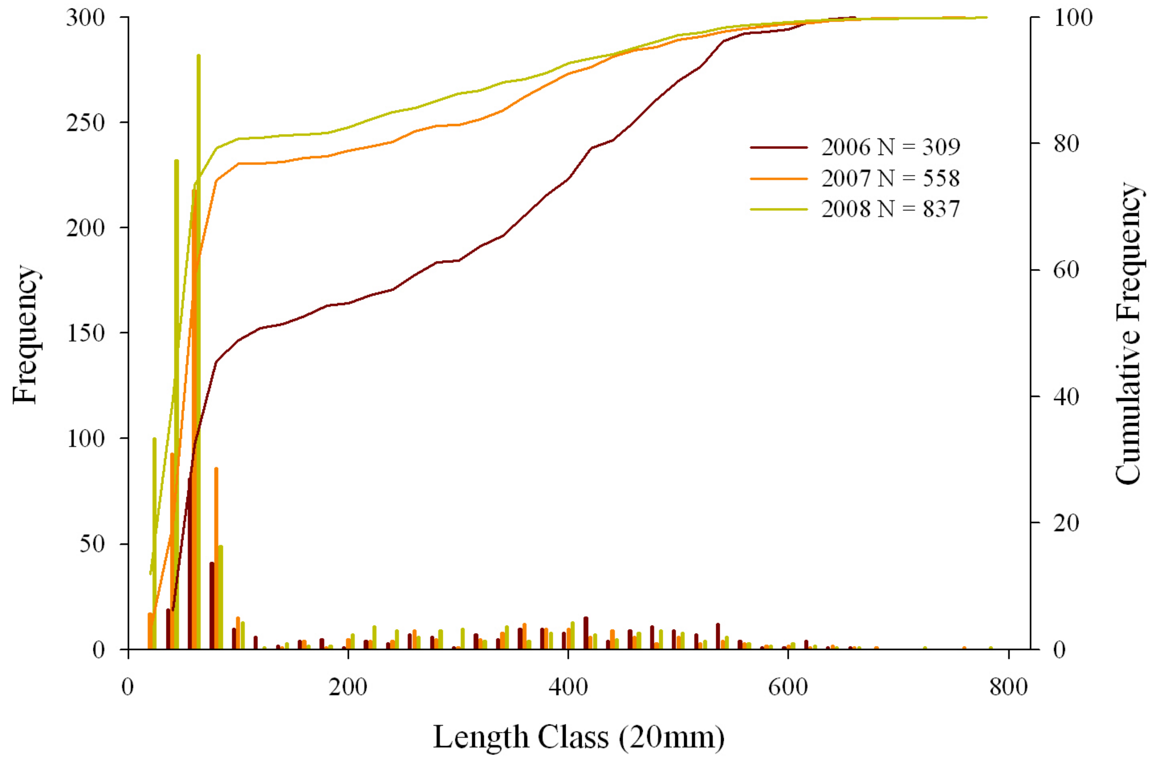


Figure III.4.31. Length frequency distributions and cumulative frequencies for measured channel catfish (N) at Tobacco Island from 2006 - 2008.

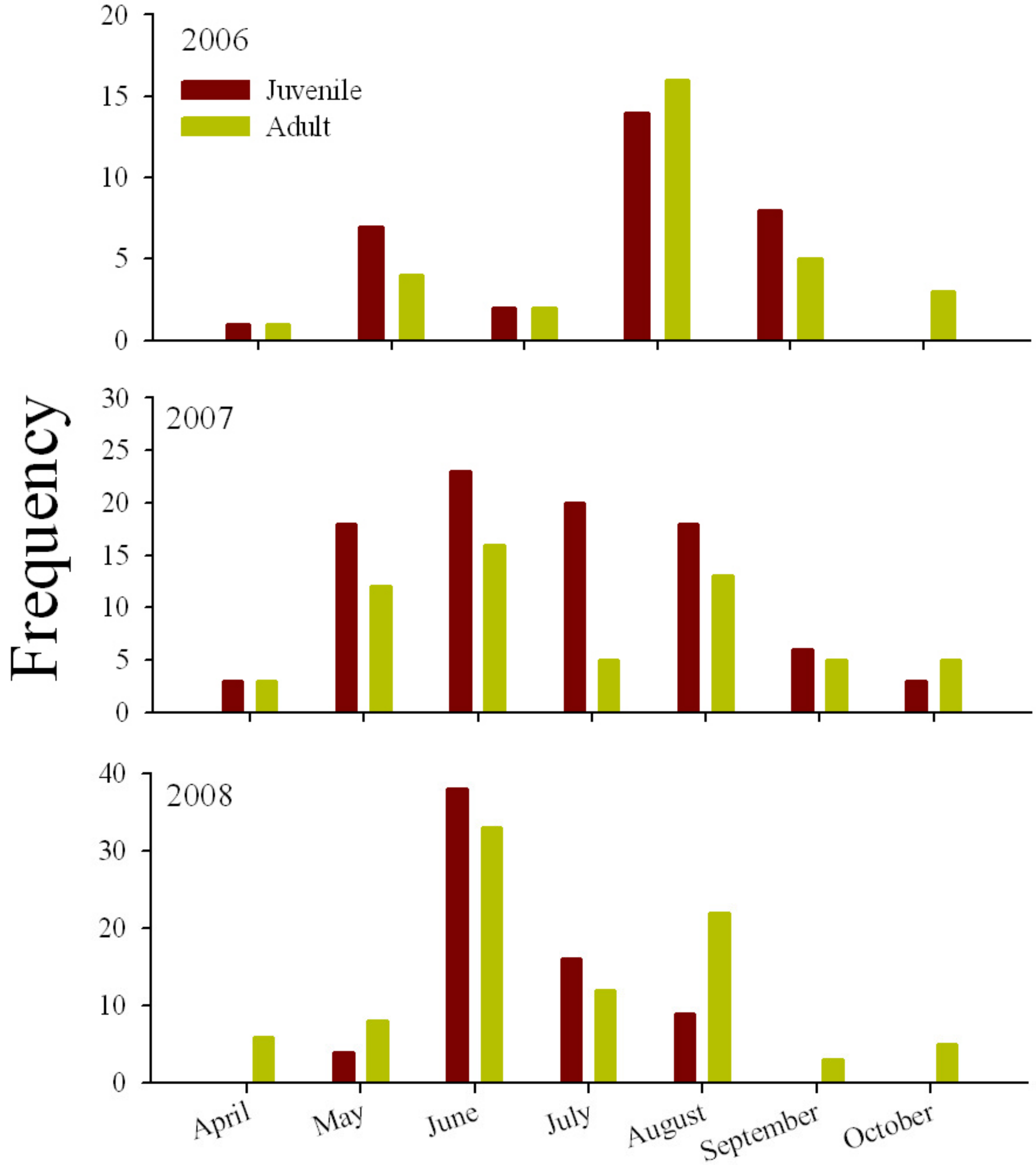


Figure III.4.32. Monthly frequency of juvenile (<381 mm) and adult (≥381 mm) flathead catfish caught at Tobacco Island from 2006 - 2008. Please note differences in scale of frequency.

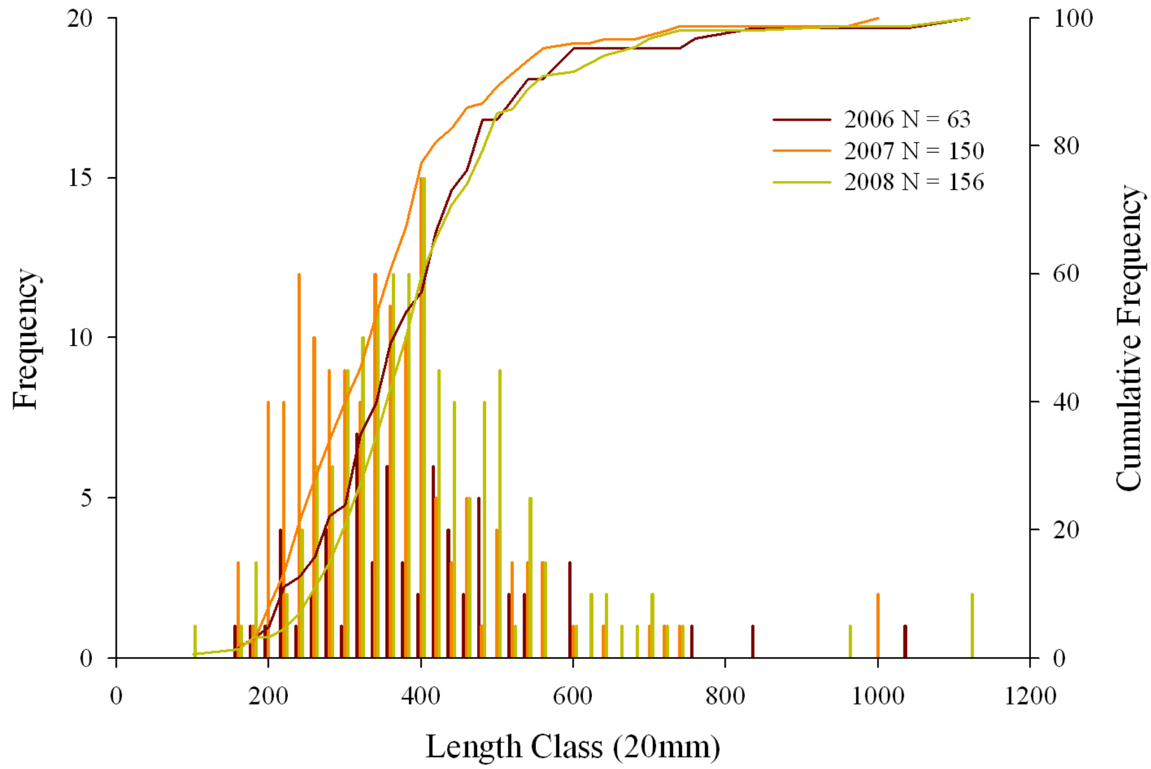


Figure III.4.33. Length frequency distributions and cumulative frequencies for measured flathead catfish (N) at Tobacco Island from 2006 - 2008.

Section III
Chapter 5
Upper Hamburg Bend

LIST OF TABLES

Table Page

LIST OF FIGURES

Figure Page

Figure Page

A total of 10,846 fish comprising 60 different species was sampled in Upper Hamburg from 2006 to 2008. Unidentified fish due to their small size or poor condition totaled 255. Seventy-four percent of the total number of fish was juveniles. The highest number of fish (5,025) and greatest species diversity (46) was found during the 2008 sampling season, while the lowest number of fish (2,736) and lowest species diversity (40) was found during 2007. However, species diversity, evenness and richness varied little throughout the three years (Table III.5.2). The fish community in Upper Hamburg was similar among all three years (Table III.5.3). Monthly species richness in 2006 tended to decline towards the end of the sampling season and ranged from 20 to 29 species. Monthly species richness in 2007 peaked in August (27 species) and then dropped very low (17 species) in October (Figure III.5.1). Species richness was its highest in the three years of sampling (34 species) during August 2008.

Upper Hamburg was typically dominated by a handful of species: blue catfish, channel catfish, emerald shiner, freshwater drum, river shiner, shovelnose sturgeon, sand shiner, and silver chub. These fish accounted for over 75% of all fish sampled (Table III.5.1). Other species of interest were not sampled in as large of numbers. Only species that averaged 50 measured individuals a year were included in the analyses. Only 26 *Hybognathus* species were collected during the three years, and 25 of them were collected during 2008. Four pallid sturgeon were collected in Upper Hamburg. One fish was collected in both 2006 and 2007, and two pallid sturgeon were collected in 2008. All four pallid sturgeon were considered juvenile size (<750mm) with two of them having been tagged previously and were possibly thought to be stocked fish. Sturgeon chub and sauger were also sampled in low numbers (Table III.5.1).

Blue catfish

A total of 533 blue catfish was caught between 2006 and 2008. In 2006 only 40 fish were sampled while in 2007 a total of 321 was caught. The majority of the blue catfish sampled were juveniles (<508mm) with mean length decreasing significantly each year from 2006 to 2008 (228mm, 115mm, and 70mm, respectively). The percentage of juvenile blue catfish was different between 2006 (77.5%) and 2007 (94.7%) (Table III.5.4). Length-frequency distributions were significantly different among all years (Table III.5.5). The time period when the peak number of juveniles were sampled happened primarily in July and August (Figure III.5.2). Electrofishing catch per unit efforts (CPUE) were different among all years (Table III.5.7). Otter trawl CPUE was different between 2006 and 2007 and also between 2006 and 2008 (Table III.5.7). Push trawls and otter trawls were the best gears for sampling blue catfish. The highest CPUE's for these gears occurred in August (Table III.5.8).

Blue sucker

A total of 207 blue sucker was sampled during the three years with the highest number of fish occurring in 2006 (84 fish) and the lowest number occurring in 2007 (57 fish). Most of the fish sampled were adults with mean lengths that did not differ significantly among years (581mm to 610mm). There was little use of Upper Hamburg by juvenile blue sucker. Adults tended to be most common in September of each year (Figure III.5.4). The percentage of juveniles were similar for all years (10.6% - 16.7%) as well as length-frequency distributions (Table III.5.4; Figure III.5.5). Otter trawl CPUE was different between 2006 and 2008 (Table III.5.7). Electrofishing had the highest

CPUE for blue sucker. Blue sucker were sampled most in September and October with electrofishing (Table III.5.8).

Channel catfish

A total of 1,135 channel catfish was sampled between 2006 and 2008 with most fish being caught in 2008 (413 fish). The lowest number of channel catfish was sampled in 2007 (323 fish). Most of the fish were juveniles with mean lengths ranging from 93mm to 98mm. Juvenile channel catfish capture peaked in April of 2006, August of 2007 and October of 2008 (Figure III.5.6). The percentage of juvenile channel catfish did not differ significantly among years (93.5% - 96.6%). However, length-frequency distributions were significantly different between 2006 and 2007. Catch per unit effort for all gears were similar among years (Table III.5.7). Push trawls were the best gear for channel catfish. The highest push trawl CPUE numbers were in April and August (Table III.5.8).

Common carp

A total of 229 common carp was sampled with only 46 fish being caught in 2007. Most fish were sampled in 2008 (104 fish). There were significant differences among all years in the percent of juveniles with mean lengths dropping significantly between 2007 and 2008 (491mm to 225mm). Length-frequencies were significantly different between 2007 and 2008 as well (Table III.5.5). Most fish were adults during 2006 and 2007, but a high number of juveniles were sampled in June of 2008 (Figure III.5.8). Electrofishing CPUE was different between 2006 and 2008 (Table III.5.7). Mini-fyke net CPUE was different between 2006 and 2007. Otter trawl CPUE was different between 2007 and

2008 (Table III.5.7). Electrofishing was the best gear for common carp with August and September being the best months (Table III.5.8).

Emerald shiner

A total of 1,468 emerald shiners was sampled with the lowest catch occurring in 2007 (244 fish) and the highest catch occurring in 2008 (639 fish). Most fish were juveniles with peaks in August (Figure III.5.10). The percentage of juveniles differed significantly among all years (66.8%, 82.1%, and 89.2%, respectively) with mean lengths getting smaller each year (57mm, 53mm, and 45mm, respectively). Length-frequencies were significantly different among years as well (Table III.5.5). Mini-fyke net CPUE was different between 2006 and 2007 (Table III.5.7). Otter trawl CPUE was different between 2006 and 2007 and between 2007 and 2008 (Table III.5.7). Push trawl CPUE was different between 2007 and 2008 (Table III.5.7). Emerald shiners were sampled most in mini-fyke nets and push trawls. Both gears had a high CPUE in August (Table III.5.8).

Flathead catfish

A total of 395 flathead catfish was sampled during the three years with highest numbers occurring in 2006 (147 fish) and lowest numbers occurring in 2007 (112 fish). July and August were peak months for juveniles with the percentage of juveniles differing each year (78.9%, 63.0%, and 47.0%, respectively; Table III.5.4). Mean lengths significantly increased from 2006 to 2007 (289mm to 379mm). Length-frequencies were also different between 2006 and 2007. Small hoop net CPUE was different between

2006 and 2008 and between 2007 and 2008 (Table III.5.7). Flathead catfish were sampled mostly by electrofishing with the highest CPUE in August (Table III.5.8).

Freshwater Drum

A total of 646 freshwater drum was sampled with the lowest number of fish occurring in 2006 (141 fish) and the highest number occurring in 2008 (363). Most fish were juveniles (90.2% - 94.4%), and mean lengths were significantly smaller between 2006 and 2007 (123mm to 84mm; Table III.5.6). Juvenile captures peaked in different months for each year with a June peak in 2006, an August peak in 2007, and a July peak in 2008 (Figure III.5.14). The percentage of juveniles changed each year (Table III.5.4) as well as length-frequencies (Table III.5.5). Catch per unit effort was similar each year (Table III.5.7). Freshwater drum were sampled in higher numbers by electrofishing with April being the best month (Table III.5.8).

Gizzard Shad

A total of 213 gizzard shad was sampled with the highest numbers occurring in 2006 consisting of 122 fish and the lowest numbers occurring in 2007 consisting of 33 fish. Most of the fish were juveniles (85.7% - 94.8%) with mean lengths decreasing from 2006 to 2007 (131mm to 89mm). Juvenile gizzard shad use was highest from July through October for most years (Figure III.5.16). The percentage of juveniles did not differ among years (Table III.5.4) but the length-frequencies did differ among all years (Table III.5.5). Catch per unit effort was similar each year (Table III.5.7). Gizzard shad were sampled best by electrofishing. Fall months (September and October) tended to have the highest CPUE for this gear (Table III.5.8).

Red shiner

A total of 476 red shiners was caught with the majority being collected in 2008 (223 fish) and the least being collected in 2007 (115 fish). Each year the mean length was significantly smaller (51mm, 44mm, and 40mm, respectively). Length-frequencies were different among all years (Table III.5.5) as well as the percentage of juveniles (Table III.5.4). Each year the percentage of juvenile red shiners increased from 30.4% in 2006 to 51.3 % in 2007 to 82.0% in 2008. Juvenile red shiner use peaked in August and September in 2006 and 2008 but April was a peak month during 2007 (Figure III.5.18). Otter trawl CPUE was different between 2006 and 2007 (Table III.5.7). Push trawl CPUE was different between 2007 and 2008 (Table III.5.7). Push trawls and mini-fyke nets were the best gears for sampling red shiner. Push trawls were better in April while mini-fyke net CPUE was highest in August (Table III.5.8).

River carpsucker

A total of 253 fish was sampled during the three years with only 19 river carpsuckers being caught in 2007 while 157 were caught in 2008. Mean lengths were significantly higher in 2008 (146mm) compared with 2006 (69mm; Table III.5.6). However, most fish were juveniles, and the percentage of juveniles between 2006 (94.3%) and 2007 (73.7%) were significantly different (Table III.5.4). Juvenile river carpsucker capture was highest in July and August during most years (Figure III.5.20). Length-frequencies were significantly different between 2006 and 2008. Catch per unit efforts for hoop nets, otter trawls and push trawls were different between 2007 and 2008

(Table III.5.7). River carpsucker were sampled best by electrofishing with most September being the best month (Table III.5.8).

River shiner

A total of 1,189 river shiners was sampled between 2006 and 2008. The highest number of fish were collected in 2008 (764 fish) and the lowest number in 2006 (201 fish). Juvenile use peaked in August (Figure III.5.22). The percentage of juveniles did not change year to year (91.7%, 95.7%, 94.3%) while the mean length in 2008 (38mm) was significantly higher than in 2007 (36mm). Length-frequencies also differed between 2006 and 2008 (Table III.5.5). Catch per unit effort was similar for each year (III.5.7). River shiner were sampled best by push trawls and mini-fyke nets. Push trawl CPUE was highest in July while mini-fyke nets were best in August (Table III.5.8).

Sand shiner

A total of 935 fish was sampled during the three years with 2008 having 573 fish collected and 2006 only having 154 fish collected. Most of the fish were juveniles with mean lengths ranging from 35mm to 37mm. The percentage of juveniles each year (80.2% - 87.9%) was not significantly different (Table III.5.4) nor were length-frequencies (Table III.5.5). Juvenile usage tended to peak in July and August in most years (Figure III.5.24). Otter trawl CPUE was different between 2006 and 2007 and between 2006 and 2008 (Table III.5.7). Push trawls and mini-fyke nets were the best gears for sand shiners. Push trawls were most effective in July while mini-fyke net CPUE was highest in August (Table III.5.8).

Shovelnose sturgeon

A total of 789 shovelnose sturgeon was caught with higher numbers being sampled in 2008 (296 fish) and lower numbers being sampled in 2006 (222 fish). Shovelnose sturgeon were primarily adult fish with July through September being peak months for adult and juvenile fish captures (Figure III.5.26). The percentage of juveniles (35.1% - 43.9%) did not change year to year (Table III.5.4) and the mean lengths did not differ as well (Table III.5.6). Length-frequencies were similar among all years (Table III.5.5). Otter trawl CPUE was different between 2006 and 2007 and between 2006 and 2008 (Table III.5.7). Shovelnose sturgeon were sampled best by trammel nets and otter trawls. Trammel nets had high catch per unit efforts from August through October while otter trawls were most effective in August (Table III.5.8).

Silver chub

A total of 869 silver chubs was sampled between 2006 and 2008. Most of the fish were sampled in 2008 (425 fish) while 2007 had the least number collected (165 fish). Most of the fish sampled were juveniles, and mean lengths were significantly smaller between 2007 and 2008 (63mm and 48mm). The percentage of juveniles changed between 2006 (78.9%) and 2007 (92.8%) with monthly juvenile use usually peaking in June and July (Figure III.5.28). Length-frequencies were significantly different among all three years (Table III.5.5). Mini-fyke net CPUE was different between 2006 and 2008 (Table III.5.7). Otter trawl CPUE was different between 2006 and 2007 and between 2006 and 2008 (Table.III.5.7). The push trawl was the best gear for silver chub with July being the best month (Table III.5.8).

Speckled chub

A total of 325 speckled chubs was caught during the study with 176 fish being caught in 2008 and only 64 being caught in 2006. Mostly adult speckled chubs were sampled with adult and juvenile monthly use hitting peaks in April and October for most years (Figure III.5.30). Mean lengths were significantly smaller from 2006 to 2007 (47mm to 38mm) and the percentage of juveniles was also significantly different between those years (21.9% and 48.8%). Mean lengths did significantly increase between 2007 and 2008 (38mm to 41mm). Length-frequencies were significantly different between 2006 and 2007 (Table III.5.5). Otter trawl CPUE was different between 2006 and 2008 (Table III.5.7). Push trawls had the highest CPUE for speckled chub with April being the best month (Table III.5.8).

Key Findings

- The majority of the fish community was juveniles (74%).
- Flathead catfish, shovelnose sturgeon and blue sucker were typically adults.
- Fish community, species richness, and species diversity were similar for all years.
- 8 species accounted for 75% of the fish community (blue catfish, channel catfish, emerald shiner, freshwater drum, river shiner, shovelnose sturgeon, sand shiner, and silver chub).
- For most species the percentage of juveniles increased year to year.
- 4 Pallid sturgeon were sampled with 2 being stocked fish from Bellevue, NE and 2 unconfirmed.
- Shiners typically had higher numbers in 2008.

Table III.5.1. Total species caught at Upper Hamburg Bend 2006-2008 and the percent of catch that each species represents. *Indicates a species that was used in analysis. †Indicates a species of note for this chute.

Species	Scientific name	2006	2007	2008	Total	% Catch
Bullhead catfish	Ameiurus sp.	0	1	0	1	0.009
Bighead carp†	Hypopthalmichthys nobilis	0	0	1	1	0.009
Bullhead minnow†	Pimephales vigilax	1	3	24	28	0.264
Black crappie†	Pomoxis nigromaculatus	0	0	1	1	0.009
Brook silverside	Labidesthes sicculus	0	0	1	1	0.009
Blue catfish*†	Ictalurus furcatus	40	321	172	533	5.034
Bluegill sunfish†	Lepomis macrochirus	5	106	18	129	1.218
Bigmouth buffalo†	Ictiobus cyprinellus	3	26	8	37	0.349
Bluntnose minnow†	Pimephales notatus	4	1	2	7	0.066
Blue sucker*†	Cycleptus elongates	84	57	66	207	1.955
Common carp*†	Cyprinus carpio	79	46	104	229	2.163
Creek chub	Semotilus atromaculatus	0	1	25	26	0.246
Central stoneroller	Campostoma anomalum	0	5	0	5	0.047
Channel catfish*†	Ictalurus punctatus	399	323	413	1135	10.719
Channel shiner	Notropis wickliffi	9	0	17	26	0.246
Emerald shiner*†	Notropis atherinoides	585	244	639	1468	13.863
Flathead catfish*†	Pylodictus olivaris	147	112	136	395	3.73
Fathead minnow†	Pimephales promelas	6	11	71	88	0.831
Freshwater drum*†	Aplodinotus grunniens	141	142	363	646	6.101
Goldeye†	Hiodon alosoides	19	25	23	67	0.633
Golden redhorse	Moxostoma erythrurum	1	0	0	1	0.009
Green sunfish	Lepomis cyanellus	1	0	1	2	0.019
Grass carp†	Ctenopharyngodon idella	6	5	7	18	0.17
Ghost shiner	Notropis buchanani	1	0	0	1	0.009
Gizzard shad*†	Dorosoma cepedianum	122	33	58	213	2.012
Hybognathus sp.†	Hybognathus sp.	0	1	25	26	0.246
Largemouth bass†	Micropterus salmoides	0	2	1	3	0.028
Longnose gar†	Lepisosteus osseus	6	5	10	21	0.198
Largescale stoneroller	Campostoma oligolepis	0	0	0	0	0
Mooneye†	Hiodon tergisus	0	0	0	0	0
Mosquito fish	Gambusia affinis	3	2	1	6	0.057
Orangespotted sunfish	Lepomis humilis	1	0	0	1	0.009
Paddlefish†	Polyodon spathula	0	0	6	6	0.057
Pallid sturgeon†	Scaphirhynchus albus	1	1	2	4	0.037
Pugnose minnow	Opsopoeodus emiliae	0	0	3	3	0.028
Quillback†	Carpiodes cyprinus	1	1	0	2	0.019
Rainbow smelt	Osmerus mordax	0	1	0	1	0.009
Red shiner*†	Cyprinella lutrensis	138	115	223	476	4.495
River carpsucker*†	Carpiodes carpio	157	19	77	253	2.389
River shiner*†	Notropis blennius	201	224	764	1189	11.229
Striped bass	Morone saxatilis	1	0	0	1	0.009
Spotfin shiner†	Cyprinella spiloptera	18	0	22	40	0.378
Sturgeon chub†	Macrhybopsis gelida	35	13	30	78	0.737
Sauger†	Stizostedion canadense	9	0	1	10	0.094
Shorthead redhorse	Moxostoma macrolepidotum	1	1	0	2	0.019
Skipjack herring	Alosa chrysochloris	1	0	0	1	0.009

Table III.5.1 continued. Total species caught at Upper Hamburg Bend 2006-2008 and the percent of catch that each species represents. *Indicates a species that was used in analysis. †Indicates a species of note for this chute.

Species	Scientific name	2006	2007	2008	Total	% Catch
Speckled chub*†	Macrhybopsis aestivalis	64	85	176	325	3.069
Smallmouth buffalo†	Ictiobus bubalus	3	45	24	72	0.68
Smallmouth bass	Micropterus dolomieu	1	0	0	1	0.009
Shortnose gar†	Lepisosteus platostomus	35	34	40	109	1.029
Shovelnose sturgeon*†	Scaphirhynchus platorynchus	222	271	296	789	7.451
Sand shiner*†	Notropis stramineus	154	208	573	935	8.83
Spotted bass	Micropterus punctulatus	0	0	5	5	0.047
Stonecat	Noturus flavus	11	9	20	40	0.378
Silver chub*†	Macrhybopsis storeriana	279	165	425	869	8.207
Silver carp†	Hypopthalmichthys molitrix	2	2	2	6	0.057
Walleye	Stizostedion vitreum	0	0	1	1	0.009
White bass	Morone chrysops	13	10	10	33	0.312
White crappie†	Pomoxis annularis	2	7	7	16	0.151
White perch	Morone americana	0	1	0	1	0.009

Table III.5.2. Species richness (S), species evenness (E), Shannon's diversity index (H) and Simpson's diversity index (D) for Upper Hamburg Bend 2006-2008.

Year	**S**	**E**	**H**	**D**
2006	44	0.7248	2.743	0.9104
2007	40	0.7685	2.835	0.9257
2008	46	0.7245	2.774	0.9143

Table III.5.3. Community assemblage similarity, using Morisita's index, for Upper Hamburg between years (2006 - 2008). Values less than 0.300 mean fish communities are dissimilar and values more than 0.700 mean fish communities are similar.

Year	**2006 v 2007**	**2006 v 2008**	**2007 v 2008**
Morisita's Index	0.917	0.963	0.973

Table III.5.4. Results for analysis of life stage proportions at Upper Hamburg from 2006 -2008. A z-test was used to determine differences in proportions of juveniles and adults of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold. Values not between -2.135 to 2.135 are significant.

	Z statistic		
Species	**2006 vs 2007**	**2006 vs 2008**	**2007 vs 2008**
Blue catfish	**-3.844**	**-4.790**	-1.520
Blue sucker	-0.580	-1.015	-0.403
Channel catfish	1.424	1.987	0.482
Common carp	**-2.616**	**-7.436**	**-5.728**
Emerald shiner	**-4.091**	**-7.799**	**-2.510**
Flathead catfish	**2.810**	**5.554**	**2.510**
Freshwater drum	-1.229	-0.106	1.247
Gizzard shad	-1.264	-1.798	-0.179
Red shiner	**-3.375**	**-9.046**	**-5.476**
River carpsucker	**3.132**	**3.970**	-0.269
River shiner	-1.463	-0.980	0.670
Sand shiner	-0.930	-1.988	-1.156
Shovelnose sturgeon	-1.148	-2.018	-0.916
Silver chub	**-3.900**	**-4.242**	-0.443
Speckled chub	**-3.341**	**-2.408**	1.368

Table III.5.5. Results for analysis of length frequency distribution at Upper Hamburg from 2006 - 2008. A Kolmogorov-Smirnov test was used to determine differences in length frequency distribution of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

	2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**D**	**p-value**	**D**	**p-value**	**D**	**p-value**
Blue catfish	**0.392**	**0.0001**	**0.624**	**0.0001**	**0.455**	**0.0001**
Blue sucker	0.169	0.283	0.118	0.683	0.147	0.526
Channel catfish	**0.152**	**0.0007**	**0.1478**	**0.0005**	0.093	0.113
Common carp	0.177	0.2711	**0.702**	**0.0001**	**0.555**	**0.0001**
Emerald shiner	**0.1997**	**0.0001**	**6.22**	**0.0001**	**4.284**	**0.0001**
Flathead catfish	**0.313**	**0.0001**	**0.455**	**0.0001**	**0.209**	**0.0099**
Freshwater drum	**0.223**	**0.0046**	**0.397**	**0.0001**	**0.249**	**0.0001**
Gizzard shad	**0.391**	**0.0008**	**0.392**	**0.0001**	**0.169**	**0.579**
Red shiner	**0.33**	**0.0001**	**0.526**	**0.0001**	**0.303**	**0.0001**
River carpsucker	0.327	0.0531	**0.386**	**0.0001**	0.141	0.92
River shiner	0.139	0.1026	**0.255**	**0.0001**	0.126	0.08
Sand shiner	0.081	0.674	0.132	0.11	0.0724	0.603
Shovelnose sturgeon	0.089	0.2699	0.096	0.1955	0.075	0.3961
Silver chub	**0.152**	**0.017**	**0.443**	**0.0001**	**0.447**	**0.0001**
Speckled chub	**0.412**	**0.0001**	**0.377**	**0.0001**	0.198	0.051

Table III.5.6. Results for analysis of species mean length at Upper Hamburg from 2006 - 2008. A t-test was used to determine differences in mean length of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

	2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**t**	**p-value**	**t**	**p-value**	**t**	**p-value**
Blue catfish	**2.856**	**0.0065**	**4.058**	**0.0002**	**3.68**	**0.0003**
Blue sucker	-1.547	0.1241	-0.175	0.8613	1.411	0.1609
Channel catfish	0.325	0.7455	-0.244	0.807	-0.599	0.5495
Common carp	1.646	0.106	**12.078**	**0.0001**	**7.369**	**0.0001**
Emerald shiner	**3.889**	**0.0001**	**13.096**	**0.0001**	**7.691**	**0.0001**
Flathead catfish	**-4.233**	**0.0001**	**-5.967**	**0.0001**	**-0.738**	**0.461**
Freshwater drum	**2.962**	**0.0035**	**2.719**	**0.0071**	-0.102	0.919
Gizzard shad	**2.421**	**0.0167**	**2.936**	**0.0038**	-0.133	0.8944
Red shiner	**5.478**	**0.0001**	**10.171**	**0.0001**	**3.595**	**0.0004**
River carpsucker	-2.091	0.0498	**-3.929**	**0.0002**	0.042	0.9669
River shiner	0.553	0.5804	-1.698	0.0909	**-2.888**	**0.0041**
Sand shiner	1.327	0.185	2.022	0.0439	0.649	0.5164
Shovelnose sturgeon	0.312	0.7548	-0.567	0.5707	-0.99	0.3225
Silver chub	1.867	0.0626	**9.573**	**0.0001**	**7.112**	**0.0001**
Speckled chub	**6.392**	**0.0001**	**5.607**	**0.0001**	**-2.607**	**0.0103**

Table III.5.7. Results for analysis of species catch per unit effort (CPUE) at California (IA) from 2006 - 2008. Effort for each gear is defined as: electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Push trawl was not used in 2006. A Kruskal-Wallis test was used to determine differences in CPUE of a species by gear between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

		2006 v 2007		2006 v 2008		2007 v 2008	
Species	**Gear**	**χ2**	**p-value**	**χ2**	**p-value**	**χ2**	**p-value**
Blue Catfish	**EF**	**65.33**	**0.0001**	**72**	**0.0001**	**64.72**	**0.0001**
	HN	0.15	0.6973	0.88	0.3483	1.59	0.2076
	MF	1.89	0.1686	2.6	0.1066	0.089	0.7655
	OT	**7.72**	**0.0055**	**6.74**	**0.0094**	0.08	0.7797
	PT	NA	NA	NA	NA	4.33	0.0375
	SHN	1	0.3173	0.003	0.9546	1.083	0.298
Blue Sucker	**EF**	0.198	0.6557	0.213	0.6443	0.004	0.9525
	OT	0.004	0.9519	1.103	0.2934	0.876	0.3492
	HN	4.27	0.0389	**7.66**	**0.0056**	0.603	0.4374
	SHN	0.098	0.7538	1.29	0.2553	0.72	0.395
	TN	0.301	0.5831	0.007	0.9352	0.427	0.5132
Common Carp	**EF**	4.11	0.0426	**5.43**	**0.0198**	0.001	0.9714
	HN	0.46	0.496	0.016	0.8987	0.27	0.6011
	MF	**4.89**	**0.026**	2.6	0.1066	0.45	0.503
	SHN	1.08	0.2978	0.021	0.8831	1.37	0.2424
	OT	1.73	0.1883	1.77	0.1831	**6.32**	**0.012**
Channel Catfish	**EF**	0.82	0.3663	0	1	0.833	0.3613
	HN	0.12	0.7257	0.41	0.5241	0.9	0.3427
	MF	0.049	0.8398	0.068	0.7934	0.003	0.9538
	OT	1.2	0.2733	0.61	0.4357	0.13	0.719
	PT	NA	NA	NA	NA	1.75	0.1857
	SHN	0.001	0.9719	2.15	0.1422	2.31	0.1283
Emerald Shiner	**EF**	2.013	0.156	0.003	0.9587	1.75	0.1859
	MF	**6.58**	**0.0103**	0.99	0.3186	1.236	0.2662
	OT	**6.75**	**0.0094**	0.023	0.8794	**6.14**	**0.0132**
	PT	NA	NA	NA	NA	**9.57**	**0.002**
Flathead Catfish	**EF**	0.006	0.9363	3.13	0.0768	2.39	0.1223
	HN	0.034	0.8528	0.186	0.6661	0.383	0.5355
	MF	2.88	0.09	2.6	0.1066	0.01	0.9198
	OT	0.62	0.4305	1.82	0.1771	4.08	0.4033
	PT	NA	NA	NA	NA	1.82	0.1768
	SHN	3.69	0.0546	**17.46**	**0.0001**	**5.91**	**0.015**
Freshwater Drum	**EF**	0.55	0.4587	1.27	0.2595	3.07	0.0799
	HN	0.1	0.7513	0.683	0.4083	0.278	0.5979
	MF	1.58	0.2095	0.503	0.4783	0.165	0.6847
	OT	4.13	0.0421	3.97	0.0463	0.002	0.9617
	PT	NA	NA	NA	NA	1.54	0.2145

Table III.5.7 continued. Results for analysis of species catch per unit effort (CPUE) at California (IA) from 2006 - 2008. Effort for each gear is defined as: electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Push trawl was not used in 2006. A Kruskal-Wallis test was used to determine differences in CPUE of a species by gear between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

		2006 v 2007		2006 v 2008		2007 v 2008	
Species	**Gear**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**
	SHN	1.87	0.1712	1.64	0.2008	0.003	0.9546
Gizzard Shad	**EF**	1.59	0.206	0.61	0.436	0.14	0.7036
	MF	1.98	0.1592	2.54	0.1111	0.09	0.7628
	OT	0	1	1.892	0.169	1.872	0.1712
	PT	NA	NA	NA	NA	0.009	0.9253
Red Shiner	**EF**	0.03	0.8724	0.98	0.3223	1.2	0.2733
	MF	0.6	0.4369	0.002	0.9644	0.29	0.5909
	OT	4.49	0.0341	**8.59**	**0.0034**	0.87	0.3511
	PT	NA	NA	NA	NA	**8.02**	**0.0046**
River Carpsucker	**EF**	0.638	0.4244	0.021	0.886	0.431	0.5116
	HN	0	1	4.775	0.0343	**4.564**	**0.0327**
	MF	0.664	0.4151	0.003	0.9585	0.437	0.5082
	OT	1.99	0.1584	1.16	0.281	**4.75**	**0.0292**
	PT	NA	NA	NA	NA	**6.64**	**0.01**
	SHN	0	1	1.083	0.298	1.083	0.298
River Shiner	**EF**	0.82	0.3663	0	1	0.83	0.3613
	MF	0.484	0.4868	0.091	0.7636	0.182	0.6699
	OT	0.492	0.483	0.002	0.9609	0.396	0.5294
	PT	NA	NA	NA	NA	0.615	0.4329
Speckled Chub	**MF**	0.938	0.3329	0.26	0.1066	0.708	0.4002
	OT	3.94	0.0472	**5.21**	**0.0224**	0.184	0.6676
	PT	NA	NA	NA	NA	0.013	0.9081
Shovelnose Sturgeon	**EF**	0.607	0.4359	2.614	0.1059	0.676	0.4109
	HN	1.097	0.2947	0.023	0.8797	0.696	0.4043
	OT	**8.77**	**0.0031**	**5.081**	**0.0242**	0.616	0.4324
	PT	NA	NA	NA	NA	0.46	0.4975
	SHN	0.742	0.3891	0.127	0.7215	1.338	0.2473
	TN	0.575	0.4485	0.091	0.7634	0.267	0.6053
Sand Shiner	**EF**	0.816	0.3663	0.98	0.3223	0	1
	MF	0.005	0.9448	2.739	0.0979	2.373	0.1235
	OT	**7.149**	**0.0075**	**5.167**	**0.023**	0.931	0.3345
	PT	NA	NA	NA	NA	2.404	0.121
Silver Chub	**MF**	**7.34**	**0.0067**	2.37	0.1239	1.305	0.2533
	OT	**7.068**	**0.0078**	**20.722**	**0.0001**	4.147	0.0417
	PT	NA	NA	NA	NA	1.839	0.175

Table III.5.8. Species monthly catch per unit effort (± 2 SE) at Upper Hamburg from 2006 - 2008. Effort for each gear is defined as: bag seine (BS), fish caught per 50 m^2 seined; electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4’ hoop nets (HN), fish caught per net night; 2’ hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8’ and 16’ otter trawls (OT), fish caught per 100 m trawled; and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Bag seines were only used in 2006. Push trawls were not used in 2006.

		April			**May**			**June**			**July**			**August**			**September**			**October**		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Blue Catfish	**EF**											0.83 (1.67)			3.98 (5.45)	1.07 (2.14)	1.58 (2.11)	1.34 (2.69)				
	MF															0.25 (0.50)		0.50 (1.00)			0.25 (0.50)	
	HN								0.25 (0.33)			0.75 (0.73)	0.14 (0.29)	0.63 (0.53)	0.50 (0.66)		0.25 (0.33)		0.13 (0.25)			0.25 (0.50)
	SHN									0.25 (0.50)	0.13 (0.25)											
	PT											0.29 (0.58)	0.31 (0.61)		9.78 (19.19)			0.57 (1.14)			2.71 (2.84)	
	OT		0.03 (0.07)		0.11 (0.21)			0.04 (0.08)			0.59 (0.76)	5.09 (4.61)		0.13 (0.19)	10.07 (6.85)	4.32 (2.33)	0.18 (0.17)	0.15 (0.17)	1.09 (1.54)			0.61 (0.49)
Blue Sucker	**EF**	1.46 (2.92)			2.33 (3.23)	2.32 (2.70)		1.13 (1.49)	2.72 (2.70)				4.38 (5.23)		1.58 (2.08)	4.73 (3.68)	6.13 (4.88)	13.32 (5.82)	10.51 (14.15)	13.27 (5.51)		11.41 (10.40)
	HN	0.13 (0.25)					0.25 (0.33)	1.71 (2.08)	0.25 (0.33)		0.50 (0.54)	0.75 (1.05)	0.29 (0.57)	0.38 (0.37)	0.38 (0.53)	0.25 (0.33)	1.38 (1.00)	0.50 (0.76)		0.75 (0.96)		
	SHN			0.25 (0.33)			0.63 (0.84)	0.38 (0.58)	0.13 (0.25)			0.25 (0.33)	..38 (0.75)		0.13 (0.25)		0.13 (0.25)		0.13 (0.25)	0.25 (0.50)	0.13 (0.25)	0.25 (0.50)
	OT	0.06 (0.12)						0.07 (0.10)		0.28 (0.29)	0.07 (0.09)	0.15 (0.18)	0.03 (0.05)	0.03 (0.06)	0.28 (0.29)	0.05 (0.07)	0.24 (0.20)	0.11 (0.12)	0.07 (0.13)	0.06 (0.08)	0.14 (0.16)	0.03 (0.06)
	TN						0.37 (0.74)					0.83 (1.67)						0.50 (1.01)		1.17 (2.34)		
Common Carp	**EF**	2.13 (2.95)		1.77 (2.34)	2.34 (4.31)	2.75 (3.20)	0.68 (1.36)	10.83 (5.55)		4.06 (3.36)	1.25 (1.68)	6.69 (5.16)		12.99 (6.81)			6.40 (5.67)	8.47 (7.96)	7.07 (5.47)	3.33 (6.67)		2.83 (5.66)
	MF					0.50 (0.58)						0.50 (0.54)	0.71 (0.95)									
	HN		0.38 (0.75)	0.13 (0.25)	0.13 (0.25)		0.13 (0.25)	0.43 (0.60)	0.25 (0.50)			0.88 (0.96)	0.57 (1.14)	0.13 (0.25)		0.13 (0.25)						
	SHN			0.13 (0.25)	0.13 (0.25)		0.13 (0.25)	0.13 (0.25)	0.25 (0.33)		0.13 (0.25)		0.13 (0.25)	0.13 (0.25)	0.13 (0.25)	0.13 (0.25)	0.25 (0.33)		0.25 (0.33)			
	OT	0.10 (0.20)		0.03 (0.06)	0.14 (0.19)				0.08 (0.15)	1.71 (1.18)	0.06 (0.13)	0.06 (0.08)		0.07 (0.14)			0.03 (0.05)			0.02 (0.05)		0.03 (0.06)

.

Table III.5.8 continued. Species monthly catch per unit effort (± 2 SE) at Upper Hamburg from 2006 - 2008. Effort for each gear is defined as: bag seine (BS), fish caught per 50 m^2 seined; electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled; and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Bag seines were only used in 2006. Push trawls were not used in 2006.

		April			May			June			July			August			September			October		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Channel Catfish	**BS**	4.40 (3.86)			0.13 (0.26)															0.49 (0.97)		
	EF				1.45 (2.90)														0.56 (1.11)			
	MF	1.33 (1.91)	1.00 (1.00)	1.00 (1.03)	0.17 (0.33)	0.25 (0.50)	0.33 (0.42)	0.14 (0.29)	0.13 (0.25)		0.13 (0.25)	0.13 (0.25)	0.43 (0.40)	2.17 (1.89)	0.50 (0.54)	0.13 (0.25)	1.00 (1.51)	0.25 (0.33)	0.38 (0.75)	0.50 (1.00)	2.00 (3.37)	
	HN	0.25 (0.33)	0.13 (0.25)	0.13 (0.25)			0.13 (0.25)	0.29 (0.57)	0.63 (0.75)		0.13 (0.25)	0.63 (0.84)		0.13 (0.25)					0.13 (0.25)			
	SHN		0.13 (0.25)	0.13 (0.25)	0.13 (0.25)	0.50 (1.00)				0.75 (0.96)	0.50 (0.54)	0.38 (0.53)	0.13 (0.25)	0.25 (0.50)	0.13 (0.25)	1.38 (0.92)			0.13 (0.25)		0.13 (0.25)	
	PT		4,73 (5.78)	24.83 (34.67)			1.04 (2.08)		3.65 (4.27)			3.65 (2.50)	11.66 (19.33)		15.56 (18.70)	1.85 (2.43)		10.21 (11.74)				3.96 (6.36)
	OT	4.71 (6.64)	0.99 (0.64)	1.22 (1.41)	4.32 (3.91)	0.30 (0.28)	0.60 (0.43)	2.48 (1.24)	1.30 (1.43)	0.19 (0.21)	1.25 (1.06)	0.54 (0.36)	1.59 (1.46)	0.17 (0.16)	3.20 (2.56)	0.62 (0.38)	1.30 (0.64)	0.47 (0.33)	1.06 (0.95)	0.47 (0.50)	0.78 (0.35)	4.78 (2.58)
Emerald Shiner	**BS**	3.84 (7.03)			5.36 (8.00)			0.80 (1.21)			1.20 (1.30)			10.70 (10.27)			14.59 (10.17)			9.52 (4.03)		
	EF					1.82 (2.17)					0.71 (1.43)	1.13 (2.26)					1.53 (2.03)	15.26 (24.99)	6.66 (8.86)			
	MF	1.67 (1.23)	5.88 (5.68)	1.83 (1.96)	0.50 (0.45)	2.50 (5.00)	0.33 (0.42)	1.00 (1.69)	0.13 (0.25)		11.13 (20.30)		2.43 (3.20)	31.17 (26.32)	1.50 (2.00)	35.75 (48.79)	2.25 (1.55)	3.38 (4.12)	3.25 (5.45)	1.25 (0.96)	10.75 (20.84)	
	PT		1.47 (2.94)	13.50 (24.73)			0.49 (0.93)		1.35 (1.94)				12.76 (13.40)		10.97 (10.56)	31.61 (20.50)		2.44 (2.20)	7.07 (6.50)			
	OT								0.08 (0.17)		0.12 (0.24)			0.73 (0.77)		1.51 (2.90)	1.09 (2.19)					0.90 (0.74)
Flathead Catfish	**EF**	1.53 (1.88)			0.02 (0.04)	9.64 (8.20)	4.16 (3.69)	18.01 (13.23)	4.58 (4.41)		17.95 (14.12)	12.65 (5.83)	17.41 (10.72)	28.97 (19.31)	16.90 (10.04)	25.41 (7.97)	14.32 (13.40)	2.95 (2.99)	2.02 (2.98)	7.14 (9.48)		
	MF					0.25 (0.50)						0.13 (0.25)	0.14 (0.29)		0.13 (0.25)	0.13 (0.25)						
	HN	0.38 (0.53)			0.13 (0.25)	1.50 (1.29)	0.13 (0.25)	0.14 (0.29)	0.38 (0.37)		0.38 (0.53)		0.14 (0.29)	0.38 (0.53)	0.50 (0.66)	0.75 (0.63)	0.38 (0.75)	0.13 (0.25)	0.13 (0.25)		0.13 (0.25)	
	SHN	0.13 (0.25)		0.25 (0.33)	0.13 (0.25)	1.75 (1.71)	0.50 (0.54)	0.13 (0.25)	0.63 (0.84)	2.75 (3.20)	0.63 (0.75)	0.63 (0.75)	2.13 (1.39)		1.25 (1.12)	3.13 (0.00)		0.13 (0.25)				
	PT								0.42 (0.83)						0.16 (0.32)							
	OT		0.03 (0.07)	0.07 (0.09)	0.08 (0.15)					0.13 (0.14)			0.06 (0.11)	0.03 (0.06)		0.02 (0.04)	0.06 (0.08)	0.05 (0.10)				0.09 (0.12)

Table III.5.8 continued. Species monthly catch per unit effort (± 2 SE) at Upper Hamburg from 2006 - 2008. Effort for each gear is defined as: bag seine (BS), fish caught per 50 m^2 seined; electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled; and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Bag seines were only used in 2006. Push trawls were not used in 2006.

		April			May			June			July			August			September			October		
Species	Gear	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Freshwater Drum	**BS**																0.49 (0.97)			0.49 (0.97)		
	EF			3.49 (3.98)	2.29 (3.25)	0.75 (1.50)	0.87 (1.75)	1.07 (2.14)				0.71 (1.43)	0.78 (1.55)	1.13 (2.25)			0.94 (1.88)	1.17 (2.34)	3.37 (3.42)	1.36 (2.73)		1.42 (2.83)
	MF		0.38 (0.37)					0.14 (0.29)	1.00 (2.00)		0.25 (0.50)	2.38 (2.40)	1.14 (1.11)	1.33 (1.52)	0.75 (0.63)	0.75 (0.73)	0.13 (0.25)		0.25 (0.50)	0.25 (0.50)	0.25 (0.50)	
	HN			0.13 (0.25)	0.13 (0.25)	0.25 (0.50)	0.13 (0.25)	0.14 (0.29)		0.25 (0.50)		0.13 (0.25)	0.29 (0.57)	0.13 (0.25)	0.38 (0.37)	0.13 (0.25)	0.13 (0.25)		0.13 (0.25)			
	SHN	0.13 (0.25)			0.13 (0.25)	0.25 (0.50)					0.25 (0.33)					0.13 (0.25)						
	PT		1.63 (1.90)						9.27 (12.58)			0.94 (0.95)	81.16 (97.15)		6.46 (8.96)	0.61 (1.22)		0.57 (1.14)				
	OT				0.07 (0.14)			4.89 (9.05)		0.06 (0.13)	0.43 (0.34)	0.16 (0.13)	0.10 (0.21)		1.98 (2.89)	0.26 (0.51)	1.46 (2.37)	0.06 (0.09)	0.76 (0.97)	0.26 (0.30)		0.48 (0.43)
Gizzard Shad	**BS**										0.96 (1.15)			1.39 (1.90)			9.30 (11.82)			6.97 (13.93)		
	EF	6.92 (3.08)			8.42 (8.33)				0.75 (1.50)			0.50 (1.00)	0.78 (1.55)		0.79 (1.49)		12.24 (9.14)	10.77 (13.51)				21.64 (28.47)
	MF								1.25 (2.50)				1.71 (2.38)	0.17 (0.33)	0.75 (0.73)	0.63 (0.75)	0.13 (0.25)	0.25 (0.50)				
	PT											0.31 (0.63)	1.79 (3.57)									
	OT															0.03 (0.06)						
Red Shiner	**BS**				1.41 (1.92)			4.35 (3.50)			0.24 (0.47)			2.11 (2.38)			6.76 (10.34)			0.49 (0.97)		
	EF											0.89 (1.78)										
	MF	0.67 (1.33)	3.50 (3.14)	2.00 (4.00)	0.83 (0.96)	0.75 (0.76)	2.50 (3.64)	0.86 (0.81)	0.13 (0.25)		0.75 (1.24)	0.13 (0.25)	1.57 (2.22)	1.50 (2.24)	0.88 (1.75)	14.50 (20.59)	1.88 (1.98)	0.50 (0.54)	0.50 (0.54)	1.25 (1.89)	1.00 (1.41)	
	PT		10.45 (18.60)	0.23 (0.46)			1.67 (3.33)		10.19 (8.79)			3.20 (3.42)	2.77 (3.98)		0.89 (1.17)			1.67 (2.81)				
	OT	0.12 (0.24)	0.03 (0.05)					0.24 (0.30)			0.13 (0.25)	0.10 (0.14)		0.40 (0.44)	0.16 (0.31)		0.13 (0.25)			0.22 (0.45)		0.08 (0.10)

Table III.5.8 continued. Species monthly catch per unit effort (± 2 SE) at Upper Hamburg from 2006 - 2008. Effort for each gear is defined as: bag seine (BS), fish caught per 50 m^2 seined; electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled; and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Bag seines were only used in 2006. Push trawls were not used in 2006.

		April			May			June			July			August			September			October		
Species	Gear	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
River Carpsucker	BS	0.61			0.25			0.76			10.81			4.34			0.49			1.40		
		(0.81)			(0.50)			(1.02)			(8.91)			(6.22)			(0.64)			(1.62)		
	EF	0.75		0.77	2.34							0.49		1.86	1.46			2.49	8.93	1.36		
		(1.50)		(1.54)	(3.23)							(0.91)		(2.47)	(1.94)			(4.97)	(10.35)	(2.73)		
	MF	0.17	0.50		0.17	0.25		1.43	0.13				1.71	1.33	0.13	0.75	0.13	0.50	0.13		0.25	
		(0.33)	(0.54)		(0.33)	(0.50)		(1.68)	(0.25)				(1.56)	(0.67)	(0.25)	(0.82)	(0.25)	(0.76)	(0.25)		(0.50)	
	HN																		0.13			0.75
																			(0.25)			(0.96)
	SHN															0.13						
																(0.25)						
	PT			0.94								0.63	2.21			0.90						
				(0.96)								(1.25)	(2.71)			(1.27)						
	OT							0.04									0.08					0.99
								(0.07)									(0.17)					(1.22)
River Shiner	BS				0.49			0.25			0.57			0.38			1.65			2.19		
					(0.97)			(0.49)			(0.94)			(0.77)			(2.39)			(2.00)		
	EF																0.87		0.73			
																	(1.74)		(1.47)			
	MF		5.25	2.33	0.50	24.50	3.33	2.75			2.75		0.29	17.50	3.25	35.75		2.00	0.50	0.25	0.25	
			(3.94)	(3.21)	(1.00)	(41.23)	(6.67)	(3.62)			(3.62)		(0.37)	(21.01)	(5.22)	(56.67)		(2.75)	(1.00)	(0.50)	(0.50)	
	PT			6.91					7.90				118.43		0.32	26.58		2.78				
				(12.38)					(7.31)				(231.50)		(0.64)	(31.26)		(5.07)				
	OT		0.05									0.20		0.17			0.03		0.18	0.03		0.90
			(0.10)									(0.35)		(0.19)			(0.06)		(0.25)	(0.06)		(1.40)
Speckled Chub	BS	0.32			0.31																	
		(0.65)			(0.61)																	
	MF												0.29								1.00	
													(0.37)								(2.00)	
	PT		15.71	3.46			1.04						2.94		0.64			1.89			15.00	
			(30.02)	(4.44)			(2.08)						(5.31)		(1.28)			(3.38)			(25.75)	
	OT	0.66	0.19	0.59	1.18	0.30		0.07	0.65	0.03				0.11			0.55	0.03	0.06	0.37	0.13	5.04
		(0.87)	(0.25)	(1.04)	(1.19)	(0.45)		(0.14)	(0.57)	(0.06)				(0.15)			(0.42)	(0.07)	(0.12)	(0.38)	(0.15)	(5.14)

Table III.5.8 continued. Species monthly catch per unit effort (± 2 SE) at Upper Hamburg from 2006 - 2008. Effort for each gear is defined as: bag seine (BS), fish caught per 50 m^2 seined; electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled; and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Bag seines were only used in 2006. Push trawls were not used in 2006.

		April			May			June			July			August			September			October		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Shovelnose Sturgeon	**EF**			3.37	1.36	0.75	2.26	0.50	1.67						2.14	1.46	0.64	0.83	3.50	1.67		1.25
				(3.47)	(1.80)	(1.50)	(3.25)	(1.00)	(2.19)						(2.89)	(2.91)	(1.28)	(1.67)	(5.17)	(3.33)		(2.50)
	HN	5.50	0.38	0.13	0.88		0.63	0.86	1.00	0.50	0.50	1.00	1.29			0.75	0.25	0.50		0.50	0.50	0.25
		(10.72)	(0.75)	(0.25)	(0.70)		(0.65)	(0.92)	(1.46)	(1.00)	90.66)	(1.46)	(1.29)			(0.82)	(0.33)	(0.76)		(1.00)	(0.54)	(0.50)
	SHN	0.25	0.13	0.25	0.38	0.25	0.50	0.50			0.13	0.25	0.50	0.13	0.25	0.38	0.13				0.13	0.75
		(0.33)	(0.25)	(0.50)	(0.53)	(0.50)	(0.76)	(0.54)			(0.25)	(0.33)	(0.54)	(0.25)	(0.33)	(0.53)	(0.25)				(0.25)	(0.96)
	PT						0.33					0.29	0.45									
							(0.67)					(0.58)	(0.89)									
	OT	1.29	0.98	1.05	1.18	0.31	0.47	0.50	2.56	1.58	0.12	0.68	1.64	0.24	3.09	1.38	0.98	2.73	0.67	0.30	1.06	0.75
		(1.04)	(0.62)	(1.02)	(0.67)	(0.29)	(0.37)	(0.29)	(1.52)	(1.17)	(0.11)	(0.85)	(1.03)	(0.22)	(2.58)	(0.82)	(0.65)	(2.16)	(0.46)	(0.33)	(0.38)	(0.79)
	TN	2.92		0.65		1.24	1.22	0.81		0.40	3.97	2.92		5.99	1.98			6.25	8.33	1.39	4.81	9.95
		(4.26)		(1.30)		(2.48)	(1.33)	(1.62)		(0.80)	(4.61)	(3.87)		(4.14)	(2.64)			(10.46)	(11.20)	(2.78)	(9.62)	(7.83)
Sand Shiner	**BS**				0.50			0.56			1.13			0.50			1.70			2.45		
					(1.00)			(0.69)			(1.51)			(0.65)			(2.88)			(2.93)		
	EF																0.87					
																	(1.74)					
	MF	0.50	2.75	2.67	0.17	11.00	2.33	2.29			6.38	0.13	3.43	4.00	3.25	47.63	1.25	1.63	4.50	1.25	4.25	
		(0.45)	(3.83)	(3.08)	(0.33)	(12.14)	(2.62)	(2.92)			(12.19)	(0.25)	(6.53)	(4.32)	(2.64)	(70.42)	(1.30)	(1.73)	(4.52)	(1.50)	(5.68)	
	PT		3.10	0.89			2.98		8.92			10.08	10.48		0.35	0.47		3.59				
			(4.17)	(0.91)			(4.37)		(9.10)			(10.17)	(16.04)		(0.46)	(0.94)		(4.52)				
	OT							0.28			0.06			0.18			0.03					0.04
								(0.43)			(0.13)			(0.29)			(0.06)					(0.07)
Silver Chub	**BS**	0.81			0.50			0.31			0.99			0.17			1.65					
		(0.82)			(1.00)			(0.63)			(1.48)			(0.35)			(2.06)					
	MF		0.13					0.86	1.00		0.63		1.57	3.33		0.13	1.25		0.13		4.75	
			(0.25)					(0.92)	(1.73)		(0.75)		(1.57)	(2.91)		(0.25)	(1.50)		(0.25)		(9.50)	
	PT		1.79	1.32					5.83			3.60	139.67		5.18	3.50		2.92			3.21	
			(3.57)	(1.70)					(5.00)			(3.35)	(228.11)		(5.78)	(4.34)		(2.88)			(1.38)	
	OT	1.85	0.90	0.09	1.52	0.17	0.10	1.89	0.93	0.07	0.41	0.47		0.80	0.07	0.05	0.55		0.10	2.15	0.35	1.26
		(3.39)	(0.69)	(0.13)	(1.00)	(0.15)	(0.19)	(1.67)	(0.89)	(0.14)	(0.31)	(0.48)		(0.53)	(0.15)	(0.07)	(0.57)		(0.19)	(2.58)	(0.50)	(0.67)

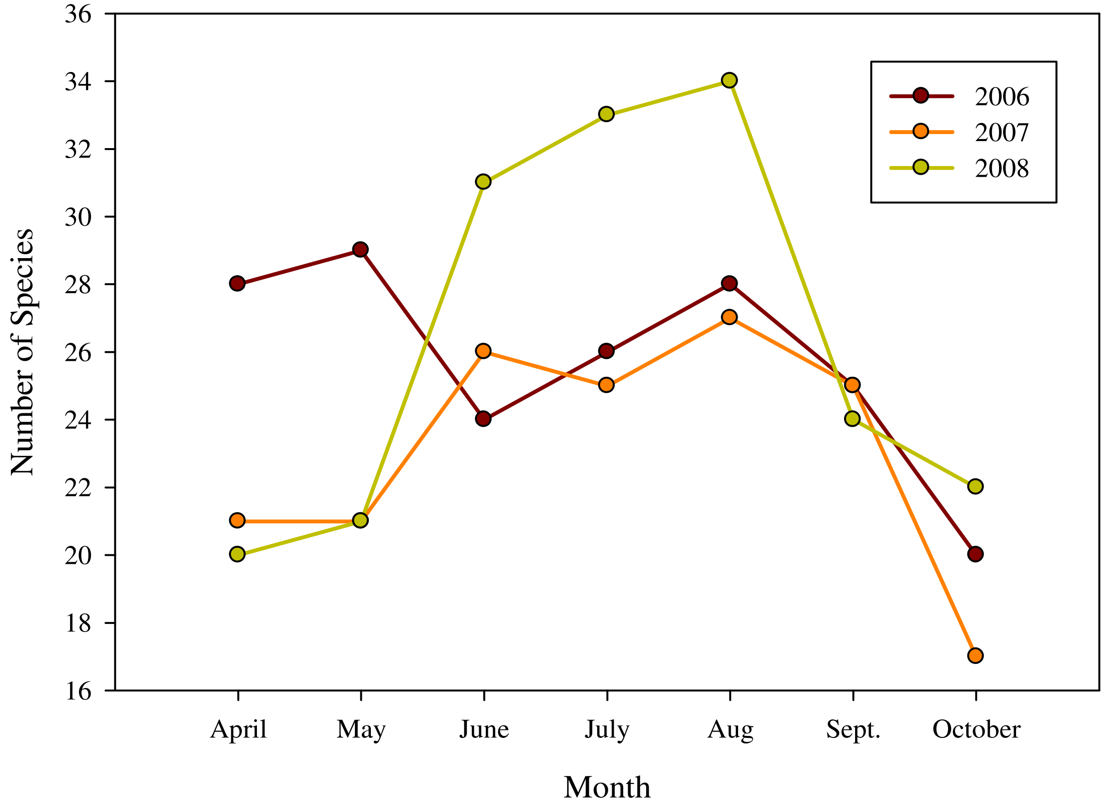


Figure III.5.1. Monthly species richness for Upper Hamburg Bend from 2006 – 2008.

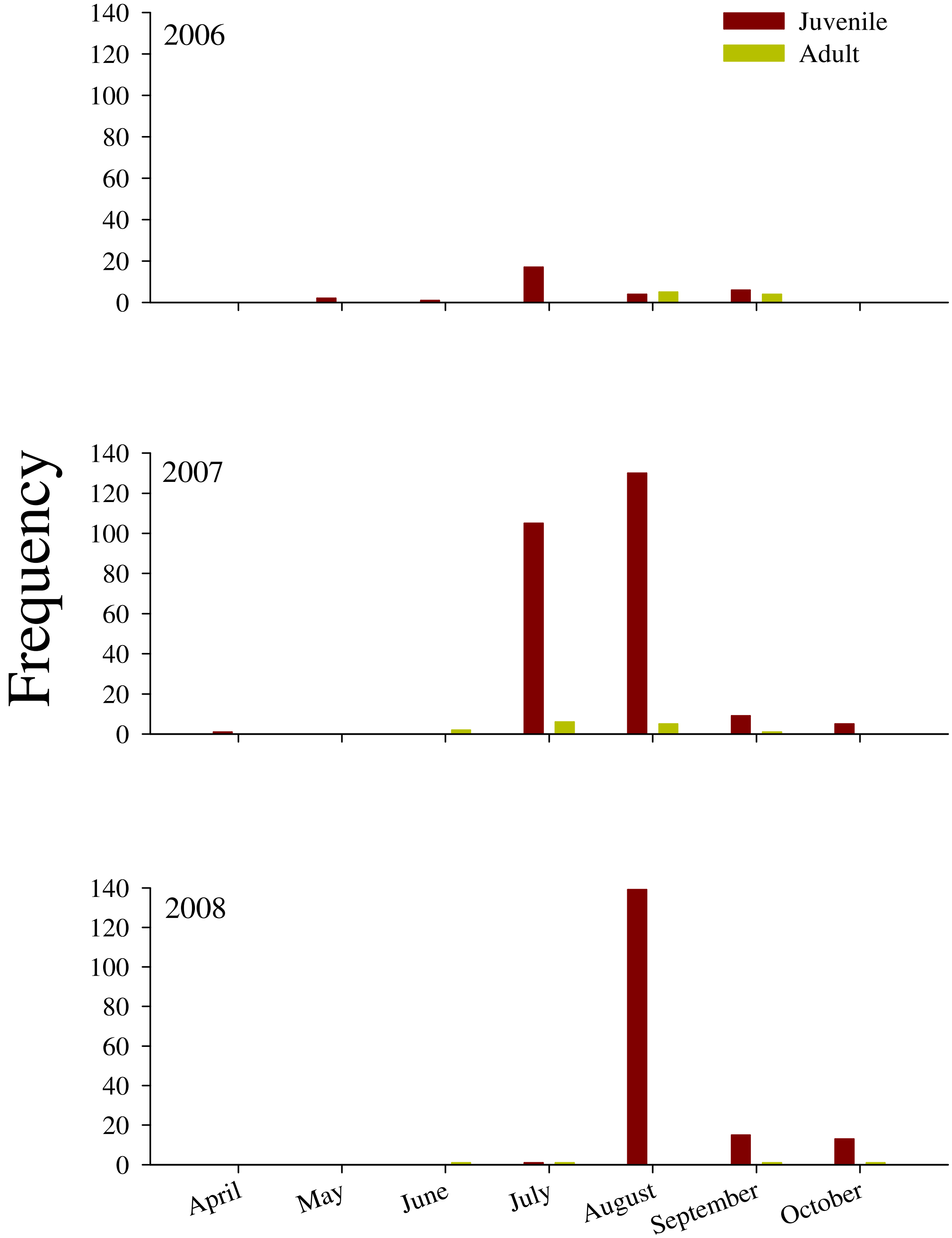


Figure III.5.2. Monthly frequency of juvenile (<508mm) and adult (≥508mm) blue catfish caught at Upper Hamburg Bend from 2006 - 2008.

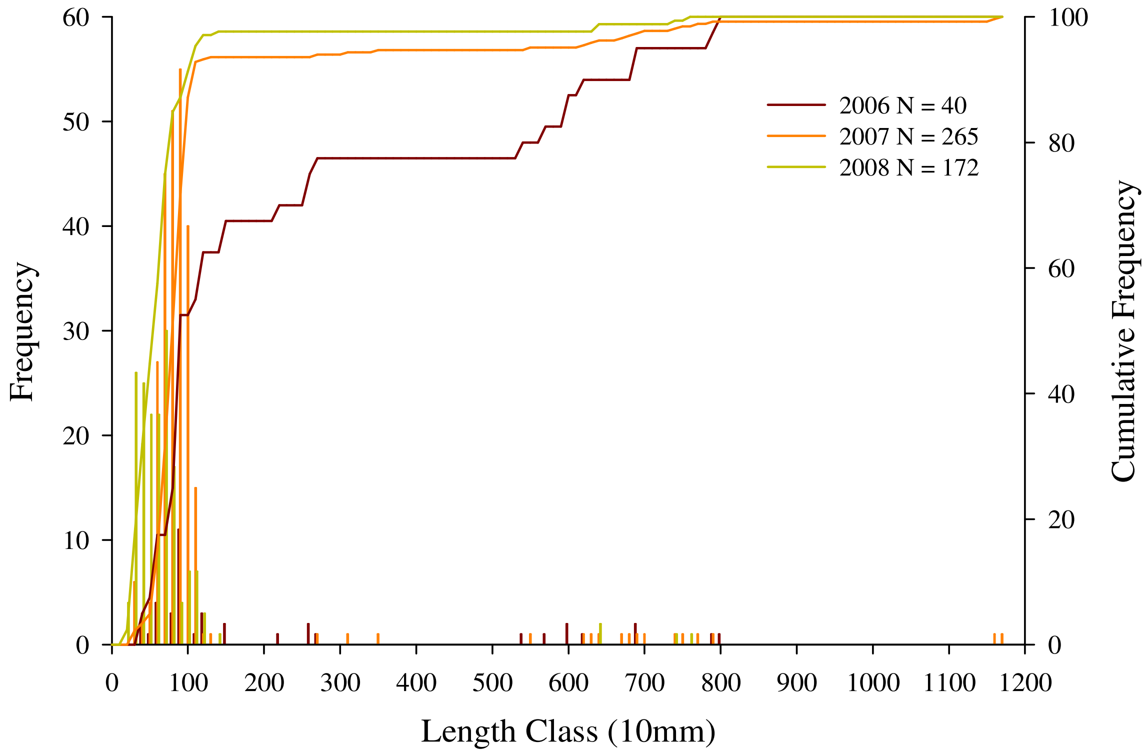


Figure III.5.3. Length frequency distributions and cumulative frequencies for measured blue catfish (N) at Upper Hamburg Bend from 2006 – 2008.

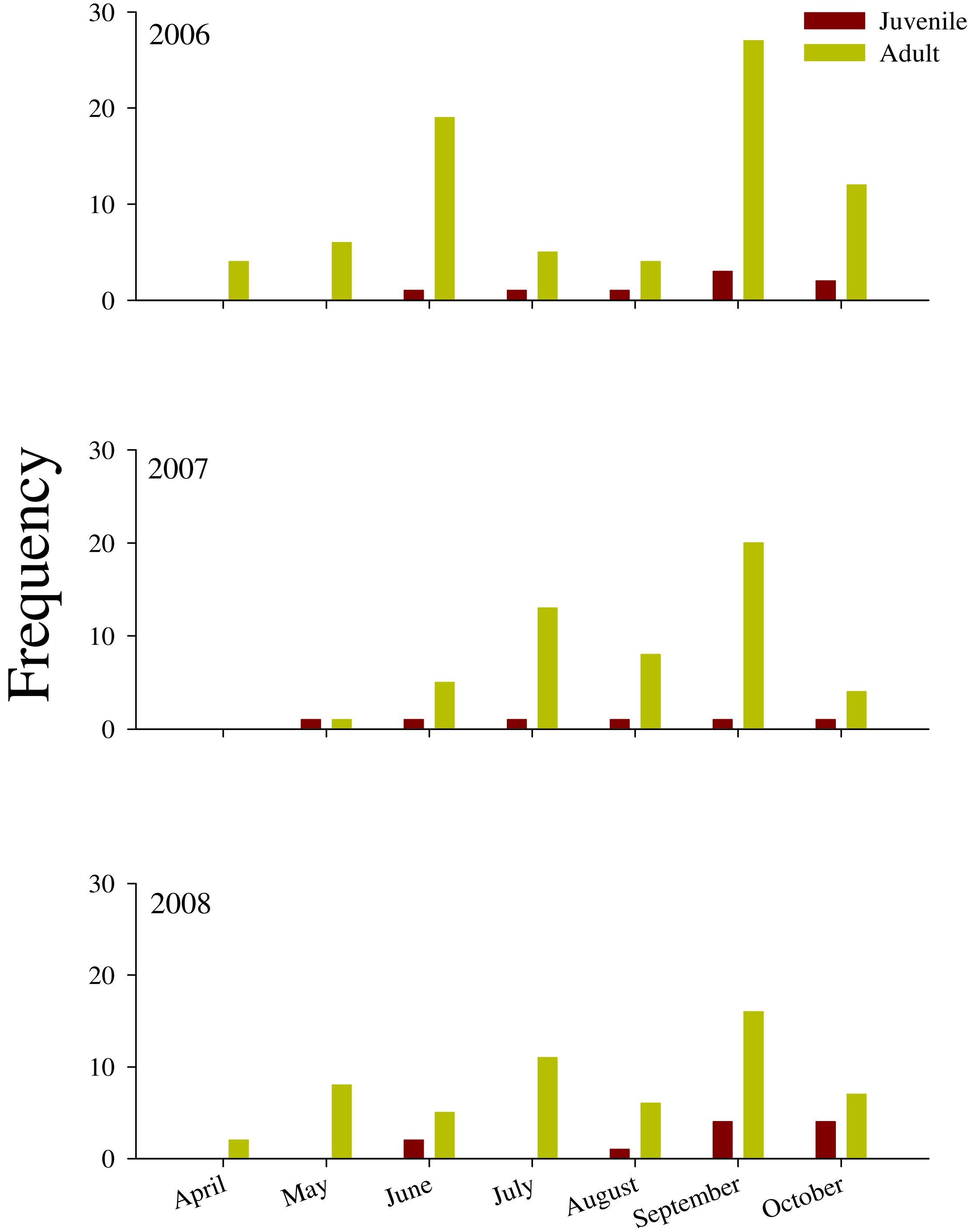


Figure III.5.4. Monthly frequency of juvenile (<508mm) and adult (≥508mm) blue sucker caught at Upper Hamburg Bend from 2006 - 2008.

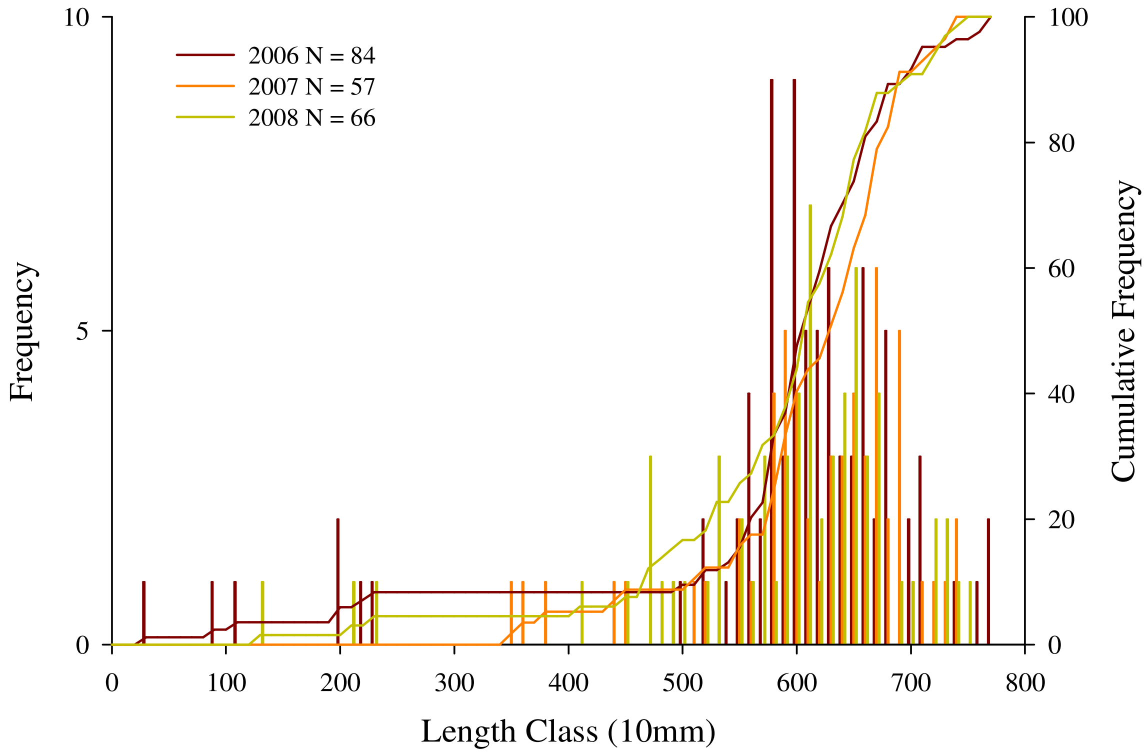


Figure III.5.5. Length frequency distributions and cumulative frequencies for measured blue sucker (N) at Upper Hamburg Bend from 2006 – 2008.

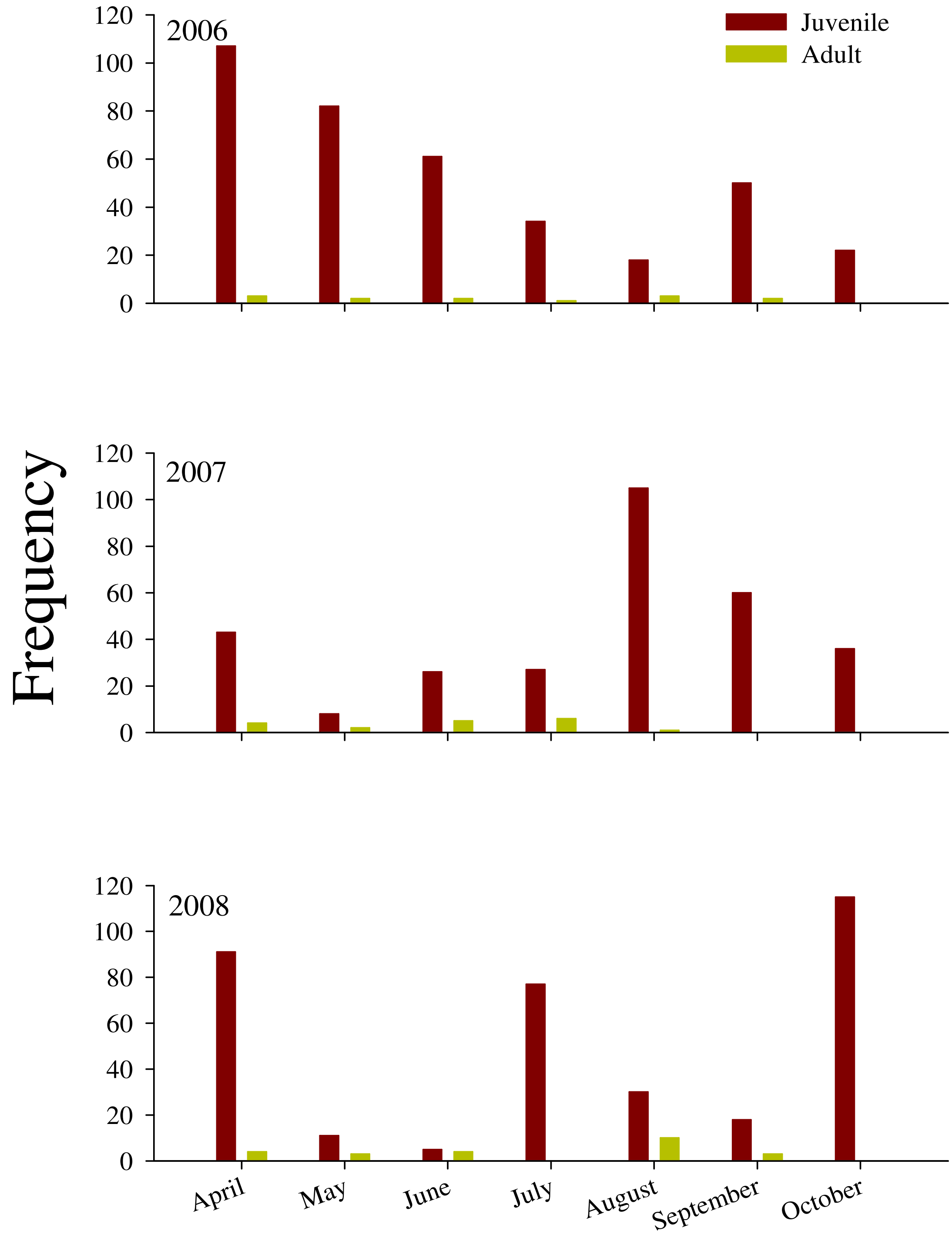


Figure III.5.6. Monthly frequency of juvenile (<305mm) and adult (≥305mm) channel catfish caught at Upper Hamburg Bend from 2006 - 2008.

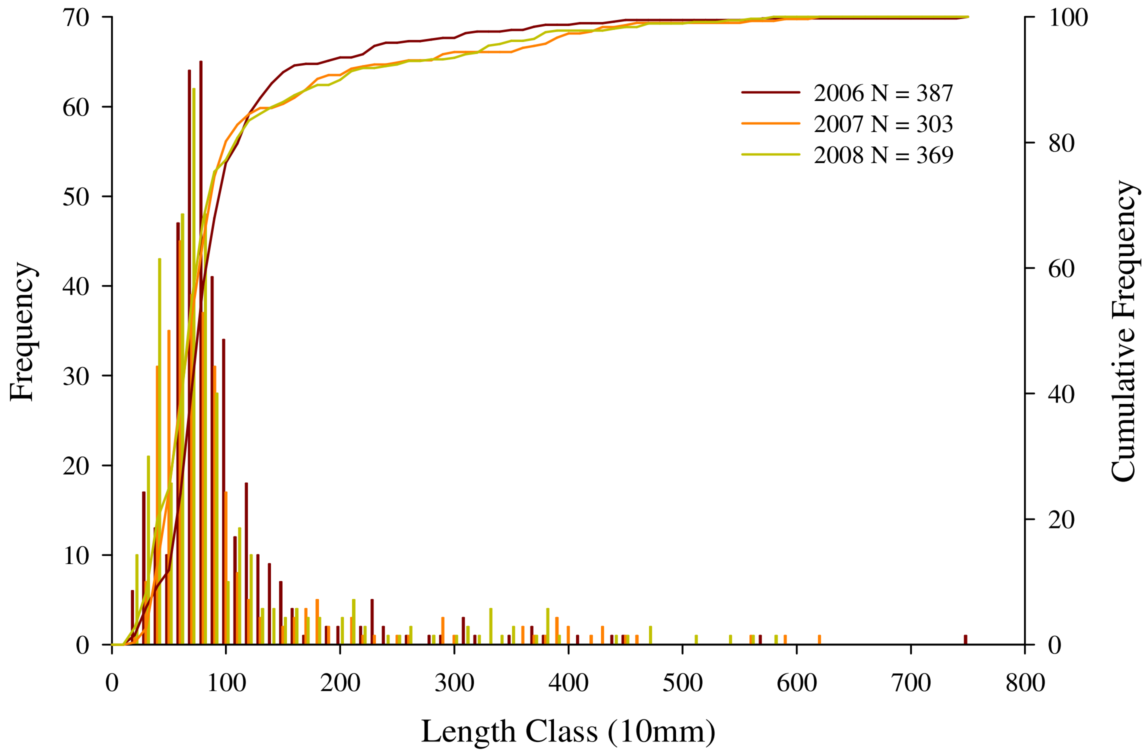


Figure III.5.7. Length frequency distributions and cumulative frequencies for measured channel catfish (N) at Upper Hamburg Bend from 2006 – 2008.

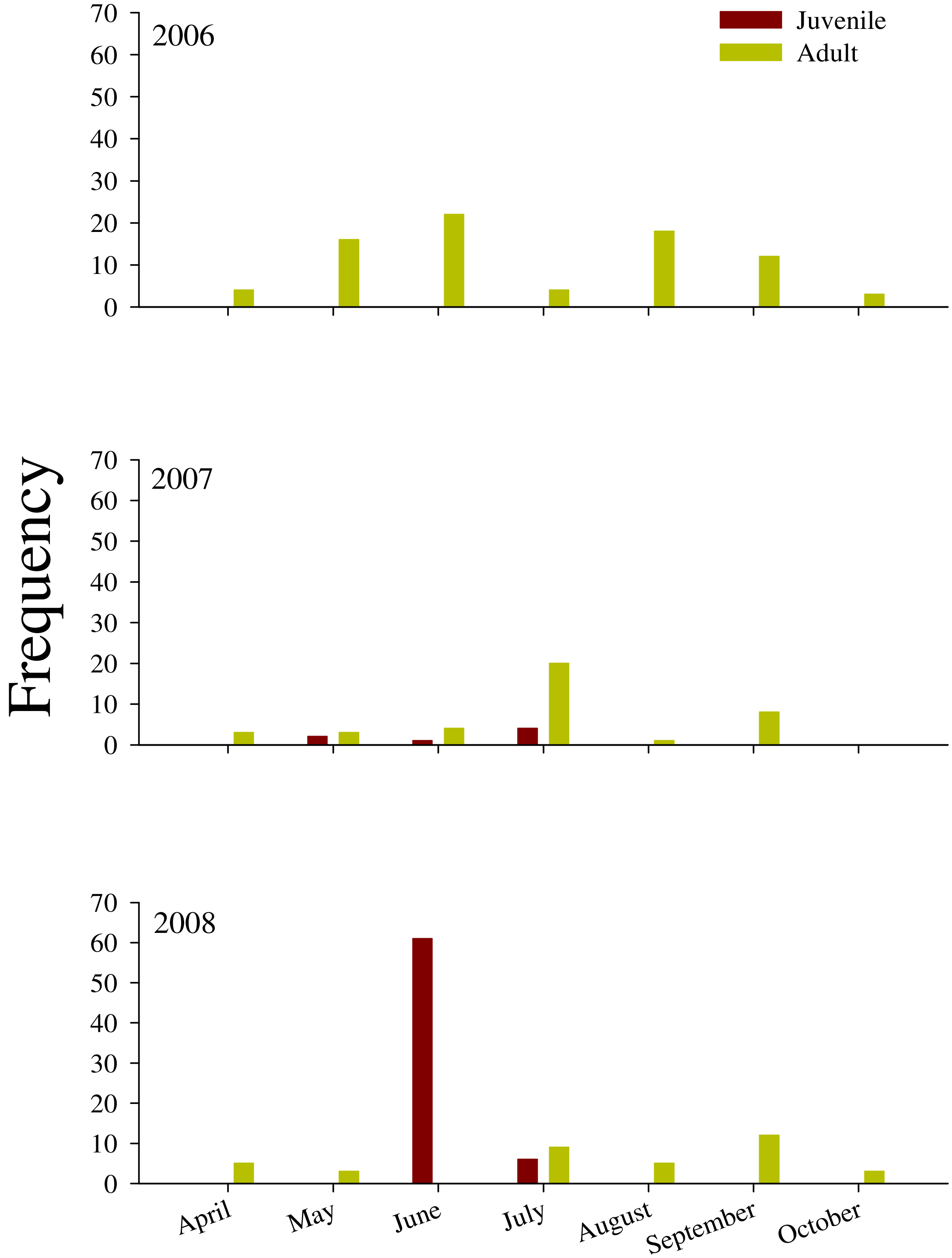


Figure III.5.8. Monthly frequency of juvenile (<305mm) and adult (≥305mm) common carp caught at Upper Hamburg Bend from 2006 - 2008.

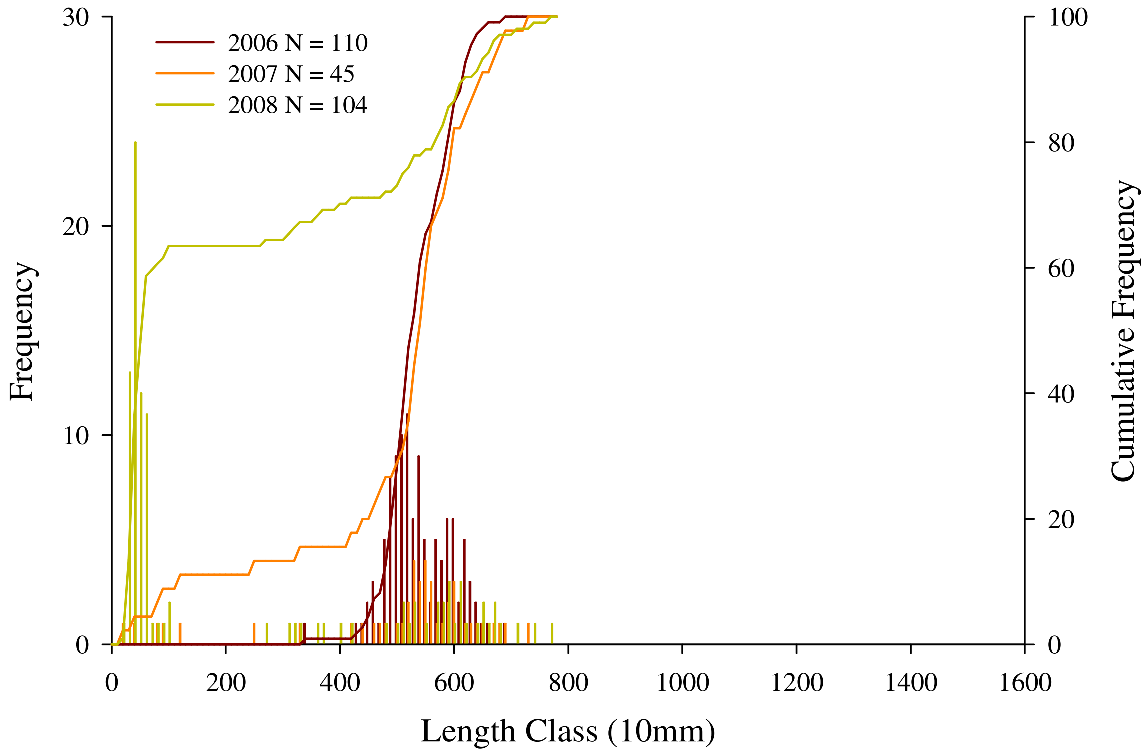


Figure III.5.9. Length frequency distributions and cumulative frequencies for measured common carp (N) at Upper Hamburg Bend from 2006 – 2008.

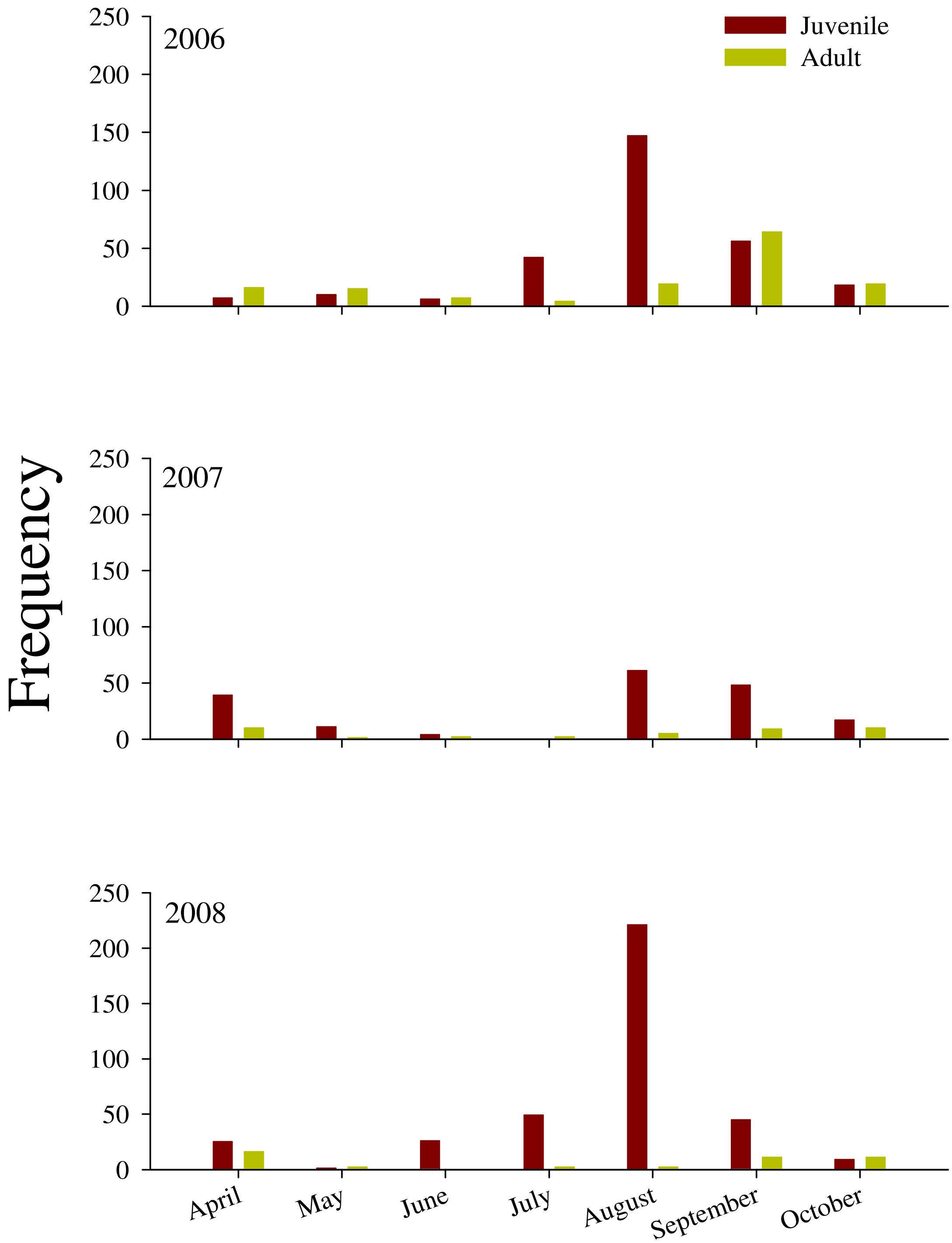


Figure III.5.10. Monthly frequency of juvenile (<64mm) and adult (≥64mm) emerald shiner caught at Upper Hamburg Bend from 2006 - 2008.

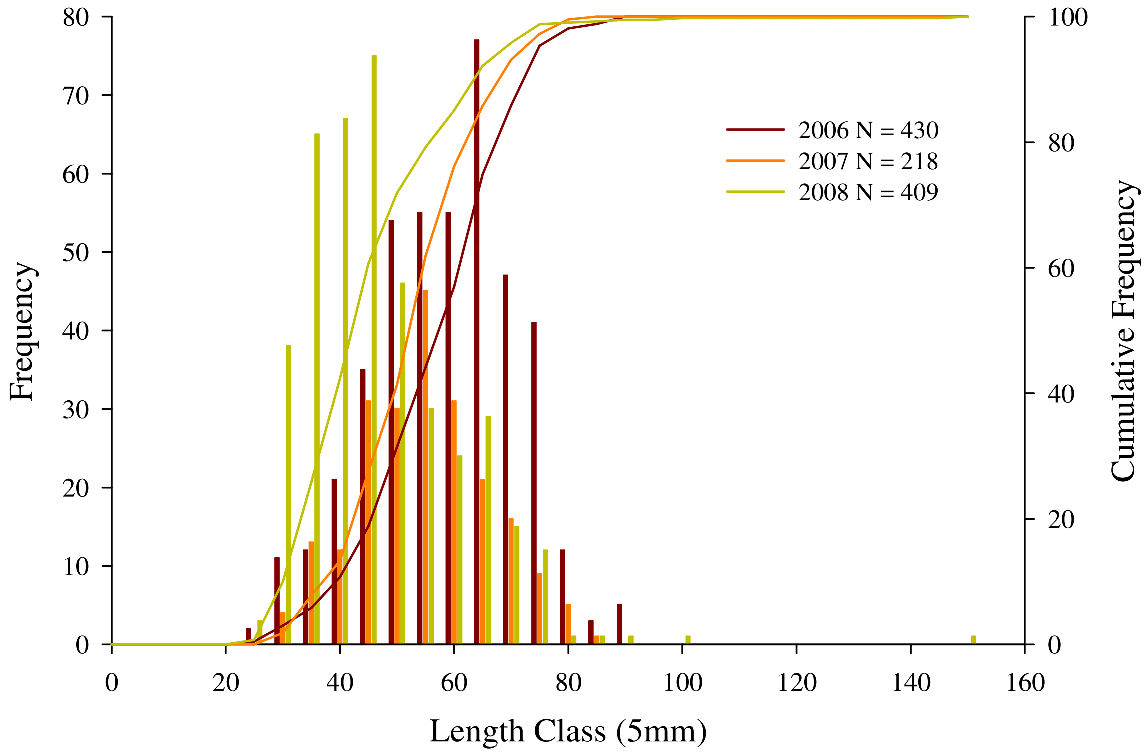


Figure III.5.11. Length frequency distributions and cumulative frequencies for measured emerald shiner (N) at Upper Hamburg Bend from 2006 – 2008.

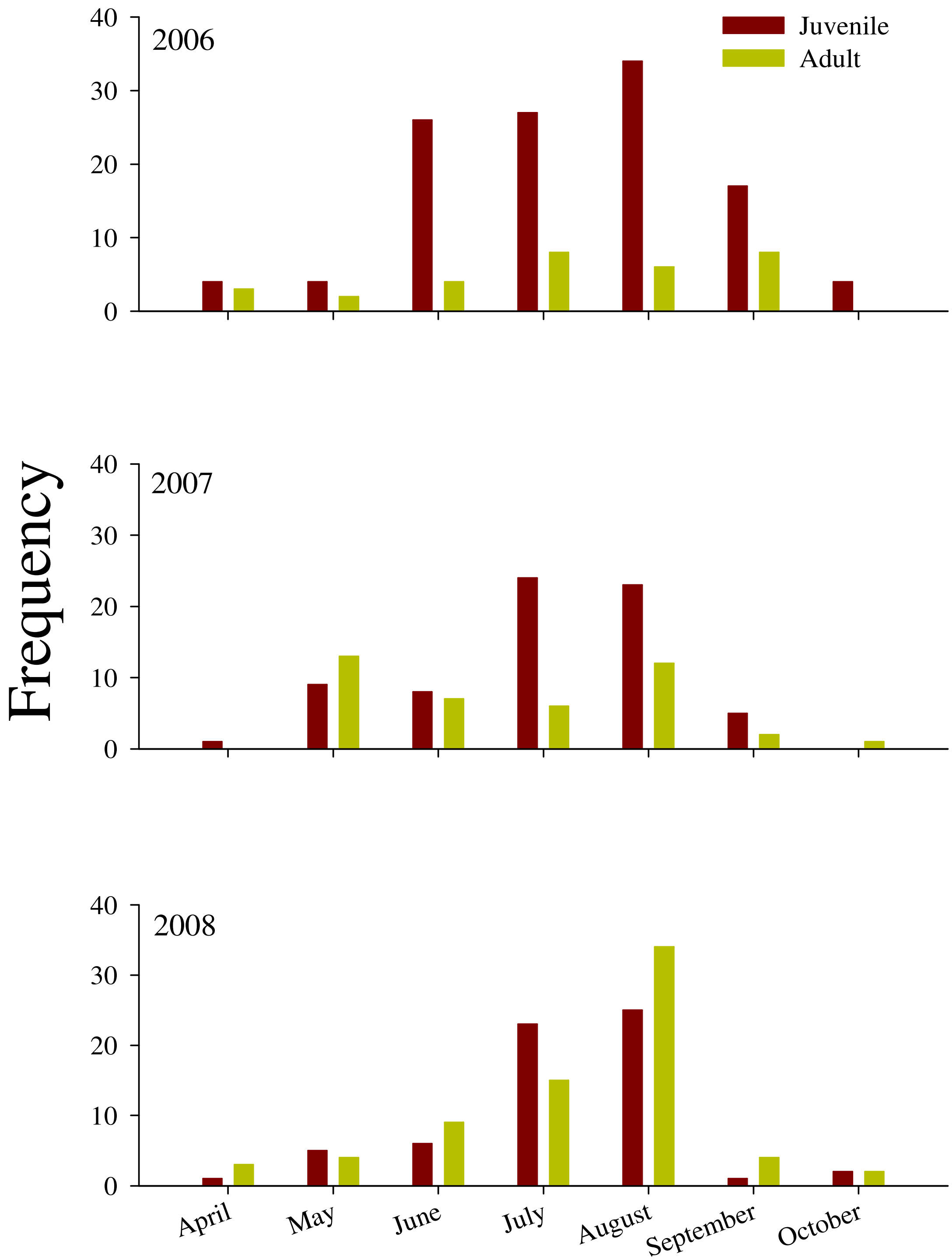


Figure III.5.12. Monthly frequency of juvenile (<381mm) and adult (≥381mm) flathead catfish caught at Upper Hamburg Bend from 2006 – 2008.

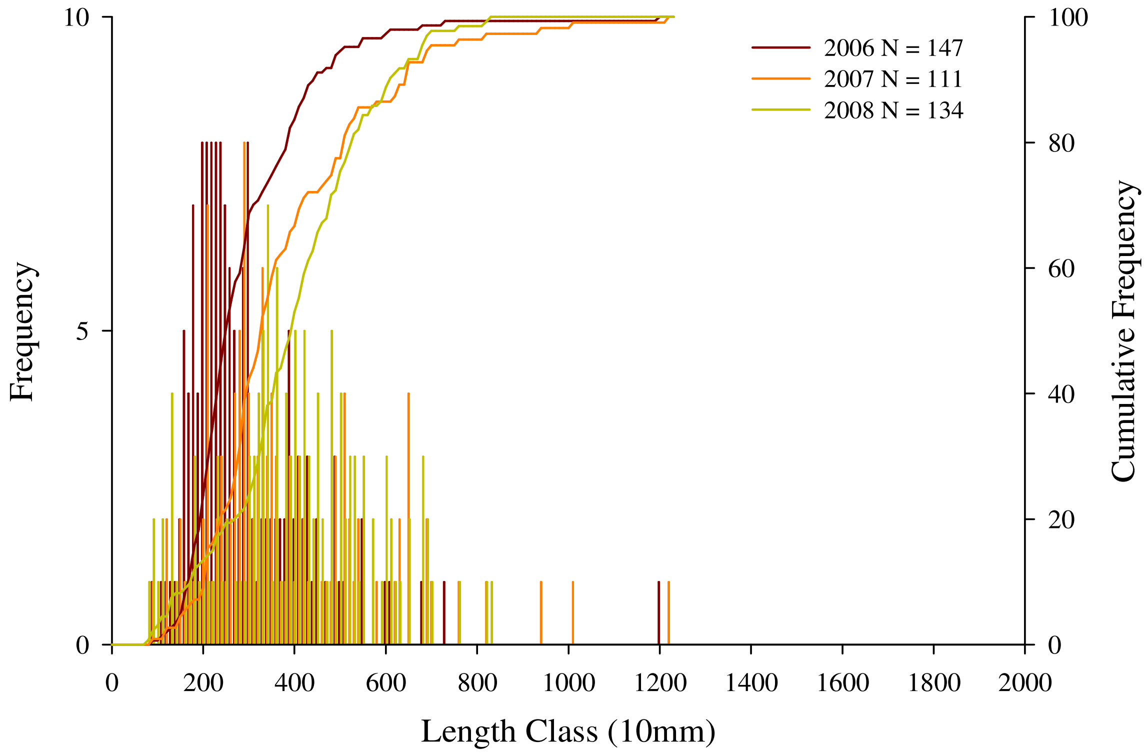


Figure III.5.13. Length frequency distributions and cumulative frequencies for measured flathead catfish (N) at Upper Hamburg Bend from 2006 – 2008.

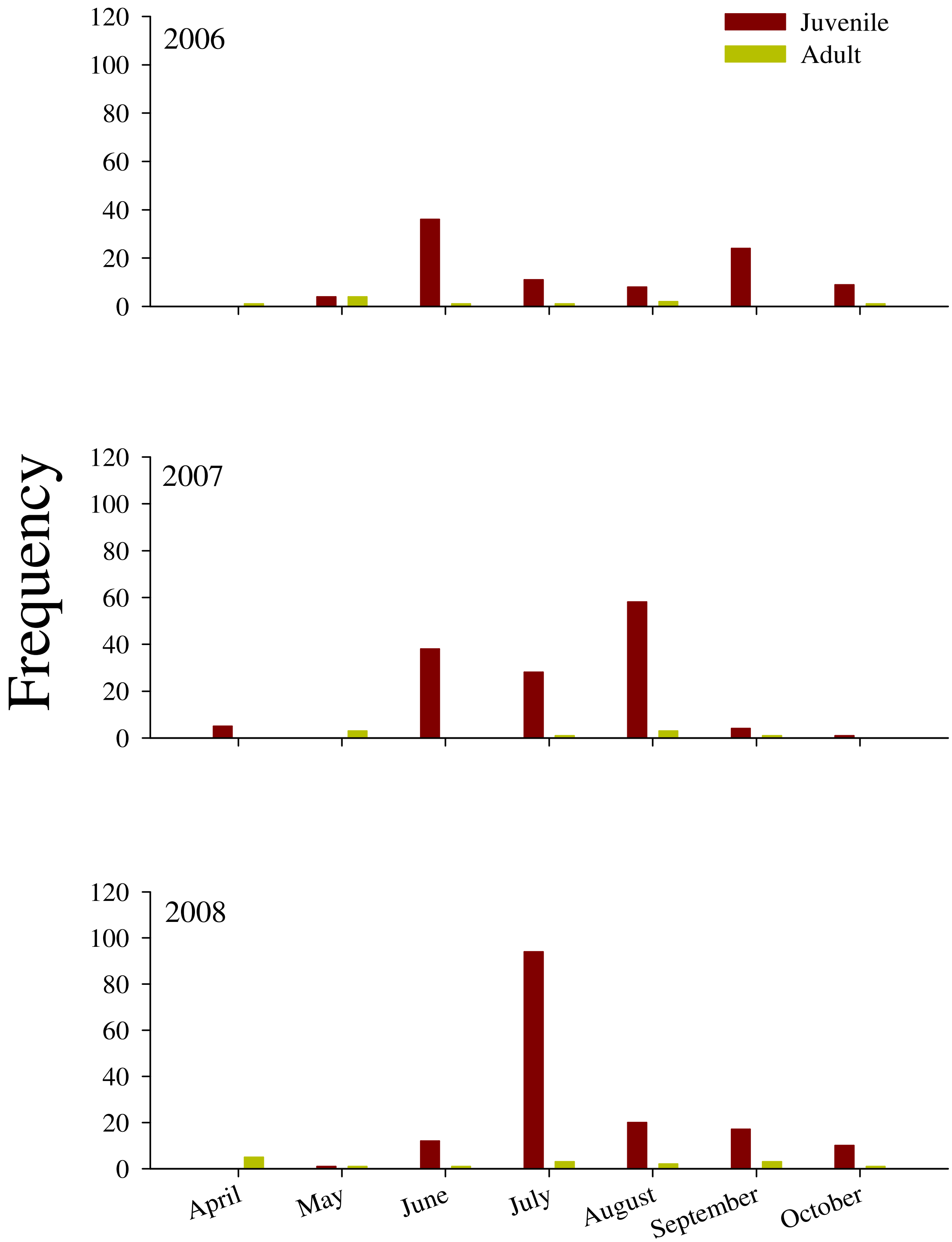


Figure III.5.14. Monthly frequency of juvenile (<305mm) and adult (≥305mm) freshwater drum caught at Upper Hamburg Bend from 2006 - 2008.

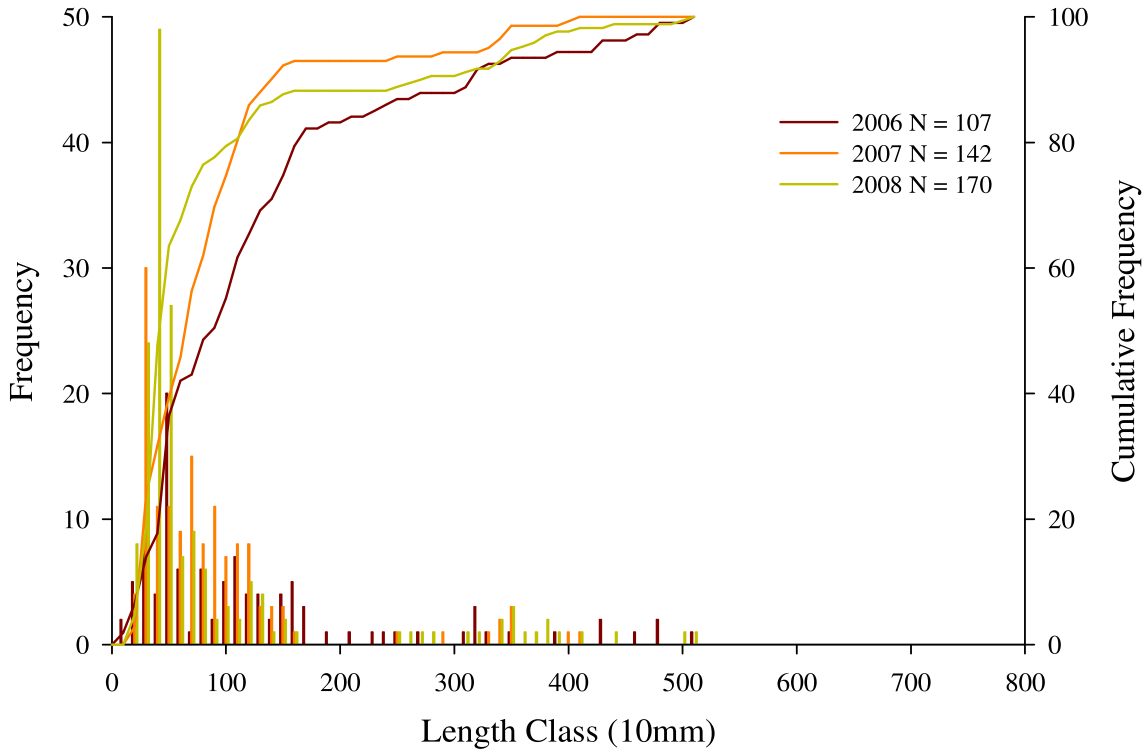


Figure III.5.15. Length frequency distributions and cumulative frequencies for measured Freshwater drum (N) at Upper Hamburg Bend from 2006 – 2008.

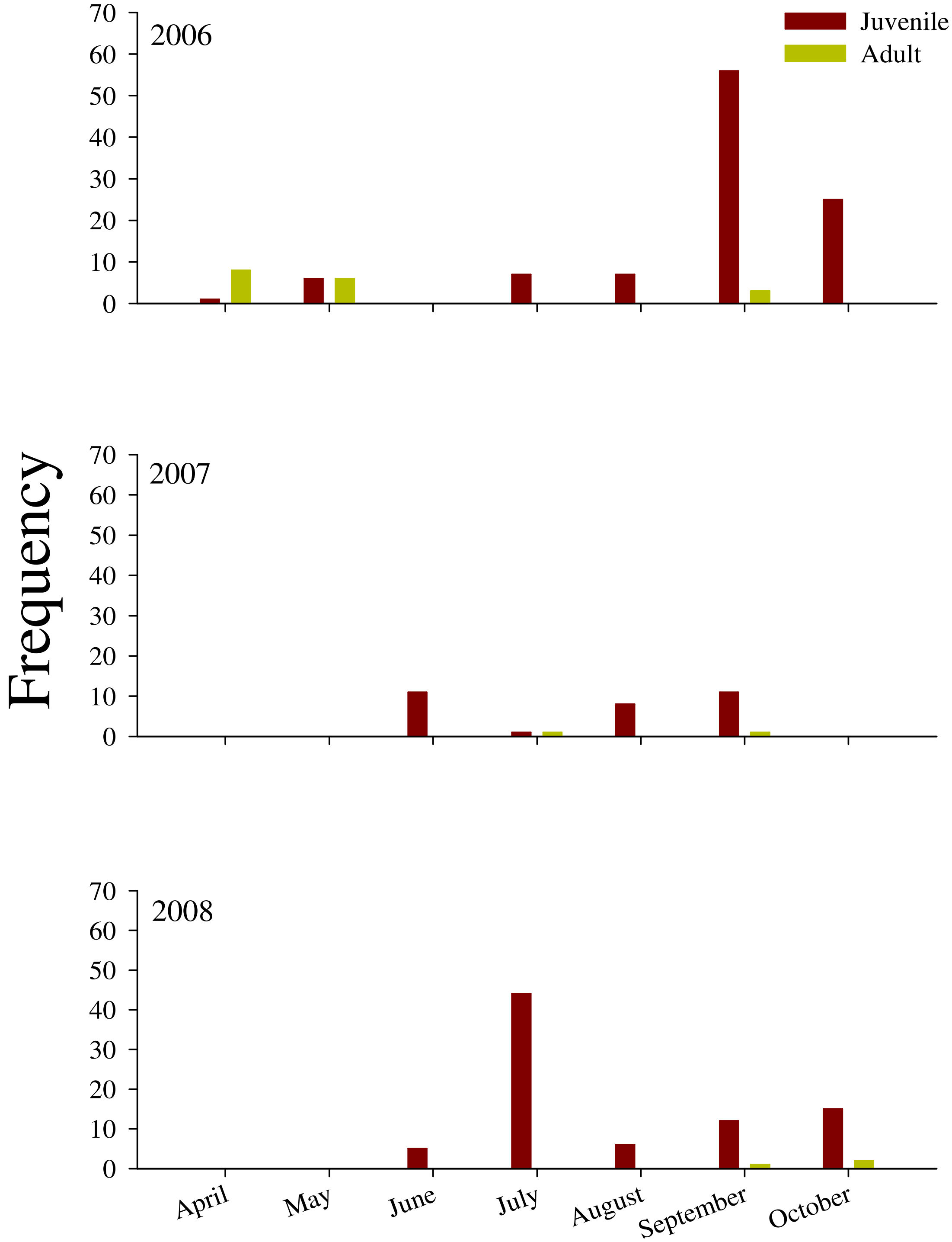


Figure III.5.16. Monthly frequency of juvenile (<229mm) and adult (≥229mm) gizzard shad caught at Upper Hamburg Bend from 2006 - 2008.

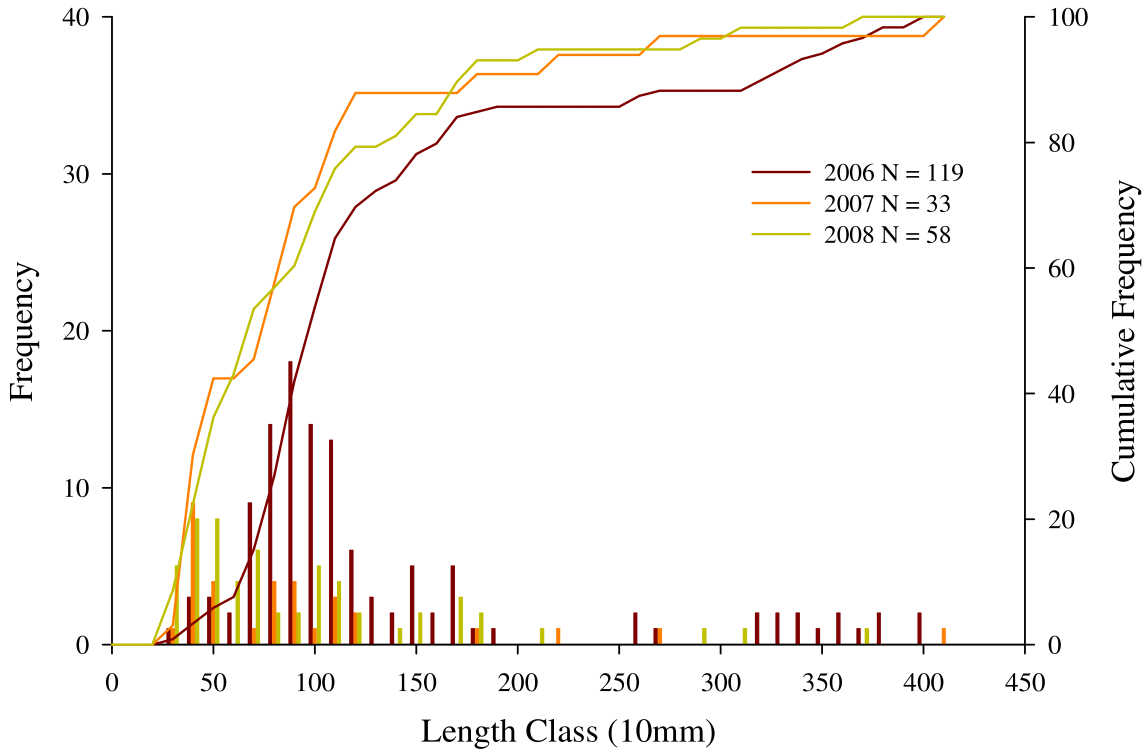


Figure III.5.17. Length frequency distributions and cumulative frequencies for measured gizzard shad (N) at Upper Hamburg Bend from 2006 – 2008.

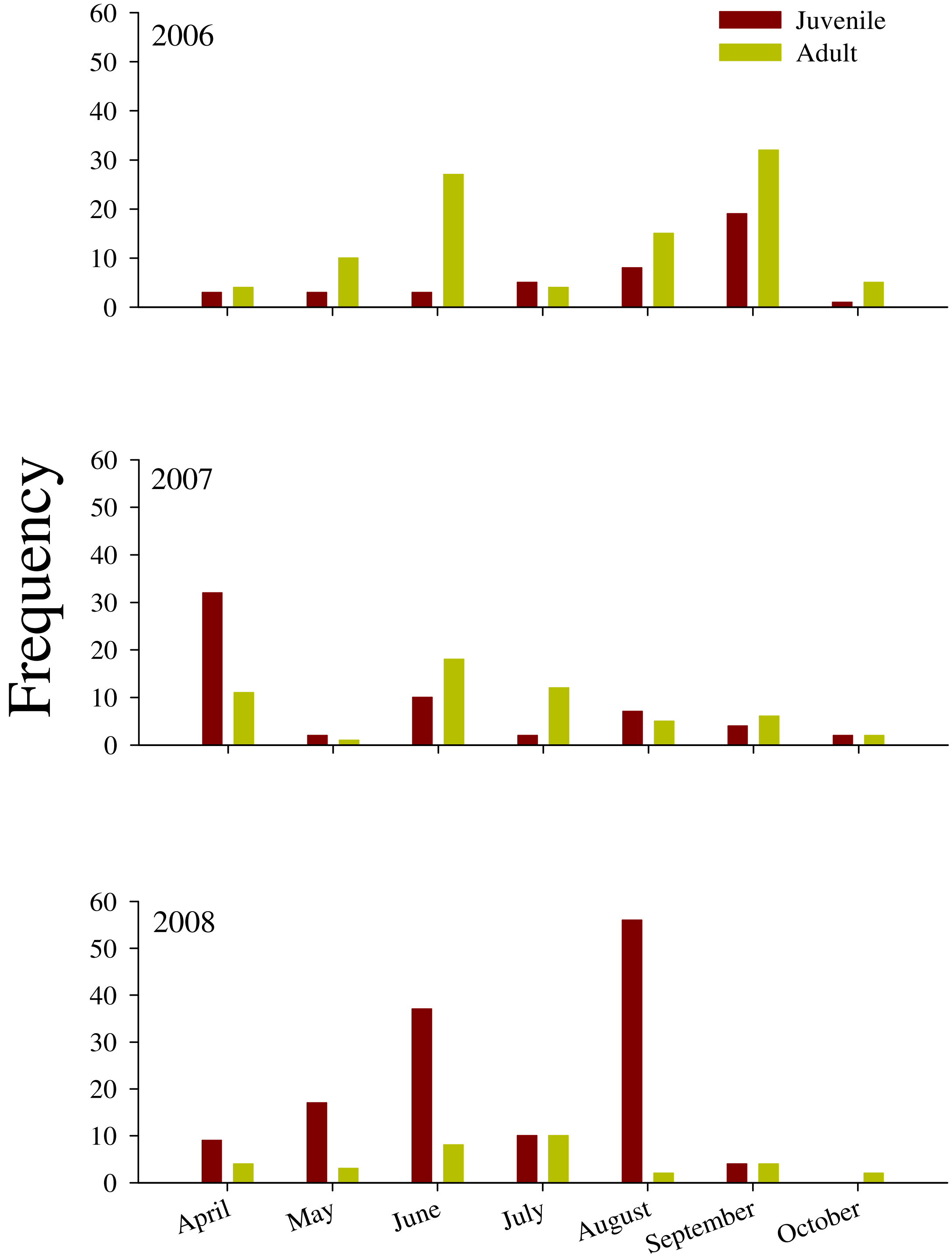


Figure III.5.18. Monthly frequency of juvenile (<46mm) and adult (≥46mm) red shiner caught at Upper Hamburg Bend from 2006 - 2008.

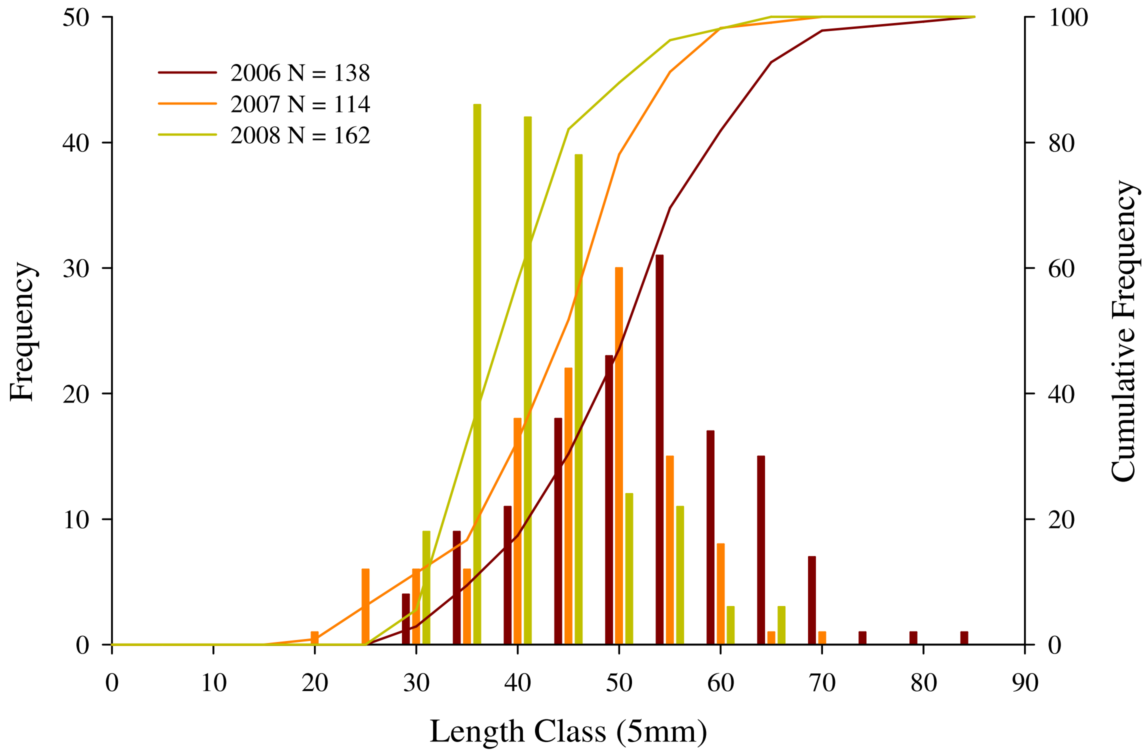


Figure III.5.19. Length frequency distributions and cumulative frequencies for measured red shiner (N) at Upper Hamburg Bend from 2006 – 2008.

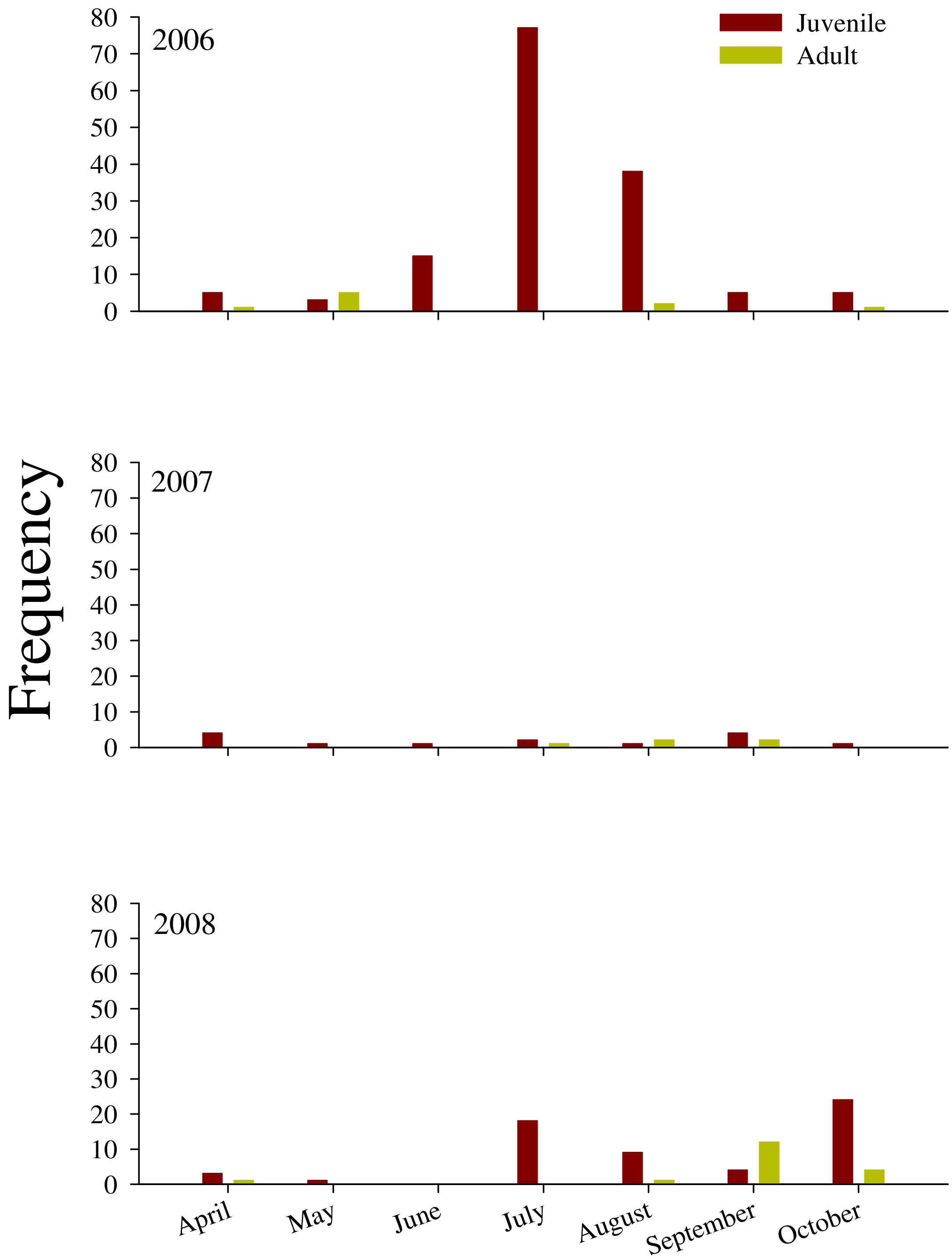


Figure III.5.20. Monthly frequency of juvenile (<305mm) and adult (≥305mm) river carpsucker caught at Upper Hamburg Bend from 2006 - 2008.

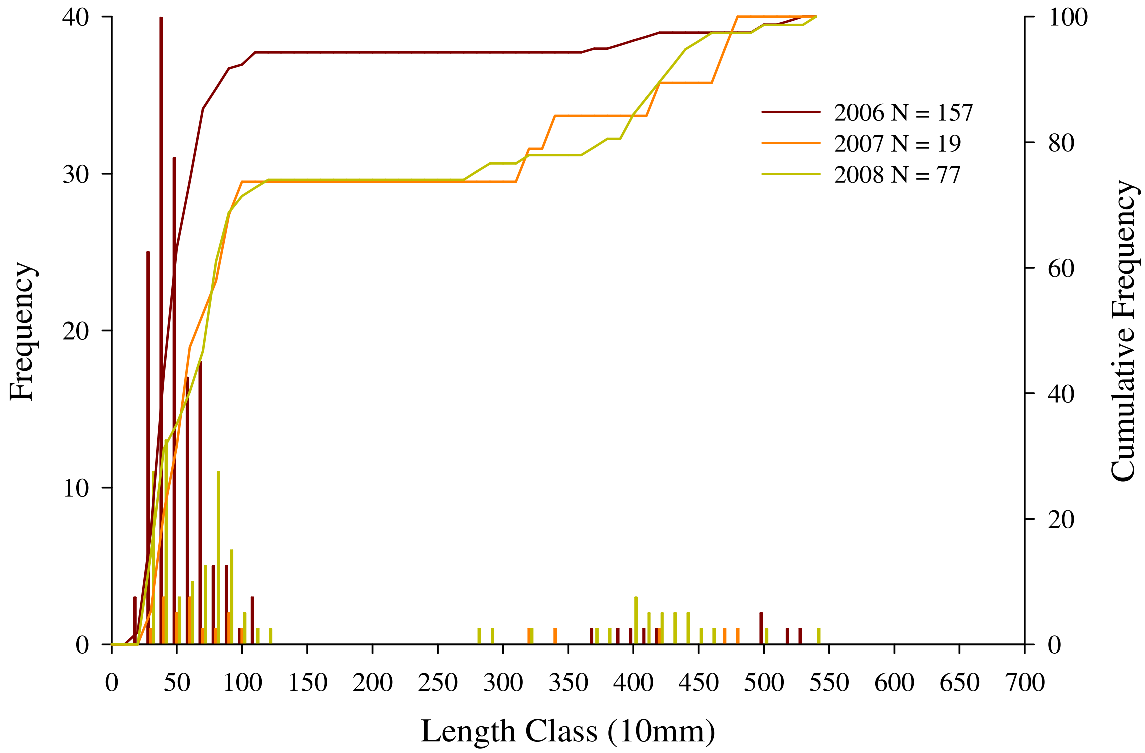


Figure III.5.21. Length frequency distributions and cumulative frequencies for measured river carpsucker (N) at Upper Hamburg Bend from 2006 – 2008.

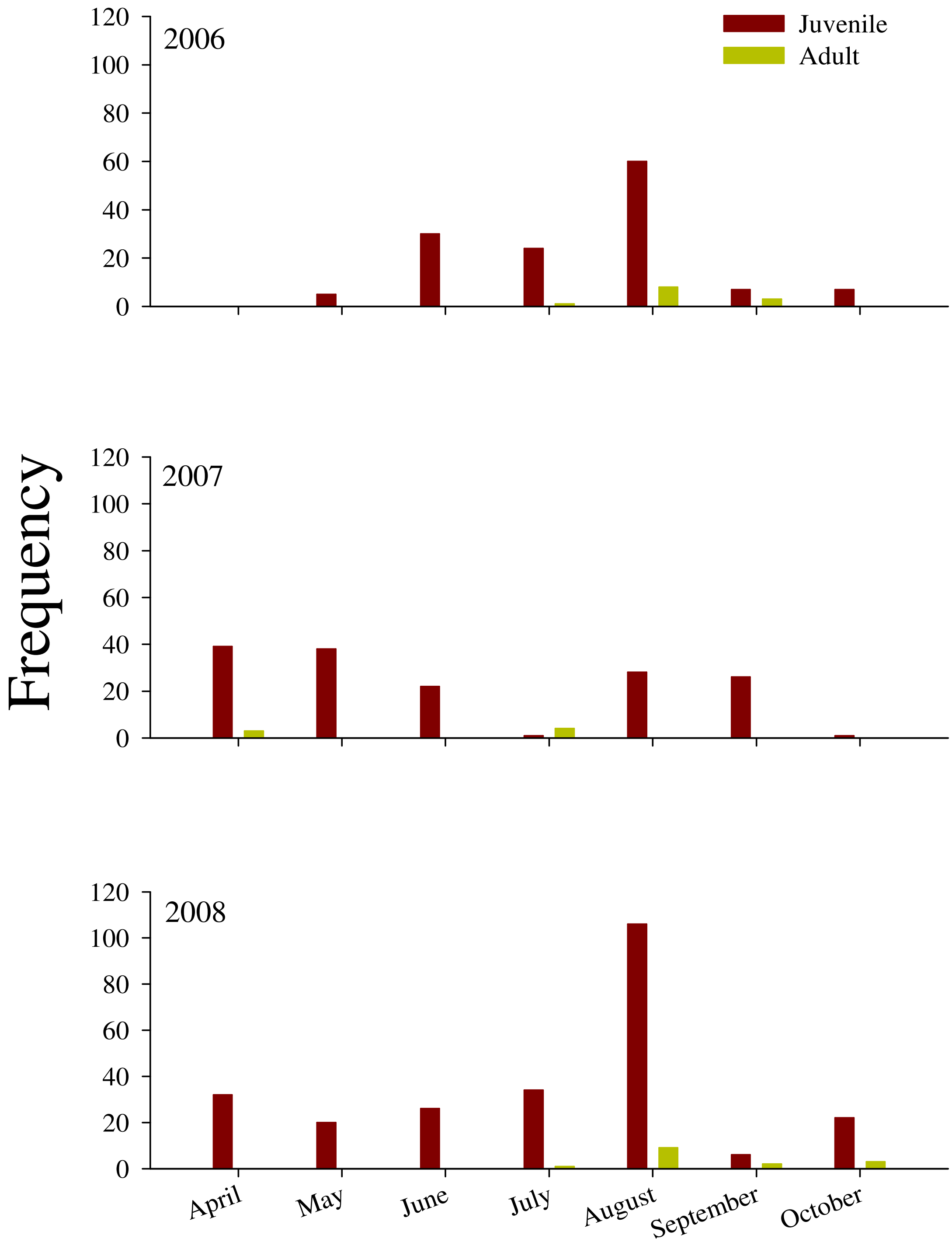


Figure III.5.22. Monthly frequency of juvenile (<51mm) and adult (≥51mm) river shiner caught at Upper Hamburg Bend from 2006 - 2008.

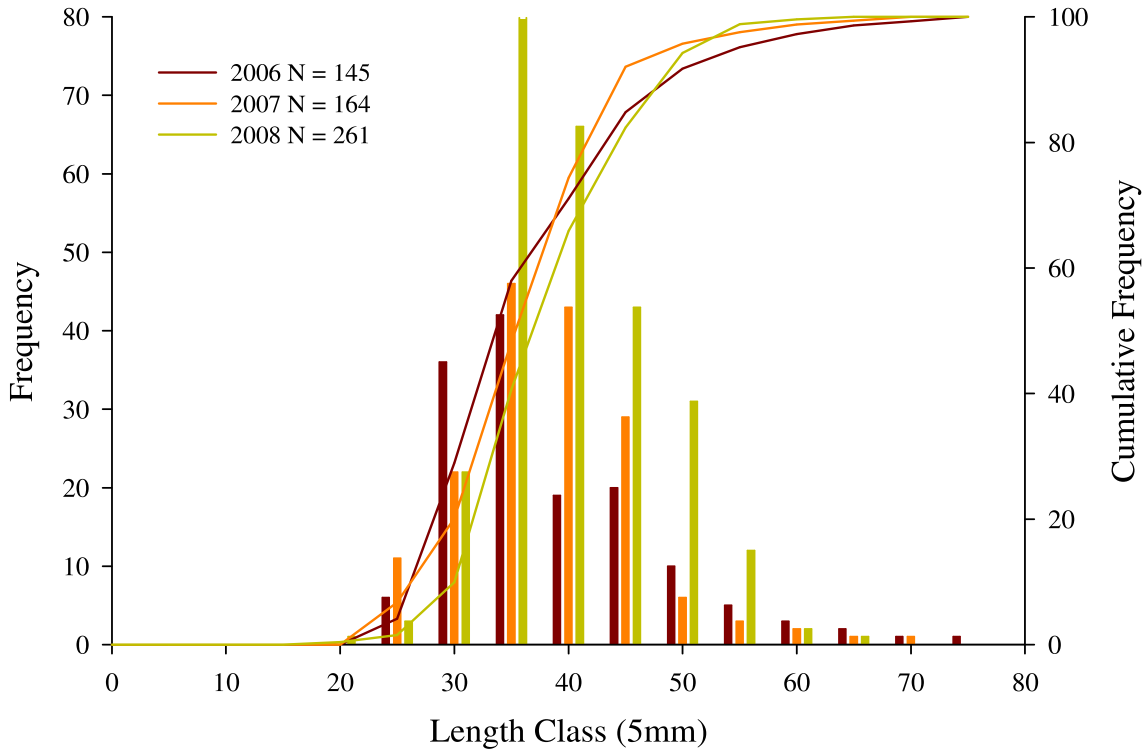


Figure III.5.23. Length frequency distributions and cumulative frequencies for measured river shiner (N) at Upper Hamburg Bend from 2006 – 2008.

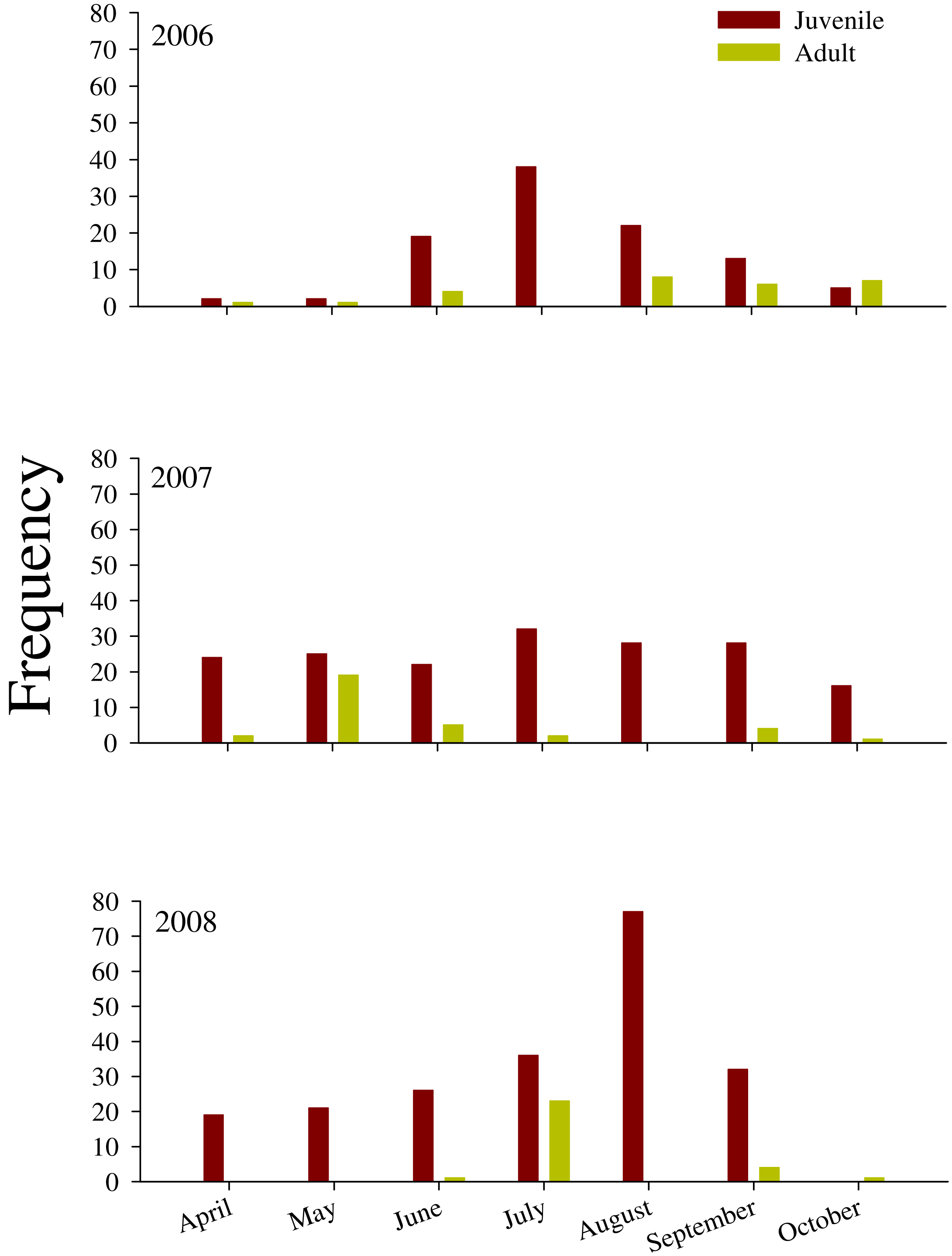


Figure III.5.24. Monthly frequency of juvenile (<43mm) and adult (≥43mm) sand shiner caught at Upper Hamburg Bend from 2006 - 2008.

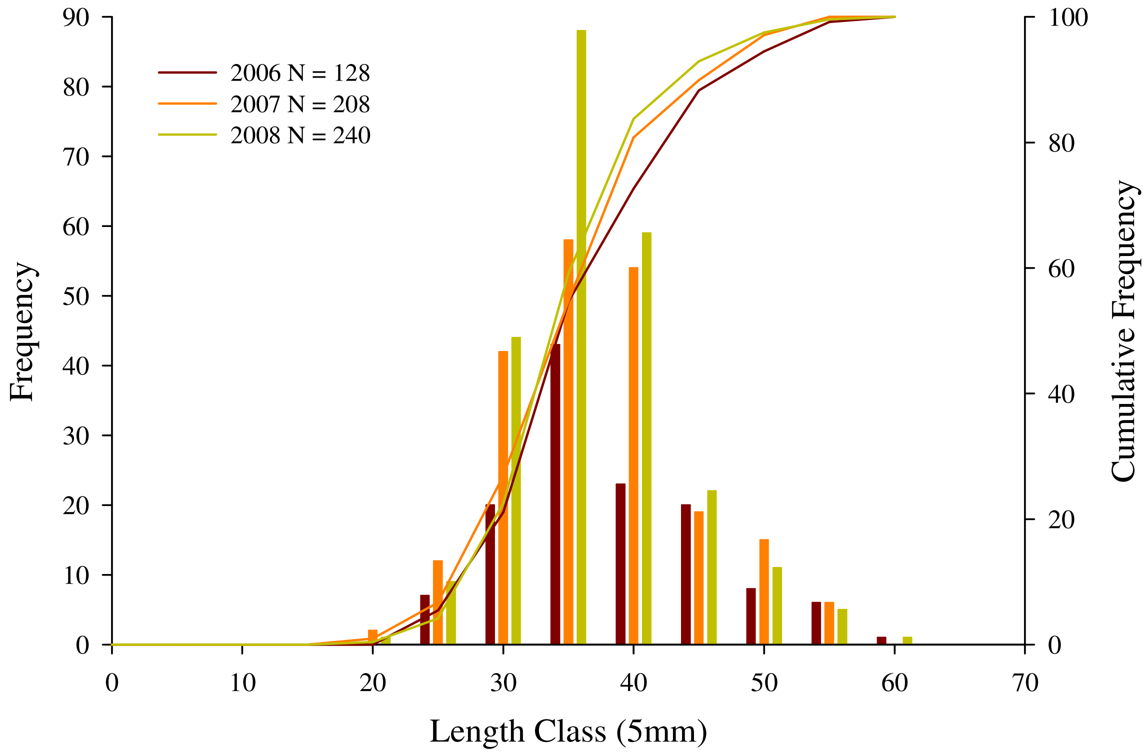


Figure III.5.25. Length frequency distributions and cumulative frequencies for measured sand shiner (N) at Upper Hamburg Bend from 2006 – 2008.

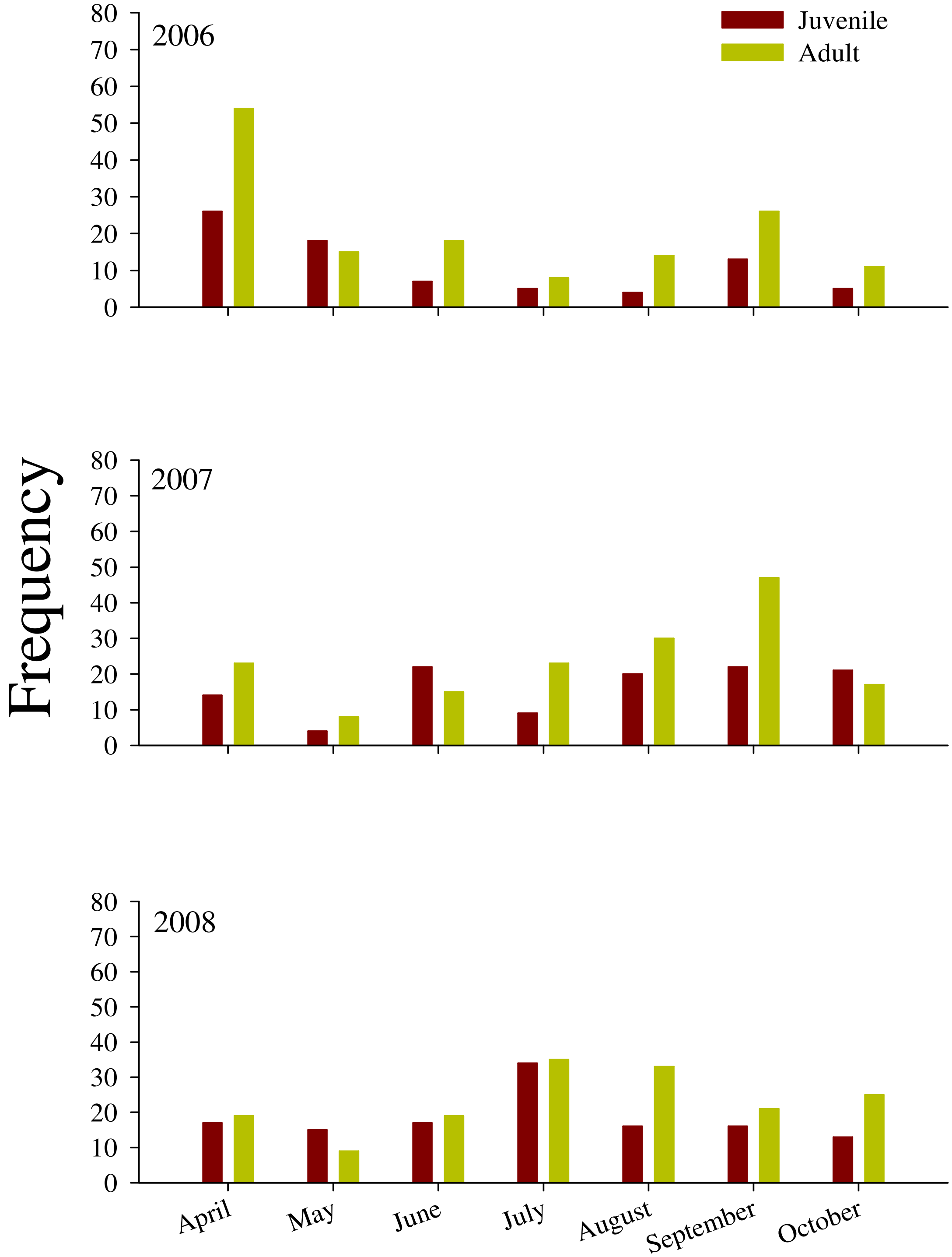


Figure III.5.26. Monthly frequency of juvenile (<540mm) and adult (≥540mm) shovelnose sturgeon caught at Upper Hamburg Bend from 2006 - 2008.

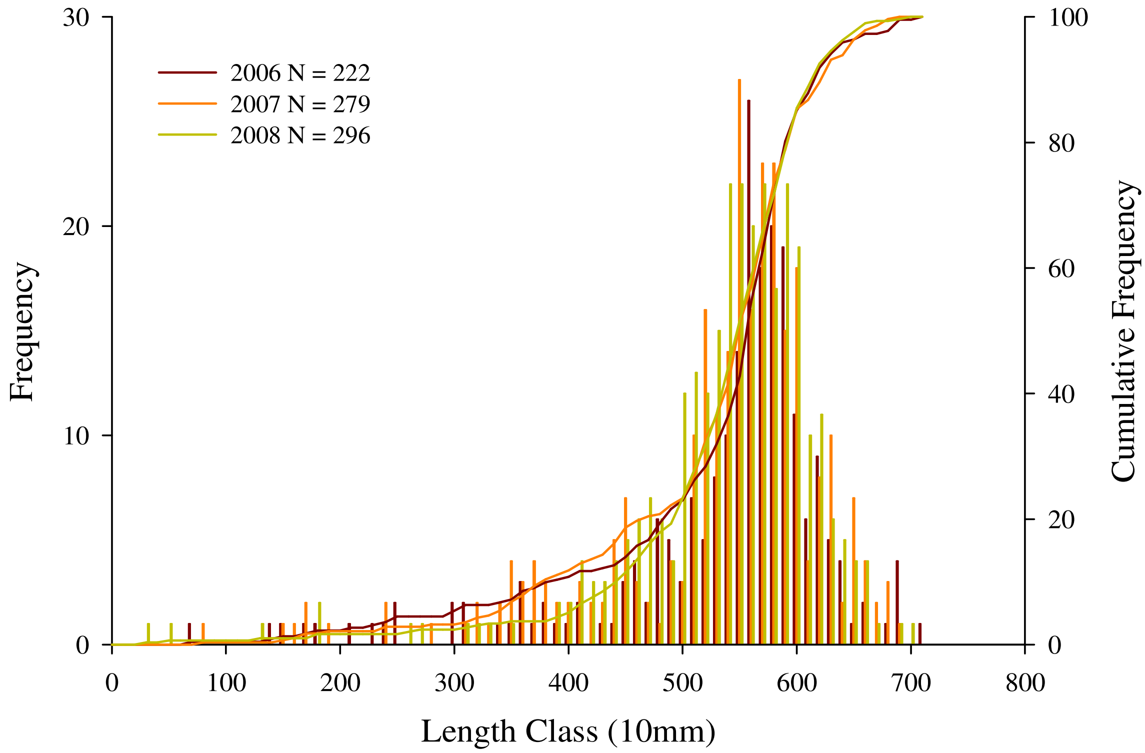


Figure III.5.27. Length frequency distributions and cumulative frequencies for measured shovelnose sturgeon (N) at Upper Hamburg Bend from 2006 – 2008.

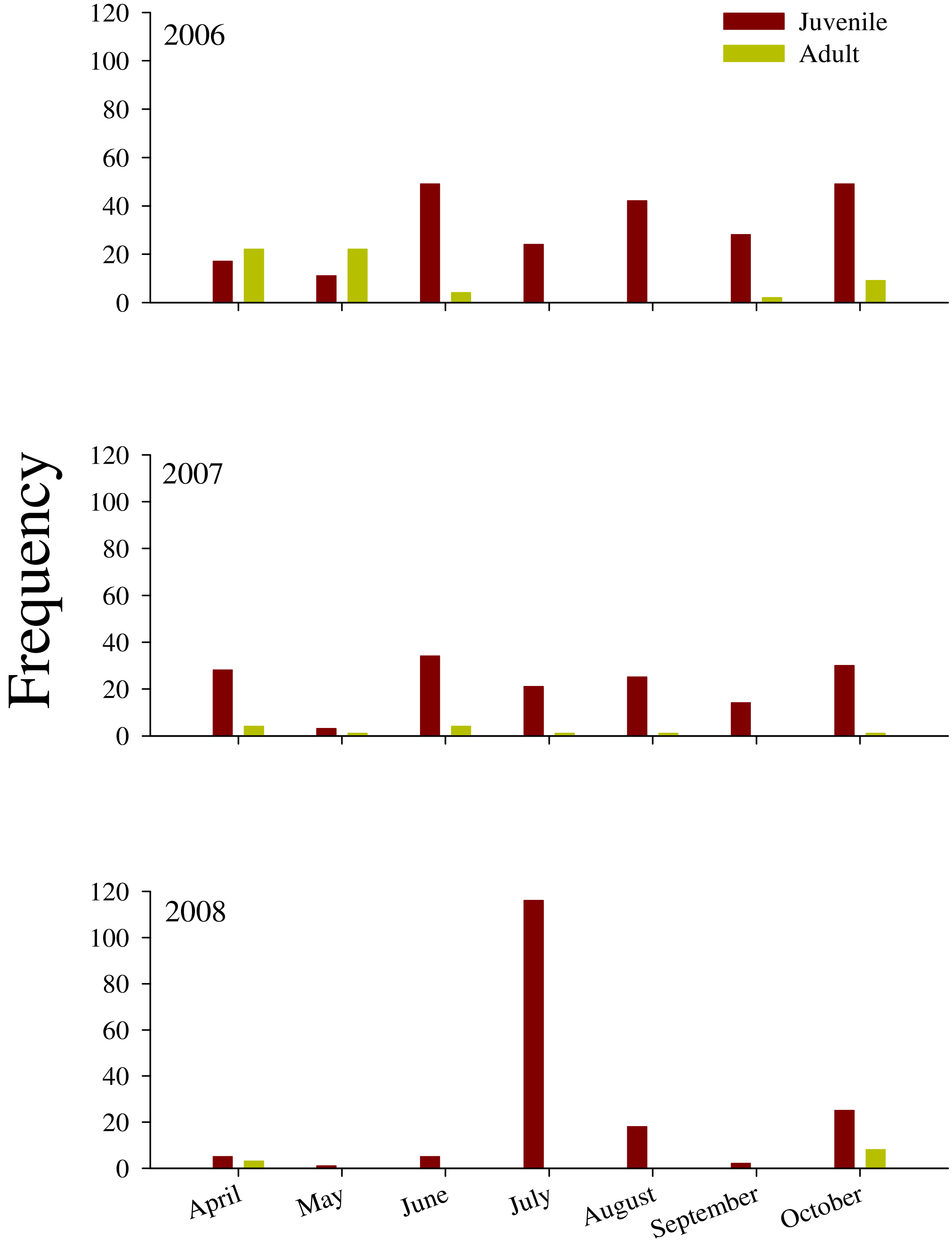


Figure III.5.28. Monthly frequency of juvenile (<89mm) and adult (≥89mm) silver chub caught at Upper Hamburg Bend from 2006 - 2008.

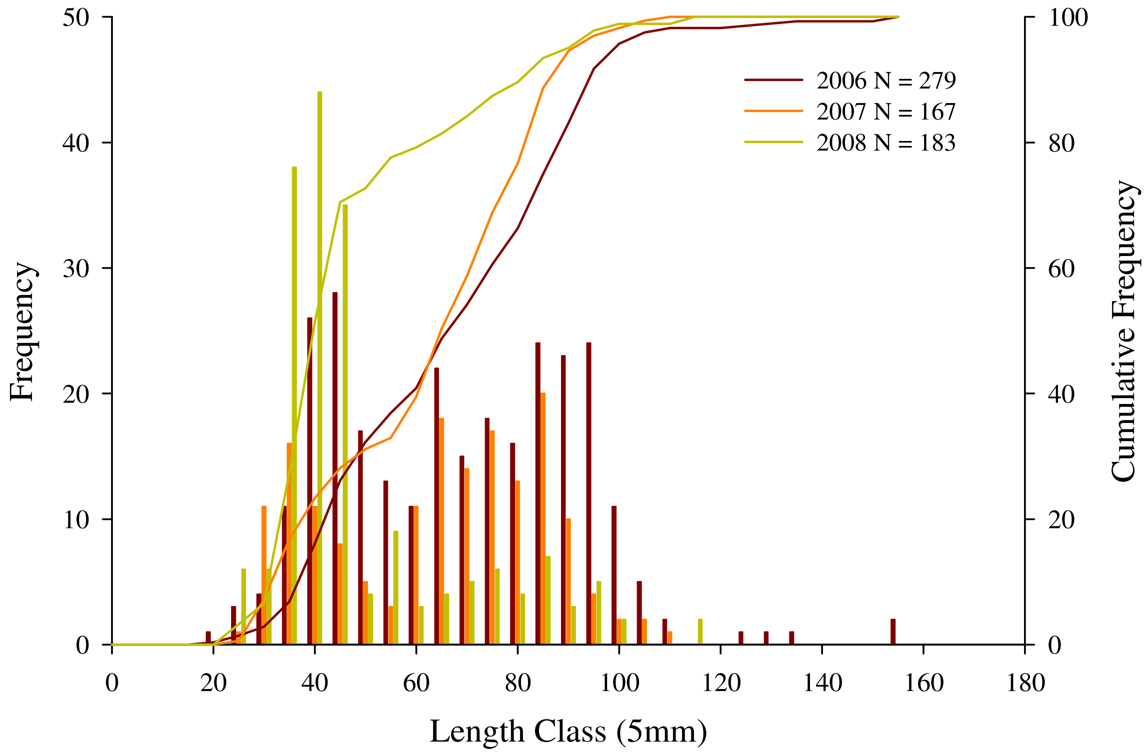


Figure III.5.29. Length frequency distributions and cumulative frequencies for measured silver chub (N) at Upper Hamburg Bend from 2006 – 2008.

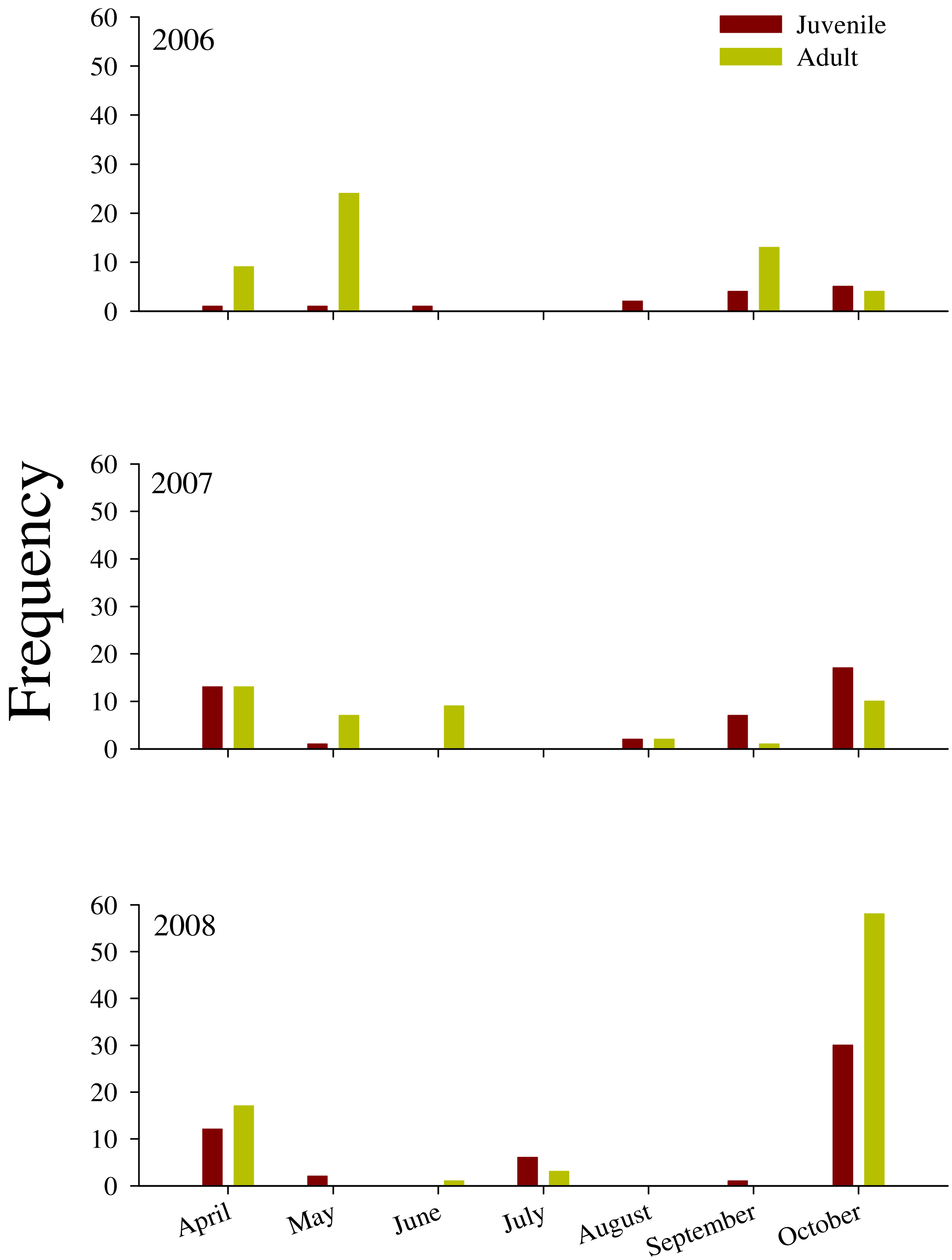


Figure III.5.30. Monthly frequency of juvenile (<40mm) and adult (≥40mm) speckled chub caught at Upper Hamburg Bend from 2006 - 2008.

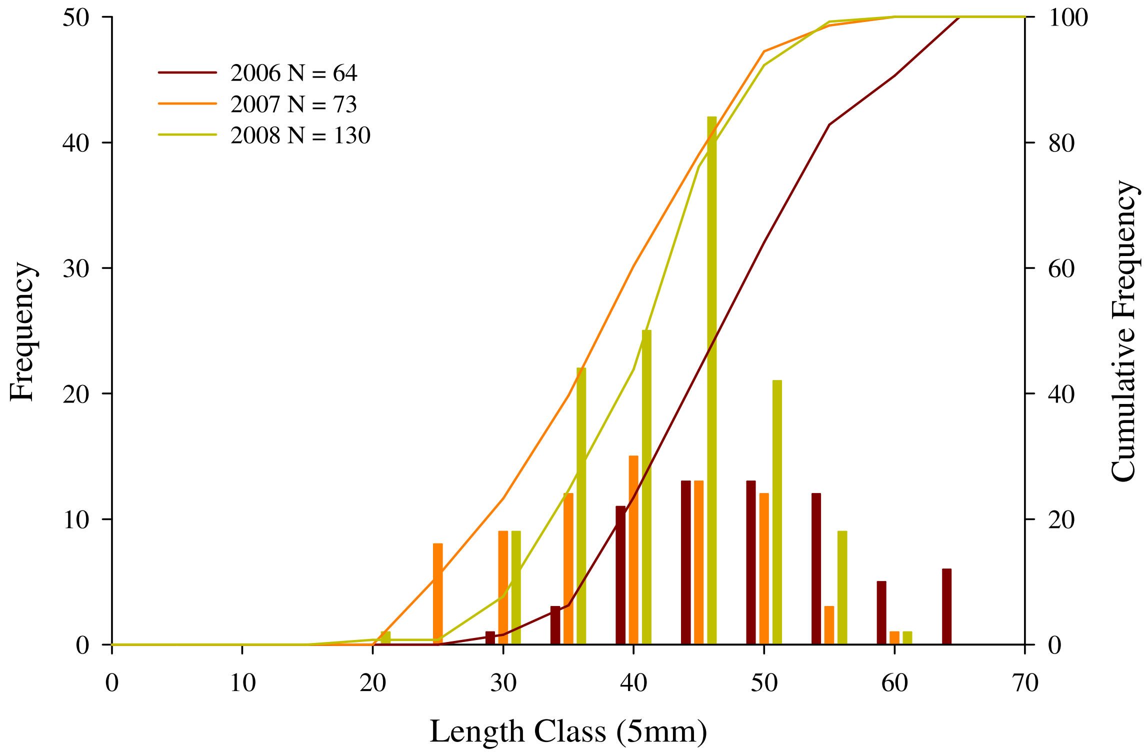
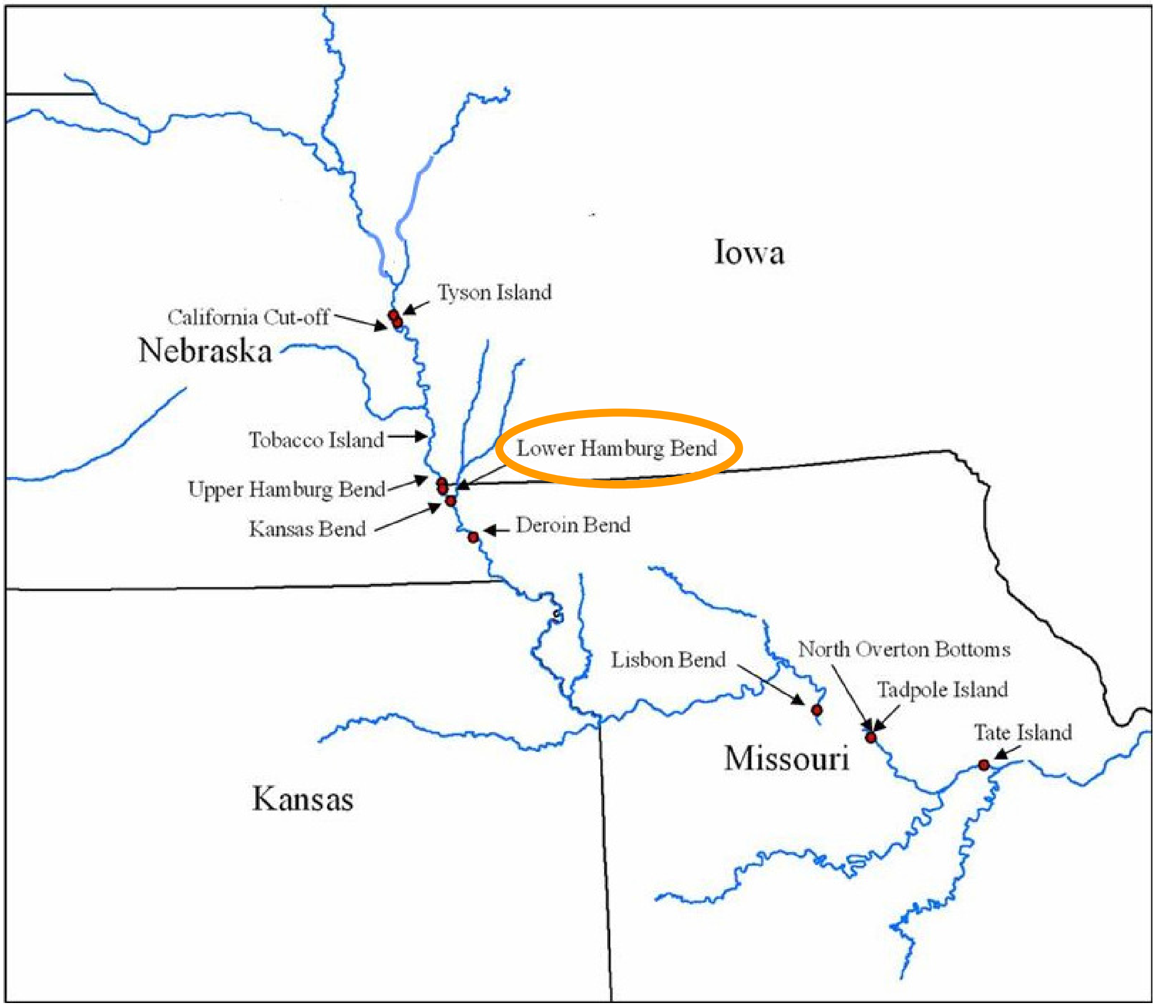


Figure III.5.31. Length frequency distributions and cumulative frequencies for measured speckled chub (N) at Upper Hamburg Bend from 2006 – 2008.

Section III
Chapter 6
Lower Hamburg Bend



LIST OF TABLES

Table | Page

Table | Page

LIST OF FIGURES

Figure Page

Figure Page

A total of 6,072 fish comprising 53 different species were sampled in Lower Hamburg from 2006 to 2008. Unidentified fish due to their small size or poor condition totaled 479. Sixty-one percent of the total number of fish caught were juveniles. The highest number of fish (2,417) was found in 2006 while the greatest species diversity (41) and lowest number of fish (1,769) were found during the 2007 sampling season. Species diversity and evenness increased from 2006 to 2008 ranging from 2.595 to 2.866 and 0.7036 to 0.7937 respectively (Table III.6.2). The fish community was similar in 2006 and 2007 but neither similar nor dissimilar between 2007 and 2008 (Table III.6.3). Monthly species richness in 2006 was highest in May (31 species) and lowest in October (20 species). Monthly species richness in 2007 peaked in July and was lowest in October (12 species). In 2008 species richness was highest in June with 28 species and lowest in October with 14 species.

Lower Hamburg was typically dominated by a handful of species: channel catfish, emerald shiner, freshwater drum, red shiner, river carpsucker, river shiner, shovelnose sturgeon, and silver chub. These fish accounted for over 65% of all fish sampled (Table III.6.1). Other species of interest were not sampled in as large of numbers. Only species that averaged 50 measured individuals a year were included in the analysis. Only 1 *Hybonathus* species, a western silvery minnow, was sampled in 2008. No pallid sturgeon was sampled in Lower Hamburg. Sturgeon chub were caught in fairly low numbers (64 fish) with the majority being sampled in 2006 (39 fish). Only nine sauger were sampled with over half coming in 2006 (Table III.6.1). Speckled chub were found the most during the 2008 season while only 19 were sampled in 2007. Blue sucker catch from 2006 to 2008 totaled only 89 fish.

Channel catfish

A total of 481 channel catfish was sampled from 2006 to 2008 with most fish being caught in 2008 (231 fish). The lowest numbers of channel catfish was sampled in 2006 (119 fish). Distributions were different between 2006 and 2007 (Table III.6.5). Mean lengths of channel catfish significantly decreased from 207mm in 2006 to 145mm in 2008 (Table III.6.6). Most of the channel catfish sampled were juveniles with peak usage found in July for most chutes and September in 2008 (Figure III.2). The percentage of juvenile channel catfish increased significantly from 68.9% in 2006 to 80.8% in 2007 (Table III.6.4). Otter trawl catch per unit effort (CPUE) was different between 2006 and 2008 and between 2007 and 2008 (Table III.6.7). The push trawl was the best gear for channel catfish with the highest CPUE in April (Table III.6.8).

Common carp

A total of 240 common carp was sampled with 145 fish in 2008 and only 32 in 2007. Distributions were significantly different each year (Table III.6.5) and mean lengths got significantly smaller each year from 514mm in 2006 to 199mm in 2008 (Table III.6.6). Adult common carp were most common in 2006 with a few juveniles being sampled in 2007. More juveniles were sampled in 2008 with June being the peak month (Figure III.6.4). The percentage of juvenile common carp increased significantly among years from 3.2% to 68.9% (Table III.6.4). Electofishing CPUE was different between 2006 and 2007 and between 2006 and 2008 (Table III.6.7). Mini-fyke net CPUE was different between 2006 and 2008 (Table III.6.7). Carp were sampled most by

mini-fyke nets and electrofishing. June was the best month for mini-fyke CPUE while September was best for electrofishing (Table III.6.8).

Emerald shiner

A total of 1,102 emerald shiners was sampled. A majority of the fish were sampled in 2006 (725 fish) while only a handful were caught in 2008 (31 fish). Mean lengths differed between 2006 and 2007 (Table III.6.6) tending to get smaller (59mm to 52mm) and length-frequency distributions were significantly different as well among these years (Table III.6.5). Juvenile emerald shiner use peaked during July and August (Figure III.6.6). The percentage of juvenile emerald shiners increased significantly from 54.5 % in 2006 to 72.3% in 2007 (Table III.6.4). Electrofishing CPUE in 2008 was different from the other years (Table III.6.7). Otter trawl CPUE was different between 2006 and 2007 (Table III.6.7). Push trawls and mini-fyke nets were the best gears for sampling emerald shiner. Catch per unit efforts were highest in April for push trawls and in August and September for mini-fyke nets (Table III.6.8).

Flathead catfish

A total of 167 flathead catfish was sampled. Numbers of fish were low most years with the most coming in 2008 with 63 fish and the lowest in 2006 with 42 fish. Length-frequency distributions were significantly different between 2006 and 2008 (Table III.6.5). Mean lengths were similar among all years ranging from 347mm to 425mm. Flathead catfish juveniles tended to have peak usage in July and August while adults of the species were higher in June and July (Figure III.6.8). The percentage of

juvenile flathead catfish decreased significantly from 76.2% in 2006 to 40.3% in 2007 (Table III.6.4). Catch per unit effort was similar among years (Table III.6.7). Flathead catfish were sampled most by electrofishing in the months of June and August (Table III.6.8)

Freshwater drum

A total of 377 freshwater drum was sampled with only 78 being caught in 2006. Most of the freshwater drum were sampled in 2007 (193 fish). Length-frequency distributions were different among all years (Table III.6.5) but mean lengths were similar ranging from 91mm to 139mm (Table III.6.6). Juvenile freshwater drum were sampled highest in June and July (Figure III.6.10). The percentage of juvenile freshwater drum was similar among all years ranging from 84.1% to 87.3% (Table III.4). Hoop net CPUE was different between 2006 and 2007 and small hoop net CPUE was different between 2007 and 2008 (Table III.6.7). Otter trawls were the best gear for freshwater drum. Catch per unit effort for otter trawls was highest in June and July (Table III.6.8)

Gizzard shad

A total of 226 gizzard shad was sampled. The best year for sampling gizzard shad was in 2006 (160 fish), but a very low number of gizzard shad were caught in 2008 (17 fish). Mean lengths and length-frequency distributions were significantly different between 2007 and the other years (Table III.6.6; Table III.6.5). Mean lengths got smaller in 2007 (75mm) but were higher in 2006 (137mm) and 2008 (123mm). Most of the gizzard shad sampled were juveniles which tended to be found more from June through

September (Figure III.6.12). The percentage of juvenile gizzard shad significantly increased from 80.1% in 2006 to 98.0% in 2007 (Table III.6.4). Electrofishing CPUE was different between 2006 and 2008 (Table III.6.7). Electrofishing was the best gear for sampling gizzard shad with high catch per unit efforts in April, September and October (Table III.6.8).

Red shiner

A total of 319 red shiner was sampled. Most were caught in 2006 (171 fish) with only a small number in 2008 (29). Length-frequency distributions were significantly different between 2006 and 2008 and between 2007 and 2008 (Table III.6.5). Mean lengths in 2006 differed from those in 2008 (49mm and 43mm respectively). Mean lengths were also different between 2007 (48mm) and 2008 (Table III.6.6). Juvenile red shiner usage peaked between the months of June and August (Figure III.6.14). The percentage of juvenile red shiners significantly increased from 40.3% in 2007 to 65.5% in 2008 (Table III.6.4). Catch per unit effort was similar among years (Table III.6.7). Red shiners were sampled most in mini-fyke nets with high catch per unit efforts in June and July (Table III.6.8).

River carpsucker

A total of 309 river carpsuckers was sampled with 247 being caught in 2006 but only 25 in 2007. Length-frequency distributions were different among all years (Table III.6.5). Mean length in 2006 (97mm) was significantly different than in 2007 (191mm) and in 2008 (170mm; Table III.6.6). Juvenile river carpsucker use peaked between June

and September but overall low numbers were found in 2007 and 2008 (Figure III.6.16). The percentage of juvenile river carpsuckers significantly decreased from 89.9% in 2006 to 72.0% in 2007 (Table III.6.4). Catch per unit effort was similar among all years (Table III.6.7). Electrofishing was the best gear at sampling river carpsucker. Electrofishing CPUE was highest in the months of May and June (Table III.6.8).

River shiner

A total of 291 river shiners was sampled with the highest number being caught in 2007 (187 fish). Length-frequency distributions were different among all years (Table III.6.5). Mean lengths got significantly smaller each year ranging from 45mm in 2006 to 33mm in 2008 (Table III.6.6). River shiner juveniles were sampled in higher numbers in July for 2006 and 2007 but were found more in April during 2008 (Figure III.6.18). .The percentage of juvenile river shiners significantly increased from 55.8% in 2006 to 91.9% in 2007 (Table III.6.4). Catch per unit effort was similar among years (Table III.6.7). River shiners were sampled best by push trawls in July and by mini-fyke nets in April (Table III.6.8).

Sand shiner

A total of 215 sand shiners was sampled with only 25 fish caught in 2008. Sand shiners were sampled in greatest numbers in 2007 with 126 fish being caught. All years had different length-frequency distributions (Table III.6.5). Mean lengths were significantly smaller each year ranging from 43mm in 2006 to 32mm in 2008 (Table III.6.6). Juvenile sand shiner use peaked between April and July (Figure III.6.20). The

percentage of juvenile sand shiners significantly increased from 43.8% in 2006 to 84.0% in 2007 (Table III.6.4). Catch per unit effort was similar among years (Table III.6.7). Push trawls and mini-fyke nets were the most effective gears at sampling sand shiners. Both gears had their highest CPUE in July (Table III.6.8).

Shovelnose sturgeon

A total of 536 shovelnose sturgeon was sampled with the majority (280 fish) being caught in 2008. Length-frequency distributions were different between 2006 and 2008 (Table III.6.5). Mean length increased between 2006 and 2008 from 523mm to 550mm, respectively (Table III.6.6). The majority of shovelnose sturgeon that was sampled were adults. Juvenile use, however, tended to peak in May for 2006 and 2008 but in June of 2007 (Figure III.6.22). The percentage of juvenile shovelnose sturgeon significantly decreased each year from 46.5 % in 2006 to 20.4% in 2008 (Table III.6.4). Otter trawl and trammel net CPUEs were different between 2006 and 2008 (Table III.6.7). Shovelnose sturgeon were sampled most in trammel nets and hoop nets. Trammel nets were more effective in October and hoop nets had higher catch per unit efforts in May (Table III.6.8).

Silver chub

A total of 286 silver chub was sampled with 167 fish caught in 2006 and only 37 fish in 2008. Length-frequency distributions were similar among all years (Table III.6.5). Mean lengths were similar for all years and ranged from 54mm to 60mm (Table III.6.6). Peak months for juvenile silver chub tended to be July and August (Figure III.6.24).

Most silver chubs were juveniles in any given year (91.8% - 100%). Catch per unit effort was similar among years (Table III.6.7). Push trawls were the best gear for sampling silver chubs with June being the best month (Table III.6.8).

Key Findings

- Most fish were juvenile size (61%).
- The fish community was more similar between 2006 and 2007.
- The month of October had the lowest monthly species richness for all years.
- 8 species accounted for 65% of the fish assemblage (channel catfish, emerald shiner, freshwater drum, red shiner, river carpsucker, river shiner, shovelnose sturgeon, silver chub).
- The percentage of juveniles for most species increased each year except for flathead catfish, river carpsuckers and shovelnose sturgeon.
- Species of interest for Missouri River recovery (blue sucker, pallid sturgeon, *hybognathus sp*., sauger, speckled chub and sturgeon chub) were sampled in low numbers or not at all.

Table III.6.1. Total species caught at Lower Hamburg Bend 2006-2008 and the percent of catch that each species represents. *Indicates a species that was used in analysis. †Indicates a species of note for this chute.

Species	Scientific name	2006	2007	2008	Total	%Catch
Bullhead catfish	*Ameiurus sp.*	0	1	0	1	0.018
Bighead carp†	*Hypopthalmichthys nobilis*	2	1	0	3	0.053
Bullhead minnow†	*Pimephales vigilax*	0	1	1	2	0.036
Black crappie†	*Pomoxis nigromaculatus*	1	0	4	5	0.089
Brook silverside	*Labidesthes sicculus*	1	1	0	2	0.036
Blue catfish†	*Ictalurus furcatus*	2	47	61	110	1.966
Bluegill sunfish†	*Lepomis macrochirus*	26	1	6	33	0.589
Bigmouth buffalo†	*Ictiobus cyprinellus*	3	13	24	40	0.715
Blue sucker†	*Cycleptus elongates*	32	27	30	89	1.591
Common carp*†	*Cyprinus carpio*	63	32	145	240	4.29
Creek chub	*Semotilus atromaculatus*	0	0	3	3	0.054
Central stoneroller	*Campostoma anomalum*	0	11	0	11	0.197
Channel catfish*†	*Ictalurus punctatus*	119	131	231	481	8.598
Channel shiner	*Notropis wickliffi*	7	0	6	13	0.232
Emerald shiner*†	*Notropis atherinoides*	725	346	31	1102	19.699
Flathead chub	*Platygobio gracilis*	1	0	0	1	0.018
Flathead catfish*†	*Pylodictus olivaris*	42	62	63	167	2.985
Fathead minnow†	*Pimephales promelas*	8	15	64	87	1.555
Freshwater drum*†	*Aplodinotus grunniens*	78	193	106	377	6.739
Goldeye†	*Hiodon alosoides*	33	25	29	87	1.555
Green sunfish	*Lepomis cyanellus*	0	1	0	1	0.018
Grass carp†	*Ctenopharyngodon idella*	2	2	2	6	0.107
Gizzard shad*†	*Dorosoma cepedianum*	160	49	17	226	4.04
Largemouth bass†	*Micropterus salmoides*	0	1	0	1	0.018
Longnose gar†	*Lepisosteus osseus*	1	4	12	17	0.304
Largescale stoneroller	*Campostoma oligolepis*	0	9	0	9	0.161
Mooneye†	*Hiodon tergisus*	0	1	0	1	0.018
Mosquito fish	*Gambusia affinis*	5	0	0	5	0.089
Orangespotted sunfish	*Lepomis humilis*	25	0	1	26	0.465
Paddlefish†	*Polyodon spathula*	0	0	3	3	0.054
Quillback†	*Carpiodes cyprinus*	8	2	0	10	0.179
Red shiner*†	*Cyprinella lutrensis*	171	119	29	319	5.703
River carpsucker*†	*Carpiodes carpio*	247	25	37	309	5.524
River shiner*†	*Notropis blennius*	52	187	52	291	5.202
Spotfin shiner†	*Cyprinella spiloptera*	5	2	0	7	0.125
Sturgeon chub†	*Macrhybopsis gelida*	39	11	14	64	1.144
Sauger†	*Stizostedion canadense*	5	3	1	9	0.161

Table III.6.1 continued. Total species caught at Lower Hamburg Bend 2006-2008 and the percent of catch that each species represents. *Indicates a species that was used in analysis. †Indicates a species of note for this chute.

Species	Scientific name	2006	2007	2008	Total	%Catch
Skipjack herring	*Alosa chrysochloris*	1	0	3	4	0.072
Speckled chub†	*Macrhybopsis aestivalis*	42	19	65	126	2.252
Smallmouth buffalo†	*Ictiobus bubalus*	1	28	11	40	0.715
Shortnose gar†	*Lepisosteus platostomus*	39	17	48	104	1.859
Shovelnose sturgeon*†	*Scaphirhynchus platorynchus*	142	114	280	536	9.582
Sand shiner*†	*Notropis stramineus*	64	126	25	215	3.843
Spotted bass	*Micropterus punctulatus*	0	0	14	14	0.25
Stonecat	*Noturus flavus*	20	12	37	69	1.233
Silver chub*†	*Macrhybopsis storeriana*	167	82	37	286	5.113
Silver carp†	*Hypopthalmichthys molitrix*	0	1	1	2	0.036
Walleye	*Stizostedion vitreum*	2	0	0	2	0.036
Western silvery minnow†	*Hybognathus argyritis*	0	0	1	1	0.018
White bass	*Morone chrysops*	18	3	0	21	0.375
White crappie†	*Pomoxis annularis*	1	3	10	14	0.25
Yellow bullhead	*Ameiurus natalis*	1	0	0	1	0.018

Table III.6.2. Species richness (S), species evenness (E), Shannon's diversity index (H) and Simpson's diversity index (D) for Lower Hamburg Bend 2006-2008.

Year	**S**	**E**	**H**	**D**
2006	40	0.7036	2.595	0.8691
2007	40	0.7435	2.761	0.9093
2008	37	0.7937	2.866	0.9144

Table III.6.3. Community assemblage similarity, using Morisita's index, for Lower Hamburg between years (2006 - 2008). Values less than 0.300 mean fish communities are dissimilar and values more than 0.700 mean fish communities are similar.

Year	**2006 v 2007**	**2006 v 2008**	**2007 v 2008**
Morisita's Index	0.887	0.409	0.634

Table III.6.4. Results for analysis of life stage proportions at Lower Hamburg from 2006 - 2008. A z-test was used to determine differences in proportions of juveniles and adults of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold. Values not between -2.135 to 2.135 are significant.

	Z statistic		
Species	**2006 vs 2007**	**2006 vs 2008**	**2007 vs 2008**
Channel catfish	**-2.242**	**-3.383**	-0.905
Common carp	**-4.642**	**-8.312**	**-3.044**
Emerald shiner	**-3.809**	-1.397	0.517
Flathead catfish	**3.606**	**3.220**	-0.466
Freshwater drum	0.205	0.523	0.396
Gizzard shad	**-2.992**	-1.408	1.693
Red shiner	-0.883	**-2.884**	**-2.443**
River carpsucker	**2.543**	**3.544**	0.371
River shiner	**-5.923**	**-4.174**	-1.047
Sand shiner	**-5.484**	**-4.136**	-1.027
Shovelnose sturgeon	**2.231**	**6.213**	**2.658**
Silver chub	-2.068	-1.802	-0.701

Table III.6.5. Results for analysis of length frequency distribution at Lower Hamburg from 2006 - 2008. A Kolmogorov-Smirnov test was used to determine differences in length frequency distribution of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

	2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**D**	**p-value**	**D**	**p-value**	**D**	**p-value**
Channel catfish	**0.195**	**0.0139**	**0.323**	**0.0001**	0.149	0.0375
Common carp	**0.382**	**0.002**	**0.674**	**0.0001**	**0.349**	**0.0042**
Emerald shiner	**0.28**	**0.0001**	0.259	0.048	0.144	0.636
Flathead catfish	0.272	0.049	**0.421**	**0.0003**	0.182	0.25
Freshwater drum	**0.371**	**0.0001**	**0.509**	**0.0001**	**0.536**	**0.0001**
Gizzard shad	**0.374**	**0.0001**	0.338	0.0606	**0.565**	**0.0006**
Red shiner	0.1004	0.7731	**0.421**	**0.0015**	**0.32**	**0.0165**
River carpsucker	**0.476**	**0.0001**	**0.388**	**0.0002**	**0.446**	**0.005**
River shiner	**0.273**	**0.0043**	**0.536**	**0.0001**	**0.428**	**0.0001**
Sand shiner	**0.417**	**0.0001**	**0.621**	**0.0001**	**0.362**	**0.01**
Shovelnose sturgeon	0.179	0.0402	**0.161**	**0.0151**	0.077	0.7504
Silver chub	0.139	0.302	0.208	0.162	0.23	0.142

Table III.6.6. Results for analysis of species mean length at Lower Hamburg from 2006 - 2008. A t-test was used to determine differences in mean length of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

	2006 v 2007		2006 v 2008		2007 v 2008	
Species	**t**	**p-value**	**t**	**p-value**	**t**	**p-value**
Channel catfish	1.986	0.048	**3.617**	**0.0003**	**1.61**	**0.1082**
Common carp	**4.165**	**0.0002**	**13.003**	**0.0001**	**2.924**	**0.004**
Emerald shiner	**4.99**	**0.0001**	**2.817**	**0.0052**	0.225	0.8218
Flathead catfish	-2.076	0.0404	-2.015	0.0465	0.299	0.7652
Freshwater drum	0.572	0.5684	2.129	0.0349	1.849	0.066
Gizzard shad	**5.308**	**0.0001**	0.735	0.4685	-3.03	0.0035
Red shiner	1.07	0.286	**4.269**	**0.0001**	**3.384**	**0.0011**
River carpsucker	**-4.055**	**0.0001**	**-2.399**	**0.021**	0.503	0.6165
River shiner	**2.632**	**0.0105**	**5.541**	**0.0001**	**4.192**	**0.0001**
Sand shiner	**6.145**	**0.0001**	**6.145**	**0.0001**	**2.797**	**0.0059**
Shovelnose sturgeon	-1.755	0.0806	**-2.76**	**0.0063**	-0.501	0.6173
Silver chub	1.569	0.118	-0.726	0.469	-1.944	0.0544

Table III.6.7. Results for analysis of species catch per unit effort (CPUE) at Lower Hamburg from 2006 - 2008. Effort for each gear is defined as: electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Push trawl was not used in 2006. A Kruskal-Wallis test was used to determine differences in CPUE of a species by gear between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

		2006 v 2007		2006 v 2008		2007 v 2008	
Species	**Gear**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**
Common Carp	**EF**	**6.69**	**0.0097**	**4.77**	**0.029**	0.42	0.518
	HN	0.01	0.9198	0.79	0.3743	1.01	0.3146
	MF	0.43	0.5111	**4.78**	**0.0288**	2.68	0.1014
	OT	0	1	3.055	0.0805	3.055	0.0805
	SHN	0.003	0.9546	3	0.0831	3.36	0.0666
	TN	1.156	0.2824	1.222	0.2689	0	1
Channel Catfish	**EF**	0.26	0.611	0.31	0.5798	0	1
	HN	0.088	0.766	1.265	0.2607	0.776	0.3783
	MF	0.078	0.78	0.074	0.7856	0.248	0.6186
	OT	0.244	0.6216	**13.148**	**0.0003**	**11.878**	**0.0006**
	PT	NA	NA	NA	NA	0.138	0.7096
	SHN	0.005	0.9823	0.014	0.9053	0.008	0.9285
	TN	2.6	0.1068	0.818	0.3657	1.087	0.2972
Emerald Shiner	**EF**	0.001	0.9788	**4.624**	**0.0315**	**4.615**	**0.031**
	MF	0.182	0.67	2.444	0.118	1.408	0.2354
	OT	**6.312**	**0.012**	3.874	0.049	0.714	0.3983
	PT	NA	NA	NA	NA	2.956	0.0856
Flathead Catfish	**EF**	0.558	0.455	1.911	0.1669	0.294	0.5879
	HN	0.071	0.7895	0.007	0.9329	0.121	0.728
	MF	2.105	0.1468	0	1	0.849	0.3569
	OT	2.034	0.1538	3.055	0.0805	0.189	0.664
	SHN	2.952	0.0858	3.467	0.0626	0.044	0.8341
	TN	1.156	0.2824	1.222	0.2689	0	1
Freshwater Drum	**EF**	0.04	0.8297	1.677	0.1953	0.85	0.3567
	HN	**6.462**	**0.011**	3.601	0.0577	0.488	0.4846
	MF	1.738	0.1874	0.478	0.4893	0.11	0.7398
	OT	0.007	0.9337	2.153	0.1423	1.464	0.2263
	PT	NA	NA	NA	NA	2.004	0.1568
	SHN	2.537	0.1112	0.958	0.3276	**4.61**	**0.0315**

Table III.6.7 continued. Results for analysis of species catch per unit effort (CPUE) at Lower Hamburg from 2006 - 2008. Effort for each gear is defined as: electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Push trawl was not used in 2006. A Kruskal-Wallis test was used to determine differences in CPUE of a species by gear between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

		2006 v 2007		2006 v 2008		2007 v 2008	
Species	**Gear**	**χ2**	**p-value**	**χ2**	**p-value**	**χ2**	**p-value**
Gizzard Shad	**EF**	1.213	0.2708	**5.015**	**0.0251**	0.969	0.325
	MF	1.91	0.167	1.31	0.2525	0.002	0.9695
	OT	1	0.3173	0	1	1.367	0.2424
	PT	NA	NA	NA	NA	0.307	0.5795
	TN	0.865	0.3522	0	1	1.058	0.3037
Red Shiner	**MF**	2.327	0.1271	0.069	0.7936	0.421	0.5164
	OT	0.392	0.5311	0.574	0.4488	0.011	0.9164
	PT	NA	NA	NA	NA	1.349	0.2455
River Carpsucker	**EF**	0.875	0.3497	4.405	0.0358	0.817	0.366
	HN	0.003	0.9546	2.198	0.1382	2.483	0.1151
	MF	1.968	0.1607	0	1	0.793	0.3733
	OT	2.034	0.1538	0	1	2.772	0.0959
	SHN	0.24	0.6239	0	0.9879	0.239	0.6248
River Shiner	**MF**	4.338	0.0373	0.44	0.5069	3.779	0.0519
	OT	0.003	0.9601	0.115	0.7344	0.162	0.6871
	PT	NA	NA	NA	NA	0.313	0.576
Shovelnose Sturgeon	**EF**	0.379	0.538	0.296	0.5866	0.015	0.9024
	HN	2.009	0.1563	0.529	0.4672	3.573	0.0587
	OT	3.137	0.0765	**6.185**	**0.0129**	0.687	0.0407
	SHN	2.56	0.1096	0.11	0.7397	4.022	0.0449
	TN	2.164	0.1413	**7.774**	**0.0053**	2.4	0.1213
Sand Shiner	**MF**	0.85	0.3566	0.188	0.665	0.057	0.8117
	OT	2.034	0.1538	0	1	2.772	0.0959
	PT	NA	NA	NA	NA	0.599	0.4388
Silver Chub	**MF**	0.078	0.7801	0.57	0.4501	1.013	0.3143
	OT	2.697	0.1005	2.457	0.117	0.409	0.5227
	PT	NA	NA	NA	NA	0.423	0.5154

Table III.6.8. Species monthly catch per unit effort (± 2 SE) at Lower Hamburg from 2006 - 2008. Effort for each gear is defined as: bag seine (BS), fish caught per 50 m^2 seined; electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled; and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Bag seines were only used in 2006. Push trawls were not used in 2006.

		April			May			June			July			August			September			October		
Species	Gear	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Common Carp	EF	10.41		5.19	9.04	1.36	1.84	12.94			4.60	4.67	6.47	5.80	3.55		6.88	7.01	8.24	5.51		3.06
		(16.89)		(4.30)	(6.19)	(2.73)	(2.41)	(5.67)			(4.01)	(3.13)	(4.07)	(4.21)	(4.13)		(5.67)	(5.29)	(4.75)	(3.72)		(4.31)
	MF					4.00		0.17		44.50		0.57										
						(8.00)		(0.33)		(27.00)		(1.14)										
	HN				0.29		0.38			0.25		0.13	0.17		0.13	0.13	0.13				0.13	
					(0.37)		(0.53)			(0.50)		(0.25)	(0.33)		(0.25)	(0.25)	(0.25)				(0.25)	
	SHN	0.14		0.13						0.75			0.17		0.13							
		(0.29)		(0.25)						(0.50)			(0.33)		(0.25)							
	OT									1.51												
										(0.70)												
	TN																0.83					
																	(1.67)					
Channel Catfish	BS	0.97			0.67																	
		(1.93)			(1.33)																	
	EF	2.31			0.42	0.75							0.78	2.37	1.06	0.99			0.98			
		(3.16)			(0.84)	(1.50)							(1.56)	(3.53)	(2.12)	(1.97)			(1.87)			
	MF	0.33	2.00	0.67		0.50	0.50				0.43	0.14		0.67	0.17		0.25		0.33	3.50		
		(0.67)	(2.45)	(1.33)		(1.00)	(1.00)				(0.60)	(0.29)		(1.33)	(0.33)		(0.50)		(0.67)	(7.00)		
	HN	0.67	0.50	1.17	0.86	0.50	0.75				0.50	0.38	0.50	0.25	0.50	0.38		0.13		0.50	0.13	0.25
		(0.99)	(0.66)	(1.59)	(1.71)	(1.00)	(0.82)				(1.00)	(0.53)	(1.00)	(0.50)	(1.00)	(0.53)		(0.25)		(1.00)	(0.25)	(0.50)
	SHN	0.43	0.25	0.50	0.43		0.25	0.13	0.88	1.00	0.75	1.13	0.33	0.43	0.50	0.50	0.57		0.13	0.50	0.88	
		(0.86)	(0.33)	(0.54)	(0.60)		(0.33)	(0.25)	(1.03)	(1.16)	(0.82)	(1.49)	(0.67)	(0.86)	(0.76)	(0.54)	(0.60)		(0.25)	(0.58)	(0.96)	
	PT		8.08	13.04					0.56						3.33	3.03						
			(4.79)	(0.00)					(1.11)						(6.67)	(0.00)						
	OT		0.33	1.32			2.23	1.11	0.32	0.49	0.76	1.88	3.06	0.07		2.49	0.65	0.62	3.99	0.12	1.39	2.79
			(0.42)	(1.55)			(2.93)	(0.51)	(0.30)	(0.56)	(0.58)	(2.56)	(1.69)	(0.13)		(0.75)	(0.50)	(0.60)	(2.80)	(0.15)	(2.47)	(1.50)
	TN		0.50												1.67				0.83			
			(1.00)												(3.33)				(1.67)			
Emerald Shiner	BS	0.64			77.55			4.12			0.34						91.83			13.44		
		(0.79)			(150.45)			(8.24)			(0.45)						(103.87)			(15.23)		
	EF	2.60				1.36					0.75			0.86	1.06		2.82	1.10				
		(3.32)				(2.73)					(1.50)			(1.71)	(2.12)		(5.65)	(2.19)				
	MF	5.33	12.00	1.67	3.60	1.50		0.17	1.14	1.00	4.00	17.29		72.33	1.00		0.25	33.00		12.50		
		(10.67)	(8.91)	(2.40)	(5.24)	(1.00)		(0.33)	(2.29)	(2.00)	(4.58)	(26.92)		(132.85)	(2.00)		(0.50)	(66.00)		(25.00)		
	PT		5.59	10.81			3.33		1.67				2.56		5.00	9.09			3.23			
			(8.68)	(0.00)			(0.00)		(3.33)				(0.00)		(10.00)	(0.00)			(6.45)			
	OT		0.10				0.34		0.05	0.56		2.30						0.29				0.13
			(0.20)				(0.68)		(0.09)	(0.74)		(3.84)						(0.58)				(0.26)

Table III.6.8 continued. Species monthly catch per unit effort (± 2 SE) at Lower Hamburg from 2006 - 2008. Effort for each gear is defined as: bag seine (BS), fish caught per 50 m^2 seined; electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled; and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Bag seines were only used in 2006. Push trawls were not used in 2006.

		April			May			June			July			August			September			October		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Flathead Catfish	**EF**				1.52 (1.54)	1.50 (3.00)	1.84 (2.41)	30.22 (32.85)	0.83 (1.67)		18.70 (19.73)	1.88 (3.75)	8.88 (2.96)	27.38 (30.77)	12.78 (7.69)	9.79 (6.85)	9.30 (11.08)	4.07 (4.54)	2.03 (2.77)			
	MF								0.14 (0.29)			0.14 (0.29)										
	HN				0.14 (0.29)	0.25 (0.50)	0.13 (0.25)	0.29 (0.37)	0.88 (1.28)	0.75 (0.96)	0.25 (0.33)	0.63 (1.00)			0.25 (0.50)	0.13 (0.25)		0.13 (0.25)			0.13 (0.25)	0.50 (0.58)
	SHN					0.25 (0.50)	0.13 (0.25)	0.13 (0.25)	0.25 (0.33)	2.25 (2.63)	0.25 (0.33)	0.75 (0.50)	0.83 (0.62)	0.71 (1.13)	0.25 (0.50)	0.38 (0.37)	0.14 (0.29)		0.50 (0.38)	0.25 (0.50)		
	OT								0.06 (0.12)	0.15 (0.20)		0.10 (0.20)	0.10 (0.20)						0.08 (0.17)			
	TN	1.39 (2.78)																				
Freshwater Drum	**BS**	0.97 (1.29)						1.55 (0.35)						0.43 (0.86)			2.31 (2.25)					
	EF	0.80 (0.16)		0.93 (1.86)	1.37 (1.83)		0.90 (1.80)				0.40 (0.80)	1.50 (3.00)	1.56 (3.13)		1.36 (2.73)		3.30 (3.57)	1.92 (2.54)		1.64 (3.27)		
	MF		0.50 (1.00)					0.67 (0.84)	1.57 (2.22)	2.50 (5.00)		1.86 (2.78)	2.00 (0.00)	0.33 (0.67)	0.17 (0.33)				0.33 (0.67)			
	HN		0.13 90.25)			0.25 (0.50)	0.25 (0.33)	0.14 (0.29)	0.25 (0.33)	0.75 (1.50)		0.75 (0.98)	0.33 (0.42)		0.13 (0.25)	0.13 (0.25)				0.25 (0.50)	0.63 (0.53)	0.25 (0.50)
	SHN								0.38 (0.75)			0.13 (0.25)			0.38 (0.53)			0.13 (0.25)		0.25 (0.50)		
	PT								1.81 (1.74)			0.83 (1.74)										
	OT							1.70 (1.84)		5.79 (7.56)		15.67 (26.61)	0.96 (1.23)	0.07 (0.13)		0.37 (0.74)		0.10 (0.19)	0.35 (0.26)			0.21 (0.42)
Gizzard Shad	**BS**	0.97 (1.93)						0.69 (1.37)			1.60 (1.60)			20.22 (16.18)			12.98 (20.10)			3.70 (0.37)		
	EF	22.66 (4.94)			6.88 (4.08)			0.66 (1.32)			0.78 (1.56)				1.38 (1.81)		2.22 (3.14)	9.92 (10.71)	3.04 (6.08)	1.64 (3.27)		7.30 (7.82)
	MF	0.67 (1.33)	0.50 (0.58)						3.00 (4.02)	1.00 (2.00)		0.14 (0.29)	1.00 (0.00)	0.33 (0.67)	0.17 (0.33)				0.33 (0.67)	1.50 (3.00)		
	PT											5.00 (10.00)	6.06 (0.00)									
	OT																				0.12 (0.24)	
	TN											0.63 (1.25)										

Table III.6.8 continued. Species monthly catch per unit effort (± 2 SE) at Lower Hamburg from 2006 - 2008. Effort for each gear is defined as: bag seine (BS), fish caught per 50 m^2 seined; electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled; and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Bag seines were only used in 2006. Push trawls were not used in 2006.

		April			May			June			July			August			September			October		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Red Shiner	**BS**				10.67 (21.33)			5.50 (10.99)						1.12 (1.32)			45.73 (78.41)			2.63 (2.56)		
	MF	3.50 (3.42)		0.33 (0.67)	0.60 (0.80)	0.50 (1.00)		0.33 (0.42)	0.71 (0.95)	10.50 (5.00)	0.57 (0.60)	5.57 (7.02)	3.00 (0.00)	2.67 (4.37)	2.33 (3.60)		0.50 (0.58)	3.33 (6.67)				
	PT		5.01 (6.65)						9.72 (11.94)							3.03 (0.00)						
	OT					0.11 (0.23)		0.06 (0.12)	0.03 (0.06)	0.10 (0.20)		1.60 (3.20)				0.09 (0.18)						
River Carpsucker	**BS**	2.56 (3.62)			10.00 (20.00)			8.78 (6.56)			28.78 (45.19)			10.01 (14.03)			13.52 (24.34)			1.75 (3.51)		
	EF	1.60 (3.20)			3.63 (3.02)	1.36 (2.73)	3.64 (5.47)	0.66 (1.32)	2.23 (2.94)		1.55 (1.69)					1.16 (2.32)	2.13 (2.26)	1.99 (2.66)	1.27 (2.54)	3.50 (4.06)		
	MF	3.67 (5.46)	2.25 (3.20)						0.29 (0.37)	11.50 (23.00)				0.33 (0.67)	0.33 (0.67)							
	HN			0.67 (1.33)			0.25 (0.33)								0.13 (0.25)	0.13 (0.25)	0.13 (0.25)					
	SHN	0.57 (1.14)					0.13 (0.25)		0.25 (0.50)													0.13 (0.25)
	OT											0.13 (0.25)						0.10 (0.19)				
River Shiner	**BS**				1.33 (2.67)									0.59 (0.72)			8.52 (13.38)			2.63 (5.26)		
	MF		9.75 (11.15)			2.50 (1.00)		0.67 (0.99)	0.29 (0.57)	1.00 (2.00)		8.86 (11.65)		1.67 (1.76)	4.67 (9.33)		0.50 (0.58)					
	PT		0.69 (1.39)	0.93 (0.48)				0.83 (1.67)			20.26 (21.01)			0.63 (1.25)								
	OT		0.09 (0.18)				0.23 (0.45)		0.29 (0.59)	0.10 (0.20)	0.12 (0.15)	0.10 (0.20)		0.12 (0.16)			0.10 (0.19)		0.24 (0.36)			

Table III.6.8 continued. Species monthly catch per unit effort (± 2 SE) at Lower Hamburg from 2006 - 2008. Effort for each gear is defined as: bag seine (BS), fish caught per 50 m^2 seined; electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled; and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Bag seines were only used in 2006. Push trawls were not used in 2006.

		April			May			June			July			August			September			October		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Shovelnose Sturgeon	**EF**				3.01 (2.00)			4.00 (4.15)					1.04 (2.07)		1.06 (2.12)	1.17 (2.34)		3.15 (4.70)	2.12 (2.92)			1.03 (2.05)
	HN	1.83 (2.55)	0.25 (0.50)	0.50 (1.00)	2.00 (1.57)	0.75 (1.50)	14.88 (10.22)	0.43 (0.60)	0.25 (0.33)	1.00 (2.00)	0.50 (0.54)	0.38 (0.75)	1.33 (1.23)	0.25 (0.33)	1.63 (1.60)	0.63 (0.65)	0.25 (0.33)	0.63 (0.84)	0.13 (0.25)	0.50 (1.00)	0.13 (0.25)	0.25 (0.50)
	SHN	0.43 (0.60)		0.25 (0.33)	4.29 (4.42)	0.25 (0.50)	5.63 (7.09)	0.13 (0.25)	0.13 (0.25)		0.88 (1.49)	0.50 (0.54)	0.33 (0.42)	0.57 (0.60)	1.38 (1.56)	0.88 (0.70)	0.57 (0.60)	0.50 (0.76)	1.00 (1.25)	0.25 (0.50)		
	OT		0.33 (0.42)	0.07 (0.13)			0.24 (0.35)	0.12 (0.15)	0.77 (0.58)	0.12 (0.24)	0.06 (0.13)	0.60 (0.95)	2.09 (1.63)	0.19 (0.38)		1.57 (0.71)	0.67 (0.94)	0.07 (0.13)	0.42 (0.50)	0.05 (1.00)	0.12 (0.24)	0.77 (0.93)
	TN	4.01 (2.82)	0.83 (1.67)		3.07 (4.10)		1.25 (2.50)	3.24 (3.79)			0.76 (1.52)	3.17 (3.56)		3.04 (3.43)	7.00 (6.37)	4.12 (5.10)	0.83 (1.67)		1.40 (1.88)	10.29 (20.54)	1.14 (2.27)	2.02 (2.71)
Sand Shiner	**BS**				3.79 (6.26)			5.50 (10.99)						0.37 (0.74)			5.81 (9.83)			8.77 (17.54)		
	MF	1.67 (3.33)	5.75 (11.50)	0.33 (0.67)	0.60 (1.20)				0.71 (1.43)	0.50 (1.00)	1.00 (2.00)	7.71 (12.96)		1.00 (1.16)	1.67 (2.57)		0.25 (0.50)	2.33 (4.67)	1.00 (1.16)	0.50 (1.00)		
	PT		2.13 (1.58)	0.43 (0.48)					4.17 (8.33)			16.93 (4.60)										
	OT								0.04 (0.07)			0.70 (1.40)										
Silver Chub	**BS**	1.40 (2.79)									14.77 (29.54)			1.71 (3.42)			3.50 (6.99)					
	MF		0.75 (0.50)					0.17 (0.33)	1.00 (1.45)		1.43 (2.04)			3.00 (5.03)	0.33 (0.67)							
	PT		0.51 (1.02)						8.33 (10.85)				2.56 (0.00)		6.67 (13.33)							
	OT		0.09 (0.18)	0.20 (0.25)			0.13 (0.25)		0.34 (0.51)		2.07 (0.90)	3.98 (5.01)		0.13 (0.27)		2.03 (4.06)	0.81 (0.82)		0.41 (0.30)	0.35 (0.46)		0.59 (0.43)

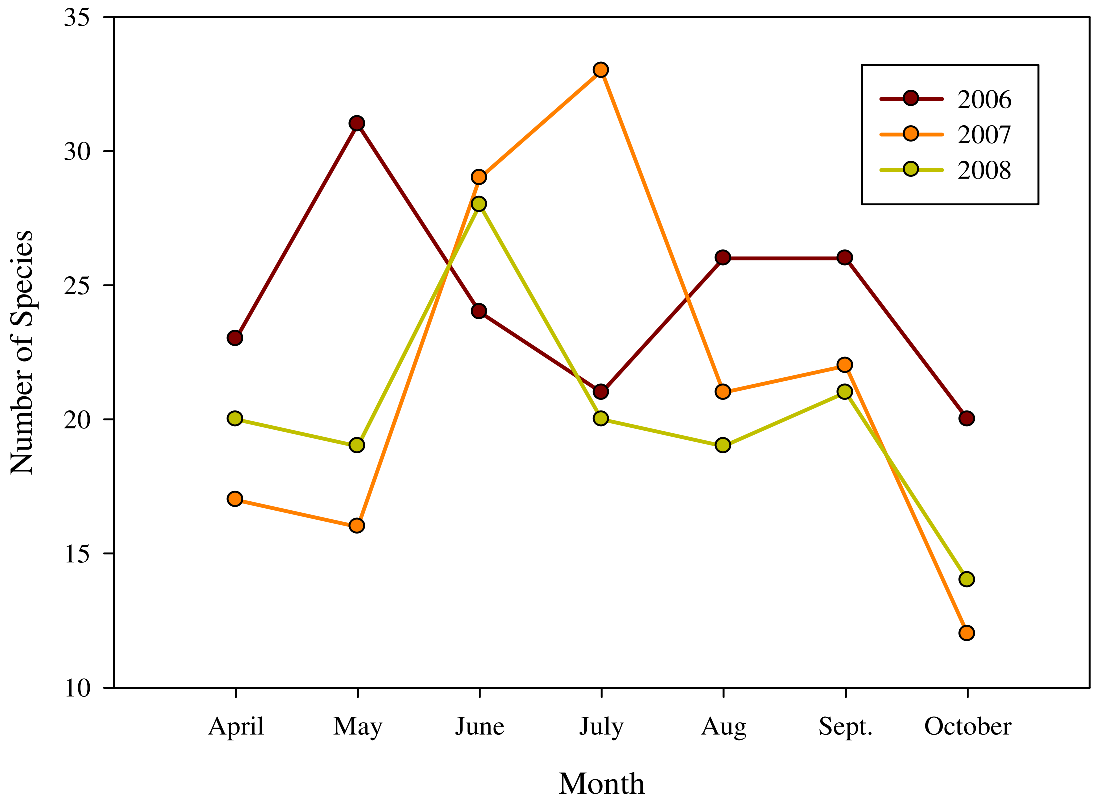


Figure III.6.1. Monthly species richness for Lower Hamburg Bend from 2006 – 2008.

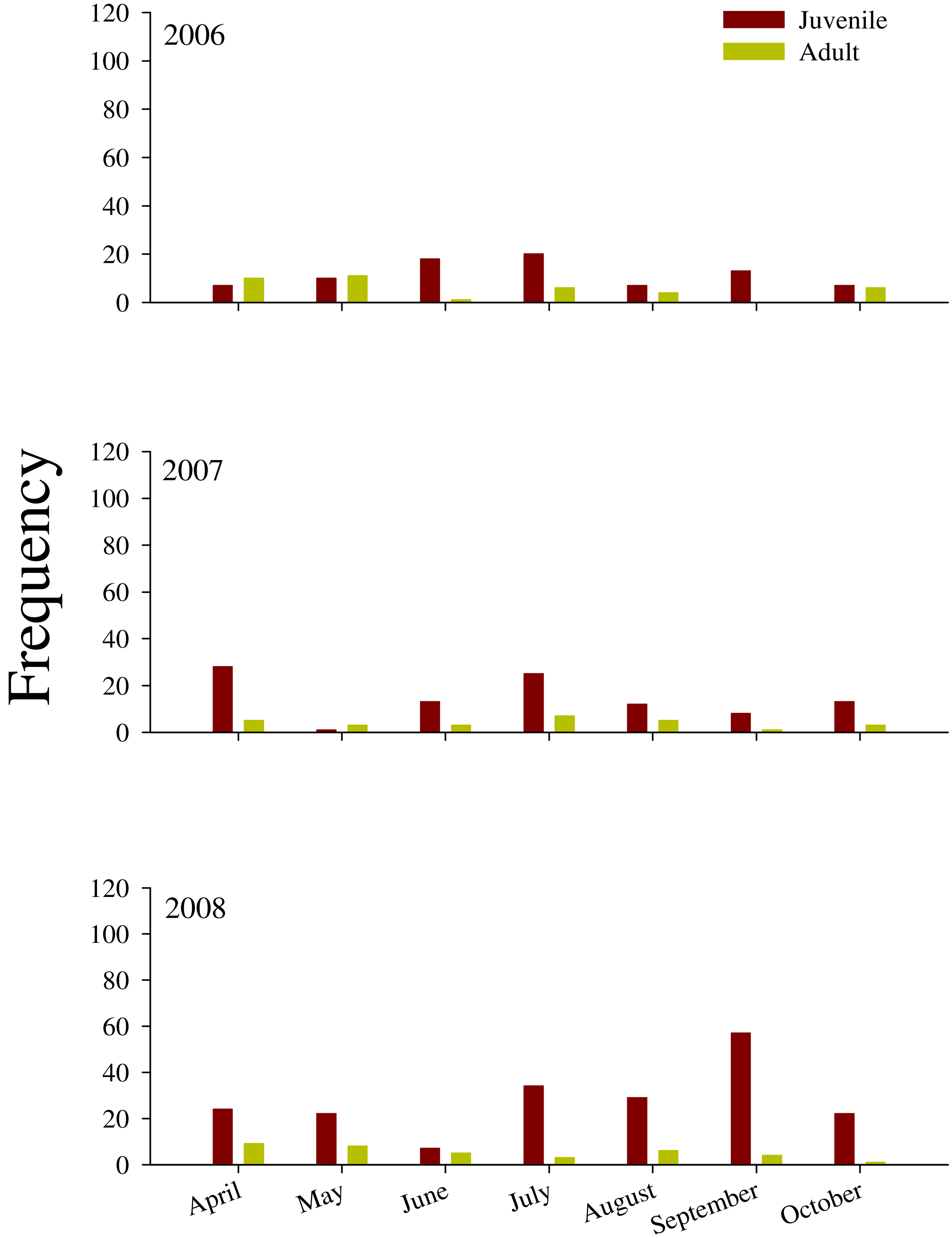


Figure III.6.2. Monthly frequency of juvenile (<305mm) and adult (≥305mm) channel catfish caught at Lower Hamburg Bend from 2006 - 2008.

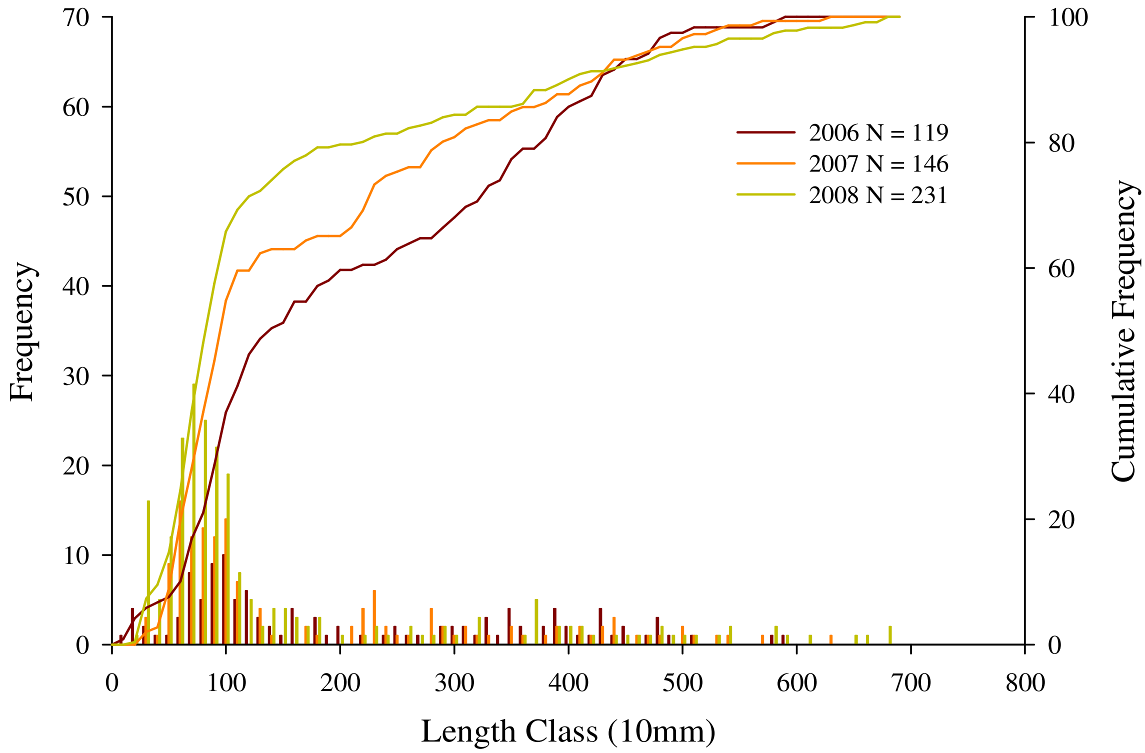


Figure III.6.3. Length frequency distributions and cumulative frequencies for measured channel catfish (N) at Lower Hamburg Bend from 2006 – 2008.

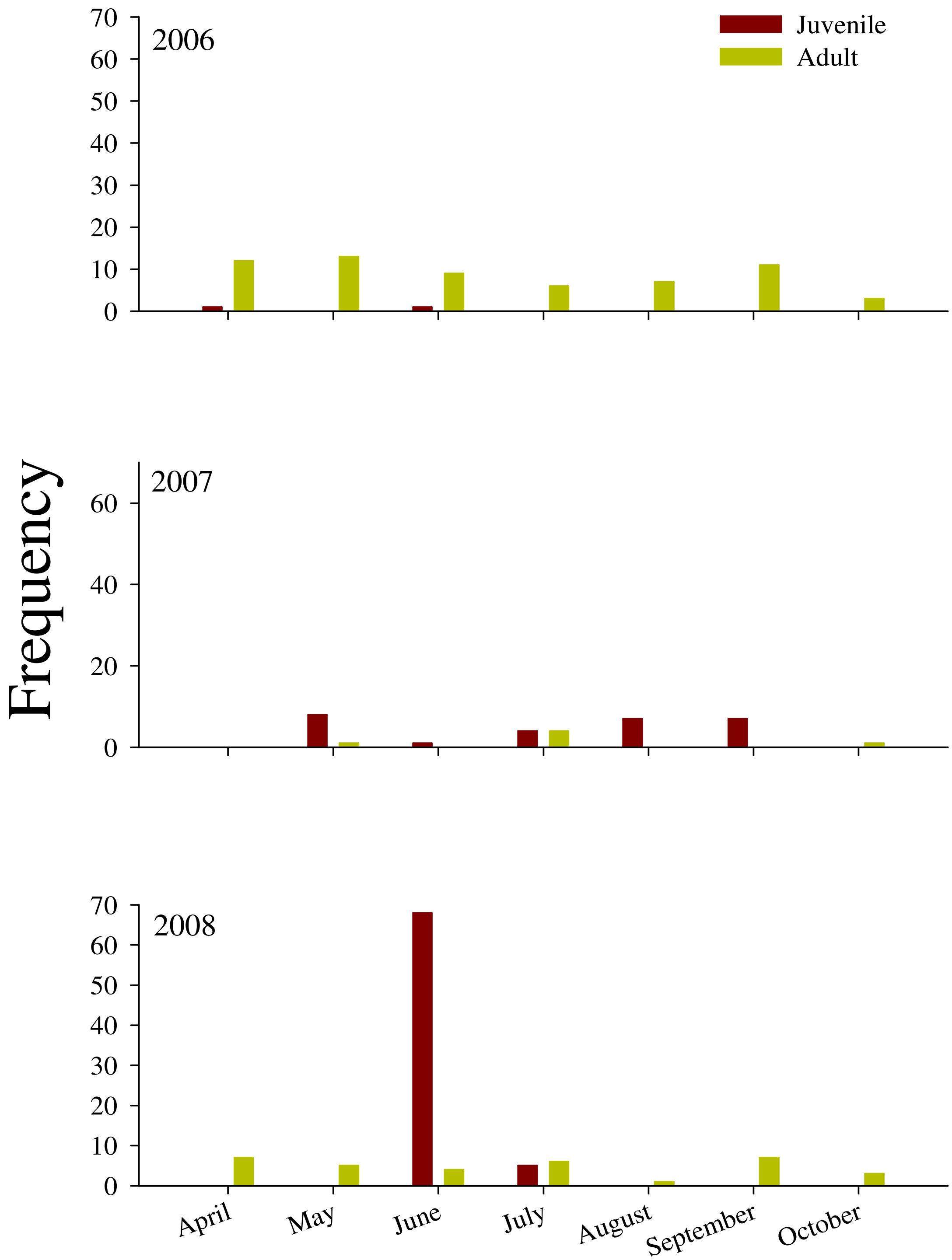


Figure III.6.4. Monthly frequency of juvenile (<305mm) and adult (≥305mm) common carp caught at Lower Hamburg Bend from 2006 - 2008.

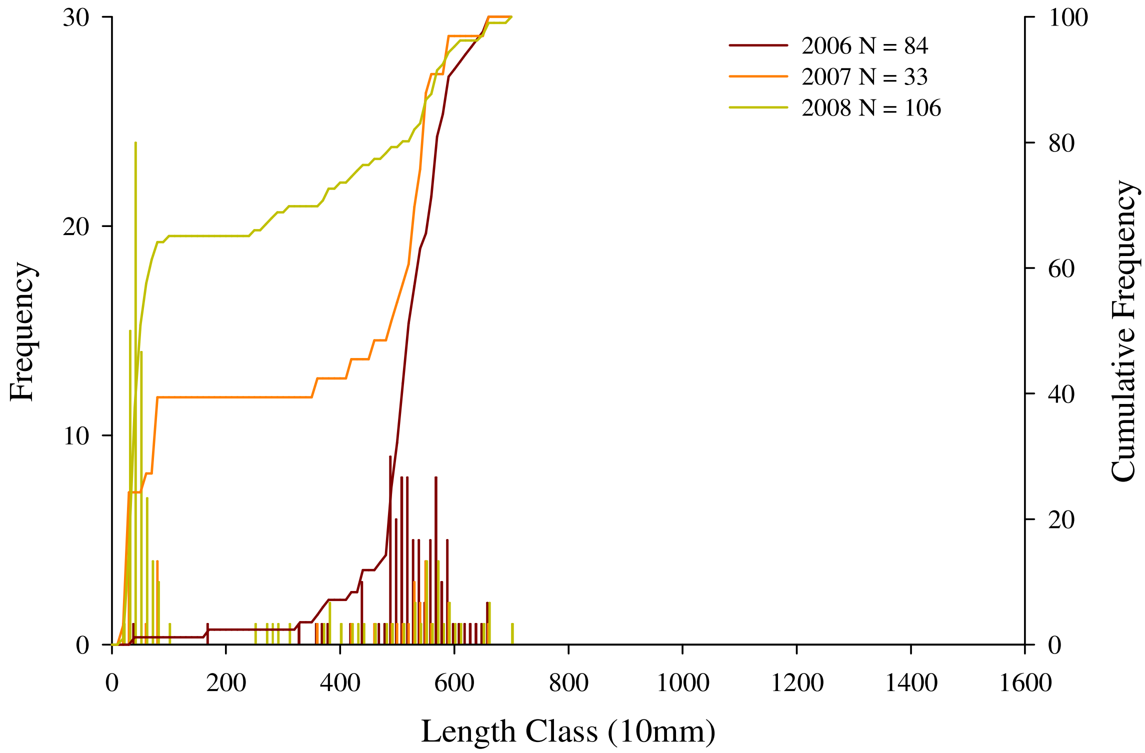


Figure III.6.5. Length frequency distributions and cumulative frequencies for measured common carp (N) at Lower Hamburg Bend from 2006 – 2008.

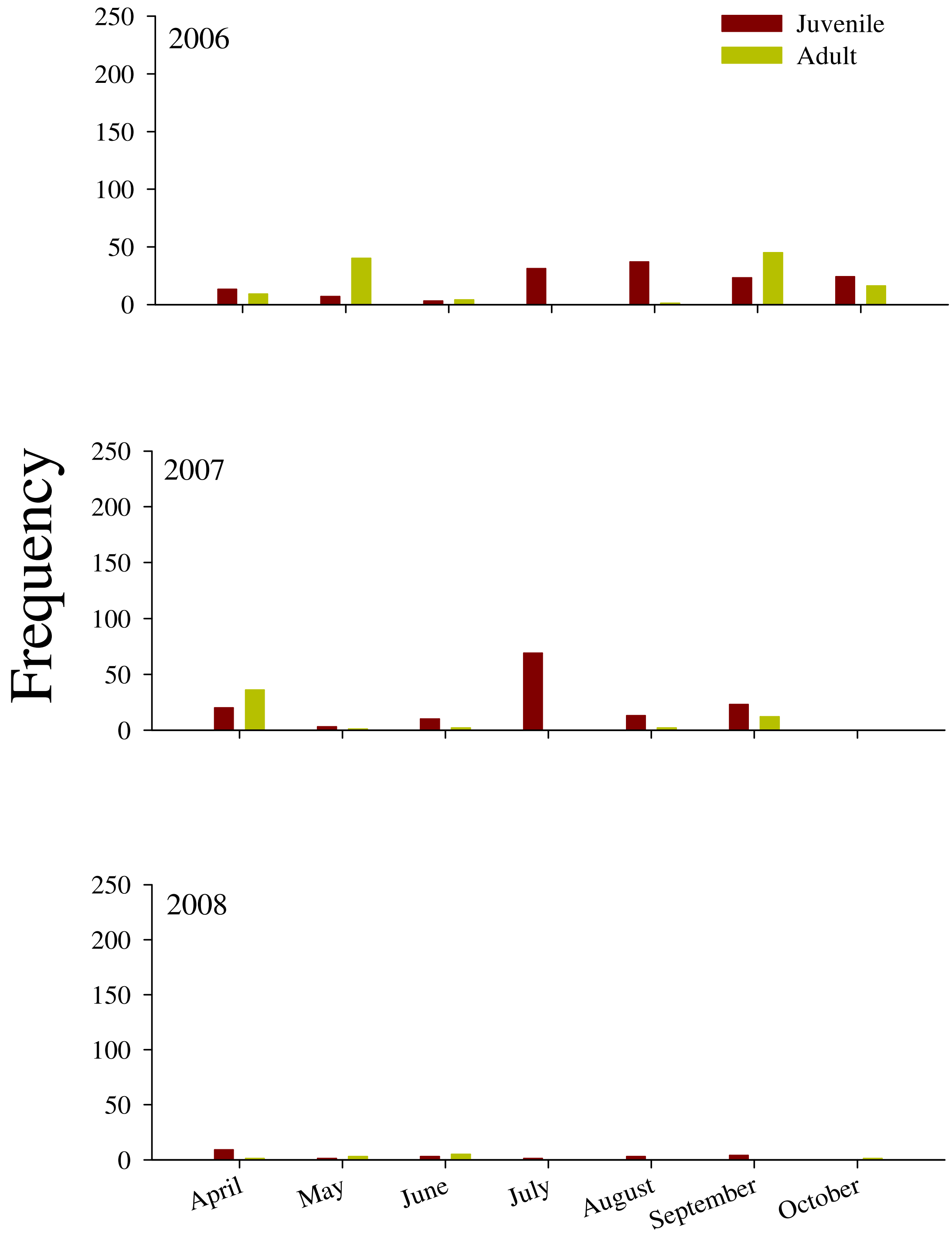


Figure III.6.6. Monthly frequency of juvenile (<64mm) and adult (≥64mm) emerald shiner caught at Lower Hamburg Bend from 2006 - 2008.

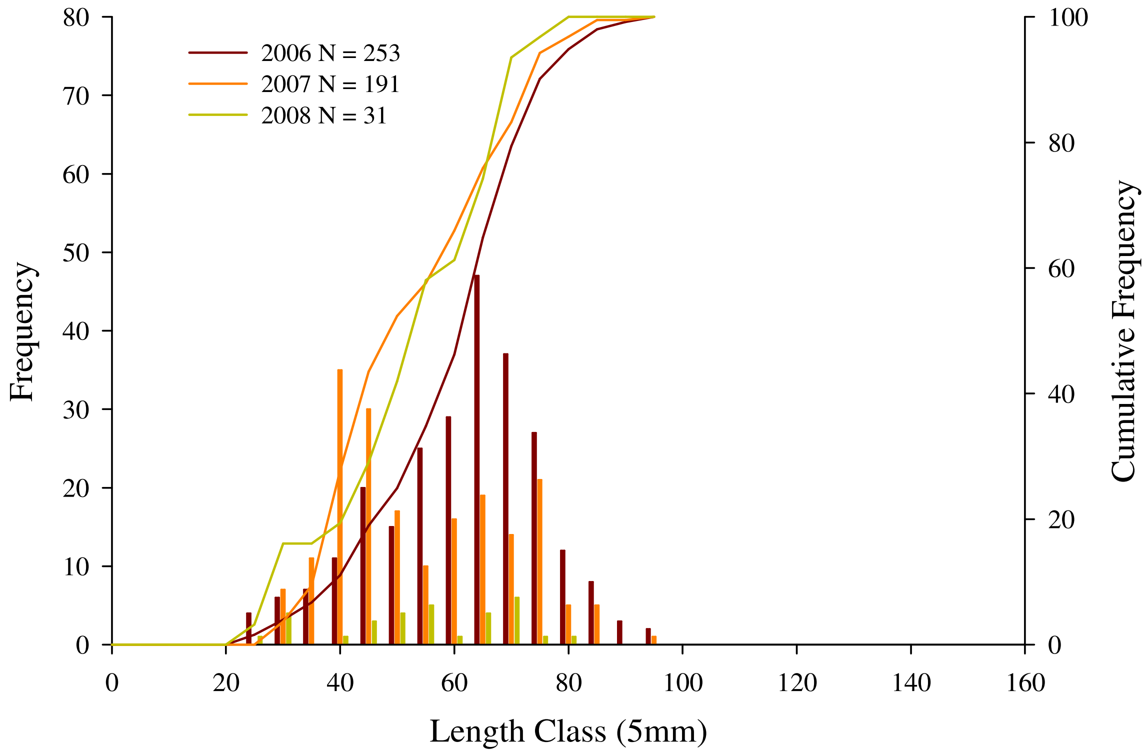


Figure III.6.7. Length frequency distributions and cumulative frequencies for measured emerald shiner (N) at Lower Hamburg Bend from 2006 – 2008.

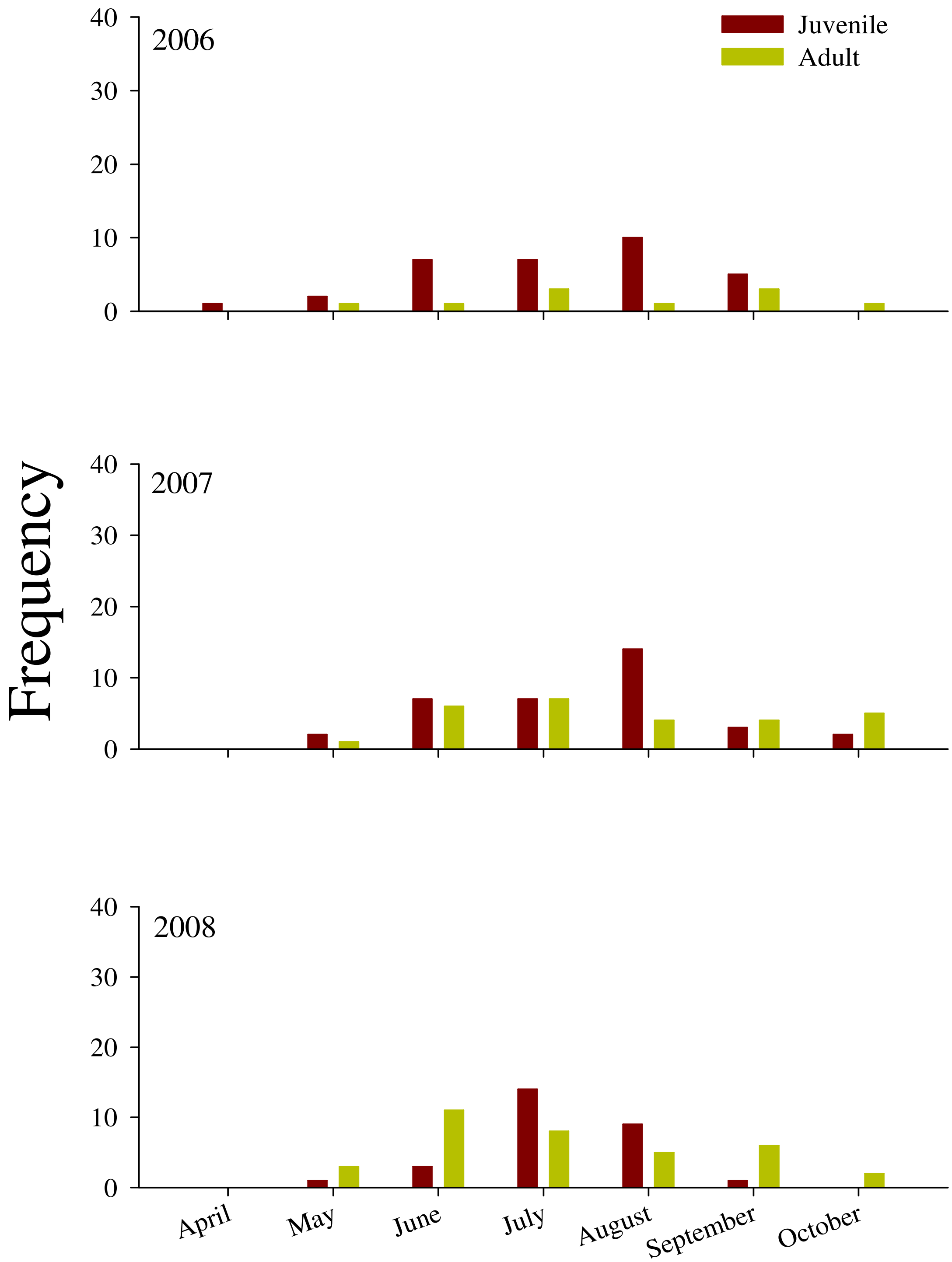


Figure III.6.8. Monthly frequency of juvenile (<381mm) and adult (≥381mm) flathead catfish caught at Lower Hamburg Bend from 2006 – 2008.

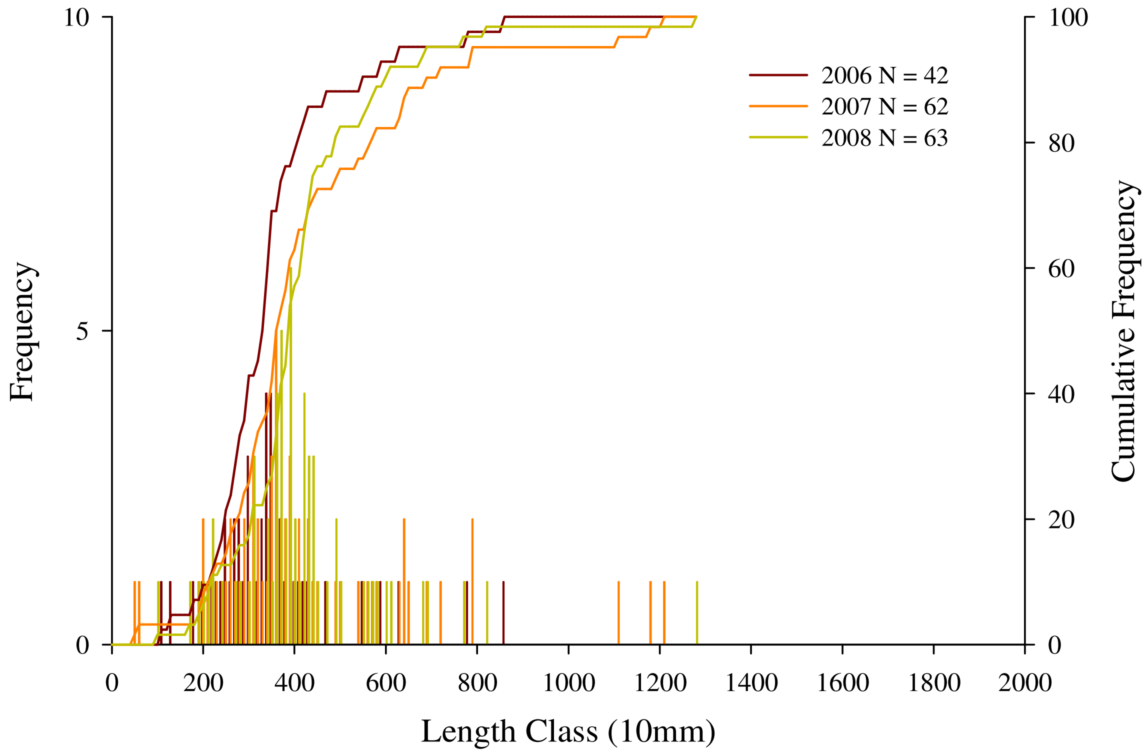


Figure III.6.9. Length frequency distributions and cumulative frequencies for measured flathead catfish (N) at Lower Hamburg Bend from 2006 – 2008.

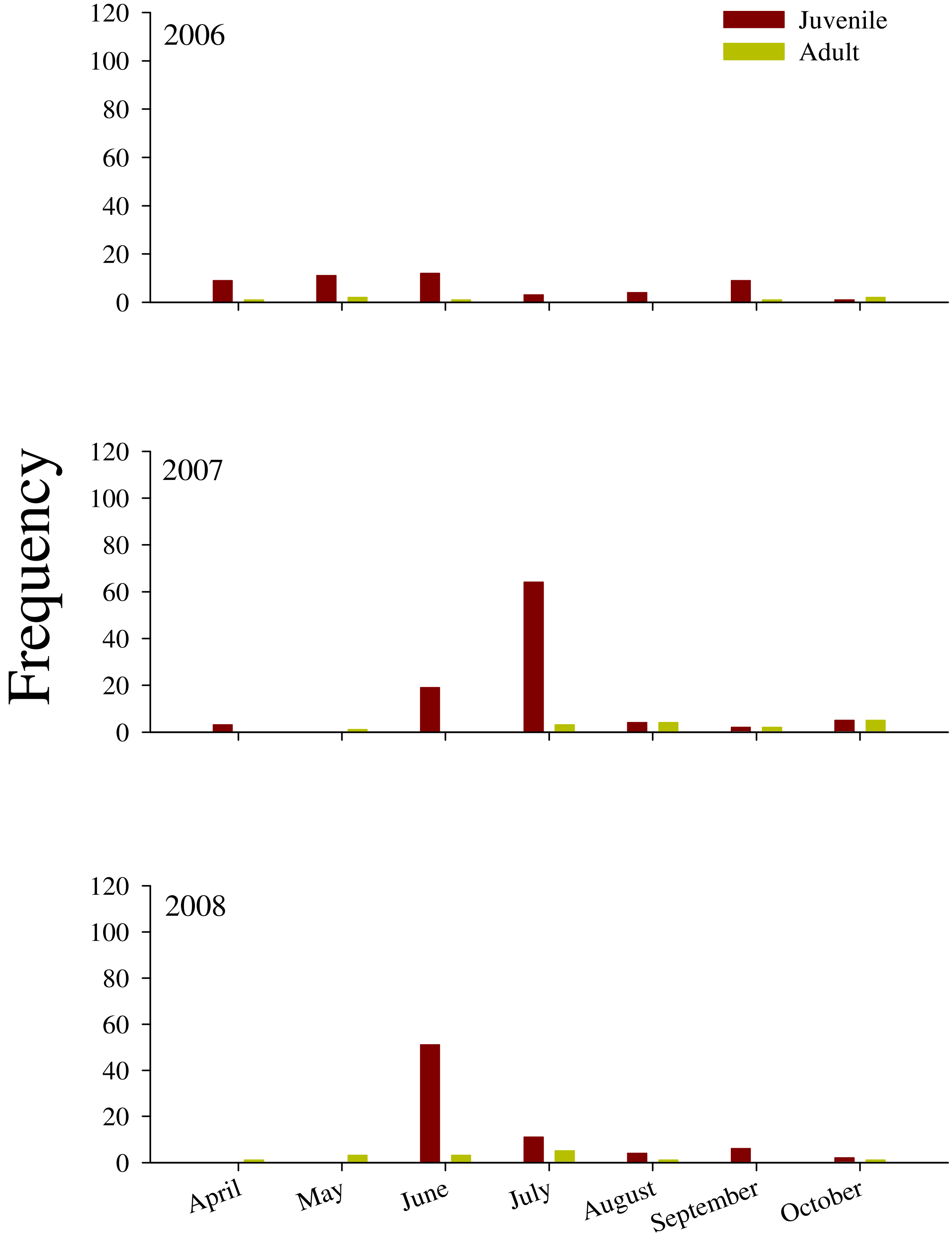


Figure III.6.10. Monthly frequency of juvenile (<305mm) and adult (≥305mm) freshwater drum caught at Lower Hamburg Bend from 2006 - 2008.

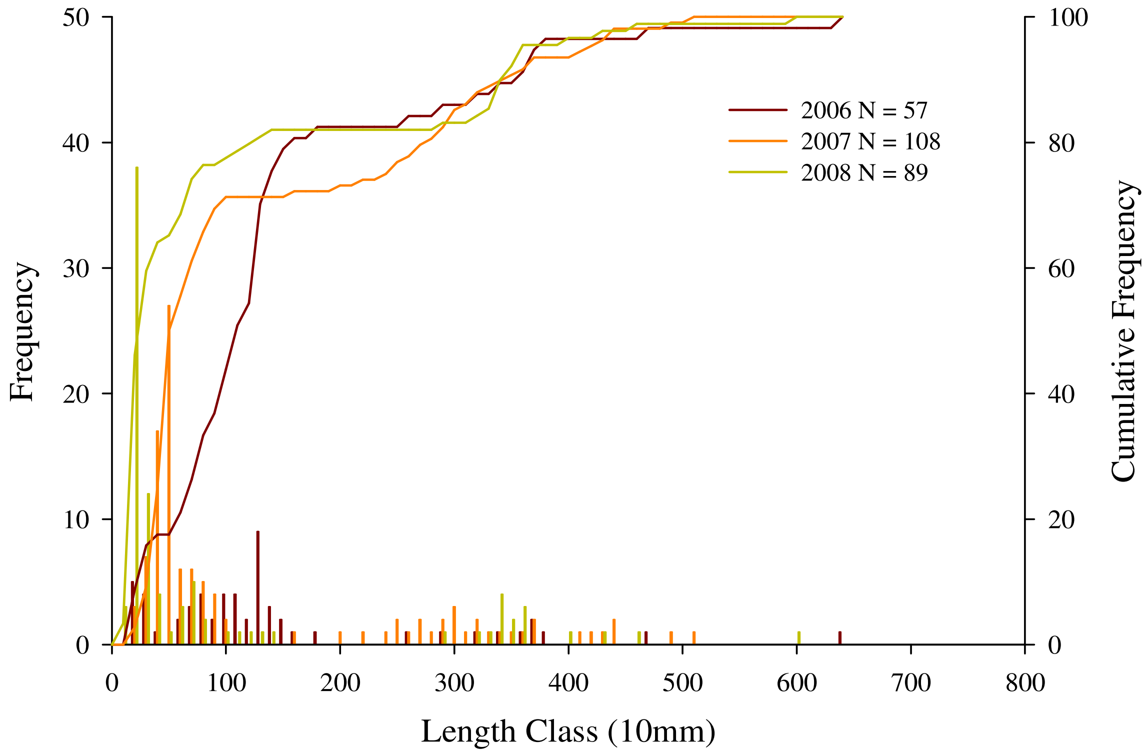


Figure III.6.11. Length frequency distributions and cumulative frequencies for measured freshwater drum (N) at Lower Hamburg Bend from 2006 – 2008.

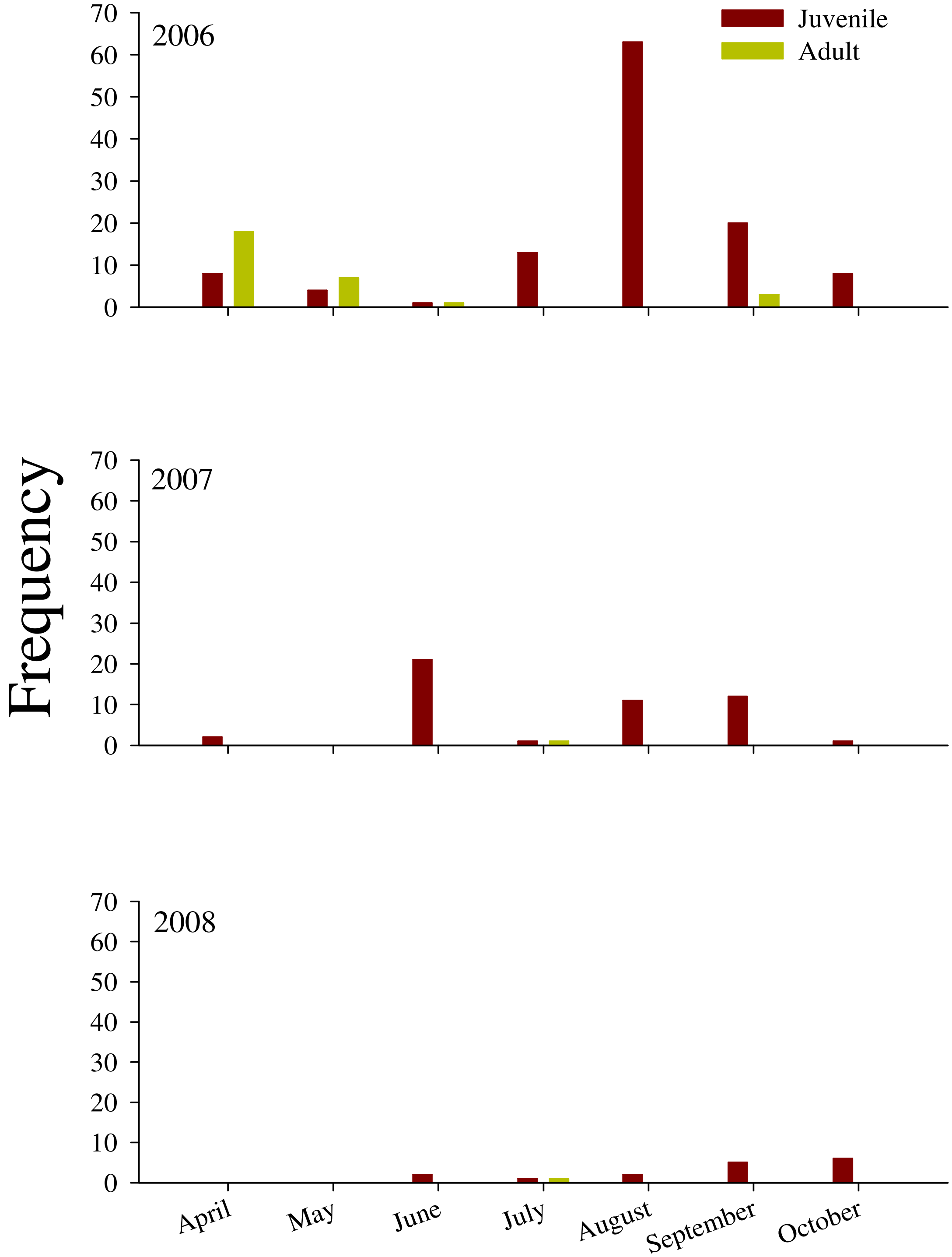


Figure III.6.12. Monthly frequency of juvenile (<229mm) and adult (≥229mm) gizzard shad caught at Lower Hamburg Bend from 2006 - 2008.

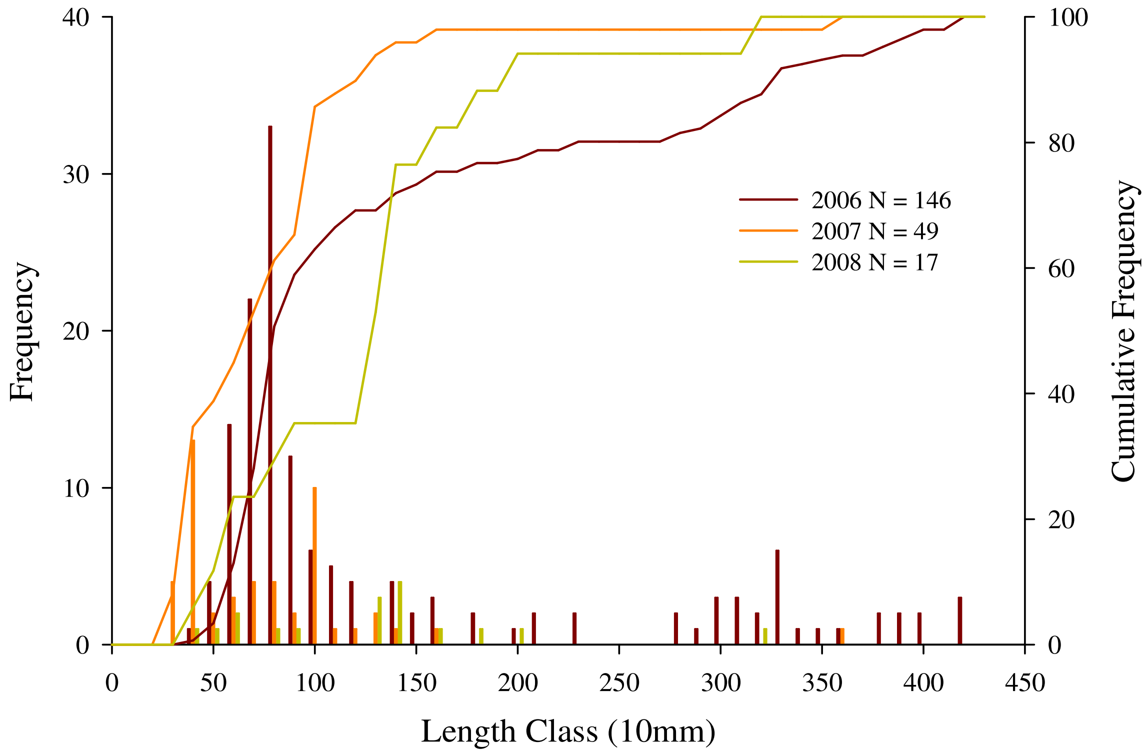


Figure III.6.13. Length frequency distributions and cumulative frequencies for measured gizzard shad (N) at Lower Hamburg Bend from 2006 – 2008.

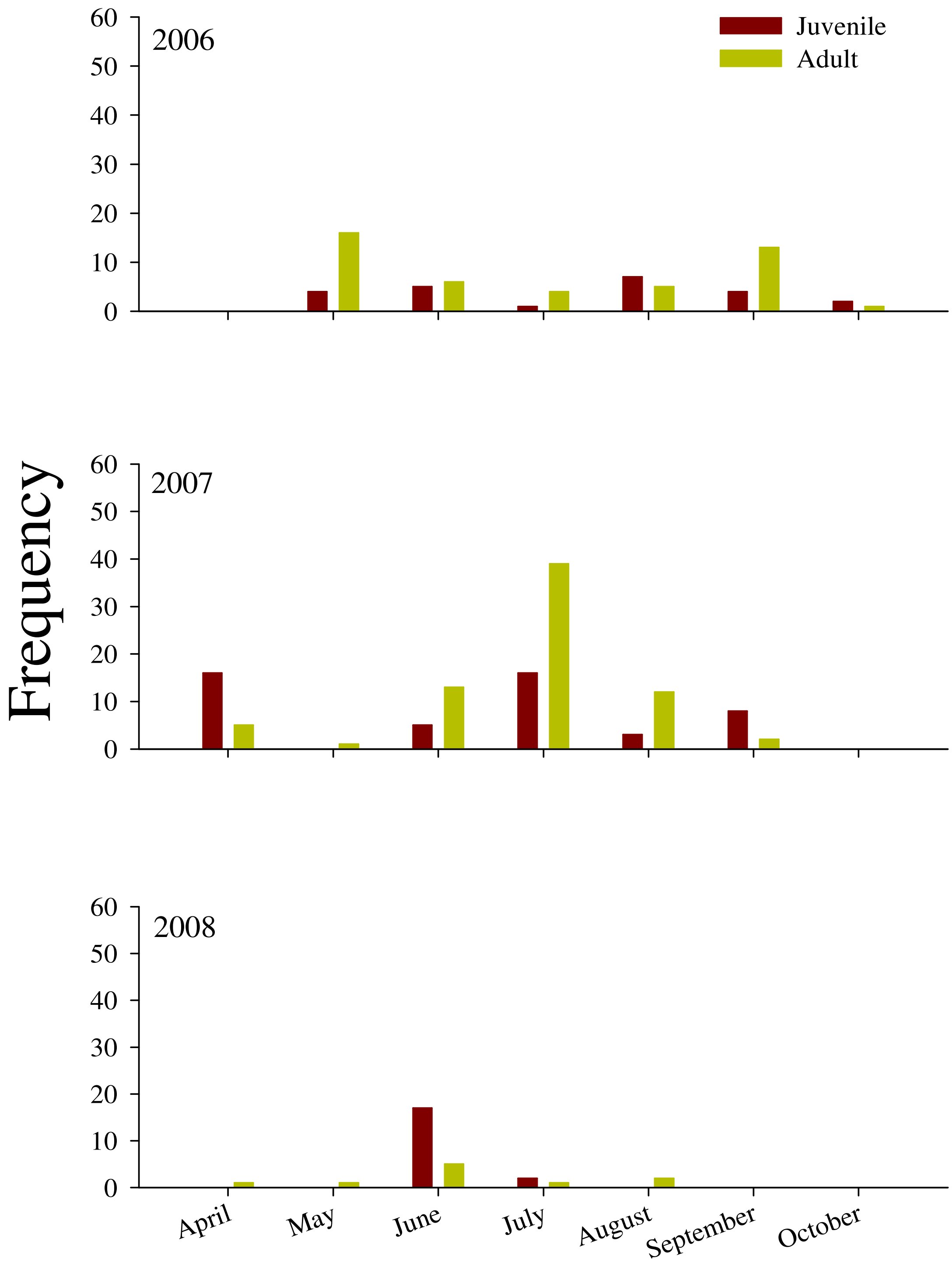


Figure III.6.14. Monthly frequency of juvenile (<46mm) and adult (≥46mm) red shiner caught at Lower Hamburg Bend from 2006 - 2008.

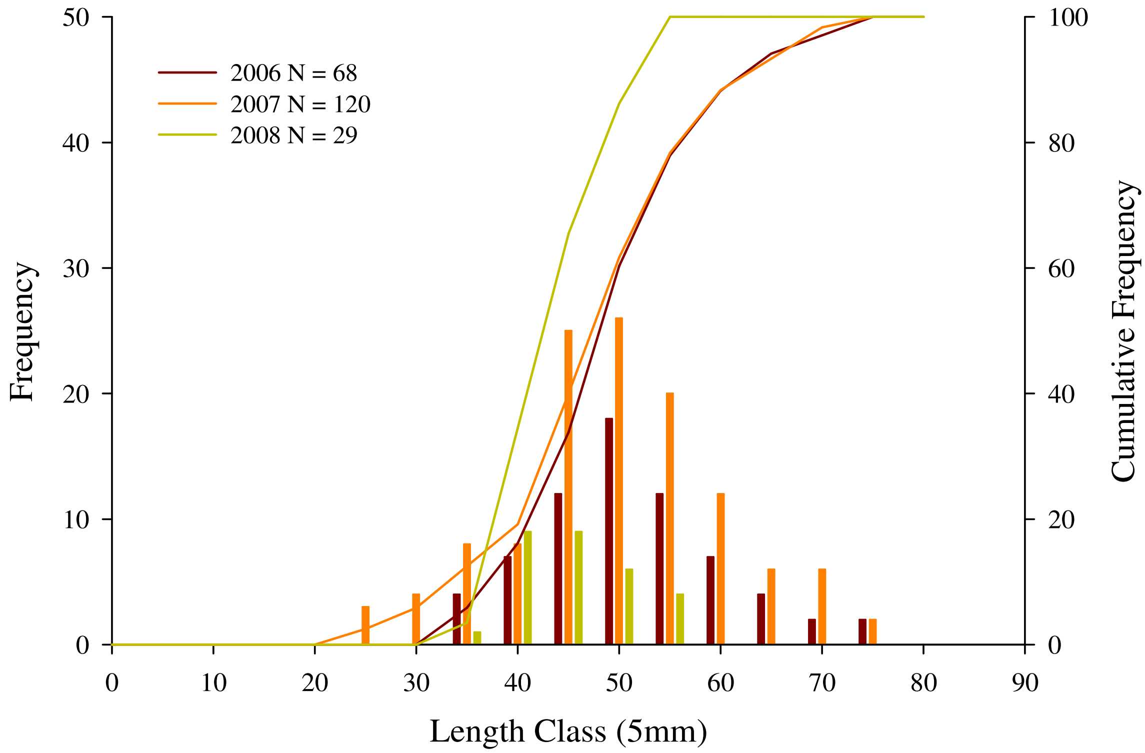


Figure III.6.15. Length frequency distributions and cumulative frequencies for measured red shiner (N) at Lower Hamburg Bend from 2006 – 2008.

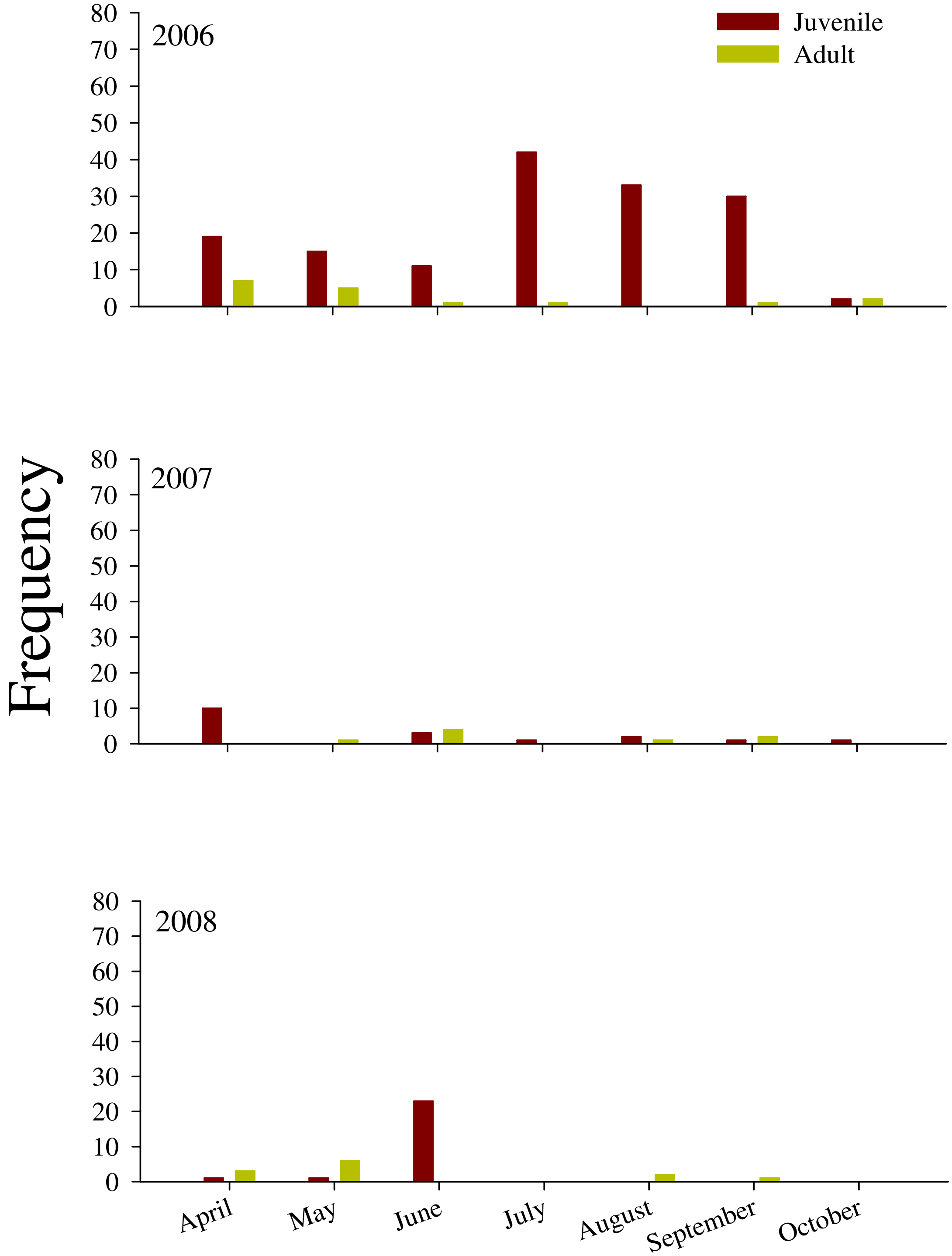


Figure III.6.16. Monthly frequency of juvenile (<305mm) and adult (≥305mm) river carpsucker caught at Lower Hamburg Bend from 2006 - 2008.

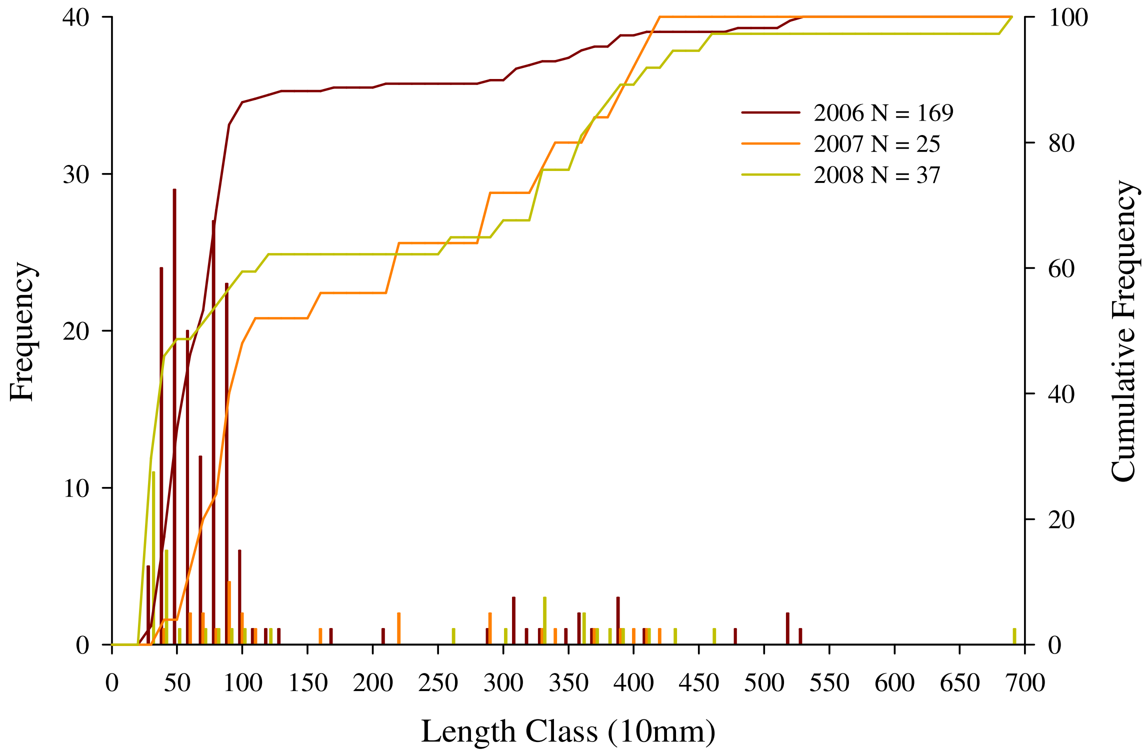


Figure III.6.17. Length frequency distributions and cumulative frequencies for measured river carpsucker (N) at Lower Hamburg Bend from 2006 – 2008.

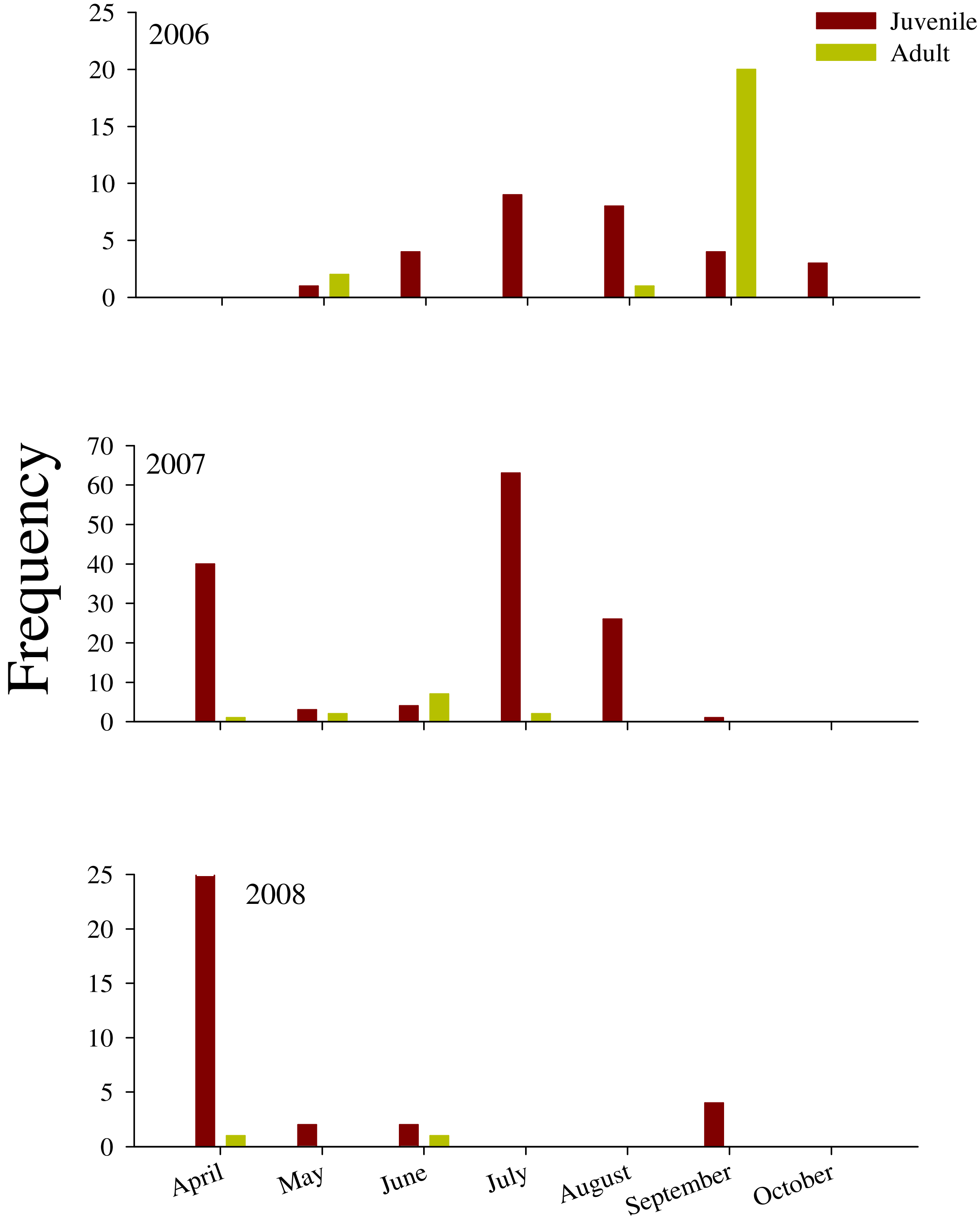


Figure III.6.18. Monthly frequency of juvenile (<51mm) and adult (≥51mm) river shiner caught at Lower Hamburg Bend from 2006 - 2008.

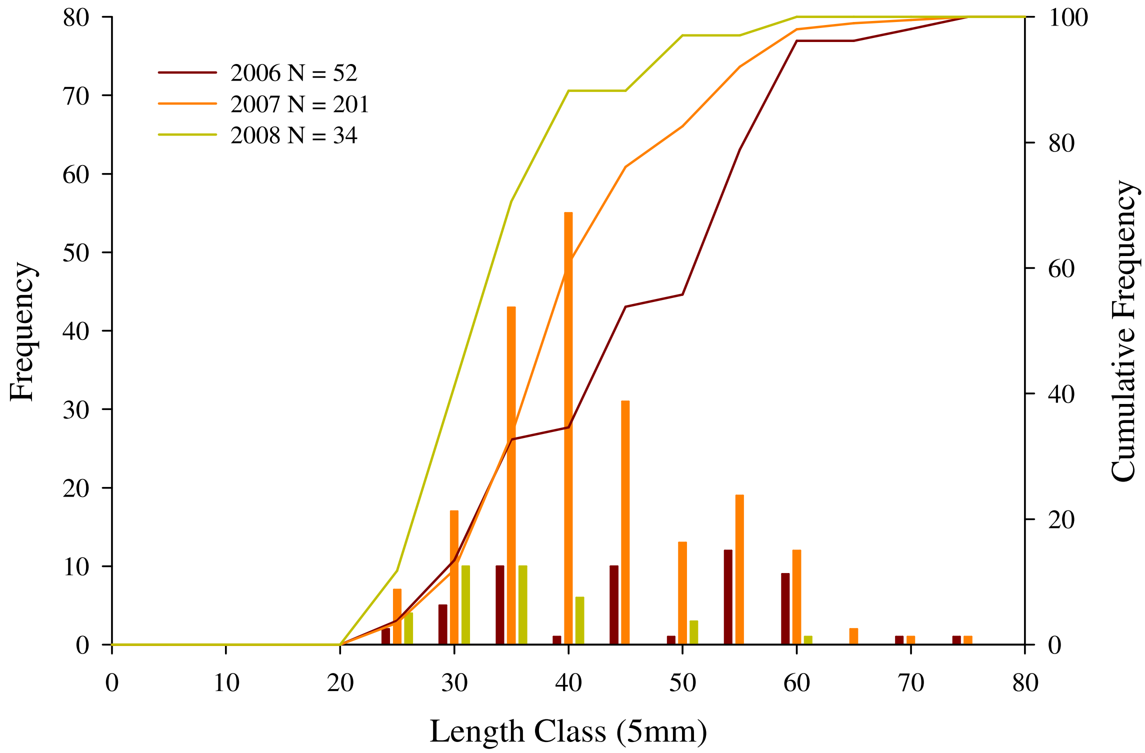


Figure III.6.19. Length frequency distributions and cumulative frequencies for measured river shiner (N) at Lower Hamburg Bend from 2006 – 2008.

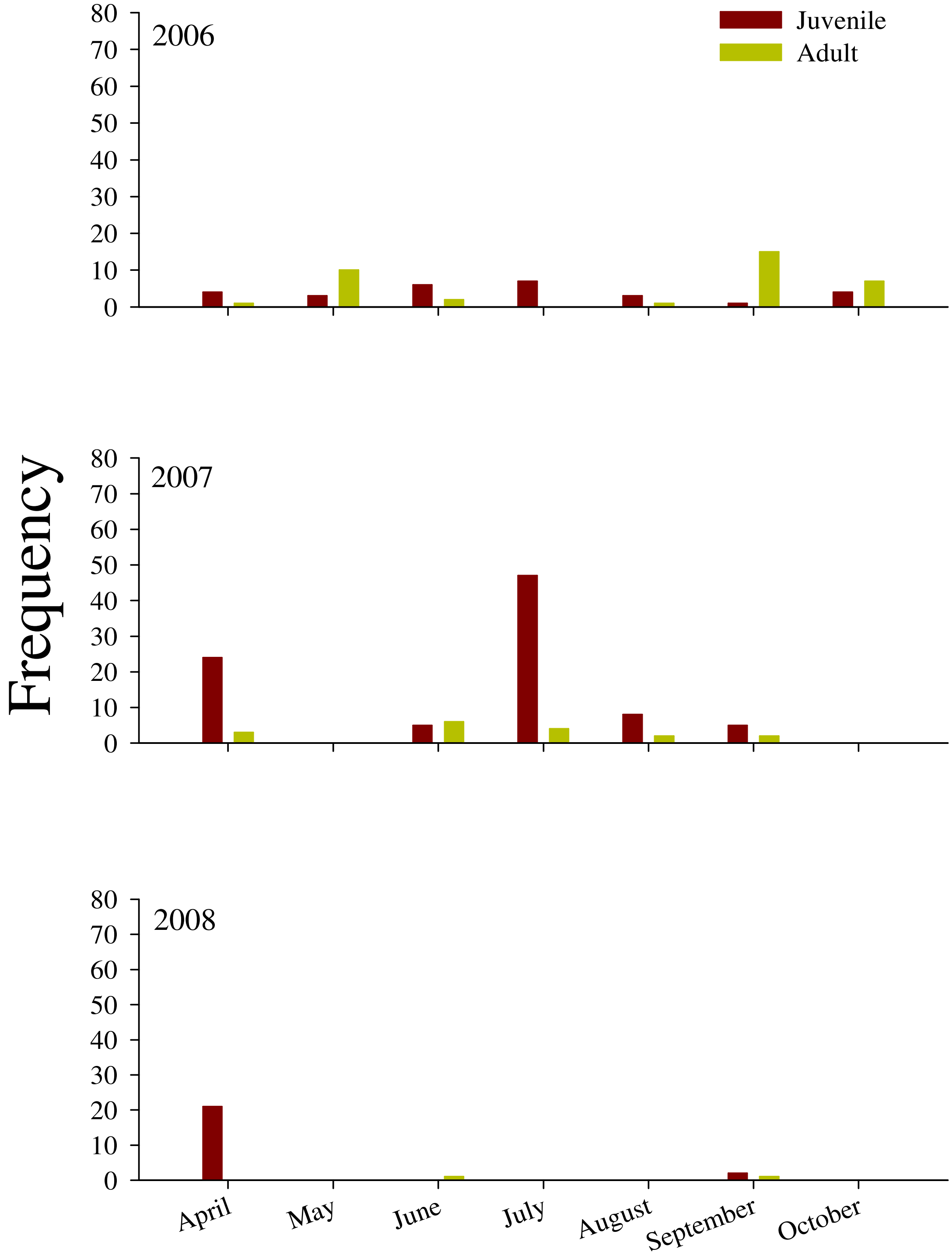


Figure III.6.20. Monthly frequency of juvenile (<43mm) and adult (≥43mm) sand shiner caught at Lower Hamburg Bend from 2006 - 2008.

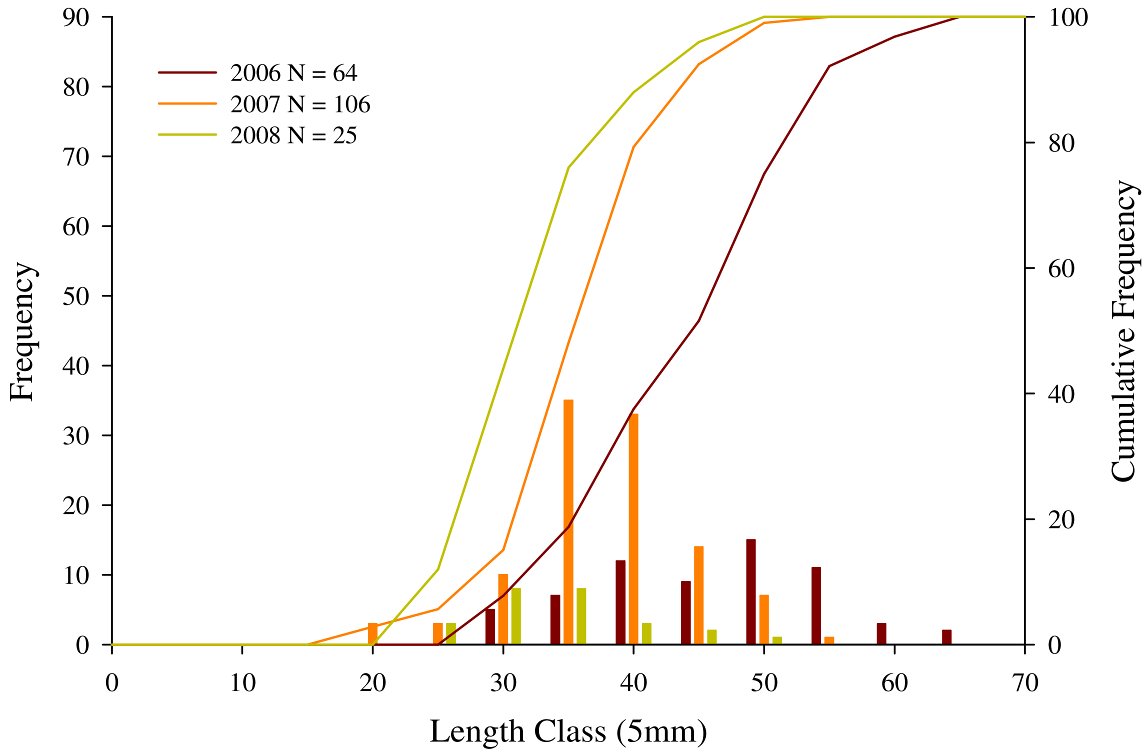


Figure III.6.21. Length frequency distributions and cumulative frequencies for measured sand shiner (N) at Lower Hamburg Bend from 2006 – 2008.

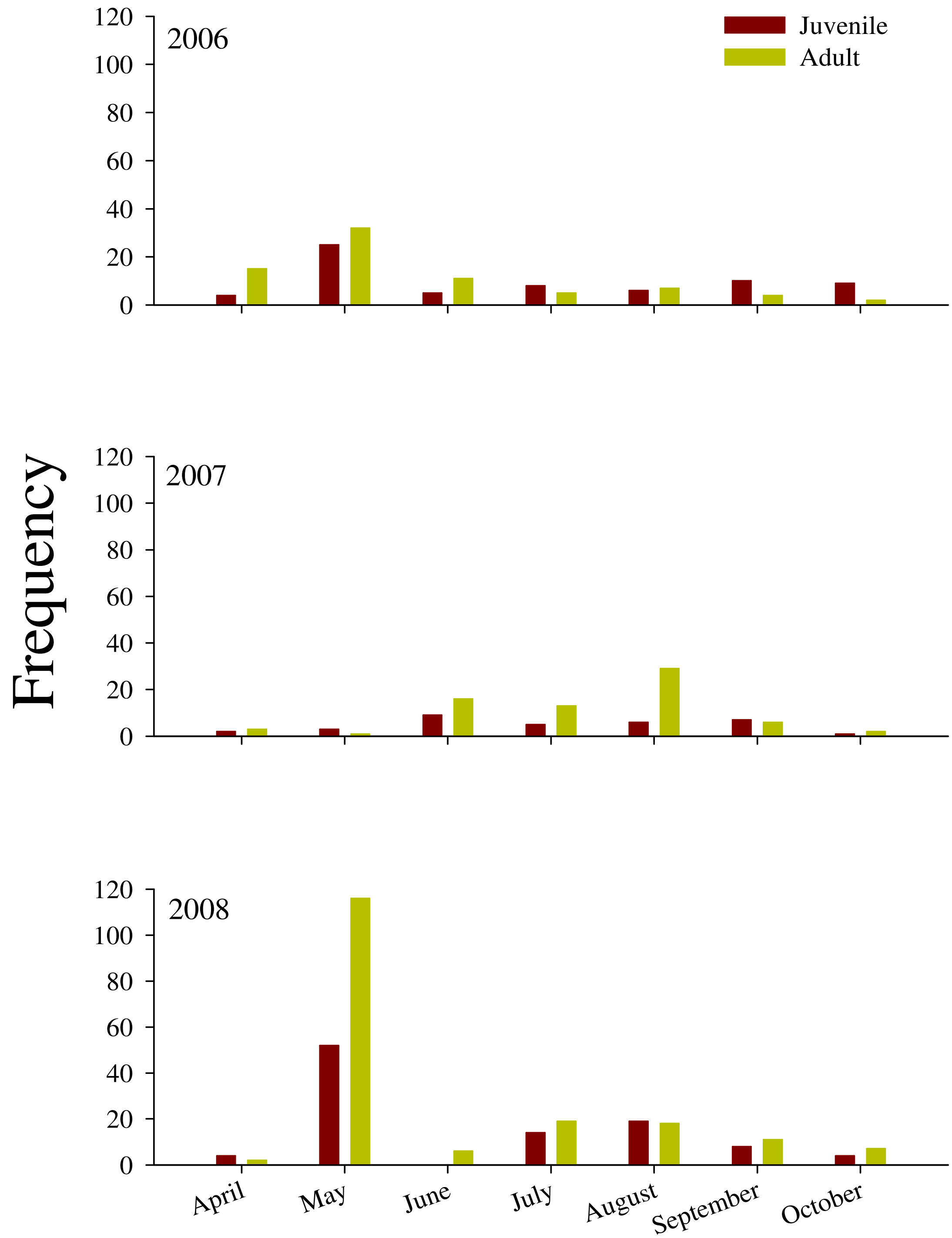


Figure III.6.22. Monthly frequency of juvenile (<540mm) and adult (≥540mm) shovelnose sturgeon caught at Lower Hamburg Bend from 2006 - 2008.

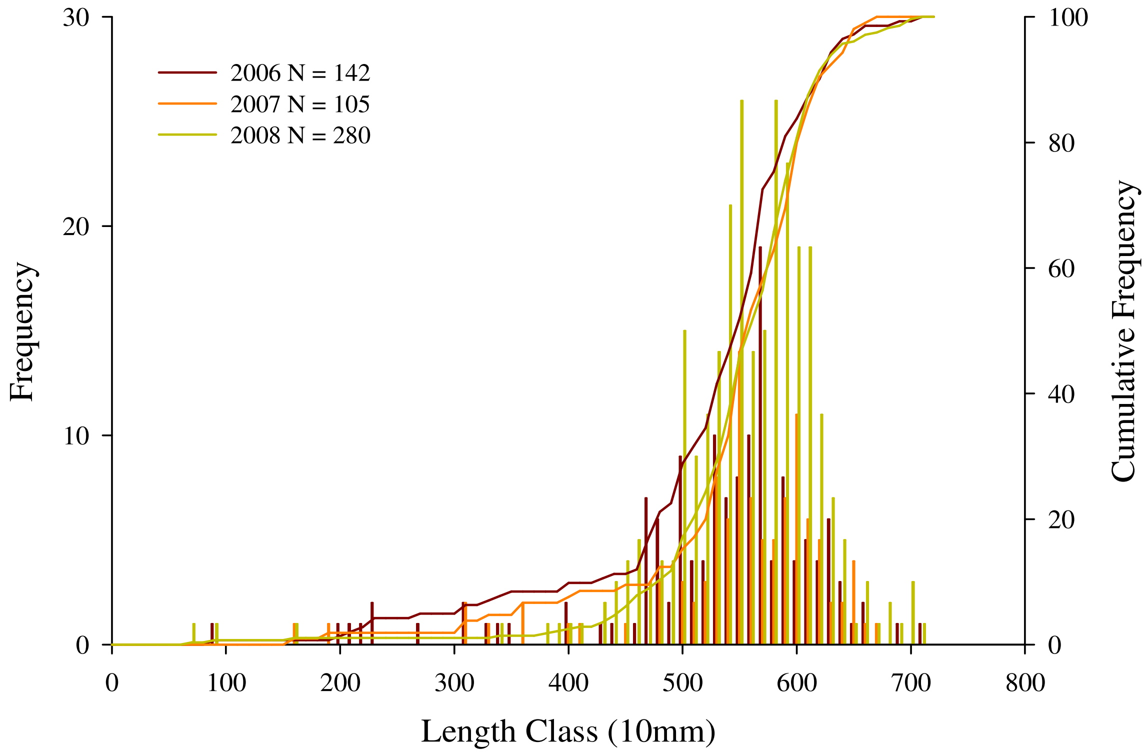


Figure III.6.23. Length frequency distributions and cumulative frequencies for measured shovelnose sturgeon (N) at Upper Hamburg Bend from 2006 – 2008.

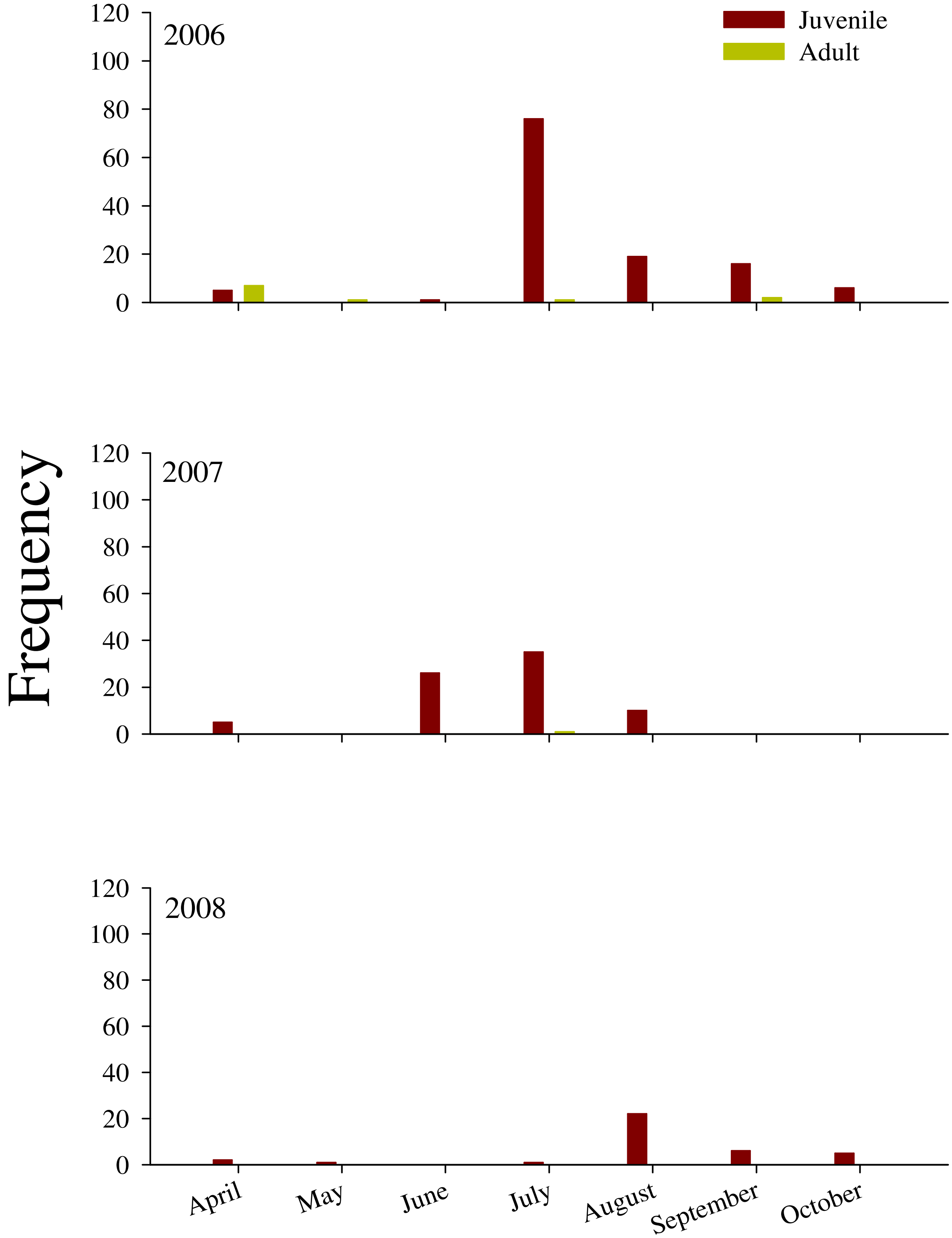


Figure III.6.24. Monthly frequency of juvenile (<89mm) and adult (≥89mm) silver chub caught at Lower Hamburg Bend from 2006 - 2008.

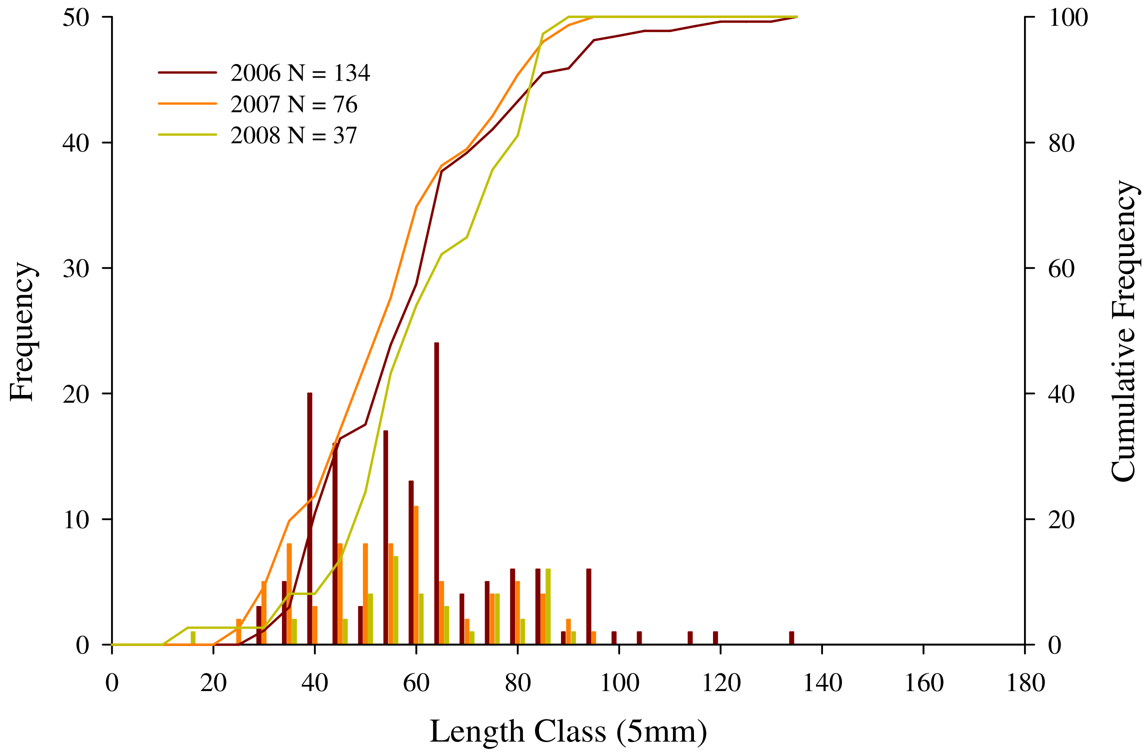
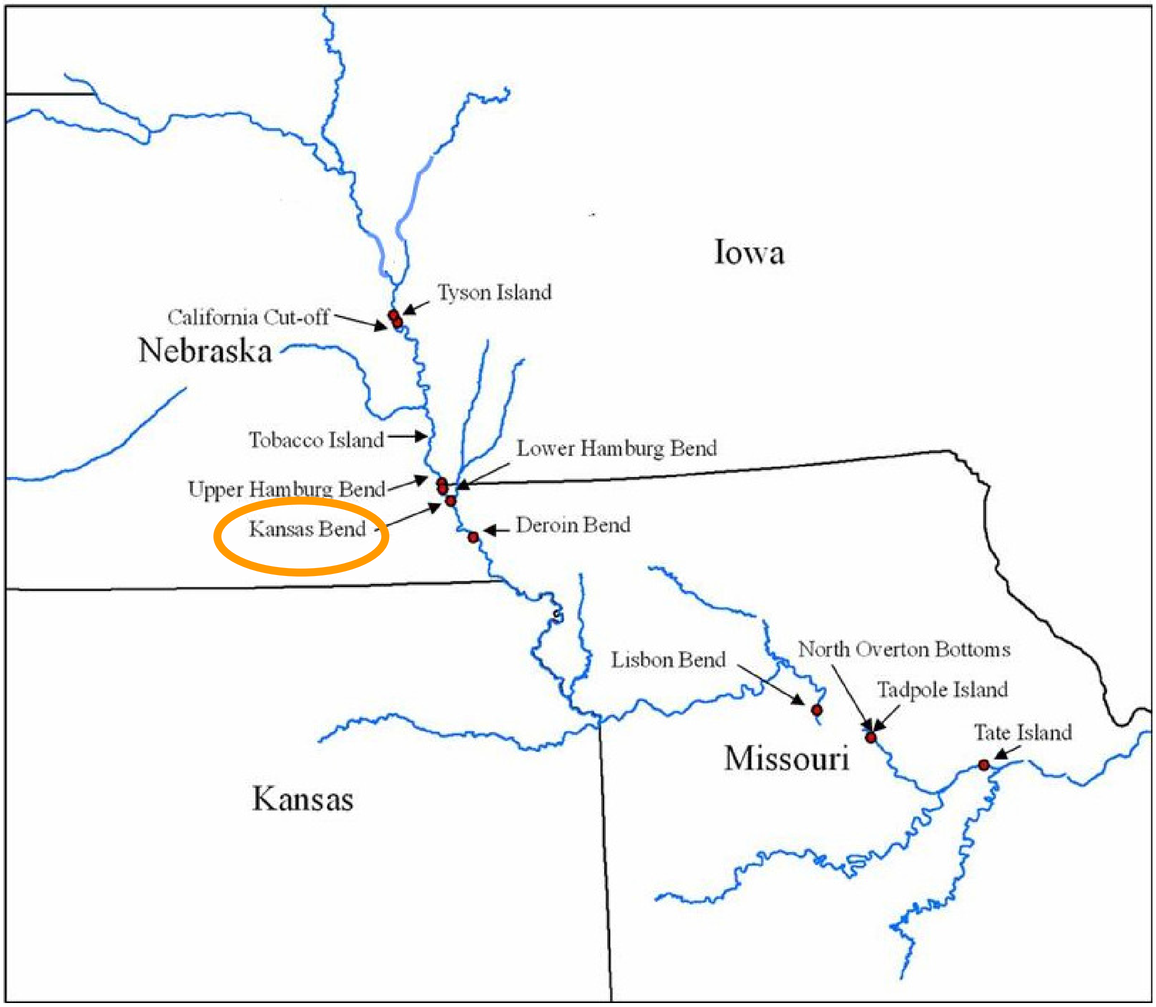


Figure III.6.25. Length frequency distributions and cumulative frequencies for measured silver chub (N) at Lower Hamburg Bend from 2006 – 2008.

Section III
Chapter 7
Kansas Bend



List of Tables

Table Page

Table Page

List of Figures

Figure Page

A total of 7,586 fish comprising 45 different species was sampled in Kansas from 2006 to 2008. Unidentified fish due to their small size or poor condition totaled 81. Sixty-four percent of the total number of fish were juveniles. The highest number of fish (5,384) and greatest species diversity (42) was found in 2006 while the lowest species diversity (34) and lowest number of fish (986) was found during the 2007 sampling season. Species diversity and evenness increased from 2006 to 2007 (1.676 to 3.017 and 0.4483 to 0.8557 respectively) and then decreased from 2007 to 2008 (Table III.7.2). The fish community was similar in 2007 and 2008 but neither similar nor dissimilar between 2006 and 2007 (Table III.7.3). Monthly species richness in 2006 was highest in June (29 species) and lowest in October (19 species). Monthly species richness in 2007 peaked in July and was lowest in October (13 species). In 2008 species richness was highest in August with 26 species and lowest in October with 11 species.

Kansas was typically dominated by a handful of species: emerald shiner, river shiner, sand shiner, and shovelnose sturgeon. These fish accounted for over 70% of all fish sampled (Table III.7.1). Other species of interest were not sampled in as large of numbers. Only species that averaged 50 measured individuals a year were included in the analysis. A total of 6 *Hybognathus* species were sampled in Kansas with none being collected in 2008. Only 4 sauger were sampled with at least one caught each year. There were no pallid sturgeon collected in Kansas. Very low numbers of speckled chub were sampled in 2008 (14 fish) while a total of 59 were sampled from 2006 to 2008. Sturgeon chub were sampled most in 2006 (24 fish). There were a total of 139 blue suckers caught from 2006 to 2008. Blue sucker catches increased each year from 35 fish in 2006 to 60 fish in 2008.

Channel catfish

A total of 357 channel catfish was sampled with 164 fish being caught in 2008 and only 91 fish in 2007. Length-frequency distributions were similar among all years (Table III.7.5). Mean length in 2006 (118mm) was different than in 2008 (167mm; Table III.7.6). Juvenile channel catfish tended to be sampled in greater numbers during July and August (Figure III.7.2). The percentage of juvenile channel catfish significantly decreased from 89.2% in 2006 to 77.4% in 2008 (Table III.7.4). Catch per unit effort was similar among years (Table III.7.7). Push trawls were the best gear for sampling channel catfish with May being the best month (Table III.7.8).

Emerald shiner

A total of 3,267 emerald shiners was sampled with 3,024 fish being caught in 2006. Length-frequency distributions were different between 2006 and 2008 and also between 2007 and 2008 (Table III.7.5). Mean lengths were also different between 2006 (55mm) and 2008 (45mm) as well as between 2007 (55mm) and 2008 (Table III.7.6). Most emerald shiners were juveniles ranging from 70.0% to 83.5% of the fish sampled from year to year (Table III.7.4). July and August tended to be peak months for juveniles (Figure III.7.4). Otter trawl CPUE was different between 2006 and 2008 and between 2007 and 2008 (Table III.7.7). Mini-fyke nets and push trawls were most effective at sampling emerald shiners. Both gears had their highest catch per unit efforts in July (Table III.7.8).

Flathead catfish

A total of 240 flathead catfish was sampled. Higher numbers of flathead catfish were sampled in 2007 (104) than in 2008 (67). Length-frequency distributions were

significantly different between 2007 and 2008 (Table III.7.5). Mean lengths were similar among all years and ranged from 380mm to 438mm (Table III.7.6). The majority of flathead catfish sampled were adult size, but juveniles tended to be sampled June through August (Figure III.7.6). The percentage of juvenile flathead catfish significantly decreased from 63.1% in 2007 to 44.8% in 2008 (Table III.7.4). Electrofishing CPUE was different between 2007 and 2008 (Table III.7.7). Flathead catfish were sampled most by electrofishing during the months of July and August (Table III.7.8).

Freshwater drum

A total of 162 freshwater drum was sampled with 2008 having the highest number (59) and 2006 the lowest (45). Length-frequency distributions were different between 2006 and 2008 (Table III.7.5). Mean lengths were similar among all years and ranged from 127mm to 155mm (Table III.7.6). Juvenile freshwater drum had peaks from June to August (Figure III.7.8). The percentage of juvenile freshwater drum was similar among years and ranged fro 75.9% to 88.9% (Table III.7.4). Catch per unit effort was similar for each year (Table III.7.7). Push trawls were the best gear for freshwater drum having highest catch per unit efforts during July and August (Table III.7.8).

River shiner

A total of 978 river shiners was sampled. The majority were caught in 2006 (902 fish) while only 24 were sampled in 2008. Length-frequency distributions were similar among all years (Table III.7.5). Mean lengths decreased from 41mm to 38mm between 2006 and 2007 and also between 2006 and 2008 (36mm; Table III.7.6). The majority of red shiners sampled were juveniles with a significant increase from 82.9% in 2006 to 100% in 2007 (Table III.7.4). Juveniles were found in higher numbers from May to July

(Figure III.7.10). Catch per unit effort was similar for each year (Table III.7.7). River shiner were sampled best with mini-fyke nets and push trawls. Both gears had high catch per unit efforts in July (Table III.7.8).

Sand shiner

A total of 537 sand shiners was sampled. In 2006 a total of 362 fish were sampled while only 39 were caught in 2007. Length-frequency distributions were similar among all years (Table III.7.5). Mean lengths were also similar among all years and ranged from 36mm to 37mm (Table III.7.6). Juvenile sand shiners were found in greater numbers during July for most years (Figure III.7.12). The percentage of juvenile sand shiners was similar each year ranging from 76.6% to 84.7% (Table III.7.4). Catch per unit effort was similar among years (Table III.7.7). Sand shiners were sampled most by push trawls and mini-fyke nets. Push trawls had their highest CPUE in May and mini-fyke nets in July (Table III.7.8).

Shovelnose sturgeon

A total of 445 shovelnose sturgeon was sampled with the highest numbers in 2008 (204 fish) and the fewest in 2007 (66 fish). Length-frequency distributions were similar among all years (Table III.7.5). Mean lengths were similar among all years and ranged from 541mm to 550mm (Table III.7.6). The majority of shovelnose sturgeon were adults. Juvenile shovelnose sturgeon had low percentages each year ranging from 28.6% to 42.4% with no significant differences between years (Table III.7.4). Juvenile shovelnose sturgeon had peak numbers in April (Figure III.7.14). Otter trawl CPUE was different between 2006 and 2008 (Table III.7.7). Small hoop net CPUE was different between 2006 and 2007 (Table III.7.7). Hoop nets were the best gear for sampling

shovelnose sturgeon. Catch per unit effort for hoop nets was highest in April (Table III.7.8).

Silver chub

A total of 153 silver chub was sampled. Numbers of silver chub were low in 2008 with only 26 fish being caught. The highest number of silver chub was sampled in 2006 (80 fish). Length-frequency distributions were different between 2007 and all other years (Table III.7.5). Mean lengths decreased from 54mm in 2006 to 45mm in 2007 and then increased from 2007 to 58mm in 2008 (Table III.7.6). The majority of silver chubs were juveniles (88.5% - 97.5%) with no differences among years (Table III.7.4). Juvenile usage peaked from June to August (Figure III.7.16). Mini-fyke net and otter trawl CPUEs were different between 2006 and 2007 (Table III.7.7). Silver chub were sampled most by push trawls. High push trawl catch per unit efforts were in April and August (Table III.7.8).

Key Findings

- 64% of all fish sampled were juveniles.
- Species diversity increased between 2006 and 2007.
- The fish community was more similar between 2007 and 2008.
- The month of October had the lowest monthly species richness for all years.
- 4 species accounted for 70% of all fish sampled (emerald shiner, river shiner, sand shiner, and shovelnose sturgeon).
- Missouri River Recovery species of interest were found in low numbers or not at all (blue sucker, pallid sturgeon, *hybognathus sp*., speckled chub, sturgeon chub, and sauger).

- Flathead catfish and shovelnose sturgeon were primarily adults.

Table III.7.1. Total species caught at Kansas Bend 2006-2008 and the percent of catch that each species represents. *Indicates a species that was used in analysis. †Indicates a species of note for this chute.

Species	Scientific name	2006	2007	2008	Total	%Catch
Bighead carp†	*Hypopthalmichthys nobilis*	1	3	1	5	0.067
Bullhead minnow†	*Pimephales vigilax*	0	2	1	3	0.039
Blue catfish†	*Ictalurus furcatus*	8	30	51	89	1.186
Bluegill sunfish†	*Lepomis macrochirus*	6	14	26	46	0.613
Bigmouth buffalo†	*Ictiobus cyprinellus*	1	6	1	8	0.107
Bluntnose minnow†	*Pimephales notatus*	1	0	1	2	0.027
Blue sucker†	*Cycleptus elongates*	35	44	51	130	1.732
Common carp†	*Cyprinus carpio*	16	18	19	53	0.706
Creek chub	*Semotilus atromaculatus*	1	0	9	10	0.133
Central stoneroller	*Campostoma anomalum*	2	0	0	2	0.027
Channel catfish*†	*Ictalurus punctatus*	102	91	164	357	4.757
Channel shiner	*Notropis wickliffi*	1	0	0	1	0.013
Emerald shiner*†	*Notropis atherinoides*	3024	80	163	3267	43.531
Flathead catfish*†	*Pylodictus olivaris*	69	104	67	240	3.198
Fathead minnow†	*Pimephales promelas*	13	3	2	18	0.239
Freshwater drum*†	*Aplodinotus grunniens*	45	58	59	162	2.159
Goldeye†	*Hiodon alosoides*	26	18	35	79	1.053
Green sunfish	*Lepomis cyanellus*	4	0	6	10	0.133
Grass carp†	*Ctenopharyngodon idella*	3	0	3	6	0.079
Gizzard shad†	*Dorosoma cepedianum*	65	43	16	124	1.652
Hybognathus sp.†	*Hybognathus sp.*	2	4	0	6	0.079
Largemouth bass†	*Micropterus salmoides*	0	2	0	2	0.027
Longnose gar†	*Lepisosteus osseus*	6	9	7	22	0.293
Mosquitofish	*Gambusia affinis*	9	0	0	9	0.119
Orangespotted sunfish	*Lepomis humilis*	2	1	4	7	0.093
Paddlefish†	*Polyodon spathula*	1	1	1	3	0.039
Pugnose minnow	*Opsopoeodus emiliae*	1	0	0	1	0.013
Red shiner†	*Cyprinella lutrensis*	206	18	9	233	3.105
River carpsucker†	*Carpiodes carpio*	63	63	26	152	2.025
River shiner*†	*Notropis blennius*	902	52	24	978	13.031
Silverband shiner	*Notropis shumardi*	1	0	0	1	0.013
Striped bass	*Morone saxatilis*	1	1	0	2	0.027
Sturgeon chub†	*Macrhybopsis gelida*	31	2	6	39	0.519
Sauger†	*Stizostedion canadense*	2	1	1	4	0.053
Skipjack herring	*Alosa chrysochloris*	2	0	0	2	0.027
Speckled chub†	*Macrhybopsis aestivalis*	24	21	7	52	0.693
Smallmouth buffalo†	*Ictiobus bubalus*	8	28	23	59	0.786
Shortnose gar†	*Lepisosteus platostomus*	16	40	10	66	0.879
Shovelnose sturgeon*†	*Scaphirhynchus platorynchus*	175	66	204	445	5.929
Sand shiner*†	*Notropis stramineus*	362	39	136	537	7.155
Stonecat	*Noturus flavus*	26	16	38	80	1.066
Silver chub*†	*Macrhybopsis storeriana*	80	47	26	153	2.039
Walleye	*Stizostedion vitreum*	1	0	0	1	0.013
White bass	*Morone chrysops*	20	12	3	35	0.466
White crappie†	*Pomoxis annularis*	0	3	1	4	0.053

Table III.7.2. Species richness (S), species evenness (E), Shannon's diversity index (H) and Simpson's diversity index (D) for Kansas Bend 2006-2008.

Year	**S**	**E**	**H**	**D**
2006	42	0.4483	1.676	0.6456
2007	34	0.8557	3.017	0.9412
2008	35	0.7688	2.733	0.9081

Table III.7.3. Community assemblage similarity, using Morisita's index, for Kansas Bend between years (2006 - 2008). Values less than 0.300 mean fish communities are dissimilar and values more than 0.700 mean fish communities are similar.

Year	**2006 v 2007**	**2006 v 2008**	**2007 v 2008**
Morisita's Index	0.348	0.454	0.912

Table III.7.4. Results for analysis of life stage proportions at Kansas Bend from 2006 - 2008. A z-test was used to determine differences in proportions of juveniles and adults of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold. Values not between -2.135 to 2.135 are significant.

	Z statistic		
	2006 vs 2007	**2006 vs 2008**	**2007 vs 2008**
Channel catfish	1.359	**2.397**	0.928
Emerald shiner	0.363	-2.110	-2.063
Flathead catfish	-1.241	1.032	**2.352**
Freshwater drum	1.691	1.055	-0.725
River shiner	**-3.151**	-1.054	2.110
Sand shiner	0.386	1.396	0.672
Shovelnose sturgeon	-2.050	-1.789	0.750
Silver chub	0.547	1.889	1.180

Table III.7.5. Results for analysis of length frequency distribution at Kansas Bend from 2006 - 2008. A Kolmogorov-Smirnov test was used to determine differences in length frequency distribution of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

	2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**D**	**p-value**	**D**	**p-value**	**D**	**p-value**
Channel catfish	0.155	0.1986	0.132	0.247	0.103	0.586
Emerald shiner	0.084	0.773	**0.375**	**0.0001**	**0.39**	**0.0001**
Flathead catfish	0.153	0.2895	0.181	0.2151	**0.278**	**0.0038**
Freshwater drum	0.153	0.555	**0.295**	**0.018**	0.179	0.305
River shiner	0.17	0.298	0.345	0.226	0.298	0.108
Sand shiner	0.178	0.315	0.139	0.3405	0.131	0.7697
Shovelnose sturgeon	0.154	0.2061	0.14	0.0493	0.097	0.7395
Silver chub	**0.487**	**0.0001**	0.208	0.3657	**0.421**	**0.0054**

Table III.7.6. Results for analysis of species mean length at Kansas Bend from 2006 - 2008. A t-test was used to determine differences in mean length of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

	2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**t**	**p-value**	**t**	**p-value**	**t**	**p-value**
Channel catfish	-1.594	0.1129	**-2.736**	**0.0067**	-0.798	0.4258
Emerald shiner	0.013	0.9898	6.093	0.0001	4.751	0.001
Flathead catfish	0.165	0.8694	-1.803	0.0736	-1.95	0.0529
Freshwater drum	-0.235	0.8144	1.123	0.2639	1.31	0.1928
River shiner	**2.209**	**0.0288**	**2.382**	**0.0189**	1.11	0.276
Sand shiner	-0.288	0.7737	-1.075	0.2847	-0.642	0.5225
Shovelnose sturgeon	1.343	0.1805	0.917	0.36	-0.762	0.448
Silver chub	**2.81**	**0.0064**	-0.795	0.4328	**-2.537**	**0.0134**

Table III.7.7. Results for analysis of species catch per unit effort (CPUE) at Kansas Bend from 2006 - 2008. Effort for each gear is defined as: electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Push trawl was not used in 2006. A Kruskal-Wallis test was used to determine differences in CPUE of a species by gear between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

		2006 v 2007		2006 v 2008		2007 v 2008	
Species	**Gear**	**$\chi2$**	**p-value**	**$\chi2$**	**p-value**	**$\chi2$**	**p-value**
Channel Catifsh	**EF**	0.096	0.7571	1.854	0.1734	1.222	0.2689
	HN	0.148	0.7002	2.932	0.0868	1.758	0.1849
	MF	0.609	0.4352	0.538	0.4634	0.09	0.7638
	OT	0.8	0.3712	0.018	0.08943	0.482	0.4873
	PT	NA	NA	NA	NA	0.105	0.7462
	SHN	0.238	0.6257	1.135	0.2867	2.199	0.1381
	TN	1	0.3173	1.058	0.3037	0	1
Emerald Shiner	**EF**	0.627	0.4283	1.041	0.3077	0.032	0.8577
	HN	0.98	0.3221	0.882	0.3476	0	1
	MF	3.687	0.0548	0.063	0.8017	1.374	0.2411
	OT	0	1	**6.132**	**0.0133**	**5.167**	**0.023**
	PT	NA	NA	NA	NA	0.109	0.7416
	SHN	1.02	0.3126	0	1	0.941	0.332
Flathead Catfish	**EF**	1.683	0.1945	1.509	0.2193	**4.927**	**0.0264**
	HN	0.482	0.4876	0.666	0.4146	0.017	0.8957
	MF	1.094	0.2956	0.313	0.5762	0	1
	OT	0.022	0.8829	0.511	0.4745	0.272	0.602
	PT	NA	NA	NA	NA	0.984	0.3212
	SHN	0.758	0.3839	3.497	0.0615	0.84	0.3595
Freshwater Drum	**EF**	0.118	0.7316	0.706	0.4008	0.117	0.732
	HN	2.685	0.1006	1.546	0.2137	0.16	0.689
	MF	0.013	0.9082	0.0004	0.9835	0.002	0.9688
	OT	2.787	0.0951	0.142	0.7067	3.597	0.0579
	PT	NA	NA	NA	NA	0.336	0.562
	SHN	1.464	0.2262	0.01	0.9191	1.132	0.2874
River Shiner	**EF**	0	1	1.091	0.2963	0.818	0.3657
	MF	0.034	0.8529	0.061	0.805	0.024	0.8758
	OT	0.838	0.36	0.865	0.3524	0	1
	PT	NA	NA	NA	NA	2.613	0.106
Shovelnose Sturgeon	**EF**	0.76	0.3835	4.232	0.0397	1.284	0.2571
	HN	0.006	0.9267	0.065	0.7993	0.064	0.7998
	MF	0.914	0.339	0	1	0.286	0.593
	OT	4.23	0.0397	**5.909**	**0.0151**	0.406	0.5238
	SHN	**5.438**	**0.0197**	0.043	0.8353	4.166	0.0412
	TN	2.667	0.1025	0.003	0.9557	2.543	0.1108
Sand Shiner	**MF**	1.725	0.1891	0.01	0.9192	1.084	0.2978
	OT	0.838	0.3609	0.865	0.3524	0	1
	PT	NA	NA	NA	NA	2.199	0.1381

Table III.7.7 continued. Results for analysis of species catch per unit effort (CPUE) at Kansas Bend from 2006 - 2008. Effort for each gear is defined as: electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Push trawl was not used in 2006. A Kruskal-Wallis test was used to determine differences in CPUE of a species by gear between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

		2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**Gear**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**
Silver Chub	**EF**	1.333	0.2482	0	1	1.222	0.2689
	MF	**9.74**	**0.0018**	2.974	0.0846	0	1
	OT	**6.798**	**0.0091**	3.859	0.0495	0.412	0.5211
	PT	NA	NA	NA	NA	0.351	0.5533

Table III.7.8. Species monthly catch per unit effort (± 2 SE) at Kansas Bend from 2006 - 2008. Effort for each gear is defined as: bag seine (BS), fish caught per 50 m^2 seined; electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4’ hoop nets (HN), fish caught per net night; 2’ hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8’ and 16’ otter trawls (OT), fish caught per 100 m trawled; and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Bag seines were only used in 2006. Push trawls were not used in 2006.

		April			May			June			July			August			September			October		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Channel Catfish	**BS**	1.57 (1.39)			0.55 (1.10)			1.99 (0.00)														
	EF							1.77 (2.32)										1.07 (2.14)				
	MF	2.25 (1.71)	1.20 (1.94)			0.50 (1.00)					0.14 (0.29)			0.25 (0.50)	0.67 (0.67)	1.50 (3.00)	0.20 90.40)			0.33 90.67)		
	HN	0.13 (0.25)	0.13 (0.25)	0.88 (0.70)		0.14 (0.29)			0.38 (0.53)	0.20 (0.40)	0.38 (0.75)		0.14 (0.29)		0.29 (0.57)	0.38 (0.53)	0.13 (0.25)			0.25 (0.50)		
	SHN	0.63 (0.53)	0.25 (0.33)	0.13 (0.25)	0.13 (0.25)	0.63 (1.00)	0.29 (0.37)	0.13 (0.25)	0.56 (1.11)	2.14 (2.37)	0.13 (0.25)			0.38 (0.75)	0.13 (0.25)	0.75 (0.82)			0.38 (0.75)			
	PT	4.57 (3.73)	37.50 (75.00)			76.98 (150.04)					0.79 (1.59)			9.35 (5.54)				0.76 (1.520		5.42 (4.17)		
	OT	1.19 (1.39)	0.20 (0.40)	0.12 (0.25)				0.37 (0.47)		0.33 (0.67)	2.04 (1.06)	1.23 (1.87)	0.87 (1.15)			2.37 (2.73)	0.09 (0.18)	0.73 (1.45)	2.18 (2.39)	0.34 (0.33)	1.37 (0.83)	
	TN				0.60 (1.19)																	
Emerald Shiner	**BS**	7.46 (14.91)			5.28 (5.09)			13.93 (0.00)			0.96 (1.15)			3.14 (6.29)			29.54 (32.20)			8.74 (17.47)		
	EF	3.03 (3.53)			1.67 (3.33)						12.50 (25.00)				2.08 (2.80)	7.92 (13.01)				1.67 (3.33)		
	MF	0.50 (0.58)	0.40 (0.80)	1.00 (2.00)	1.00 (2.00)	5.67 (5.95)	3.00 (6.00)		0.88 (1.16)		336.86 (609.64)	0.13 (0.25)	0.50 (1.00)		2.00 (2.00)	3.50 (3.00)	98.60 (192.24)	0.33 (0.67)		2.00 (2.00)		
	HN																0.13 (0.25)					
	SHN								0.11 (0.22)													
	PT		4.31 (6.80)				24.00 (48.00)		4.76 (6.71)			2.38 (4.76)	102.89 (205.72)		2.31 (3.66)	2.13 (4.26)		1.31 (2.61)	5.44 (10.87)		2.50 (5.00)	
	OT									0.17 (0.33)			0.45 (0.56)			1.26 (1.98)						
Flathead Catfish	**EF**	3.53 (7.06)			3.34 (3.37)	1.22 (2.45)	1.97 (3.95)	9.57 (8.61)	5.25 (7.67)		10.43 (11.97)	42.89 (24.88)	8.36 (5.97)	6.01 (7.21)	11.67 (12.54)	21.18 (21.93)	3.91 (5.38)	13.50 (17.82)				
	MF										0.29 (0.57)											
	HN	0.13 (0.25)		0.25 (0.50)		1.00 (1.16)	0.29 (0.37)	0.57 (0.86)	0.13 (0.25)	0.40 (0.80)	0.38 (0.53)	0.25 (0.50)		0.38 (0.53)	0.14 (0.29)	0.13 (0.25)	0.25 (0.33)	0.13 (0.25)	0.13 (0.25)	0.25 (0.50)		
	SHN	0.13 (0.25)		0.25 (0.50)	0.25 (0.33)	0.38 (0.37)	0.29 (0.57)	1.00 (1.25)	0.89 (1.13)	2.14 (1.41)	0.13 (0.25)	0.17 (0.33)	0.14 (0.29)	0.25 (0.33)	1.63 (1.25)	0.75 (0.73)		0.25 (0.33)	0.88 (0.59)	0.50 (1.00)		
	PT		0.74 (1.47)												0.39 (0.78)							
	0T			0.12 (0.25)							0.10 (0.20)					0.07 (0.13)				0.12 (0.25)		

Table III.7.8 continued. Species monthly catch per unit effort (± 2 SE) at Kansas Bend from 2006 - 2008. Effort for each gear is defined as: bag seine (BS), fish caught per 50 m^2 seined; electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled; and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Bag seines were only used in 2006. Push trawls were not used in 2006.

		April			May			June			July			August			September			October		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Freshwater Drum	**BS**							15.92 (0.00)						0.10 (0.19)			2.59 (5.18)					
	EF	1.36 (2.73)		4.27 (4.21)	1.99 (2.65)			0.50 (1.00)	2.35 (3.14)		2.68 (3.52)	1.39 (2.79)		0.89 (1.79)		2.62 (3.38)	1.25 (2.50)	3.65 (3.61)		5.83 (6.87)		2.26 (4.51)
	MF	0.25 (0.50)							0.13 (0.25)		0.57 (0.60)	0.63 (0.53)	1.00 (2.00)	0.50 (0.58)	1.00 (2.00)	0.50 (1.00)	0.20 (0.40)				0.50 (1.00)	
	HN	0.13 (0.25)	0.13 (0.25)	0.13 (0.25)		0.43 (0.60)	0.29 (0.37)	0.14 (0.29)		0.20 (0.40)	0.13 (0.25)	0.50 (0.38)	0.29 (0.37)								0.25 (0.50)	
	SHN					0.13 (0.25)			0.11 (0.22)	0.29 (0.57)	0.13 (0.25)		0.14 (0.29)		0.38 (0.53)			0.13 (0.25)		0.25 (0.50)		
	PT		1.47 (2.94)						4.21 (5.26)			1.11 (2.22)	17.82 (25.89)		5.21 (10.42)						3.33 (6.67)	
	OT							0.07 (0.14)		0.68 (1.35)	0.23 (0.22)	0.36 (0.72)	0.10 (0.20)	0.16 (0.32)		1.40 (1.94)				0.08 (0.16)		
River Shiner	**BS**	2.63 (5.26)			0.55 (1.10)			0.25 (0.88)			1.63 (2.43)									0.95 (1.90)		
	EF															1.65 (3.30)						
	MF					6.50 (6.65)		0.17 (0.33)	1.00 (1.13)		121.86 (239.08)	0.38 (0.75)	2.50 (1.00)	2.00 (2.45)			2.00 (3.10)					
	PT		0.89 (1.79)				14.00 (28.00)					1.11 (2.22)	8.65 (17.31)						2.17 (4.35)			
	OT													0.08 (0.16)								
Shovelnose Sturgeon	**EF**			1.22 (2.43)									1.19 (2.39)		2.50 (5.00)	1.30 (2.59)		1.30 (2.59)	12.43 (19.65)	2.50 (5.00)		
	MF								0.13 (0.25)													
	HN	10.38 (11.55)	0.50 (0.76)	5.13 (9.97)	0.88 (1.22)	0.43 (0.40)	4.14 (6.65)	0.71 (0.72)	0.63 (0.53)	1.00 (1.55)	0.75 (1.24)	1.38 (1.65)	0.43 (0.60)	0.38 (0.37)	0.43 (0.40)	0.88 (0.96)	0.25 (0.50)	0.25 (0.33)	0.25 (0.50)		0.25 (0.50)	0.67 (0.67)
	SHN	1.63 (1.69)	0.25 90.33)	3.25 (5.40)	1.00 (1.00)	0.50 (0.76)	2.00 (1.45)	0.25 (0.50)	0.22 (0.29)	0.29 (0.37)	1.50 (1.25)	0.17 (0.33)	0.14 (0.29)	0.13 (0.25)	0.13 (0.25)	0.88 (0.96)	0.38 (0.75)	0.13 (0.25)	0.38 (0.53)	1.00 (0.82)	0.50 (1.00)	0.25 (0.50)
	OT							0.07 (0.14)	0.49 (0.52)	0.17 (0.34)	0.31 (0.43)	0.40 (0.55)	1.14 (1.15)	0.08 (0.16)		2.00 (1.30)		0.49 (0.44)	0.16 (0.32)		1.32 (2.18)	0.59 (0.74)
	TN	0.83 (1.09)		4.29 (5.71)				1.15 (1.63)			0.69 (1.39)	1.65 (3.29)							3.50 (3.57)			

Table III.7.8 continued. Species monthly catch per unit effort (± 2 SE) at Kansas Bend from 2006 - 2008. Effort for each gear is defined as: bag seine (BS), fish caught per 50 m^2 seined; electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled; and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Bag seines were only used in 2006. Push trawls were not used in 2006.

		April			May			June			July			August			September			October		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Sand Shiner	**BS**	1.75			0.36			7.96			6.64						2.53			2.91		
		(3.51)			(0.72)			(0.00)			(13.27)						(5.05)			(5.83)		
	MF	1.00	0.20		0.33	2.67	0.50	0.67	1.00		43.57	0.13	1.50			7.50	0.80	0.67		5.67		
		(1.16)	(0.40)		(0.67)	(3.49)	(1.00)	(1.33)	(1.25)		(71.69)	(0.25)	(3.00)			(5.00)	(1.60)	(1.33)		(4.67)		
	PT						168.00		2.40				24.04		1.92	6.38			2.17		2.50	
							(336.00)		(3.36)				(48.08)		(3.85)	(12.77)			(4.35)		(5.00)	
	OT							0.06														
								(0.12)														
Silver Chub	**BS**	0.88			0.55			19.90						1.43			2.59					
		(1.75)			(1.10)			(0.00)						(1.44)			(5.18)					
	EF																	1.42				
																		(2.84)				
	MF							1.33			0.71			1.00						0.67		
								(1.76)			(0.72)			(1.41)						(1.33)		
	PT		2.94	8.75			9.96		16.00			1.11	3.66		4.03						2.50	
			(4.16)	(17.50)			(12.08)		(32.00)			(2.22)	(7.32)		(7.07)						(5.00)	
	OT		0.11	0.24				0.13			1.52			0.98		0.39	0.07		0.31	0.07	0.30	
			(0.22)	(0.31)				(0.26)			(1.09)			(0.66)		(0.79)	(0.14)		(0.38)	(0.14)	(0.40)	

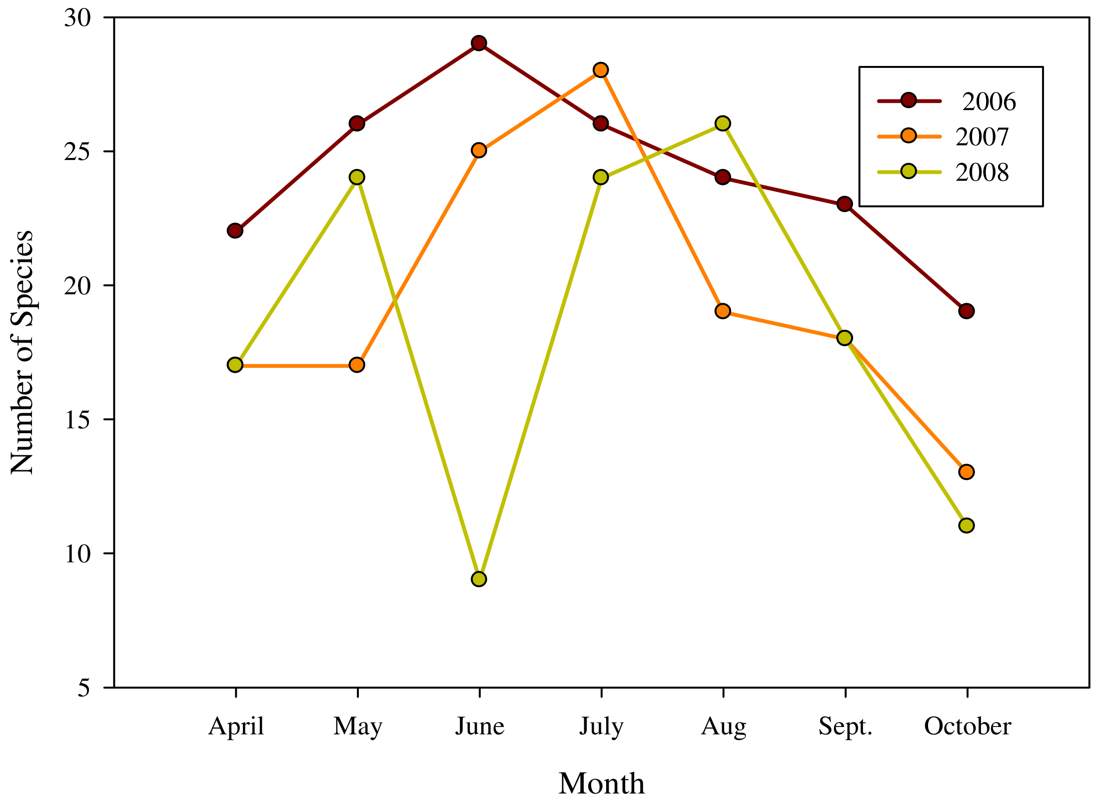


Figure III.7.1. Monthly species richness for Kansas Bend from 2006 – 2008.

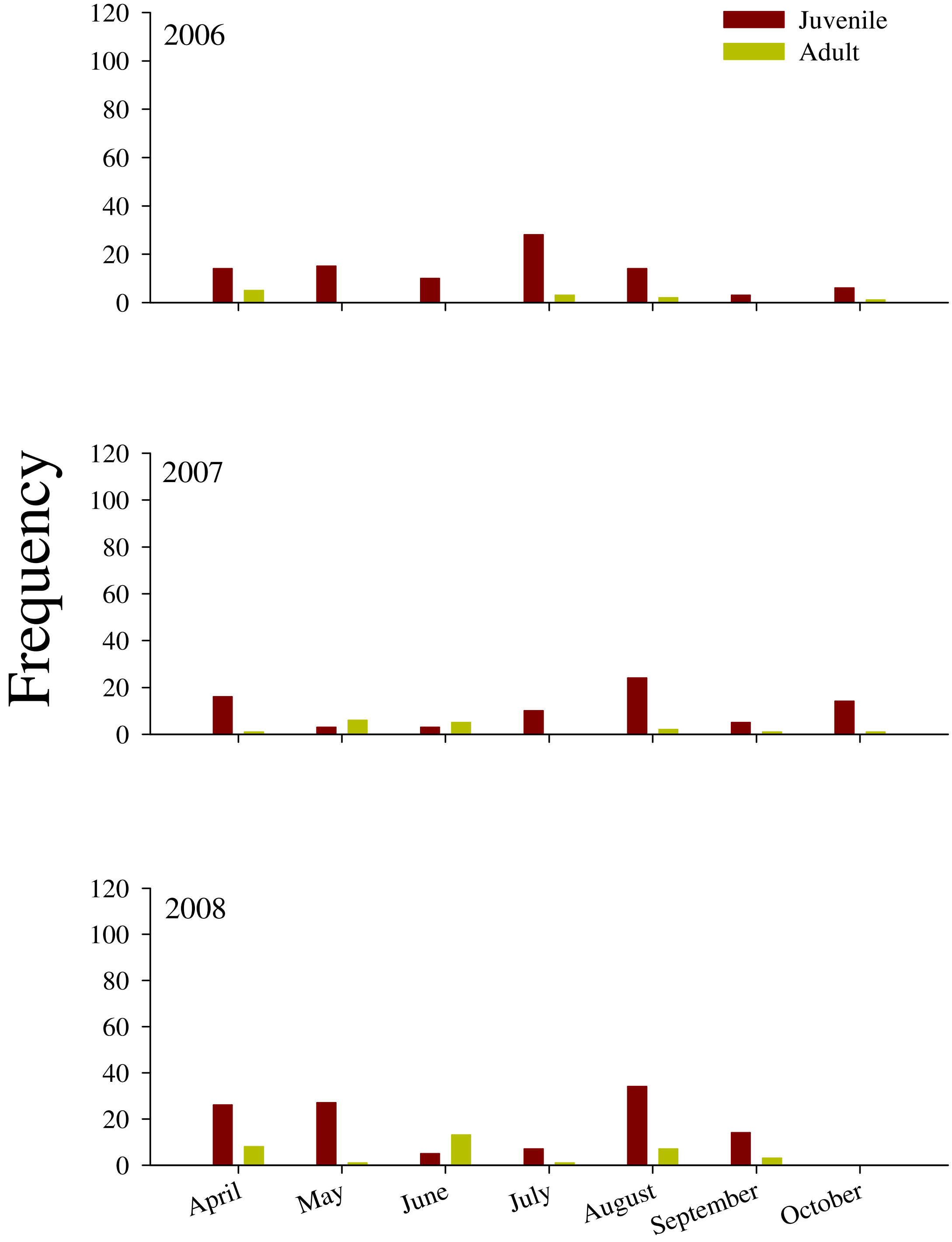


Figure III.7.2. Monthly frequency of juvenile (<305mm) and adult (≥305mm) channel catfish caught at Kansas Bend from 2006 - 2008.

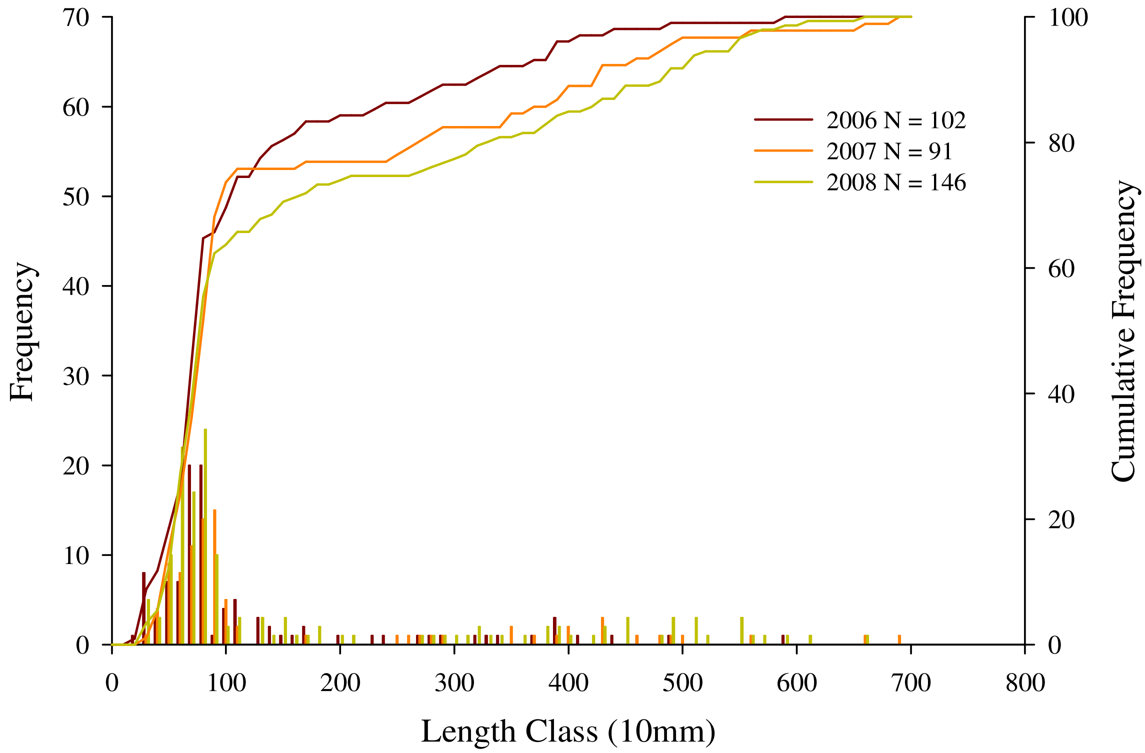


Figure III.7.3. Length frequency distributions and cumulative frequencies for measured channel catfish (N) at Kansas Bend from 2006 – 2008.

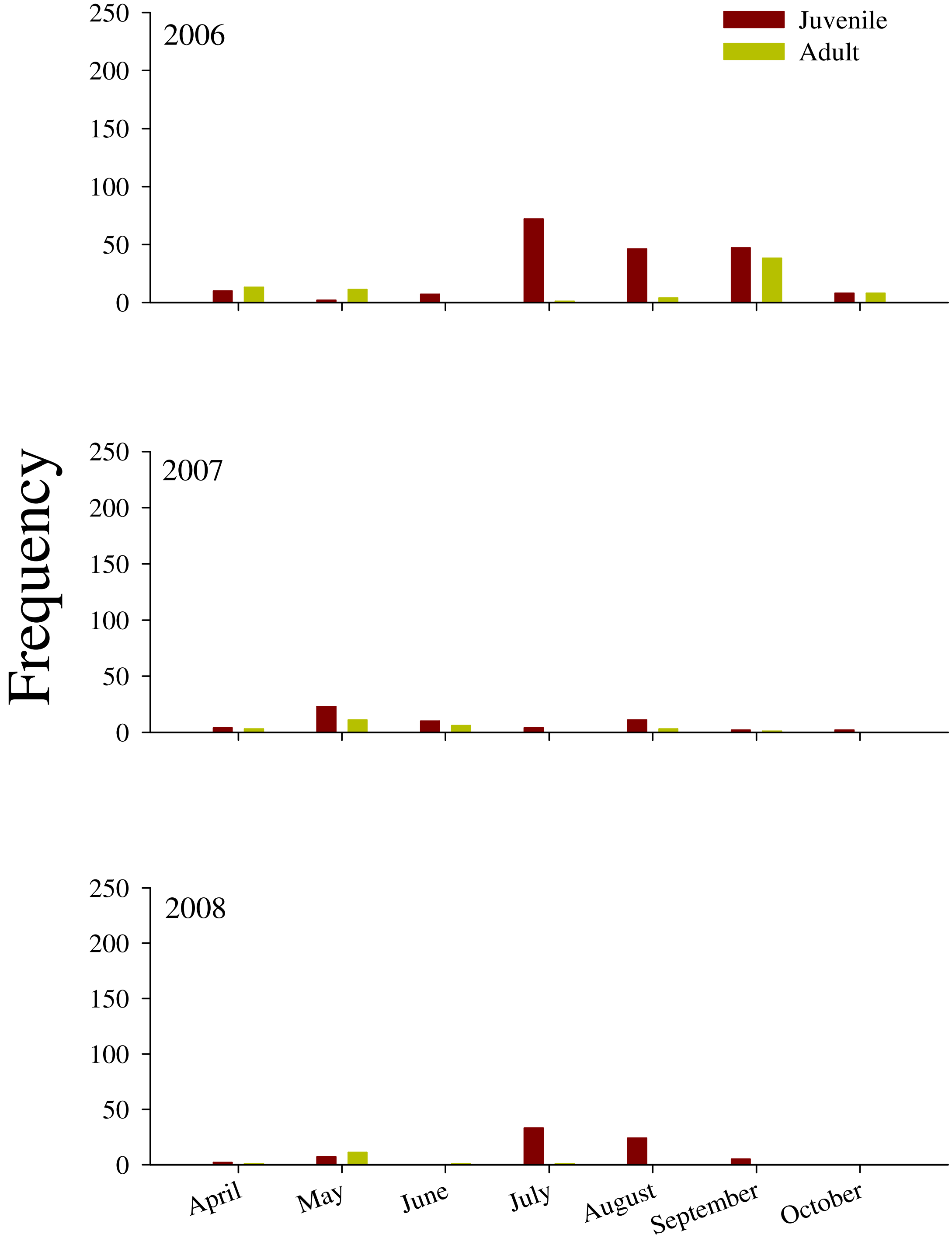


Figure III.7.4. Monthly frequency of juvenile (<64mm) and adult (≥64mm) emerald shiner caught at Kansas Bend from 2006 - 2008.

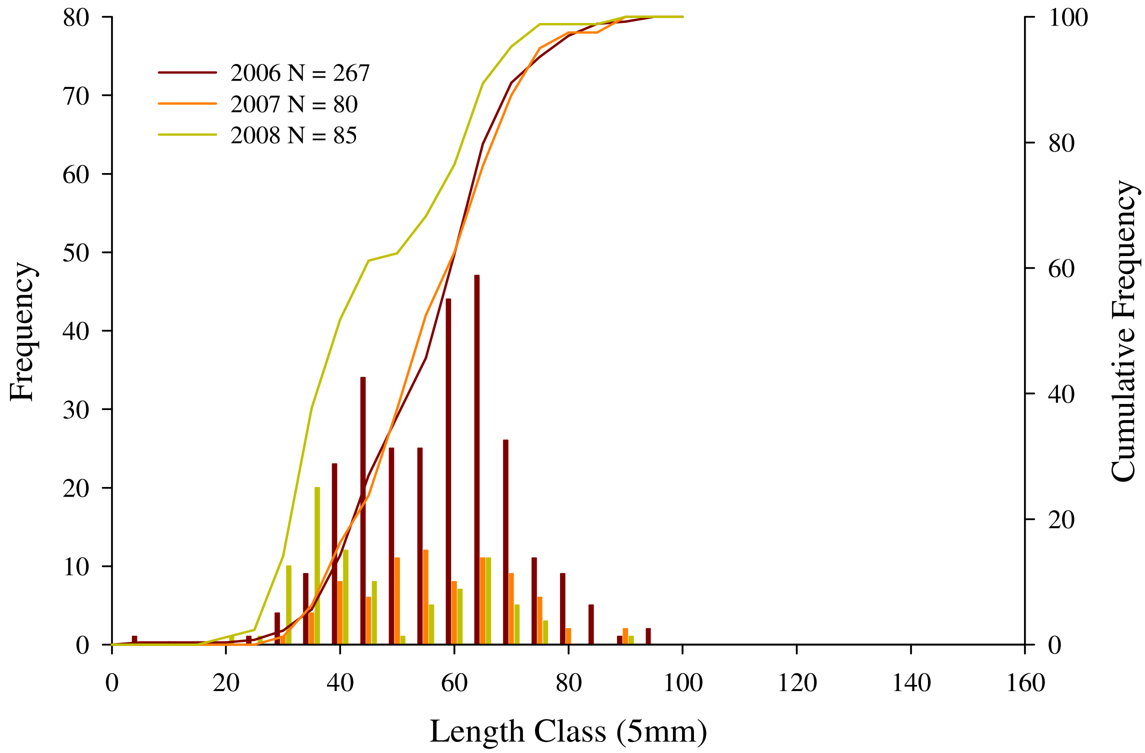


Figure III.7.5. Length frequency distributions and cumulative frequencies for measured emerald shiner (N) at Kansas Bend from 2006 – 2008.

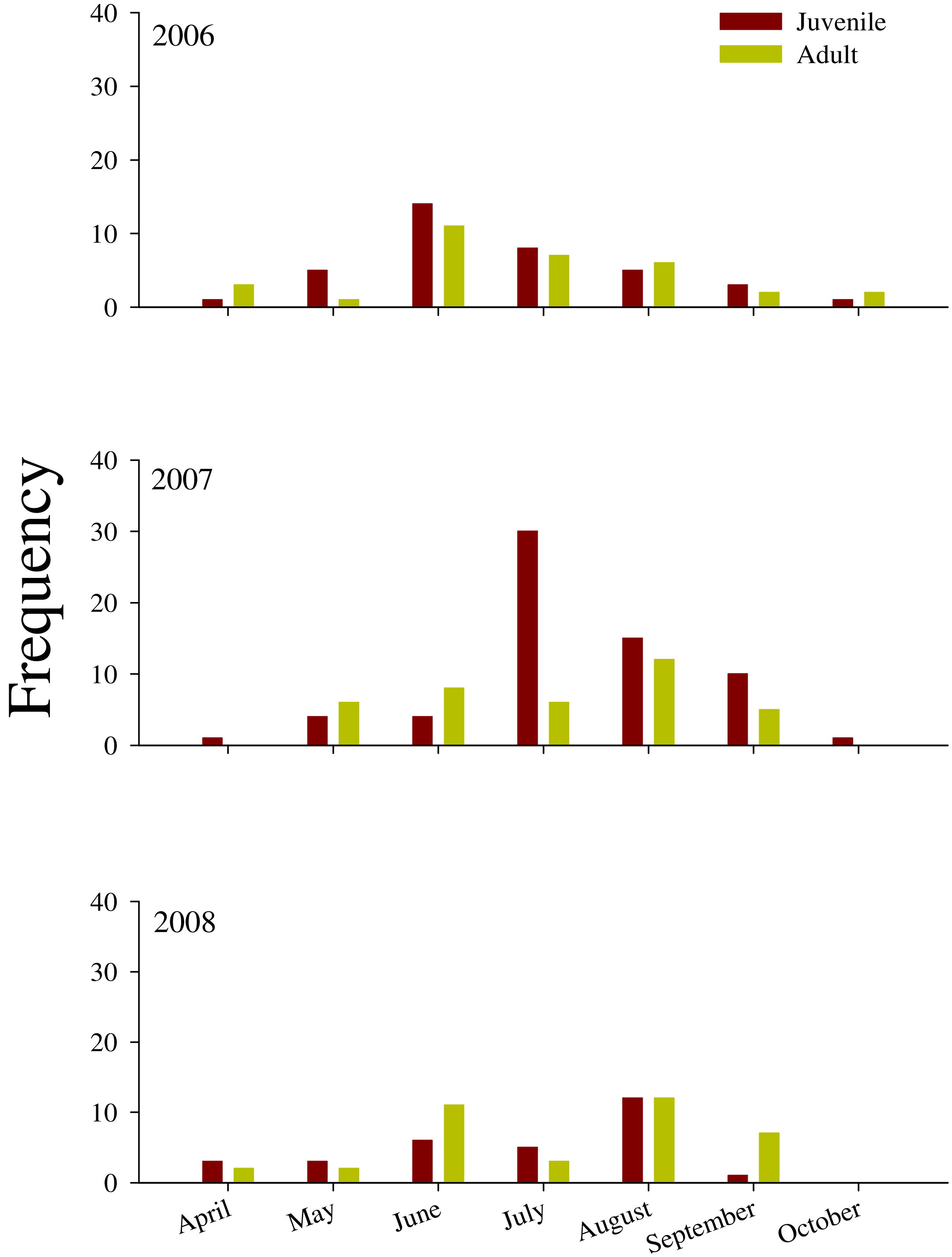


Figure III.7.6. Monthly frequency of juvenile (<381mm) and adult (≥381mm) flathead catfish caught at Kansas Bend from 2006 – 2008.

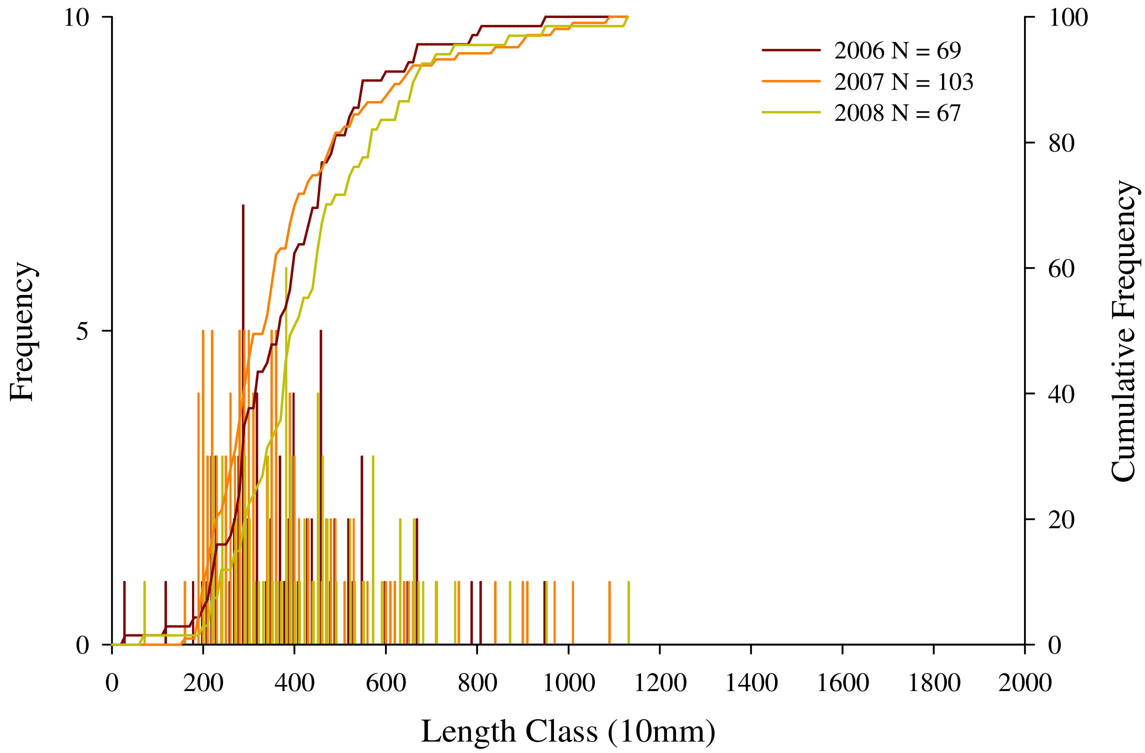


Figure III.7.7. Length frequency distributions and cumulative frequencies for measured flathead catfish (N) at Kansas Bend from 2006 – 2008.

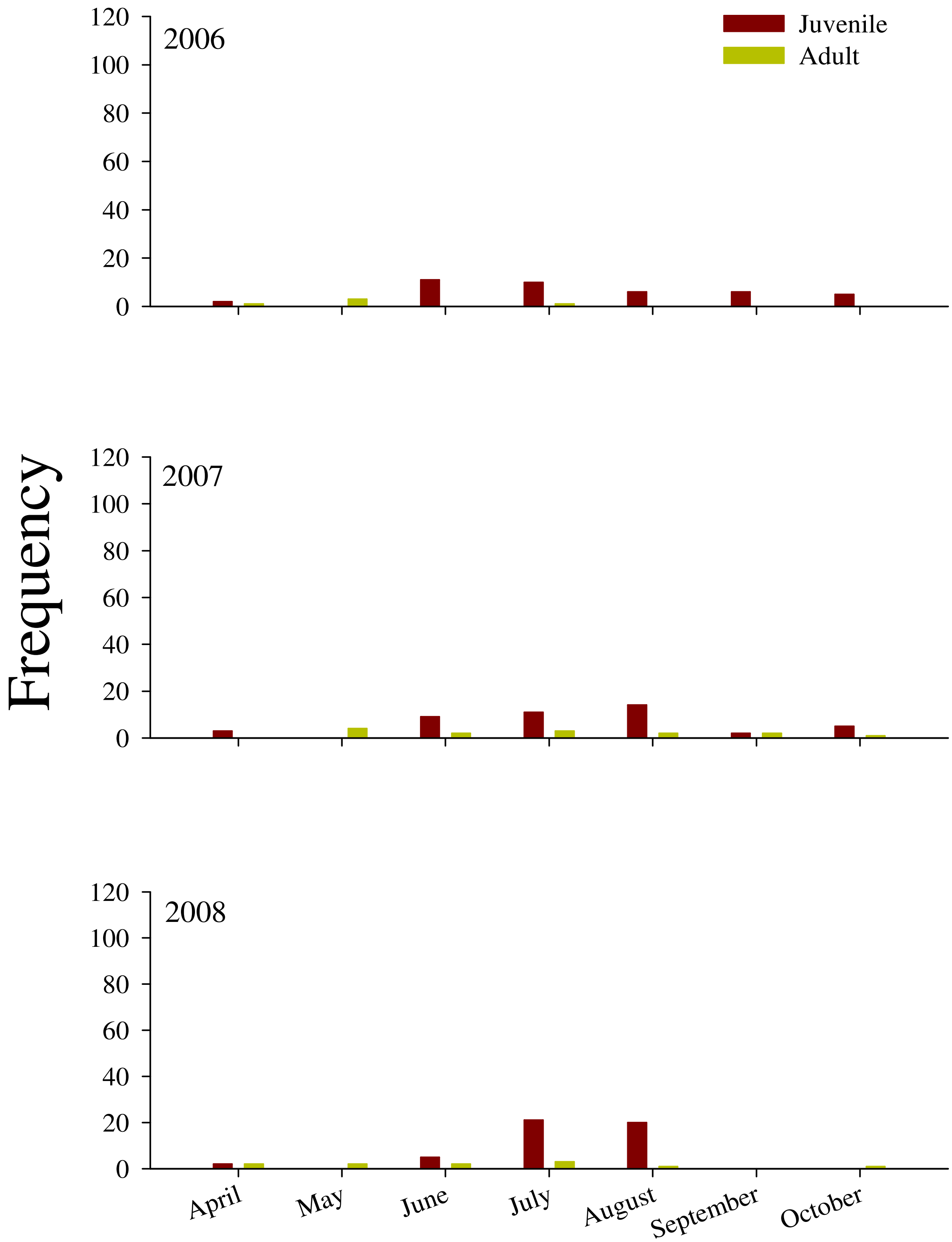


Figure III.7.8. Monthly frequency of juvenile (<305mm) and adult (≥305mm) freshwater drum caught at Kansas Bend from 2006 - 2008.

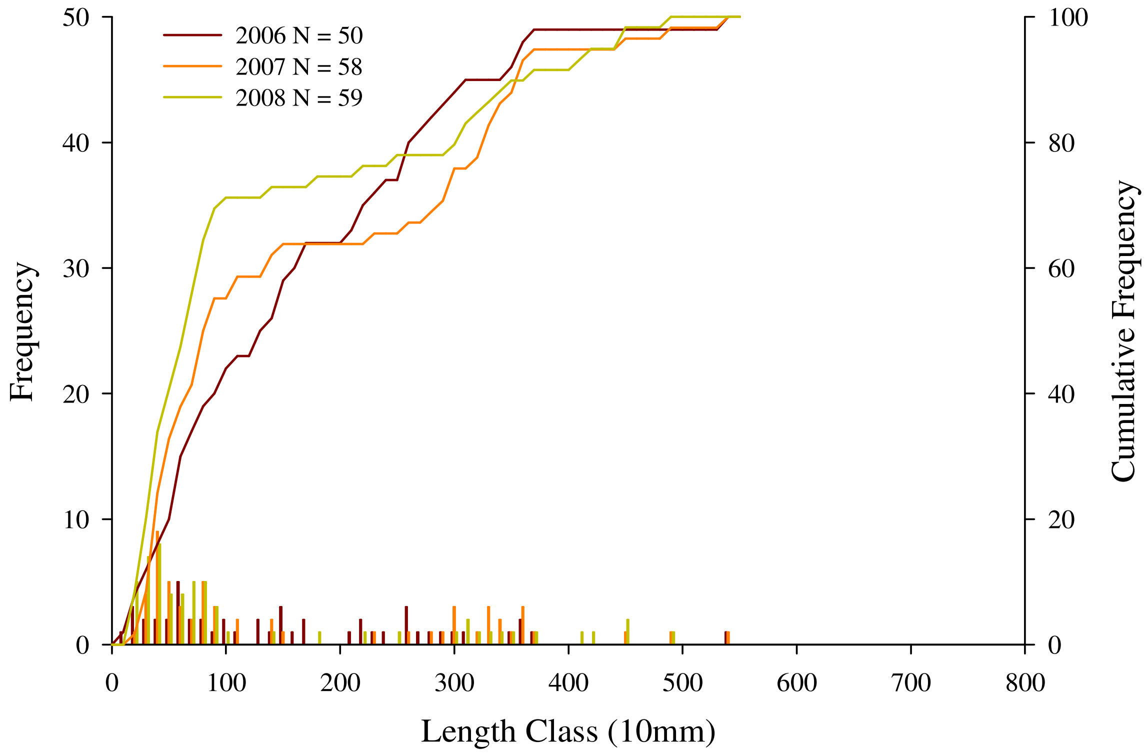


Figure III.7.9. Length frequency distributions and cumulative frequencies for measured freshwater drum (N) at Kansas Bend from 2006 – 2008.

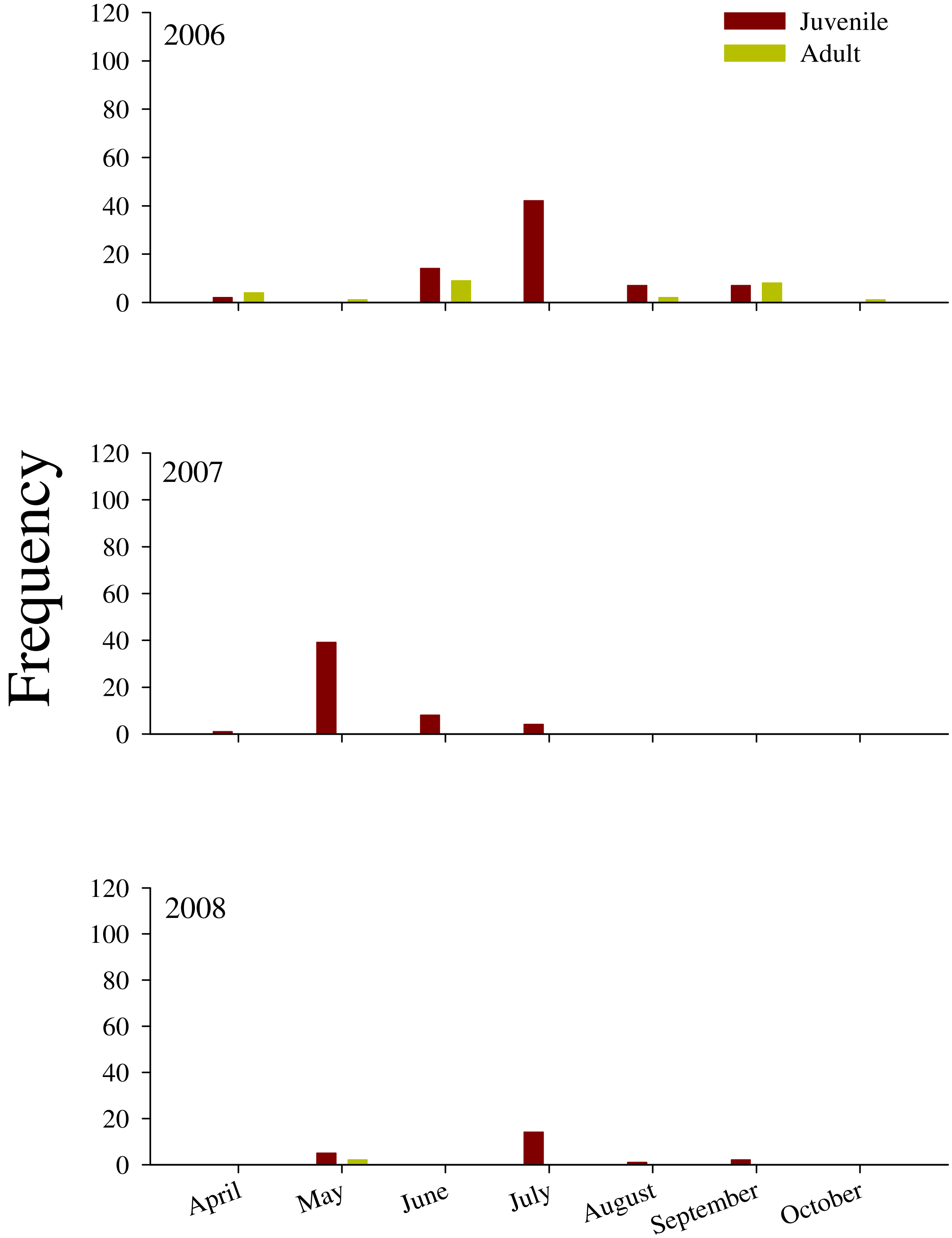


Figure III.7.10. Monthly frequency of juvenile (<51mm) and adult (≥51mm) river shiner caught at Kansas Bend from 2006 - 2008.

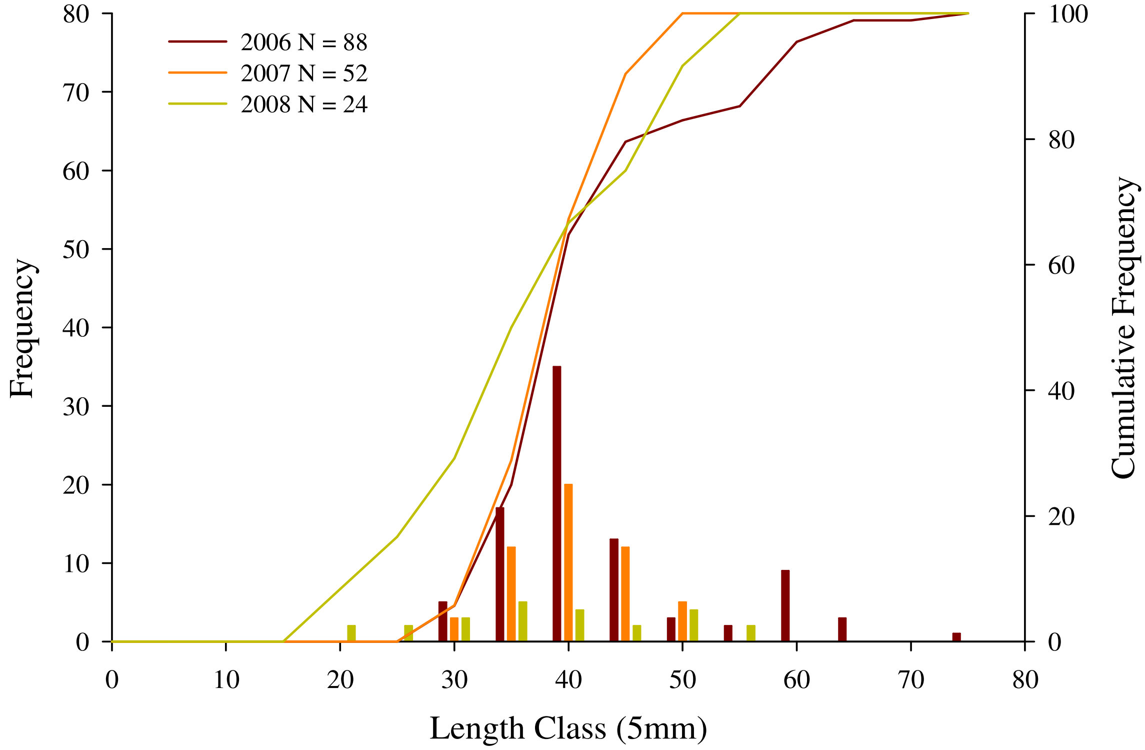


Figure III.7.11. Length frequency distributions and cumulative frequencies for measured river shiner (N) at Kansas Bend from 2006 – 2008.

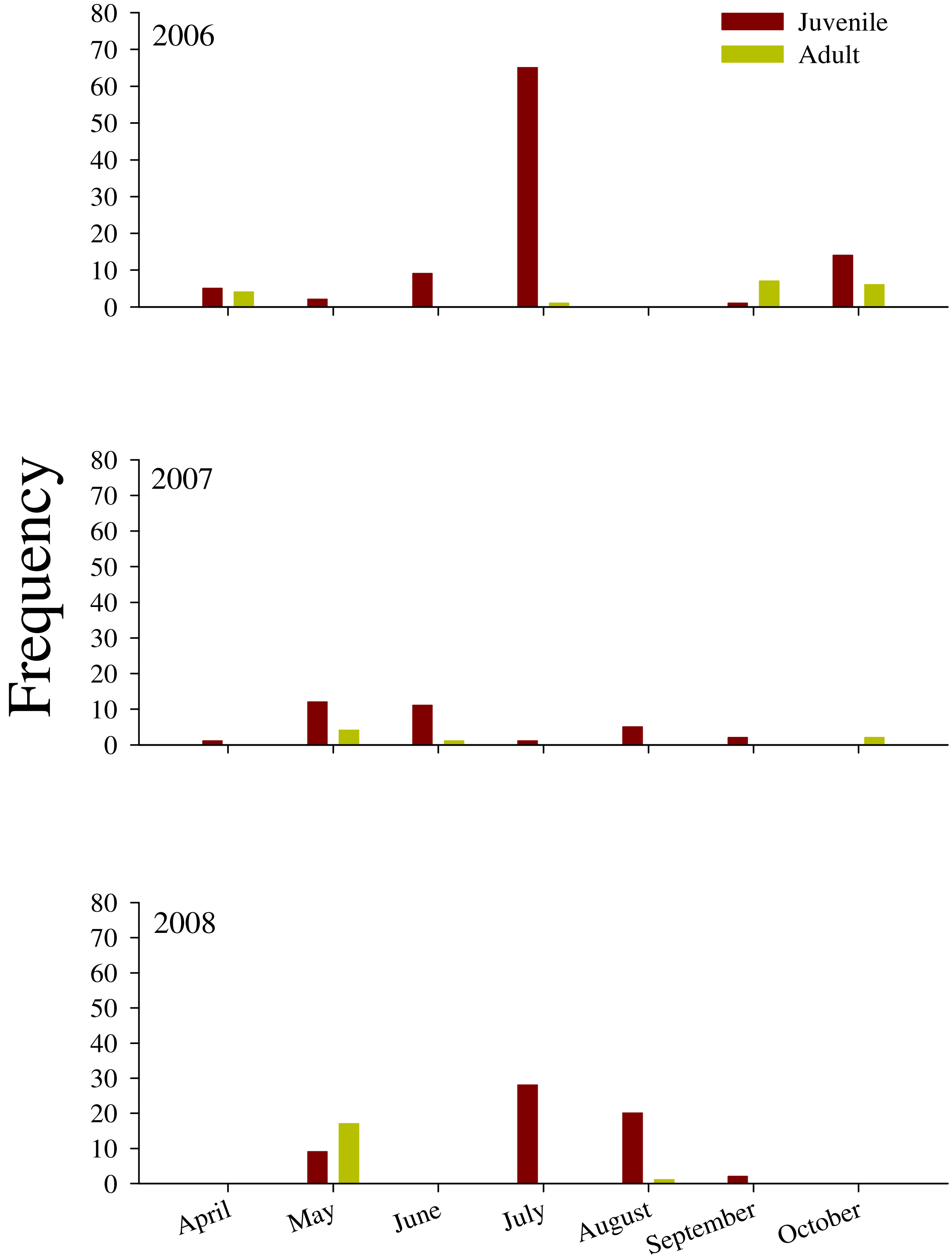


Figure III.7.12. Monthly frequency of juvenile (<43mm) and adult (≥43mm) sand shiner caught at Kansas Bend from 2006 - 2008.

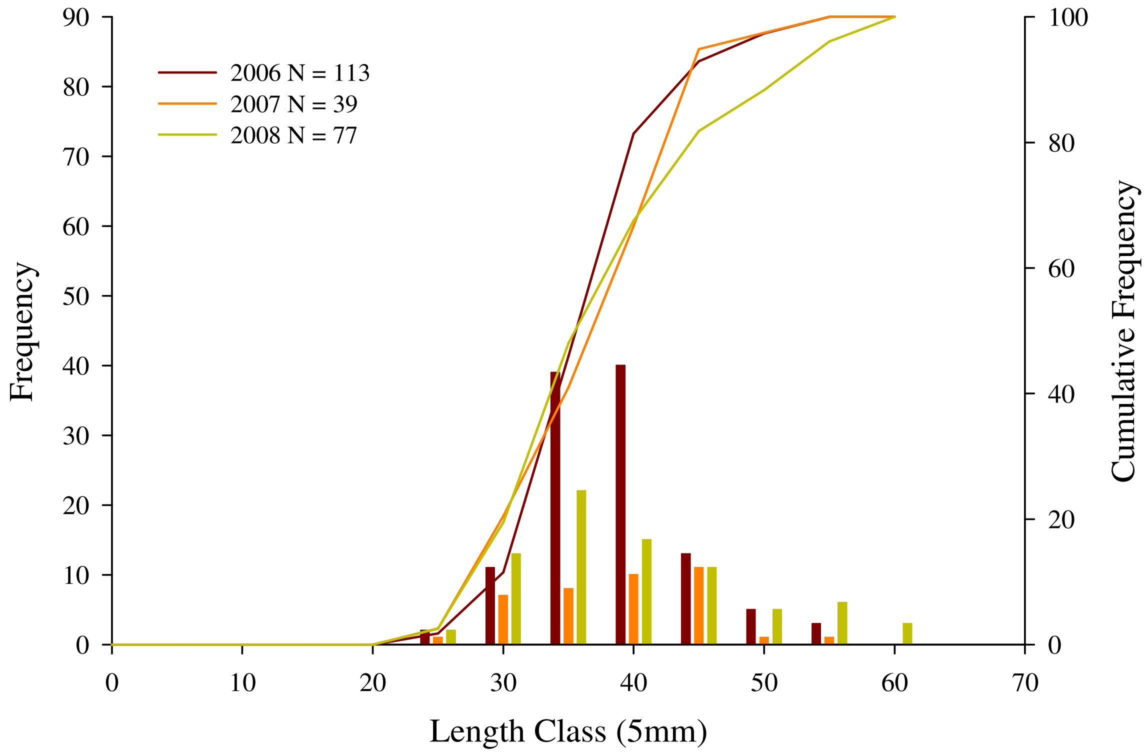


Figure III.7.13. Length frequency distributions and cumulative frequencies for measured sand shiner (N) at Kansas Bend from 2006 – 2008.

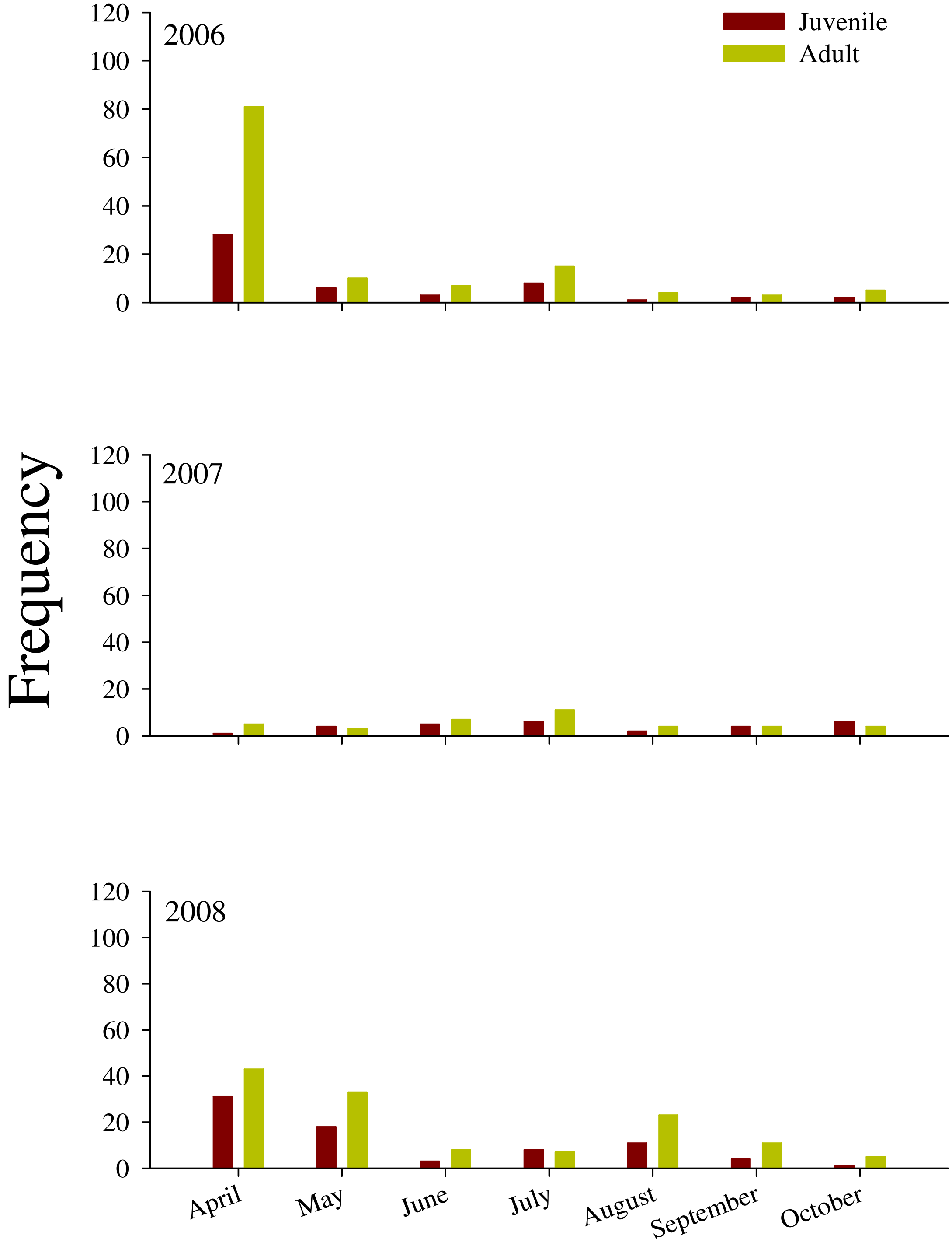


Figure III.7.14. Monthly frequency of juvenile (<540mm) and adult (≥540mm) shovelnose sturgeon caught at Kansas Bend from 2006 - 2008.

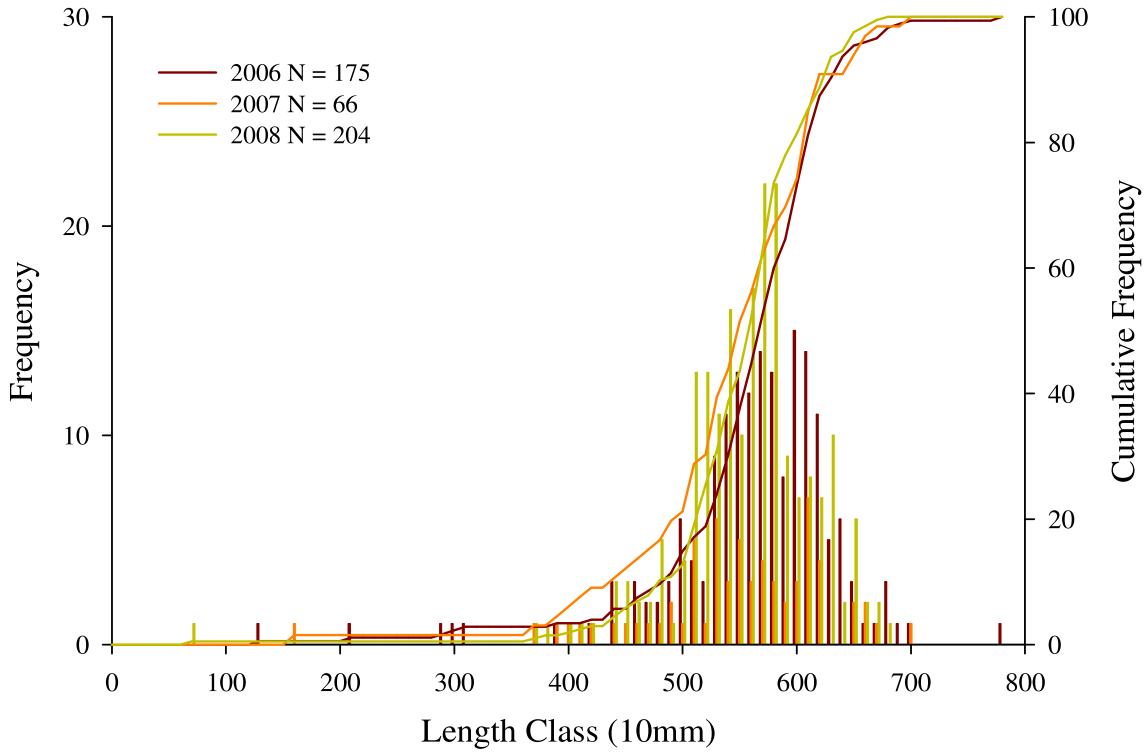


Figure III.7.15. Length frequency distributions and cumulative frequencies for measured shovelnose sturgeon (N) at Kansas Bend from 2006 – 2008.

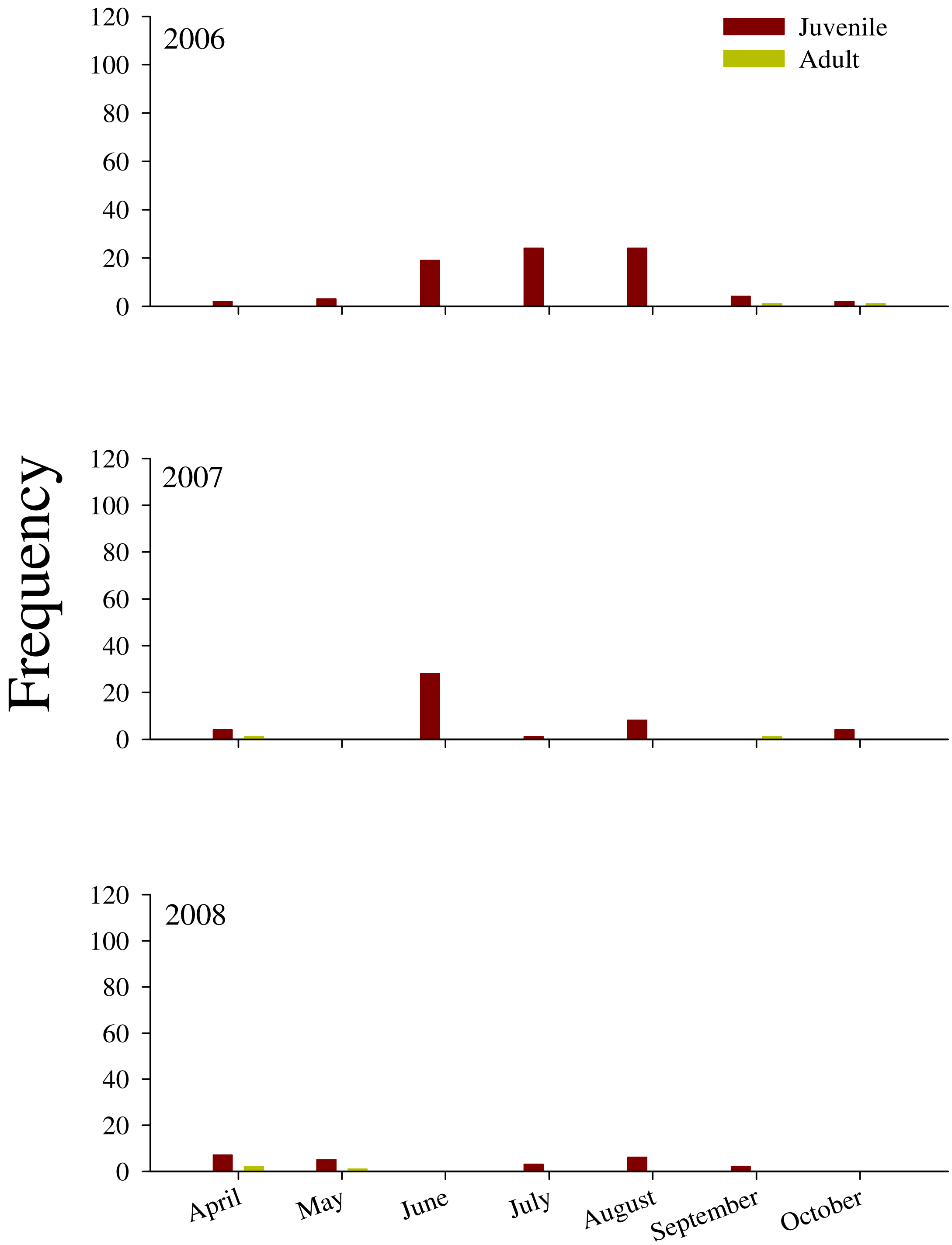


Figure III.7.16. Monthly frequency of juvenile (<89mm) and adult (≥89mm) silver chub caught at Kansas Bend from 2006 - 2008.

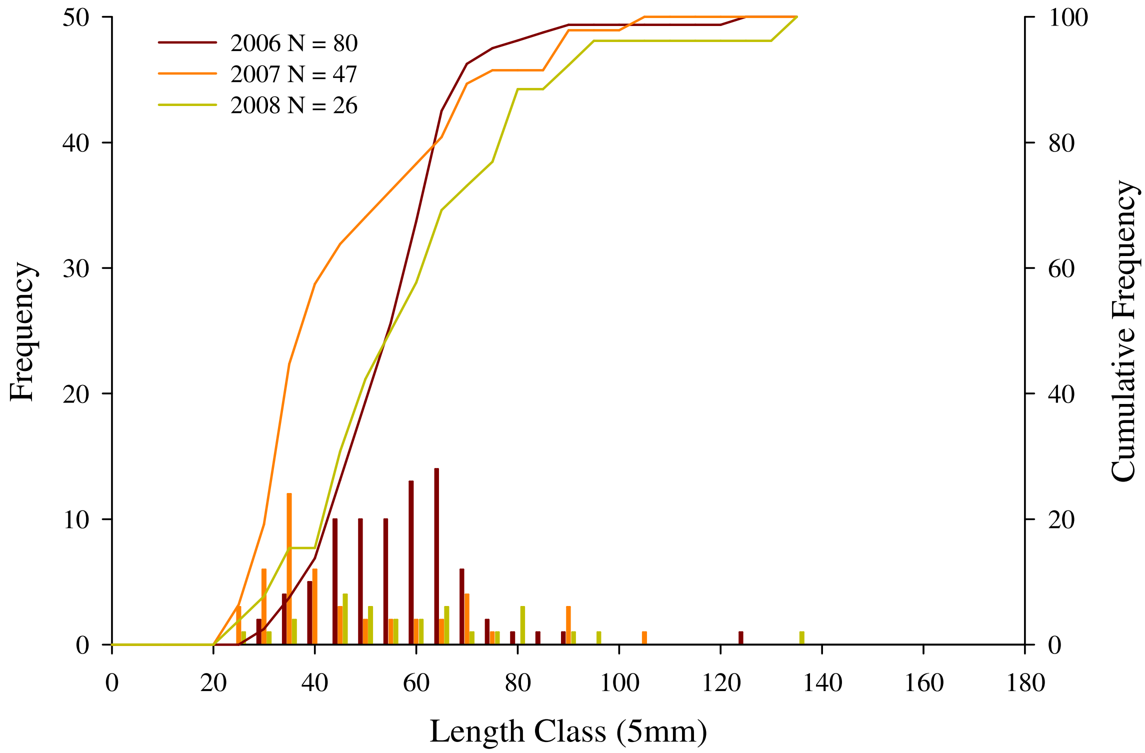
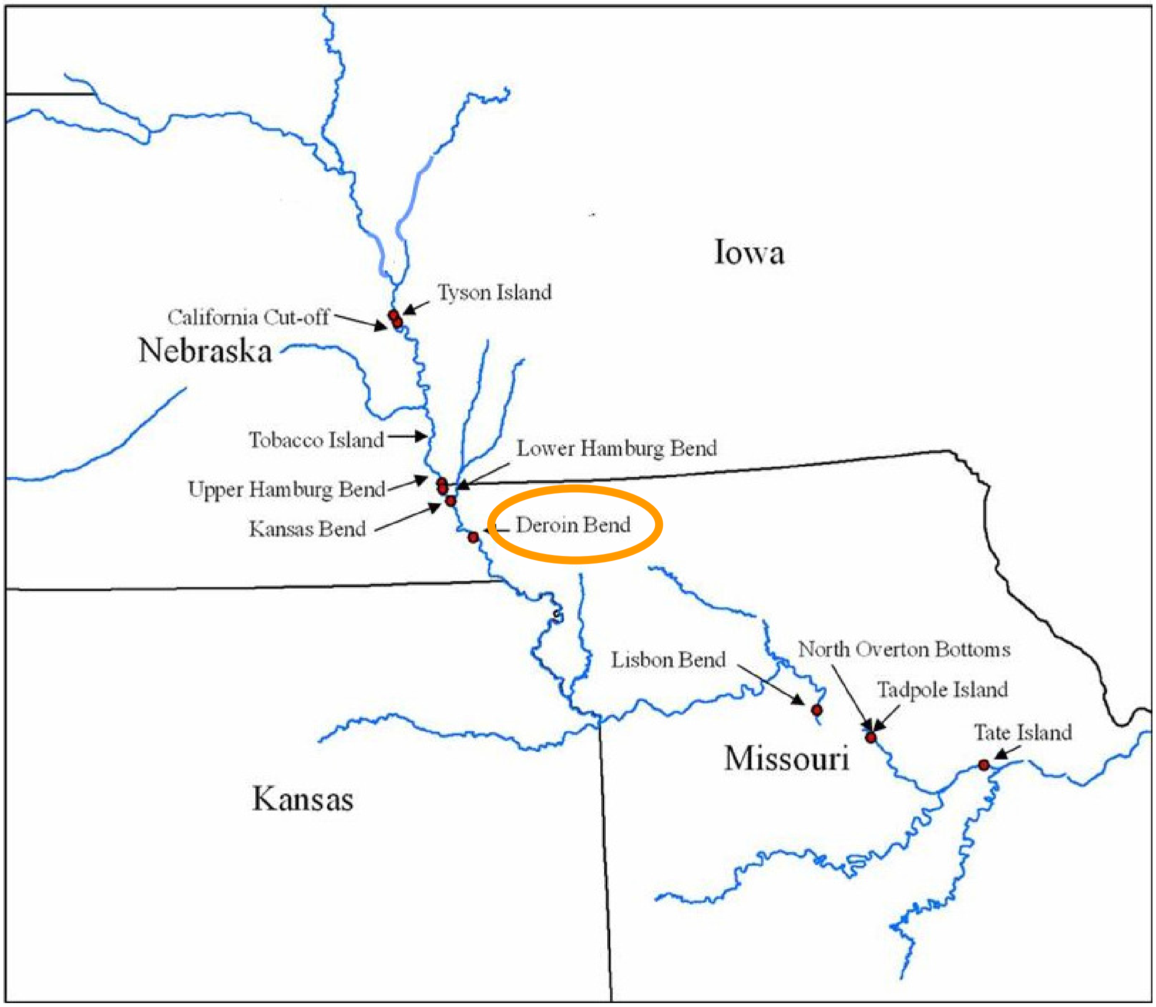


Figure III.7.17. Length frequency distributions and cumulative frequencies for measured silver chub (N) at Kansas Bend from 2006 – 2008.

Section III
Chapter 8
Deroin Bend



List of Tables

Table Page

List of Figures

Figure Page

A total of 5,930 fish comprising 50 different species was sampled in Deroin from 2006 to 2008. Of the total number of fish sampled, 149 fish were unidentified because of small size or poor condition. Sixty-nine percent of the total number of fish caught were juveniles. The highest number of fish (2,498) and greatest species diversity (41) was found during the 2008 sampling season, while the lowest number of fish (1,401) and lowest species diversity (36) were found during 2007. Species diversity ranged from 2.708 to 2.918 and evenness increased from 0.770 in 2006 to 0.8144 in 2007. Species richness was highest in 2008 (Table III.8.2). The fish community was similar between 2006 and 2007 but was neither similar nor dissimilar between 2007 and 2008 (Table III.8.3). Monthly species richness in 2006 was highest in August and September (26 species) and lowest in October (20 species). Monthly species richness in 2007 peaked in June and then dropped very low in October (Figure III.8.1). In 2008 species richness was its highest in the three years of sampling (32 species) during July.

Deroin was dominated by a handful of species: channel catfish, emerald shiner, freshwater drum, shovelnose sturgeon, and sand shiner. These fish accounted for over 50% of all fish sampled (Table III.8.1). Other species of interest were not sampled in as large of numbers. Only species that averaged 50 measured individuals a year were included in the analysis. There were no *Hybognathus* species sampled in Deroin. Only five sauger were sampled from 2006 to 2008. One pallid sturgeon was sampled in 2006. The fish was 422mm in length and had been previously tagged. Speckled chub were most prevalent in 2006 with 64 of the 119 sampled caught in that year. Sturgeon chub were also found in higher numbers in 2006 (72 fish) while only 1 was sampled in 2007.

From 2006 to 2008 102 sturgeon chub were sampled. A total of 114 blue suckers were caught in Deroin with the majority being sampled in 2008.

Channel catfish

A total of 603 channel catfish was sampled with 2006 having the highest number of fish (269) and 2007 having the lowest number (161). Length-frequency distributions were different between 2007 and all other years (Table III.8.5). Mean lengths were similar among all years and ranged from 108mm to 123mm (Table III.8.6). The majority of channel catfish sampled in each year were juveniles (91.3% - 94.2%) and did not differ from year to year (Table III.8.4). Juvenile channel catfish use was highest from July through September for most years (Figure III.8.2). Catch per unit effort was similar among years (Table III.8.7). Push trawls and electrofishing had the highest catch per unit efforts for channel catfish (Table III.8.8). August was the best month for push trawls and October for electrofishing.

Common carp

A total of 207 common carp was sampled. In 2007 the highest number of common carp were sampled (80 fish) while in 2006 the lowest number were sampled (48 fish). Length-frequency distributions were different among all years (Table III.8.5). Mean length decreased from 540mm in 2006 to 248mm in 2007 and then increased to 418mm in 2008 resulting in significant differences (Table III.8.6). Common carp sampled tended to be adults but juvenile use was highest in June for most years (Figure III.8.4). The percentage of juvenile common carp was significantly different among all

years ranging from 4.2% in 2006 to 56.3% in 2007 and 24.1% in 2008 (Table III.8.4). Mini-fyke net catch per unit effort (CPUE) was different between 2006 and 2007 (Table III.8.7). Otter trawl CPUE was different between 2006 and 2008 (Table III.8.7). Most common carp were sampled by electrofishing. The best months for electrofishing were April, May and September (Table III.8.8).

Emerald shiner

A total of 810 emerald shiners was sampled with 600 fish being caught in 2008 while only 62 were caught in 2007. Length-frequency distributions in 2006 were different compared to the other years (Table III.8.5). Mean lengths decreased each year from 55mm in 2006 and 44mm in 2008 (Table III.8.6). Juvenile emerald shiner numbers peaked in July and August (Figure III.8.6). The percentage of juvenile emerald shiners significantly increased from 61.3% in 2006 to 90.9% in 2007 (Table III.8.4). Mini-fyke net CPUE was different between 2006 and 2007 (Table III.8.7). Emerald shiners were sampled most in push trawls and mini-fyke nets. Push trawl CPUE was highest in July and August while mini-fyke net CPUE was highest in August and September (Table III.8.8).

Flathead catfish

A total of 296 flathead catfish was sampled with most fish caught in 2006 (129) and the least number of fish in 2008 (60). Length-frequency distributions were different among all years (Table III.8.5). Mean lengths increased between 2006 and 2007 from 316mm to 396mm and then to 446mm in 2008 (Table III.8.6). Flathead catfish juvenile

use peaked in July (Figure III.8.8). The percentage of juvenile flathead catfish significantly decreased each year (78.3%, 55.1%, and 36.7%, respectively; Table III.8.4). Electrofishing CPUE was different between 2008 and all other years (Table III.8.7). Otter trawl CPUE was different between 2007 and 2008 (Table III.8.7). Flathead catfish were sampled best by electrofishing with the highest CPUE in July (Table III.8.8).

Freshwater drum

A total of 603 freshwater drum was sampled. Only 62 fish were sampled in 2007 while 364 freshwater drum were caught in 2006. Length-frequency distributions were different between 2006 and 2007 and between 2007 and 2008 (Table III.8.5). Mean length of freshwater drum increased from 88mm in 2006 to 139mm in 2007 and then decreased in 2008 to 114mm (Table III.8.6). The majority of freshwater drum were juveniles with a significant decrease in the percentage of juveniles from 98.2% in 2006 to 83.9% in 2007 (Table III.8.4). Juvenile use was highest between June and August (Figure III.8.10). Small hoop net CPUE was different between 2006 and 2007 (Table III.8.7). Electrofishing was the best gear for sampling freshwater drum with the highest CPUE in October (Table III.8.8).

River carpsucker

A total of 181 river carpsuckers was sampled with only 23 being caught in 2007 and the highest number (95 fish) in 2006. Length-frequency distributions were significantly different between 2006 and 2007 and also between 2006 and 2008 (Table III.8.5). Mean length significantly increased from 80mm in 2006 to 265mm in 2007 and

240mm in 2008 (Table III.8.6). River carpsucker juvenile use peaked during the month of July (Figure III.8.12). The percentage of juvenile river carpsuckers significantly decreased from 88.4% to 47.8% from 2006 to 2007 (Table III.8.4). Catch per unit effort was similar among years (Table III.8.7). River carpsuckers were sampled most by electrofishing. Electrofishing CPUE was highest in October (Table III.8.8).

Sand shiner

A total of 404 sand shiners was sampled with greatest numbers in 2008 (310 fish) and lowest numbers in 2007 (22 fish). Length-frequency distributions were similar among all years (Table III.5). Mean lengths ranged from 34mm to 36mm and were not significantly different (Table III.8.6). Juvenile sand shiners were sampled most in August and September (Figure III.8.14). The percentage of juvenile sand shiners were similar year to year and ranged from 87.9% to 90.9% (Table III.8.4). Catch per unit effort was similar among years (Table III.8.7). Sand shiners were caught most using mini-fyke nets with high catch per unit effort in September (Table III.8.8).

Shovelnose sturgeon

A total of 512 shovelnose sturgeon was sampled. The greatest numbers of shovelnose sturgeon were captured in 2008 with 214 and the lowest numbers were sampled in 2007 with 103. Length-frequency distributions were similar among all years (Table III.8.5). Mean lengths were significantly different between 2006 and 2007 decreasing from 550mm to 519mm (Table III.8.6). Shovelnose sturgeon were mainly adults year to year with anywhere between 35.9% to 48.5% being juveniles (Table

III.8.4). Juvenile shovelnose sturgeon numbers were highest from May to July (Figure III.8.16). Hoop net CPUE was different between 2006 and 2008 (Table III.8.7). Otter trawl, small hoop net and trammel net CPUEs were different between 2007 and 2008 (Table III.8.7). Small hoop nets were best at sampling shovelnose sturgeon with catch per unit effort being highest in May (Table III.8.8).

Silver chub

A total of 197 silver chubs was sampled. The highest number of silver chubs were sampled in 2006 (99 fish) and the lowest in 2008 (39 fish). Length-frequency distributions were different between 2006 and all other years (Table III.8.5). Mean lengths decreased from 62mm in 2006 to 46mm in 2007 and then increased to 64mm in 2008 (Table III.8.6). The majority of silver chubs sampled in a given year were juveniles (82.8% - 94.9%) with no differences between years (Table III.8.4). Silver chub juveniles were found to be highest from July through September (Figure III.8.18). Otter trawl CPUE was different between 2006 and 2007 and between 2007 and 2008 (Table III.8.7). Push trawls were the best gear for silver chubs with high catch per unit effort in July (Table III.8.8).

Key Findings

- 69% of all fish were juveniles.
- 2008 had the highest species richness.
- The fish community was more similar between 2006 and 2007.
- Species monthly richness was low in October for all years.

- 5 species accounted for 50% of the fish community (channel catfish, emerald shiner, freshwater drum, shovelnose sturgeon, and sand shiner).
- One pallid sturgeon was sampled in 2006 in the mouth of an associated backwater.
- Missouri River Recovery species of interest were sampled in low numbers or not at all (blue sucker, sauger, hybognathus sp., speckled chub, sturgeon chub, and pallid sturgeon).
- Common carp, shovelnose sturgeon and flathead catfish were predominantly adults.

Table III.8.1. Total species caught at Deroin Bend 2006-2008 and the percent of catch that each species represents. *Indicates a species that was used in analysis. †Indicates a species of note for this chute.

Species	Scientific name	2006	2007	2008	Total	%Catch
Bighead carp†	*Hypopthalmichthys nobilis*	0	2	13	15	0.259
Bullhead minnow†	*Pimephales vigilax*	0	0	2	2	0.035
Black bullhead	Ameiurus melas	0	0	3	3	0.052
Black crappie†	*Pomoxis nigromaculatus*	0	5	1	6	0.104
Brook silverside	*Labidesthes sicculus*	1	0	0	1	0.017
Blue catfish†	*Ictalurus furcatus*	15	54	77	146	2.526
Bluegill sunfish†	*Lepomis macrochirus*	12	18	201	231	3.996
Bigmouth buffalo†	*Ictiobus cyprinellus*	2	222	9	233	4.03
Bluntnose minnow†	*Pimephales notatus*	0	0	1	1	0.017
Blue sucker†	*Cycleptus elongates*	34	31	49	114	1.972
Common carp*†	*Cyprinus carpio*	48	80	79	207	3.581
Creek chub	*Semotilus atromaculatus*	5	16	20	41	0.709
Channel catfish*†	*Ictalurus punctatus*	269	161	173	603	10.431
Channel shiner	*Notropis wickliffi*	0	54	1	55	0.951
Emerald shiner*†	*Notropis atherinoides*	148	62	600	810	14.011
Flathead catfish*	*Pylodictus olivaris*	129	107	60	296	5.12
Fathead minnow†	*Pimephales promelas*	1	9	4	14	0.242
Freshwater drum*†	*Aplodinotus grunniens*	364	62	177	603	10.431
Goldeye†	*Hiodon alosoides*	33	15	47	95	1.643
Green sunfish	*Lepomis cyanellus*	2	2	121	125	2.162
Grass carp†	*Ctenopharyngodon idella*	4	7	6	17	0.294
Gizzard shad†	*Dorosoma cepedianum*	115	16	13	144	2.491
Largemouth bass†	*Micropterus salmoides*	0	4	0	4	0.069
Longnose gar†	*Lepisosteus osseus*	8	3	6	17	0.294
Mooneye†	*Hiodon tergisus*	0	0	3	3	0.052
Orangespotted sunfish	*Lepomis humilis*	1	1	3	5	0.086
Paddlefish†	*Polyodon spathula*	0	0	1	1	0.017
Pallid sturgeon†	*Scaphirhynchus albus*	1	0	0	1	0.017
Quillback†	*Carpiodes cyprinus*	1	0	0	1	0.017
Red shiner†	*Cyprinella lutrensis*	55	18	28	101	1.747
River carpsucker*†	*Carpiodes carpio*	95	23	63	181	3.131
River shiner†	*Notropis blennius*	75	19	30	124	2.145
Sicklefin chub†	Macrhybopsis meeki	2	0	0	2	0.035
Spotfin shiner†	*Cyprinella spiloptera*	0	0	1	1	0.017
Sturgeon chub†	*Macrhybopsis gelida*	72	1	29	102	1.764
Sauger†	*Stizostedion canadense*	2	1	2	5	0.086
Skipjack herring	*Alosa chrysochloris*	2	0	0	2	0.035

Table III.8.1 continued. Total species caught at Deroin Bend 2006-2008 and the percent of catch that each species represents. *Indicates a species that was used in analysis. †Indicates a species of note for this chute.

Species	**Scientific name**	**2006**	**2007**	**2008**	**Total**	**%Catch**
Speckled chub†	*Macrhybopsis aestivalis*	64	25	30	119	2.058
Smallmouth buffalo†	*Ictiobus bubalus*	1	30	1	32	0.554
Shortnose gar†	*Lepisosteus platostomus*	33	21	28	82	1.418
Shovelnose x Pallid hybrid	Scaphirhynchus platorynchus x Scaphirhynchus albus	0	2	0	2	0.035
Shovelnose sturgeon*†	*Scaphirhynchus platorynchus*	195	103	214	512	8.857
Sand shiner*†	*Notropis stramineus*	72	22	310	404	6.988
Stonecat	*Noturus flavus*	15	15	27	57	0.986
Silver chub*†	*Macrhybopsis storeriana*	99	59	39	197	3.408
Silver carp†	*Hypopthalmichthys molitrix*	1	0	6	7	0.121
Walleye	*Stizostedion vitreum*	1	0	0	1	0.017
White bass	*Morone chrysops*	38	6	0	44	0.761
White crappie†	*Pomoxis annularis*	0	4	4	8	0.138
Yellow bullhead	Ameiurus natalis	0	0	4	4	0.069

Table III.8.2. Species richness (S), species evenness (E), Shannon's diversity index (H) and Simpson's diversity index (D) for Deroin Bend 2006-2008.

Year	S	E	H	D
2006	37	0.77	2.78	0.9156
2007	36	0.8144	2.918	0.9233
2008	41	0.7292	2.708	0.8952

Table III.8.3. Community assemblage similarity, using Morisita's index, for Deroin Bend between years (2006 - 2008). Values less than 0.300 mean fish communities are dissimilar and values more than 0.700 mean fish communities are similar.

Year	2006 v 2007	2006 v 2008	2007 v 2008
Morisita's Index	0.712	0.700	0.523

Table III.8.4. Results for analysis of life stage proportions at Deroin Bend from 2006 - 2008. A z-test was used to determine differences in proportions of juveniles and adults of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold. Values not between -2.135 to 2.135 are significant.

	Z statistic		
Species	**2006 vs 2007**	**2006 vs 2008**	**2007 vs 2008**
Channel catfish	0.865	1.164	0.202
Common carp	**-5.918**	**-2.925**	**4.140**
Emerald shiner	**-3.983**	**-5.988**	0.164
Flathead catfish	**3.790**	**5.588**	**2.292**
Freshwater drum	**4.657**	**5.257**	0.057
River carpsucker	**4.410**	**4.831**	-0.513
Sand shiner	-0.269	0.185	0.388
Shovelnose sturgeon	-2.117	-1.749	0.695
Silver chub	**-2.210**	-0.629	1.369

Table III.8.5. Results for analysis of length frequency distribution at Deroin Bend from 2006 - 2008. A Kolmogorov-Smirnov test was used to determine differences in length frequency distribution of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

	2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**D**	**p-value**	**D**	**p-value**	**D**	**p-value**
Channel catfish	**0.237**	**0.0001**	0.102	0.227	**0.248**	**0.0002**
Common carp	**0.546**	**0.0001**	**0.299**	**0.0028**	**0.398**	**0.0001**
Emerald shiner	**0.281**	**0.0048**	**0.326**	**0.0001**	0.209	0.0461
Flathead catfish	**0.241**	**0.0022**	**0.476**	**0.0001**	**0.287**	**0.0035**
Freshwater drum	**0.229**	**0.0119**	0.142	0.0472	**0.232**	**0.0171**
River carpsucker	**0.704**	**0.0001**	**0.717**	**0.0001**	0.161	0.779
Sand shiner	0.245	0.264	0.222	0.067	0.197	0.544
Shovelnose sturgeon	0.166	0.0495	0.116	0.131	0.089	0.63
Silver chub	**0.368**	**0.0001**	0.174	0.3628	**0.495**	**0.0001**

Table III.8.6. Results for analysis of species mean length at Deroin Bend from 2006 - 2008. A t-test was used to determine differences in mean length of a species between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

	2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**t**	**p-value**	**t**	**p-value**	**t**	**p-value**
Channel catfish	0.357	0.7216	-1.103	0.2706	-1.194	0.2333
Common carp	**8.732**	**0.0001**	**3.906**	**0.0001**	**-4.693**	**0.0001**
Emerald shiner	**2.643**	**0.0092**	**6.349**	**0.0001**	**2.697**	**0.0075**
Flathead catfish	**-2.908**	**0.0041**	**-5.305**	**0.0001**	-1.737	0.0843
Freshwater drum	**-2.948**	**0.0043**	**-2.162**	**0.0316**	1.253	0.2116
River carpsucker	**-5.606**	**0.0001**	**-6.737**	**0.0001**	0.613	0.5419
Sand shiner	-1.14	0.2571	-1.87	0.0636	-0.162	0.8718
Shovelnose sturgeon	**2.878**	**0.0045**	1.793	0.0737	-1.653	0.0993
Silver chub	**4.662**	**0.0001**	-0.265	0.7917	**-4.131**	**0.0001**

Table III.8.7. Results for analysis of species catch per unit effort (CPUE) at Deroin Bend from 2006 - 2008. Effort for each gear is defined as: electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Push trawl was not used in 2006. A Kruskal-Wallis test was used to determine differences in CPUE of a species by gear between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

		2006 v 2007		**2006 v 2008**		**2007 v 2008**	
Species	**Gear**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**
Common Carp	**EF**	0.072	0.788	1.571	0.2101	2.282	0.1309
	HN	0.009	0.9251	1.081	0.2986	1.248	0.264
	MF	**4.955**	**0.026**	2.115	0.1459	0.343	0.558
	OT	1.799	0.1799	**7.54**	**0.006**	1.986	0.1588
	SHN	1.012	0.3145	4.224	0.0399	1.176	0.2781
Channel Catfish	**EF**	2.596	0.1072	0.014	0.9076	1.847	0.1741
	HN	1.336	0.2477	3	0.0833	0.471	0.4924
	MF	1.641	0.2002	1.526	0.2167	0.047	0.8292
	OT	2.587	0.1077	0.038	0.8457	3.608	0.0575
	PT	NA	NA	NA	NA	0.002	0.9615
	SHN	0.057	0.8111	3.279	0.0702	2.519	0.1125
Emerald Shiner	**EF**	1.716	0.1902	1.205	0.2723	4.053	0.0441
	MF	0.364	0.5464	4.182	0.0408	**5.708**	**0.0169**
	OT	0.542	0.4614	1.114	0.2912	0.055	0.8144
	PT	NA	NA	NA	NA	2.462	0.1166
Flathead Catfish	**EF**	0.262	0.6086	**12.794**	**0.0003**	**7.489**	**0.0062**
	HN	0.48	0.4882	0.01	0.9199	0.563	0.4531
	MF	1.12	0.2899	2.333	0.1266	0.29	0.5904
	OT	2.104	0.1469	0.839	0.3598	**5.329**	**0.021**
	SHN	1.312	0.252	3.104	0.0781	0.496	0.4815
Freshwater Drum	**EF**	0	1	4.06	0.0439	3.442	0.0636
	HN	0.577	0.4474	0.072	0.7889	0.982	0.3218
	MF	0.854	0.3554	0.364	0.5463	0.03	0.8622
	OT	3.305	0.0691	1.056	0.3041	0.866	0.352
	PT	NA	NA	NA	NA	0.174	0.6764
	SHN	**5.007**	**0.0252**	4.441	0.0351	0.03	0.8626
River Carpsucker	**EF**	0.628	0.428	0.469	0.4937	0.004	0.9489
	HN	3.203	0.0735	1.119	0.2901	0.921	0.3372
	MF	0.001	0.9742	1.043	0.307	1.023	0.3117
	OT	1.485	0.223	0.397	0.5287	0.709	0.3998
	PT	NA	NA	NA	NA	1.909	0.1671
	SHN	0.957	0.3278	1.071	0.3006	0.006	0.9362

Table III.8.7 continued. Results for analysis of species catch per unit effort (CPUE) at Deroin Bend from 2006 - 2008. Effort for each gear is defined as: electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Push trawl was not used in 2006. A Kruskal-Wallis test was used to determine differences in CPUE of a species by gear between years. Significant results, at a Bonnferroni correction of 0.033 (alpha = 0.1), are shown in bold.

		2006 v 2007		2006 v 2008		2007 v 2008	
Species	**Gear**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**	**$\chi 2$**	**p-value**
Shovelnose Sturgeon	**EF**	0.006	0.941	0.012	0.9128	0	1
	HN	**8.509**	**0.0035**	2.967	0.085	1.288	0.2564
	OT	0.718	0.3969	2.271	0.1318	**5.004**	**0.0253**
	PT	NA	NA	NA	NA	0.524	0.4692
	SHN	1.805	0.1791	0.632	0.4266	**5.514**	**0.0189**
	TN	2.284	0.1307	0.803	0.3702	**4.879**	**0.0272**
Sand Shiner	**EF**	0	1	1.15	0.2835	0.975	0.3234
	MF	0.041	0.84	2.662	0.1028	2.686	0.1012
	OT	0.737	0.3907	1.04	0.3079	0	1
	PT	NA	NA	NA	NA	1.385	0.2392
Silver Chub	**EF**	0	1	1.15	0.2835	0.975	0.3234
	MF	0.246	0.6196	0.064	0.7997	0.01	0.9194
	OT	**13.216**	**0.0003**	1.295	0.2552	**7.488**	**0.0062**
	PT	NA	NA	NA	NA	1.052	0.3051

Table III.8.8. Species monthly catch per unit effort (± 2 SE) at Deroin Bend from 2006 - 2008. Effort for each gear is defined as: bag seine (BS), fish caught per 50 m^2 seined; electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled; and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Bag seines were only used in 2006. Push trawls were not used in 2006.

		April			May			June			July			August			September			October		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Common Carp	**BS**										0.27											
											(0.53)											
	EF			8.05	9.00	1.22	3.65	5.24	1.46		2.08	2.91	5.71	4.55	3.10	7.99	3.50	4.68	7.28	2.90		2.40
				(13.72)	(12.78)	(1.59)	(2.86)	(4.40)	(1.57)		(2.06)	(2.43)	(3.92)	(4.18)	(4.46)	(6.30)	(3.61)	(4.43)	(6.86)	(3.41)		(2.79)
	MF							0.20	7.00				2.50		0.50	0.33	0.20	7.00				
								(0.40)	(6.63)				(5.00)		(1.00)	(0.67)	(0.40)	(6.63)				
	HN	0.17	0.13		0.43	0.25					0.13	0.13	0.14	0.25	0.50							
		(0.33)	(0.250		(0.86)	(0.50)					(0.25)	(0.25)	(0.29)	(0.33)	(0.66)							
	SHN			0.13			0.29		0.25			0.25		0.13	0.29	0.13						0.50
				(0.25)			(0.37)		(0.50)			(0.50)		(0.25)	(0.57)	(0.25)						(0.58)
	OT				0.07	0.22	0.07			0.66			0.02						0.03			0.05
					(0.15)	(0.24)	(0.11)			(0.61)			(0.05)						(0.06)			(0.10)
Channel Catfish	**BS**	4.37																				
		(0.94)																				
	EF	0.83													0.63			3.46				24.13
		(1.67)													(1.25)			(3.87)				(48.26)
	MF	1.00	1.00	2.50		0.67	1.00		0.17		0.17	0.33			0.75							
		(1.16)	(2.00)	(3.32)		(1.33)			(0.33)		(0.33)	(0.42)			(1.50)							
	HN	1.00				0.50			0.14		0.13	0.13		0.25	0.13	0.63	0.38					
		(1.27)				(1.00)			(0.290		(0.25)	(0.25)		(0.50)	(0.25)	(0.84)	(0.37)					
	SHN	0.14	0.50	0.75	0.60	0.25	0.10	0.17	0.13		0.13		0.50		0.29		0.29	0.25				
		(0.29)	(0.76)	(0.63)	(1.20)	(0.50)	(0.62)	(0.33)	90.25)		(0.25)		(0.54)		90.57)		(0.37)	(0.33)				
	PT		2.42	4.74			1.09					1.19			26.44	1.39		4.94				
			(4.84)	(4.08)			(2.17)					(2.38)			(40.42)	(2.78)		(9.88)				
	OT	1.28		0.61	5.33	0.11	0.80	1.14	0.03	0.57	0.37	1.40	0.17	2.19		0.80	1.14	0.73	2.00	0.16	0.84	0.28
		(1.40)		(0.58)	(5.62)	(0.16)	(0.50)	(0.59)	(0.06)	(0.35)	(0.52)	(1.93)	(0.24)	(1.96)		(0.68)	(1.81)	(1.02)	(1.82)	(0.15)	(0.60)	(0.21)
Emerald Shiner	**BS**	6.79												3.49						61.16		
		(5.79)												(3.86)						(64.07)		
	EF	1.49		1.10									1.34									178.55
		(1.74)		(2.20)									(1.80)									(357.11)
	MF	1.25	0.67	13.75	0.50	2.00	4.00	0.60	0.50				2.50	8.80	8.75	0.33	1.00		109.00	1.00		
		(1.50)	(1.33)	(14.22)	(0.58)	(2.31)		(1.20)	(0.68)				(1.00)	(11.34)	(14.89)	(0.67)			(218.00)	(2.00)		
	PT		0.56	0.85					0.56	106.25					4.69				23.21			
			(1.11)	(1.70)					(1.11)	(133.36)					(3.63)				(46.43)			
	OT									0.07		0.03					0.24			0.07		
										(0.14)		(0.06)					(0.37)			(0.13)		

Table III.8.8 continued. Species monthly catch per unit effort (± 2 SE) at Deroin Bend from 2006 - 2008. Effort for each gear is defined as: bag seine (BS), fish caught per 50 m^2 seined; electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled; and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Bag seines were only used in 2006. Push trawls were not used in 2006.

		April			May			June			July			August			September			October		
Species	**Gear**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Flathead Catfish	**EF**				1.38	0.98	0.91	11.96	6.78		22.94	9.86	4.39	14.27	9.77	9.12	14.91	8.07	2.21	3.33		1.21
					(1.35)	(1.96)	(1.83)	(6.98)	(8.80)		(16.70)	(10.39)	(4.30)	(15.02)	(3.42)	(6.50)	(15.02)	96.76)	(4.41)	(6.67)		(2.41)
	MF														0.25	0.33						
															(0.50)	(0.67)						
	HN				0.14	0.25	0.13	0.17	0.43		0.38	1.25	0.71		0.63	0.38				0.50		0.25
					(0.29)	(0.50)	(0.25)	(0.33)	(0.86)		(0.37)	(1.40)	(1.43)		(1.00)	(0.37)				(1.00)		(0.50)
	SHN	0.29	0.13	0.50	0.20	0.25	0.14	0.83	1.25		0.25	0.50	2.00	0.38	0.29	1.13	0.14	0.63	0.13			0.25
		(0.37)	(0.25)	(0.76)	(0.40)	(0.50)	(0.29)	(1.67)	(1.12)		(0.33)	(0.76)	(1.46)	(0.53)	(0.37)	(0.96)	(0.29)	(0.53)	(0.25)			(0.50)
	OT	0.14		0.06	0.58	0.11			0.03			0.03		0.06							0.38	0.05
		(0.27)		(0.11)	(0.86)	(0.22)			(0.07)			(0.06)		(0.12)							(0.33)	(0.10)
Freshwater Drum	**BS**	0.61																				
		(1.21)																				
	EF	4.28		3.34	2.19		1.58		0.82					0.54				2.82	3.56			34.41
		(4.40)		(3.60)	(2.90)		(2.09)		(1.14)					(1.07)				(2.85)	(2.76)			(60.78)
	MF			0.25				9.80	1.67		0.17	0.50	1.50	1.20	0.50	0.33						
				(0.50)				(13.86)	(1.61)		(0.33)	(0.45)	(1.00)	(1.94)	(0.58)	(0.67)						
	HN	0.50				0.25			0.29		0.13	0.13	1.57		0.13							
		(0.68)				(0.50)			(0.37)		(0.25)	(0.25)	(2.30)		(0.25)							
	SHN	.							0.25			0.13	0.25		0.29	0.25						
									(0.33)			(0.25)	(0.33)		(0.37)	(0.33)						
	PT		2.42			2.78			4.95			31.67										
			(4.84)			(3.62)			(2.43)			(56.00)										
	OT				0.14			8.48	0.02	1.27	0.03	0.46	2.27	2.66		0.34	1.17	0.25	0.22	0.02	0.05	0.09
					(0.29)			(11.86)	(0.05)	(2.15)	(0.05)	(0.83)	(4.24)	(2.51)		(0.60)	(1.71)	(0.34)	(0.44)	(0.04)	(0.09)	(0.13)
River Carpsucker	**BS**										8.26			2.27						0.97		
											(10.95)			(1.59)						(1.94)		
	EF	2.50		9.92	2.81			0.71	0.88				3.17				0.68	0.88				22.92
		(5.00)		(19.84)	(3.00)			(1.43)	(1.21)				(6.34)				(1.36)	(1.67)				(45.85)
	MF		3.00	0.75		0.33		5.20	0.17				1.50	4.40		0.33						
			(6.00)	(1.50)		(0.67)		(10.40)	(0.33)				(3.00)	(7.84)		(0.67)						
	HN			0.13		1.00			0.14						0.13							
				(0.25)		(2.00)			(0.29)						(0.25)							
	SHN						0.14		0.13													
							(0.29)		(0.25)													
	PT												2.08									
													(4.17)									
	OT	0.09															0.05		0.03			
		(0.18)															(0.11)		(0.06)			

Table III.8.8 continued. Species monthly catch per unit effort (± 2 SE) at Deroin Bend from 2006 - 2008. Effort for each gear is defined as: bag seine (BS), fish caught per 50 m^2 seined; electrofishing (EF), fish caught per hour; mini-fyke net (MF), fish caught per net night; 4' hoop nets (HN), fish caught per net night; 2' hoop nets (SHN), fish caught per net night; push trawls (PT), fish caught per 100 m trawled; 8' and 16' otter trawls (OT), fish caught per 100 m trawled; and trammel nets (TN), fish caught per 125 ft of net drifted 100 m. Bag seines were only used in 2006. Push trawls were not used in 2006.

		April			May			June			July			August			September			October		
Species	Gear	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Shovelnose Sturgeon	EF	1.67 (3.33)			0.44 (0.88)		1.91 (2.51)	1.33 (1.69)	0.82 (1.14)									0.85 (1.70)	0.73 (1.46)			
	HN	4.00 (4.82)		0.13 (0.25)	0.57 (0.40)		2.00 (2.59)	0.17 (0.33)	0.43 (0.86)		0.75 (0.73)	0.50 (0.66)	0.57 (0.68)	0.75 (0.98)	0.88 (1.28)	0.38 (0.53)	0.63 (0.75)	0.17 (0.33)	0.25 (0.50)	1.50 (1.00)	0.25 (0.50)	0.50 (1.00)
	SHN	2.29 (2.50)	0.25 (0.50)	1.00 (1.20)	4.80 (6.40)	7.00 (12.68)	2.29 (1.73)	1.83 (1.82)	0.13 (0.25)		0.13 (0.25)	0.13 (0.25)	0.38 (0.53)	0.25 (0.50)	0.29 (0.37)	0.88 (0.88)			0.25 (0.330			
	PT		0.81 (1.61)																			
	OT	0.83 (0.89)		0.40 (0.34)	0.67 (0.73)	0.26 (0.52)	0.75 (0.52)	0.38 (0.26)	0.34 (0.27)	1.34 (2.43)	0.57 (0.54)	0.56 (0.50)	1.82 (0.70)	0.31 (0.23)		0.86 (0.71)	0.73 (0.86)	0.05 (0.09)	0.36 (0.30)	0.26 (0.33)	1.46 (5.45)	0.43 (0.53)
	TN	0.65 (1.30)									0.60 (1.19)		0.33 (0.66)			0.42 (0.83)			0.82 (1.65)			4.75 (9.490
Sand Shiner	BS										1.40 (1.80)			2.75 (2.77)			0.95 (0.90)			2.91 (5.83)		
	EF																		0.92 (1.84)			
	MF	0.25 (0.50)	0.33 (0.67)	1.25 (2.50)		1.00 (2.00)	10.00 (0.00)	0.80 (1.60)	1.00 (1.03)		0.83 (1.67)		1.50 (3.00)	5.20 (9.43)	2.50 (3.11)		9.00 (0.00)		134.90 (269.00)	3.67 (7.33)		
	PT												1.39 (2.78)		1.04 (2.08)	1.39 (2.78)						
	OT																			0.04 (0.09)		
Silver Chub	BS	0.61 (1.21)																				
	EF																					2.41 (4.83)
	MF		0.33 (0.67)	0.50 (1.00)				2.80 (5.12)	0.50 (0.68)		0.33 (0.42)	0.83 (1.67)		0.80 (0.98)		0.67 (1.33)						
	PT								0.56 (1.11)			19.30 (16.00)	2.78 (5.56)		11.53 (14.61)	2.78 (5.56)						
	OT	0.20 (0.27)			0.66 (0.56)	0.10 (0.20)	0.06 (0.11)	0.15 (0.26)		0.07 (0.13)	0.88 (1.46)	0.09 (0.18)	0.13 (0.15)	0.24 (0.33)		0.15 (0.22)	1.79 (2.42)		0.40 (0.36)	0.12 (0.12)		0.29 (0.26)

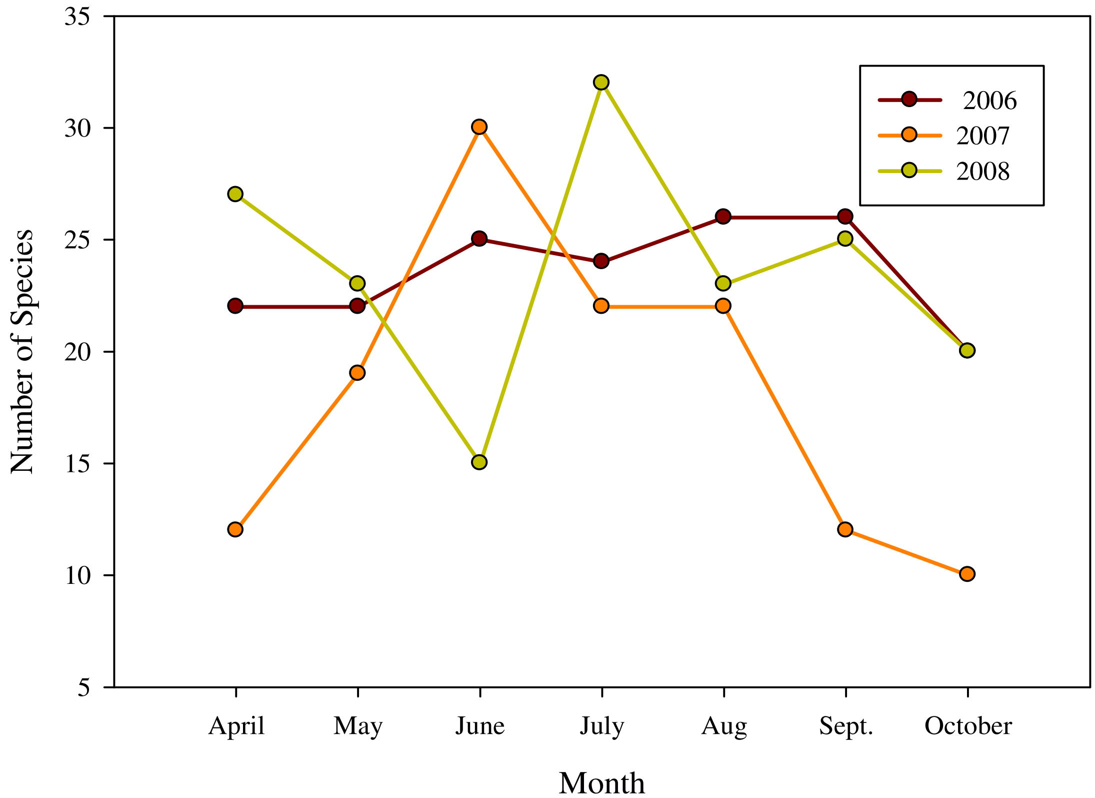


Figure III.8.1. Monthly species richness for Deroin Bend from 2006 – 2008.

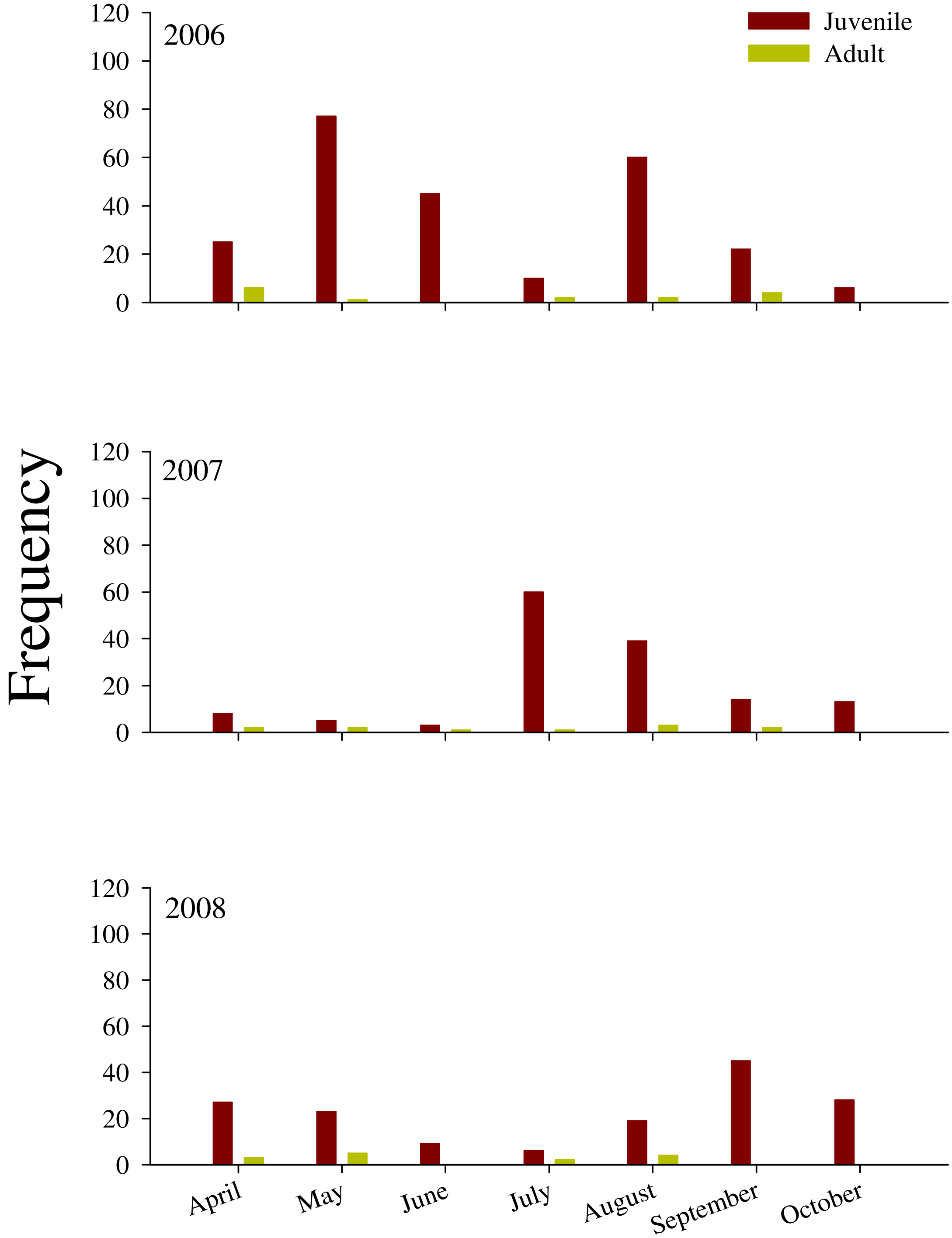


Figure III.8.2. Monthly frequency of juvenile (<305mm) and adult (≥305mm) channel catfish caught at Deroin Bend from 2006 - 2008.

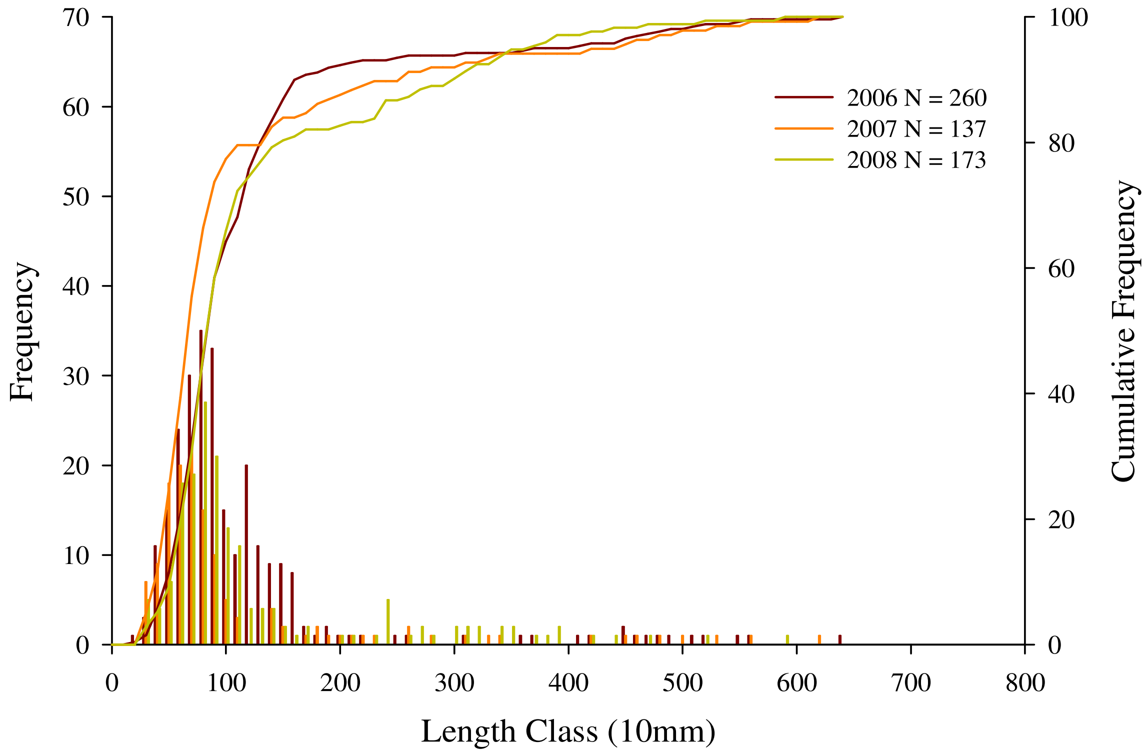


Figure III.8.3. Length frequency distributions and cumulative frequencies for measured channel catfish (N) at Deroin Bend from 2006 – 2008.

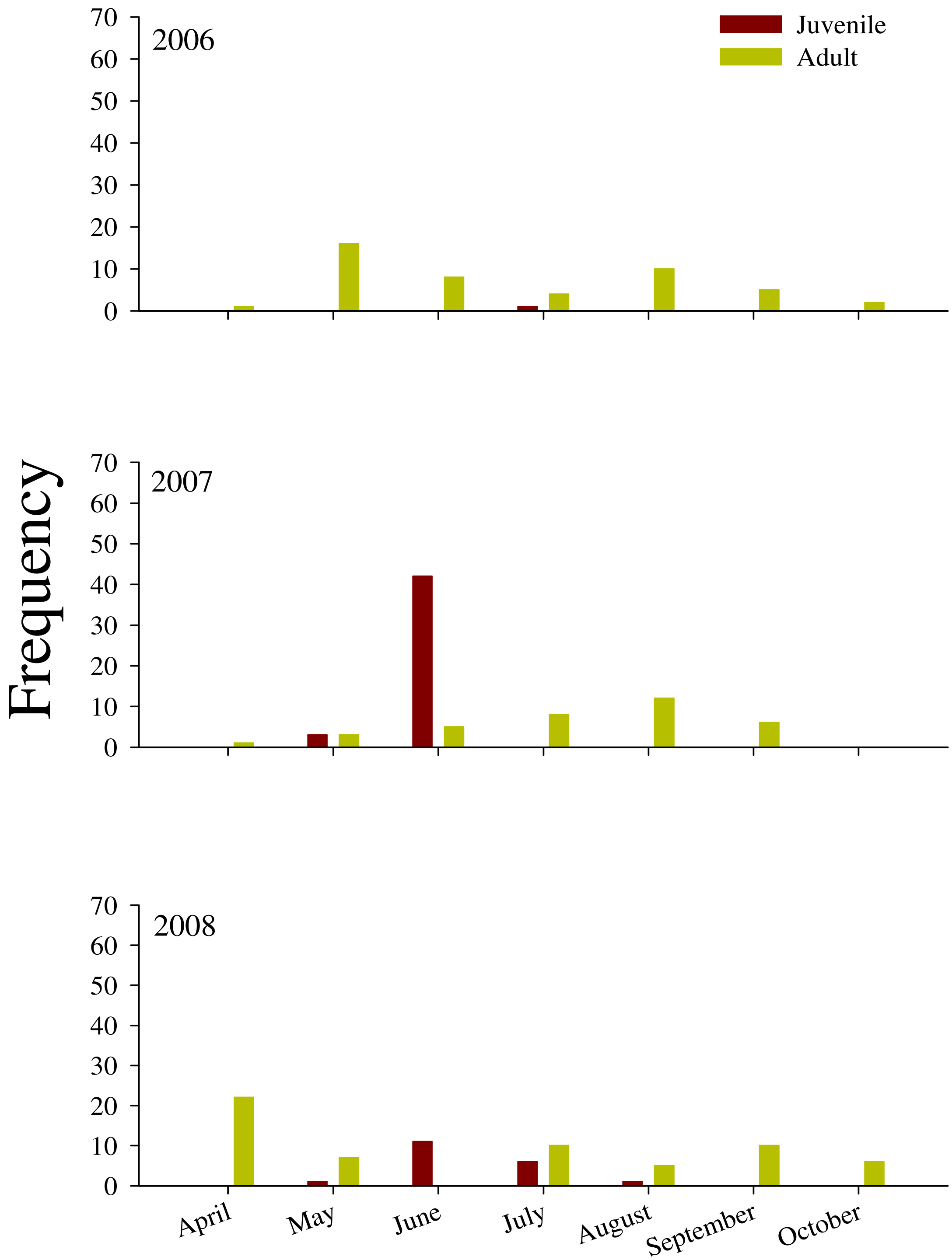


Figure III.8.4. Monthly frequency of juvenile (<305mm) and adult (≥305mm) common carp caught at Deroin Bend from 2006 - 2008.

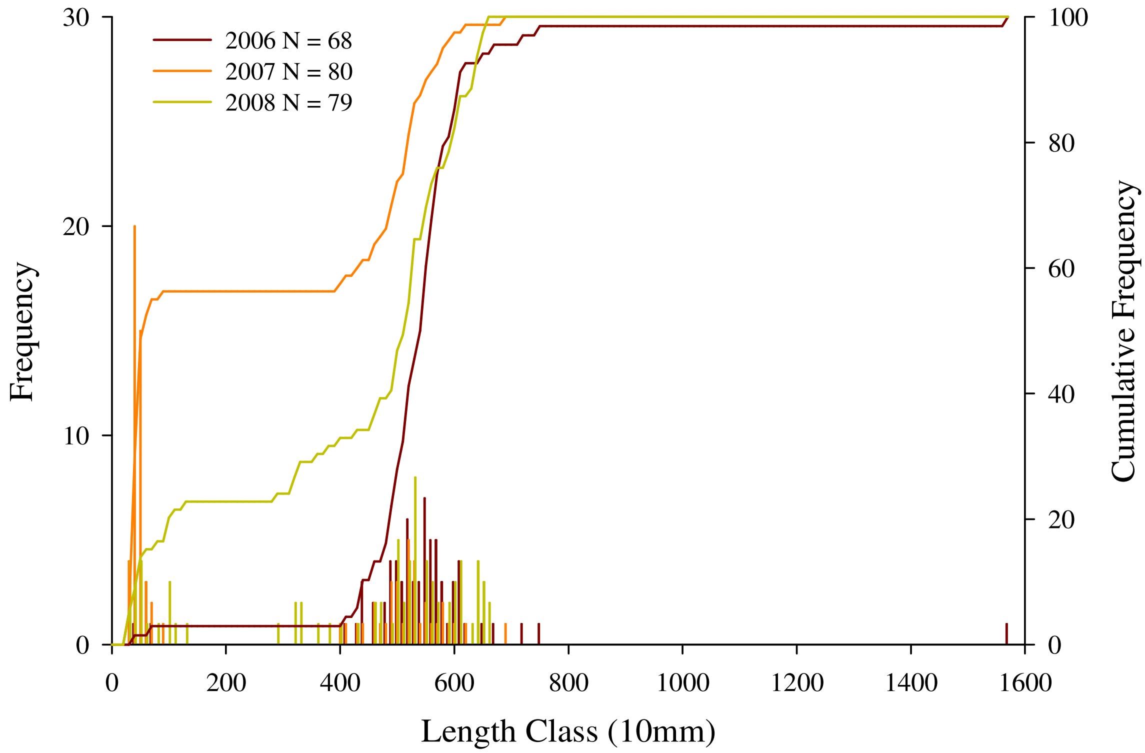


Figure III.8.5. Length frequency distributions and cumulative frequencies for measured common carp (N) at Deroin Bend from 2006 – 2008.

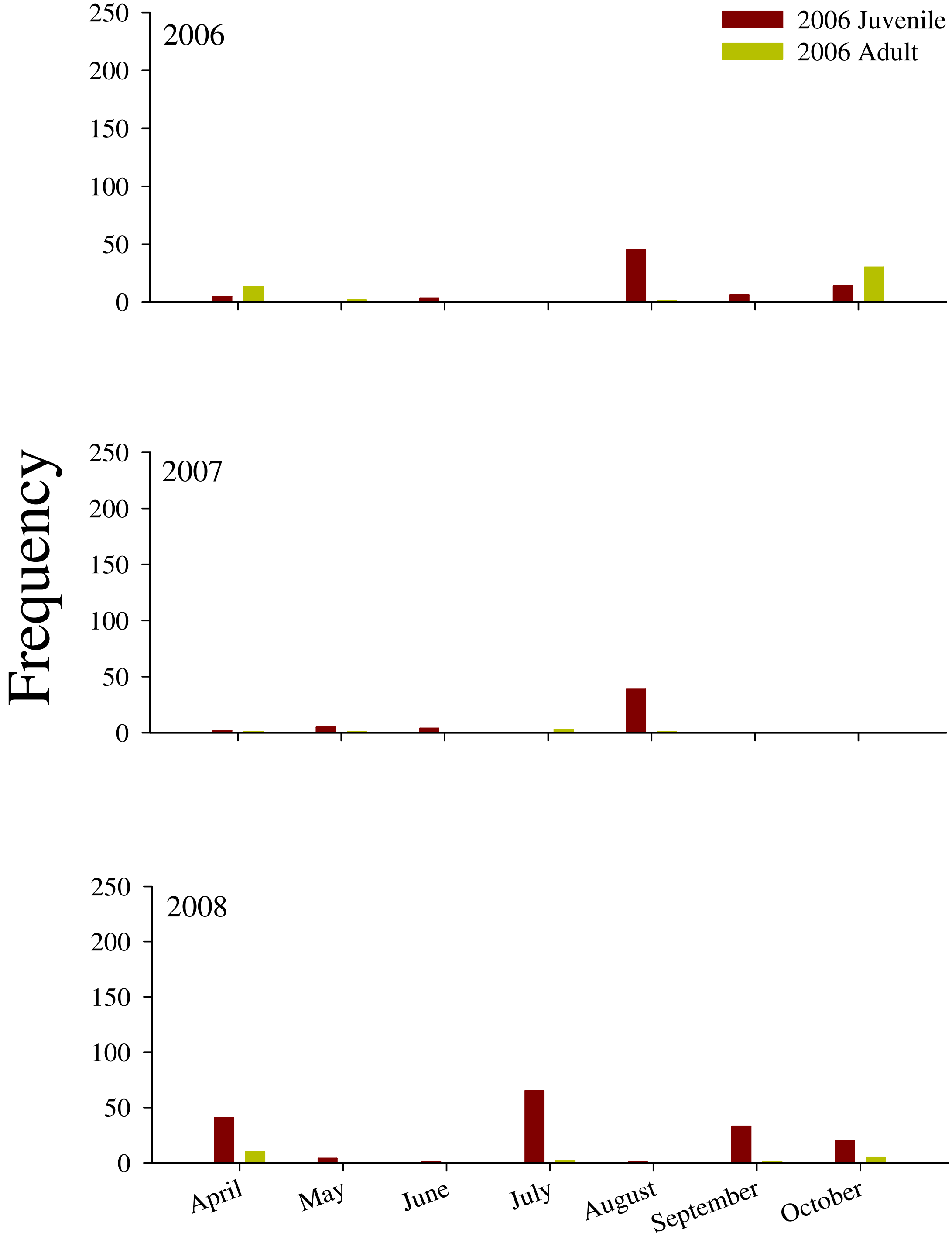


Figure III.8.6. Monthly frequency of juvenile (<64mm) and adult (≥64mm) emerald shiner caught at Deroin Bend from 2006 - 2008.

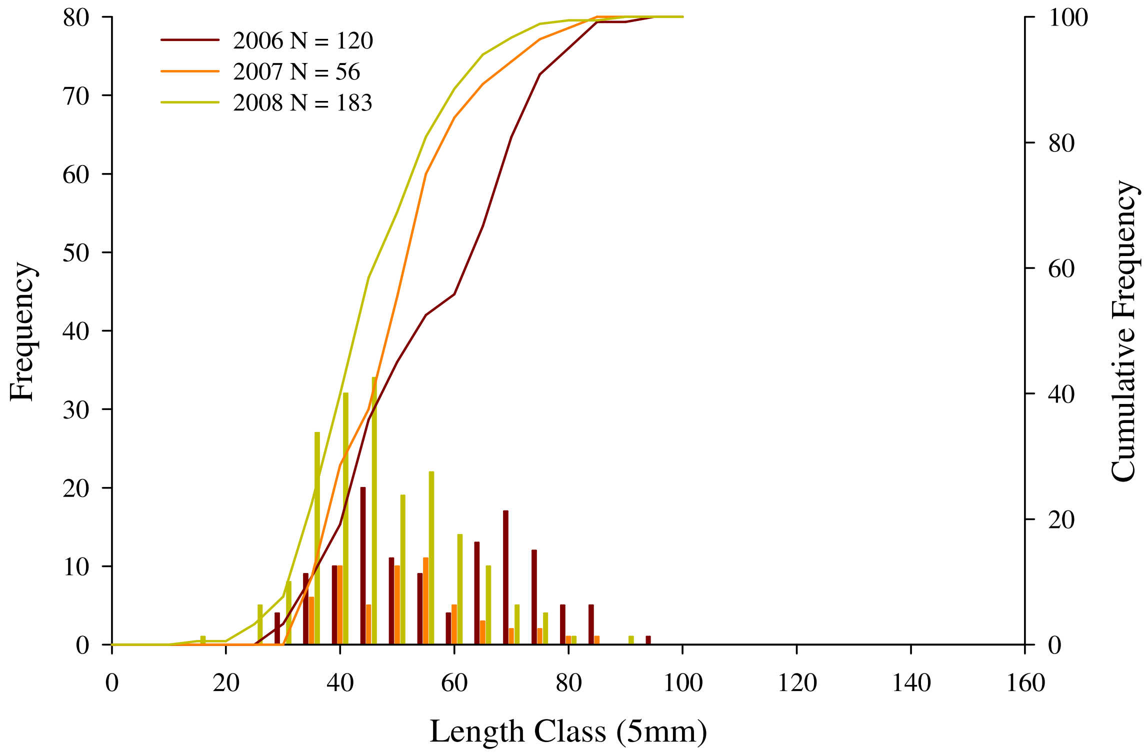


Figure III.8.7. Length frequency distributions and cumulative frequencies for measured emerald shiner (N) at Deroin Bend from 2006 – 2008.

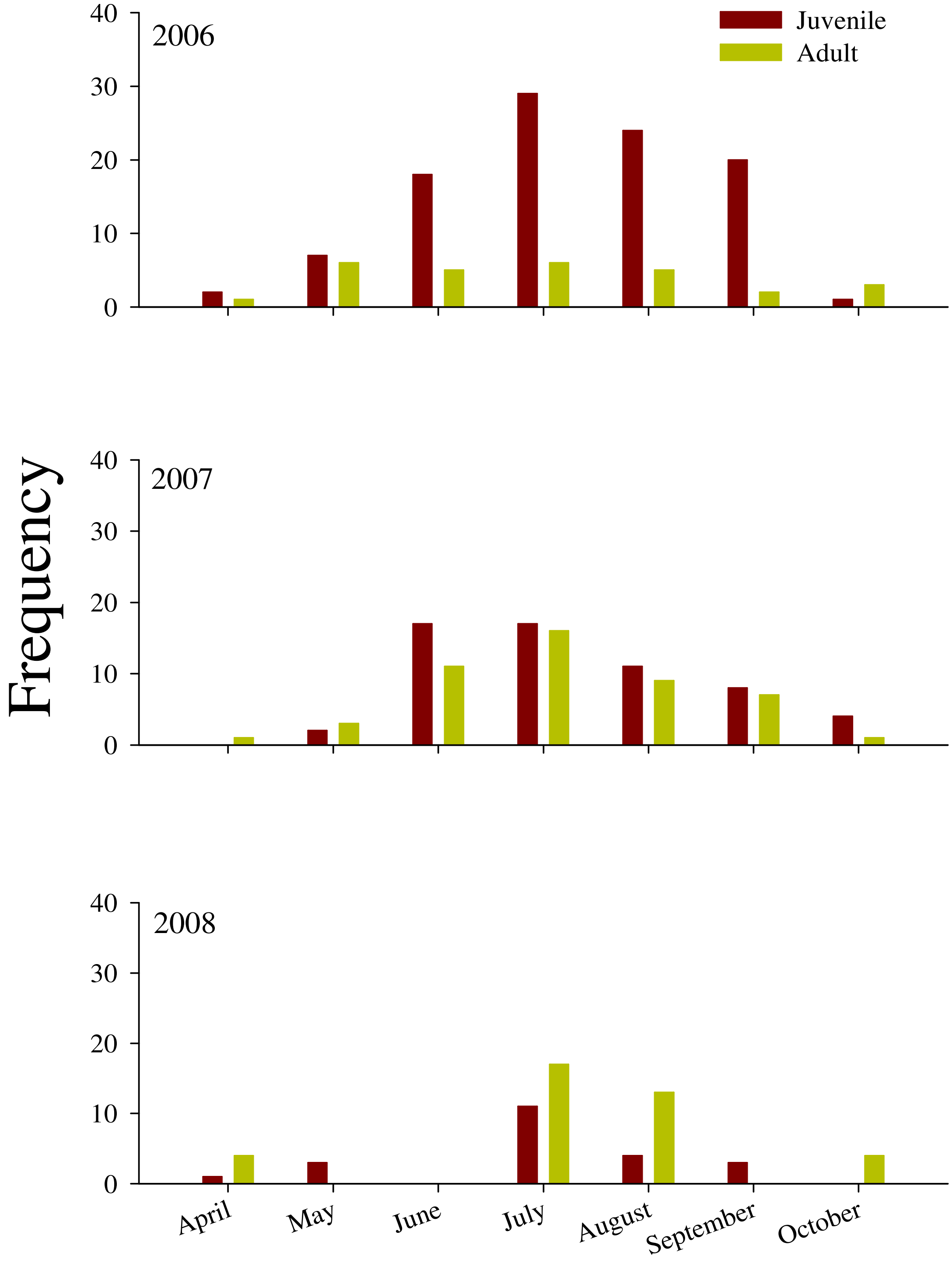


Figure III.8.8. Monthly frequency of juvenile (<381mm) and adult (≥381mm) flathead catfish caught at Deroin Bend from 2006 – 2008.

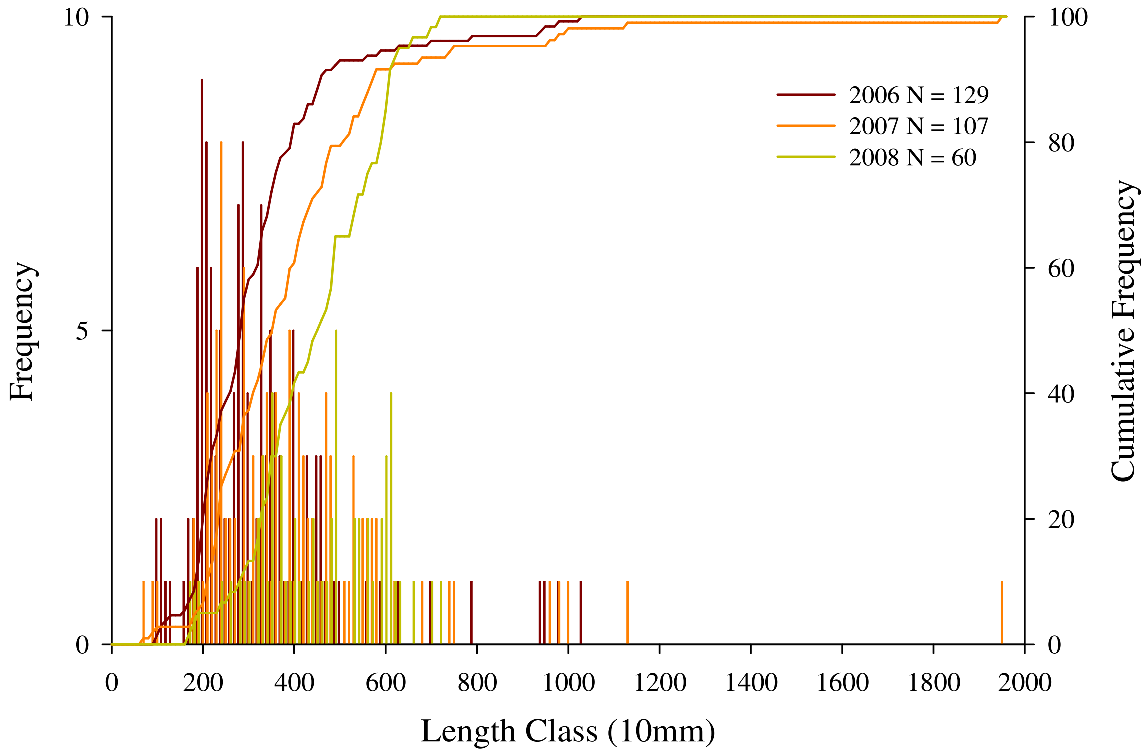


Figure III.8.9. Length frequency distributions and cumulative frequencies for measured flathead catfish (N) at Deroin Bend from 2006 – 2008.

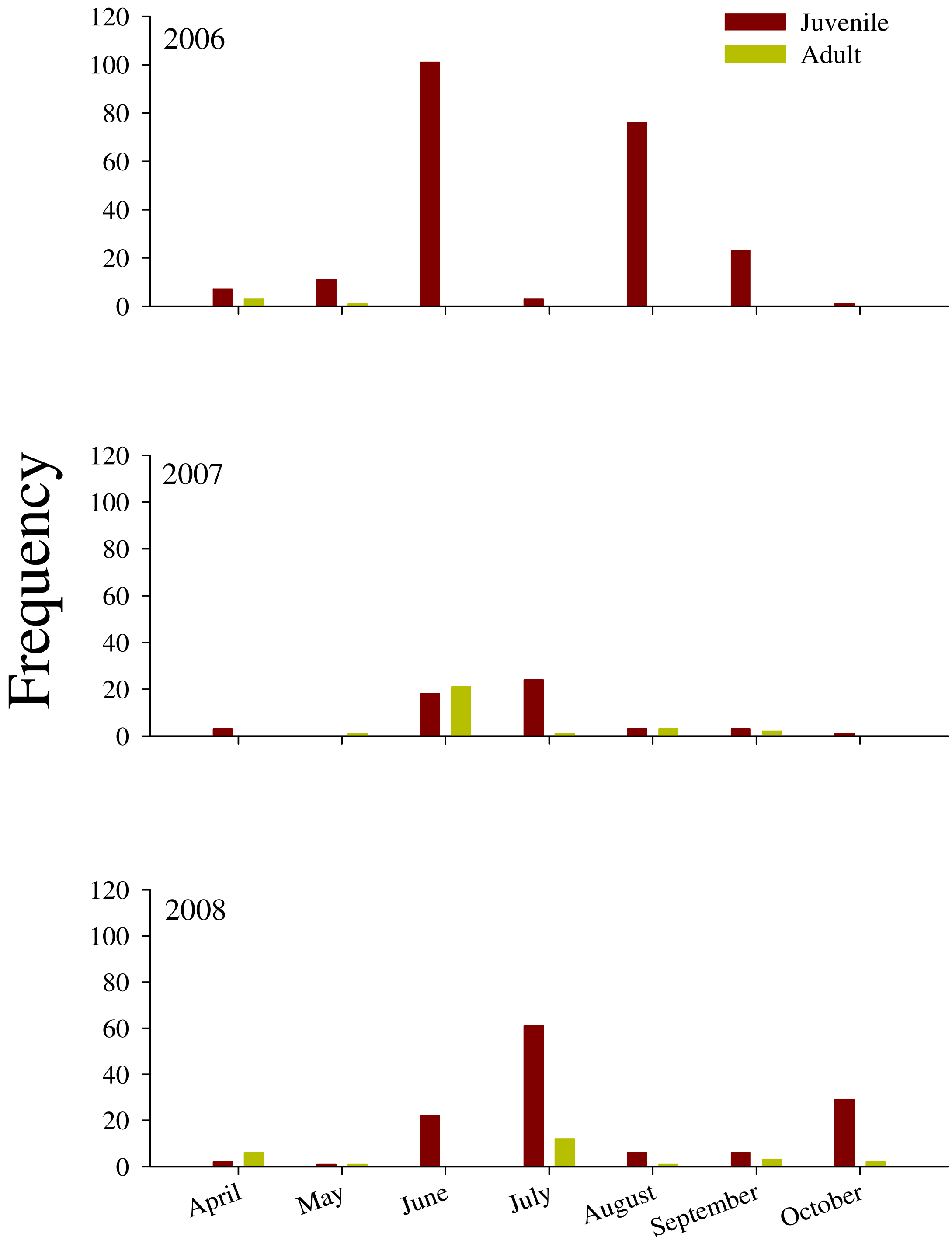


Figure III.8.10. Monthly frequency of juvenile (<305mm) and adult (≥305mm) freshwater drum caught at Deroin Bend from 2006 - 2008.

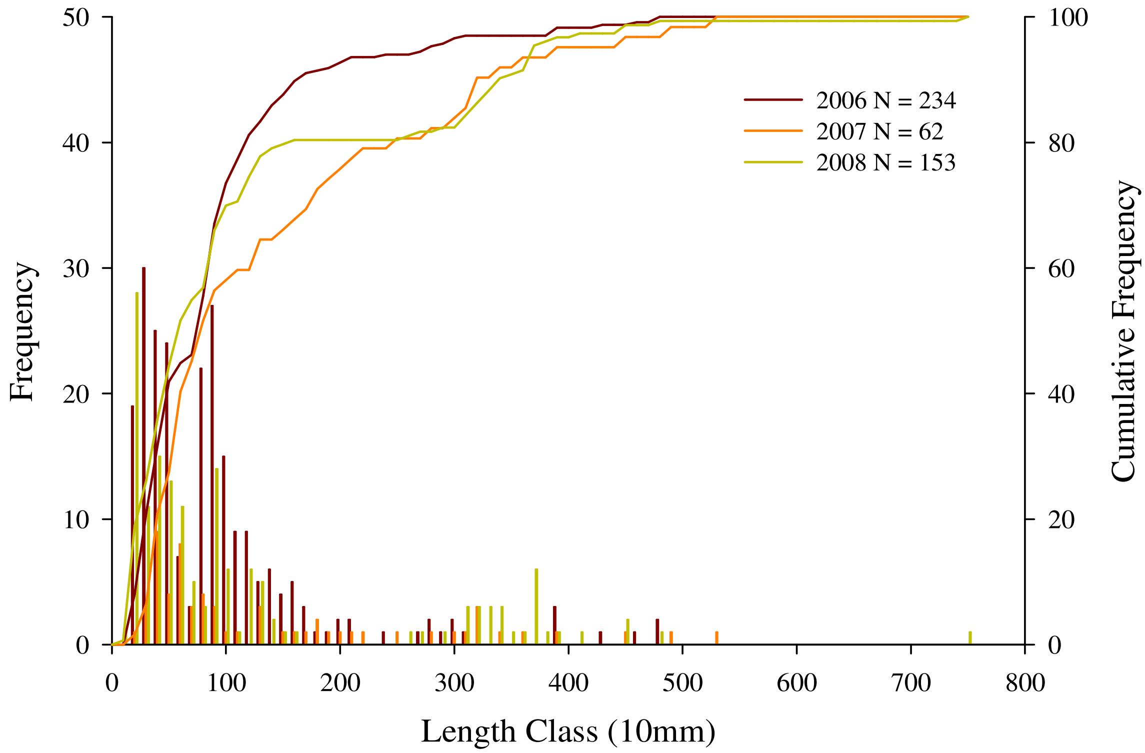


Figure III.8.11. Length frequency distributions and cumulative frequencies for measured Freshwater drum (N) at Deroin Bend from 2006 – 2008.

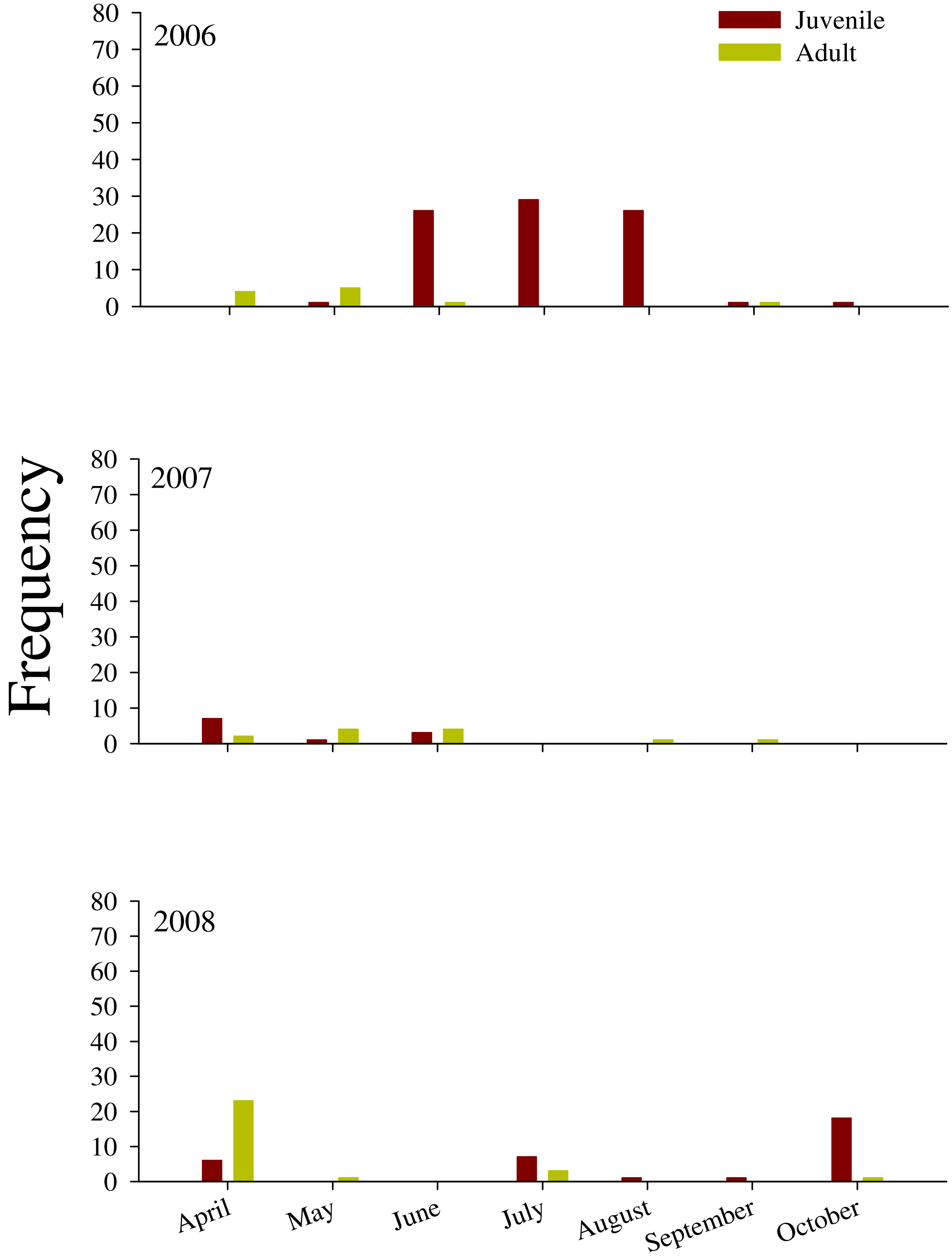


Figure III.8.12. Monthly frequency of juvenile (<305mm) and adult (≥305mm) river carpsucker caught at Deroin Bend from 2006 - 2008.

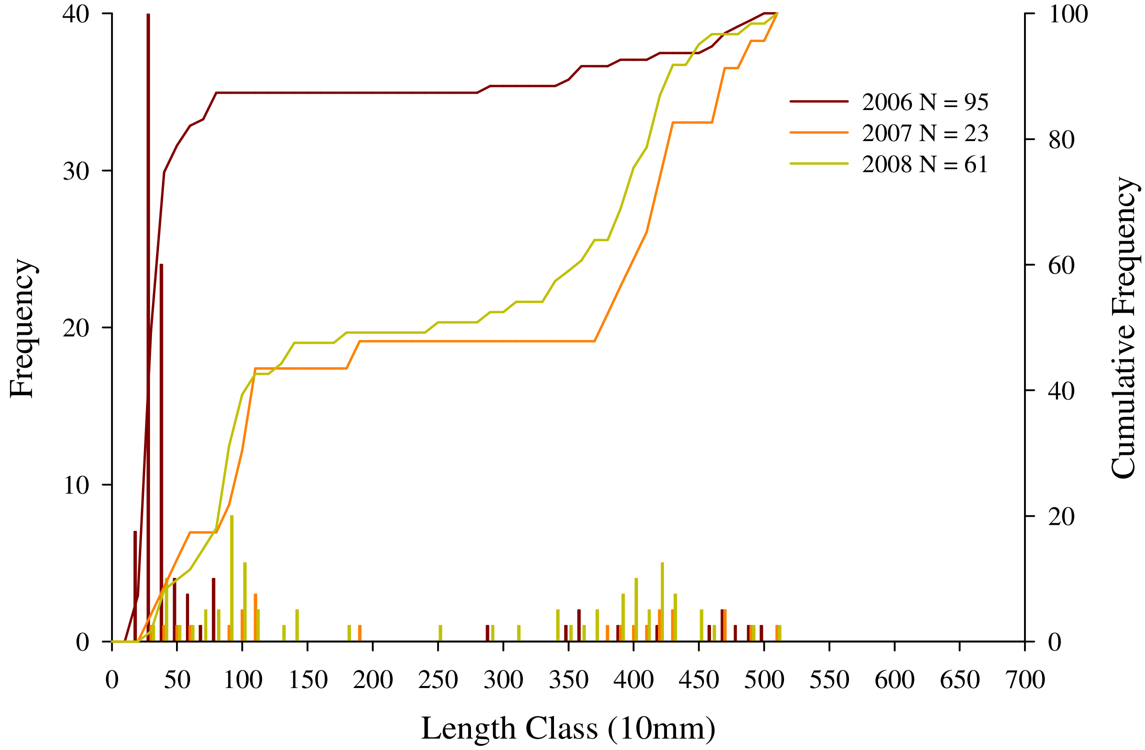


Figure III.8.13. Length frequency distributions and cumulative frequencies for measured river carpsucker (N) at Deroin Bend from 2006 – 2008.

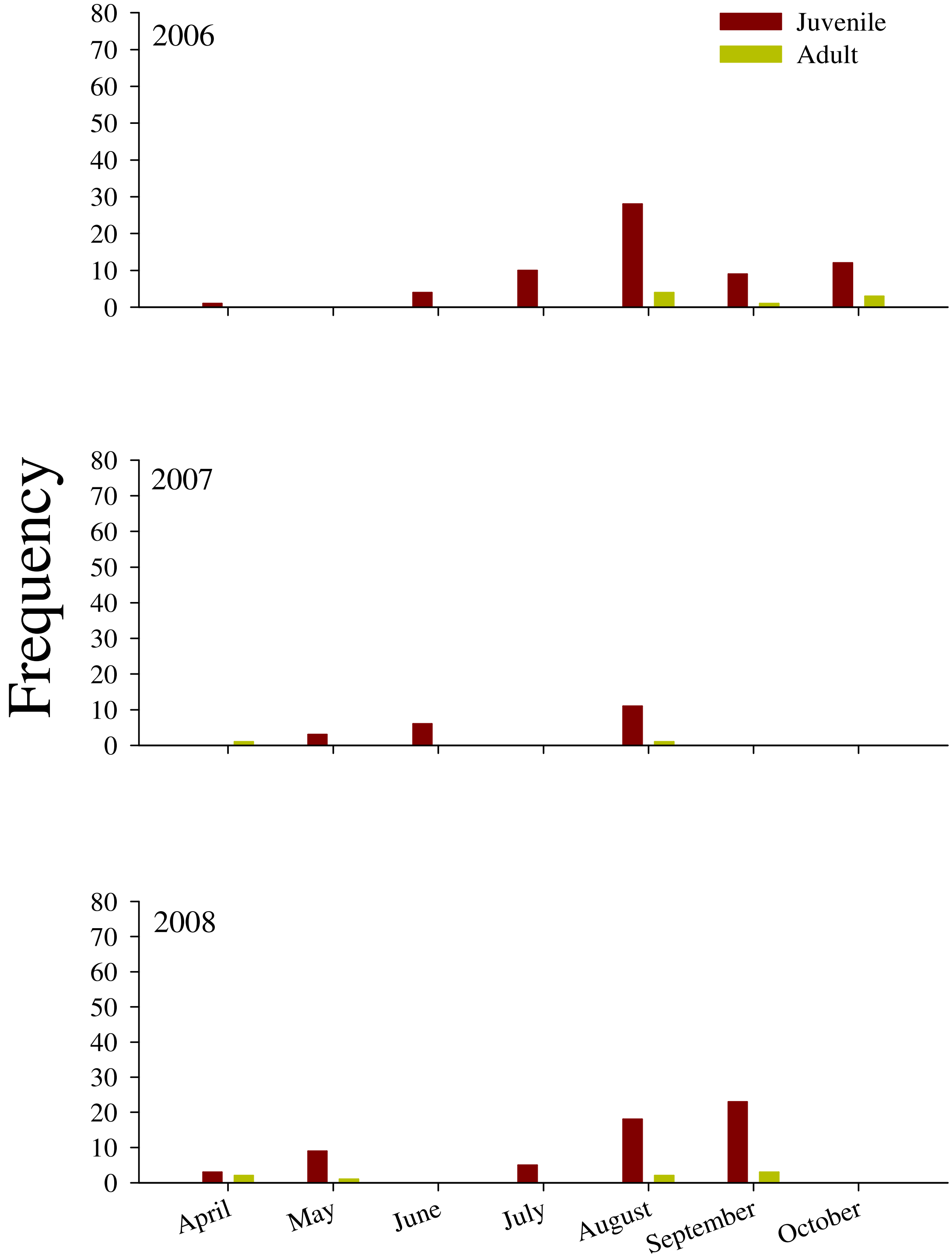


Figure III.8.14. Monthly frequency of juvenile (<43mm) and adult (≥43mm) sand shiner caught at Deroin Bend from 2006 - 2008.

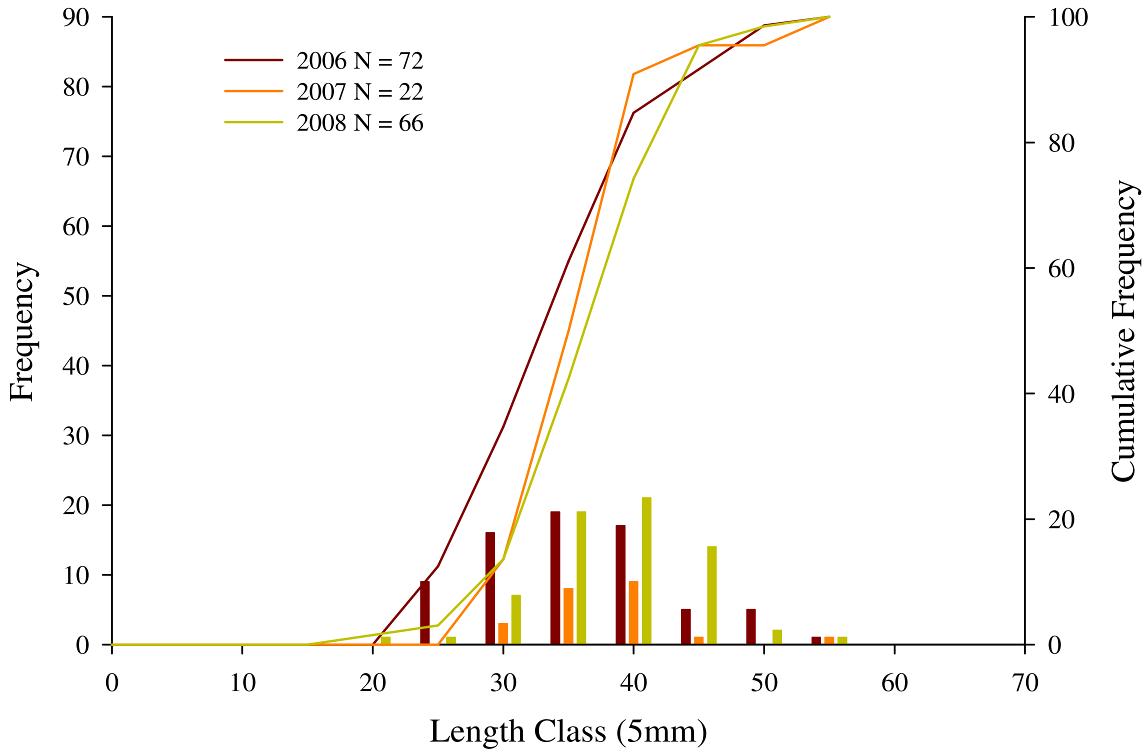


Figure III.8.15. Length frequency distributions and cumulative frequencies for measured sand shiner (N) at Deroin Bend from 2006 – 2008.

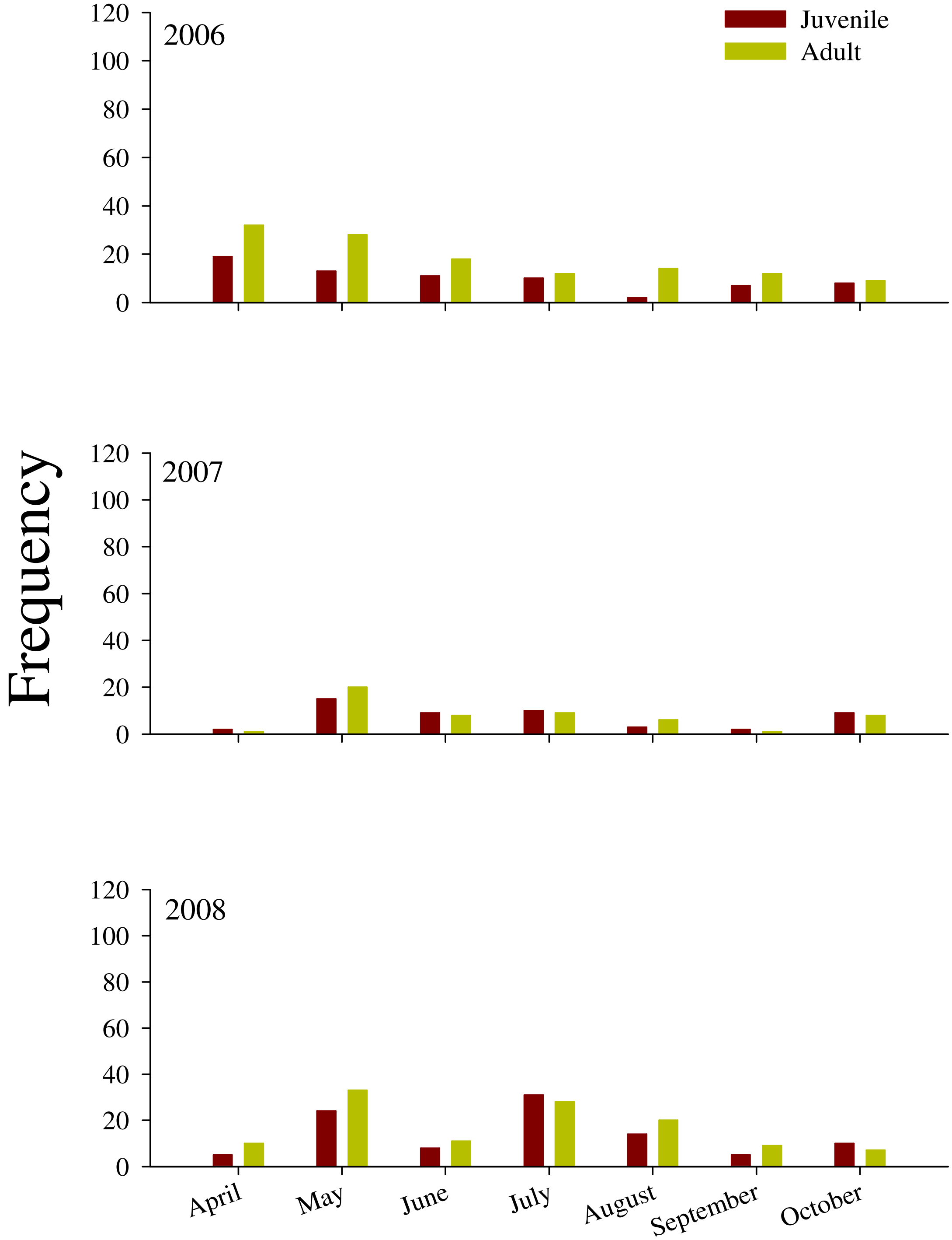


Figure III.8.16. Monthly frequency of juvenile (<540mm) and adult (≥540mm) shovelnose sturgeon caught at Deroin Bend from 2006 - 2008.

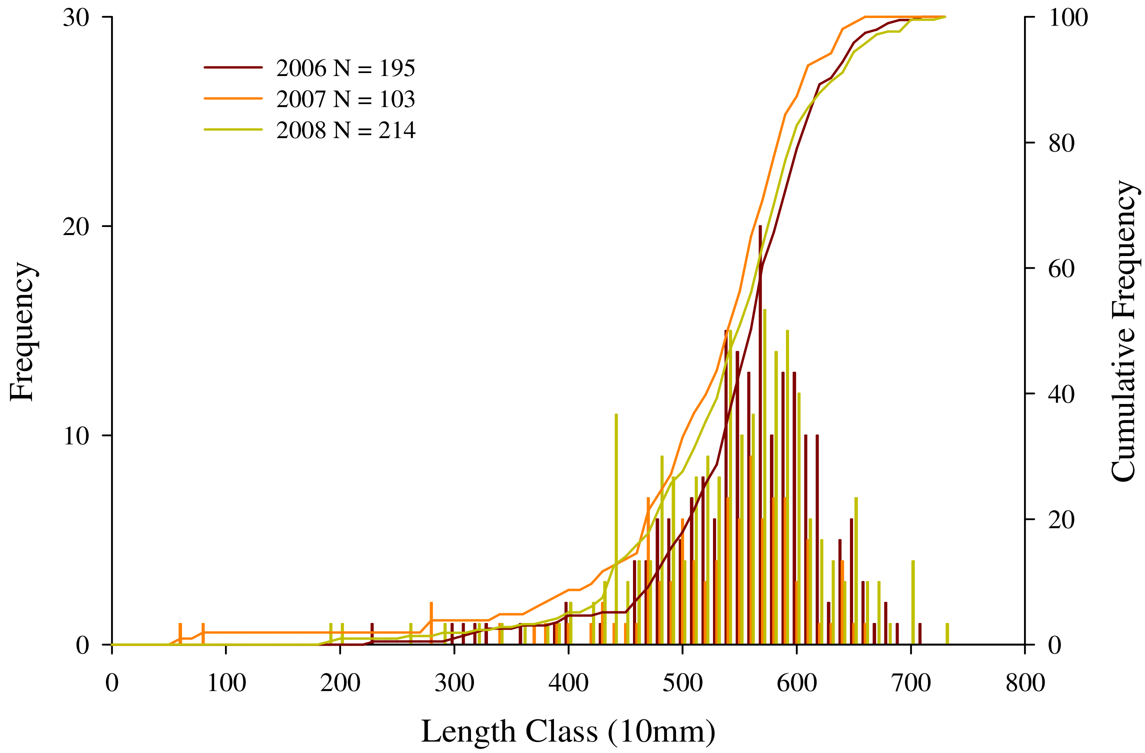


Figure III.8.17. Length frequency distributions and cumulative frequencies for measured shovelnose sturgeon (N) at Deroin Bend from 2006 – 2008.

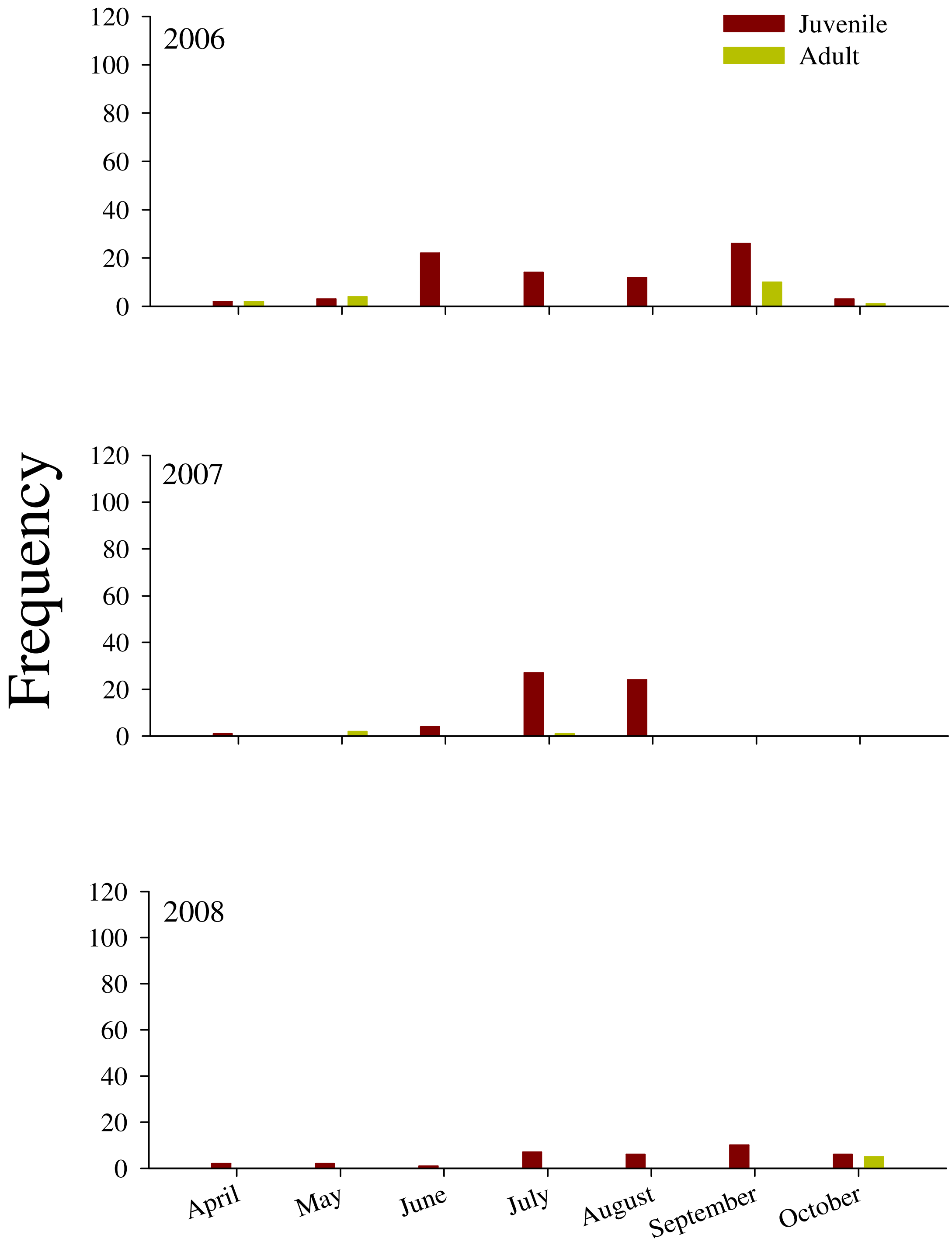


Figure III.8.18. Monthly frequency of juvenile (<89mm) and adult (≥89mm) silver chub caught at Deroin Bend from 2006 - 2008.

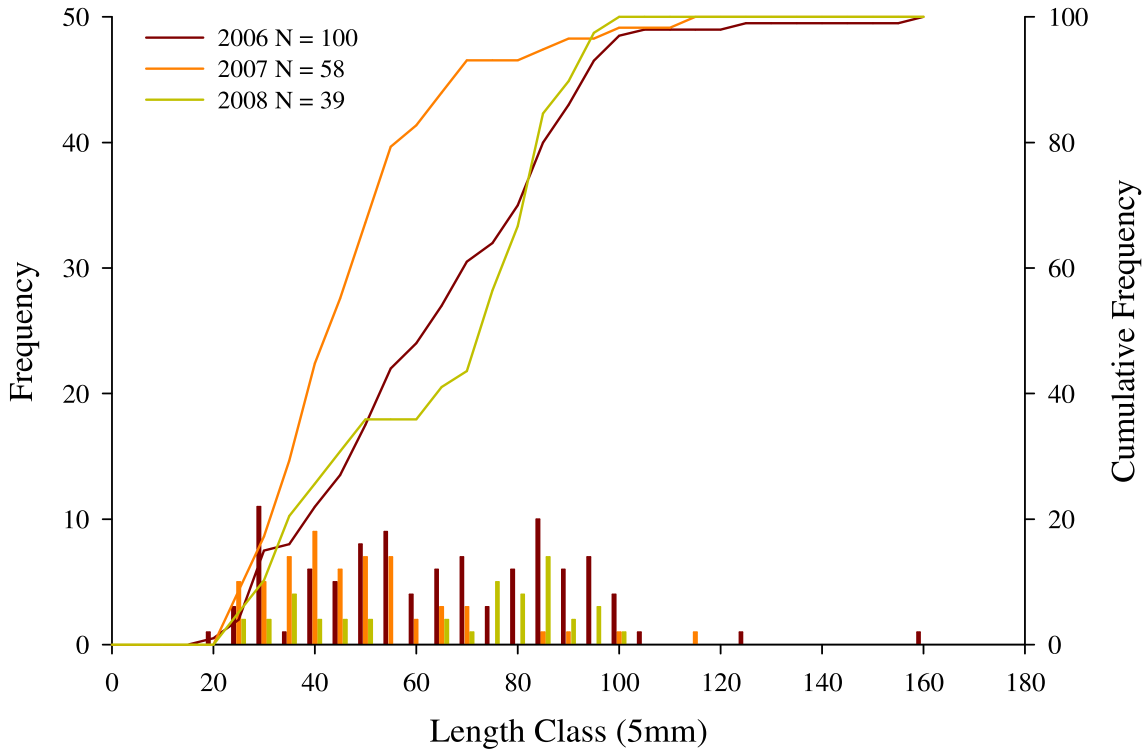


Figure III.8.19. Length frequency distributions and cumulative frequencies for measured silver chub (N) at Deroin Bend from 2006 – 2008.

FINAL REPORT

Missouri River Fish and Wildlife Mitigation Program

Fish Community Monitoring and Habitat Assessment of Off-channel Mitigation Sites

Section III Biological Monitoring (Chapters 9-12)

Tieville-Decatur Bend[1], Louisville Bend[1], Tyson Island[1], California Cut-Off[1,2], Tobacco Island[2], Upper and Lower Hamburg Bend[2,3], Kansas Bend[2,3], Deroin Bend[2,3], Lisbon Bottom[4], North Overton Bottoms[4], Tadpole Island[4] and Tate Island[4]

Prepared for the U.S. Army Corps of Engineers

By:

[1]Van Sterner and Royce Bowman
[2]Brandon Eder, Sabrina Negus and Gerald Mestl
[3]Kasey Whiteman, Darrick Garner and Vince Travnichek
[4]Joshua Schloesser, Joseph McMullen and Tracy Hill

April 2009

[1]Van Sterner and Royce Bowman
Contract number –
Iowa Department of Natural Resources
607 10th St
Onawa, Iowa 51040

[2]Brandon Eder, Sabrina Negus and Gerald Mestl
Contract number – W9128F-05-P-0171
Nebraska Game and Parks Commission
Missouri River Program – Fisheries Division
2200 North 33rd Street
Lincoln, NE 68503

[3]Kasey Whiteman, Darrick Garner and Vince Travnichek
Contract number – W912DQ-07-D-0001
Missouri Department of Conservation
Nodaway Valley CA
21999 Hwy B
Maitland, MO 64466

[4]Joshua Schloesser, Joseph McMullen and Tracy Hill
Contract number - W59XQG83460940
U.S. Fish and Wildlife Service
Columbia National Fish & Wildlife Conservation Office
101 Park DeVille Drive, Suite A
Columbia, MO 65203-0057

Executive Summary

The Missouri River has been developed for flood control, commercial navigation, irrigation, fish and wildlife conservation, municipal water supply, water quality control and hydropower production through a series of congressional acts. However, prior to development, the lower Missouri River was characterized by a highly sinuous to braided channel with abundant log jams, sand bars, secondary channels and cut-off channels. Construction of the Bank Stabilization and Navigation Project (BSNP) converted the lower Missouri River into a narrow, self scouring channel. The active channel downstream of Sioux City, Iowa was as wide as 1.8 km before river modification, but is now confined to a 91.4 m channel. Total river and floodplain habitat altered or destroyed by the BSNP is estimated at 211,246 hectares.

The Missouri River Fish and Wildlife Mitigation Project (Mitigation Project) was established to restore fish and wildlife habitat lost by the construction, operation and maintenance of the BSNP. The Water Resources Development Act of 1986 authorized the United States Army Corps of Engineers (COE) to acquire and develop habitat on 12,100 hectares of non public lands and the development of 7,365 hectares of habitat on existing public lands to mitigate habitat losses. The Water Resources Development Act of 1999 authorized an additional 48,016 hectares to the program. The Final Supplemental Environmental Impact Statement (FSEIS) for the expanded Mitigation Project was issued in March of 2003, and it included a preferred alternative proposing the creation of additional shallow water habitat (defined as areas less than 1.5 m deep with a current velocity of less than 0.76 m/s). The preferred action in the FSEIS for the expanded

Mitigation Project included creation of 2,833 to 8,094 hectares of shallow water habitat (SWH).

In 2005, the Iowa Department of Natural Resources, Nebraska Game and Parks Commission (NGPC), Missouri Department of Conservation and U.S. Fish and Wildlife Service, Columbia Fisheries Resource Office (renamed to Columbia National Fish and Wildlife Conservation Office) were contracted by the COE to monitor and evaluate fish communities of select off-channel aquatic habitat sites that were constructed through the Mitigation Project. Additionally, the NGPC was contracted to collect physical habitat information from the secondary channels that were selected for biological monitoring in the upper channelized section above Kansas City. Sixteen sites selected for monitoring covered a range of aquatic habitats including backwaters and secondary channels with varying levels of engineering and development. Sites from upstream to downstream included Tieville-Decatur Bend (two backwaters), Louisville Bend (backwater), Tyson Island (backwater), California Bend (chute on the Nebraska bank and a chute with connected backwater on the Iowa bank), Tobacco Island (chute), Upper and Lower Hamburg Bends (one chute each), Kansas Bend (two small chutes, treated as one), Deroin Bend (chute), Lisbon Bottom (natural chute), North Overton Bottoms (chute), Tadpole Island (chute) and Tate Island (chute). The study was designed to include three field sampling seasons, but due to delays implementing contracts in 2005 another complete year of sampling was added. Thus, fish community monitoring and habitat assessment of off-channel mitigation sites began in April, 2006 and concluded in October, 2008. The objective of this project was to determine biological performance and functionality of chutes and backwaters and to compare chutes and backwaters in an effort to identify

designs most beneficial to native Missouri River fish species. Additionally, this project was designed to help determine if additional modifications are needed at existing mitigation sites, if existing designs are providing a range of habitats, if these habitats are of value to the biological diversity of the Missouri River and if these habitats are of specific value to species of concern or importance, such as pallid sturgeon.

Chutes and backwaters were sampled monthly from April thru October 2006 – 2008. Each chute was divided into 16 sampling segments, and eight segments were randomly chosen without replacement each month for each gear type used. The standard gears used for this project include; trammel nets, large and small otter trawls, push trawls, bag seines, electrofishing, large and small diameter hoop nets and mini-fyke nets. Additional gears used only in backwaters include experimental gill nets and large frame trap nets. Set lines and hook and line were used as wild gears (gears in addition to those required for standard sampling), these gears were used to target pallid sturgeon.

Chutes and backwaters provided habitat for different fish communities. Chutes were found to have more riverine species while these species were lacking in backwaters. Contiguous backwaters had greater species diversity and richness than those that were impounded. This connection to the river allowed species to access these areas that they otherwise could not have.

Chutes separated themselves out geographically. The available fish community in the main channel affected the fish community in the chutes. Chutes that were located farther up the Missouri River tended to benefit different species than those on the lower end of the river. Therefore, the benefit of a chute to the overall fish community probably depended on if the chute provided something different than what was already found in the

main channel. Also more diverse fish communities were found in the older constructed and natural chutes. This is probably due to the greater habitat diversity these chutes have developed compared to the younger chutes.

Overall, the fish communities in most sites were dominated by juveniles of most species. The habitat that has been developed via chutes and backwaters therefore are functioning as refuges for smaller fish. This is a valuable asset to the fish communities in the Missouri River. Currently little is known if these juveniles are spawned or drifted into the chutes and backwaters. It is also unknown if these juveniles are able to move out of the chutes and backwaters and into the main channel.

Predictive models indicated that chutes had different probabilities of presence for target species. In general, chutes that were relatively longer, wider, shallower and had greater sinuosity were more likely to have target species present. Conversely, chutes that were short, had low width to depth ratios and low sinuosity were less likely to have target species present.

Important predictor variables for species presence were year (85% of species models), water depth (80%), turbidity (65%), water temperature (60%), month (60%) and water velocity (50%). A year effect, likely related to river discharge, for many species supports the need for multiple year assessment programs. Water depth and, to some extent, water velocity were recognized as two variables that can be manipulated by river engineers and we found that the selected range of depths and velocities varied by species, which was expected with a diverse fish community. Many juvenile and small-bodied fishes utilized shallow water habitats (<1.0 m) over a broad range of water velocities (0.0-1.0 m/s), but large-bodied fishes tended to orient towards relatively deeper water. Therefore, creating

shallow water habitats with a range of velocities would likely benefit many juvenile native species.

Mitigation Project designs are providing a range of habitats. Backwater habitats are creating a habitat not currently available in most reaches of the Missouri River. Different backwater designs do not appear to be creating different habitats from each other; however, backwaters can only be used by riverine fish if they are connected to the river. All chutes are providing some habitat diversity, however, some chutes, including; California (NE), Upper Hamburg, Lisbon and Tate contain more habitat diversity, and therefore, are providing much needed habitat complexity to that reach of the river.

Backwater and chute habitats appear to be beneficial to the biodiversity of the Missouri River system; however, it is important to note that different reaches of the river have different needs. The highly modified middle Missouri River, from Sioux City, IA to Kansas City, MO has very little habitat diversity available within the main channel and many different habitats may be necessary to restore the healthy function of the river system. While the lower Missouri River has greater habitat diversity within the main channel, there are still habitats that may be limited, such as habitat diverse chutes (e.g., Lisbon or Tate) or backwaters that may be needed to restore a fully functioning river.

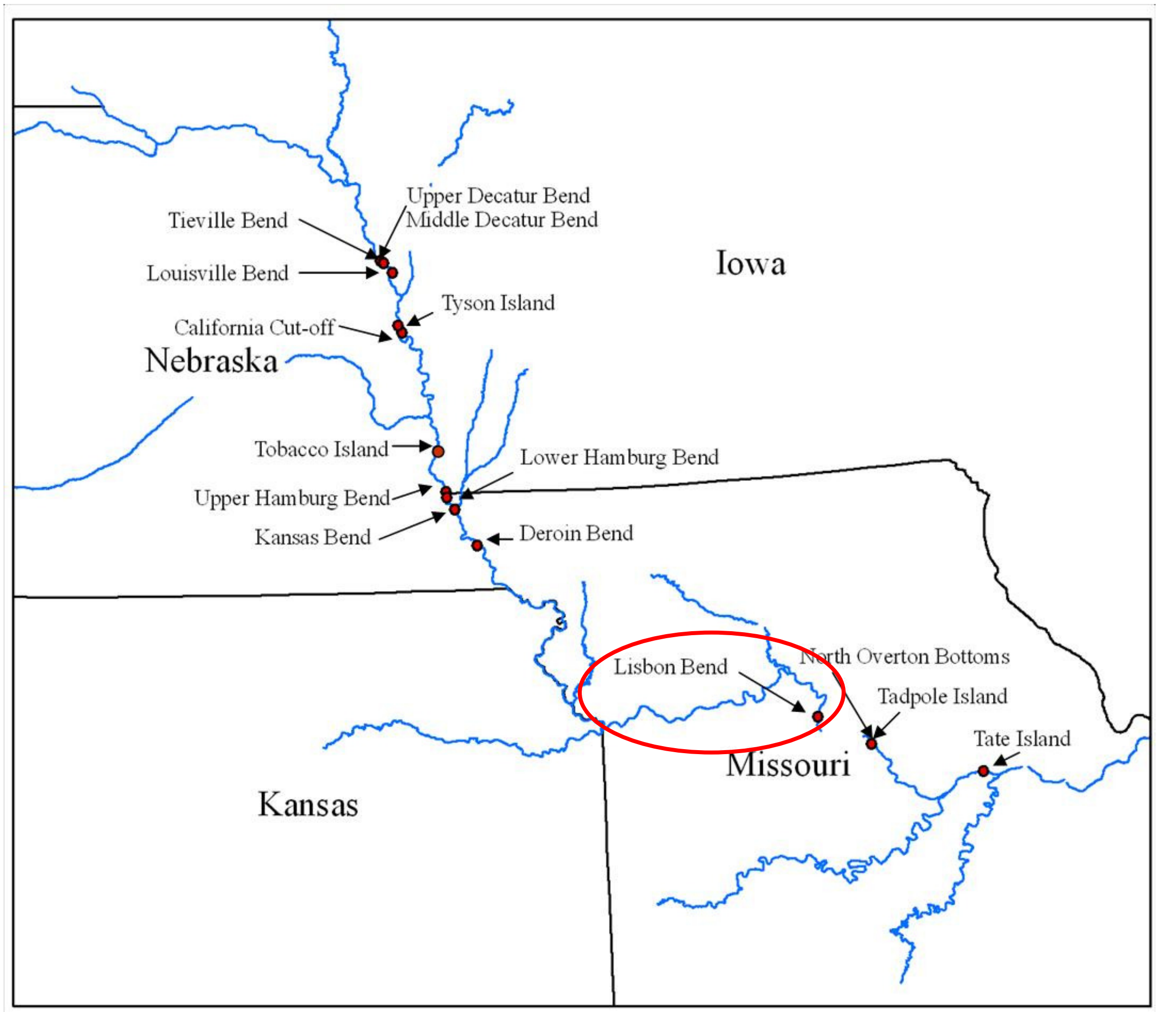
General Recommendations

- Promote natural side channel creation on suitable public lands. Allowing the river to naturally create side channel habitat may provide the most suitable habitat for riverine fish.
- We recommend constructing chutes that allow for floodplain connectivity, encourage natural river processes and maintain greater complexities of habitats (i.e. high width to depth ratios, diverse substrates, diverse depths, diverse velocities, shallow sandbars, woody debris and vegetated sandbars)
- Construction of longer chutes should receive higher priority than short chutes
- If a short chute must be built, build width, sinuosity and habitat diversity (deep scour holes, bar features and large woody debris).
- Promote channel movement through the use of structures or large woody debris.
- Soil type should be an important consideration in chute design, sites with clay or compacted soils need to be built to finished width or with wider pilot channels to hasten evolution.
- Slope banks when possible to allow large woody debris to accumulate in chutes rather than on high banks.
- Promote capture of large woody debris to increase habitat diversity and secondary productivity.
- Avoid designing chute entrances that may block upstream migration of fish (e.g., high sills or constricted entrances with high velocities and turbulence).
- Evaluate entrance structures to determine if certain life stages of some species (e.g., young of the year sturgeon) are being excluded from entering the chute.
- Avoid designs that promote sedimentation at chute entrances; keep entrances open so desired flows can be achieved.
- If a chute is intended to widen with increased main channel discharge, avoid designs where velocities decrease as main channel discharges increase such as at California (IA) and Kansas (upper).
- Use pilings, like those at Tate chute, instead of rip rap to create water control structures. Using pilings, as opposed to rock structures, may increase the permeability of water structures at varying levels of the water column, particularly the benthos.
- Include tie-channels and braids in chute designs to increase the amount of shallow, slow moving water at sites and provide more area that is in contact with the main channel.
- Design tie-channels, braids and connected backwaters to limit sedimentation.
- Tie channels can be used to direct flows to lower portions of the chute, allowing the upper portions to act more like backwater habitat.

- Create side channel habitat by building islands as opposed to digging channels, as was the case with Tate Island chute.
- Consider reopening existing, naturally formed side channels that are presently cut off from regular flows; there are at least 13 historic chutes that may be considered on the lower Missouri River.
- Contiguous dredged backwaters (such as Tyson Island and California (IA)) are recommended over impounded (disconnected) wetlands (such as Tieville, Louisville and Decatur). Contiguous sites provide connectivity that allows fish access to spawning and nursery habitat. Pumping did not provide accessible floodplain fish habitat.
- Backwaters should maintain a consistent, direct river connection. Open river connections are preferred over water control structures (culverts).
- Connectivity introduces sediment that will eventually fill backwaters. Siltation must be addressed by mechanical removal or improved backwater design.
- Backwaters of the upper channelized river become dewatered and isolated during winter discharges, backwaters should maintain adequate depth to prevent winter fish kills (approximately 3 m deep from December through February)
- Continued monitoring of chutes and backwaters would allow the determination of the rate at which the chute or backwater is evolving, the level of functionality that they can attain, value each chute has to different species, and how future manipulations affect the habitat and fish community.
- The variation in fish abundances seen among the three years of sampling indicates that a long term monitoring effort would be needed to detect population trends in chutes or backwaters. Furthermore, fish data from the chutes and backwaters should be compared to data from the main channel to determine how the chutes and backwaters are functioning with respect to main channel fish use.

TABLE OF CONTENTS

Section III
Chapter 9
Lisbon Bottom
Missouri



LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

Figure **Page #**

Key Findings

- Sampling efforts at Lisbon chute produced a greater overall abundance of fish than at other chutes on the lower Missouri River (i.e. Overton, Tadpole and Tate).
- Lisbon also supported the largest number of juvenile fish on the lower river. Young of the year chubs, minnows, suckers and sunfish were all abundant in Lisbon chute.
- Large numbers of juvenile fish were collected in 2007 and in some instances during 2006. The opposite was true in 2008, when very few juveniles were collected.
- Large numbers of riverine species such as shovelnose sturgeon, speckled chubs, red shiners and channel catfish were collected in Lisbon chute.
- Species richness was lowest in 2006.
- Shovelnose sturgeon, sicklefin chub and silver chub each had lower catch rates in 2006 than in subsequent years, suggesting habitat suitability for these species was different that year, perhaps in relation to different conditions in the main channel.
- Lisbon chute was the only lower Missouri River chute where pallid sturgeon were collected.
- Few young of the year sturgeon (*Scaphirhynchus spp.*) were captured in Lisbon chute despite the presence of large numbers of young of the year fish of other riverine species.
- Few *Hybognathus* species (Mississippi silvery minnow, plains minnow, and western silvery minnow) were found in Lisbon chute. However, *Hybognathus*

species were captured in greater numbers at Lisbon chute than at other lower Missouri River chutes.

- Non-target species were abundant in Lisbon chute, including blue catfish, bluntnose minnow, bullhead minnow, freshwater drum and longnose gar.
- Lisbon supported high numbers of game species such as blue and flathead catfish, black and white crappie and sauger.
- Wide variations in abundance and size of fish species occurred throughout the three year sampling period.
- Influences of flow and population abundance in the main channel make it difficult to interpret how the chute functions as habitat.

Recommendations

- Promote natural side channel creation on suitable public lands. Allowing the river to naturally create side channel habitat may provide the most suitable habitat for riverine fish.
- Lisbon chute's closing structure (at the head of the chute) should be evaluated to determine if certain life stages of some species (e.g., young of the year sturgeon) are being excluded from entering the chute.
- Lisbon chute, because of its natural origin, as well as its diversity of habitats and fish assemblages, should serve as a basis of comparison when evaluating created fish habitat in mitigated side-channels.

- Continued biological monitoring of Lisbon chute is critical to determine the level of functionality that created chutes will attain and to provide long term data on unique side channel habitats that may influence future mitigation projects.
- Because chute habitat availability and functionality is highly influenced by river stage, long term monitoring is necessary to understand the ecological role of chute habitat under a range of conditions.
- Future monitoring could be streamlined with the information obtained from intense monthly sampling efforts. These data that document which gears and times of the year were most efficient for collecting an array of species would make it possible to develop rapid bio-assessment technique that could be used for future monitoring.

Results

A total of 19,583 fish of 67 species, representing 16 families, were captured in Lisbon chute between 2006 and 2008 (Table III.9.1). A total of 2,258 fish (11.5% of the total catch) could not be identified beyond genus, or in some cases family, due to small size; most unidentified fish were juveniles, usually young of the year. The majority of unidentified fish from Lisbon chute were young-of-the-year chubs (*Macrhybopsis spp.*) and minnows (*Cyprinidae*). The 2007 sampling season recorded the highest number of fish in a single year when 8,664 individuals were captured, representing over 44% of the total catch at Lisbon chute. Species contributing to high 2007 catch rates included juvenile catfish, and small bodied fish such as bullhead minnow, bluntnose minnow, emerald shiner and red shiner. Species richness was also highest in 2007 with 59 species

collected in the chute (Table III.9.2, Fig III.9.1). Conversely, 2008 had the lowest number of fish caught (3,540) which is approximately 18% of the total catch at Lisbon. This may be attributed to reduced gear deployments in 2008, due to prolonged flood events during June and July (Table III.9.3).

The most abundant species captured in Lisbon chute between 2006 and 2008 was the river carpsucker, comprising 13.1% of the total catch (N = 2,557) (Table III.9.1), of which most were juveniles collected in 2006. Other numerically abundant species included red shiner (12%, N = 2,358), freshwater drum (10.9%, N = 2,129), channel catfish (8.1%, N = 1,593), gizzard shad (7.9%, 1,553), emerald shiner (7.8%, N = 1,533), and bullhead minnow (6.1%, N = 1,193). Freshwater drum and gizzard shad numbers at Lisbon were evenly distributed among years; however abundant minnow and shiner species had higher numbers in 2007, when high catches of juveniles were recorded. Unidentified chubs and minnows represented 3.4% (N = 660) and 2.9% (N = 565) of the total catch respectively. Unidentified minnows followed the same pattern as those abundant minnow and shiner species previously mentioned, having greater numbers in 2007. Most chub species were more abundant in 2006, as were unidentified chubs. Shovelnose sturgeon represented 2.2% (N = 428) of the total catch at Lisbon and were one of a few species that were most abundant in 2008. Speckled and silver chubs represented 2.1% (N = 408) and 1.9% (N = 365) of the total catch respectively.

Target species accounts for Lisbon chute are presented hereafter, in alphabetical order with analysis (Table III.9.1). Mean catch per unit effort (CPUE) values for target species were analyzed with a Kruskal-Wallis test (Table III.9.4) to detect differences among years; raw CPUE values are presented in Table III.9.5. Mean length values for

target species were tested with analysis of variance; mean length values and the results of analysis are presented in Table III.9.6. Length frequency distributions for target species are presented in Figures III.9.2 through III.9.23 in alphabetical order by common name. Proportions of adult and juvenile target species were analyzed with a z-test, the results of which are presented in Table III.9.7. Life stage frequency graphs for target species are presented in Figures III.9.24 through III.9.45 in alphabetical order by common name. Tables and figures are not referenced hereafter. The contents of all tables are in alphabetical order by fish's common name. Figures and species accounts are ordered alphabetically, by fish's common name, with one exception; *Hybognathus* species (plains minnow, Mississippi silvery minnow and western silvery minnow) were combined, and labeled as such because of extremely low numbers of these species.

Bighead carp

Few bighead carp were captured in Lisbon chute but their numbers were evenly distributed among years. Fish were primarily captured in large hoop nets but were also collected in mini-fyke nets and while electrofishing. There were no differences in catch rates of bighead carp among years with any gear. There were no differences in the mean length of bighead carp among years with any gear. However, length frequency distributions in 2006 show several smaller, young of the year fish that were captured in mini-fyke nets. There was no difference in life stage proportions of bighead carp among years but 2006 was the only year when young of the year of fish were captured.

Blue sucker

Blue suckers were documented in low numbers in Lisbon chute; fish were most commonly captured while electrofishing but were collected with large hoop nets, mini-fykes, otter trawls and trammel nets. There were no differences in catch rates of blue sucker among years. There was no difference in the mean length of blue sucker among years with any gear. There was no difference in life stage proportions of blue sucker among years. Juvenile blue suckers and young of the year are rare in the main channel of the lower Missouri River (Plauk 2007), but were found during each year of sampling in Lisbon chute.

Channel catfish

Nearly 1,600 channel catfish were captured at Lisbon, over half of which were collected in 2007. Channel catfish were collected with all gears; catch rates were the highest in otter trawls and mini-fyke nets but electrofishing and small hoop nets also consistently caught channel catfish. Both otter trawls and push trawls had significantly different catch rates of channel catfish among years. Fewer fish were captured in otter trawls in 2008 than any other year. Fewer fish were captured in push trawls in 2006 than in 2007. Mean length of channel catfish varied among all years in small hoop nets. Mean length of channel catfish captured in otter trawls was higher in 2008. Fewer juvenile channel catfish were caught in 2007 compared to other years. Overall, juvenile channel catfish were much more abundant than adults and were most common during August and September.

Common Carp

Common carp were regularly collected in Lisbon chute, with the highest number of fish captured during 2007. Fish were collected most consistently and effectively by electrofishing; however, high catch rates were also encountered in mini-fyke nets. Common carp were also caught with large and small hoop nets. The only difference in catch rates of common carp was a significantly higher catch in mini-fyke nets in 2007. Mean length of fish captured in small hoop nets was smaller during 2007. Mean length of fish collected in mini-fyke nets was larger in 2006 than in 2007. No common carp were documented in mini-fyke nets during 2008, suggesting poor recruitment. All years differed with respect to life stage proportions of common carp. During 2007 a large number of young of the year fish were captured, nearly all of which were collected in June.

Emerald shiner

Over 1,500 emerald shiners were captured in Lisbon chute, with the highest numbers recorded in 2007. Emerald shiners were collected most effectively with mini-fyke nets but were also consistently captured while electrofishing and in push trawls; few emerald shiners were caught with otter trawls. There was no difference in catch rates of emerald shiners among years with any gear, except otter trawls; no emerald shiners were captured in otter trawls in 2008. Mean length of emerald shiners captured in mini-fyke nets varied among all years; progressively smaller fish were captured over the course of the study. Conversely, the mean length of fish caught in mini-fyke nets was higher in 2008 than in previous years. In general, mini-fyke nets and electrofishing collected

larger individuals than push trawls. Life stage proportions of emerald shiners were different in 2006 when juveniles represented a larger percentage of the total catch.

Flathead catfish

There were 256 flathead catfish collected at Lisbon chute and the highest catch was in 2007. Flathead catfish were caught with every gear except trammel nets. The most effective gears were large and small hoop nets but flathead catfish were routinely collected while electrofishing. Catch rates of flathead catfish in small hoop nets were lower in 2006 than in other years. Mean length of flathead catfish was consistent among years in all gears except large hoop nets. Mean length of fish caught in large hoop nets in 2008 was smaller than in other years. Life stage proportions of flathead catfish were different in 2008, when the total catch was comprised of a larger percentage of adults than in previous years. Most juveniles were collected in 2007 and this was the only year when young of the year fish were collected. In general adults were captured consistently throughout the year while juveniles were most abundant in July and August.

Gizzard shad

Over 1,500 gizzard shad were captured in Lisbon chute; catch rates were fairly constant among years. Gizzard shad were collected with all gears except small hoop nets. Electrofishing had the highest catch rates for gizzard shad and most consistently caught the species. Catch rates were consistent among years for all gears except mini-fyke nets. Gizzard shad catches in mini-fyke nets were smaller in 2006 than in other years. Mean length of gizzard shad caught by electrofishing, large hoop nets, mini-fyke nets and push

trawls varied among years. In 2006, fish captured by electrofishing, mini-fyke nets and push trawls were significantly larger than in other years. Mean length of fish captured in large hoop nets was greater in 2007. Life stage frequencies of gizzard shad were different in 2006, when the total catch was comprised of a larger percentage of adults than in subsequent years. In general gizzard shad catches were highest during June, July and August when large numbers of juveniles were present.

Goldeye

There were 183 goldeye captured in Lisbon chute, most of which were collected in 2007. Goldeye were collected in all gears except small hoop nets. Electrofishing captured goldeye most effectively and consistently. Catch rates for goldeye were constant among years with all gears. Mean length of goldeye captured while electrofishing was lowest in 2007. Conversely, mean length of fish collected in mini-fyke nets was highest in 2007. Life stage proportions of goldeye were different in 2006, the only year when adult fish were captured.

***Hybognathus* species**

There were 28 individuals captured in Lisbon chute that belonged to the genus *Hybognathus*. One Mississippi silvery minnow, 18 plains minnows and nine western silvery minnows were captured. Capture of *Hybognathus* species was highest during 2008. *Hybognathus* species were caught most consistently and effectively in mini-fyke nets but were also collected electrofishing and in push trawls. No *Hybognathus* species exhibited different catch rates among years for any gear. Mean length of western silvery

minnow captured in mini-fyke nets was greater in 2008 than in 2007. Mean lengths of all other *Hybognathus* species were similar among years with all gears. Life stage proportions of *Hybognathus* species were consistent among years. The majority of individuals were captured during August; none were caught prior to August. All fish captured were juveniles.

Pallid sturgeon

Two pallid sturgeon were caught in Lisbon chute. Both fish were collected in otter trawls during 2008, one in April and the other in September. There was no difference in catch rates, mean lengths or life stage proportions of pallid sturgeon among years. Both pallid sturgeon captured in Lisbon were of similar size (615 mm fork length) and each was presumed to be a wild fish, possessing no markings of any kind. Lisbon was the only of the four lower Missouri River side channels (Lisbon, Overton, Tadpole and Tate) where pallid sturgeon were collected.

Red shiner

Over 2,300 red shiners were captured in Lisbon chute, with highest numbers of individuals being collected in 2007. Red shiners were collected most consistently while electrofishing but mini-fyke nets had the highest catch rates. Push trawls were also effective at catching red shiners, while otter trawls caught few fish. Catch rates for red shiners varied among years while electrofishing and in mini-fyke nets. Electrofishing catch rates were higher in 2007 than in 2008, while mini-fyke nets had higher catch rates in 2006 than in 2008. Overall, 2008 had relatively low catch rates of red shiners in all

gears, contributing to the overall decrease in fish abundance witnessed in Lisbon during 2008. Mean length of red shiners collected while electrofishing and in mini-fyke nets and push trawls varied among years. The mean length of red shiners caught while electrofishing was progressively smaller over the course of the study. However, red shiners caught in mini-fyke nets and push trawls were smallest in 2007. Life stage proportions of red shiners were different in 2006 than in subsequent years, when adults made up a much larger percentage of the population. Overall, red shiners were captured throughout the year but were collected in the greatest numbers during July, August and September.

River carpsucker

River carpsucker was the most abundant species collected in Lisbon chute; over 2,500 individuals were captured, with the majority of fish caught in 2006. River carpsuckers were collected with all gears. Electrofishing caught fish most consistently but mini-fyke nets had some of the highest catch rates. Catch rates of river carpsuckers collected in mini-fyke nets, otter trawls and push trawls was highest in 2006. Mean length of fish caught in mini-fyke nets, otter trawls and push trawls varied. In mini-fyke nets and push trawls progressively larger fish were collected over the course of the study, while otter trawls caught larger fish in 2007. Life stage proportions of river carpsucker varied among all years. The 2006 catches were dominated by juvenile fish; 2007 catches had a more even distribution of adults and juveniles and in 2008 adults made up a larger percentage of the total catch. In general, adult river carpsucker numbers varied little with

respect to month, while juveniles of the species were most abundant during July and August.

River shiner

There were 167 river shiners collected in Lisbon chute but as with most shiner species they were found in greater numbers during 2007. Fish were collected in mini-fyke nets most effectively and consistently but were also collected while electrofishing and in otter and push trawls. There was no difference in catch rates of river shiners among years with any gear. The mean length of river shiners caught in mini-fyke nets was smallest in 2008. Life stage proportions of river shiners were different in 2006 when adults made up a larger percentage of the total population.

Sand shiner

Fifty sand shiners were collected at Lisbon chute, with the majority of the catch occurring in 2007. Mini-fyke nets collected sand shiners most effectively but fish were caught while electrofishing and in push trawls. There was no difference in catch rates of sand shiners among years with any gear. Mean length of sand shiners caught in push trawls was different in 2006 than in other years, when smaller fish were collected. However, juveniles made up a larger proportion of the total catch in 2007.

Sauger

There were only 37 sauger collected at Lisbon chute, however sauger numbers were higher in Lisbon than in other lower river side channels. Sauger were collected

most effectively while electrofishing but were also captured in large hoop nets, otter trawls, push trawls and trammel nets. There was no difference in catch rates of sauger among years with any gear. Mean length of sauger captured in otter trawls was greater in 2008 than in 2006. Juveniles made up a larger proportion of the total catch in 2006 than in 2008.

Shortnose gar

Nearly 300 shortnose gar were collected in Lisbon chute and their numbers were evenly distributed among years. Shortnose gar were captured with every gear. Electrofishing caught fish most consistently but trammel nets and mini-fyke nets had some of the highest catch rates. Catch rates of shortnose gar caught while electrofishing and in large hoop nets were higher in 2008 than in 2007. The mean length of fish caught while electrofishing was highest in 2007. Life stage proportions of shortnose gar were different in 2008, when juveniles made up a larger percentage of the total catch. In general adults were present throughout the year, while juveniles were captured almost exclusively in August, September and October.

Shovelnose sturgeon

Over 400 shovelnose sturgeon were collected in Lisbon chute. Shovelnose sturgeon were caught in every gear except mini-fyke nets. Electrofishing, large hoop nets, otter trawls and trammel nets all consistently caught fish but trammel nets had the highest catch rates. Catch rates of shovelnose sturgeon collected while electrofishing, in large hoop nets, otter trawls and trammel nets were lower in 2006 than in other years.

There was no difference in the mean lengths of shovelnose sturgeon among years with any gear. There was no difference in the proportions of adults and juvenile shovelnose sturgeon among years. Despite a large number of juvenile fish being collected at Lisbon chute, very few, young of the year fish were collected.

Sicklefin chub

Only about 100 sicklefin chubs were captured in Lisbon chute, nearly all in 2006. Sicklefin chubs were caught most consistently in mini-fyke nets; however the highest catch rates occurred in otter trawls. Fish were also collected by electrofishing and in push trawls. Catch rates of sicklefin chubs collected in mini-fyke nets and otter trawls were higher in 2006 than in other years. The mean length of fish caught in mini-fyke nets was larger in 2008 than in 2006; no sicklefin chubs were collected in mini-fyke nets during 2007. The mean length of fish caught in push trawls was smallest in 2007. Life stage proportions of sicklefin chubs varied among years. In 2006, catches were dominated by juvenile fish, whereas in 2008 catches included mostly adult fish. In general sicklefin chubs were most abundant in July, August and September.

Silver carp

There were 39 silver carp collected in Lisbon chute, with the highest catch occurring in 2008. Silver carp were collected most consistently while electrofishing but mini-fyke nets had some of the highest catch rates for the species; large hoop nets and push trawls also captured silver carp. Catch rates were lower for silver carp caught while electrofishing in 2007. The mean length of silver carp caught in mini-fyke nets was

larger in 2008 than in previous years. Life stage proportions of silver carp were different in 2007, when juveniles made up a larger percentage of the total catch than other years. In general, juvenile silver carp were most abundant later in the year, from June to October, while adults were most commonly collected during April and May.

Silver chub

There were 365 silver chubs collected in Lisbon chute; the large majority of fish were collected in 2006. Silver chubs were collected while electrofishing and in mini-fyke nets, otter trawls and push trawls; the highest catch rates were with otter trawls. Catch rates of silver chubs caught in otter trawls was highest in 2006, while the rate of fish caught while electrofishing in 2007 was lower than other years. Mean length of silver chubs captured in mini-fyke nets, otter trawls and push trawls was progressively larger over the course of the study. In general, mini-fyke nets collected smaller fish than push trawls, while otter trawls collected the largest individuals. There was no difference in life stage proportions of silver chubs among years. Silver chub catches were dominated by juveniles of the species during all years.

Speckled chub

Speckled chubs were the most abundant chub species in Lisbon chute; 408 speckled chubs were collected at Lisbon chute. Unlike other chub species, speckled chub numbers were greatest in 2007. Speckled chubs were collected in mini-fyke nets, otter trawls and push trawls; otter trawls had the highest catch rates. Catch rates of fish captured in push trawls was smallest in 2006. Mean lengths of speckled chubs caught in

otter trawls and push trawls was greater in 2008 than in previous years. Fish caught in mini-fyke nets had a smaller mean length in 2007 than in other years. Life stage proportions of speckled chubs differed in 2007 when juveniles made up a larger percentage of the total catch. In general adults of the species were captured throughout the year while juveniles were usually collected later in the year (August, September and October).

Sturgeon chub

Five sturgeon chubs were collected from Lisbon chute. Fish were collected primarily in mini-fyke nets but one fish was collected in an otter trawl. There was no difference in catch rates, mean lengths, or life stage proportions of sturgeon chubs among years. Adult fish were documented in May and September, while juvenile fish were only collected after September.

Table III.9.1. Common name, scientific name, family, number of fish collected and percent of total catch, of all species caught in Lisbon chute 2006 – 2008. Target species are bold.

Common Name	Scientific Name	Family	2006	2007	2008	Total	% Catch
Bighead carp	***Hypophthalmichthys nobilis***	*Cyprinidae*	6	5	4	15	0.08
Bigmouth buffalo	*Ictiobus cyprinellus*	*Catostomidae*	4	55	9	68	0.35
Bigmouth shiner	*Notropis dorsalis*	*Cyprinidae*	0	5	1	6	0.03
Black buffalo	*Ictiobus niger*	*Catostomidae*	0	1	0	1	0.01
Black crappie	*Pomoxis nigromaculatus*	*Centrarchidae*	2	38	4	44	0.22
Blackside darter	*Percina maculata*	*Percidae*	1	0	1	2	0.01
Blue catfish	*Ictalurus furcatus*	*Ictaluridae*	41	117	60	218	1.11
Blue sucker	***Cycleptus elongatus***	*Catostomidae*	3	7	6	16	0.08
Bluegill	*Lepomis macrochirus*	*Centrarchidae*	15	64	51	130	0.66
Bluntnose minnow	*Pimephales notatus*	*Cyprinidae*	63	157	22	242	1.24
Brook silverside	*Labidesthes sicculus*	*Atherinidae*	1	1	0	2	0.01
Bullhead minnow	*Pimephales vigilax*	*Cyprinidae*	561	592	40	1193	6.09
Channel catfish	***Ictalurus punctatus***	*Ictaluridae*	280	905	408	1593	8.13
Channel shiner	*Notropis wickliffi*	*Cyprinidae*	3	115	3	121	0.62
Chestnut lamprey	*Ichthyomyzon castaneus*	*Petromyzontidae*	0	0	1	1	0.01
Common carp	***Cyprinus carpio***	*Cyprinidae*	45	162	53	260	1.33
Creek chub	*Semotilus atromaculatus*	*Cyprinidae*	86	2	0	88	0.45
Emerald shiner	***Notropis atherinoides***	*Cyprinidae*	542	724	267	1533	7.83
Fathead minnow	*Pimephales promelas*	*Cyprinidae*	2	2	1	5	0.03
Flathead catfish	***Pylodictis olivaris***	*Ictaluridae*	51	123	82	256	1.31
Freshwater drum	*Aplodinotus grunniens*	*Sciaenidae*	835	832	462	2129	10.87
Gizzard shad	***Dorosoma cepedianum***	*Clupeidae*	425	577	551	1553	7.93
Goldeye	***Hiodon alosoides***	*Hiodontidae*	47	79	57	183	0.93
Goldfish	*Carassius auratus*	*Cyprinidae*	0	0	1	1	0.01
Grass carp	***Ctenopharyngodon idella***	*Cyprinidae*	11	22	18	51	0.26
Green sunfish	*Lepomis cyanellus*	*Centrarchidae*	7	21	5	33	0.17
Highfin carpsucker	*Carpiodes velifer*	*Catostomidae*	0	8	1	9	0.05
Johnny darter	*Etheostoma nigrum*	*Percidae*	1	0	0	1	0.01
Largemouth bass	*Micropterus salmoides*	*Centrarchidae*	15	15	2	32	0.16
Logperch	*Percina caprodes*	*Percidae*	0	1	0	1	0.01
Longnose gar	*Lepisosteus osseus*	*Lepisosteidae*	124	54	49	227	1.16
Mimic shiner	*Notropis volucellus*	*Cyprinidae*	3	26	0	29	0.15
Mississippi silvery minnow	***Hybognathus nuchalis***	*Cyprinidae*	0	1	0	1	0.01
Orangespotted sunfish	*Lepomis humilis*	*Centrarchidae*	7	7	27	41	0.21
Paddlefish	*Polyodon spathula*	*Polyodontidae*	1	2	8	11	0.06
Pallid sturgeon	***Scaphirhynchus albus***	*Acipenseridae*	0	0	2	2	0.01
Plains minnow	***Hybognathus placitus***	*Cyprinidae*	0	6	12	18	0.09

Table III.9.1 (continued). Common name, scientific name, family, number of fish collected and percent of total catch, of all species caught in Lisbon chute 2006 – 2008. Target species are bold.

Common Name	**Scientific Name**	**Family**	**2006**	**2007**	**2008**	**Total**	**% Catch**
Quillback	*Carpiodes cyprinus*	*Catostomidae*	1	0	2	3	0.02
Rainbow smelt	*Osmerus mordax*	*Osmeridae*	2	0	0	2	0.01
Red shiner	***Cyprinella lutrensis***	*Cyprinidae*	792	1262	304	2358	12.04
River carpsucker	***Carpiodes carpio***	*Catostomidae*	2075	322	160	2557	13.06
River redhorse	*Moxostoma carinatum*	*Catostomidae*	0	1	0	1	0.01
River shiner	***Notropis blennius***	*Cyprinidae*	17	139	11	167	0.85
Sand shiner	***Notropis stramineus***	*Cyprinidae*	18	25	7	50	0.26
Sauger	***Stizostedion canadense***	*Percidae*	9	7	21	37	0.19
Shorthead redhorse	*Moxostoma macrolepidotum*	*Catostomidae*	0	1	0	1	0.01
Shortnose gar	***Lepisosteus platostomus***	*Lepisosteidae*	81	95	119	295	1.51
Shovelnose sturgeon	***Scaphirhynchus platorynchus***	*Acipenseridae*	29	144	255	428	2.19
Sicklefin chub	***Macrhybopsis meeki***	*Cyprinidae*	88	3	11	102	0.52
Silver carp	***Hypophthalmichthys molitrix***	*Cyprinidae*	13	8	18	39	0.20
Silver chub	***Macrhybopsis storeriana***	*Cyprinidae*	207	39	119	365	1.86
Skipjack herring	*Alosa chrysochloris*	*Clupeidae*	5	1	2	8	0.04
Smallmouth bass	*Micropterus dolomieu*	*Centrarchidae*	0	1	0	1	0.01
Smallmouth buffalo	*Ictiobus bubalus*	*Catostomidae*	3	36	14	53	0.27
Speckled chub	***Macrhybopsis aestivalis***	*Cyprinidae*	138	188	82	408	2.08
Spotted bass	*Micropterus punctulatus*	*Centrarchidae*	1	0	0	1	0.01
Stonecat	*Noturus flavus*	*Ictaluridae*	0	3	0	3	0.02
Striped bass	*Morone saxatilis*	*Moronidae*	0	1	0	1	0.01
Striped bass x White bass	*Morone saxatilis x chrysops*	*Moronidae*	1	1	3	5	0.03
Sturgeon chub	***Macrhybopsis gelida***	*Cyprinidae*	2	1	2	5	0.03
Suckermouth minnow	*Phenacobius mirabilis*	*Cyprinidae*	2	5	0	7	0.04
Threadfin shad	*Dorosoma petenense*	*Clupeidae*	0	2	0	2	0.01
Walleye	*Sander vitreum*	*Percidae*	0	1	1	2	0.01
Western mosquitofish	*Gambusia affinis*	*Poeciliidae*	32	25	33	90	0.46
Western silvery minnow	***Hybognathus argyritis***	*Cyprinidae*	0	3	6	9	0.05
White bass	*Morone chrysops*	*Moronidae*	20	18	10	48	0.25
White crappie	*Pomoxis annularis*	*Centrarchidae*	3	103	52	158	0.81
Yellow bullhead	*Ameiurus natalis*	*Ictaluridae*	1	1	1	3	0.02
Unidentified[1] buffalo	*Catostomidae*	*Catostomidae*	0	73	12	85	0.43
Unidentified catfish	*Ictaluridae*	*Ictaluridae*	1	34	1	36	0.18
Unidentified chub	*Macrhybopsis* spp.	*Cyprinidae*	474	167	19	660	3.37
Unidentified gar	*Lepisosteidae*	*Lepisosteidae*	0	1	0	1	0.01

Table III.9.1 (continued). Common name, scientific name, family, number of fish collected and percent of total catch, of all species caught in Lisbon chute 2006 – 2008. Target species are bold.

Common Name	Scientific Name	Family	2006	2007	2008	Total	% Catch
Unidentified herring	*Clupeidae*	*Clupeidae*	0	2	0	2	0.01
Unidentified *Hybognathus spp.*	*Hybognathus spp.*	*Cyprinidae*	0	11	8	19	0.10
Unidentified minnow	*Cyprinidae*	*Cyprinidae*	4	536	6	546	2.79
Unidentified sucker	*Catostomidae*	*Catostomidae*	0	297	35	332	1.70
Unidentified sunfish	*Centrarchidae*	*Centrarchidae*	10	13	109	132	0.67
Unidentified temperate bass	*Morone* spp.	*Moronidae*	0	19	0	19	0.10
Unidentified	Unidentified		68	49	0	117	0.60
Young-of-year fish	Unidentified		0	300	9	309	1.58
		Total	7279	8664	3640	19583	

[1]Fish labeled as ‘unidentified’ were unidentifiable due to being in larval or juvenile life stages, damage or disfigurement.

Table III.9.2. Species richness (S), species evenness (E), Shannon's diversity index (H) and Simpson's diversity index (D) for Lisbon chute by year

Year	S	E	H	D
2006	50	0.5748	2.2487	0.8036
2007	59	0.7048	2.8740	0.9126
2008	51	0.7918	3.1134	0.9343

Table III.9.3. Sampling effort (number of gear deployments) in Lisbon chute by year and gear

Year	Gear	April	May	June	July	August	September	October
2006	EF	9	9	8	5	4	6	
	HN	7	8	6	3	3	8	
	MF	6	6	1	5	8	6	
	OT16			7	6	8	8	
	POT			7		19		
	SHN	7	8	6	5	8	8	
	TN	7	6	4	6	8	8	
2007	EF	8	8	8	11	16	8	
	HN	8	7	8	8	8	7	
	MF			8	8	8	8	
	OT16	8		8	8	8		8
	POT			8	8	8	8	
	SHN	8	8	8	8	8	8	
	TN	8		8	8	8		8
2008	EF	8	8			8	8	8
	HN	8	8		8	8	8	8
	MF				8	8	8	8
	OT16	8	8		8	8	8	8
	POT				8	8	8	8
	SHN	8	8		8	8	8	8
	TN	8	8		8	8	8	8

Gears: EF = electrofishing, HN = 4' diameter hoop nets, MF = mini-fyke nets, OT16 - 16' otter trawls, OT8 = 8' otter trawls, POT = 8' otter trawls pushed, SHN = 2' diameter hoop net, TN = the combined efforts of trammel nets in 25' increments either drifted or set stationary.

Table III.9.4. Yearly mean catch per unit effort (CPUE) and results of Kruskal-Wallis test of mean CPUE of target species caught in Lisbon chute by species and gear. Significant results are bold.

Species	Gear	Mean CPUE			06 v 07 v 08		06 v 07		06 v 08		07 v 08	
		2006	2007	2008	Chi	P	Chi	P	Chi	P	Chi	P
Bighead carp	EF	0.00	0.01	0.00	1.29	0.5252						
	HN	0.00	0.07	0.07	2.33	0.3123						
	MF	0.60	0.00	0.00	4.04	0.1325						
Blue Sucker	EF	0.00	0.03	0.03	2.60	0.2728						
	HN	0.00	0.00	0.04	3.40	0.1825						
	MF	0.00	0.04	0.00	4.04	0.1325						
	OT	0.00	0.01	0.00	1.93	0.3819						
	TN	0.00	0.00	0.09	1.42	0.4925						
Channel Catfish	EF	0.30	0.52	0.44	3.07	0.2156						
	HN	0.30	0.32	0.29	1.47	0.4793						
	MF	0.23	0.70	0.71	3.69	0.1579						
	OT	1.60	3.12	0.92	**11.29**	**0.0035**	0.00	0.9505	**9.97**	**0.0016**	**6.87**	**0.0088**
	POT	0.04	0.87	0.41	**7.02**	**0.0299**	**6.73**	**0.0095**	3.79	0.0516	0.84	0.3584
	SHN	0.45	0.46	1.64	0.70	0.7042						
	TN	0.09	0.10	0.00	3.05	0.2192						
Common Carp	EF	0.35	0.42	0.24	1.05	0.5908						
	HN	0.05	0.02	0.11	3.74	0.1538						
	MF	1.16	1.70	0.00	**13.95**	**0.0009**	**5.66**	**0.0173**	2.03	0.154	**10.23**	**0.0014**
	SHN	0.03	0.02	0.13	4.39	0.1116						
Emerald Shiner	EF	0.80	0.28	0.37	1.39	0.4991						
	MF	10.90	10.23	3.68	1.45	0.4832						
	OT	0.06	0.02	0.00	**8.65**	**0.0132**	3.00	0.0834	**6.89**	**0.0087**	1.20	0.2733
	POT	0.08	0.17	0.09	0.59	0.7453						
Flathead Catfish	EF	0.27	0.34	0.17	**4.61**	**0.0997**	4.07	0.0437	0.54	0.4625	1.83	0.1765
	HN	0.10	0.29	0.36	3.89	0.1433						
	MF	0.00	0.02	0.00	2.00	0.3679						
	OT	0.06	0.03	0.02	1.40	0.4968						
	POT	0.00	0.01	0.00	4.32	0.1154						
	SHN	0.25	0.63	0.68	**6.38**	**0.0412**	**5.08**	**0.0242**	**5.12**	**0.0236**	0.01	0.9387
Gizzard Shad	EF	8.73	1.53	1.34	**6.38**	**0.0412**	**4.91**	**0.0267**	**5.06**	**0.0244**	0.03	0.8648
	HN	0.04	0.11	0.25	1.19	0.5516						
	MF	0.05	5.13	8.20	**19.98**	**<0.0001**	**16.89**	**<0.0001**	**17.42**	**<0.0001**	0.19	0.6596
	OT	0.00	0.03	0.00	3.88	0.1435						
	POT	0.00	0.05	0.04	4.14	0.126						
	TN	0.11	0.15	0.00	3.73	0.1552						
Goldeye	EF	0.25	0.32	0.46	3.26	0.1957						
	HN	0.06	0.00	0.00	**8.19**	**0.0167**	4.04	0.0443	4.22	0.04		
	MF	0.11	0.25	0.00	4.22	0.1214						
	OT	0.02	0.05	0.00	3.63	0.1625						
	POT	0.00	0.03	0.01	0.77	0.6821						
	TN	0.18	0.00	0.06	3.26	0.196						
Mississippi Silvery Minnow	MF	0.00	0.02	0.00	2.00	0.3679						
Pallid Sturgeon	OT	0.00	0.00	0.02	2.90	0.2346						
Plains Minnow	EF	0.00	0.02	0.00	2.60	0.2731						
	MF	0.00	0.05	0.20	4.33	0.1148						
	POT	0.00	0.00	0.00	0.57	0.7521						
Red Shiner	EF	1.13	1.40	0.44	**5.37**	**0.0682**	0.02	0.8802	3.43	0.0641	**4.80**	**0.0284**
	MF	14.82	14.48	4.27	**11.71**	**0.0029**	0.06	0.8087	**9.57**	**0.002**	**7.99**	**0.0047**
	OT	0.18	0.03	0.00	**7.22**	**0.027**	1.84	0.1752	**6.89**	**0.0087**	2.43	0.1192
	POT	0.23	0.40	0.24	0.34	0.845						
River Carpsucker	EF	2.56	1.57	0.88	3.21	0.2009						
	HN	0.19	0.07	0.18	0.65	0.7214						
	MF	37.25	0.32	0.11	**18.62**	**<0.0001**	**8.34**	**0.0039**	**15.45**	**<0.0001**	2.48	0.1155
	OT	0.73	0.02	0.02	**21.28**	**<0.0001**	**11.00**	**0.0009**	**13.35**	**0.0003**	0.02	0.8839
	POT	0.06	0.04	0.01	**14.35**	**0.0008**	**6.27**	**0.0123**	**13.08**	**0.0003**	2.00	0.1577
	SHN	0.02	0.02	0.05	0.44	0.8007						
	TN	0.03	0.13	0.00	3.86	0.1454						
River Shiner	EF	0.01	0.02	0.01	0.08	0.9625						
	MF	0.55	2.27	0.18	2.91	0.2329						
	OT	0.00	0.04	0.00	1.93	0.3819						
	POT	0.01	0.01	0.00	1.91	0.3855						

Table III.9.4 (continued). Yearly mean CPUE by year and results of Kruskal-Wallis test of mean CPUE of target species caught in Lisbon chute by species and gear. Significant results are in bold.

Species	Gear	Mean CPUE			06 v 07 v 08		06 v 07		06 v 08		07 v 08	
		2006	2007	2008	Chi	P	Chi	P	Chi	P	Chi	P
Sand Shiner	EF	0.00	0.01	0.01	1.18	0.5538						
	MF	0.32	0.39	0.05	**4.82**	**0.0896**	2.05	0.1518	0.30	0.5855	4.18	0.041
	POT	0.01	0.00	0.00	1.34	0.5106						
Sauger	EF	0.05	0.03	0.09	4.21	0.122						
	HN	0.00	0.00	0.07	**6.91**	**0.0316**			3.03	0.0819	3.96	0.0466
	OT	0.02	0.00	0.02	1.26	0.5324						
	POT	0.00	0.00	0.00	0.57	0.7521						
	TN	0.04	0.06	0.06	0.12	0.9411						
Shortnose Gar	EF	0.40	0.37	0.50	**5.21**	**0.0737**	0.06	0.8078	2.60	0.1066	**4.88**	**0.0271**
	HN	0.04	0.04	0.45	**8.54**	**0.014**	0.08	0.7799	4.09	0.0432	**6.08**	**0.0136**
	MF	1.04	0.50	0.32	2.84	0.2423						
	OT	0.04	0.02	0.02	1.41	0.4937						
	POT	0.00	0.00	0.00	1.56	0.4578						
	SHN	0.08	0.14	0.05	2.94	0.23						
	TN	0.54	0.06	0.00	3.38	0.1842						
Shovelnose Sturgeon	EF	0.06	0.17	0.19	**5.59**	**0.061**	**5.66**	**0.0174**	3.87	0.0493	0.01	0.9384
	HN	0.05	0.27	0.39	**5.47**	**0.0648**	**5.70**	**0.017**	3.90	0.0484	0.21	0.6471
	OT	0.05	0.82	1.44	**16.82**	**0.0002**	**11.44**	**0.0007**	**16.45**	**<0.0001**	0.70	0.4013
	POT	0.00	0.00	0.00	0.57	0.7512						
	SHN	0.00	0.16	0.34	3.69	0.1583						
	TN	0.59	2.27	5.49	**9.20**	**0.0101**	**6.21**	**0.0127**	**8.51**	**0.0035**	0.48	0.4876
Sicklefin Chub	EF	0.01	0.00	0.00	2.75	0.2528						
	MF	0.34	0.00	0.07	**6.70**	**0.0351**	**6.50**	**0.0108**	1.31	0.2523	3.10	0.0784
	OT	0.49	0.00	0.00	**29.27**	**<0.0001**	**13.98**	**0.0002**	**16.56**	**<0.0001**		
	POT	0.02	0.01	0.02	1.80	0.4066						
Silver Carp	EF	0.06	0.00	0.10	**13.62**	**0.0011**	**6.77**	**0.0093**	1.45	0.2282	**14.41**	**0.0001**
	HN	0.00	0.00	0.02	1.69	0.4301						
	MF	0.09	0.16	0.04	0.37	0.8322						
	POT	0.00	0.00	0.00	1.55	0.4597						
Silver Chub	EF	0.08	0.00	0.18	**8.65**	**0.0134**	**6.77**	**0.0093**	0.15	0.6968	**9.31**	**0.0023**
	MF	0.33	0.05	0.29	3.52	0.1717						
	OT	1.90	0.24	0.25	**28.91**	**<0.0001**	**17.42**	**<0.0001**	**20.97**	**<0.0001**	0.00	0.9535
	POT	0.05	0.04	0.26	1.91	0.3848						
Speckled Chub	MF	0.07	0.64	0.27	**5.99**	**0.0501**	3.20	0.0736	**6.21**	**0.0127**	0.46	0.4981
	OT	1.36	0.63	0.48	0.39	0.8236						
	POT	0.00	0.19	0.07	**13.74**	**0.001**	**13.42**	**0.0002**	**8.49**	**0.0036**	1.88	0.1698
Sturgeon Chub	MF	0.02	0.02	0.04	0.00	0.9997						
	OT	0.01	0.00	0.00	3.03	0.2193						
Western Silvery Minnow	MF	0.00	0.05	0.13	3.58	0.167						

Gear : EF = electrofishing, HN = 4’ diameter hoop nets, SHN = 2’ diameter hoop nets, MF = mini-fyke nets, OT = 16’ otter trawls, POT = 8’ otter trawls pushed, TN = combined efforts of 1” trammel nets in 25’ increments.

Table III.9.5. Catch per unit effort (CPUE) and 2 standard errors (SE) of target species caught in Lisbon chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Bighead carp	EF											**0.04** 0.07										
	HN			**0.13** 0.25			**0.13** 0.25		**0.25** 0.50						**0.25** 0.33	**0.25** 0.50						
	MF							**4.00** 0.00			**0.20** 0.40											
Blue sucker	EF								**0.13** 0.17							**0.08** 0.16		**0.05** 0.11	**0.05** 0.10			**0.06** 0.12
	HN															**0.13** 0.25						**0.13** 0.25
	MF								**0.25** 0.33													
	OT								**0.07** 0.14													
	TN						**0.63** 1.25															
Channel catfish	EF	**0.30** 0.30	**0.20** 0.29	**0.30** 0.30	**0.27** 0.22	**0.12** 0.15	**0.40** 0.42	**0.43** 0.34	**0.18** 0.19		**0.09** 0.18	**0.69** 0.45		**0.40** 0.79	**1.24** 0.71	**0.48** 0.45	**0.63** 0.63	**1.20** 0.96	**0.63** 0.52			**1.29** 0.41
	HN	**0.14** 0.29	**2.25** 3.11	**0.13** 0.25	**1.50** 1.60		**0.50** 0.76						**1.00** 1.13	**0.33** 0.67		**0.13** 0.25	**0.13** 0.25		**0.13** 0.25			**0.13** 0.25
	MF	**0.17** 0.33			**0.17** 0.33				**0.75** 1.24			**1.00** 1.25		**0.13** 0.25	**2.38** 1.96	**2.75** 3.06	**1.17** 0.61	**0.75** 0.98	**1.25** 1.72			**1.00** 1.25
	OT		**8.08** 7.07	**1.06** 0.85			**1.42** 1.48	**0.54** 0.41	**0.33** 0.67		**1.58** 1.52	**0.50** 0.77		**1.93** 1.55	**7.92** 3.55	**0.20** 0.40	**7.19** 4.60		**1.79** 2.93		**5.00** 4.39	**2.00** 2.05
	POT							**0.21** 0.24	**0.33** 0.23			**0.05** 0.08	**0.03** 0.05	**0.06** 0.07	**5.15** 3.69	**0.98** 0.67		**0.58** 0.61	**1.64** 1.56			**0.21** 0.25
	SHN	**1.00** 1.15	**0.25** 0.33	**9.25** 14.05	**0.38** 0.53	**0.38** 0.53	**1.00** 1.13	**0.50** 1.00	**0.25** 0.33			**0.50** 0.65	**0.88** 0.80	**1.00** 1.46	**1.25** 0.91	**0.13** 0.25	**0.25** 0.33	**0.63** 0.53				**0.25** 0.50
	TN		**0.73** 0.97											**0.23** 0.46			**0.37** 0.74					
Common carp	EF	**0.23** 0.38	**0.10** 0.14	**0.31** 0.25	**0.49** 0.34	**0.08** 0.12	**0.04** 0.08	**0.49** 0.41	**0.08** 0.15		**0.41** 0.61	**1.31** 0.63		**0.12** 0.25	**0.23** 0.16	**0.20** 0.22	**0.68** 1.13	**1.14** 0.57	**0.34** 0.28			**0.79** 0.77
	HN					**0.14** 0.29	**0.13** 0.25				**0.33** 0.67		**0.50** 0.53			**0.13** 0.25						
	MF							**8.00** 0.00	**11.00** 5.49			**0.88** 1.49		**0.13** 0.25								
	SHN			**0.13** 0.25			**0.13** 0.25		**0.13** 0.25		**0.20** 0.40					**0.13** 0.25			**0.50** 0.76			
Emerald shiner	EF	**0.25** 0.50	**0.10** 0.14	**0.07** 0.14	**0.66** 0.88	**0.10** 0.13	**1.41** 1.19	**0.07** 0.15			**0.25** 0.31	**1.11** 0.62			**0.47** 0.35	**0.26** 0.27	**4.37** 3.25	**0.19** 0.19	**0.62** 0.28			**0.20** 0.21
	MF	**5.33** 4.84			**42.50** 68.32			**4.00** 0.00	**3.88** 2.91		**2.00** 2.61	**5.88** 6.30	**6.50** 5.84	**12.00** 18.95	**5.63** 6.84	**14.38** 17.02	**10.50** 6.32	**56.25** 69.41	**2.50** 3.16			**2.38** 2.51
	OT							**0.19** 0.25						**0.23** 0.30	**0.13** 0.25							
	POT							**0.03** 0.04	**0.03** 0.06			**0.03** 0.03	**0.10** 0.12	**0.52** 0.83	**0.71** 0.84	**0.06** 0.07		**0.45** 0.51	**0.33** 0.29			**0.16** 0.29

Table III.9.5 (continued). CPUE (in bold) and 2 SE of target species caught at Lisbon chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Flathead catfish	EF		**0.13** 0.17		**0.38** 0.52		**0.37** 0.32	**0.26** 0.28	**0.13** 0.13		**0.24** 0.30	**0.51** 0.36		**1.04** 1.41	**0.98** 0.44	**0.33** 0.32		**0.65** 0.96	**0.18** 0.20			**0.32** 0.28
	HN	**0.14** 0.29		**0.13** 0.25		**1.14** 2.29	**0.25** 0.33	**0.33** 0.67	**0.63** 1.00				**0.63** 0.53		**0.13** 0.25	**1.38** 1.56	**0.25** 0.50	**0.14** 0.29	**0.13** 0.25			
	MF														**0.13** 0.25							
	OT		**0.11** 0.23	**0.08** 0.17									**0.09** 0.17	**0.18** 0.36			**0.23** 0.32				**0.13** 0.25	
	POT								**0.02** 0.03					**0.01** 0.02	**0.03** 0.04							
	SHN	**0.14** 0.29	**0.25** 0.50		**0.25** 0.33	**1.50** 0.85	**0.75** 0.63	**1.00** 0.52	**0.75** 0.63			**0.88** 0.96	**2.00** 1.07	**0.25** 0.33	**0.25** 0.33	**1.25** 0.91	**0.13** 0.25	**0.75** 0.50	**0.38** 0.37			**0.38** 0.37
Gizzard shad	EF	**7.10** 5.83	**1.11** 0.74	**1.64** 1.42	**0.64** 0.35	**0.06** 0.08	**0.06** 0.12	**0.52** 0.64	**0.23** 0.19		**12.70** 1.85	**5.72** 3.21		**34.04** 62.39	**1.39** 0.57	**5.14** 1.80	**6.08** 1.63	**2.19** 1.84	**0.45** 0.32			**2.07** 1.76
	HN	**0.14** 0.29	**0.38** 0.53	**1.75** 1.30		**0.14** 0.29		**0.17** 0.33				**0.13** 0.25			**0.13** 0.25							
	MF								**30.75** 35.40			**1.13** 0.70	**12.13** 15.38	**0.38** 0.53	**2.88** 4.11	**44.63** 37.18		**1.13** 1.98	**0.50** 0.76			**0.13** 0.25
	OT		**0.13** 0.25						**0.12** 0.23													
	POT							**0.01** 0.03	**0.27** 0.21			**0.01** 0.01	**0.16** 0.30			**0.15** 0.16		**0.09** 0.12				
	TN		**1.06** 1.05											**0.74** 1.47								
Goldeye	EF	**0.95** 0.46	**0.53** 0.43	**1.61** 0.71	**0.09** 0.18	**0.40** 0.29	**0.15** 0.20	**0.12** 0.16	**0.18** 0.28		**0.18** 0.37	**0.19** 0.23		**0.25** 0.49	**0.38** 0.23	**0.03** 0.06	**0.20** 0.24	**0.55** 0.47	**0.92** 0.51			**0.49** 0.39
	HN	**0.29** 0.37															**0.13** 0.25					
	MF								**1.75** 2.03		**0.80** 0.98											
	OT											**0.22** 0.29		**0.08** 0.16	**0.13** 0.25		**0.07** 0.14					
	POT							**0.01** 0.03	**0.23** 0.33			**0.01** 0.03	**0.06** 0.11						**0.01** 0.03			
	TN				**0.64** 1.28									**0.58** 1.17		**0.42** 0.83						
Mississippi silvery minnow	MF														**0.13** 0.25							
Pallid sturgeon	OT			**0.08** 0.17															**0.08** 0.17			
Plains minnow	EF																	**0.17** 0.24				
	MF														**0.13** 0.25	**1.38** 1.19		**0.25** 0.50				
	POT														**0.01** 0.02				**0.01** 0.02			

Table III.9.5 (continued). CPUE (in bold) and 2 SE of target species caught at Lisbon chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Red shiner	EF	**0.07** 0.14	**0.53** 0.44	**0.89** 1.61	**1.18** 1.56	**0.40** 0.44	**0.56** 0.71	**1.94** 1.16	**0.13** 0.17		**1.38** 1.59	**7.56** 9.19		**1.51** 2.66	**1.16** 0.56	**1.14** 1.49	**1.85** 1.90		**0.46** 0.30			**0.05** 0.11
	MF	**5.67** 7.81			**13.33** 10.18			**14.00** 0.00	**9.38** 13.15		**11.60** 14.85	**25.88** 28.29	**16.00** 12.53	**16.50** 9.24	**17.38** 12.12	**8.63** 11.70	**42.67** 29.82	**48.75** 50.97	**1.25** 1.72			**4.00** 4.86
	OT		**0.11** 0.23					**0.29** 0.57				**0.13** 0.25		**1.00** 1.25								
	POT							**0.45** 0.35	**0.50** 1.01			**0.03** 0.03	**1.04** 1.25	**1.18** 2.23	**1.98** 1.96	**0.05** 0.05		**0.29** 0.34	**0.53** 0.94			**0.05** 0.07
River carpsucker	EF	**1.79** 1.20	**1.51** 1.31	**2.28** 1.42	**2.81** 2.42	**1.43** 0.69	**0.62** 0.57	**2.19** 1.21	**0.48** 0.26		**0.49** 0.60	**3.87** 2.05		**5.72** 10.95	**1.28** 0.54	**1.46** 0.83	**4.93** 5.05	**2.45** 1.34	**0.61** 0.64			**1.16** 0.62
	HN	**0.14** 0.29		**0.13** 0.25					**0.13** 0.25		**0.67** 1.33	**0.25** 0.50	**0.13** 0.25			**1.00** 1.73	**0.50** 0.76	**0.14** 0.29				
	MF							**139.00** 0.00	**0.25** 0.33		**95.60** 93.46	**0.13** 0.25		**7.00** 6.60	**1.88** 1.49		**19.17** 16.03		**0.25** 0.50			**0.50** 0.65
	OT							**0.10** 0.19			**0.13** 0.27			**4.19** 4.17	**0.17** 0.33		**0.71** 0.79					**0.15** 0.29
	POT							**0.04** 0.06	**0.04** 0.08					**0.37** 0.36	**0.22** 0.29	**0.04** 0.08		**0.03** 0.03				**0.03** 0.04
	SHN			**0.25** 0.50								**0.13** 0.25					**0.13** 0.25		**0.13** 0.25			
	TN		**0.31** 0.63									**0.31** 0.63			**0.25** 0.50		**0.21** 0.42					
River shiner	EF	**0.04** 0.08		**0.06** 0.12		**0.06** 0.11												**0.10** 0.21				
	MF							**3.00** 0.00	**0.13** 0.25		**0.20** 0.40		**0.63** 1.00		**3.25** 3.87	**0.63** 0.84	**0.67** 0.99	**12.50** 15.82				
	OT																				**0.25** 0.50	
	POT							**0.05** 0.09	**0.01** 0.03						**0.08** 0.12							**0.02** 0.03
Sand shiner	EF			**0.07** 0.13		**0.03** 0.06									**0.03** 0.06							
	MF								**2.00** 1.41		**1.60** 1.96	**0.13** 0.25	**0.13** 0.25		**0.13** 0.25	**0.13** 0.25	**0.67** 0.84	**0.50** 0.76				**0.13** 0.25
	POT							**0.06** 0.07							**0.02** 0.04				**0.01** 0.02			**0.02** 0.04
Sauger	EF	**0.10** 0.19		**0.42** 0.57	**0.08** 0.15	**0.11** 0.23			**0.04** 0.08			**0.03** 0.07		**0.20** 0.40	**0.03** 0.07	**0.11** 0.11			**0.04** 0.09			**0.05** 0.11
	HN			**0.38** 0.37												**0.13** 0.25						
	OT													**0.16** 0.32								**0.12** 0.24
	POT								**0.02** 0.04				**0.01** 0.02									
	TN											**0.42** 0.83		**0.29** 0.58								**0.39** 0.78

Table III.9.5 (continued). CPUE (in bold) and 2 SE of target species caught at Lisbon chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Shortnose gar	EF	**1.68**	**1.52**	**0.51**	**0.15**	**0.11**	**1.73**	**0.30**	**0.05**		**0.25**	**0.36**			**0.28**	**0.57**	**0.39**	**0.24**	**0.40**			**0.32**
		1.20	0.89	0.57	0.15	0.15	1.06	0.23	0.11		0.50	0.26			0.16	0.35	0.34	0.24	0.29			0.20
	HN			**2.13**	**0.13**				**0.25**				**0.50**				**0.13**		**0.38**			**0.13**
				1.94	0.25				0.33				0.65				0.25		0.53			0.25
	MF	**0.83**			**0.83**			**3.00**	**1.00**		**0.20**	**0.88**	**0.38**	**1.75**	**1.38**	**1.50**	**0.67**	**0.25**	**0.38**			
		1.67			0.80			0.00	2.00		0.40	0.80	0.53	1.05	0.92	1.13	0.42	0.50	0.53			
	OT										**0.17**			**0.13**	**0.13**				**0.13**			
											0.33			0.25	0.25				0.25			
	POT														**0.01**							
															0.02							
	SHN				**0.25**	**0.13**			**0.25**		**0.20**	**0.25**		**0.13**	**0.25**	**0.38**		**0.13**				
					0.33	0.25			0.50		0.40	0.33		0.25	0.33	0.53		0.25				
	TN		**0.40**								**3.75**											
			0.80								2.50											
Shovelnose sturgeon	EF	**0.23**	**0.18**	**0.08**		**0.15**	**0.16**	**0.05**	**0.13**			**0.23**		**0.12**	**0.33**	**0.06**		**0.13**	**0.54**			**0.46**
		0.46	0.18	0.16		0.20	0.32	0.11	0.17			0.21		0.25	0.44	0.12		0.17	0.65			0.39
	HN		**0.25**			**1.00**	**2.13**	**0.33**	**0.38**			**0.25**	**0.25**			**0.13**			**0.25**			
			0.33			0.62	2.02	0.67	0.75			0.33	0.33			0.25			0.50			
	OT		**1.29**	**2.50**			**3.60**		**0.61**			**0.11**	**0.64**	**0.13**	**2.00**		**0.26**		**3.08**		**1.72**	**0.25**
			1.54	2.94			2.81		0.47			0.23	0.55	0.25	1.89		0.35		2.19		1.27	0.32
	POT														**0.02**							**0.02**
															0.05							0.04
	SHN		**0.63**	**1.50**		**0.50**	**0.88**															
			1.00	2.48		0.76	1.16															
	TN	**2.23**	**6.37**	**7.50**	**1.14**		**9.38**		**0.31**			**4.11**	**1.53**	**0.23**	**0.25**	**3.04**	**0.51**		**4.51**		**4.82**	**12.48**
		4.46	3.66	9.64	1.45		9.53		0.63			2.98	2.48	0.46	0.50	4.29	0.68		4.30		5.01	12.31
Sicklefin chub	EF							**0.07**														
								0.15														
	MF	**0.33**			**0.17**						**1.40**		**0.25**			**0.13**	**0.50**					**0.13**
		0.67			0.33						1.96		0.50			0.25	0.68					0.25
	OT							**0.67**			**0.38**			**1.72**			**0.69**					
								0.75			0.54			2.34			1.13					
	POT							**0.12**	**0.04**				**0.06**	**0.02**				**0.01**	**0.04**			**0.01**
								0.16	0.05				0.08	0.02				0.03	0.08			0.01
Silver carp	EF	**0.22**		**0.10**	**0.11**		**0.44**				**0.09**					**0.08**						**0.09**
		0.29		0.14	0.22		0.36				0.18					0.11						0.18
	HN			**0.13**																		
				0.25																		
	MF								**1.13**		**0.60**		**0.13**						**0.13**			
									2.25		0.80		0.25						0.25			
	POT							**0.03**					**0.03**									
								0.05					0.05									

Table III.9.5 (continued). CPUE (in bold) and 2 SE of target species caught at Lisbon chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Silver chub	EF	**0.09** 0.19									**0.25** 0.50						**0.22** 0.29		**1.11** 1.90			**0.14** 0.19
	MF										**2.20** 4.40	**0.13** 0.25		**0.13** 0.25	**0.25** 0.50	**1.75** 1.64			**0.25** 0.33			
	OT		**0.70** 0.91				**0.08** 0.17	**1.69** 1.75			**1.20** 1.01			**9.53** 12.56	**1.00** 1.25		**0.90** 1.07		**0.58** 0.99			**1.11** 1.64
	POT							**0.35** 0.34	**0.02** 0.04			**0.15** 0.23	**0.03** 0.05	**0.03** 0.03	**0.07** 0.05	**1.55** 1.10		**0.03** 0.05	**0.26** 0.16			
Speckled chub	MF	**0.33** 0.67			**0.17** 0.33				**0.88** 1.49				**0.88** 1.16		**3.25** 5.94	**0.25** 0.33		**0.38** 0.53	**0.25** 0.33			**0.50** 0.38
	OT		**2.06** 3.84	**0.46** 0.74			**1.17** 1.12		**0.50** 1.00					**0.41** 0.55	**0.75** 0.82		**9.11** 15.31		**1.63** 2.72		**1.12** 0.96	**0.12** 0.24
	POT								**0.09** 0.09			**0.02** 0.03	**0.07** 0.10		**0.90** 0.80	**0.14** 0.25		**0.30** 0.36	**0.07** 0.15			**0.24** 0.12
Sturgeon chub	MF	**0.17** 0.33																**0.13** 0.25				**0.25** 0.50
	OT																**0.07** 0.14					
Western silvery minnow	MF														**0.38** 0.75	**0.88** 1.03						

Gears: EF = electrofishing, HN = 4’ diameter hoop nets, MF = mini-fyke nets, OT = 16’ otter trawls, SHN = 2’ diameter hoop nets, POT = 8’ otter trawls pushed, TN = combined efforts of 1” trammel nets in 25’ increments.

Table III.9.6. Mean length (ML), standard error (SE) in parentheses and results of analysis of variance of mean length for target species caught in Lisbon chute by year and gear. Significant results are bold.

Species	Gear	ML/SE 2006	ML/SE 2007	ML/SE 2008	06 v 07 v 08		2006 v 2007		2006 v 2008		2007 v 2008	
					F	P value	F	P value	F	P value	F	P value
Bighead carp	EF		556									
	HN		715.3 (10.3)	679.5 (28.2)	1.41	0.2793						
	MF	24.2 (2.3)										
Blue sucker	EF	305.7 (157.4)	521.5 (90.8)	319 (79.1)	1.29	0.3328						
	HN			484 (131)								
	MF		33.5 (3.5)									
	OT		221									
	TN			550								
Channel catfish	EF	324.9 (35)	202.8 (16.9)	312 (19.3)	**11.11**	**0.0001**	**3.48**	**0.0006**	0.35	0.7295	**-4.07**	**0.0001**
	HN	483.5 (22)	496 (19)	482.6 (25.6)	0.12	0.8872						
	SHN	321.8 (27.9)	181.5 (14)	240.1 (10.9)	**12.11**	**0.0001**	**4.91**	**0.0001**	**3.45**	**0.0008**	**-2.59**	**0.0107**
	MF	72.4 (12.3)	63.1 (12.1)	55.5 (4.4)	0.44	0.6467						
	OT	83 (5.5)	85.5 (4.2)	104.8 (10.2)	**2.86**	**0.0589**	-0.32	0.7508	**-2.21**	**0.0279**	**-2.16**	**0.0314**
	POT	58.6 (11.1)	56.8 (1.8)	53.4 (1.3)	0.57	0.5679						
	TN	294 (22)	267.5 (14.5)	1.01	0.4204							
Common carp	EF	548.6 (9.2)	530.9 (11)	554.2 (18.2)	0.94	0.3949						
	HN	504	670	636.2 (23.1)	2.71	0.1593						
	SHN	420	91	574.6 (42.3)	8.48	0.0178	2.08	0.0829	-1.29	0.244	-4.04	0.0068
	MF	93.3 (123)	35.5 (2.4)		**5.25**	**0.0255**	**2.29**	**0.0255**				
Emerald shiner	EF	56.4 (1.1)	54.7 (1.9)	54.3 (1.6)	0.5	0.6056						
	MF	57.3 (0.9)	46.2 (0.8)	43.2 (1.1)	**55.85**	**0.0001**	**9.51**	**0.0001**	**7.95**	**0.0001**	**1.81**	**0.0712**
	OT	56.5 (4.8)	54		0.05	0.8321						
	POT	36.6 (1.7)	33.5 (1.3)	40.1 (1.6)	**4.97**	**0.0082**	1.38	0.1684	-1.32	0.1881	**-3.12**	**0.0022**
Flathead catfish	EF	261 (21.9)	280.7 (14.2)	352.7 (32.3)	**3.85**	**0.0242**	-0.72	0.474	**-2.64**	**0.0096**	**-2.37**	**0.0194**
	HN	720.8 (140.7)	790.9 (54.9)	623.3 (44.2)	**2.54**	**0.0925**	-0.62	0.5392	0.89	0.3789	**0.0311**	**0.0311**
	SHN	488.2 (65.4)	377.4 (25.2)	420.2 (22.9)	2.27	0.1099						
	MF		241									
	OT	444.7 (168.7)	229 (113)	229 (102)	0.73	0.5349						
	POT	242	194.2 (72.8)	0.07	0.802							

Table III.9.6 (continued). Mean length (ML), standard error (SE) in parentheses and results of analysis of variance of mean length for target species caught in Lisbon chute by year and gear. Significant results are bold.

Species	Gear	ML/SE 2006	ML/SE 2007	ML/SE 2008	06 v 07 v 08		2006 v 2007		2006 v 2008		2007 v 2008	
					F	P value	F	P value	F	P value	F	P value
Gizzard shad	EF	214.4 (4.3)	142.8 (5.5)	140.1 (7)	**70.3**	**0.0001**	**10.04**	**0.0001**	**9.36**	**0.0001**	0.31	0.7537
	HN	271 (31)	345.7 (25.1)	302.7 (7.2)	3.58	0.0479	-2.3	0.0332	-1.05	0.3054	2.21	0.0396
	MF	115.7 (32.4)	46 (2.8)	49.1 (1.1)	**15.71**	**0.0001**	**5.58**	**0.0001**	5.36	0.0001	-1.27	0.2069
	OT		139.5 (110.5)									
	POT	203	57.2 (7.1)	52.5 (3.1)	13.69	0.0001	5.11	0.0001	5.2	0.0001	0.5	0.623
	TN	165 (3)	302 (61)		3.02	0.1806						
Goldeye	EF	184.8 (14.2)	143.8 (7.6)	184.3 (9.9)	**5.5**	**0.0051**	**2.67**	**0.0086**	0.03	0.9726	**-2.98**	**0.0035**
	HN	337.3 (13.5)										
	MF	25 (1.7)	40.6 (2.1)		**15.3**	**0.0021**	**-3.91**	**0.0021**				
	OT	99 (9)	94.7 (12.9)	0.06	**0.825**							
	POT	63	63 (3.7)	82.3 (26.1)	0.79	0.4719						
	TN	289 (7.8)		260	**3.48**	**0.2029**						
Mississippi silvery minnow	MF		43									
Pallid sturgeon	OT			614.5 (4.5)								
Plains minnow	EF		48 (8)									
	MF		49 (3.1)	42.5 (1.9)	2.5	0.1396						
	POT		30	42								
Red shiner	EF	52.1 (1.2)	48 (0.9)	44.1 (1.4)	**8.32**	**0.0003**	**2.72**	**0.007**	**3.97**	**0.0001**	**2.13**	**0.0344**
	MF	38.5 (0.6)	35.3 (0.5)	37.8 (0.7)	**10.24**	**0.0001**	**4.34**	**0.0001**	0.67	0.5016	**-2.31**	**0.0212**
	OT	50.9 (2.5)	48 (9)		0.2	0.6623						
	POT	39.2 (1.3)	33 (1)	38.8 (1.1)	**8.71**	**0.0002**	**3.09**	**0.0022**	0.18	0.8602	**-3.47**	**0.0006**
River carpsucker	EF	202 (11.1)	243.9 (10.5)	301.3 (10.5)	**15.88**	**0.0001**	**-2.84**	**0.0046**	**-5.63**	**0.0001**	**-3.47**	**0.0006**
	HN	431.7 (17.9)	396.5 (57.4)	441.3 (10.2)	0.83	0.4504						
	SHN	180	206	433.7 (43)	6.29	0.1372						
	MF	31.2 (1)	69.7 (24.3)	141.5 (58.2)	**25.61**	**0.0001**	**-3.63**	**0.0004**	**-6.22**	**0.0001**	**-3.5**	**0.0006**
	OT	68.4 (7.6)	502	358	**47.45**	**0.0001**	**-8.18**	**0.0001**	**-5.46**	**0.0001**	**1.94**	**0.0584**
	POT	48.7 (1.6)	60.3 (15.2)	118 (51.8)	**3.6**	**0.0342**	-0.77	0.4469	**-2.68**	**0.0098**	**-2.17**	**0.0349**
	TN	155	362 (41.8)		6.14	0.1315						

Table III.9.6 (continued). Mean length (ML), standard error (SE) in parentheses and results of analysis of variance of mean length for target species caught in Lisbon chute by year and gear. Significant results are bold.

Species	Gear	ML/SE 2006	ML/SE 2007	ML/SE 2008	06 v 07 v 08		2006 v 2007		2006 v 2008		2007 v 2008	
					F	P value	F	P value	F	P value	F	P value
River shiner	EF	51.5 (0.5)	50.7 (4.2)	41	1.2	0.414						
	MF	39.7 (4.3)	40.4 (0.7)	32.2 (1.1)	**4.22**	**0.0185**	-0.23	0.8212	**1.81**	**0.0739**	**2.9**	**0.0049**
	OT		39.5 (1.5)									
	POT	43 (6.9)	33.1 (1.8)	42	1.81	0.2188						
Sand shiner	EF		43 (8)	46	0.05	0.8643						
	MF	35.8 (2.9)	32 (1.2)	37 (1)	1.42	0.2558						
	POT	54.5 (2.7)	35.5 (1.5)	33.3 (5.9)	**9.09**	**0.0153**	**3.08**	**0.0216**	**3.89**	**0.0081**	0.33	0.7502
Sauger	EF	200.2 (24.5)	393.8 (59.2)	313.1 (24.8)	**5.84**	**0.0092**	**-3.36**	**0.0029**	**-2.43**	**0.0237**	1.62	0.1185
	HN			409 (19.4)								
	OT	169 (11)		382	124.98	0.0568						
	POT		300	231								
	TN	304	493	309								
Shortnose gar	EF	554.3 (9.1)	584.8 (8.8)	546.2 (11.8)	**3.67**	**0.0276**	**-1.76**	**0.0799**	0.5	0.6207	**2.65**	**0.0088**
	HN	662.5 (5.5)	637 (9)	625.8 (10.1)	0.56	0.5806						
	SHN	585 (19.5)	600 (17)	581.7 (69.3)	0.12	0.8842						
	MF	570.9 (8.4)	582 (11.3)	545.8 (30.1)	1.24	0.2941						
	OT	544 (63)	637	634	0.53	0.6975						
	POT		596									
	TN	576.7 (33.8)	551		0.14	0.7409						
Shovelnose sturgeon	EF	559.3 (25.1)	534.8 (14)	520 (14.8)	0.71	0.4973						
	HN	526.5 (128.5)	582 (29.7)	540.2 (20.2)	0.77	0.4728						
	SHN		517.7 (27.7)	560.4 (11.4)	2.85	0.1042						
	OT	383.3 (30.7)	455.6 (18.9)	483.5 (13)	1.44	0.24						
	POT		440.3 (29.5)	324.5 (42.5)	5.47	0.1013						
	TN	473.3 (33.2)	493.1 (21.5)	499.8 (13.1)	0.32	0.7237						
Sicklefin chub	EF	33										
	MF	27 (1.5)		40.5 (3.5)	**17.22**	**0.0013**			**-4.15**	**0.0013**		
	OT	26.8 (1)										
	POT	34.6 (2)	23.3 (2.9)	32.1 (3)	**3.18**	**0.0686**	**2.52**	**0.0227**	**0.72**	**0.4838**	-1.91	0.074

Table III.9.6 (continued). Mean length (ML), standard error (SE) in parentheses and results of analysis of variance of mean length for target species caught in Lisbon chute by year and gear. Significant results are bold.

Species	Gear	ML/SE 2006	ML/SE 2007	ML/SE 2008	06 v 07 v 08		2006 v 2007		2006 v 2008		2007 v 2008	
					F	P value	F	P value	F	P value	F	P value
Silver carp	**EF**	772.7 (15.7)	585.4 (76.1)	2.92	0.1037							
	HN			280								
	MF	29.3 (3)	37.9 (1.4)	95.5 (63.5)	3.42	0.0786	-0.42	0.686	-2.4	0.0399	-2.41	0.0391
	POT	31.5 (6.5)		30	0.02	0.9157						
Silver chub	**EF**	62.3 (5.7)		56.6 (2.4)	1.08	0.3129						
	MF	24.8 (1.2)	40 (2.5)	47.1 (1.6)	43.15	0.0001	-3.95	0.0006	-9.29	0.0001	-1.96	0.0621
	OT	42.2 (1.8)	45.9 (5)	66.1 (7.2)	10.88	0.0001	-0.72	0.4757	**-4.66**	**0.0001**	**-3**	**0.0035**
	POT	38.2 (1.1)	41.4 (2.4)	49.6 (1.3)	**14.77**	**0.0001**	**-1.08**	**0.2808**	**-4.99**	**0.0001**	-3.34	0.0011
Speckled chub	**MF**	46.7 (1.5)	31.9 (1.4)	39.2 (1.7)	**8.77**	**0.0007**	**3.26**	**0.0023**	1.56	0.1264	**-3.08**	**0.0038**
	OT	33.4 (1.1)	36.2 (1.9)	43 (1.5)	8.76	0.0004	-1.21	0.2316	-3.97	0.0002	-3.06	0.003
	POT		29.4 (1)	33.5 (1.1)	5.22	0.0244					-2.28	0.0244
Sturgeon chub	**MF**	46	40	36.5 (1.5)	6.69	0.2636						
	OT	37										
Western silvery minnow	**MF**		33.7 (3.8)	44.8 (1.5)	**13.18**	**0.011**					**-3.63**	**0.011**

Gear : EF = electrofishing, HN = 4' diameter hoop nets, SHN = 2' diameter hoop nets, MF = mini-fyke nets, OT = 16' otter trawls, POT = 8' otter trawls pushed, TN = combined efforts of 1" trammel nets in 25' increments.

Table III.9.7. Results of z-test analysis of life stage proportions of target species caught in Lisbon chute. Significant results are bold.

Species	2006 v 2007 Z	2006 v 2008 Z	2007 v 2008 Z
Bighead carp	2.10	1.84	-0.18
Blue sucker	0.28	0	-0.35
Channel catfish	**-5.79**	0.42	**7.01**
Common carp	**-4.85**	**2.71**	**7.21**
Emerald shiner	**-4.92**	**-3.13**	0.22
Flathead catfish	0.10	**2.69**	**3.28**
Gizzard shad	**-5.57**	**-5.09**	0.56
Goldeye	**-2.27**	-1.94	-
Mississippi silvery minnow	-	-	-
Pallid sturgeon	-	-	-
Plains minnow	-	-	-
Red shiner	**-5.39**	**-2.98**	0.78
River carpsucker	**13.82**	**17.10**	**3.9**
River shiner	**-6.2**	**-2.46**	-0.49
Sand shiner	**-3.52**	-1.64	0.99
Sauger	2.52	**3.38**	0
Shortnose gar	-	**-2.68**	**-2.89**
Shovelnose sturgeon	0.51	0.07	-0.87
Sicklefin chub	-0.55	**3.37**	1.46
Silver carp	**-2.54**	0.09	**2.69**
Silver chub	-	1.6	0.81
Speckled chub	**-5.85**	-1.42	**4.57**
Sturgeon chub	0.87	-1.15	-1.73
Western silvery minnow	-	-	-

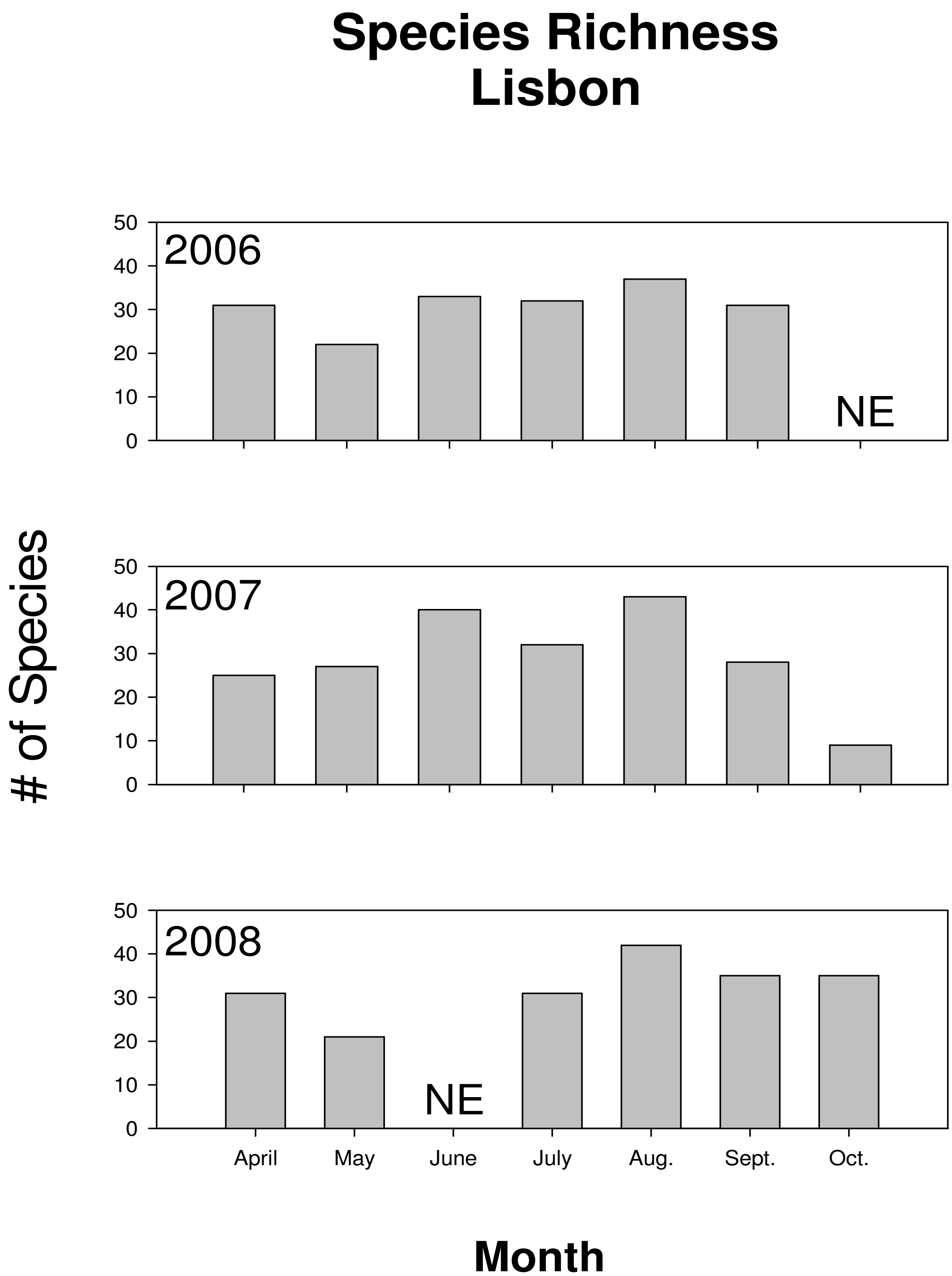


Figure III.9.1. Species richness in Lisbon chute by month and year.
NE = No effort during this month due to river conditions or construction.

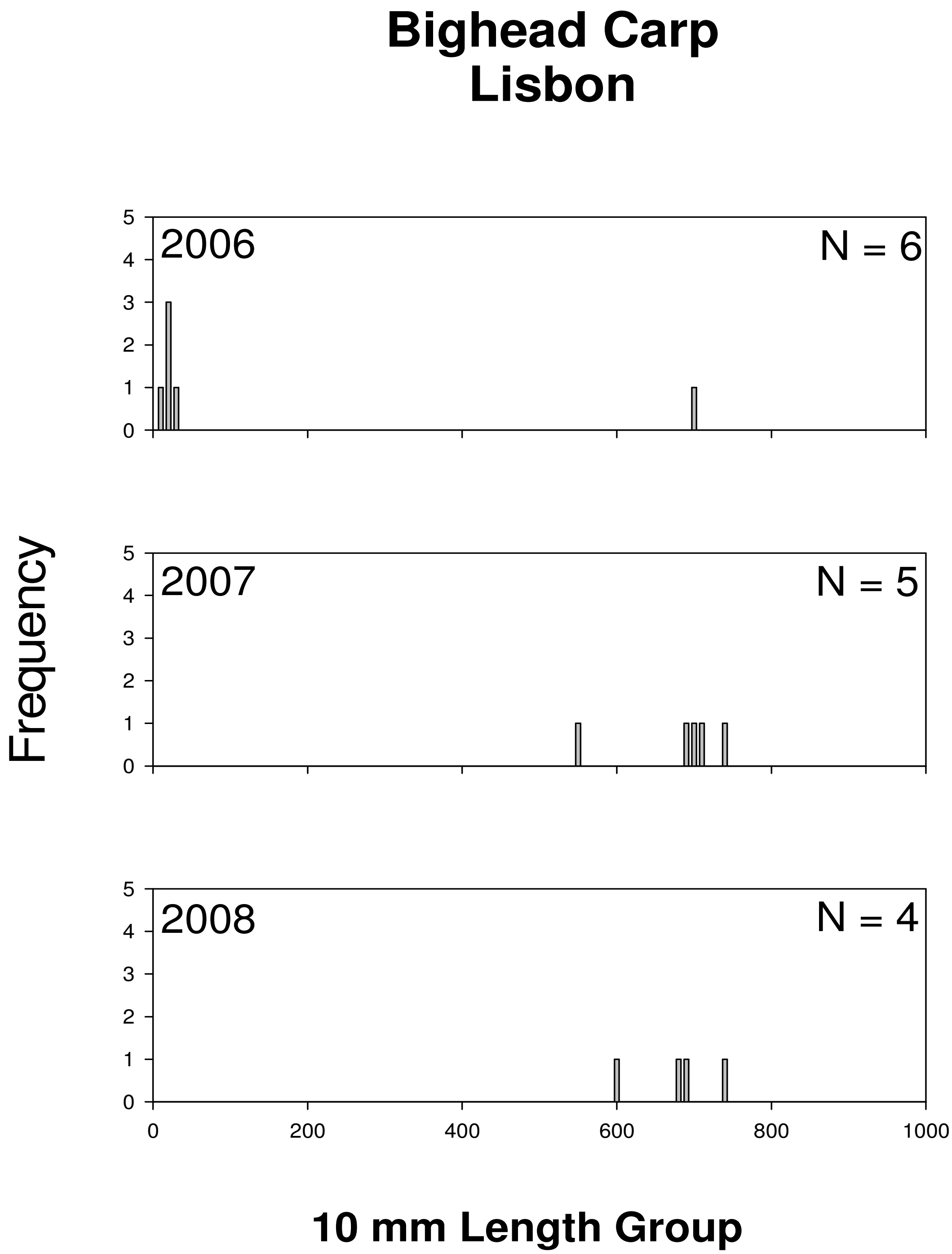


Figure III.9.2. Length frequency distribution of bighead carp in Lisbon chute by year. Length groups are in 10 mm intervals.

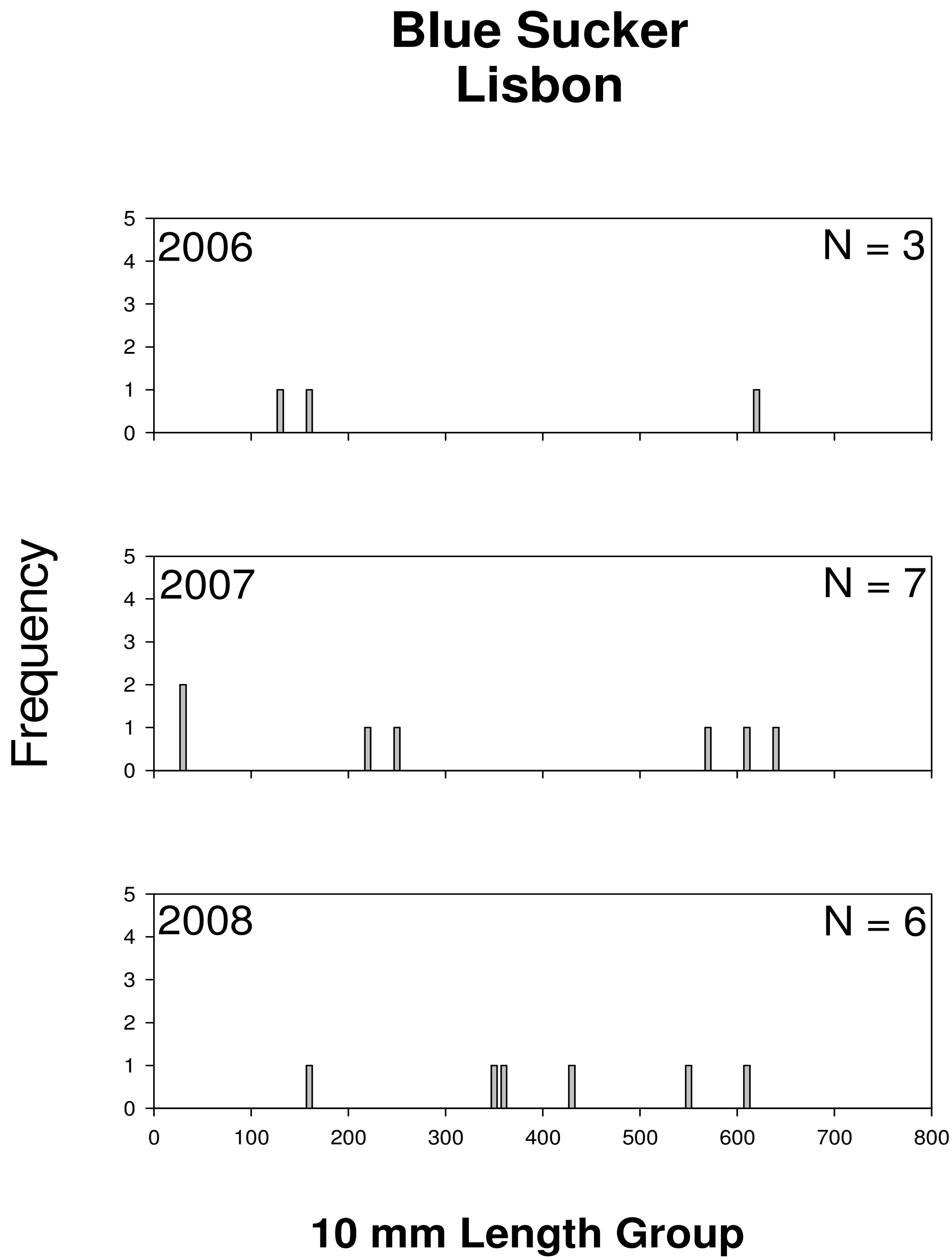


Figure III.9.3. Length frequency distribution of blue sucker in Lisbon chute by year. Length groups are in 10 mm intervals.

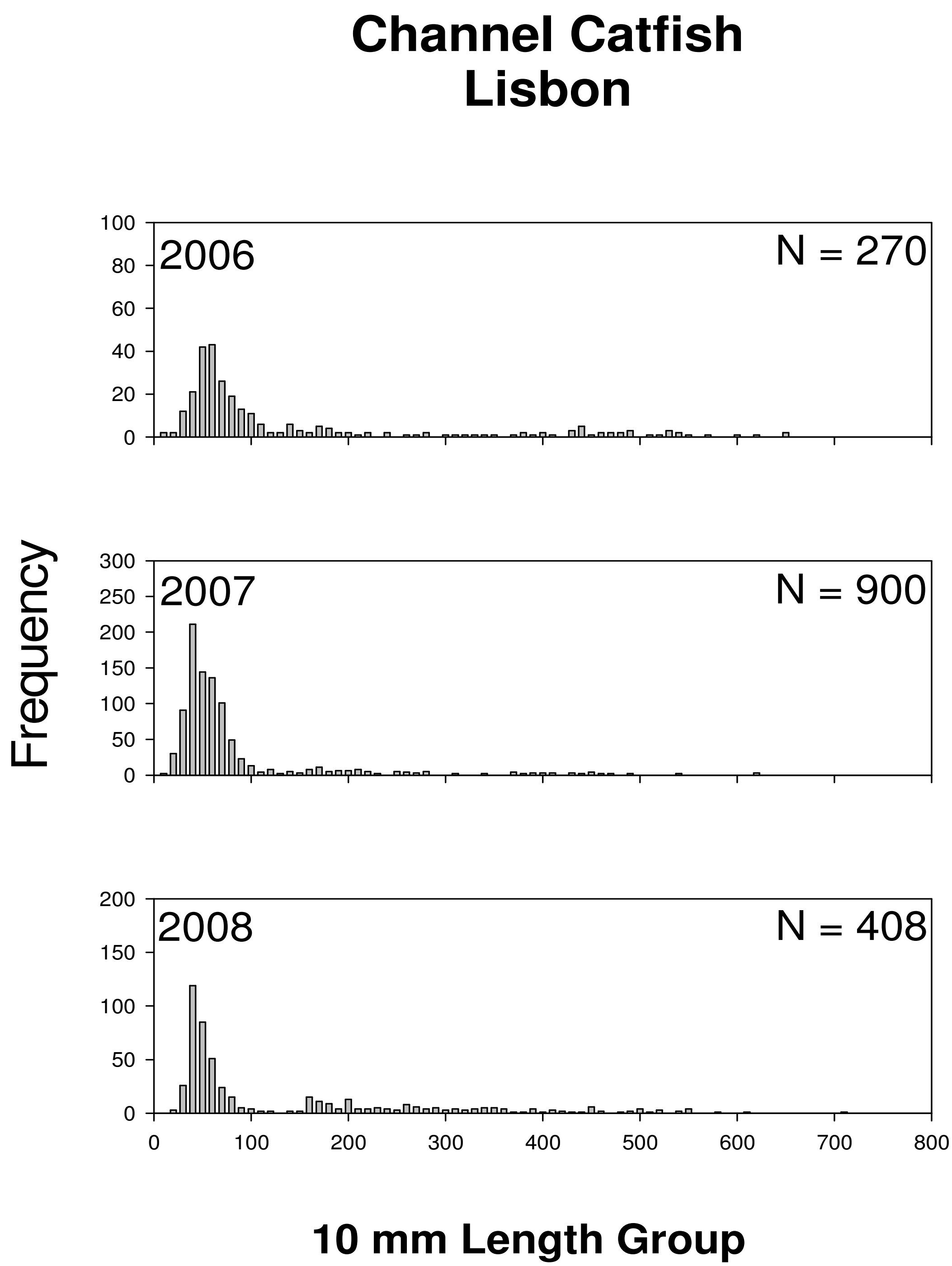


Figure III.9.4. Length frequency distribution of channel catfish in Lisbon chute by year. Length groups are in 10 mm intervals.

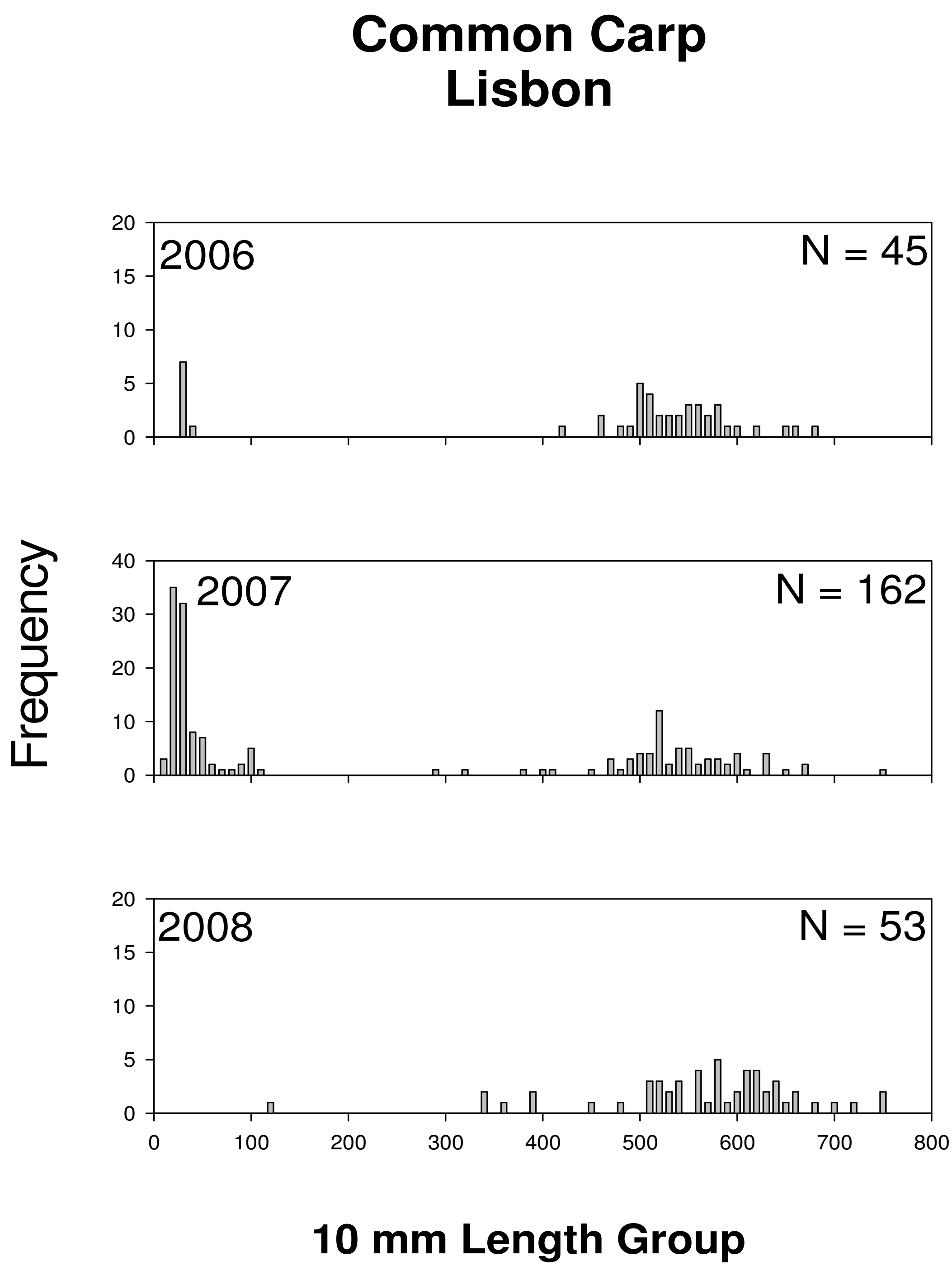


Figure III.9.5. Length frequency distribution of common carp in Lisbon chute by year. Length groups are in 10 mm intervals.

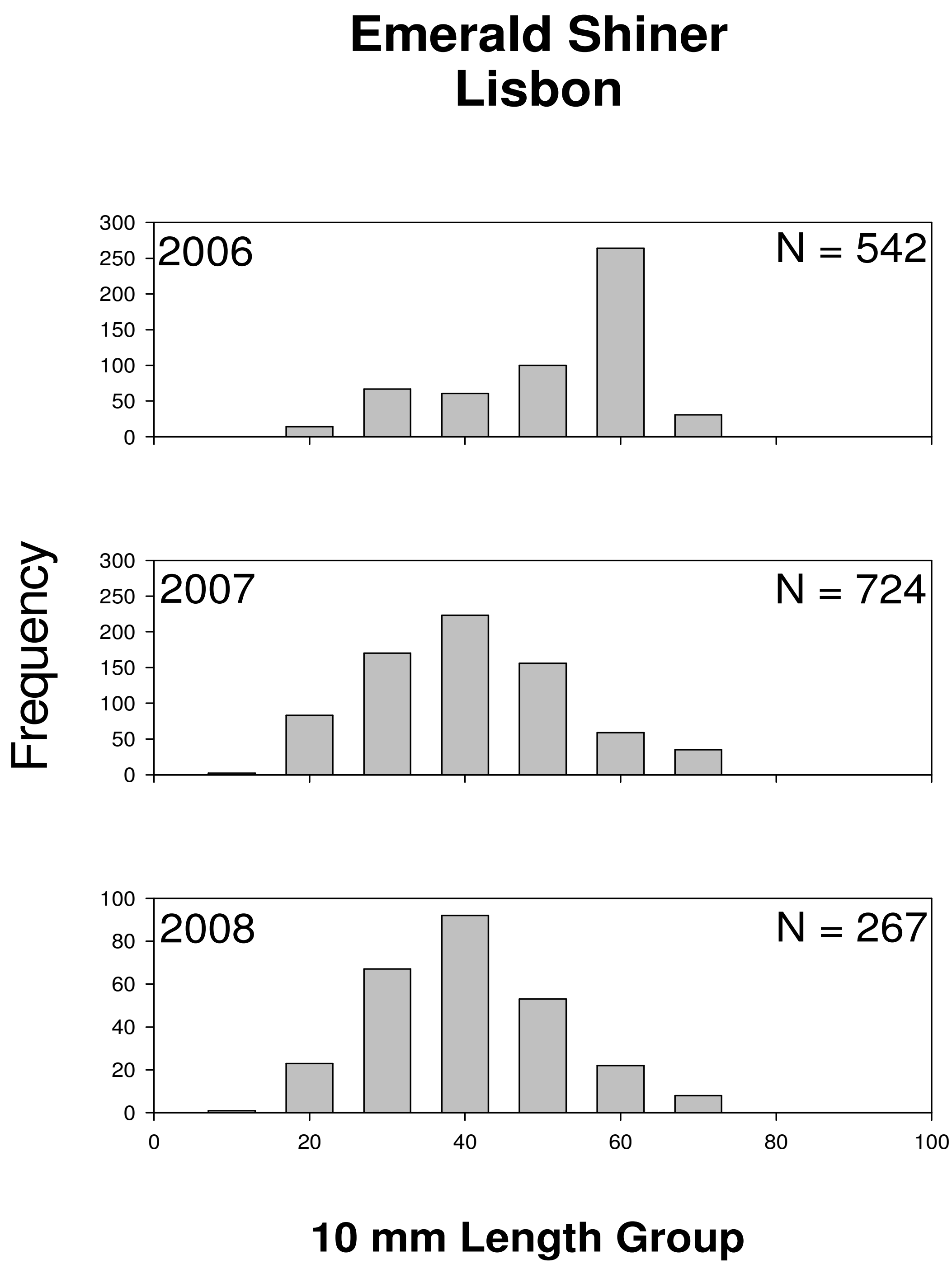


Figure III.9.6. Length frequency distribution of emerald shiner in Lisbon chute by year. Length groups are in 10 mm intervals.

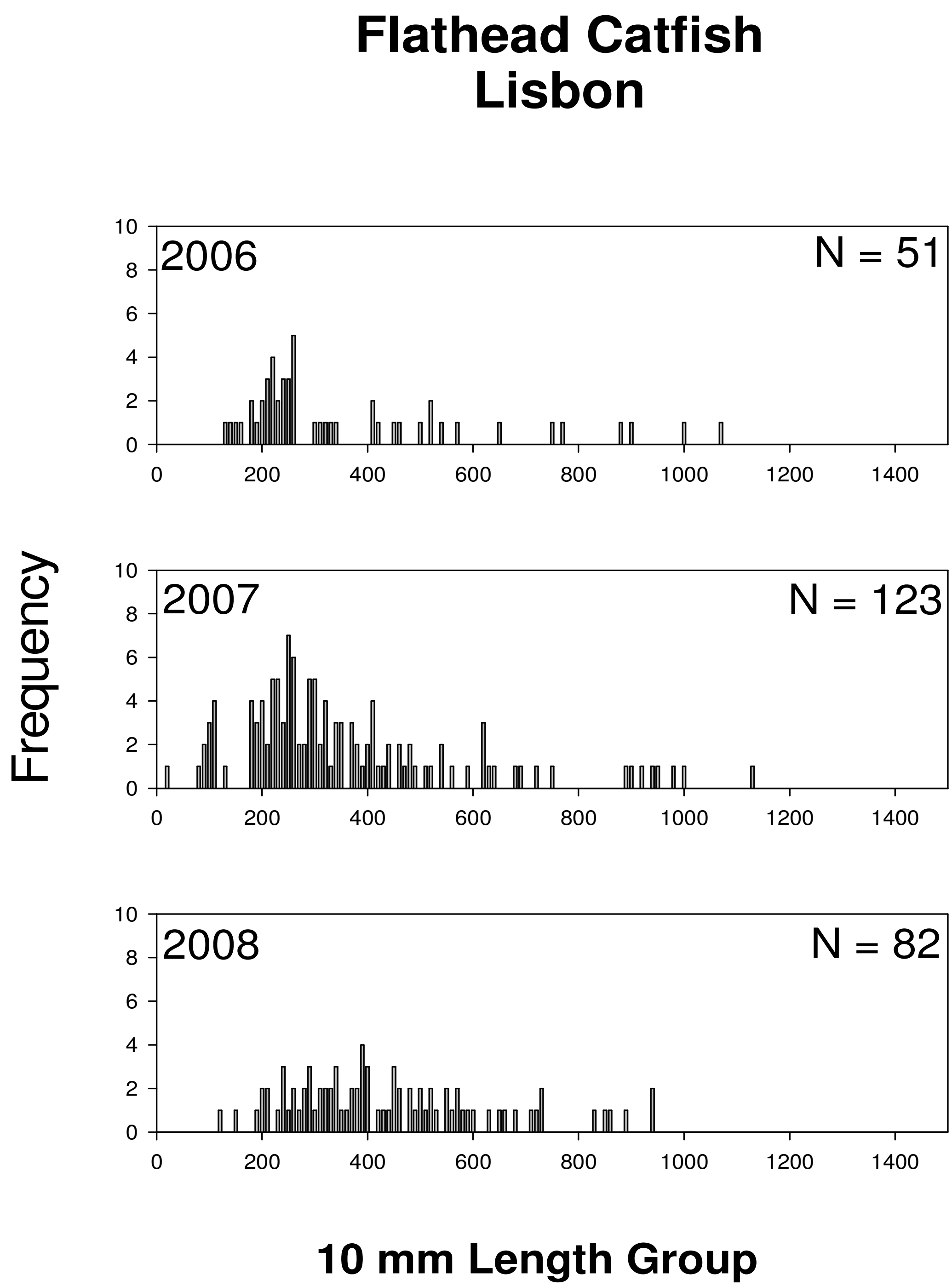


Figure III.9.7. Length frequency distribution of flathead catfish in Lisbon chute by year. Length groups are in 10 mm intervals.

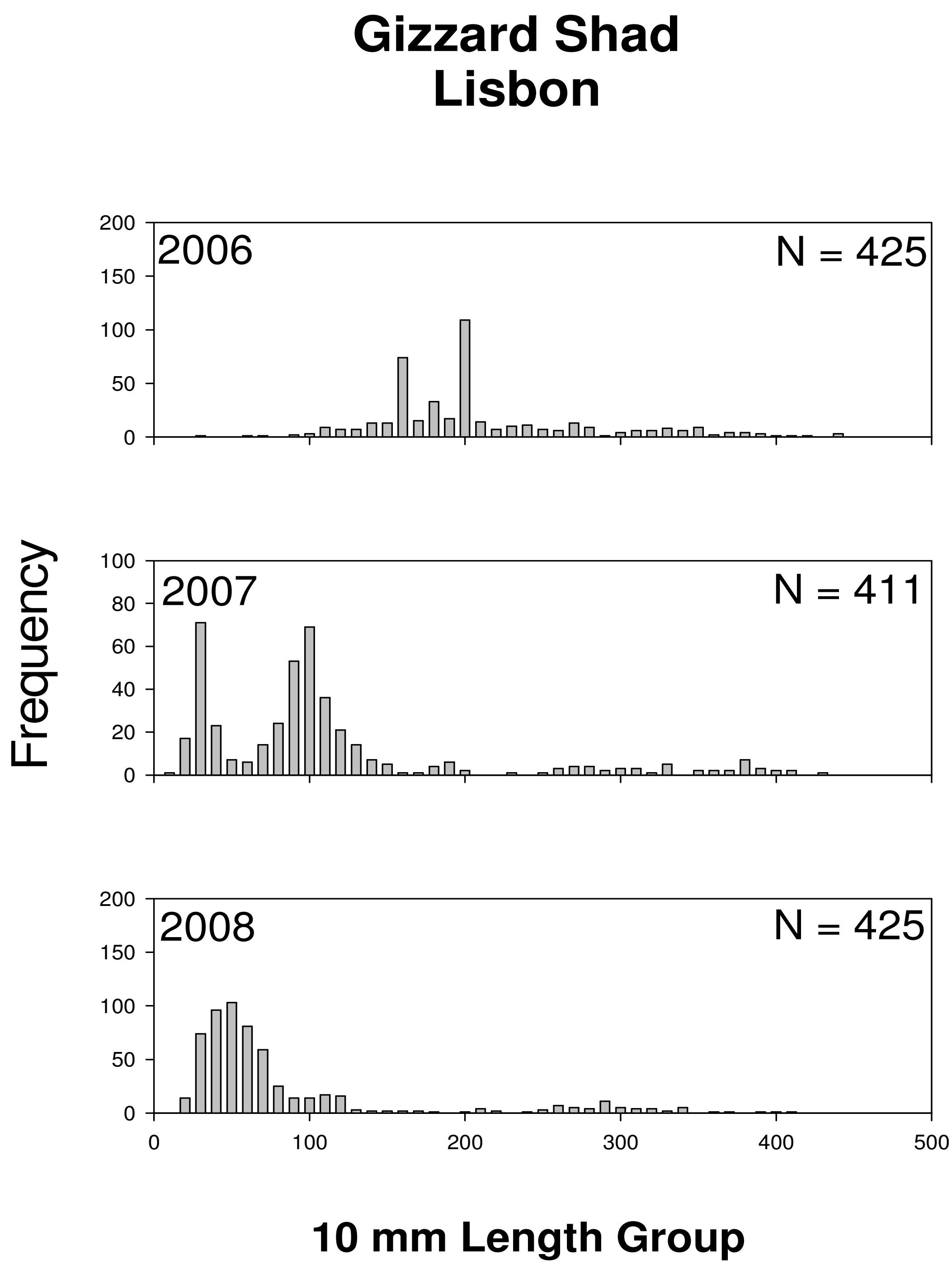


Figure III.9.8. Length frequency distribution of gizzard shad in Lisbon chute by year. Length groups are in 10 mm intervals.

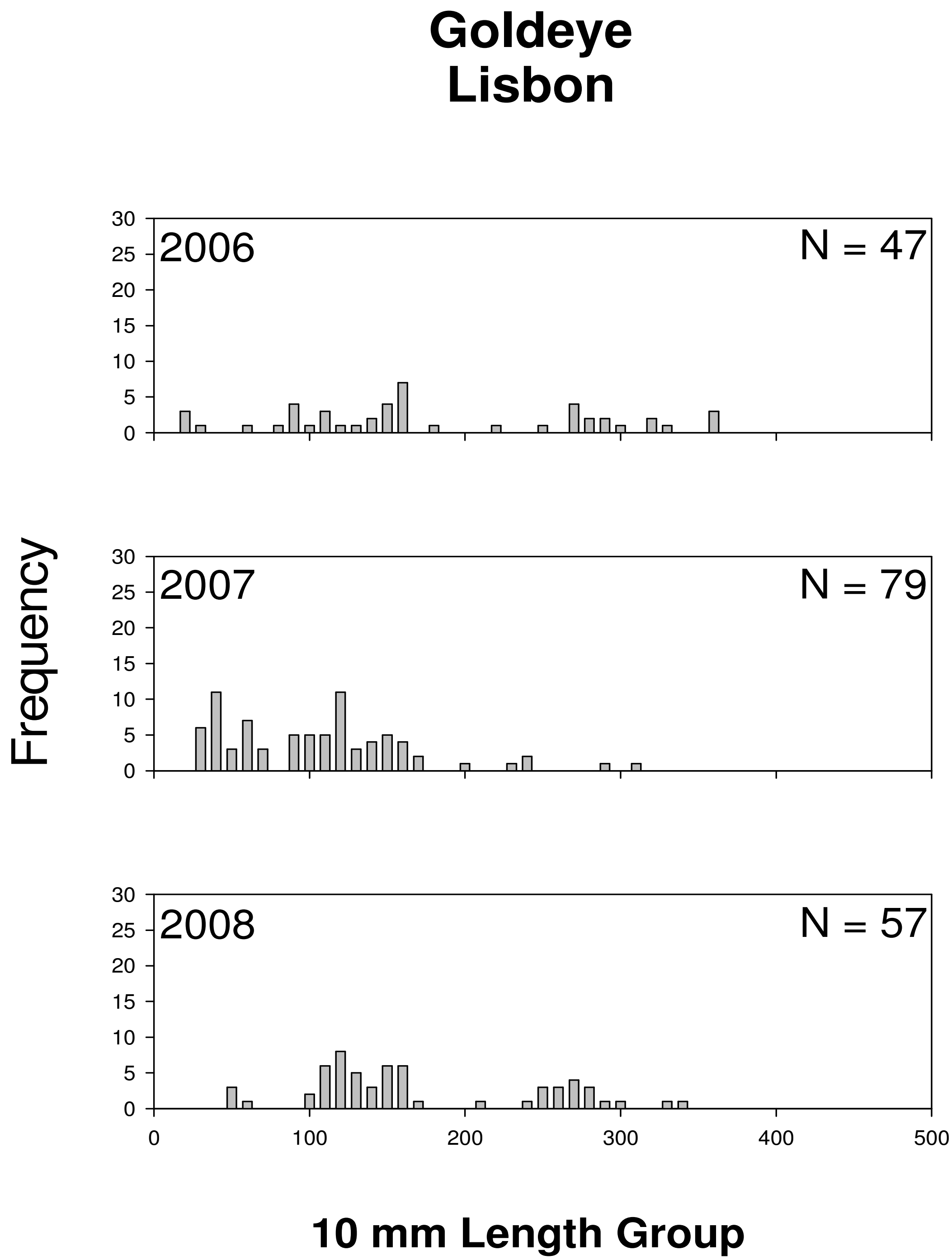


Figure III.9.9. Length frequency distribution of goldeye in Lisbon chute by year. Length groups are in 10 mm intervals.

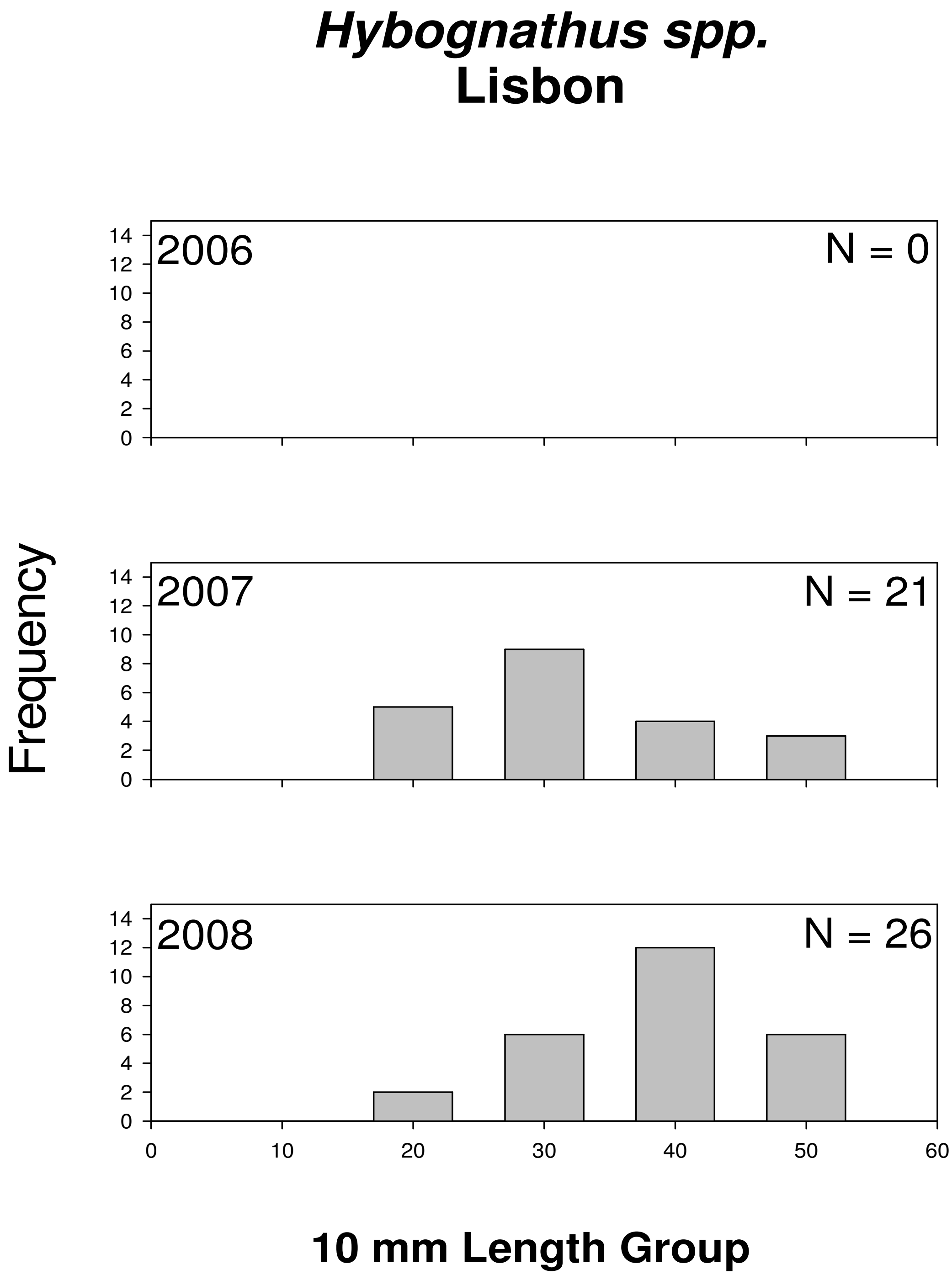


Figure III.9.10. Length frequency distribution of *Hybognathus spp*. in Lisbon chute by year. Length groups are in 10 mm intervals.

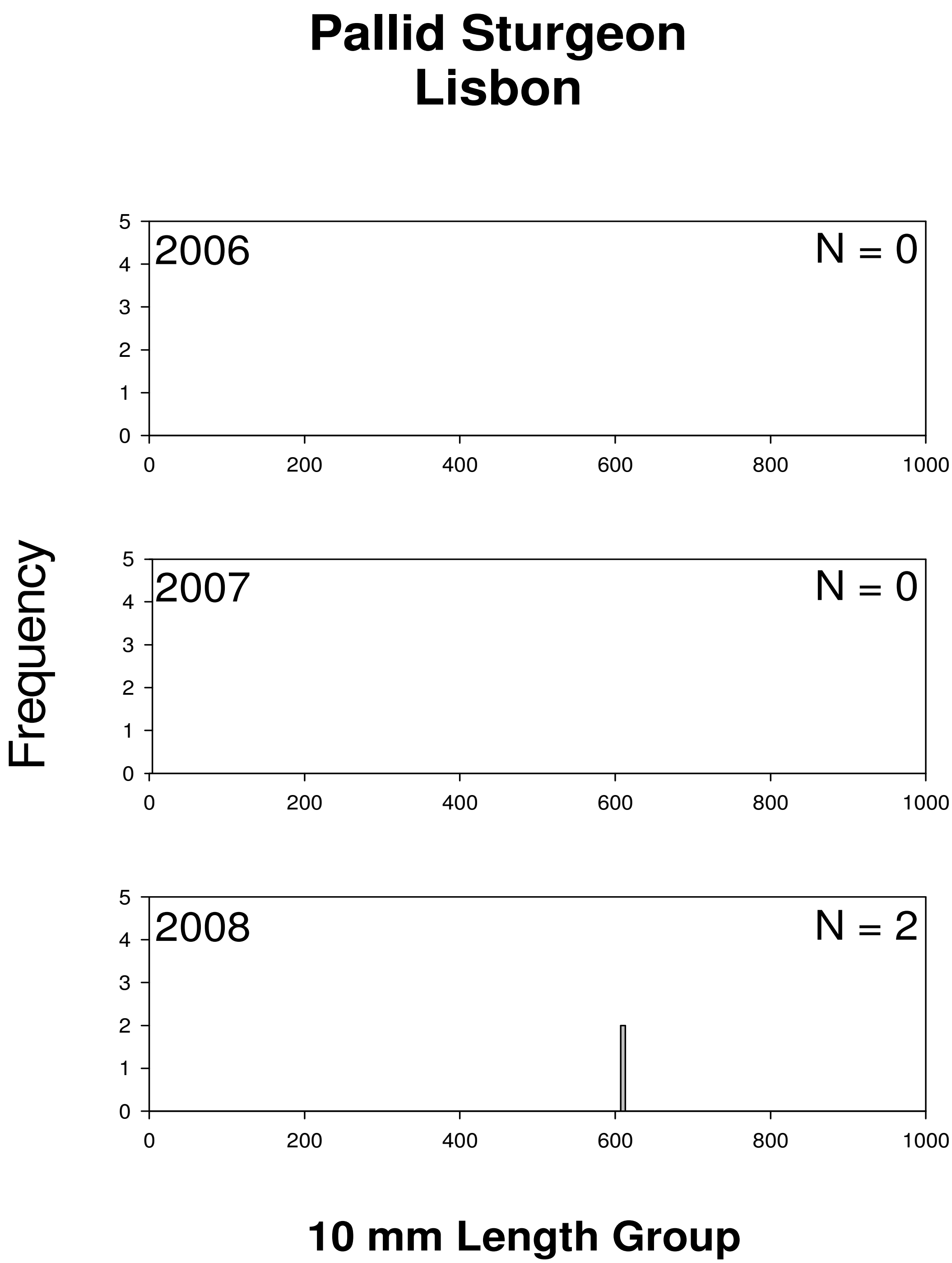


Figure III.9.10. Length frequency distribution of pallid sturgeon in Lisbon chute by year. Length groups are in 10 mm intervals.

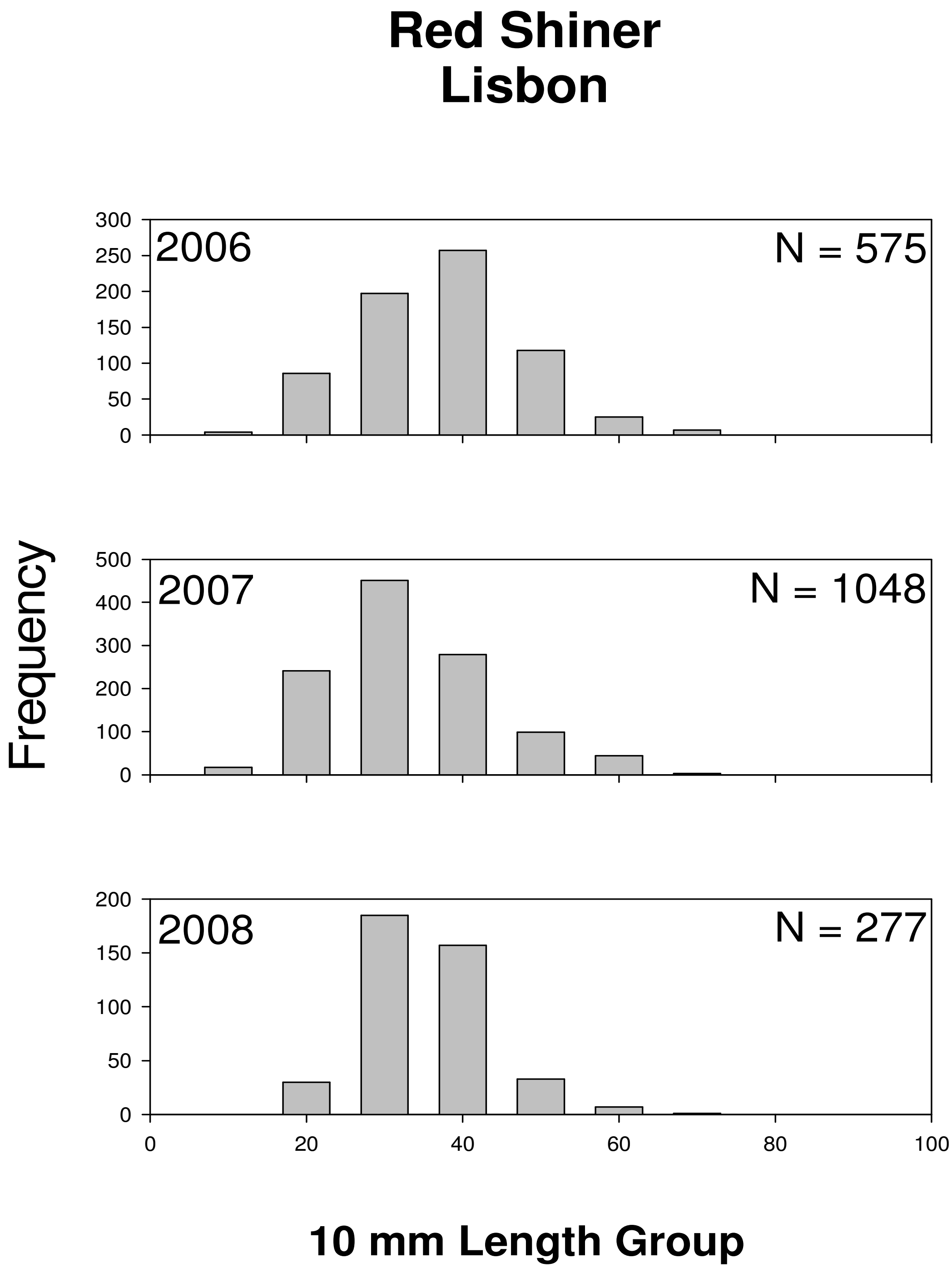


Figure III.9.12. Length frequency distribution of red shiner in Lisbon chute by year. Length groups are in 10 mm intervals.

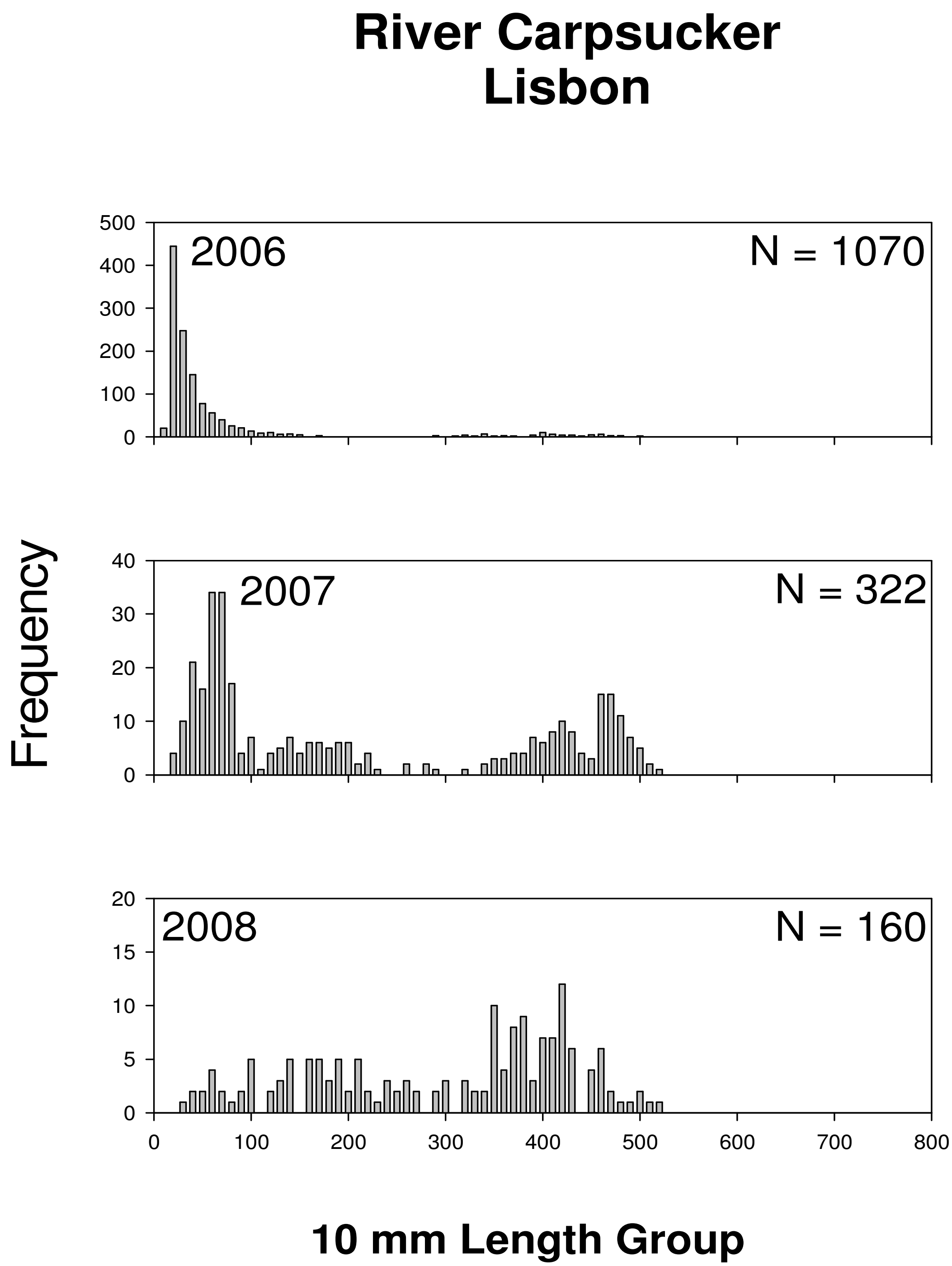


Figure III.9.13. Length frequency distribution of river carpsucker in Lisbon chute by year. Length groups are in 10 mm intervals.

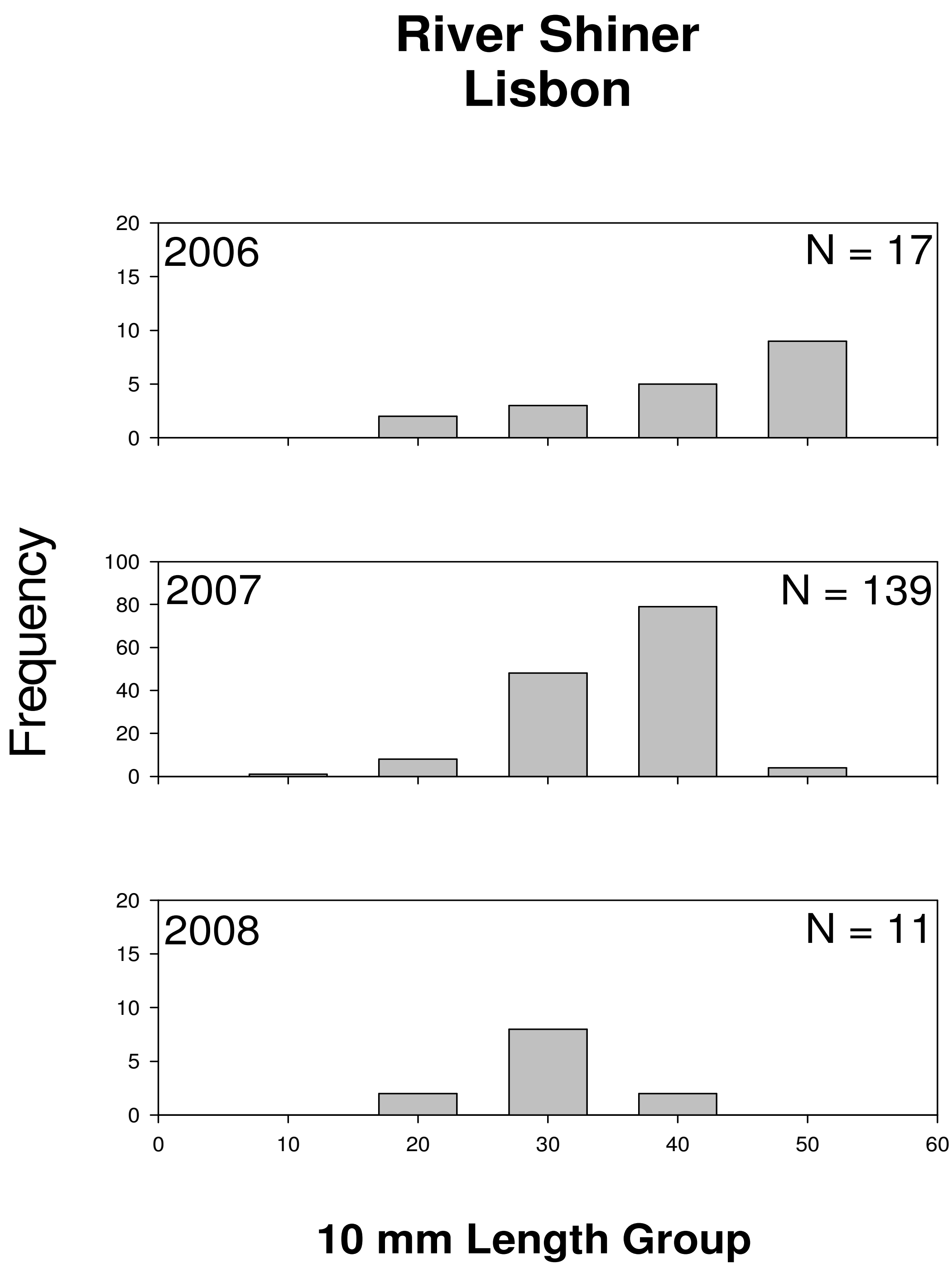


Figure III.9.14. Length frequency distribution of river shiner in Lisbon chute by year. Length groups are in 10 mm intervals.

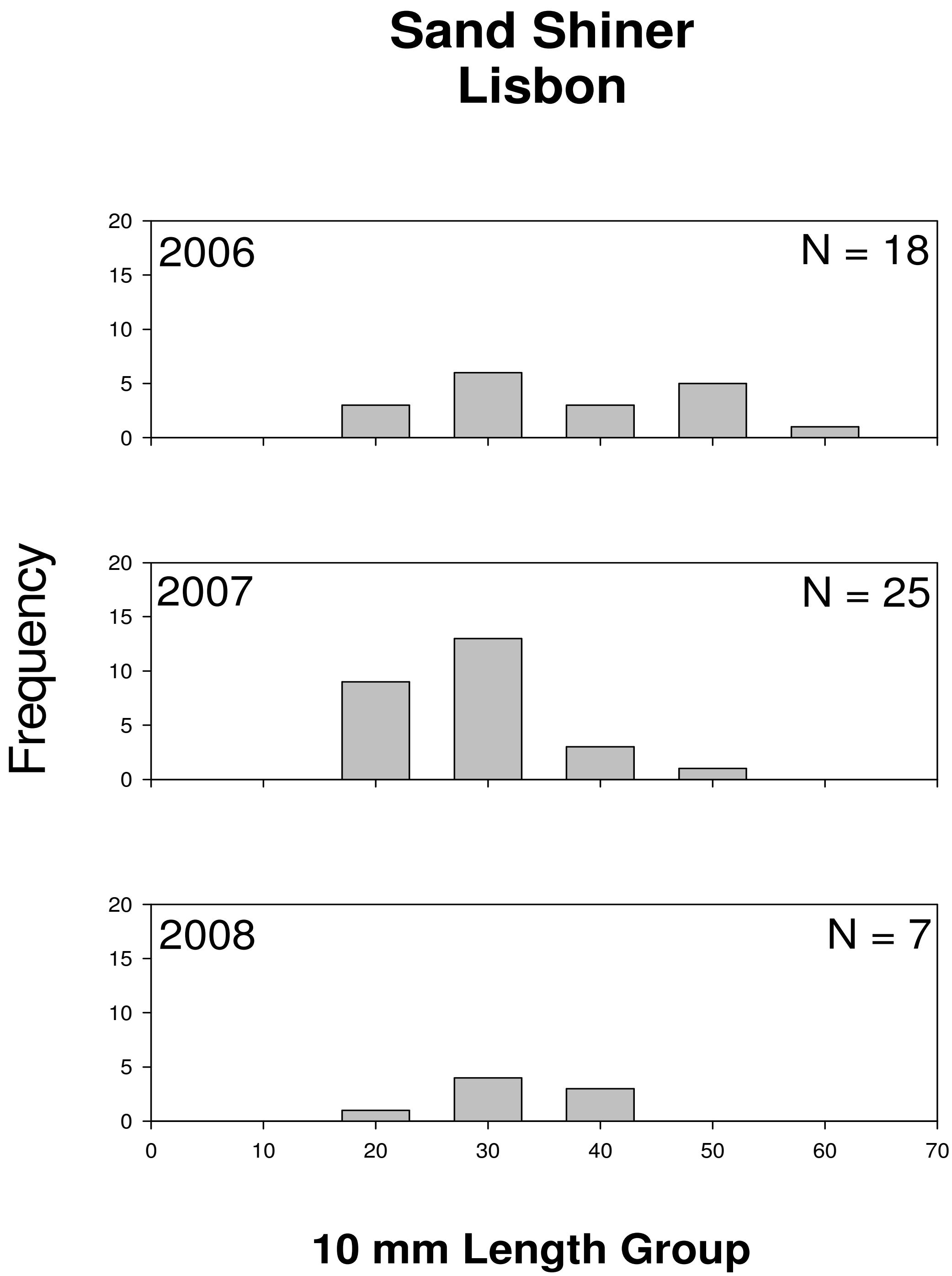


Figure III.9.15. Length frequency distribution of sand shiner in Lisbon chute by year. Length groups are in 10 mm intervals.

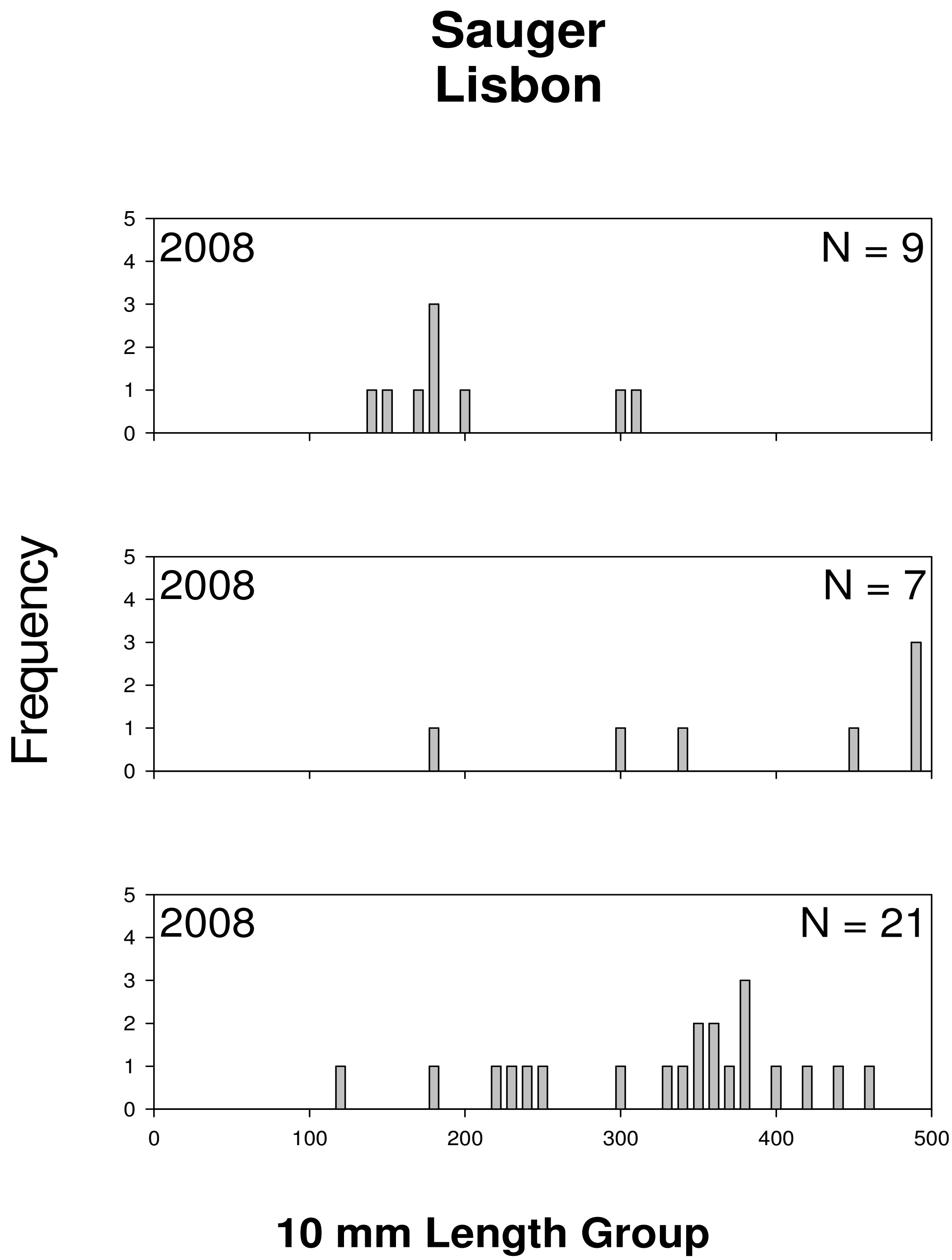


Figure III.9.16. Length frequency distribution of sauger in Lisbon chute by year. Length groups are in 10 mm intervals.

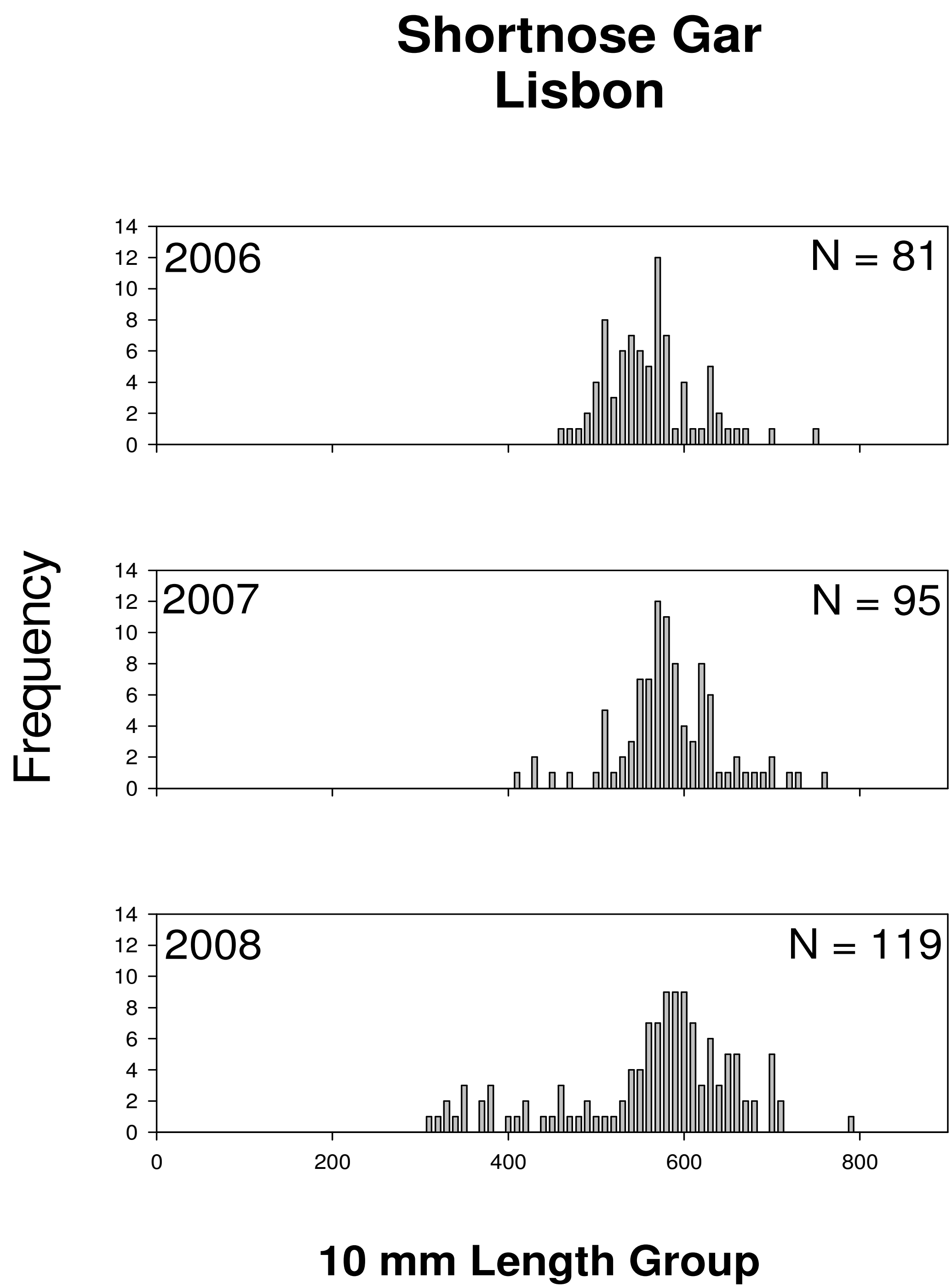


Figure III.9.17. Length frequency distribution of shortnose gar in Lisbon chute by year. Length groups are in 10 mm intervals.

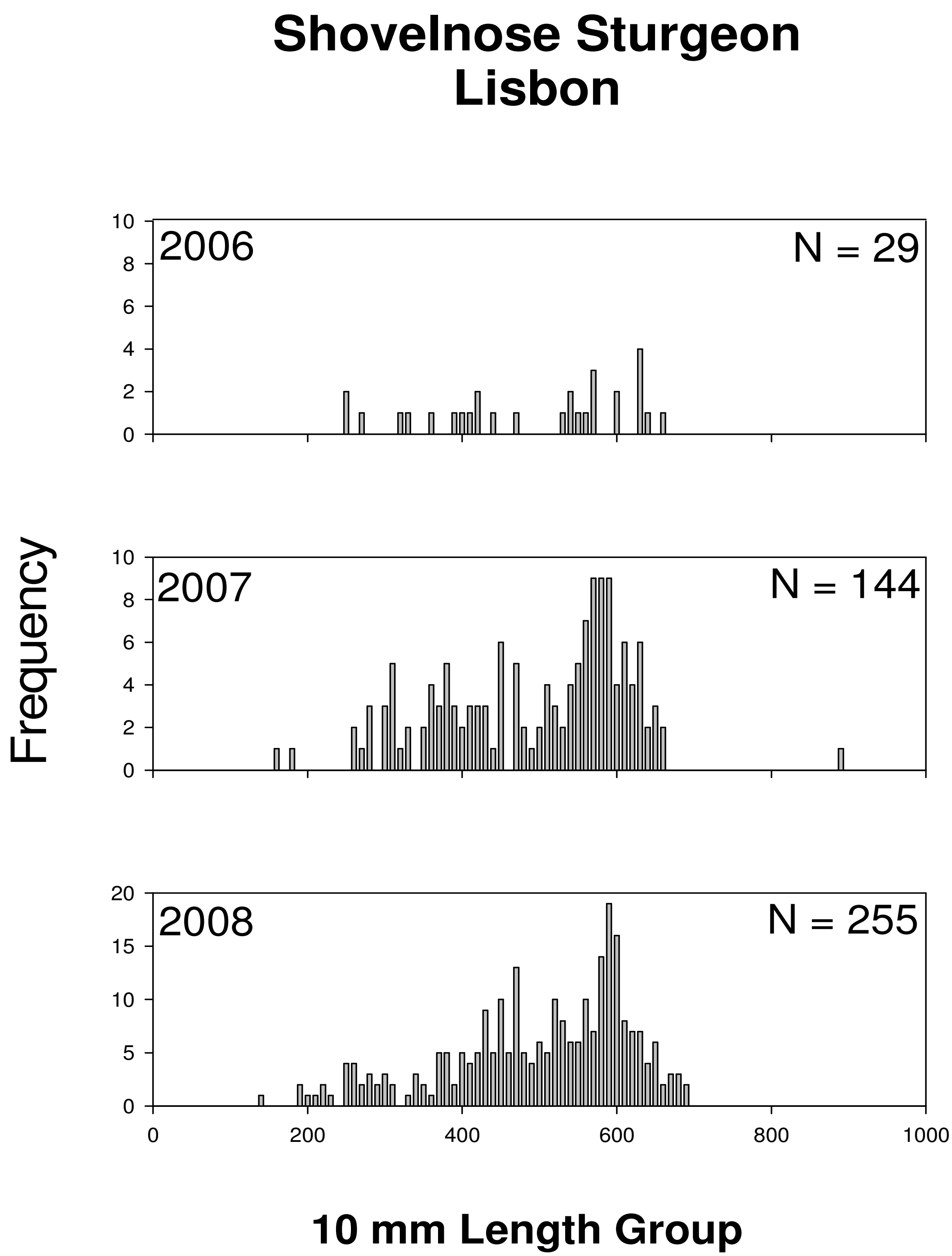


Figure III.9.18. Length frequency distribution of shovelnose sturgeon in Lisbon chute by year. Length groups are in 10 mm intervals.

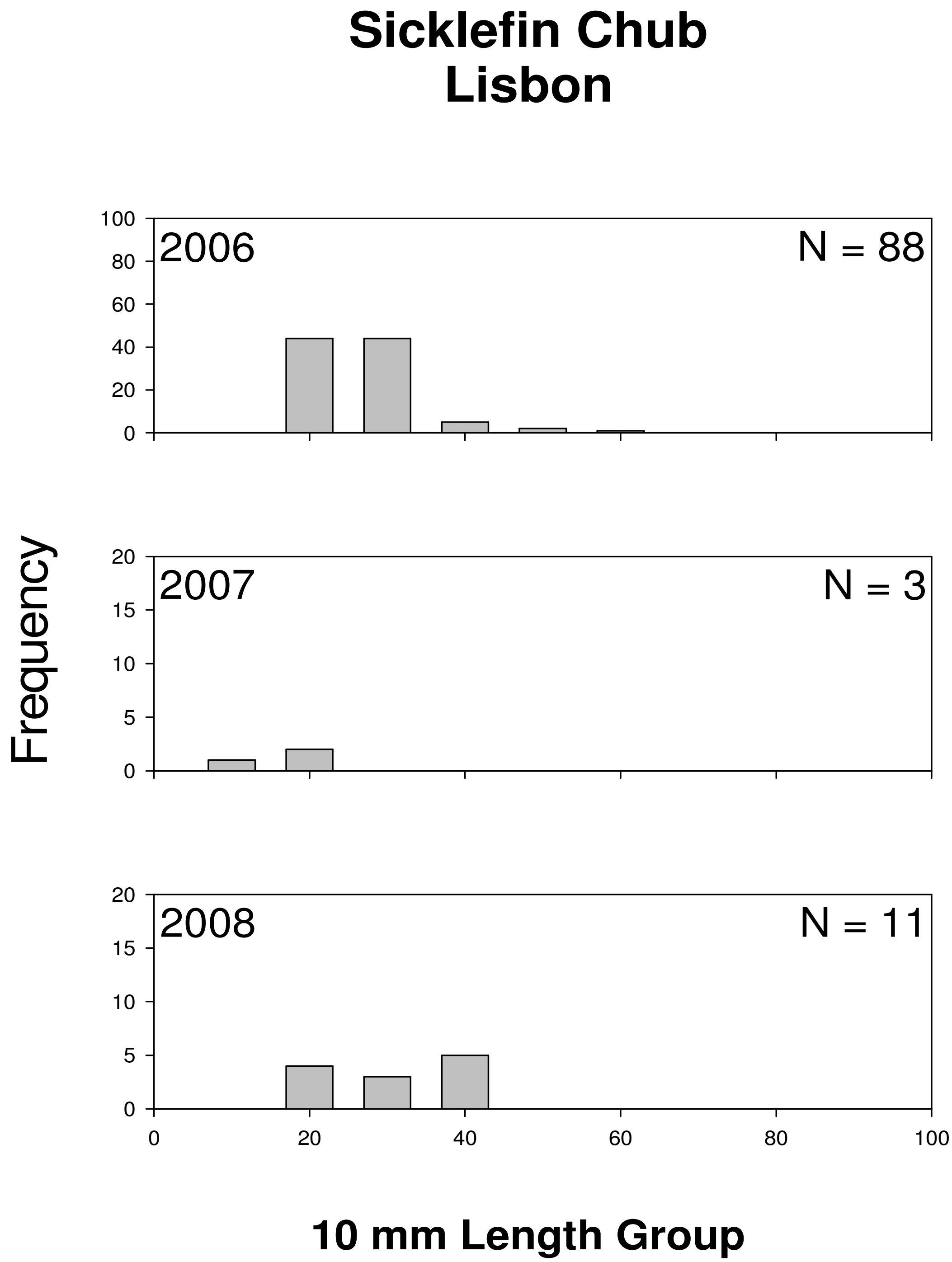


Figure III.9.19. Length frequency distribution of sicklefin chub in Lisbon chute by year. Length groups are in 10 mm intervals.

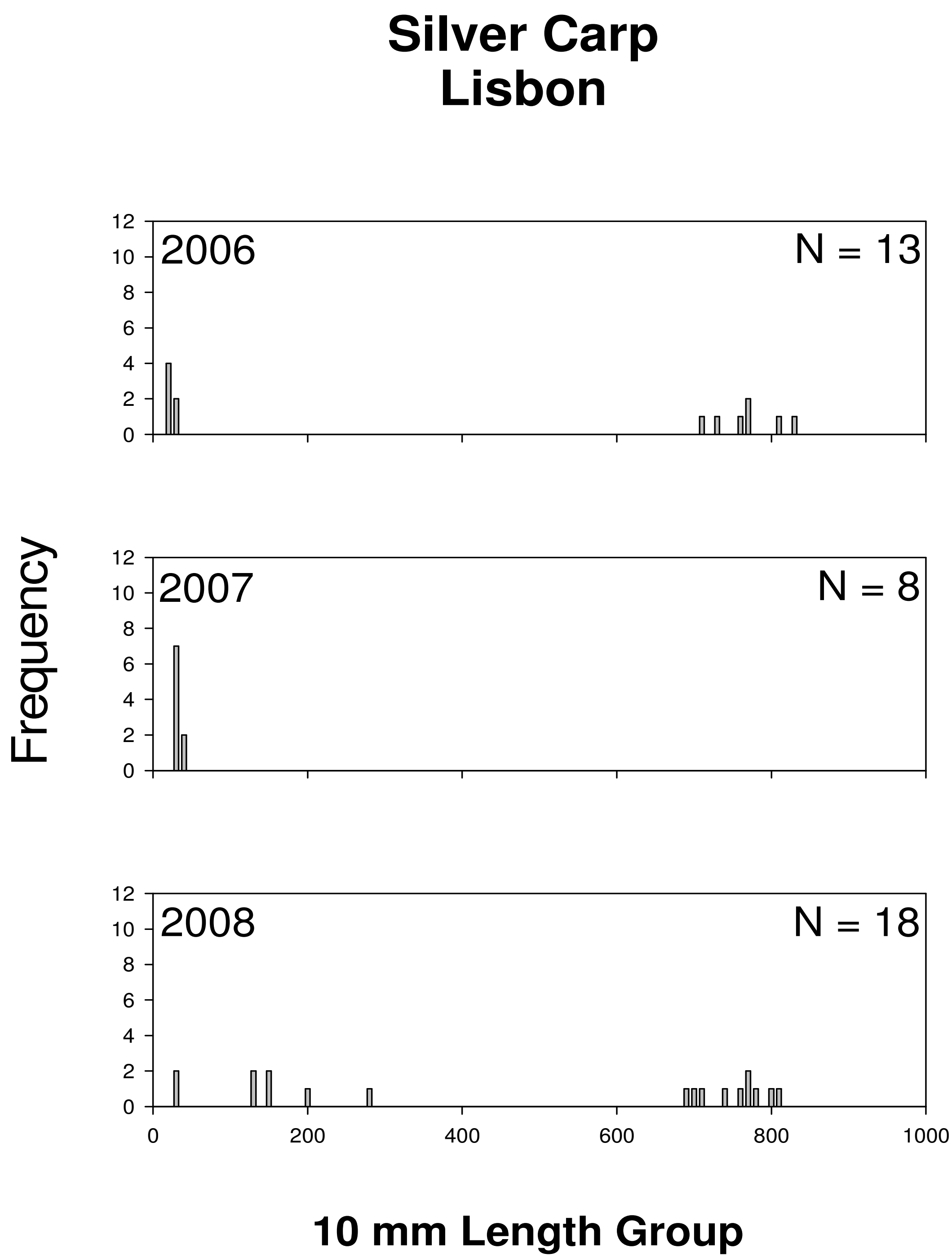


Figure III.9.20. Length frequency distribution of silver carp in Lisbon chute by year. Length groups are in 10 mm intervals.

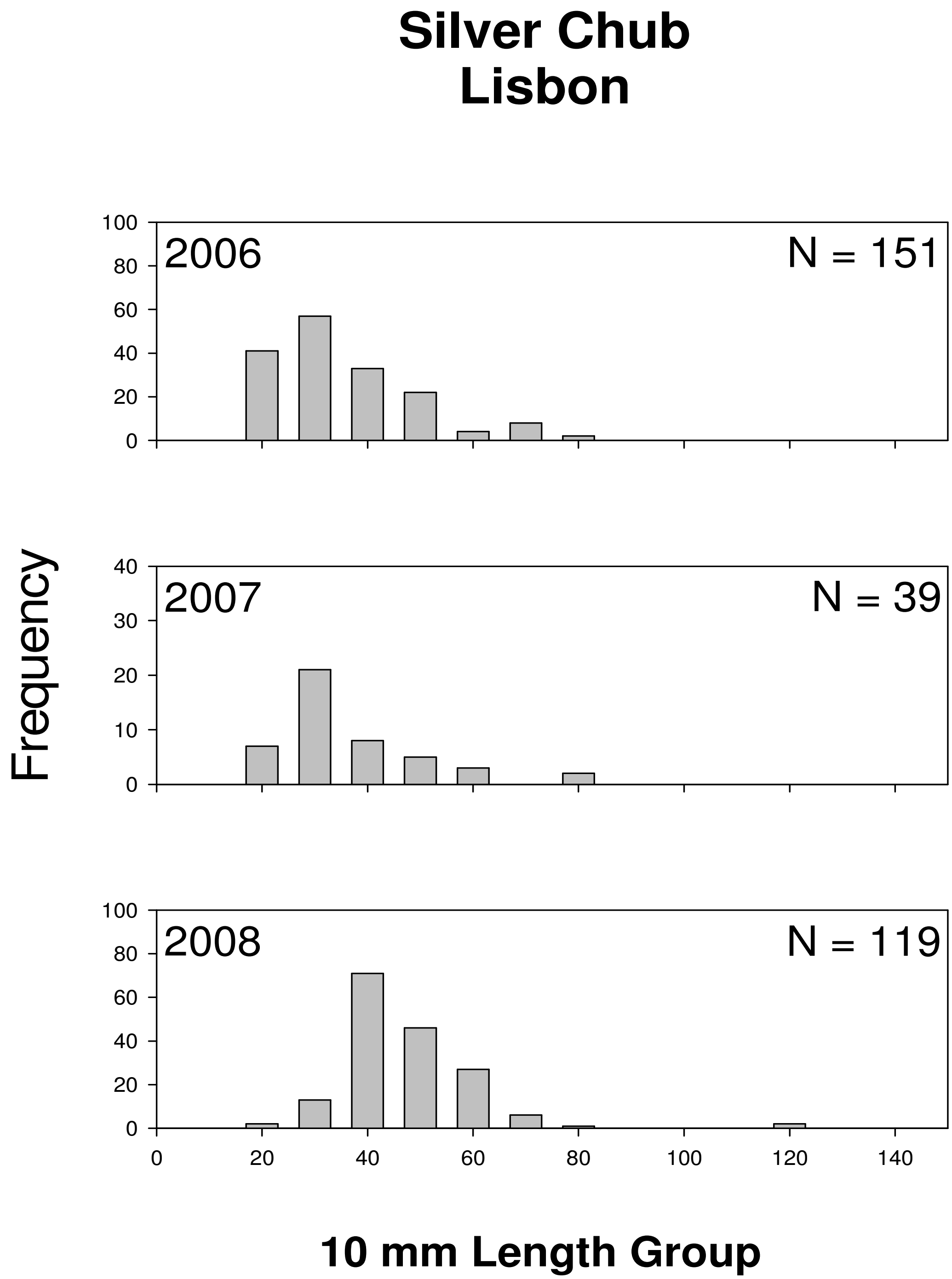


Figure III.9.21. Length frequency distribution of silver chub in Lisbon chute by year. Length groups are in 10 mm intervals.

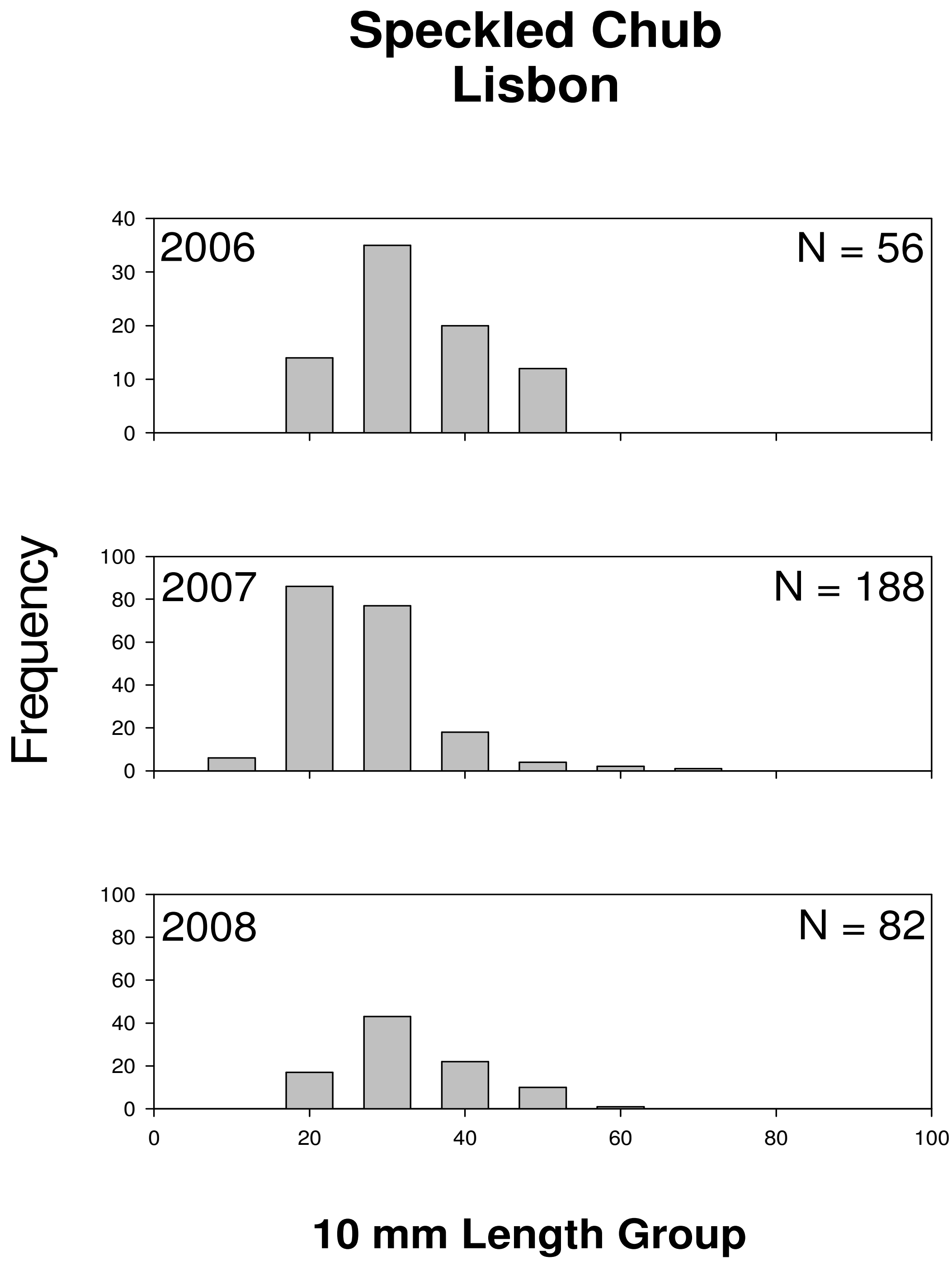


Figure III.9.22. Length frequency distribution of speckled chub in Lisbon chute by year. Length groups are in 10 mm intervals.

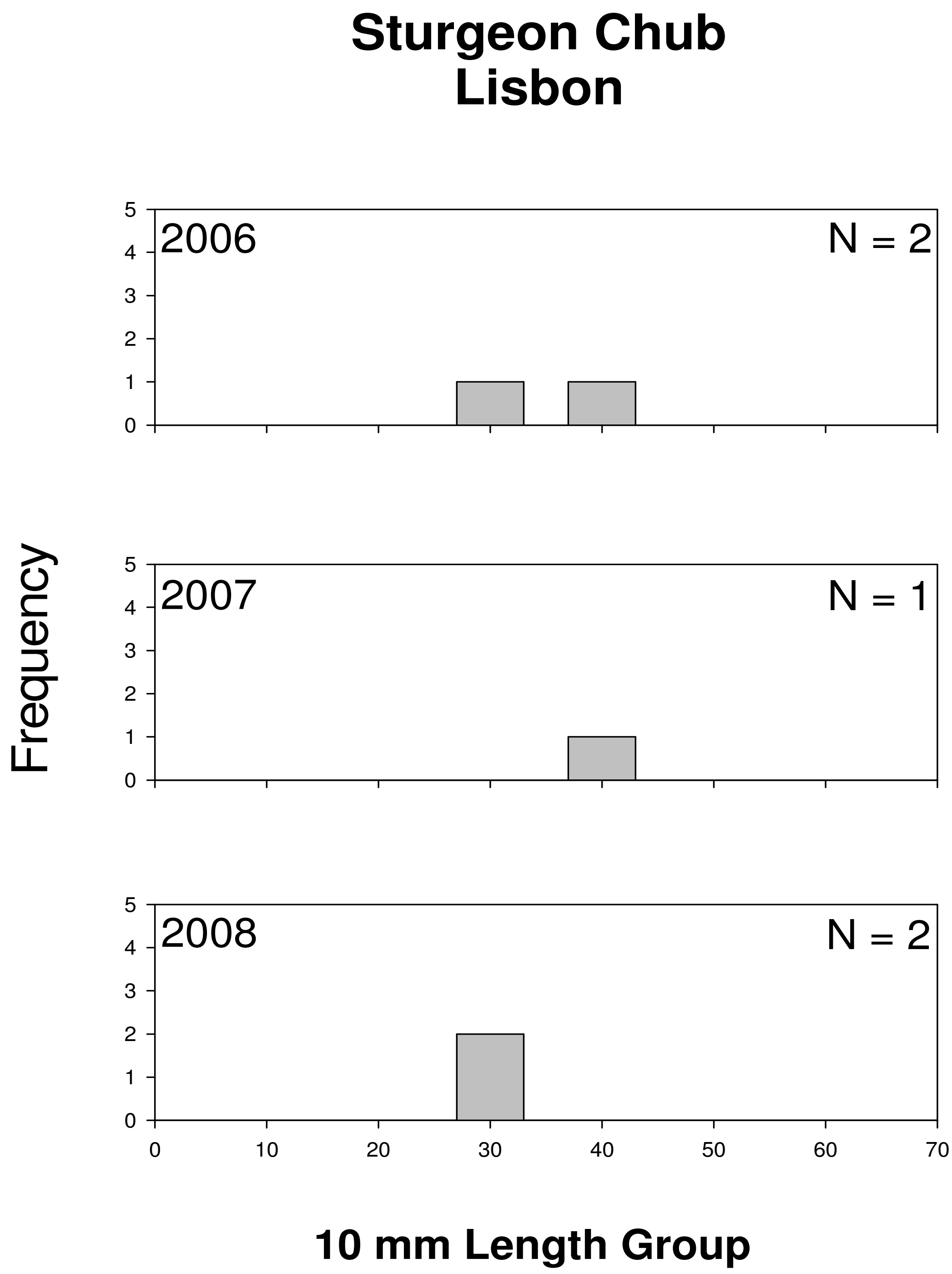


Figure III.9.23. Length frequency distribution of sturgeon chub in Lisbon chute by year. Length groups are in 10 mm intervals.

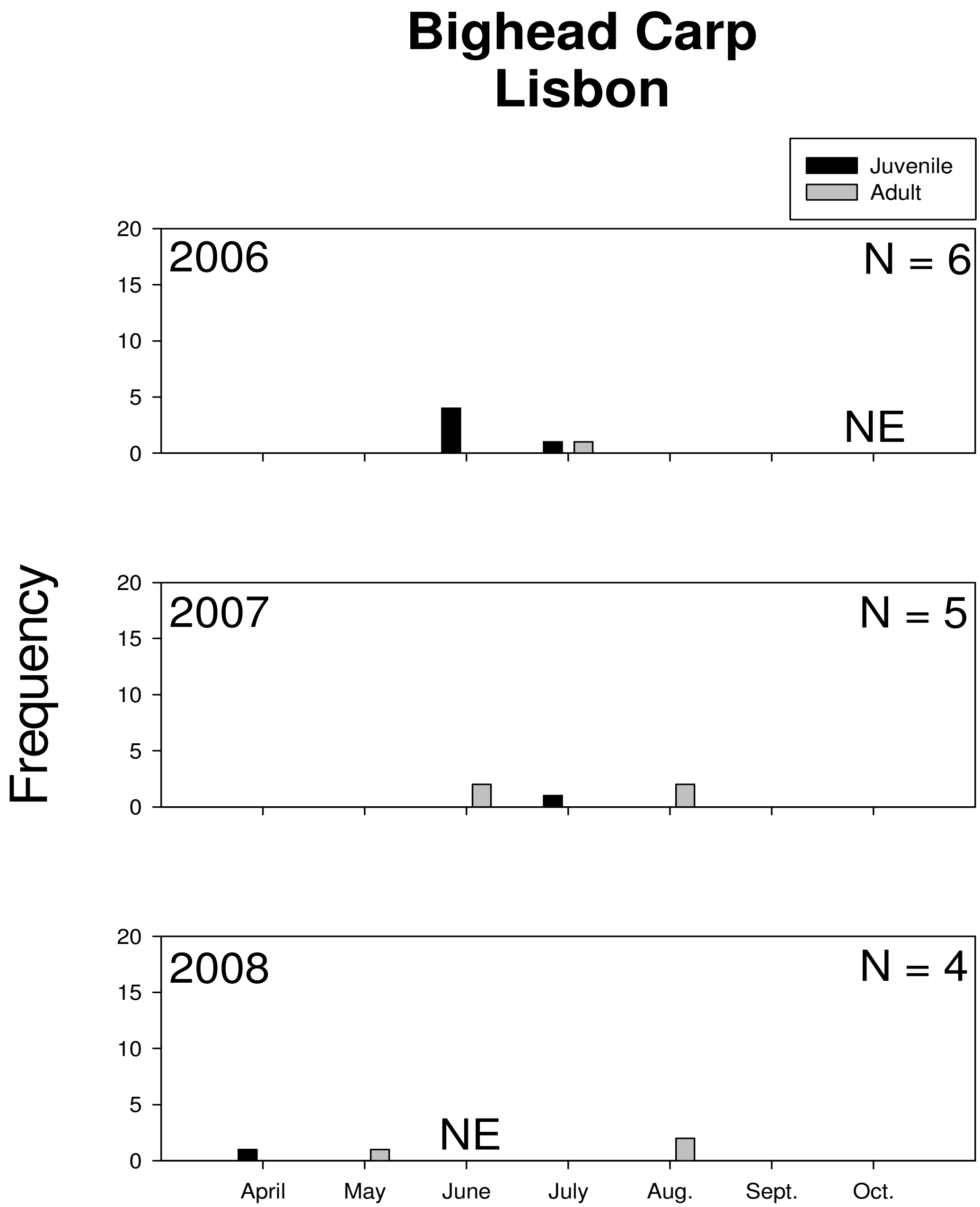


Figure III.9.24. Life stage frequency distribution of bighead carp in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

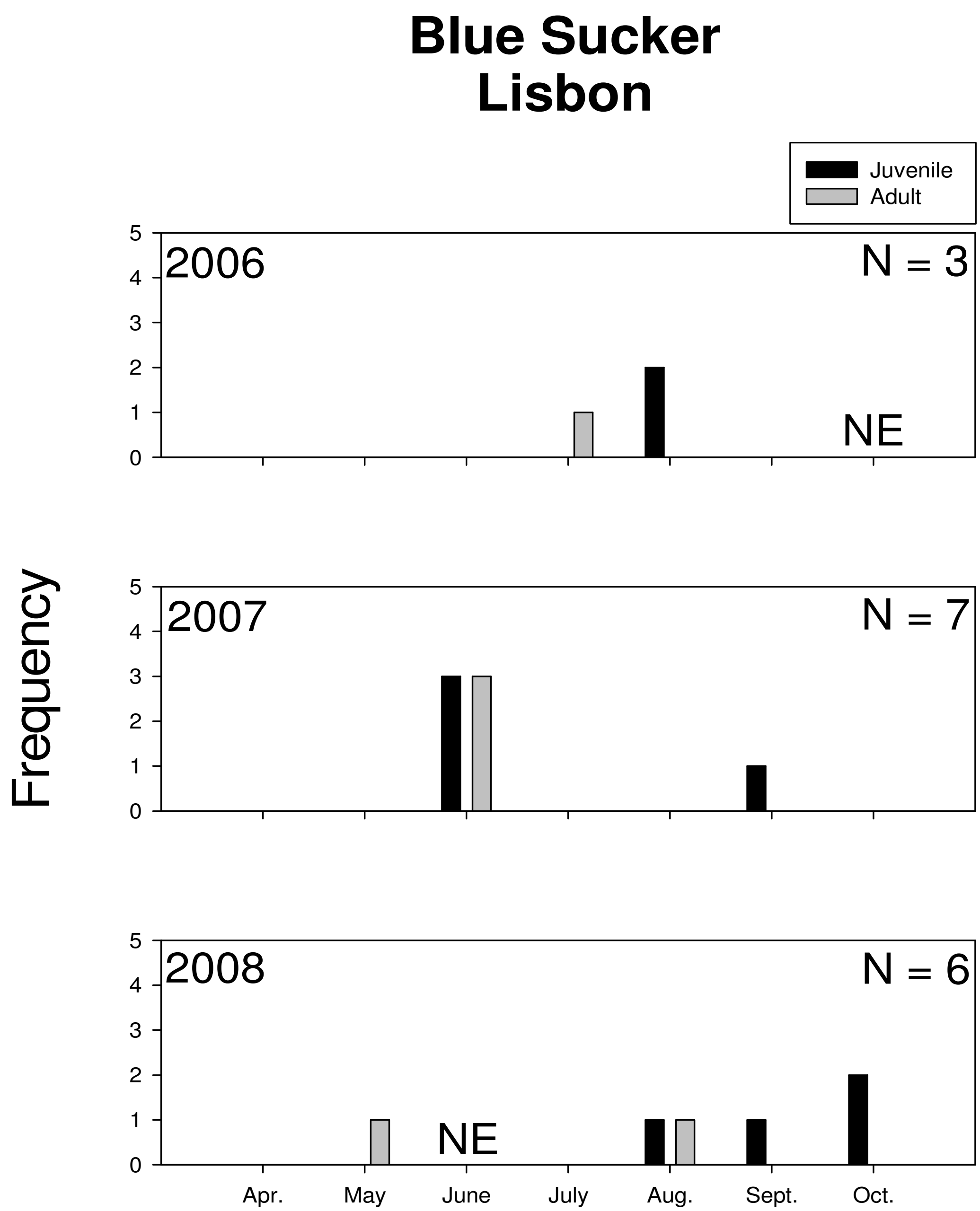


Figure III.9.25. Life stage frequency distribution of blue sucker in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

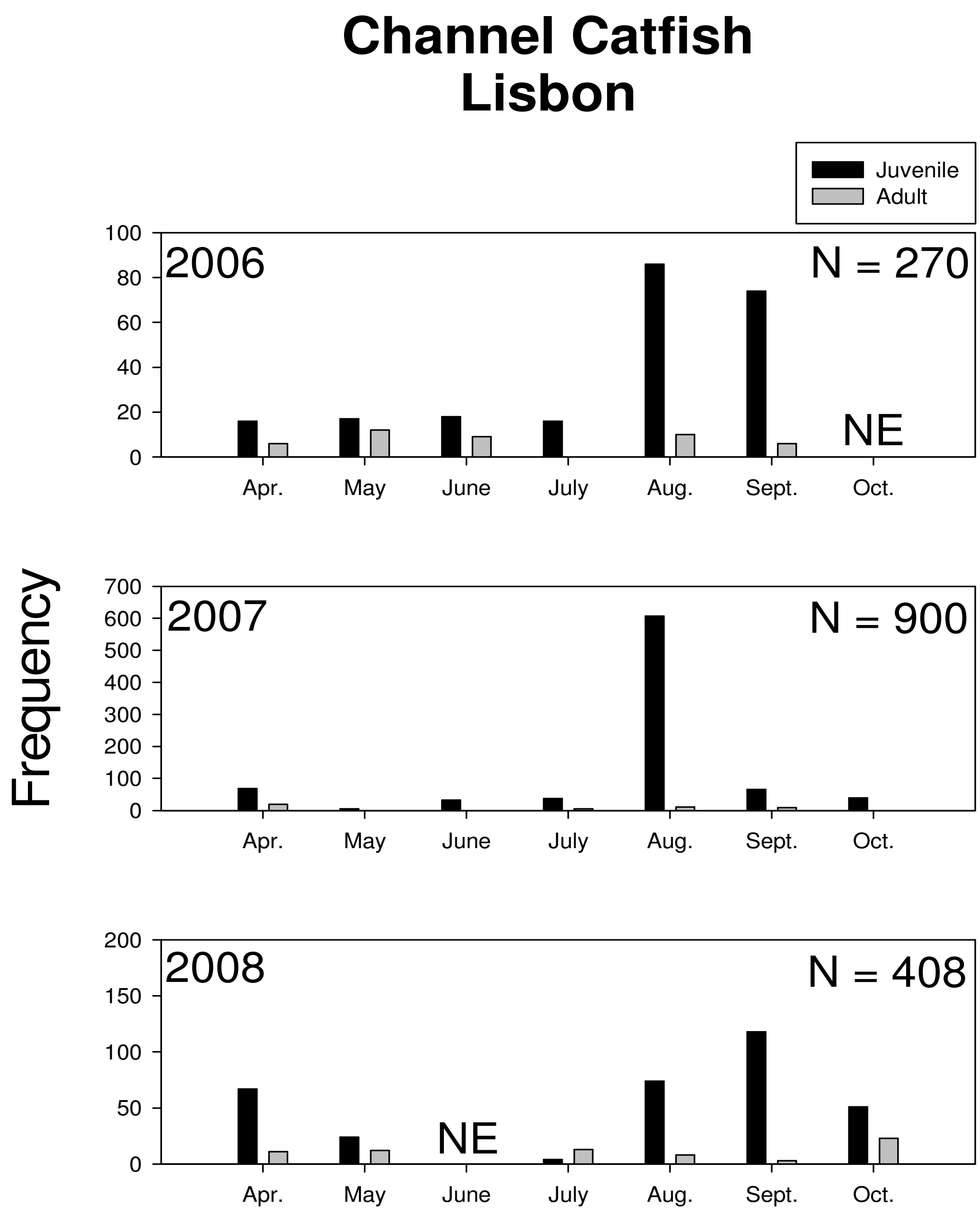


Figure III.9.26. Life stage frequency distribution of channel catfish in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

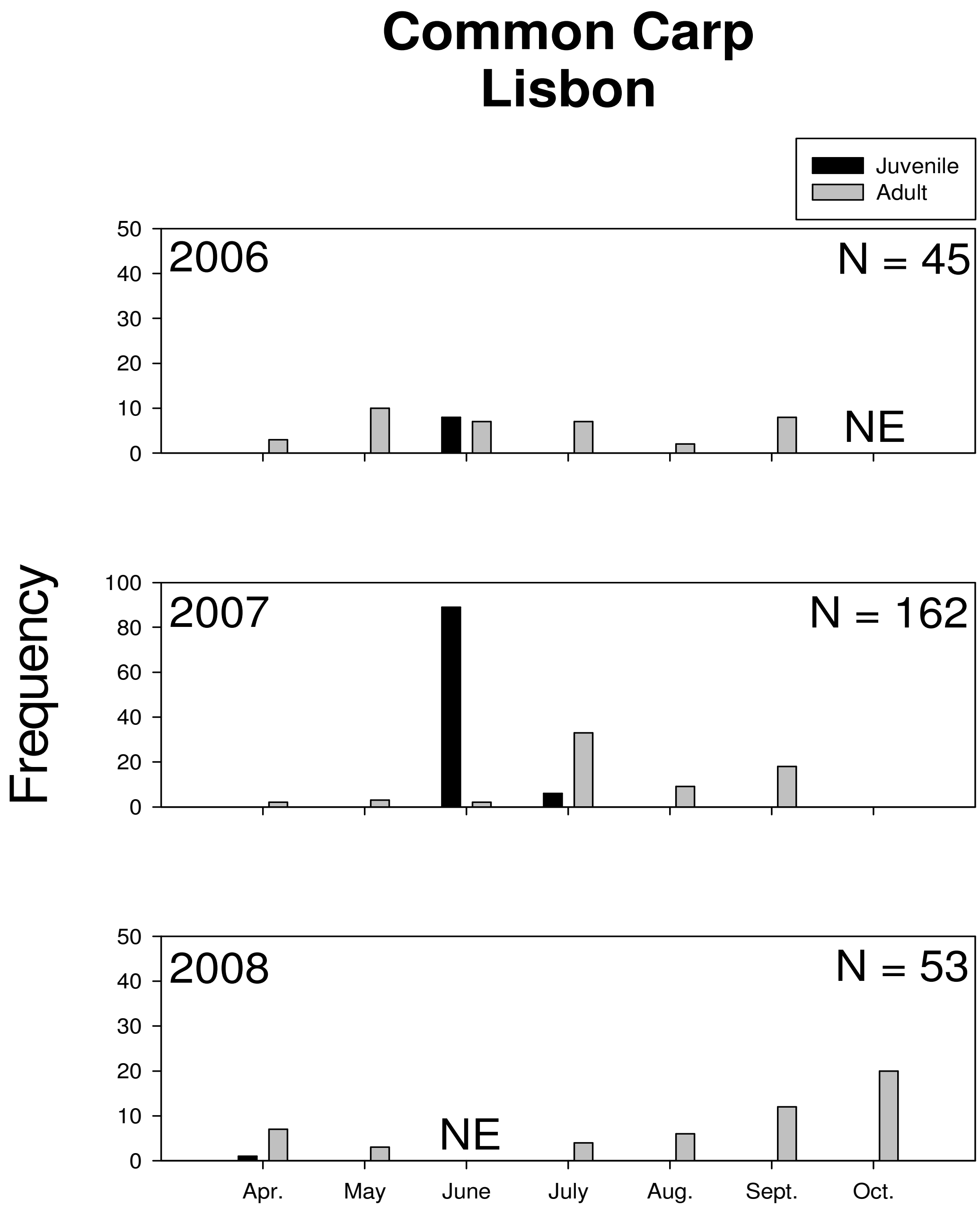


Figure III.9.27. Life stage frequency distribution of common carp in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

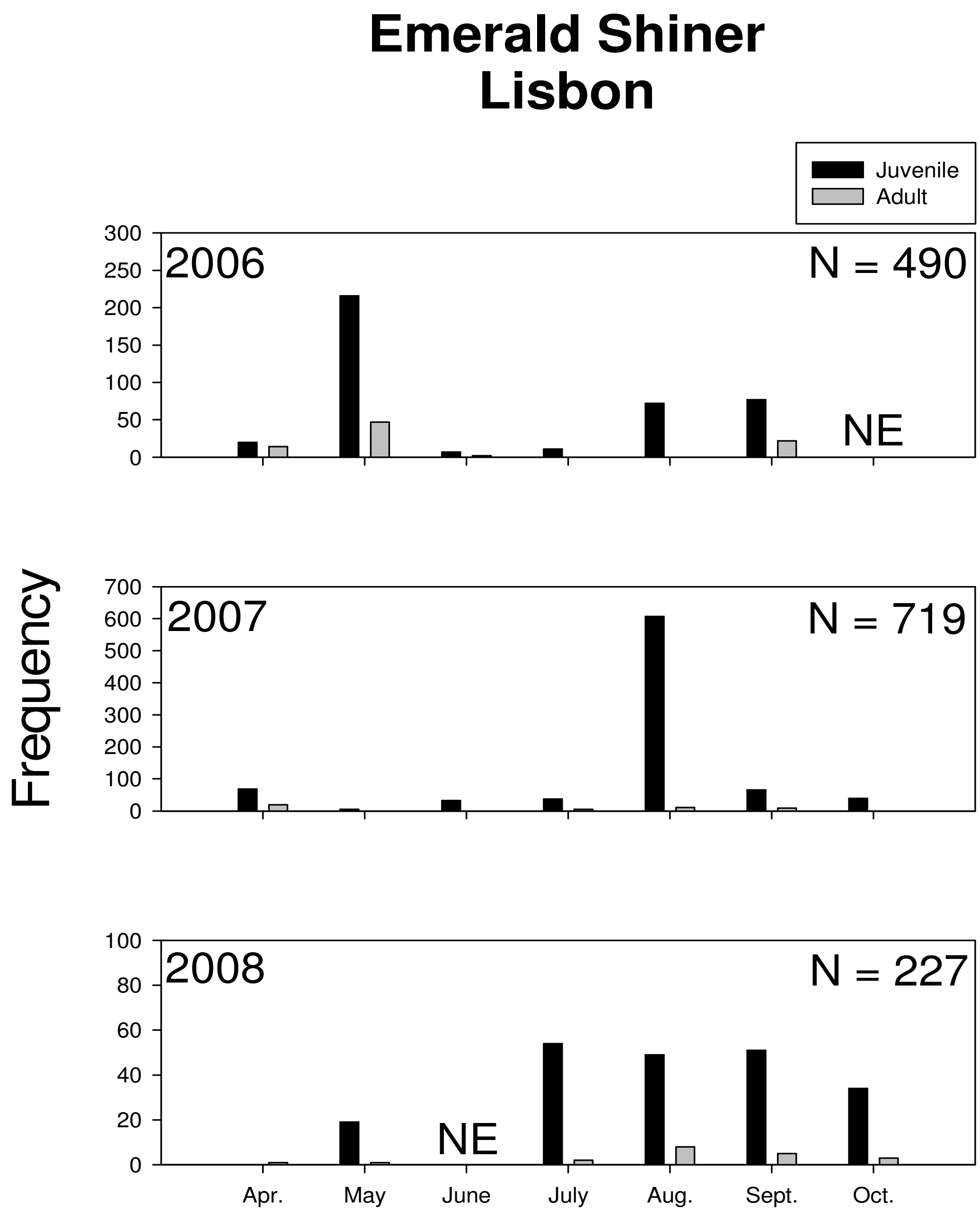


Figure III.9.28. Life stage frequency distribution of emerald shiner in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

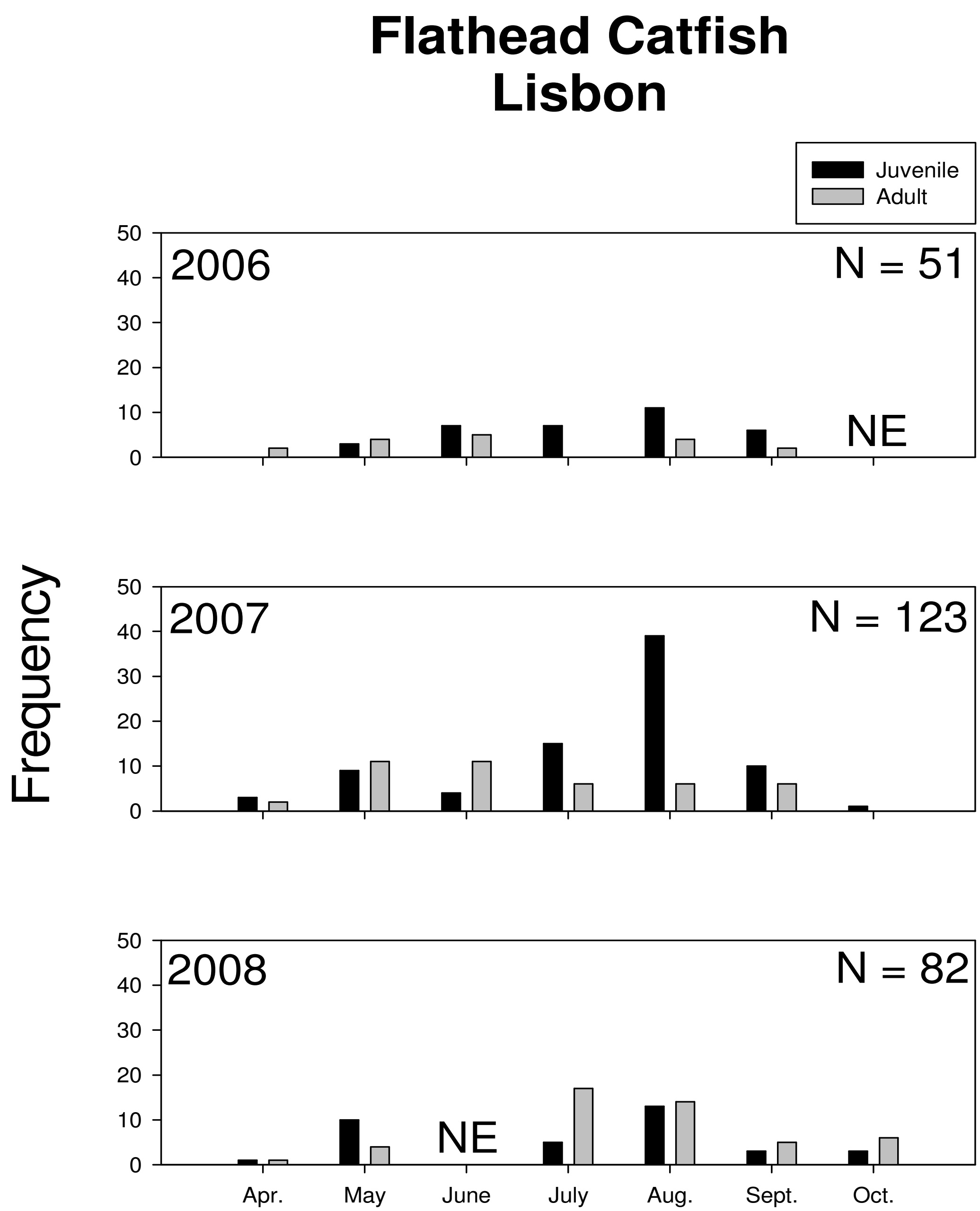


Figure III.9.29. Life stage frequency distribution of flathead catfish in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

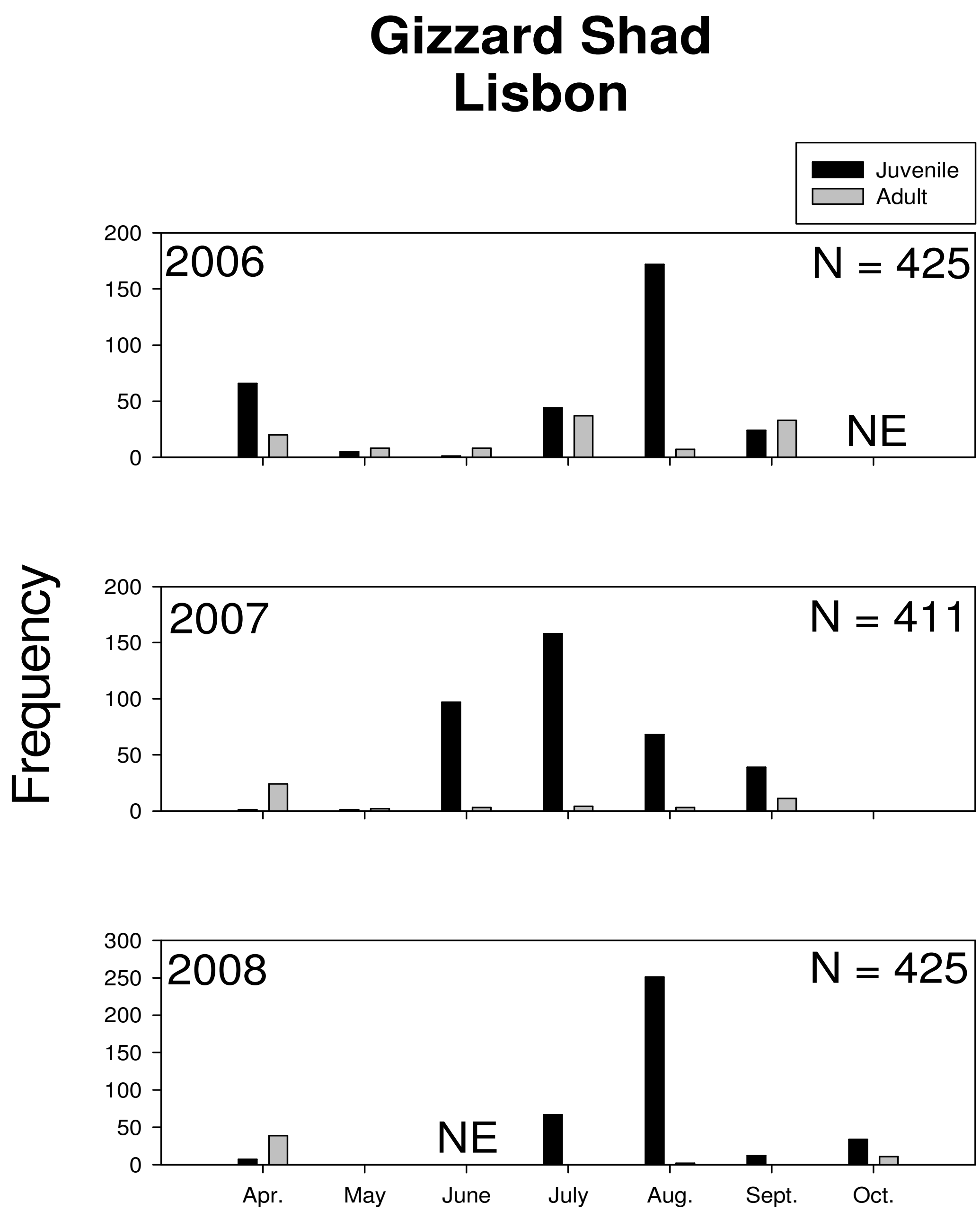


Figure III.9.30. Life stage frequency distribution of gizzard shad in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

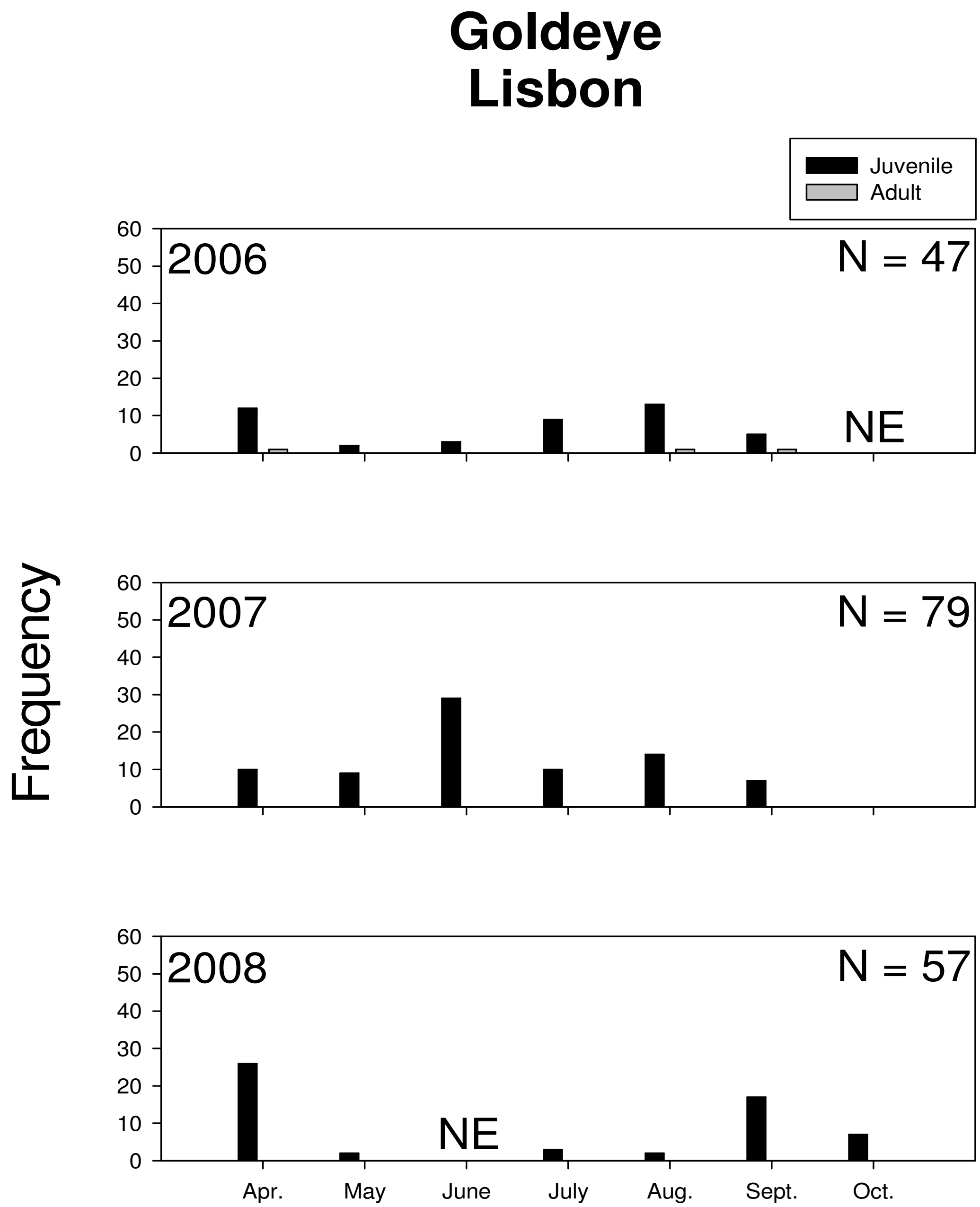


Figure III.9.31. Life stage frequency distribution of goldeye in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

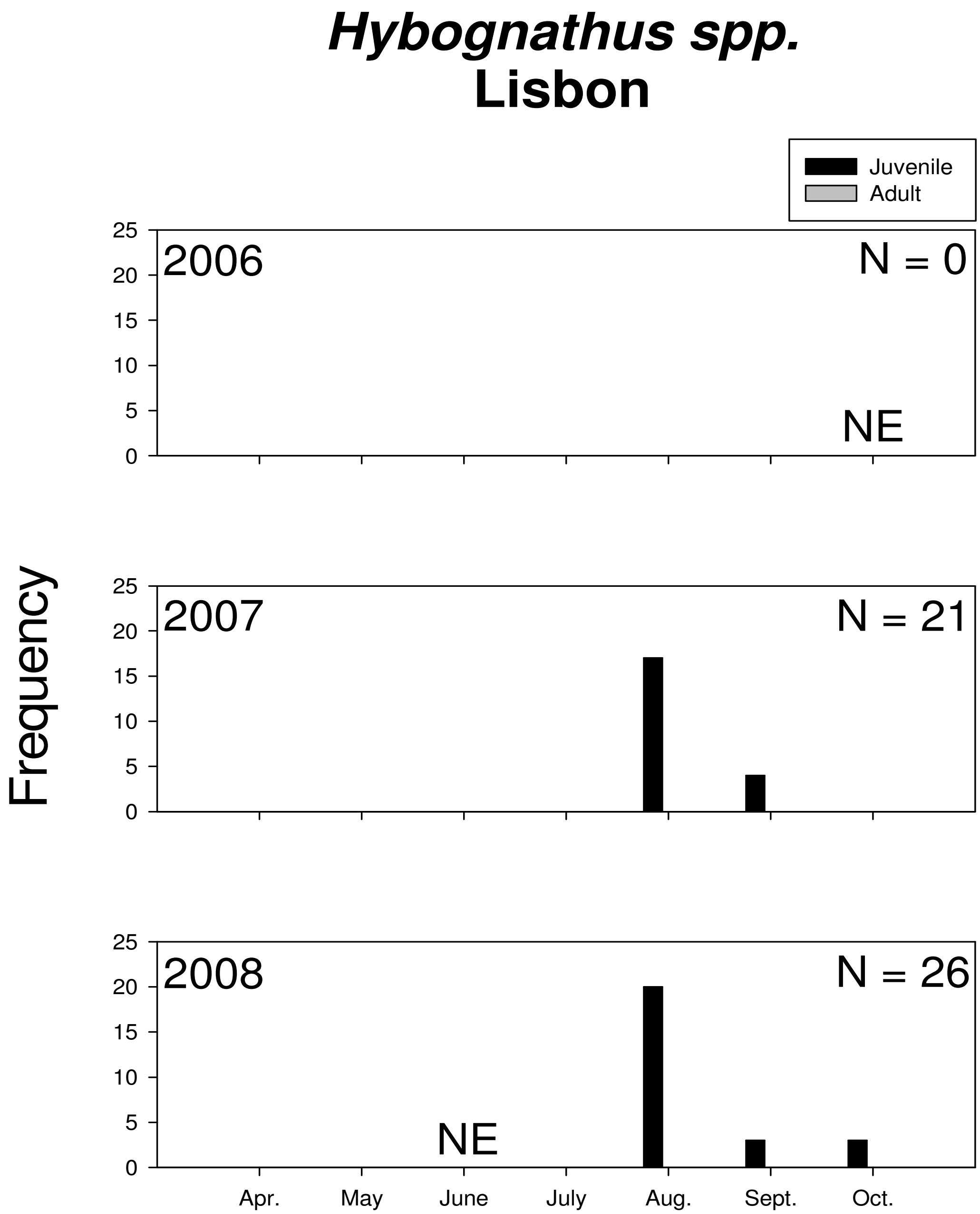


Figure III.9.32. Life stage frequency distribution of *Hybognathus spp*. in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

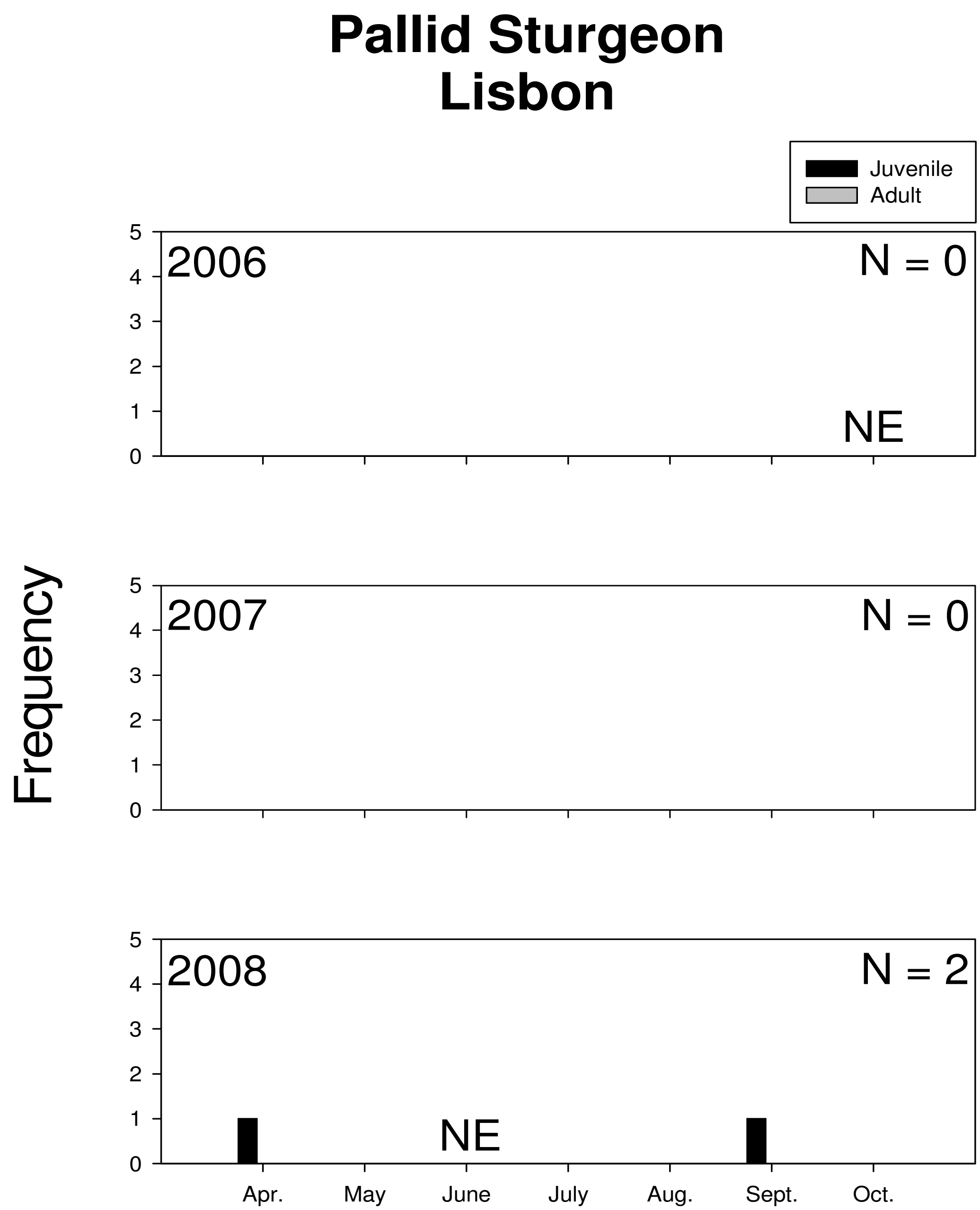


Figure III.9.32. Life stage frequency distribution of pallid sturgeon in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

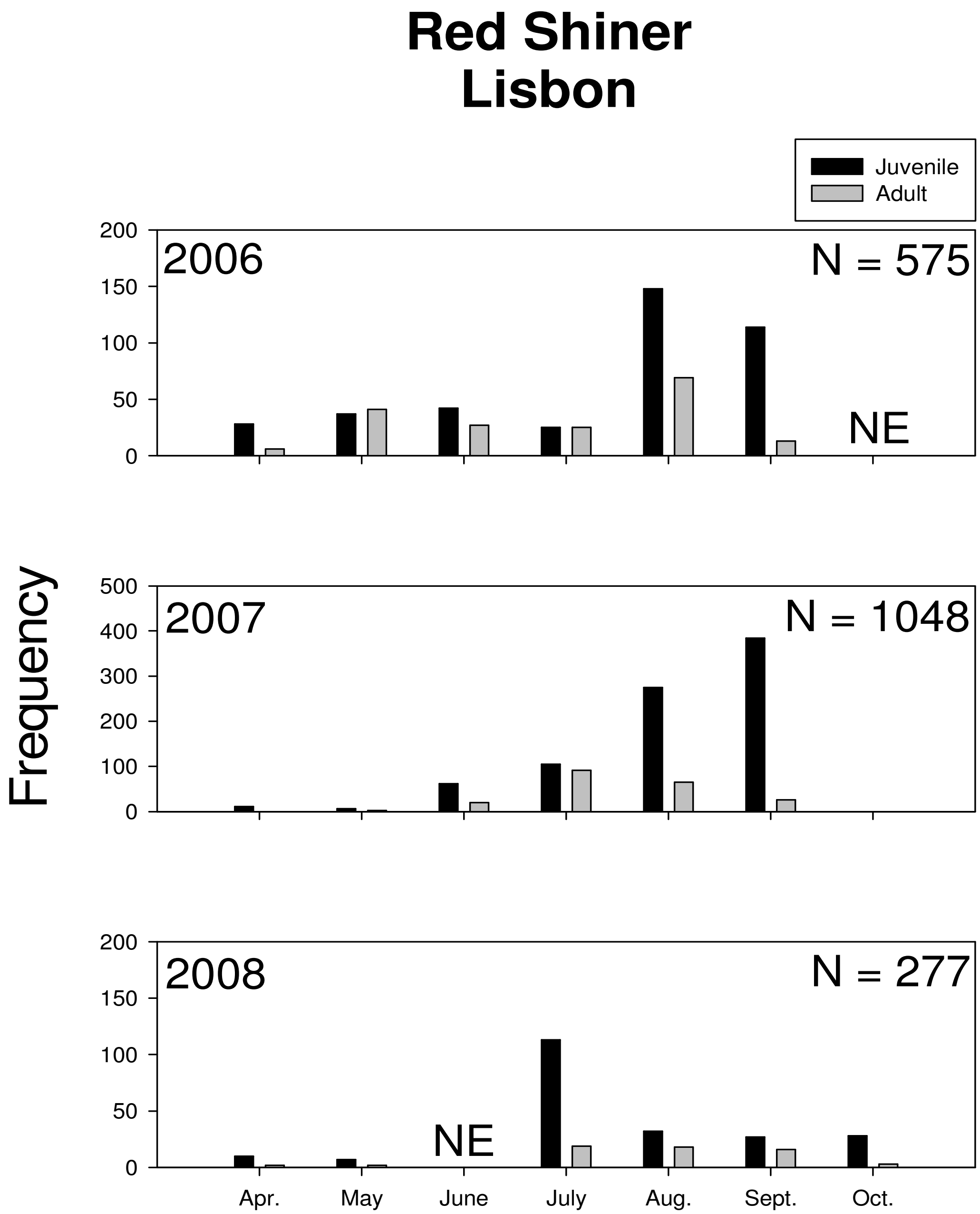


Figure III.9.34. Life stage frequency distribution of red shiner in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

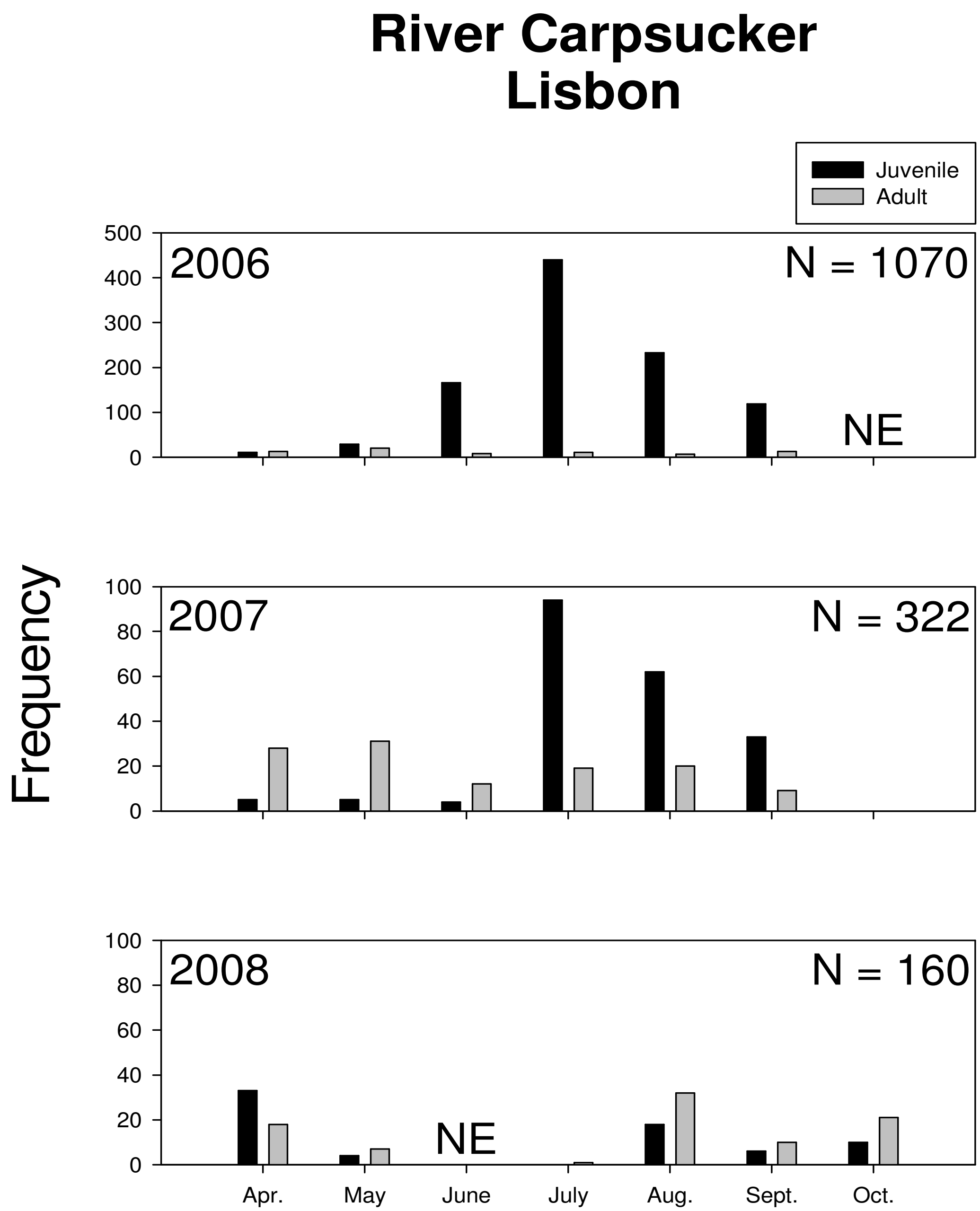


Figure III.9.35. Life stage frequency distribution of river carpsucker in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

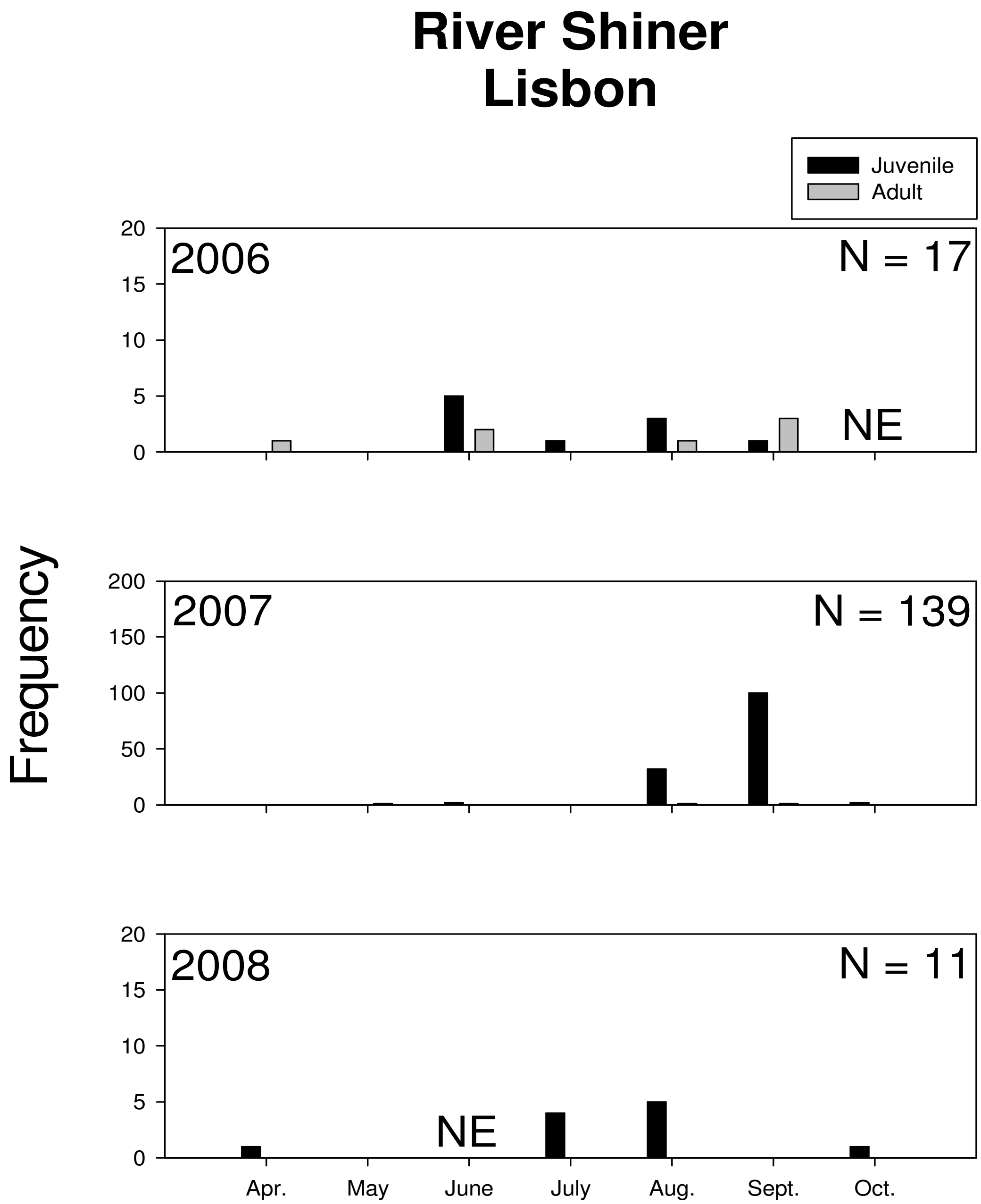


Figure III.9.36. Life stage frequency distribution of river shiner in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

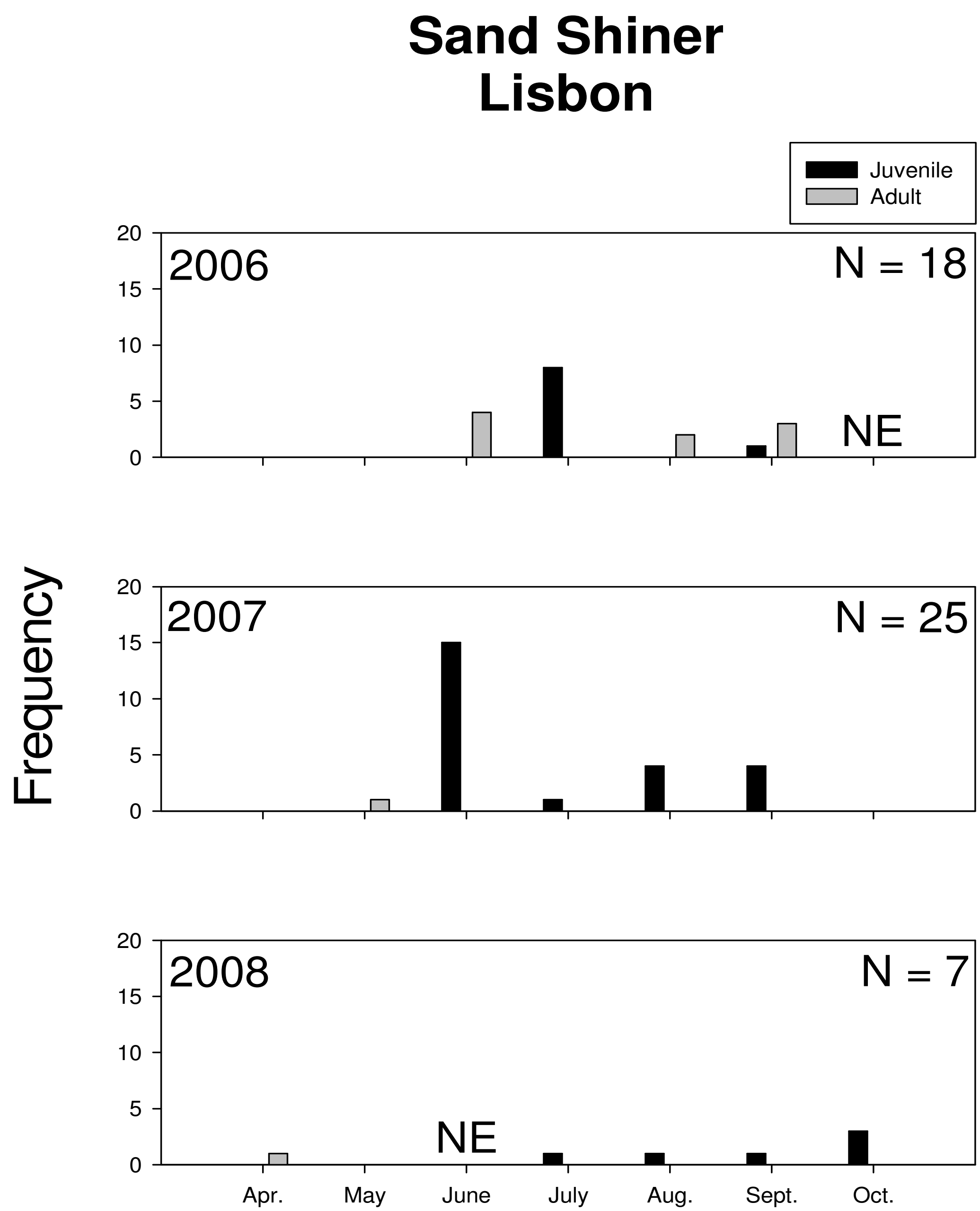


Figure III.9.37. Life stage frequency distribution of sand shiner in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

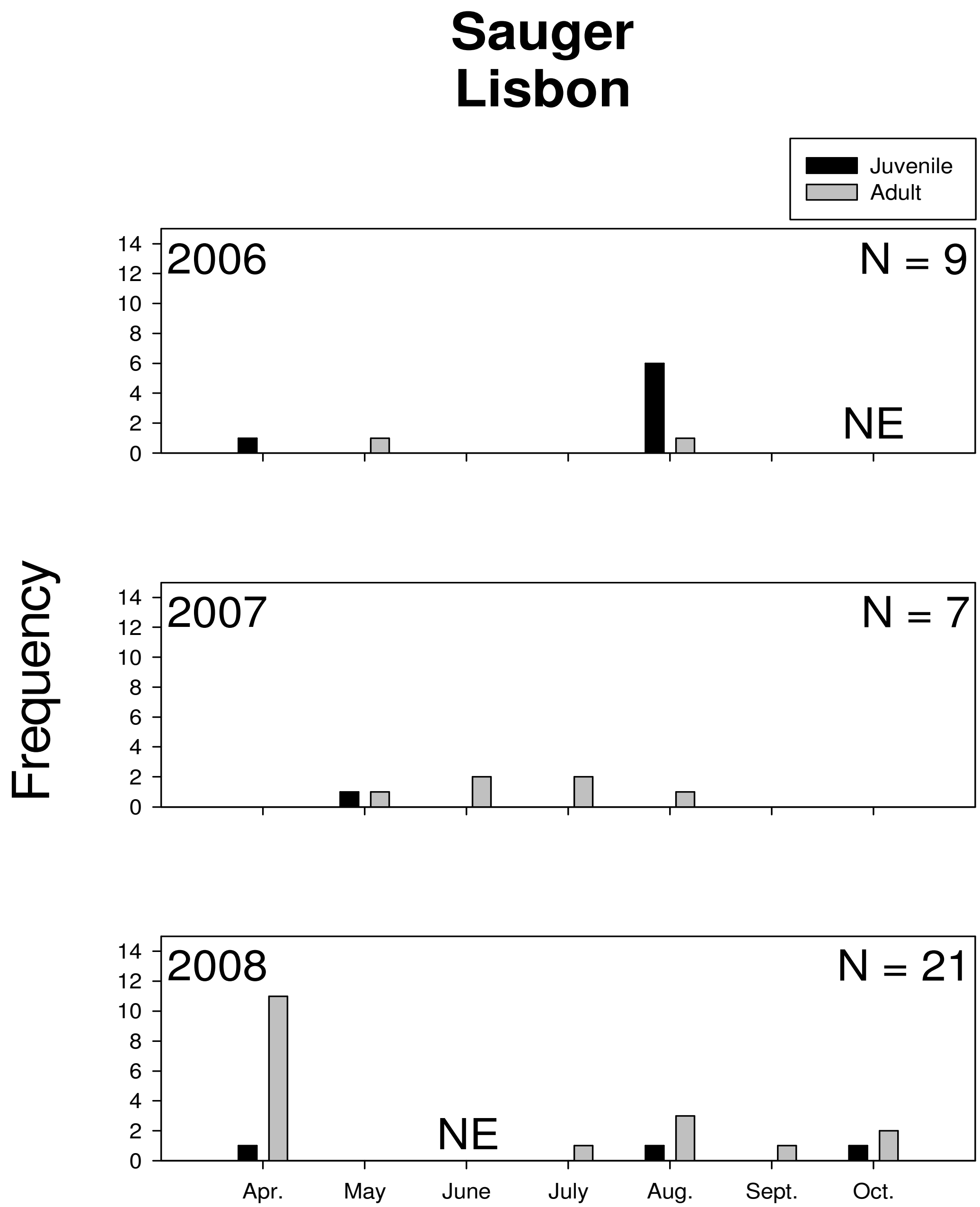


Figure III.9.38. Life stage frequency distribution of sauger in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

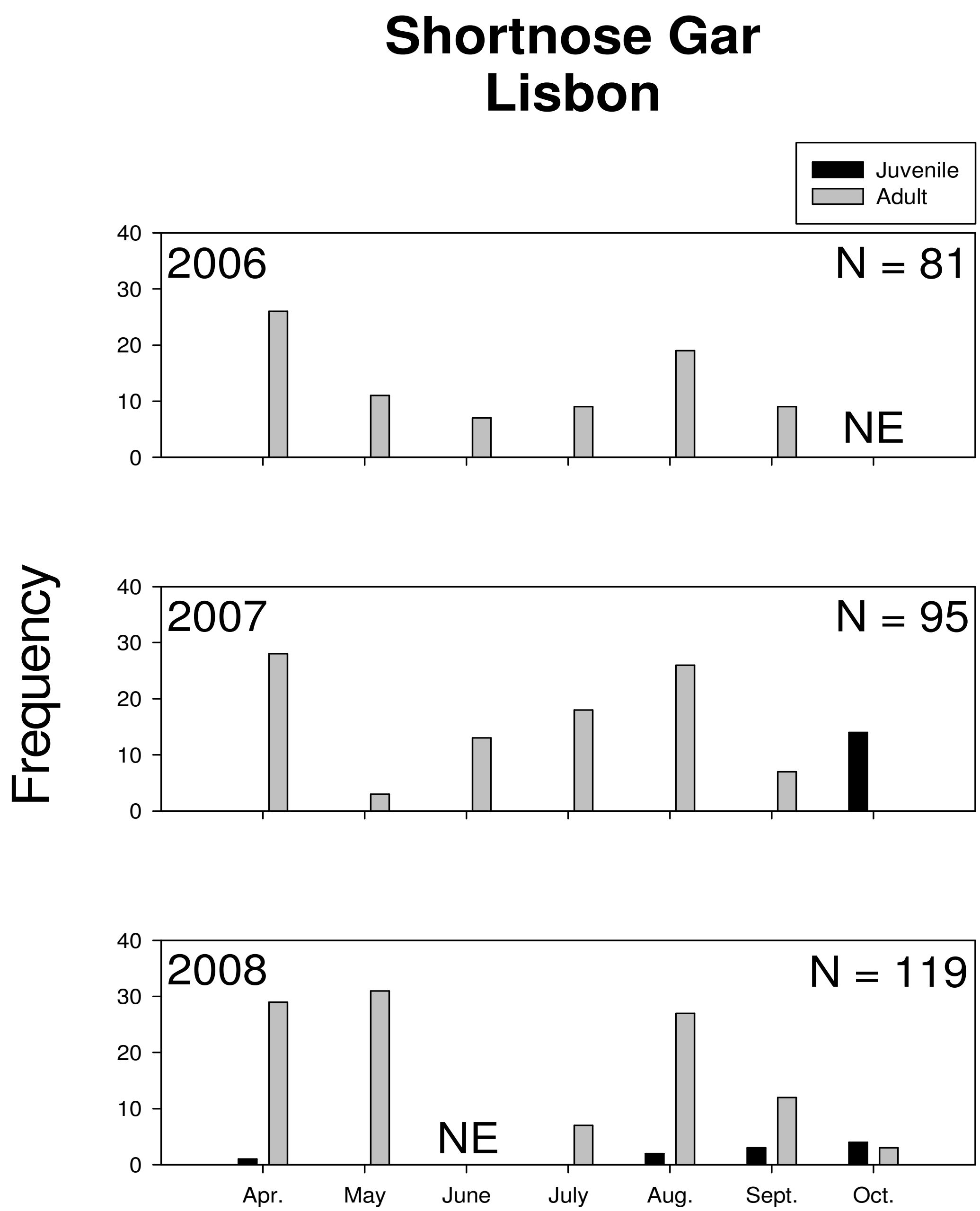


Figure III.9.39. Life stage frequency distribution of shortnose gar in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

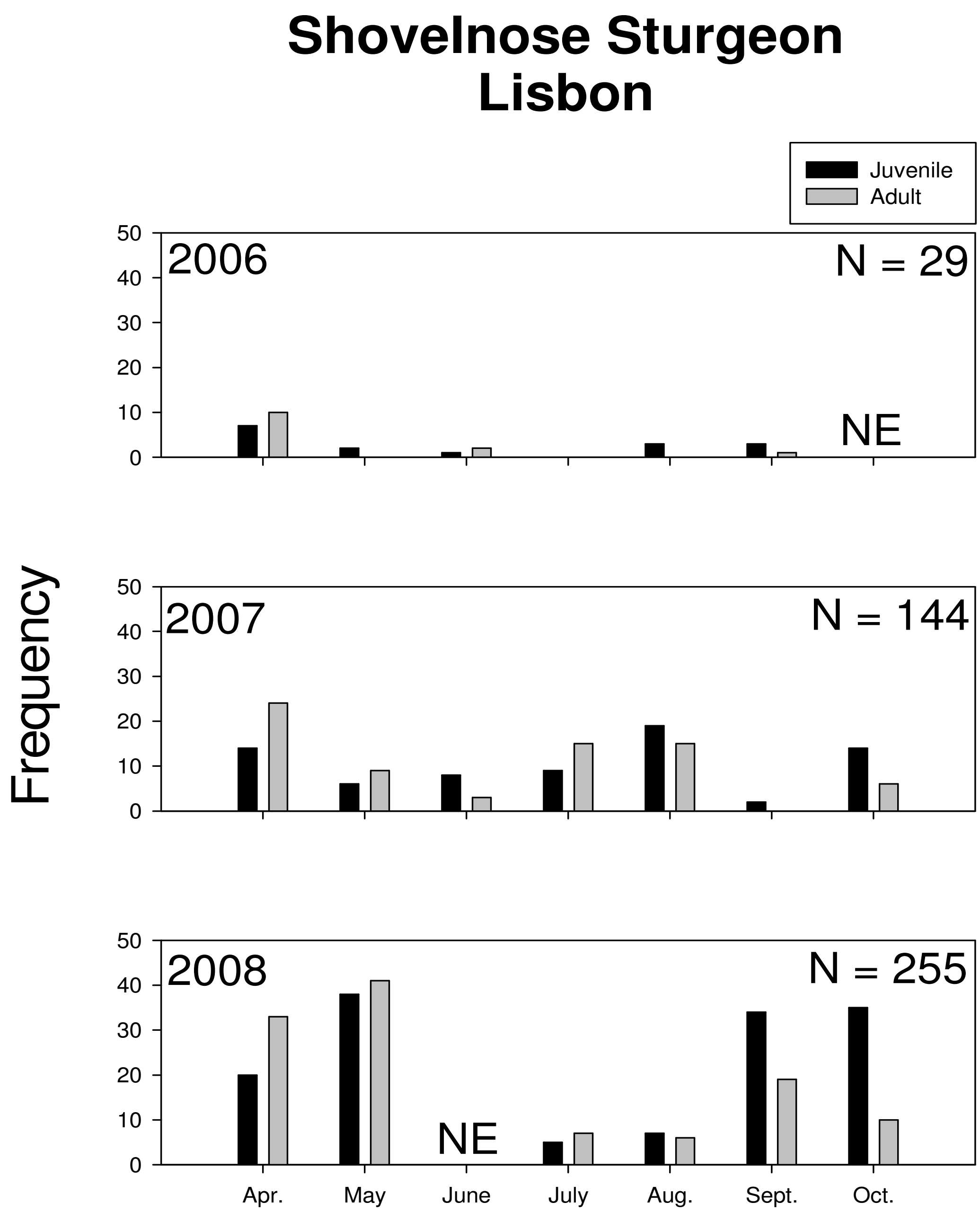


Figure III.9.40. Life stage frequency distribution of shovelnose sturgeon in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

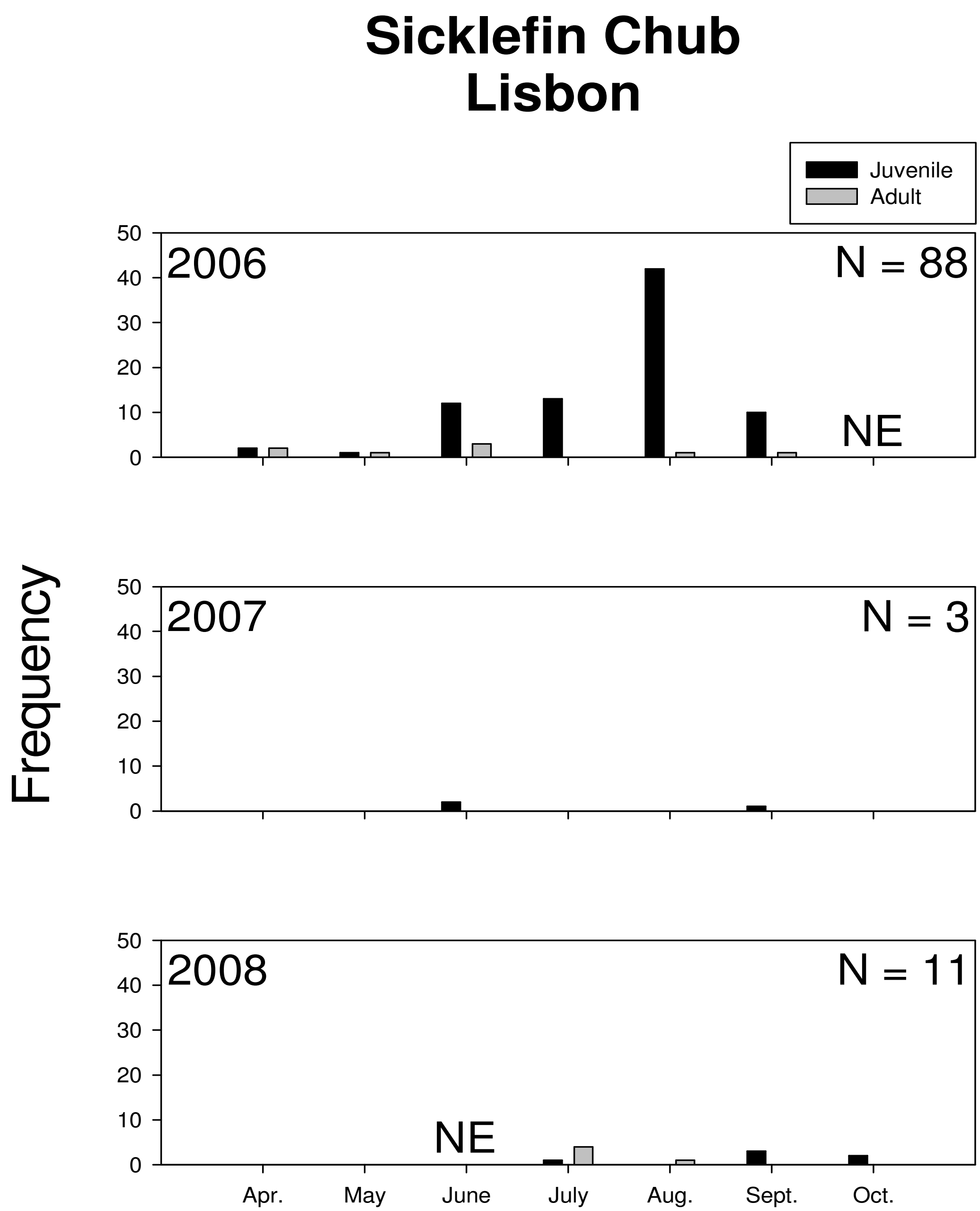


Figure III.9.41. Life stage frequency distribution of sicklefin chub in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

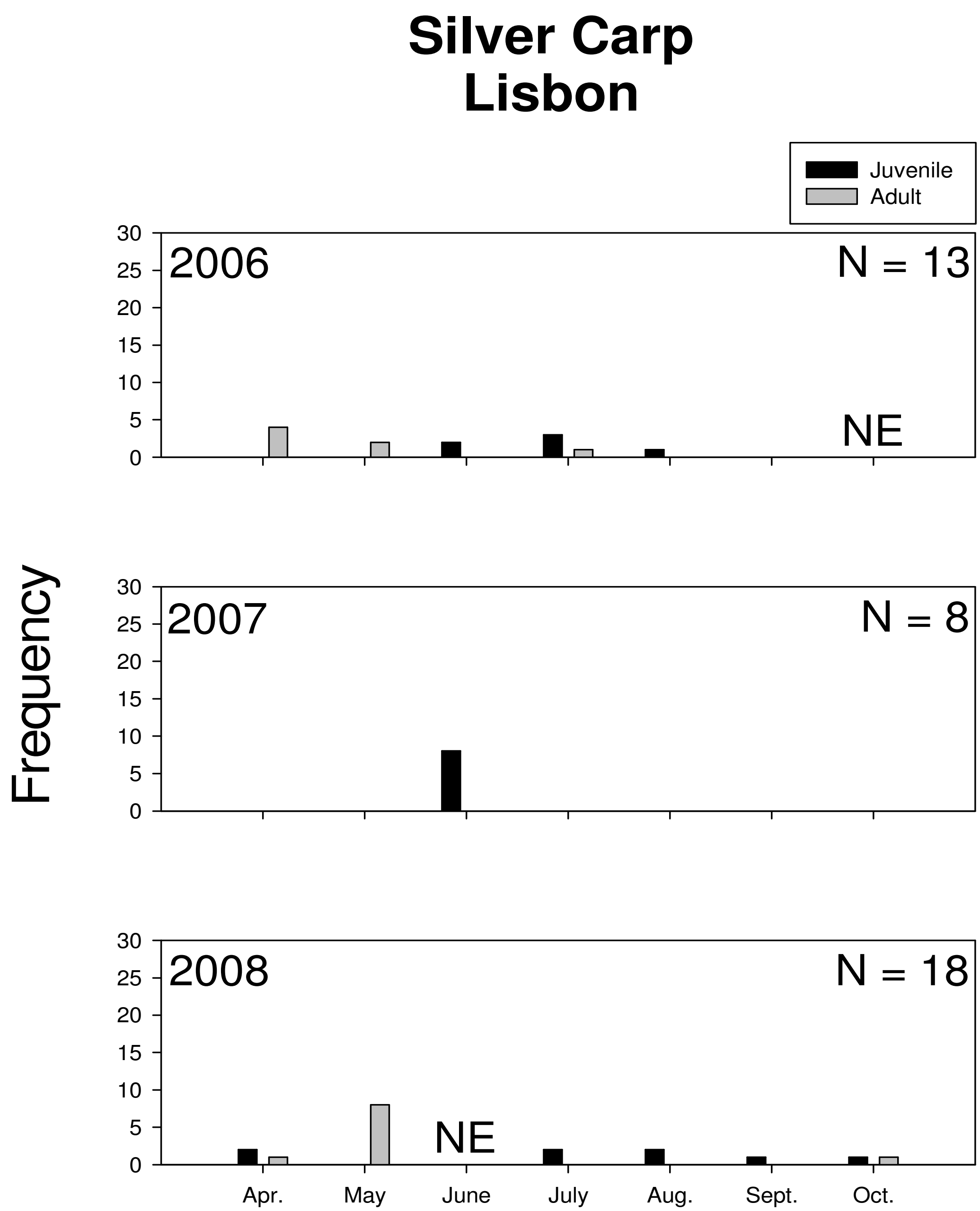


Figure III.9.42. Life stage frequency distribution of silver carp in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

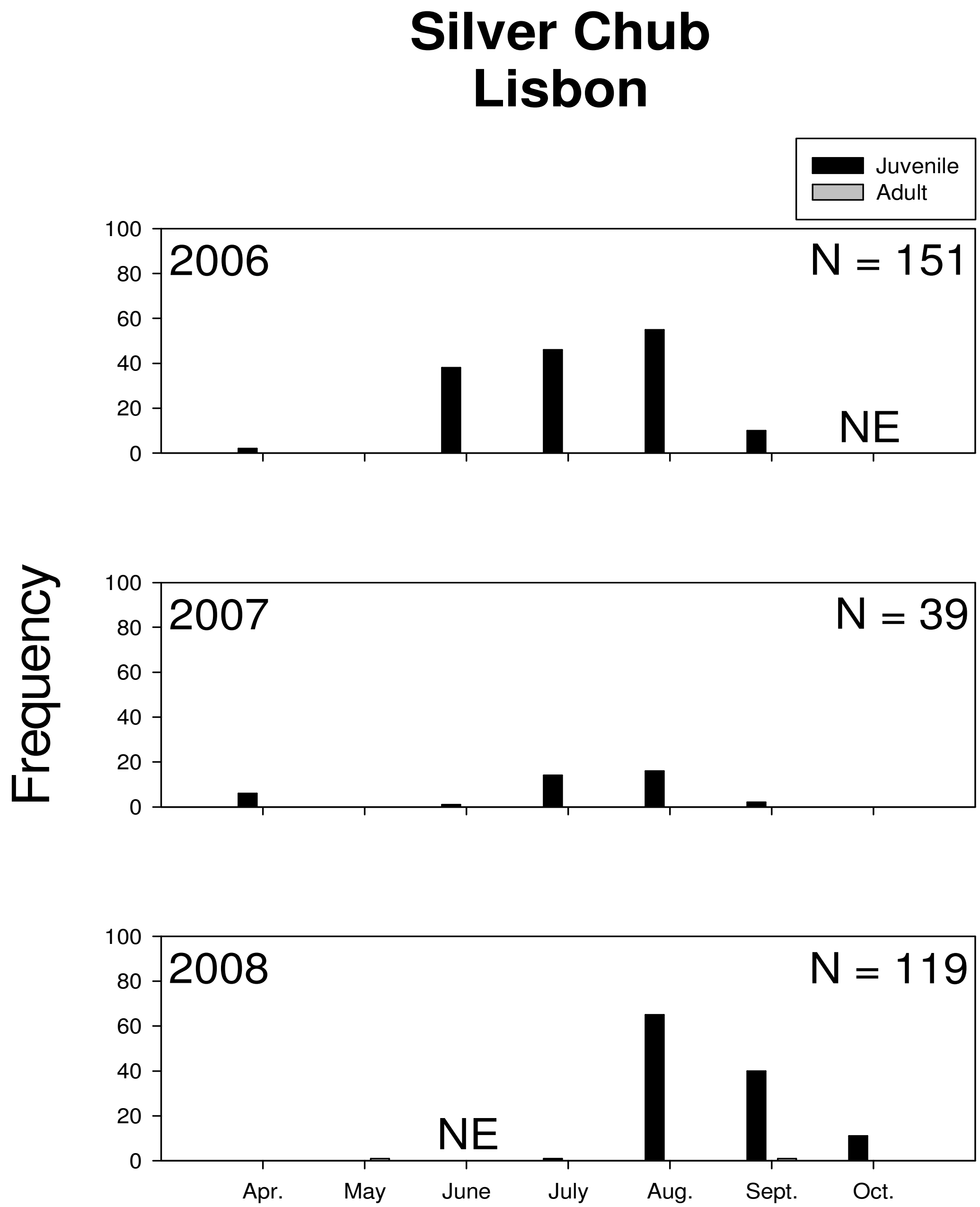


Figure III.9.43. Life stage frequency distribution of silver chub in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

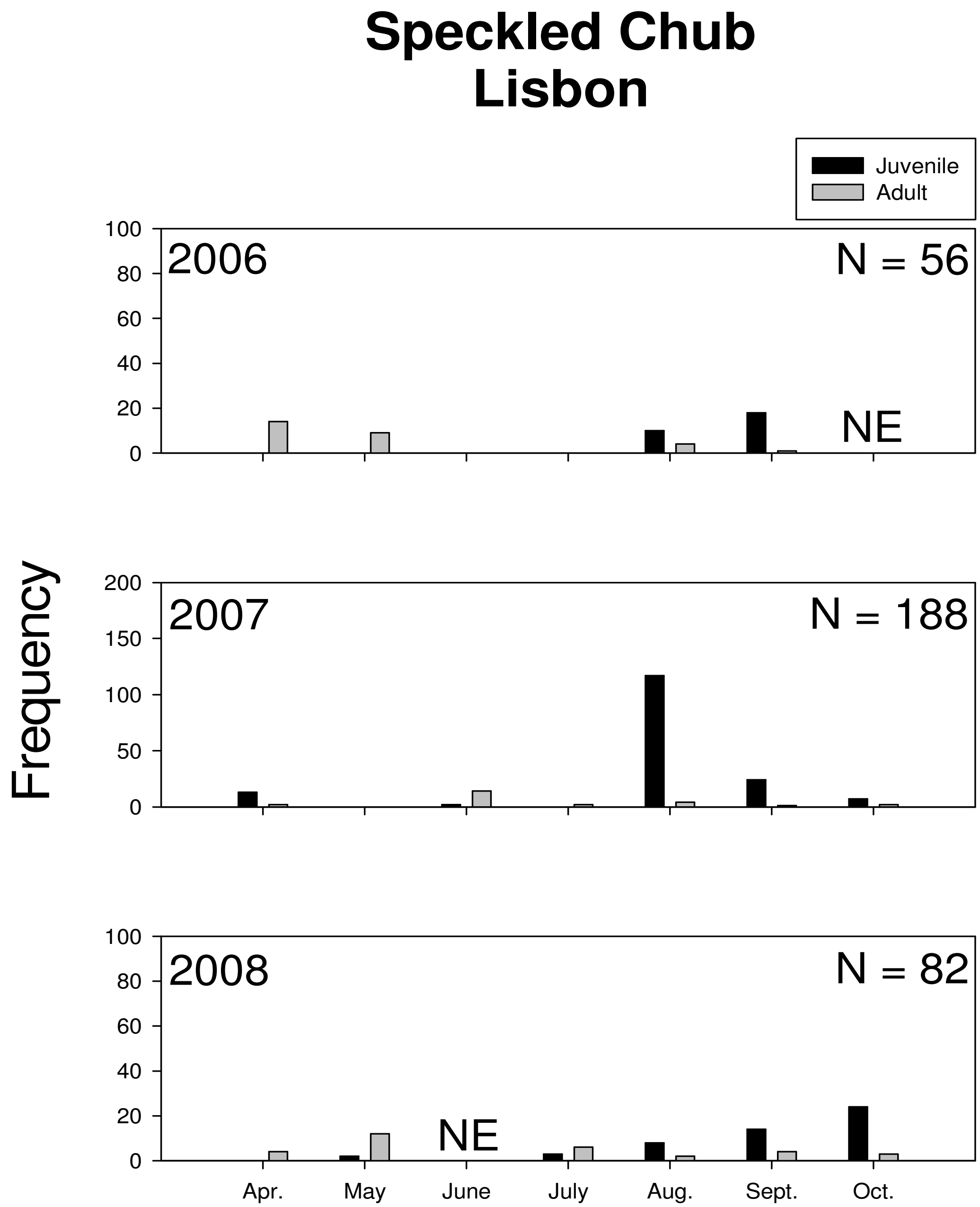


Figure III.9.44. Life stage frequency distribution of speckled chub in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

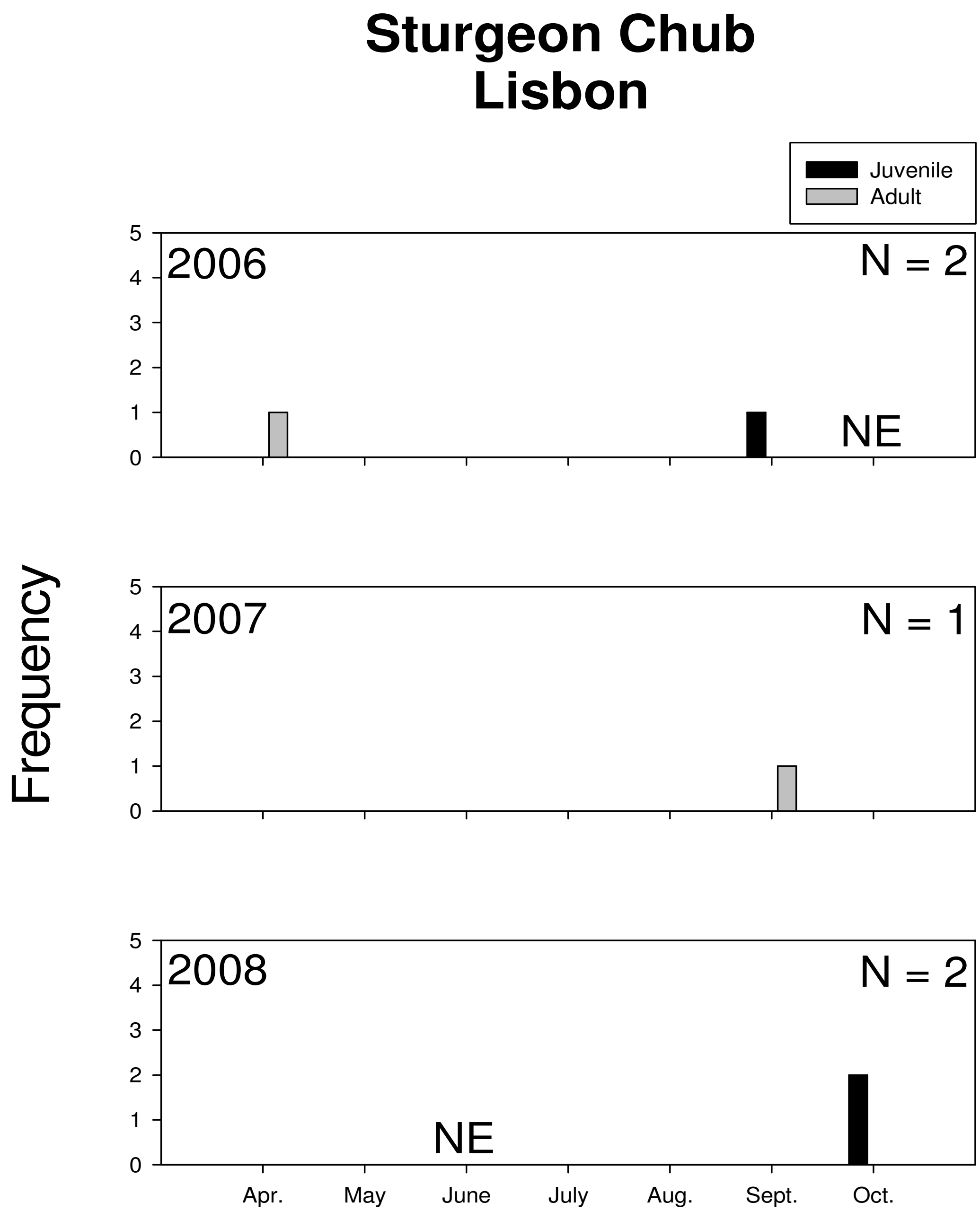
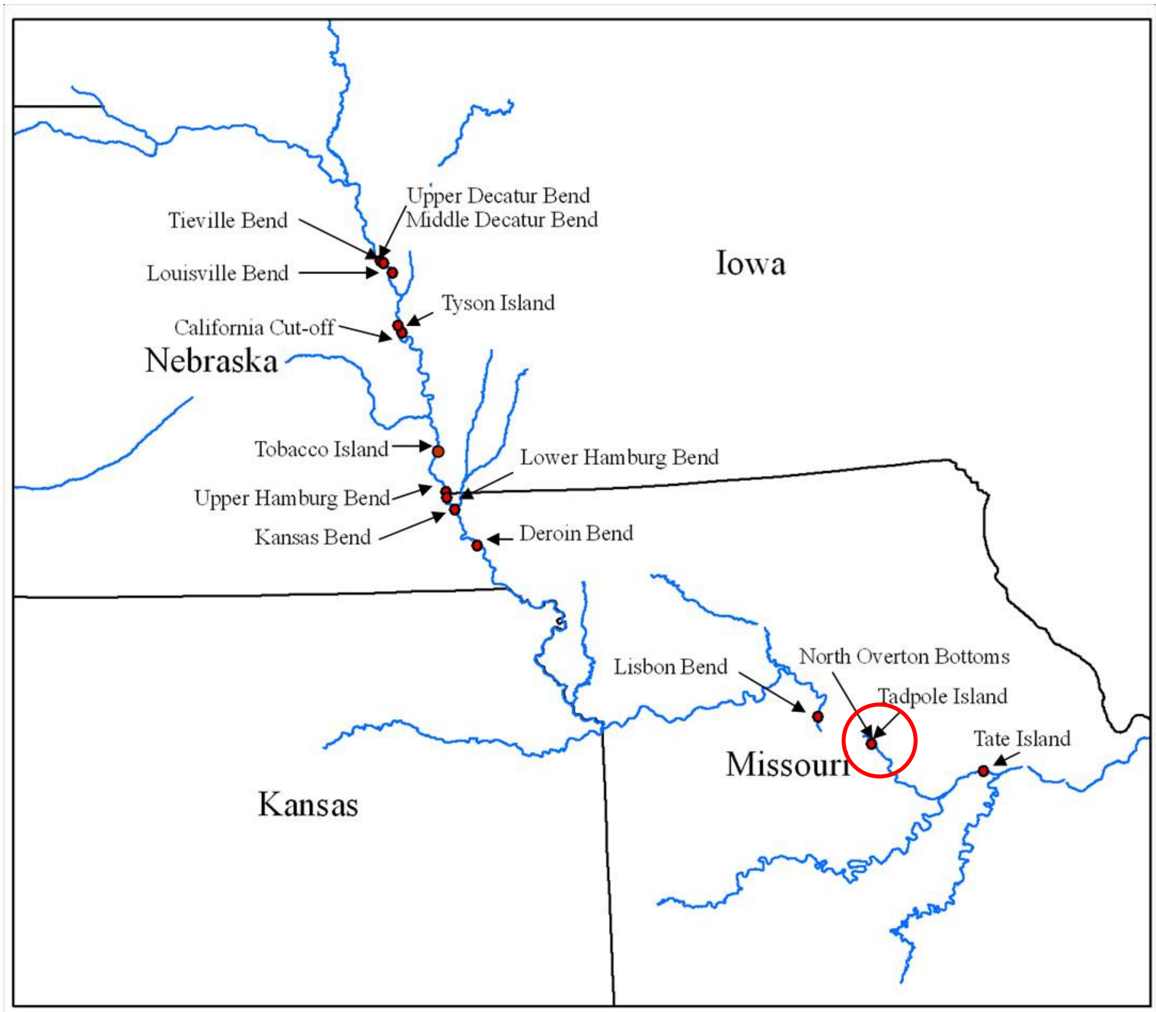


Figure III.9.45. Life stage frequency distribution of sturgeon chub in Lisbon chute by month and year. NE = No effort during this month due to river conditions or construction.

Section III
Chapter 10
North Overton Bottoms
Missouri



LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

Key Findings

- The overall catch at Overton chute was relatively low, as was species richness.
- Some individual species were captured in high numbers within Overton chute, such as goldeye, emerald shiner and red shiner. However, emerald and red shiners are generalist species and low numbers of specialist species may be an indicator of less diverse habitat.
- Young of the year and other juvenile fish were detected in relatively low numbers in Overton chute, indicating that the present conditions at this chute are not providing nursery habitat comparable with that of older, more diverse chutes on the lower Missouri River (i.e., Lisbon and Tate chutes).
- The majority of juvenile fish that were collected in Overton chute were caught during 2006 and 2007.
- Riverine species such as shovelnose sturgeon, speckled chubs and channel catfish were found in Overton chute.
- No pallid sturgeon were captured in Overton chute.
- Overton chute produced the largest number of lake sturgeon among lower Missouri River chutes.
- Few *Hybognathus* species (i.e., Mississippi silvery minnow, plains minnow and western silvery minnow) were collected in Overton chute.
- A few game species were abundant in Overton chute including blue and flathead catfish. However, other species such as black and white crappie, paddlefish, sauger and white bass were captured in low numbers.

Recommendations

- Avoid creating side channels characterized by homogeneous geomorphology, steep banks, uniform depth, high, uniform flows and narrow widths. These factors may be delaying the creation and evolution of habitat within Overton chute and should be taken into consideration when designing future side channel projects.
- Consider creation and or promotion of habitat diversity within Overton chute, by any means. Create back water areas, build tie channels, knock down or promote erosion of high banks restricting access to the floodplain and create or encourage increased channel sinuosity and meander.
- Steps should be taken to produce or promote shallow water habitat; shallower depths and slower velocities should be pursued in Overton chute.
- The variation in fish abundances seen among the three years of sampling at Overton chute indicates that a long term monitoring effort would be needed to detect population trends at the chute. Furthermore, fish data from the chute should be compared to data from the main channel to determine how the chute is functioning with respect to main channel fish use.
- Continued monitoring of Overton chute would be valuable in determining the rate at which the chute is evolving, and how future manipulations affect the habitat and fish community.
- Because variability in flows, through chutes, make its habitats more or less valuable to fish between years, long term monitoring is necessary to detect trends in chute's function as restoration habitat.

- Future monitoring should be streamlined with the information obtained from intense monthly sampling efforts. The data illustrates which gears and times of the year would be best for collection of an array of species and makes possible a rapid bio-assessment technique that could be utilized in future sampling.

Results

A total of 6,983 fish of 53 species, representing 15 families, were collected in Overton chute between 2006 and 2008 (Table III.10.1). A total of 201 fish were identified to the genus or family level and represented 2.9% of the total catch; all unidentified fish were juveniles, usually young of the year. The 2006 sampling season recorded the highest number of fish (2,613 individuals) representing about 37% of the total catch at Overton. Species richness was also highest in 2006 with 42 species present (Table III.10.2; Fig III.10.1). The lowest number of fish were recorded in 2008 with 1,946 fish being collected, representing about 28% of the total catch at Overton. Prolonged flood events halted sampling during July of 2008 and likely contributed to decreased catches during 2008 (Table III.10.3).

From 2006 to 2008 the most abundant species at Overton chute was red shiner, representing 19.7% (N = 1,375) (Table III.10.1) of the total catch. Red shiner numbers were highest in 2007 when catches more then doubled from the previous year. Other numerically dominant species at Overton chute included channel catfish (12.5%; N = 873), emerald shiner (10.1%; N = 704), freshwater drum (9.8%; N = 683), gizzard shad (6.7%; N = 470), bullhead minnow (4.2%; N = 296), shovelnose sturgeon (3.7%; N = 260), speckled chub (3.6%; N = 251), blue catfish (3.6%; N = 251) and goldeye (3.5%; N

= 241). All abundant species mentioned were found in the greatest numbers during 2006 with the exception of red shiner and blue catfish which were each more abundant in 2007. Target species that made up lower percentages of the total catch at Overton included river carpsucker (3.3%; N = 228), flathead catfish (2.9%; N = 203), common carp (1.6%; N = 112), silver chub (1.6 %; N = 110), shortnose gar (1.2%; N = 86), sicklefin chub (0.9%; N = 62), bighead carp (0.5%; N = 36), silver carp (0.4% N = 27), blue sucker (0.2%; N = 14), river shiner (0.1%; N = 8), sand shiner (0.1%; N = 7), sturgeon chub (0.04; N = 3), sauger (0.03%; N = 2), western silvery minnow (0.03%; N = 2) and plains minnow (0.01%; N = 1).

Target species' (Table III.10.1) accounts for Overton chute are presented hereafter, in alphabetical order with analysis. Yearly mean catch per unit effort (CPUE) values for target species were analyzed with a Kruskal-Wallis test (Table III.10.4) to detect differences among years; mean CPUE values are presented in Table III.10.5 by month and year. Mean length values for target species were tested with analysis of variance; mean length values and the results of analysis are presented in Table III.10.6. Length frequency distribution graphs for target species are presented in Figures III.10.2 through III.10.22 in alphabetical order by fish's common name. Proportions of adult and juvenile target species were analyzed with a z-test, the results of which are presented in Table III.10.7. Life stage frequency graphs for target species are presented in Figures III.10.23 through III.10.43 in alphabetical order by fish's common name. Tables and figures are not referenced hereafter. The contents of all tables are in alphabetical order by fish's common name. Figures and species accounts are ordered alphabetically, by fish's common name, with one exception; *Hybognathus* species (plains minnow,

Mississippi silvery minnow and western silvery minnow) were combined and labeled as such because of extremely low numbers.

Bighead carp

There were 36 bighead carp captured in Overton chute, the majority of which were found in 2007 and 2008. Bighead carp were caught most effectively in large hoop nets but a few fish were also collected with trammel nets. There was no difference in catch rates of bighead carp among years, with any gear. The mean length of bighead carp caught in large hoop nets was lowest in 2007. Life stage proportions of bighead carp were different in 2007 as well; 2007 was the only year that juveniles were captured. In general, adults dominated bighead carp catches and were most frequently encountered in July and August.

Blue sucker

Only 14 blue suckers were collected in Overton chute and their numbers were evenly distributed among years. Blue suckers were caught most often while electrofishing but fish were collected in large and small hoop nets, otter trawls and trammel nets as well. There was no difference in catch rates or mean length of blue suckers among years, in any gear. Life stage proportions of blue suckers were different in 2008; only juvenile fish were collected in 2008. Most fish collected were juvenile but only one individual was a young of the year. Blue suckers were collected most often during and after July.

Channel catfish

There were 873 channel catfish collected in Overton chute, nearly half of which were encountered during 2006. Channel catfish were caught in every gear; the most effective gears were otter trawls and small hoop nets. Catch rates of fish caught in otter trawls varied among all years; catch rates were highest in 2007 and lowest in 2008. The mean length of channel catfish caught while electrofishing and with push trawls varied among years. Fish collected while electrofishing had significantly greater mean lengths in 2006 than in other years, while those caught with push trawls were smaller in 2008 than during other years. Life stage proportions of channel catfish were different in 2008, when adults made up a larger percentage of the total catch than in other years. Overall, channel catfish catches were dominated by juveniles which were most abundant during and after July, while adults were caught throughout the year.

Common carp

There were 112 common carp collected from Overton chute and their numbers were evenly distributed among years. Fish were most effectively collected while electrofishing but were also regularly collected with large hoop nets. Common carp were also caught in mini-fyke nets, otter trawls, push trawls and small hoop nets. Catch rates of common carp collected with large hoop nets were higher in 2008 than in 2006. The mean length of fish caught while electrofishing was smaller in 2007 than in other years. Life stage proportions of common carp were different in 2007 when a larger number of juveniles were captured than in other years. In general, common carp catches were

dominated by adults. Adults were common throughout the year, while juveniles were only captured in May, June and July.

Emerald shiner

Just over 700 emerald shiners were collected from Overton chute, the large majority of which were captured in 2006. The highest catch rates for emerald shiners were in mini-fyke nets but fish were also collected while electrofishing and with otter and push trawls. Catch rates of emerald shiners collected while electrofishing and with mini-fyke nets were higher in 2006 than in other years. Catch rates of fish collected with push trawls were highest in 2008. The mean length of emerald shiners caught in mini-fyke nets was higher in 2008 than in other years. Life stage proportions of fish differed in 2006, from other years, when larger numbers of juveniles were collected. In general, juveniles dominated emerald shiner catches and were most abundant during and after July.

Flathead catfish

There were 203 flathead catfish caught in Overton chute, nearly half of which were captured in 2007. The highest catch rates for flathead catfish were in small hoop nets but fish were consistently collected while electrofishing, with large hoop nets and otter trawls. Trammel nets were the only gear that failed to catch flathead catfish. The catch rates of fish collected with small hoop nets were higher in 2007 than in other years, while fish caught in large hoop nets had the highest catch rates in 2008. There was no difference in mean lengths or life stage proportions of flathead catfish among years.

Overall, adults and juveniles were caught in similar numbers; however few young of the year fish were collected. Both adults and juveniles were common throughout the year.

Gizzard shad

There were 470 gizzard shad caught in Overton chute, and their numbers were evenly distributed among years. Electrofishing was the most effective gear at catching gizzard shad but fish were also collected in large hoop nets, mini-fyke nets, push trawls and trammel nets. There was no difference in catch rates of gizzard shad among years, with any gear. The mean length of fish captured while electrofishing was smaller in 2007 than in other years. Conversely, gizzard shad caught in push trawls were largest in 2007. Life stage frequencies for gizzard shad also varied in 2007. Juveniles made up a larger proportion of the total catch in 2007 than in other years. Overall, gizzard shad catches were dominated by juveniles, which were most common during July, August and September.

Goldeye

We captured 241 goldeye at Overton chute, and their numbers were equally distributed among years. Goldeye were captured in every gear except mini-fyke nets but were most effectively caught while electrofishing. There was no difference in catch rates of goldeye among years, with any gear. The mean length of fish caught in trammel nets was greater in 2008 than in other years. There was no difference in life stage proportions of goldeye among years. In general, juveniles dominated goldeye catches and were most commonly captured in July.

Hybognathus species

There was one plains minnow and two western silvery minnows collected in Overton chute, all of which were encountered during 2008. There were also six individuals collected that were only identified as *Hybognathus* species, four of which also occurred in 2008. All *Hybognathus* specimens were collected in push trawls, during July, August and September and all were considered juveniles. There was no difference in catch rates, mean lengths or life stage proportions of any *Hybognathus* species among years.

Pallid sturgeon

No pallid sturgeon were caught in Overton chute.

Red shiner

Red shiners were among the most abundant species in Overton chute; there were 1,375 individuals collected, over 800 of which were encountered during 2007. Red shiners were most effectively caught while electrofishing but were also caught in mini-fyke nets, otter trawls and push trawls. Catch rates of red shiners collected in mini-fyke nets was lower in 2008 than in other years. Mean lengths of fish caught while electrofishing and in mini-fyke nets and push trawls varied among all years; each gear caught larger fish in 2006 and the smallest fish in 2007. Life stage proportions of red shiners varied among all years. Adults dominated red shiner catches in 2006, while juveniles were more abundant in 2007; adults and juveniles were captured in similar numbers in 2008. Red shiners were most commonly captured during and after July.

River carpsucker

There were 228 river carpsuckers caught in Overton chute, nearly half of which were collected in 2006. River carpsuckers were caught with every gear except trammel nets but were most effectively collected in large hoop nets and while electrofishing. Catch rates of river carpsuckers collected with small hoop nets were highest in 2007; large hoop nets had higher catch rates in 2008. The mean lengths of fish caught while electrofishing varied among all years; the largest fish were encountered during 2008, while the smallest lengths were recorded in 2007. Life stage proportions of river carpsuckers varied among all years as well; 2006 catches were dominated by juveniles, where as 2008 catches produced the highest numbers of adults. In 2007, life stage proportions of river carpsuckers were similar. In general, river carpsucker catches were dominated by juveniles, with the exception of 2008, and were most commonly captured during and after July. Young of the year fish were collected every year except 2008.

River shiner

Eight river shiners were caught in Overton chute, most of which were collected in 2008. River shiners were collected while electrofishing and in mini-fyke nets and push trawls. There was no difference in catch rates of river shiners among years, with any gear. The mean length of fish caught while electrofishing was greatest in 2008. Life stage proportions of river shiners were different in 2006, the only year when an adult specimen was collected, than in other years. Overall, river shiner catches were dominated by juveniles which were only collected in August and September.

Sand shiner

There were seven sand shiners collected at Overton chute, most of which were collected during 2007; no sand shiners were caught during 2006. Most fish were captured in push trawls but a few were collected with mini-fyke nets. There was no difference in catch rates, mean lengths or life stage proportions of sand shiners among years. Most sand shiners collected were juveniles; all specimens were collected between July and September.

Sauger

Only two sauger were caught in Overton chute, both of which were caught in 2006. Both fish were caught while electrofishing. One fish was an adult and was caught in June; the other individual was a juvenile and was caught in August. There was no difference in catch rates, mean lengths or life stage proportions of sauger among years.

Shortnose gar

There were 86 shortnose gar caught in Overton chute. Fish were collected most effectively while electrofishing but were also caught in large and small hoop nets and mini-fyke nets. Catch rates of shortnose gar collected while electrofishing were lowest in 2006. There was no difference in mean lengths or life stage proportions of shortnose gar among years. In general shortnose gar catches were dominated by adults which were present during most months. There was only one juvenile shortnose gar captured in Overton chute and there were no fish caught that could be considered young of the year.

Shovelnose sturgeon

We collected 260 shovelnose sturgeon at Overton chute. Fish were collected most effectively in trammel nets, although large and small hoop nets, otter trawls and electrofishing consistently captured fish also. Catch rates of shovelnose sturgeon collected while electrofishing were highest in 2007, while those caught in trammel nets had higher catch rates during 2006. Fish collected in otter trawls and trammel nets had greater mean lengths in 2006 than in other years. There was no difference in life stage proportions of shovelnose sturgeon among years. Overall, adults and juveniles were found in relatively equal numbers during most months; however very few fish that could be considered young of the year were collected at Overton chute.

Sicklefin chub

There were 62 sicklefin chubs caught in Overton chute, nearly all of which were captured in 2006. Otter trawls were the most effective gear for catching sicklefin chubs but fish were collected while electrofishing and in otter and push trawls as well. Catch rates of fish caught in otter and push trawls were higher in 2006 than in other years. The mean length of sicklefin chubs caught while electrofishing was greater in 2007 than in other years, whereas fish caught in otter trawls had greater mean lengths during 2008. There was no difference in life stage proportions of sicklefin chubs among years. Juveniles and adults were collected in similar numbers and fish were most commonly captured from July through September.

Silver carp

We caught 27 silver carp in Overton chute, most of which were collected in 2006 and 2008. Silver carp were captured most effectively in large hoop nets but were also caught while electrofishing, and with mini-fyke nets, otter trawls and trammel nets. There was no difference in catch rates, mean lengths or life stage proportions of silver carp among years. Silver carp were caught throughout the year and catches were dominated by adults; 2008 was the only year when young of the year fish were collected.

Silver chub

Just over 100 silver chubs were caught in Overton chute, most of which were collected in 2006 and 2008. The highest catch rates for silver chubs were in small hoop nets but fish were also collected while electrofishing, with mini-fyke nets, otter trawls and push trawls. Electrofishing catch rates were higher in 2008 than in 2007. The mean length of silver chubs collected in small hoop nets, mini-fyke nets and push trawls was lower in 2007 than in other years. There was no difference in life stage proportions of silver chubs among years. In general, silver chubs catches were dominated, almost completely, by juveniles, which were most commonly captured during and after July. Most adult silver chubs were collected earlier in the year, during April and May.

Speckled chub

We caught 251 speckled chubs in Overton chute. Speckled chubs were collected most effectively in otter trawls but were also collected while electrofishing, with mini-fyke nets and push trawls. There was no difference in catch rates of speckled chubs

among years, with any gear. Fish caught in otter and push trawls varied among years with respect to mean lengths. Fish caught in otter trawls had the lowest mean length in 2006, while push trawls caught smaller fish in 2007. Life stage proportions of speckled chubs were different in 2006, when adults made up a larger proportion of the total catch than during other years. In general, adult fish were collected throughout the year, whereas juveniles were most commonly collected during and after July.

Sturgeon chub

Only three sturgeon chubs were caught in Overton chute, one during each year of the study. Fish were collected in mini-fyke nets and push trawls. There was no difference in catch rates, mean lengths or life stage proportions of sturgeon chubs among years. The fish caught in 2006 and 2007 were each juveniles; the individual caught in 2008 was the only adult collected.

Table III.10.1. Common name, scientific name, family, number of fish collected and percent of total catch, of all species caught in Overton chute 2006 – 2008. Target species are bold.

Common Name	Scientific Name	Family	2006	2007	2008	Total	% Catch
Bighead carp	***Hypophthalmichthys nobilis***	*Cyprinidae*	4	15	17	36	0.52
Bigmouth buffalo	*Ictiobus cyprinellus*	*Catostomidae*	0	6	22	28	0.40
Blue catfish	*Ictalurus furcatus*	*Ictaluridae*	37	128	86	251	3.59
Blue sucker	***Cycleptus elongatus***	*Catostomidae*	3	5	6	14	0.20
Bluegill	*Lepomis macrochirus*	*Centrarchidae*	8	6	22	36	0.52
Bluntnose minnow	*Pimephales notatus*	*Cyprinidae*	40	13	0	53	0.76
Brook silverside	*Labidesthes sicculus*	*Atherinidae*	3	0	0	3	0.04
Bullhead minnow	*Pimephales vigilax*	*Cyprinidae*	193	83	20	296	4.24
Channel catfish	***Ictalurus punctatus***	*Ictaluridae*	413	236	224	873	12.50
Channel shiner	*Notropis wickliffi*	*Cyprinidae*	4	5	16	25	0.36
Chestnut lamprey	*Ichthyomyzon castaneus*	*Petromyzontidae*	0	0	1	1	0.01
Common carp	***Cyprinus carpio***	*Cyprinidae*	34	37	41	112	1.60
Emerald shiner	***Notropis atherinoides***	*Cyprinidae*	510	69	125	704	10.08
Fathead minnow	*Pimephales promelas*	*Cyprinidae*	1	0	0	1	0.01
Flathead catfish	***Pylodictis olivaris***	*Ictaluridae*	45	94	64	203	2.91
Freshwater drum	*Aplodinotus grunniens*	*Sciaenidae*	243	222	218	683	9.78
Gizzard shad	***Dorosoma cepedianum***	*Clupeidae*	235	154	81	470	6.73
Golden redhorse	Moxostoma erythrurum	*Catostomidae*	0	1	0	1	0.01
Goldeye	***Hiodon alosoides***	*Hiodontidae*	88	84	69	241	3.45
Grass carp	*Ctenopharyngodon idella*	*Cyprinidae*	1	8	7	16	0.23
Green sunfish	*Lepomis cyanellus*	*Centrarchidae*	6	8	30	44	0.63
Lake Sturgeon	*Acipenser fulvescens*	*Acipenseridae*	1	3	0	4	0.06
Largemouth bass	*Micropterus salmoides*	*Centrarchidae*	2	4	1	7	0.10
Logperch	*Percina caprodes*	*Percidae*	0	1	0	1	0.01
Longnose gar	*Lepisosteus osseus*	*Lepisosteidae*	14	64	22	100	1.43
Mimic shiner	*Notropis volucellus*	*Cyprinidae*	2	3	0	5	0.07
Orangespotted sunfish	*Lepomis humilis*	*Centrarchidae*	7	0	23	30	0.43
Paddlefish	*Polyodon spathula*	*Polyodontidae*	1	0	0	1	0.01
Plains minnow	***Hybognathus placitus***	*Cyprinidae*	0	0	1	1	0.01
Red shiner	***Cyprinella lutrensis***	*Cyprinidae*	192	811	372	1375	19.69
River carpsucker	***Carpiodes carpio***	*Catostomidae*	104	76	48	228	3.27
River shiner	***Notropis blennius***	*Cyprinidae*	1	1	6	8	0.11
Sand shiner	***Notropis stramineus***	*Cyprinidae*	0	5	2	7	0.10
Sauger	***Stizostedion canadense***	*Percidae*	2	0	0	2	0.03
Shorthead redhorse	*Moxostoma macrolepidotum*	*Catostomidae*	0	0	2	2	0.03
Shortnose gar	***Lepisosteus platostomus***	*Lepisosteidae*	18	37	31	86	1.23

Table III.10.1 (continued). Common name, scientific name, family, number of fish collected and percent of total catch, of all species caught in Overton chute 2006 – 2008. Target species are bold.

Common Name	Scientific Name	Family	2006	2007	2008	Total	% Catch
Shovelnose sturgeon	***Scaphirhynchus platorynchus***	*Acipenseridae*	118	57	85	260	3.72
Sicklefin chub	***Macrhybopsis meeki***	*Cyprinidae*	55	2	5	62	0.89
Silver carp	***Hypophthalmichthys molitrix***	*Cyprinidae*	13	2	12	27	0.39
Silver chub	***Macrhybopsis storeriana***	*Cyprinidae*	48	17	45	110	1.58
Slender madtom	*Noturus exilis*	*Ictaluridae*	1	0	0	1	0.01
Smallmouth buffalo	*Ictiobus bubalus*	*Catostomidae*	16	7	13	36	0.52
Speckled chub	***Macrhybopsis aestivalis***	*Cyprinidae*	111	52	88	251	3.59
Stonecat	*Noturus flavus*	*Ictaluridae*	2	9	11	22	0.32
Striped bass	*Morone saxatilis*	*Moronidae*	1	0	0	1	0.01
Striped bass x White bass	*Morone saxatilis x chrysops*	*Moronidae*	0	2	1	3	0.04
Sturgeon chub	***Macrhybopsis gelida***	*Cyprinidae*	1	1	1	3	0.04
Suckermouth minnow	*Phenacobius mirabilis*	*Cyprinidae*	0	0	2	2	0.03
Warmouth	*Lepomis Gulosus*	*Centrarchidae*	1	0	0	1	0.01
Western mosquitofish	*Gambusia affinis*	*Poeciliidae*	4	3	12	19	0.27
Western silvery minnow	***Hybognathus argyritis***	*Cyprinidae*	0	0	2	2	0.03
White bass	*Morone chrysops*	*Moronidae*	20	2	2	24	0.34
White crappie	*Pomoxis annularis*	*Centrarchidae*	0	2	1	3	0.04
Yellow bullhead	*Ameiurus natalis*	*Ictaluridae*	0	6	1	7	0.10
Unidentified[1] buffalo	*Ictiobus spp.*	*Catostomidae*	0	1	0	1	0.01
Unidentified catfish	*Ictaluridae*	*Ictaluridae*	2	15	64	81	1.16
Unidentified chub	*Macrhybopsis* spp.	*Cyprinidae*	3	8	4	15	0.21
Unidentified *Hybognathus spp.*	*Hybognathus spp.*	*Cyprinidae*	1	1	4	6	0.09
Unidentified minnow	*Cyprinidae*	*Cyprinidae*	0	17	6	23	0.33
Unidentified sucker	*Catostomidae*	*Catostomidae*	0	12	3	15	0.21
Unidentified sunfish	*Centrarchidae*	*Centrarchidae*	0	4	21	25	0.36
Unidentified	Unidentified		4	19	0	23	0.33
Young-of-year fish	Unidentified		0	6	6	12	0.17
		Total	2613	2424	1946	6983	

[1]Fish labeled as 'unidentified' were unidentifiable due to being in larval or juvenile life stages, damage, or disfigurement.

Table III.10.2. Species richness (S), species evenness (E), Shannon's diversity index (H) and Simpson's diversity index (D) for Overton chute by year.

Year	S	E	H	D
2006	42	0.7426	2.7755	0.9023
2007	40	0.7209	2.6592	0.8678
2008	41	0.8462	3.1423	0.9433

Table III.10.3. Sampling effort (number of gear deployments) in Overton chute by year and gear.

Year	Gear	April	May	June	July	August	September	October
	EF	9	9	9	8	9	9	
	HN	8	8	8	8	8	7	
	MF	6	1		8			
2006	OT16		8	4	8	8		
	POT				8		8	
	SHN	7	8	8	8	8	8	
	TN	8	8	8	8	8	8	
	EF	8	8	8	8	16	8	
	HN	8	8	7	8	8	7	
	MF				8	8	8	
2007	OT16	8	8	8	8	8		8
	POT			8	8	8	8	
	SHN	8	8	6	8	8	8	
	TN	8	8	8	8	8		8
	EF	8	8		8	8	8	8
	HN	8	8		8	8	8	8
	MF					8	8	8
2008	OT16	8	8		8	8	8	8
	POT				8	8	8	8
	SHN	8	8		8	8	8	8
	TN	8	8		8	8	8	8

Gears: EF = electrofishing, HN = 4’ diameter hoop nets, MF = mini-fyke, OT16 - 16’ otter trawls, OT8 = 8’ otter trawls, POT = 8’ otter trawls pushed, SHN = 2’ diameter hoop net, TN = the combined efforts of trammel nets in 25’ increments either drifted or set stationary.

Table III.10.4. Yearly mean catch per unit effort (CPUE) and results of Kruskal-Wallis test of mean CPUE of target species caught in Overton chute by species and gear. Significant results are bold.

Species	Gear	Mean CPUE			06 v 07 v 08		06 v 07		06 v 08		07 v 08	
		2006	2007	2008	Chi	P	Chi	P	Chi	P	Chi	P
Bighead Carp	HN	0.05	0.23	0.30	2.11	0.3486						
	TN	0.00	0.07	0.00	4.03	0.1335						
Blue Sucker	EF	0.02	0.02	0.03	1.05	0.5929						
	HN	0.00	0.00	0.02	1.94	0.3796						
	OT	0.00	0.06	0.00	**4.83**	**0.0895**	1.80	0.1801			3.06	0.0801
	SHN	0.00	0.00	0.02	1.94	0.3796						
	TN	0.03	0.00	0.11	1.01	0.6044						
Channel Catfish	EF	0.25	0.28	0.38	4.49	0.1058						
	HN	0.09	0.27	0.34	3.55	0.1694						
	MF	0.26	0.48	0.54	0.50	0.7799						
	OT	1.37	1.57	0.48	**19.35**	**<0.0001**	**6.79**	**0.0092**	**18.13**	**<0.0001**	**5.63**	**0.0177**
	POT	0.07	0.14	0.18	4.31	0.1157						
	SHN	0.69	0.41	0.45	4.33	0.1148						
	TN	0.00	0.13	0.11	1.01	0.6044						
Common Carp	EF	0.39	0.22	0.18	3.31	0.1914						
	HN	0.06	0.21	0.32	**8.44**	**0.0147**	2.80	0.0941	**8.46**	**0.0036**	1.64	0.1997
	MF	0.00	0.05	0.00	3.30	0.1918						
	OT	0.00	0.02	0.00	1.58	0.4531						
	POT	0.00	0.00	0.00	0.73	0.6943						
	SHN	0.00	0.06	0.02	3.71	0.1564						
Emerald Shiner	EF	1.29	0.54	0.14	**6.43**	**0.0402**	0.70	0.4035	**5.80**	**0.0161**	3.60	0.0576
	MF	7.58	0.18	0.93	**6.22**	**0.0445**	**5.72**	**0.0168**	2.84	0.0921	0.96	0.3279
	OT	0.00	0.02	0.00	1.58	0.4531						
	POT	0.03	0.03	0.16	**6.11**	**0.0471**	0.13	0.722	0.71	0.4003	**6.19**	**0.0128**
Flathead Catfish	EF	0.22	0.39	0.16	**5.39**	**0.0676**	3.86	0.0494	0.36	0.5468	3.56	0.0591
	HN	0.04	0.18	0.29	**4.86**	**0.0881**	2.40	0.1214	**4.99**	**0.0256**	0.51	0.476
	MF	0.00	0.02	0.00	1.63	0.4437						
	OT	0.07	0.05	0.07	1.40	0.4977						
	POT	0.00	0.00	0.00	1.03	0.5978						
	SHN	0.29	0.77	0.41	**10.57**	**0.0051**	**8.15**	**0.0043**	0.01	0.9257	**6.90**	**0.0086**
Gizzard Shad	EF	2.43	2.00	0.65	4.37	0.1123						
	HN	0.06	0.06	0.05	0.22	0.896						
	MF	0.13	0.02	0.05	4.33	0.1149						
	POT	0.01	0.00	0.01	2.19	0.3337						
	TN	0.00	0.06	0.00	2.00	0.3679						
Goldeye	EF	1.01	0.97	0.72	2.50	0.2864						
	HN	0.05	0.06	0.00	3.21	0.2006						
	OT	0.03	0.00	0.00	**6.91**	**0.0315**	3.47	0.0623	3.47	0.0623		
	POT	0.00	0.01	0.00	2.14	0.3431						
	SHN	0.02	0.02	0.00	1.04	0.5945						
	TN	0.59	0.12	0.06	**6.62**	**0.0365**	3.74	0.053	3.93	0.0473	0.00	0.9882
Plains Minnow	POT	0.00	0.00	0.00	1.25	0.5353						
Red Shiner	EF	1.93	5.02	1.45	4.02	0.1339						
	MF	1.57	3.18	0.79	**5.85**	**0.0536**	0.49	0.484	1.15	0.283	**6.36**	**0.0117**
	OT	0.02	0.00	0.00	3.43	0.1801						
	POT	0.01	0.52	0.47	**6.09**	**0.0475**	**4.55**	**0.0329**	**6.05**	**0.0139**	0.22	0.6406
River Carpsucker	EF	0.73	0.67	0.09	**9.19**	**0.0101**	3.09	0.0788	**8.95**	**0.0028**	1.50	0.2205
	HN	0.05	0.50	0.71	**12.14**	**0.0023**	3.92	0.0477	**12.43**	**0.0004**	2.21	0.1369
	MF	0.29	0.00	0.00	**17.07**	**0.0002**	**8.89**	**0.0029**	**8.89**	**0.0029**		
	OT	0.00	0.02	0.01	0.59	0.7452						
	POT	0.04	0.00	0.00	**51.52**	**<0.0001**	**27.31**	**<0.0001**	**27.31**	**<0.0001**		
	SHN	0.00	0.02	0.00	2.07	0.3561						
River Shiner	EF	0.00	0.01	0.02	3.76	0.1526						
	MF	0.00	0.00	0.02	1.63	0.4437						
	POT	0.00	0.00	0.01	1.25	0.5353						
Sand Shiner	MF	0.00	0.04	0.00	1.63	0.4437						
	POT	0.00	0.01	0.00	0.83	0.6614						
Sauger	EF	0.02	0.00	0.00	4.46	0.1078						

Table III.10.4 (continued). Yearly mean CPUE and results of Kruskal-Wallis test of mean CPUE of target species caught in Overton chute by species and gear. Significant results are bold.

Species	Gear	Mean CPUE			06 v 07 v 08		06 v 07		06 v 08		07 v 08	
		2006	2007	2008	Chi	P	Chi	P	Chi	P	Chi	P
Shortnose Gar	EF	0.03	0.26	0.13	**6.37**	**0.0415**	**5.67**	**0.0173**	**5.69**	**0.017**	0.00	0.9481
	HN	0.11	0.27	0.14	2.48	0.2891						
	MF	0.02	0.00	0.07	1.41	0.4939						
	SHN	0.05	0.12	0.09	0.29	0.8668						
Shovelnose Sturgeon	EF	0.20	0.01	0.03	**15.20**	**0.0005**	**11.55**	**0.0007**	**6.43**	**0.0112**	1.31	0.2523
	HN	0.57	0.02	0.21	**13.93**	**0.0009**	**13.20**	**0.0003**	3.49	0.0617	**4.66**	**0.0309**
	OT	0.15	0.46	0.77	**5.16**	**0.0759**	0.29	0.59	2.50	0.1142	4.24	0.0396
	SHN	0.35	0.11	0.21	1.11	0.5755						
	TN	2.54	2.93	1.01	**4.90**	**0.0864**	0.18	0.6681	**4.82**	**0.0281**	2.70	0.1003
Sicklefin Chub	EF	0.00	0.02	0.02	2.09	0.3518						
	MF	0.05	0.00	0.00	**6.50**	**0.0387**	3.28	0.0699	3.28	0.0699		
	OT	0.25	0.00	0.02	**8.13**	**0.0172**	**7.14**	**0.0076**	2.75	0.0973	2.02	0.1551
	POT	0.05	0.00	0.00	**43.79**	**<0.0001**	**22.80**	**<0.0001**	**27.30**	**<0.0001**	1.00	0.3173
Silver Carp	EF	0.00	0.02	0.03	3.76	0.1526						
	HN	0.00	0.02	0.13	**5.18**	**0.0748**	1.02	0.3121	4.04	0.0443	1.78	0.1827
	OT	0.00	0.00	0.02	1.58	0.4531						
	TN	0.00	0.00	0.09	2.00	0.3679						
Silver Chub	EF	0.04	0.00	0.09	**9.84**	**0.0073**	2.41	0.1208	2.67	0.1024	**8.66**	**0.0033**
	MF	0.02	0.05	0.05	0.38	0.8249						
	OT	0.03	0.02	0.00	3.76	0.1526						
	POT	0.03	0.02	0.06	4.40	0.1106						
	SHN	0.00	0.02	0.09	1.01	0.6042						
Speckled Chub	EF	0.00	0.00	0.00	2.15	0.342						
	MF	0.07	0.04	0.39	1.91	0.3851						
	OT	0.10	0.19	0.13	1.31	0.5187						
	POT	0.07	0.07	0.18	4.56	0.1025						
Sturgeon Chub	MF	0.02	0.00	0.00	3.20	0.2019						
	POT	0.00	0.00	0.00	0.25	0.8808						
Western Silvery Minnow	POT	0.00	0.00	0.01	1.25	0.5353						

Gear : EF = electrofishing, HN = 4' diameter hoop nets, SHN = 2' diameter hoop nets, MF = mini-fyke nets, OT = 16' otter trawls, POT = 8' otter trawls pushed, TN = combined efforts of 1" trammel nets in 25' increments.

Table III.10.5. Catch per unit effort (CPUE) in bold, and 2 standard errors (SE) of target species caught in Overton chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Bighead carp	HN					**0.13** 0.25		**0.13** 0.25				**0.75** 1.05		**0.25** 0.33	**0.75** 0.63	**2.13** 1.39						
	TN					**0.51** 0.67																
Blue sucker	EF										**0.14** 0.27	**0.09** 0.17				**0.07** 0.14		**0.07** 0.15	**0.05** 0.09			**0.12** 0.25
	HN																					**0.13** 0.25
	OT											**0.31** 0.40									**0.13** 0.25	
	SHN												**0.13** 0.25									
	TN				**0.20** 0.39														**0.78** 1.56			
Channel catfish	EF	**0.10** 0.20		**0.41** 0.48		**0.11** 0.21		**0.39** 0.56			**0.40** 0.56	**0.48** 0.29	**0.05** 0.09	**0.24** 0.33	**0.89** 0.50	**0.48** 0.36	**0.59** 0.61	**0.51** 0.43	**1.08** 0.35			**0.67** 0.39
	HN	**0.38** 0.37	**0.63** 0.75	**0.75** 1.24		**0.25** 0.33	**0.63** 1.00	**0.13** 0.25	**0.43** 0.59		**0.13** 0.25		**0.38** 0.53		**0.13** 0.25	**0.38** 0.37		**0.43** 0.40	**0.13** 0.25			**0.13** 0.25
	MF	**1.33** 1.61									**0.50** 0.53	**1.00** 0.76			**1.00** 1.00	**0.75** 0.82		**1.38** 1.96	**0.75** 0.63			**2.25** 1.80
	OT		**0.83** 1.33	**0.21** 0.43	**0.58** 0.44	**0.27** 0.37		**0.93** 1.07	**0.14** 0.28		**1.56** 1.35	**0.75** 0.93	**0.33** 0.47	**6.54** 2.44	**0.88** 0.70				**0.40** 0.44		**8.13** 12.85	**2.41** 2.85
	POT								**0.01** 0.02		**0.50** 0.46	**0.18** 0.20	**0.36** 0.28		**0.70** 0.52	**0.34** 0.29		**0.07** 0.10	**0.21** 0.20			**0.38** 0.25
	SHN	**1.71** 0.84	**0.38** 0.53	**0.63** 0.53	**0.38** 0.53	**1.50** 1.96	**1.00** 0.85	**0.25** 0.33			**1.75** 1.35		**0.88** 1.03	**0.38** 0.37	**0.75** 0.98	**0.13** 0.25	**0.38** 0.53	**0.25** 0.33				**0.50** 0.53
	TN											**0.89** 1.79							**0.78** 1.56			
Common carp	EF	**0.10** 0.20	**0.09** 0.18	**0.14** 0.29			**0.18** 0.25	**0.48** 0.61	**0.23** 0.24		**1.09** 0.66	**0.90** 0.38	**0.13** 0.13	**0.54** 0.33	**0.05** 0.10	**0.12** 0.16	**0.54** 0.62	**0.24** 0.47	**0.41** 0.36			**0.26** 0.36
	HN	**0.13** 0.25		**0.25** 0.33		**0.38** 0.53	**1.13** 0.88		**0.71** 0.84		**0.13** 0.25	**0.13** 0.25	**0.38** 0.37		**0.13** 0.25	**0.50** 0.38	**0.14** 0.29	**0.14** 0.29				
	MF											**0.25** 0.50			**0.13** 0.25							
	OT								**0.13** 0.25													
	POT											**0.03** 0.04	**0.02** 0.04									
	SHN								**0.17** 0.33			**0.25** 0.33	**0.13** 0.25									

Table III.10.5 (continued). CPUE, in bold, and 2 SE of target species caught in Overton chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Emerald shiner	EF	**0.11** 0.23	**0.84** 0.75	**0.18** 0.23	**0.48** 0.58	**0.31** 0.30		**0.60** 0.93	**0.05** 0.10		**1.02** 1.73	**1.26** 0.84	**0.04** 0.09	**2.05** 1.90	**0.48** 0.45	**0.31** 0.19	**4.79** 3.86	**0.81** 1.08	**0.29** 0.38			**0.14** 0.18
	MF	**1.17** 2.33									**51.88** 82.35	**0.38** 0.37			**0.63** 1.25	**1.00** 1.51		**0.25** 0.33	**4.50** 7.87			**1.00** 1.51
	OT		**0.17** 0.33																			
	POT								**0.01** 0.03		**0.23** 0.31				**0.08** 0.11	**0.58** 0.98		**0.12** 0.08	**0.29** 0.21			**0.22** 0.11
Flathead catfish	EF	**0.20** 0.27				**0.18** 0.24	**0.28** 0.28	**0.22** 0.29	**0.15** 0.21		**0.63** 0.64	**0.88** 0.52	**0.32** 0.17	**0.33** 0.34	**0.77** 0.47	**0.18** 0.17	**0.13** 0.26	**0.74** 0.41	**0.32** 0.14			
	HN			**0.13** 0.25					**0.57** 0.59				**1.13** 1.49	**0.25** 0.33	**0.38** 0.53	**0.38** 0.53		**0.29** 0.57	**0.25** 0.33			**0.13** 0.25
	MF														**0.13** 0.25							
	OT		**0.16** 0.32	**0.21** 0.21			**0.28** 0.37	**0.30** 0.61			**0.11** 0.23	**0.16** 0.31		**0.10** 0.21								
	POT										**0.01** 0.03					**0.01** 0.03		**0.03** 0.04				
	SHN		**0.13** 0.25		**0.25** 0.33	**2.38** 1.25	**0.25** 0.33	**0.38** 0.37	**0.67** 0.42		**0.38** 0.37	**0.38** 0.37	**1.50** 1.00	**0.75** 0.63	**1.00** 0.53	**0.88** 0.96	**0.25** 0.33	**0.88** 0.59	**0.25** 0.33			
Gizzard shad	EF	**0.32** 0.31	**0.27** 0.37	**1.03** 0.79	**0.31** 0.31	**0.09** 0.19		**1.13** 1.08			**1.77** 1.27	**9.79** 2.69	**0.12** 0.12	**12.53** 6.25	**1.93** 1.23	**2.36** 1.29	**0.95** 0.61	**1.91** 0.72	**0.27** 0.29			**0.80** 0.81
	HN	**0.25** 0.50	**0.25** 0.50	**0.13** 0.25					**0.14** 0.29				**0.13** 0.25			**0.13** 0.25	**0.14** 0.29					
	MF										**0.88** 0.96				**0.13** 0.25	**0.13** 0.25			**0.13** 0.25			**0.13** 0.25
	POT										**0.04** 0.09		**0.02** 0.04			**0.05** 0.06		**0.03** 0.04	**0.02** 0.03			
	TN		**0.42** 0.83																			
Goldeye	EF	**0.26** 0.34	**1.45** 0.65	**1.43** 0.78	**0.12** 0.24	**1.24** 0.83	**0.35** 0.30	**0.33** 0.46	**0.10** 0.19		**5.07** 2.38	**1.84** 0.89	**1.12** 0.72	**0.60** 0.57	**0.86** 0.65	**0.12** 0.16	**0.68** 0.63	**1.33** 1.06	**0.05** 0.11			**1.97** 0.99
	HN	**0.13** 0.25										**0.13** 0.25		**0.25** 0.33				**0.29** 0.37				
	OT										**0.20** 0.26											
	POT								**0.05** 0.06		**0.02** 0.03	**0.02** 0.03	**0.02** 0.03									**0.01** 0.03
	SHN											**0.13** 0.25		**0.13** 0.25								
	TN										**1.67** 2.18			**1.24** 1.77			**1.25** 1.64				**0.83** 1.67	**0.42** 0.83

Table III.10.5 (continued). CPUE, in bold, and 2 SE of target species caught in Overton chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Plains minnow	POT															**0.02** 0.04						
Red shiner	EF		**0.38** 0.38	**0.25** 0.34	**0.39** 0.42	**1.63** 1.59	**0.08** 0.17	**0.99** 0.98	**1.67** 1.34		**8.63** 5.48	**23.86** 8.63	**4.97** 2.74	**0.82** 0.60	**7.10** 4.82	**1.26** 0.62	**2.65** 1.78	**0.54** 0.63	**3.52** 0.96			**0.09** 0.18
	MF	**1.33** 2.67									**9.63** 5.03	**11.38** 11.82			**4.63** 2.88	**3.25** 2.13		**6.25** 5.97	**1.13** 0.80			**1.13** 1.49
	OT							**0.15** 0.30														
	POT								**0.22** 0.19		**0.10** 0.12	**0.53** 0.56	**0.77** 0.65		**0.45** 0.39	**0.83** 1.53		**2.47** 1.78	**1.09** 0.55			**0.61** 0.31
River carpsucker	EF	**0.09** 0.18		**0.33** 0.36				**0.22** 0.29			**0.74** 0.91	**4.49** 2.65		**2.60** 3.29	**0.10** 0.13	**0.14** 0.18	**1.45** 1.09	**0.12** 0.24				**0.16** 0.32
	HN		**0.13** 0.25	**0.38** 0.37		**0.13** 0.25	**0.25** 0.33				**0.25** 0.33	**0.13** 0.25	**0.13** 0.25	**0.13** 0.25	**3.00** 2.78	**0.50** 0.53		**0.14** 0.29	**3.50** 2.95			**0.25** 0.33
	MF										**2.00** 1.69											
	OT		**0.17** 0.33	**0.07** 0.14																		
	POT										**0.29** 0.39											
	SHN											**0.13** 0.25										
River shiner	EF														**0.07** 0.13				**0.15** 0.15			
	MF																		**0.13** 0.25			
	POT															**0.04** 0.08						
Sand shiner	MF											**0.25** 0.50										
	POT															**0.01** 0.03		**0.04** 0.04	**0.01** 0.03			
Sauger	EF							**0.07** 0.13						**0.11** 0.21								
Shortnose gar	EF		**1.07** 1.11			**0.51** 0.44	**0.68** 0.40		**0.22** 0.32		**0.12** 0.23		**0.03** 0.06	**0.09** 0.19		**0.06** 0.11			**0.16** 0.24			
	HN			**0.13** 0.25		**0.25** 0.50		**0.38** 0.37				**1.13** 0.80			**0.50** 0.38	**0.63** 0.53	**0.43** 0.59		**0.25** 0.33			
	MF										**0.13** 0.25								**0.50** 1.00			
	SHN								**0.33** 0.67		**0.13** 0.25	**0.50** 0.53		**0.25** 0.33		**0.63** 0.65						

Table III.10.5 (continued). CPUE, in bold, and 2 SE of target species caught in Overton chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Shovelnose sturgeon	EF	**0.10** 0.21		**0.07** 0.14	**0.19** 0.25			**0.36** 0.35			**0.66** 0.52				**0.05** 0.11	**0.06** 0.13	**0.10** 0.20		**0.05** 0.11			
	HN	**2.38** 1.96		**0.25** 0.33	**1.00** 0.85	**0.13** 0.25	**1.13** 1.10	**0.38** 0.53			**0.25** 0.33											**0.13** 0.25
	OT		**0.32** 0.64	**0.29** 0.31	**0.50** 0.71		**0.42** 0.41	**0.31** 0.36	**0.10** 0.19			**1.79** 2.43	**0.11** 0.23	**0.24** 0.23					**2.37** 1.88		**1.00** 1.00	**2.24** 1.52
	SHN	**1.43** 0.96	**0.38** 0.53	**0.25** 0.50	**0.75** 1.24	**0.25** 0.33	**1.00** 0.65	**0.25** 0.50								**0.13** 0.25		**0.13** 0.25				**0.13** 0.25
	TN	**11.26** 4.88	**2.40** 3.26		**1.42** 1.15	**0.26** 0.52		**3.03** 2.00			**0.83** 1.67	**8.30** 6.27			**6.25** 9.96	**0.63** 1.25	**1.22** 1.60		**4.02** 3.40		**3.33** 2.52	**2.45** 2.43
Sicklefin chub	EF		**0.15** 0.30										**0.13** 0.18									
	MF										**0.38** 0.53											
	OT			**0.14** 0.19										**1.77** 2.06								
	POT										**0.38** 0.37							**0.01** 0.03				
Silver carp	EF			**0.08** 0.16		**0.11** 0.21													**0.05** 0.10			**0.08** 0.16
	HN											**0.13** 0.25				**0.88** 0.96						
	OT						**0.13** 0.25															
	TN												**0.64** 1.28									
Silver chub	EF																**0.26** 0.34		**0.35** 0.23			**0.26** 0.38
	MF										**0.13** 0.25	**0.13** 0.25			**0.25** 0.50	**0.25** 0.33						**0.13** 0.25
	OT				**0.07** 0.14				**0.13** 0.25		**0.11** 0.23											
	POT										**0.20** 0.19	**0.02** 0.03	**0.21** 0.17		**0.09** 0.09	**0.09** 0.11		**0.04** 0.08	**0.13** 0.24			**0.03** 0.03
	SHN		**0.13** 0.25	**0.63** 1.25																		

Table III.10.5 (continued). CPUE, in bold, and 2 SE of target species caught in Overton chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Speckled chub	**EF**												**0.03** 0.06									
	MF	**0.50** 0.68													**0.13** 0.25			**0.13** 0.25				**2.75** 2.75
	OT		**0.98** 1.11	**0.36** 0.71	**0.08** 0.17		**0.13** 0.25	**0.15** 0.30	**0.25** 0.50					**0.49** 0.55							**0.13** 0.25	**0.41** 0.54
	POT										**0.47** 0.43		**0.19** 0.16		**0.29** 0.36	**0.02** 0.04		**0.19** 0.18	**0.04** 0.08			**1.01** 0.67
Sturgeon chub	**MF**	**0.17** 0.33																				
	POT												**0.02** 0.03					**0.02** 0.04				
Western silvery minnow	**POT**															**0.04** 0.08						

Gears: EF = electrofishing, HN = 4' diameter hoop nets, MF = mini-fyke nets, OT = 16' otter trawls, SHN = 2' diameter hoop nets, POT = 8' otter trawls pushed, TN = combined efforts of 1" trammel nets in 25' increments.

Table III.10.6. Mean length (ML), standard error (SE) in parentheses and results of analysis of variance of mean length for target species caught in Overton chute, by year and gear. Significant results are bold.

Species	Gear	ML/SE 2006	ML/SE 2007	ML/SE 2008	06 v 07 v 08		2006 v 2007		2006 v 2008		2007 v 2008	
					F	P value	F	P value	F	P value	F	P value
Species	HN	768.3 (52.3)	658.6 (23.2)	733 (16.3)	**4.63**	**0.0177**	**2.26**	**0.0313**	0.74	0.4625	**-2.66**	**0.0123**
	TN		874 (120)									
Blue sucker	EF	379 (289)	487 (177)	326 (81.3)	0.23	0.8027						
	HN			470								
	SHN			440								
	OT		548 (141.8)									
	TN	605		499								
Channel catfish	EF	290.9 (40.8)	142.6 (17.3)	193.5 (28.4)	**4.6**	**0.0127**	**3.03**	**0.0032**	**2.13**	**0.0365**	-1.34	0.185
	HN	415.8 (19.8)	450.4 (30.5)	459.8 (27.6)	0.31	0.7378						
	SHN	240.2 (15.1)	285.7 (25.7)	241 (27.5)	1.27	0.2875						
	MF	68.3 (3.9)	72.7 (9.8)	76.4 (17)	0.06	0.9414						
	OT	95.6 (4.5)	104.4 (6.5)	90.4 (10)	1.02	0.3631						
	POT	75.5 (7.5)	67.1 (4.7)	56.5 (2.2)	4.17	0.017	1.21	0.2283	2.73	0.0069	1.92	0.0563
	TN	246		256								
Common carp	EF	516.8 (16)	398.9 (49.6)	562.4 (13.9)	**9.04**	**0.0003**	**3.22**	**0.002**	-1.33	0.1898	**-4.15**	**0.0001**
	HN	514.7 (17.4)	562.1 (24.7)	581.5 (24.3)	0.71	0.5004						
	SHN		640 (45.7)	565	0.67	0.4982						
	MF		64 (1.2)									
	OT		53									
	POT		106.5 (13.5)	68	2.71	0.3475						
Emerald shiner	EF	57.3 (1.1)	54.8 (2)	58.3 (3.4)	0.84	0.4339						
	MF	44 (0.5)	45.9 (4.3)	56.3 (4.3)	**21.1**	**0.0001**	-0.44	0.6578	**-6.49**	**0.0001**	**-2.26**	**0.0263**
	OT		74									
	POT	38.9 (3.4)	36.8 (2.2)	44 (1.4)	**3.39**	**0.0382**	0.57	0.572	-1.62	0.1099	**-2.36**	**0.0204**
Flathead catfish	EF	257.8 (15.2)	292 (22.1)	267.4 (16.2)	0.76	0.4704						
	HN	789.5 (139.5)	539.4 (33.5)	785.3 (87.9)	2.36	0.1172						
	SHN	389.6 (37.7)	378.6 (25.1)	364 (34.7)	0.13	0.8825						
	MF		295									
	OT	269.8 (38.4)	224.5 (34.5)	292 (83.6)	0.16	0.8519						
	POT	280	225 (103)	252	0.05	0.9545						

Table III.10.6 (continued). Mean length (ML), standard error (SE) in parentheses and results of analysis of variance of mean length for target species caught in Overton chute, by year and gear. Significant results are bold.

Species	Gear	ML/SE 2006	ML/SE 2007	ML/SE 2008	06 v 07 v 08		2006 v 2007		2006 v 2008		2007 v 2008	
					F	P value	F	P value	F	P value	F	P value
Gizzard shad	EF	149.5 (5.1)	104.7 (3.6)	146.4 (11.7)	**18.82**	**0.0001**	**5.91**	**0.0001**	0.31	0.7547	**-4.04**	**0.0001**
	HN	254.5 (13.5)	359.7 (5.2)	294 (40.3)	3.49	0.1127						
	MF	73.1 (21.6)	52	86 (17.8)	0.17	0.8467						
	POT	42.5 (7)	125.5 (20.5)	60.9 (7.7)	11.55	0.0033	-4.74	0.0011	-1.45	0.1818	3.98	0.0032
	TN		230									
Goldeye	EF	154.8 (11.3)	132.1 (4.5)	140.1 (8.8)	1.87	0.1564						
	HN	326.7 (14.5)	344 (17.3)		**0.59**	**0.4864**						
	SHN	132	290									
	OT	75.5 (5.5)										
	POT	66.5 (23.5)	65.8 (7.8)	97 (32)	**0.93**	**0.4539**						
	TN	276.1 (9.4)	258	360	5.52	0.0437	0.68	0.5221	-3.14	0.02	-2.89	0.0277
Plains minnow	POT			49								
Red shiner	EF	56 (1.3)	46.3 (0.6)	49.3 (0.6)	**31.9**	**0.0001**	**7.96**	**0.0001**	**4.88**	**0.0001**	**-2.84**	**0.0047**
	MF	50.1 (1.7)	40.5 (1)	46 (1.7)	**15.56**	**0.0001**	**5.47**	**0.0001**	**1.7**	**0.0902**	**-2.51**	**0.0126**
	OT	35										
	POT	58 (3.8)	32.3 (0.7)	38.8 (0.9)	**33.49**	**0.0001**	**6.47**	**0.0001**	**4.8**	**0.0001**	**-5.73**	**0.0001**
River carpsucker	EF	145 (14.1)	85 (9.3)	307.8 (41.6)	**19.86**	**0.0001**	**3.24**	**0.0016**	**-4.54**	**0.0001**	**-6.11**	**0.0001**
	HN	414 (46.1)	396.6 (7.1)	411.9 (6.5)	1.18	0.315						
	SHN		380									
	MF	30.6 (3.3)										
	OT		116	381								
	POT	47.3 (2.4)										
River shiner	EF		44	33.7 (1.5)	**12.64**	**0.0708**					**3.56**	**0.0708**
	MF			29								
	POT			38.5 (0.5)								
Sand shiner	MF		36 (2)									
	POT		31.3 (0.3)	39 (6)	2.91	0.1865						
Sauger	EF	197.5 (55.5)										

Table III.10.6 (continued). Mean length (ML), standard error (SE) in parentheses and results of analysis of variance of mean length for target species caught in Overton chute, by year and gear. Significant results are bold.

Species	Gear	ML/SE 2006	ML/SE 2007	ML/SE 2008	06 v 07 v 08		2006 v 2007		2006 v 2008		2007 v 2008	
					F	P value	F	P value	F	P value	F	P value
Shortnose gar	EF	566 (11.1)	577.4 (10.6)	570.4 (12)	0.23	0.7991						
	HN	655.3 (17.8)	658.5 (12.7)	655.1 (24.3)	0.01	0.987						
	SHN	605 (5)	666 (35)	614 (28.6)	1.1	0.3664						
	MF	558		449.3 (40)	1.48	0.3111						
Shovelnose sturgeon	EF	527.6 (35.7)	427	566 (26.2)	0.55	0.5913						
	HN	544.9 (16.3)	570	553.8 (19.2)	0.08	0.9227						
	SHN	549.1 (15.8)	559.3 (36.9)	548.6 (16.5)	0.06	0.9429						
	OT	333.8 (56.5)	513.8 (22.8)	460 (20.3)	6.41	0.0026	-3.58	0.0006	-2.72	0.008	1.55	0.1262
	TN	453.9 (24.9)	489.5 (26.9)	556.3 (30.3)	**2.6**	**0.0819**	-1	0.3205	**-2.27**	**0.0266**	-1.43	0.1587
Sicklefin chub	EF		68	41 (1)	**182.25**	**0.0054**					**13.5**	**0.0054**
	MF	37.3 (2.2)										
	OT	43 (1.2)		72 (12)	**38.12**	**0.0001**			**-6.17**	**0.0001**		
	POT	36.5 (2.1)	41		**0.2**	**0.6619**						
Silver carp	EF	766.2 (17.9)	763	360.7 (184.8)	**11.14**	**0.0013**	0.02	0.9823	**4.69**	**0.0003**	**2.58**	**0.0217**
	HN		813	652.3 (40)	2.02	0.2053						
	OT			784								
	TN			792								
Silver chub	EF	68.5 (5.8)		71.1 (2.5)	0.24	0.631						
	SHN		93	122.4 (1.9)	**38.31**	**0.0035**					**-6.19**	**0.0035**
	MF	53	31.7 (2)	63.3 (6.7)	**10.5**	**0.0256**	**2.16**	**0.0964**	-1.05	0.3535	**-4.54**	**0.0105**
	OT	84 (56)	111		0.08	0.8272						
	POT	47 (3.3)	31.3 (2.1)	41.7 (2.3)	**6.51**	**0.0031**	**3.53**	**0.0009**	1.41	0.1653	**-2.7**	**0.0094**
Speckled chub	EF			26								
	MF	38.3 (3.2)	36.5 (4.5)	35.8 (1.5)	0.22	0.8076						
	OT	42.4 (1.7)	48.7 (1.2)	49.2 (3.1)	3.23	0.06	-2.17	0.0419	-2.29	0.0325	-0.18	0.8553
	POT	35.2 (1)	30.2 (0.8)	34.5 (0.8)	8.96	0.0003	3.64	0.0004	0.54	0.588	-3.71	0.0003
Sturgeon chub	MF	46										
	POT		53	25								
Western silvery minnow	POT			48 (1)								

Gear : EF = electrofishing, HN = 4' diameter hoop nets, SHN = 2' diameter hoop nets, MF = mini-fyke nets, OT = 16' otter trawls, POT = 8' otter trawls pushed, TN = combined efforts of 1" trammel nets in 25' increments.

Table III.10.7. Results of z-test analysis of life stage proportions of target species caught in Overton chute. Significant results are bold.

Species	2006 v 2007 Z	2006 v 2008 Z	2007 v 2008 Z
Bighead carp	-1.53	**-2.24**	-1.17
Blue sucker	-0.19	**-2.27**	**-2.22**
Channel catfish	0.87	**3.91**	**2.62**
Common carp	**-3.01**	-0.43	**2.94**
Emerald shiner	**4.63**	**5.87**	0.19
Flathead catfish	0.87	1.18	0.45
Gizzard shad	**-4.02**	1.16	**4.59**
Goldeye	0.05	-0.37	-0.41
Plains minnow	-	-	-
Red shiner	**-9.09**	**-5.4**	**3.99**
River carpsucker	**4.57**	**9.46**	**5.52**
River shiner	-1.41	**-2.65**	-
Sand shiner	-	-	1.71
Sauger	-	-	-
Shortnose gar	-	-0.77	-1.1
Shovelnose sturgeon	0.64	0.44	-0.24
Sicklefin chub	1.63	1.64	-0.68
Silver carp	0.41	-1.6	-0.97
Silver chub	1.12	1.27	-0.08
Speckled chub	**-5.53**	**-4.86**	1.49
Sturgeon chub	-	-1.41	-1.41
Western silvery minnow	-	-	-

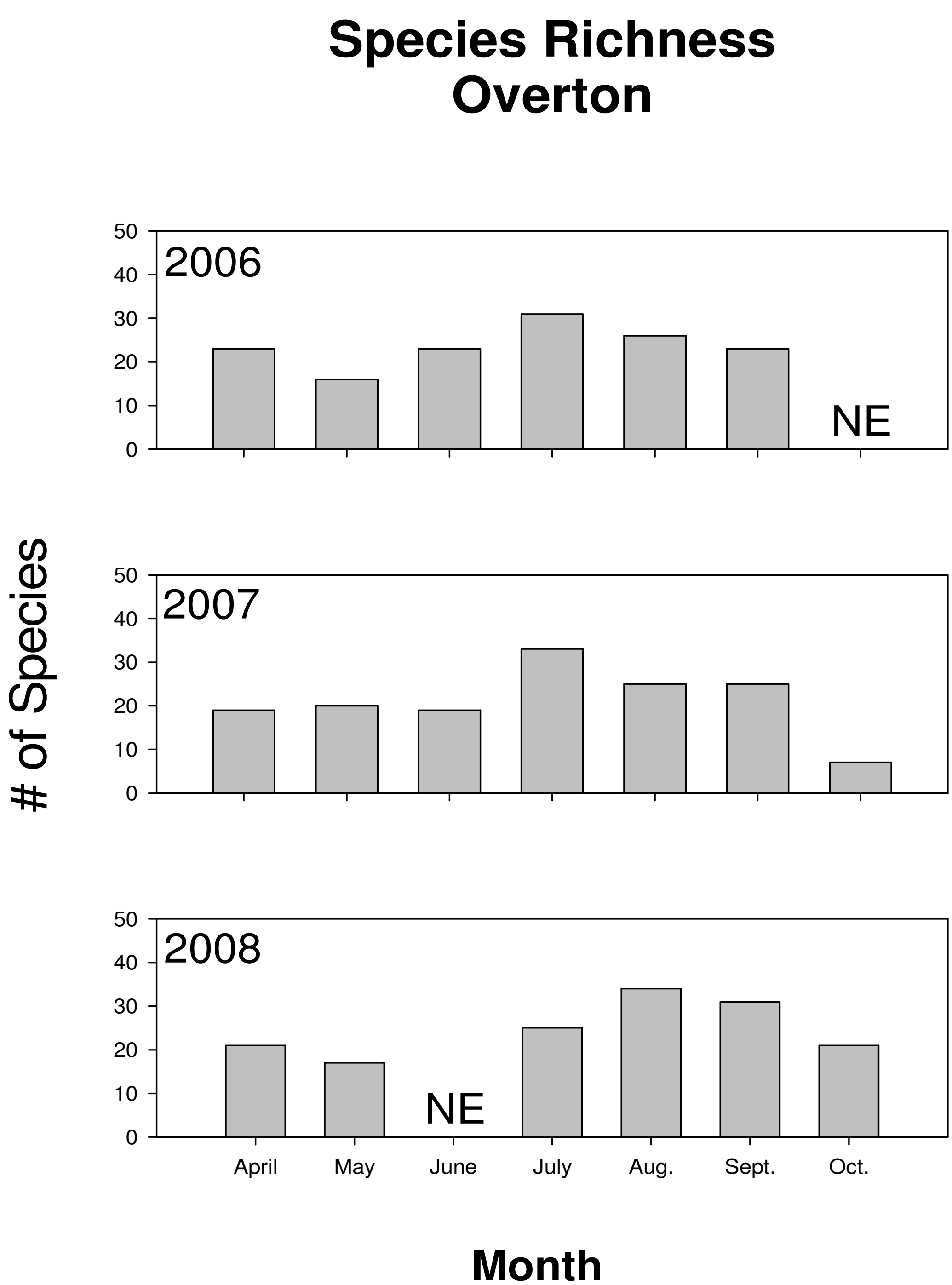


Figure III.10.1. Species richness in Overton chute by month and year.
NE = No effort during this month due to river conditions or construction.

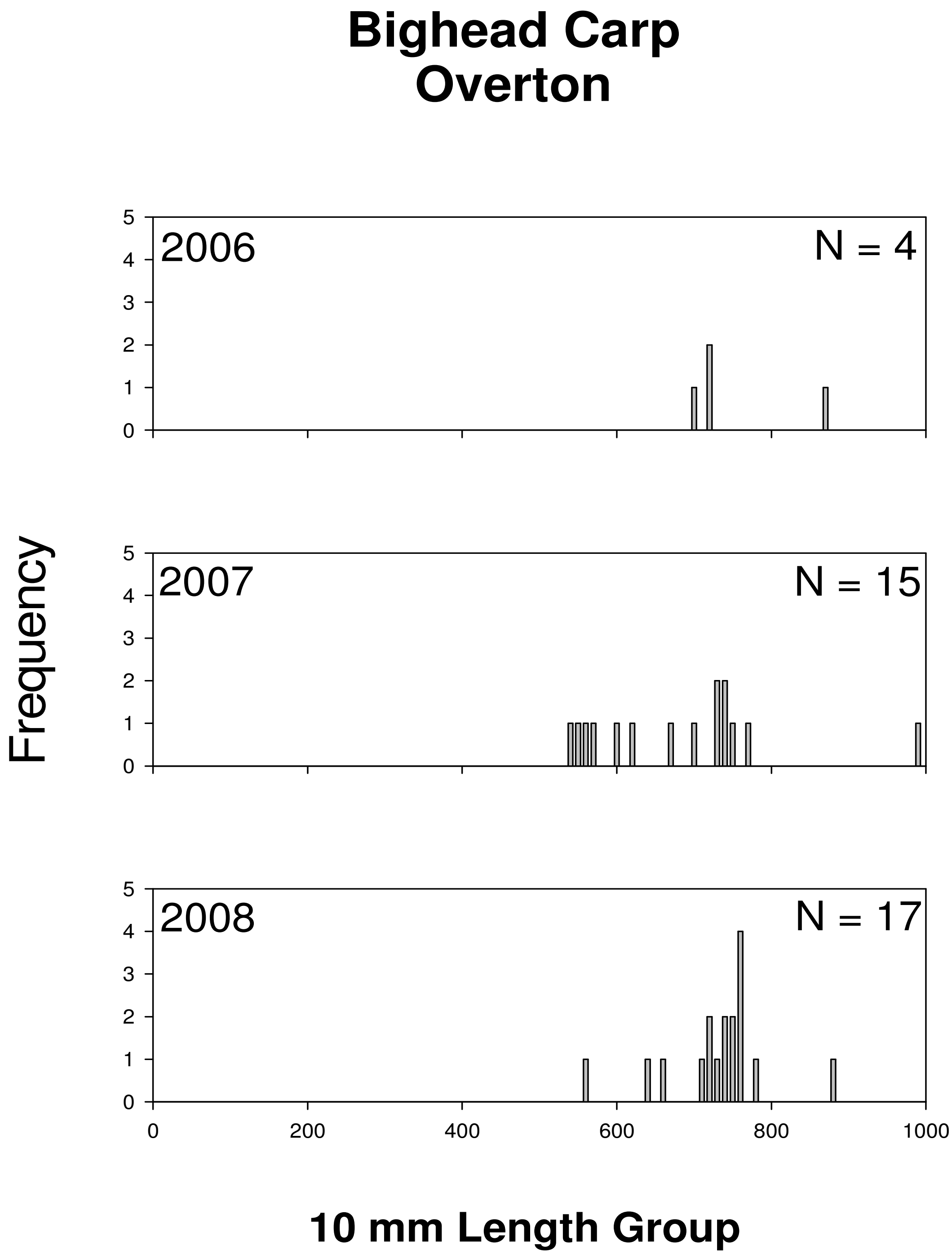


Figure III.10.2. Length frequency distribution of bighead carp in Overton chute by year. Length groups are in 10 mm intervals.

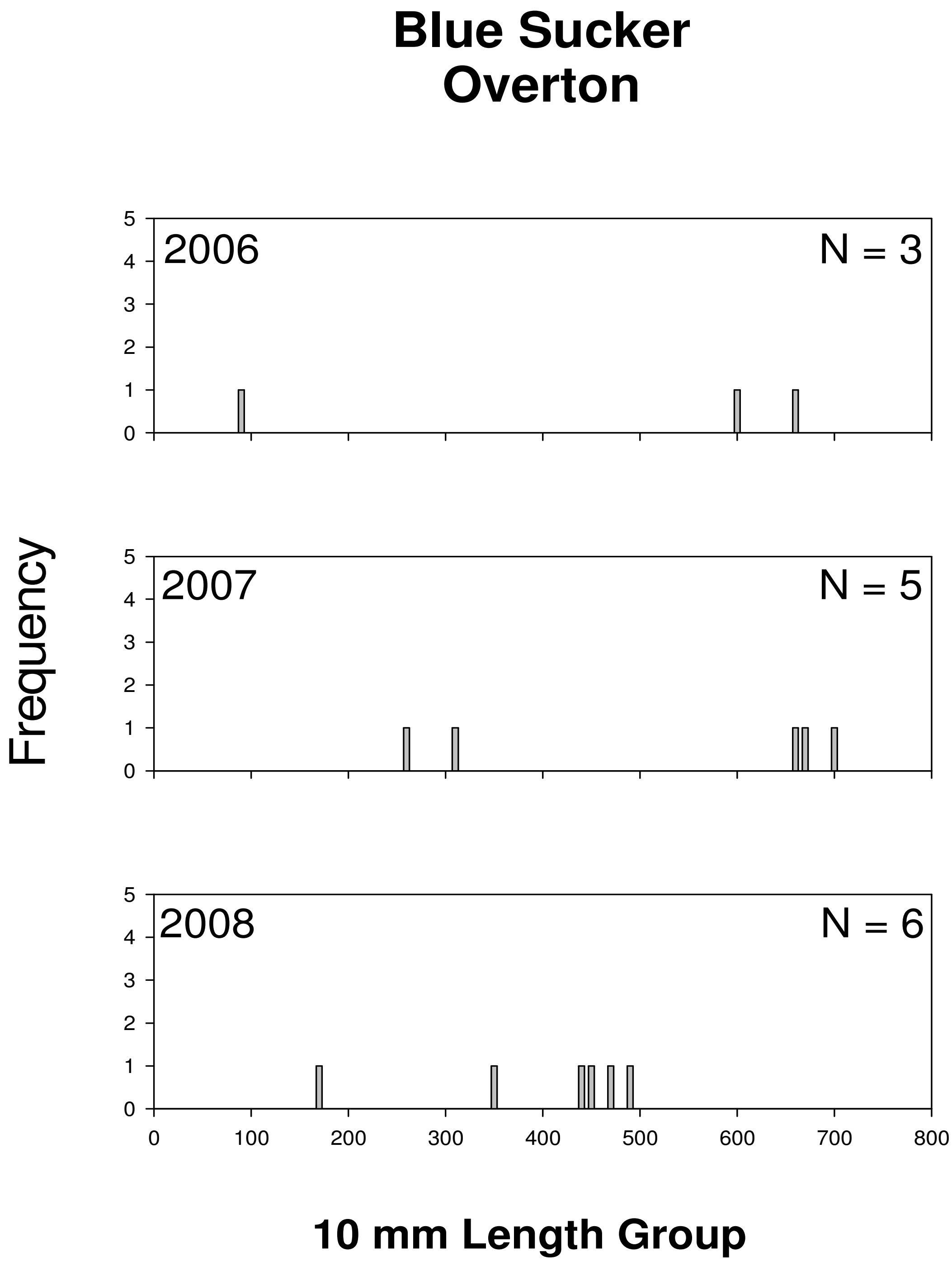


Figure III.10.3. Length frequency distribution of blue sucker in Overton chute by year. Length groups are in 10 mm intervals.

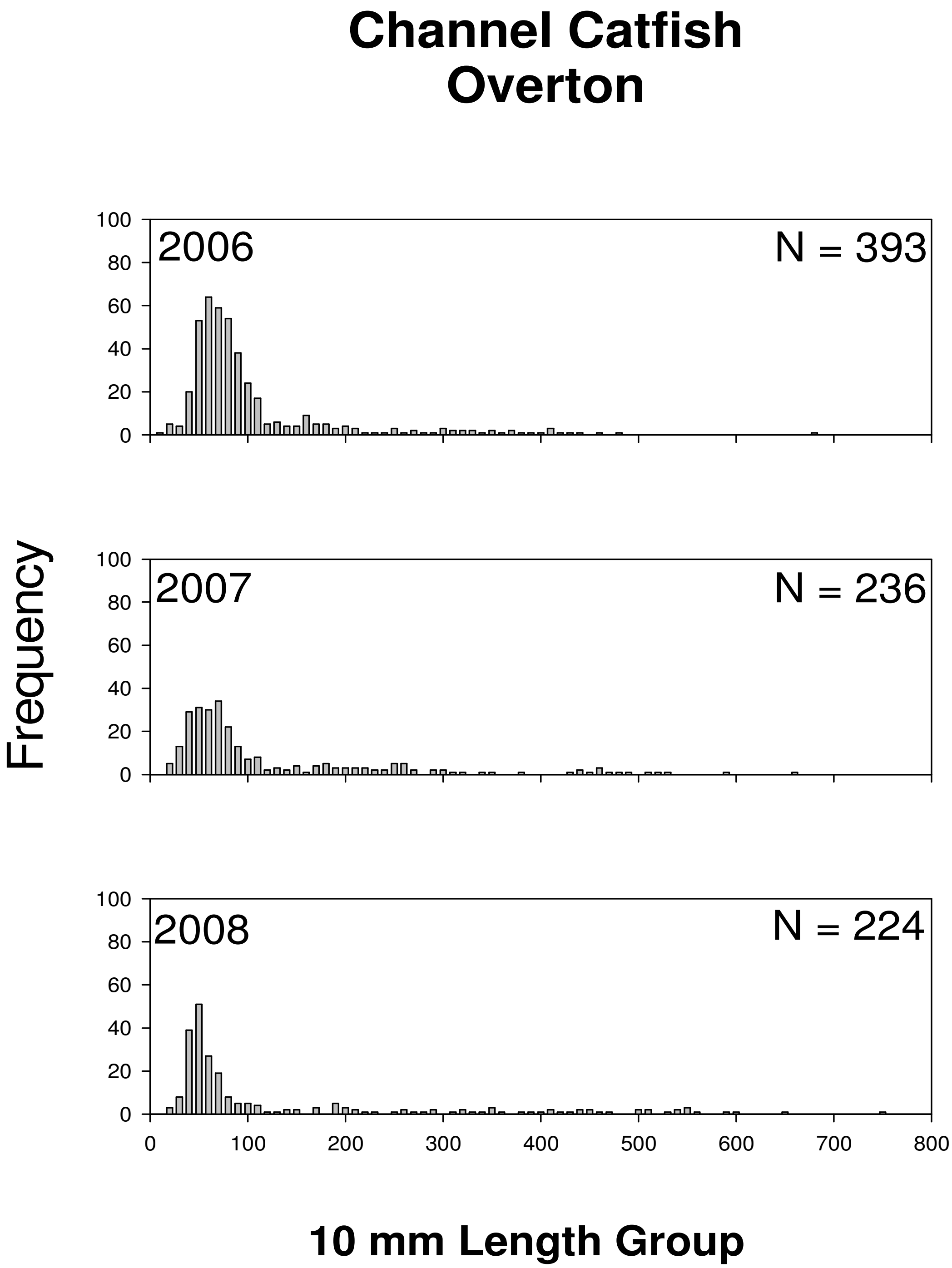


Figure III.10.4. Length frequency distribution of channel catfish in Overton chute by year. Length groups are in 10 mm intervals.

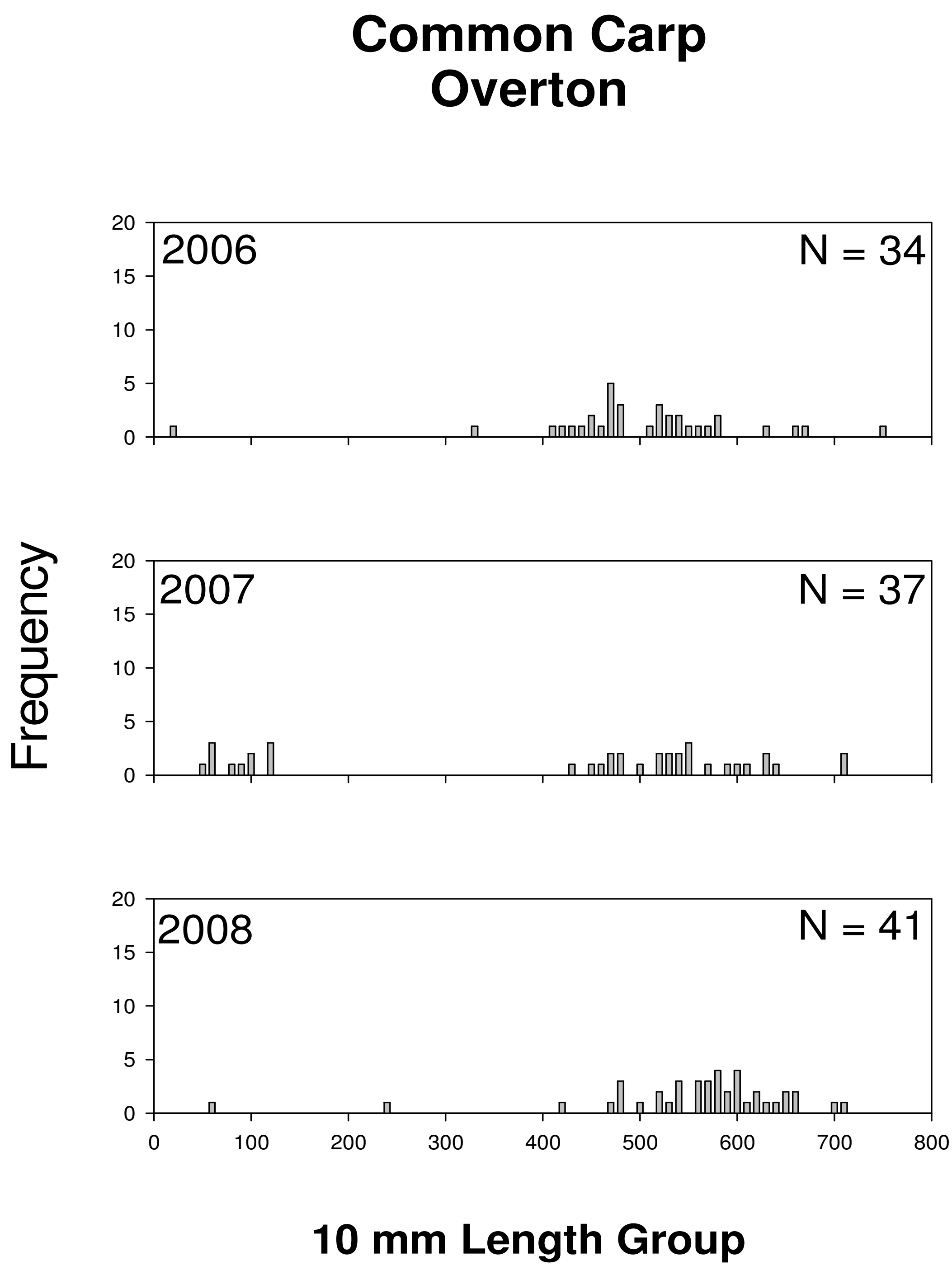


Figure III.10.5. Length frequency distribution of common carp in Overton chute by year. Length groups are in 10 mm intervals.

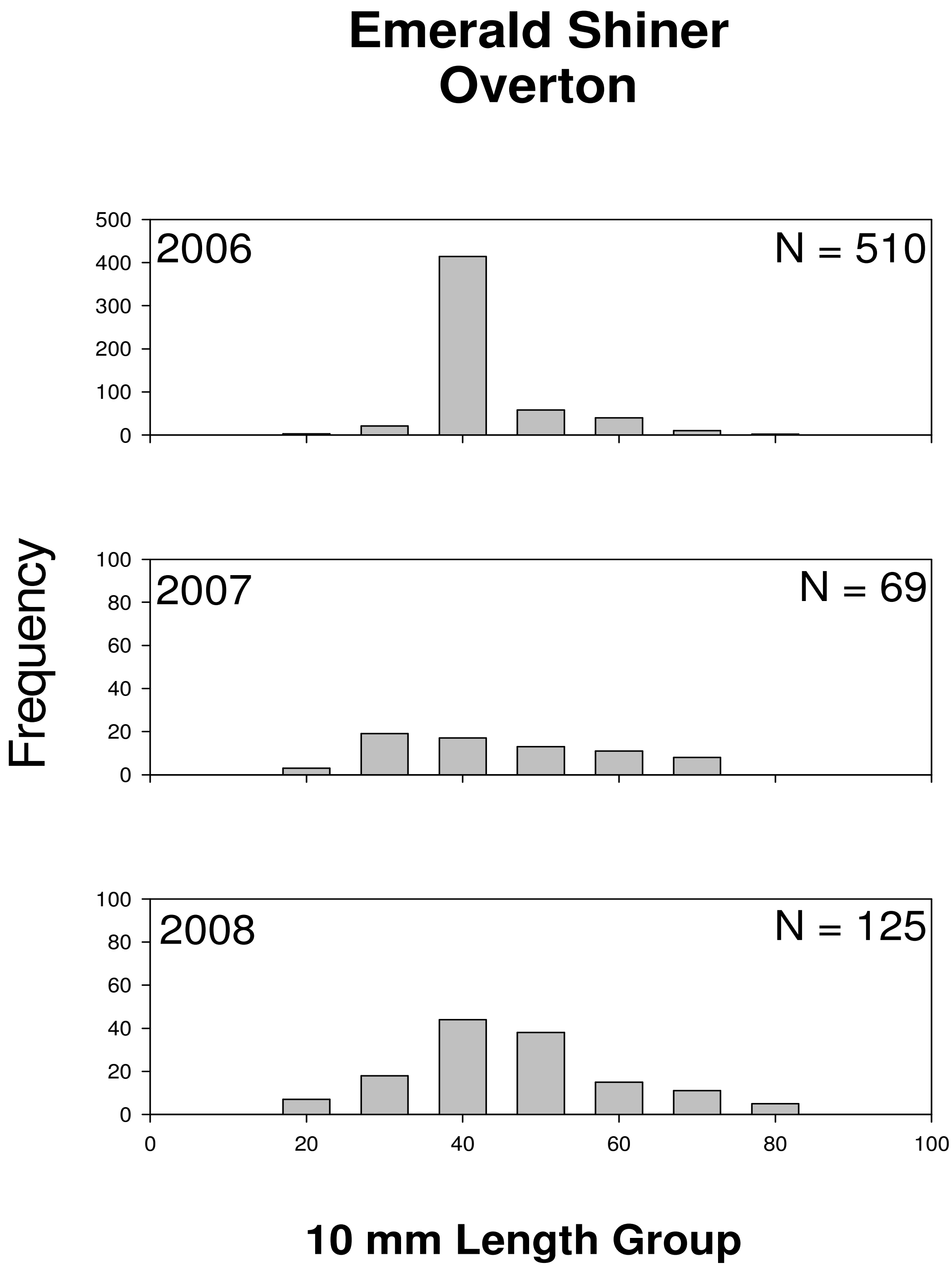


Figure III.10.6. Length frequency distribution of emerald shiner in Overton chute by year. Length groups are in 10 mm intervals.

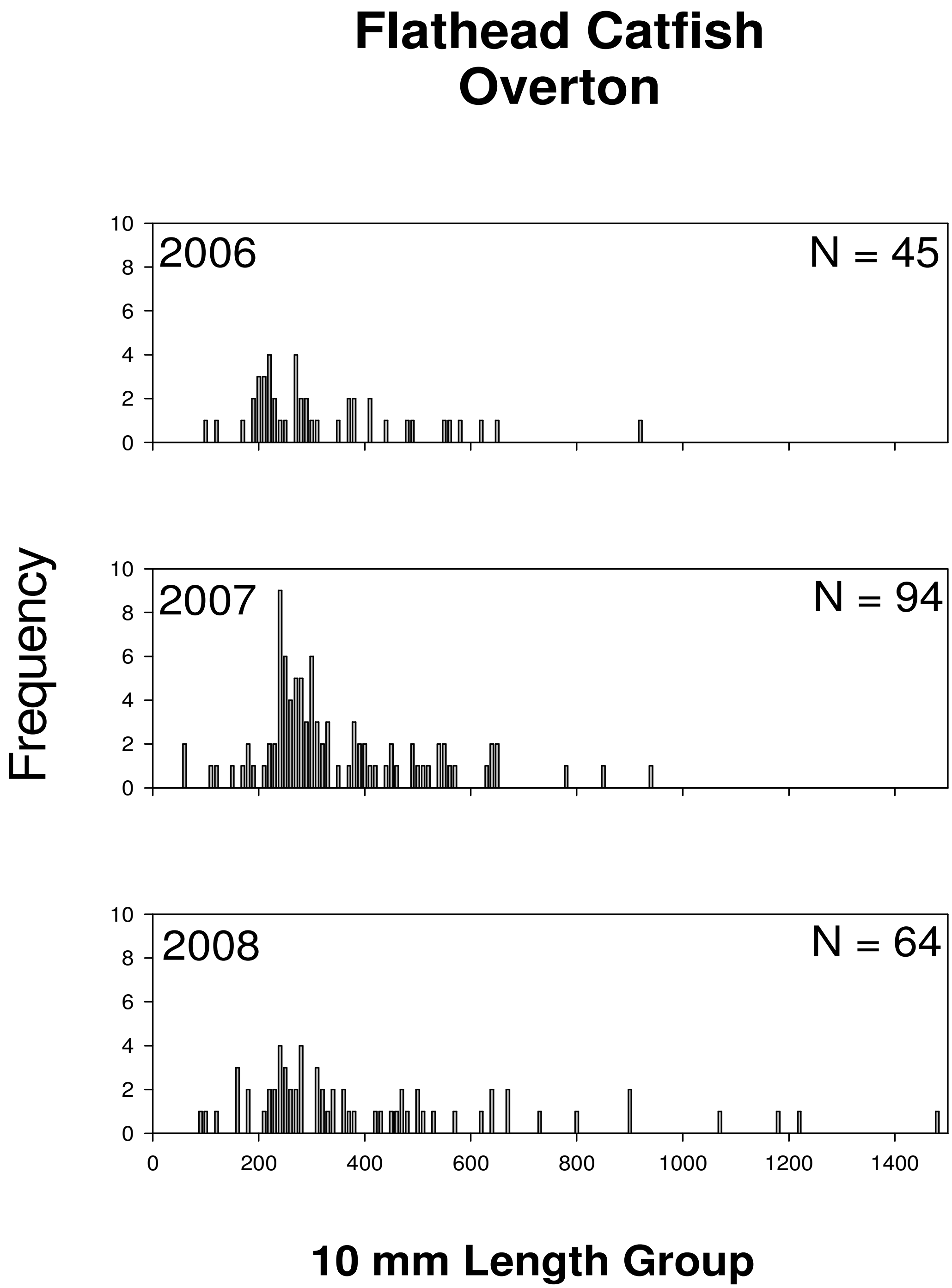


Figure III.10.7. Length frequency distribution of flathead catfish in Overton chute by year. Length groups are in 10 mm intervals.

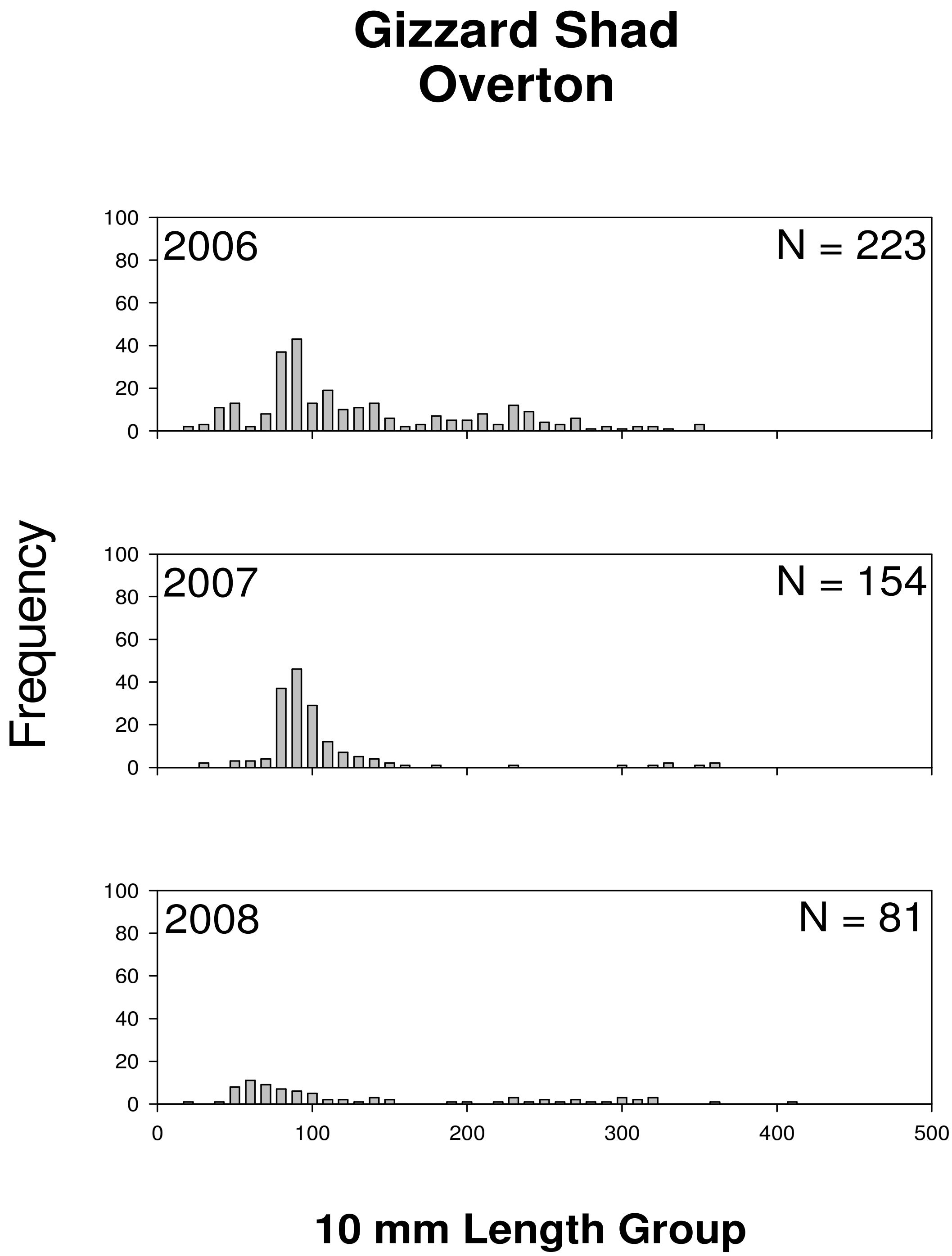


Figure III.10.8. Length frequency distribution of gizzard shad in Overton chute by year. Length groups are in 10 mm intervals.

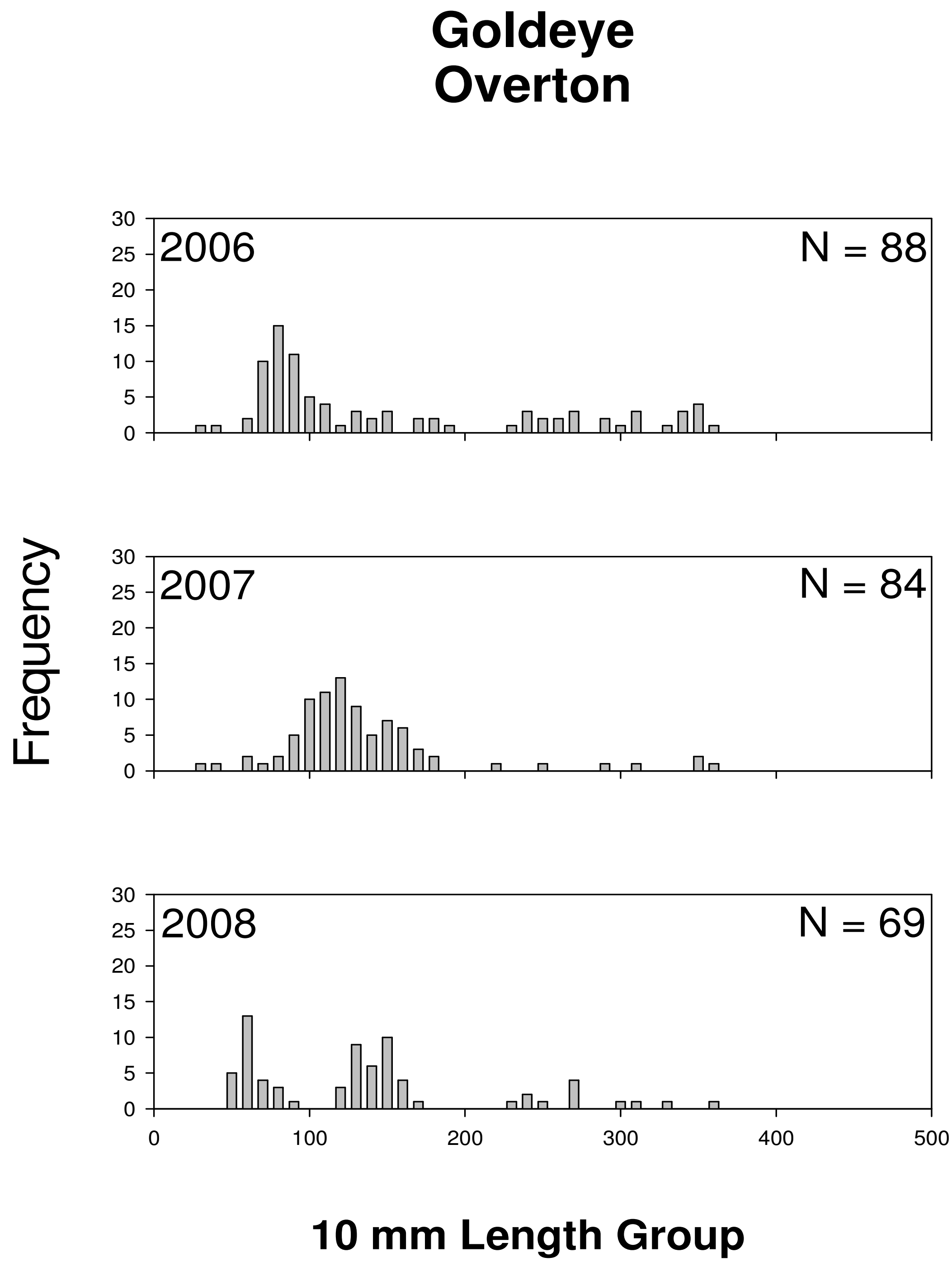


Figure III.10.9. Length frequency distribution of goldeye in Overton chute by year. Length groups are in 10 mm intervals.

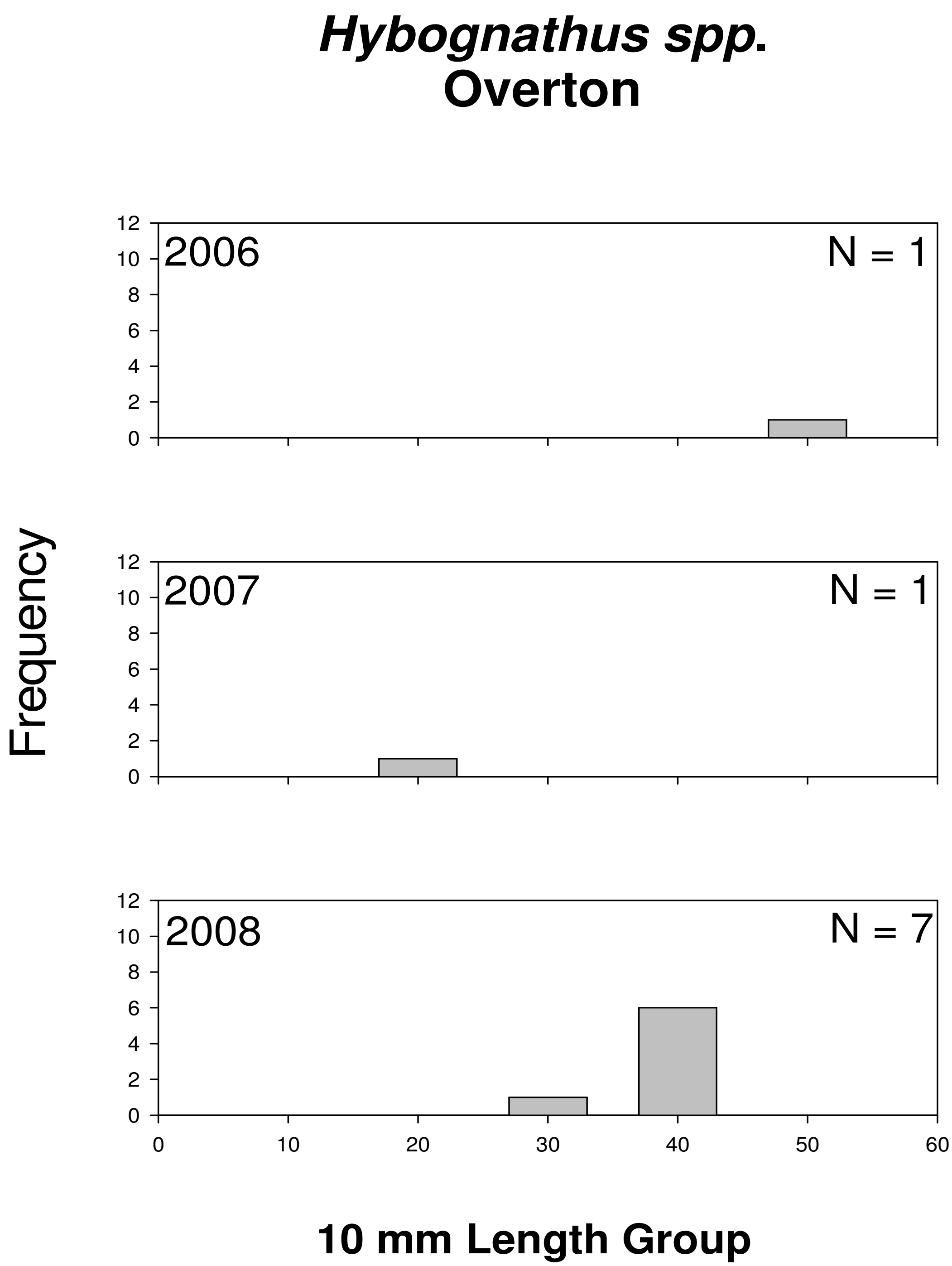


Figure III.10.10. Length frequency distribution of *Hybognathus spp*. in Overton chute by year. Length groups are in 10 mm intervals.

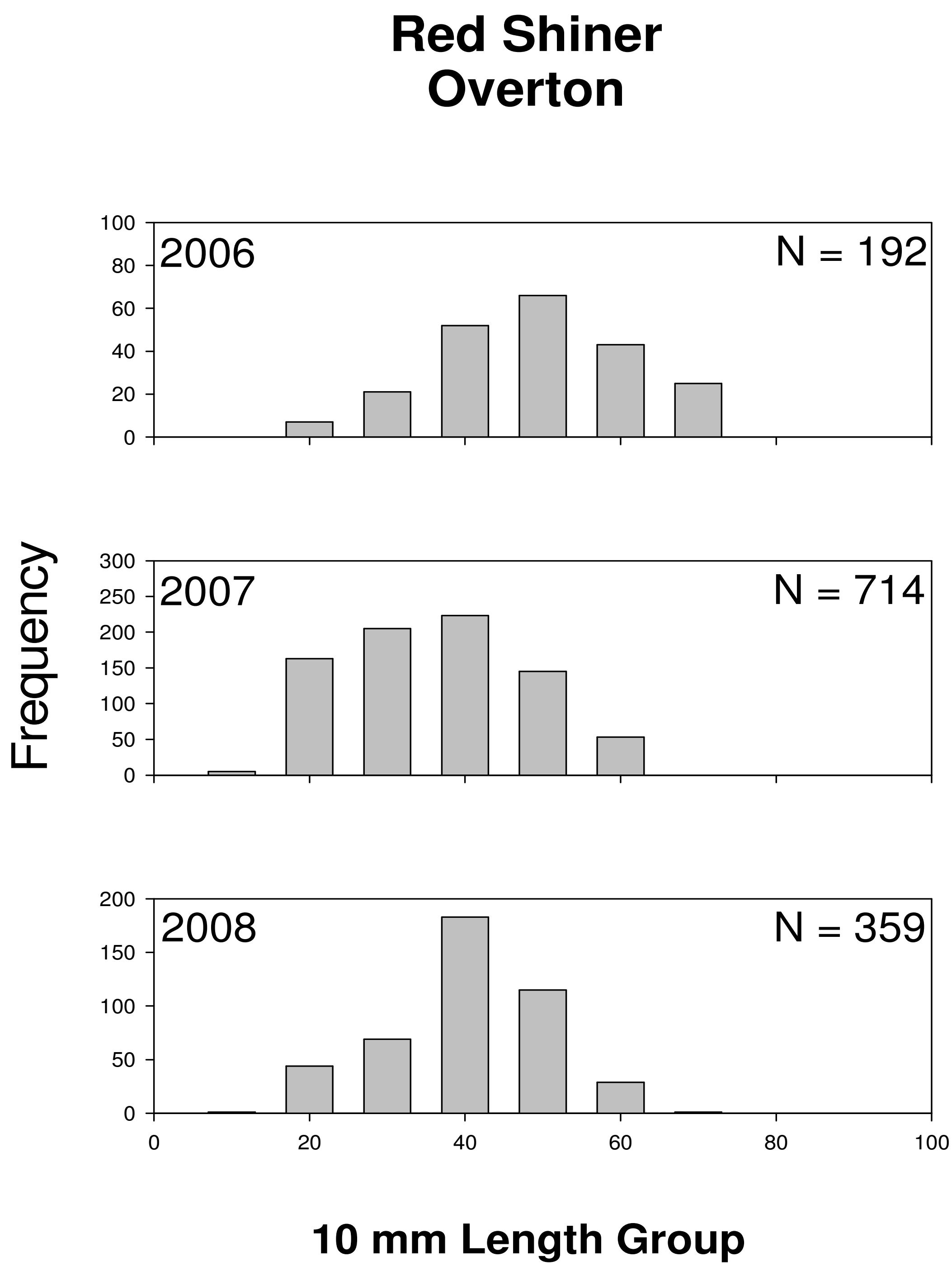


Figure III.10.11. Length frequency distribution of red shiner in Overton chute by year. Length groups are in 10 mm intervals.

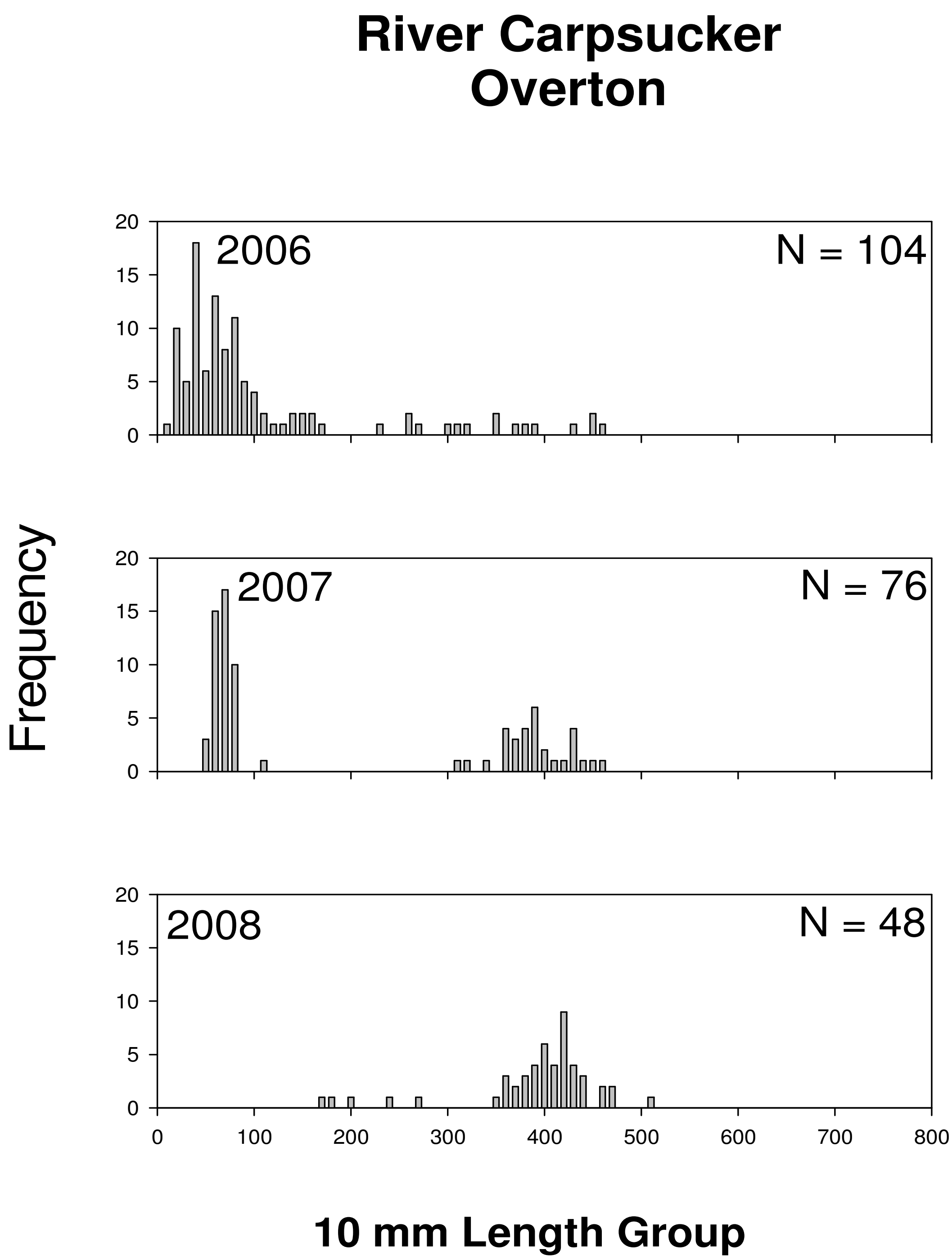


Figure III.10.12. Length frequency distribution of river carpsucker in Overton chute by year. Length groups are in 10 mm intervals.

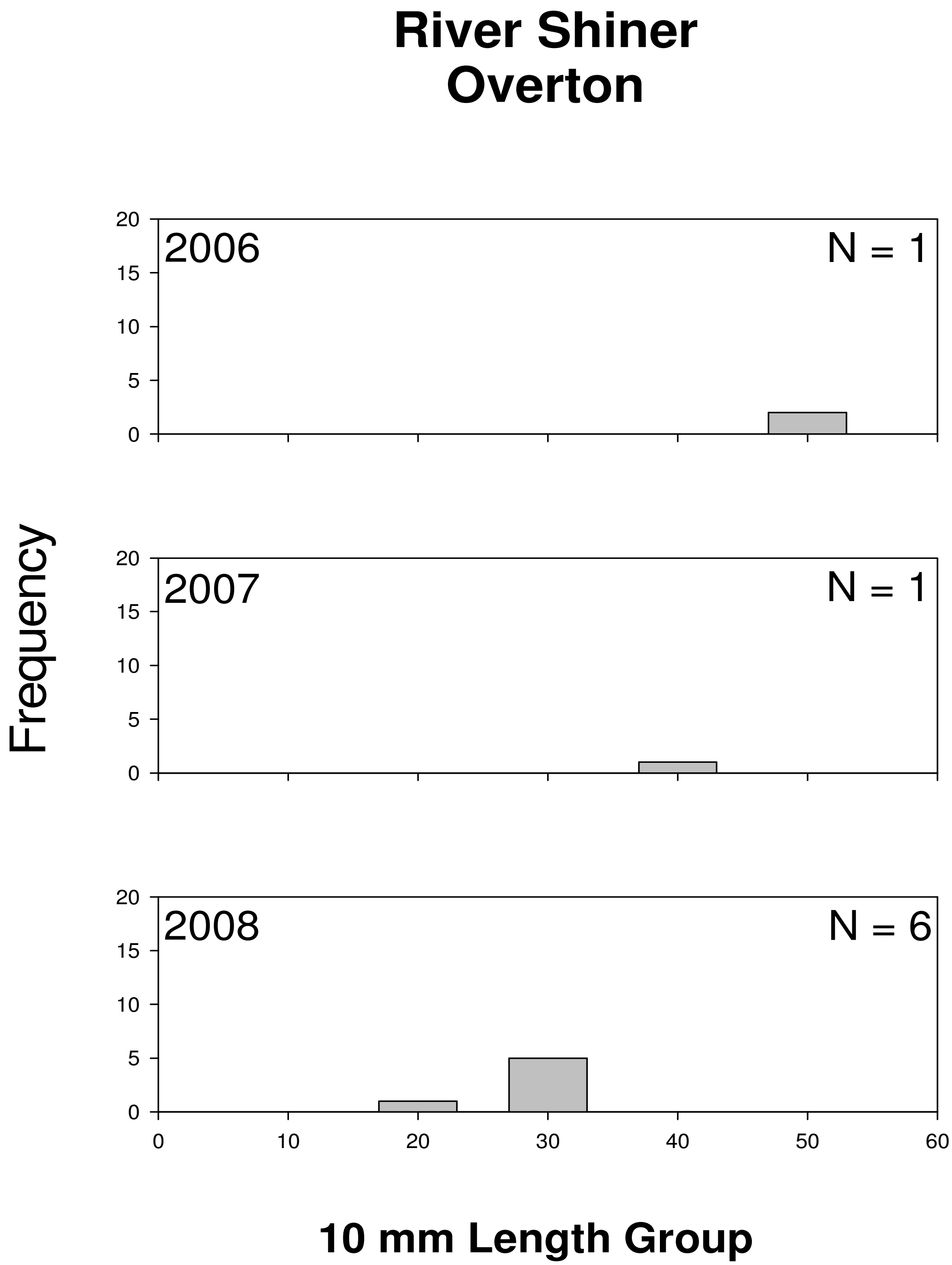


Figure III.10.13. Length frequency distribution of river shiner in Overton chute by year. Length groups are in 10 mm intervals.

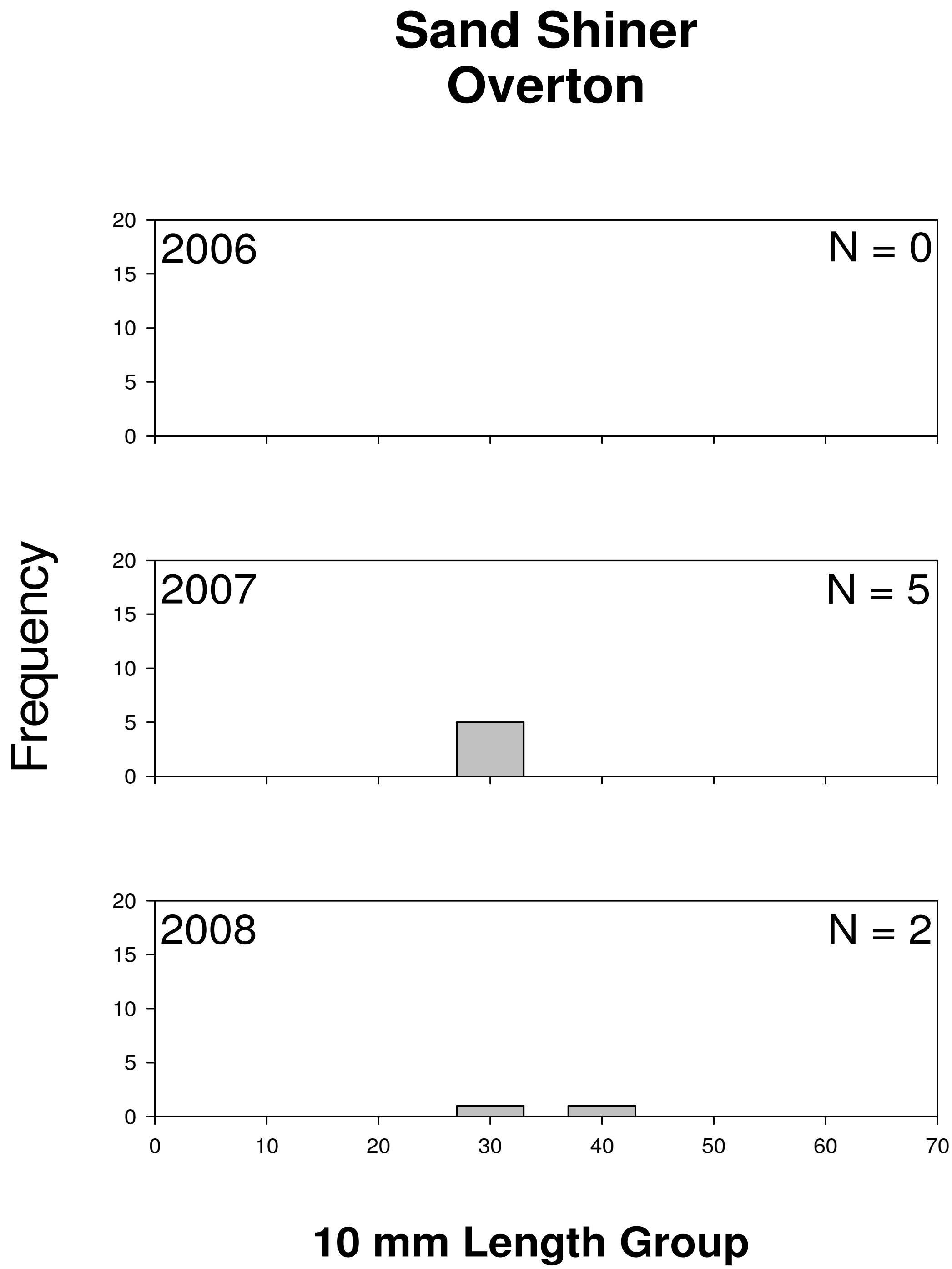


Figure III.10.14. Length frequency distribution of sand shiner in Overton chute by year. Length groups are in 10mm intervals.

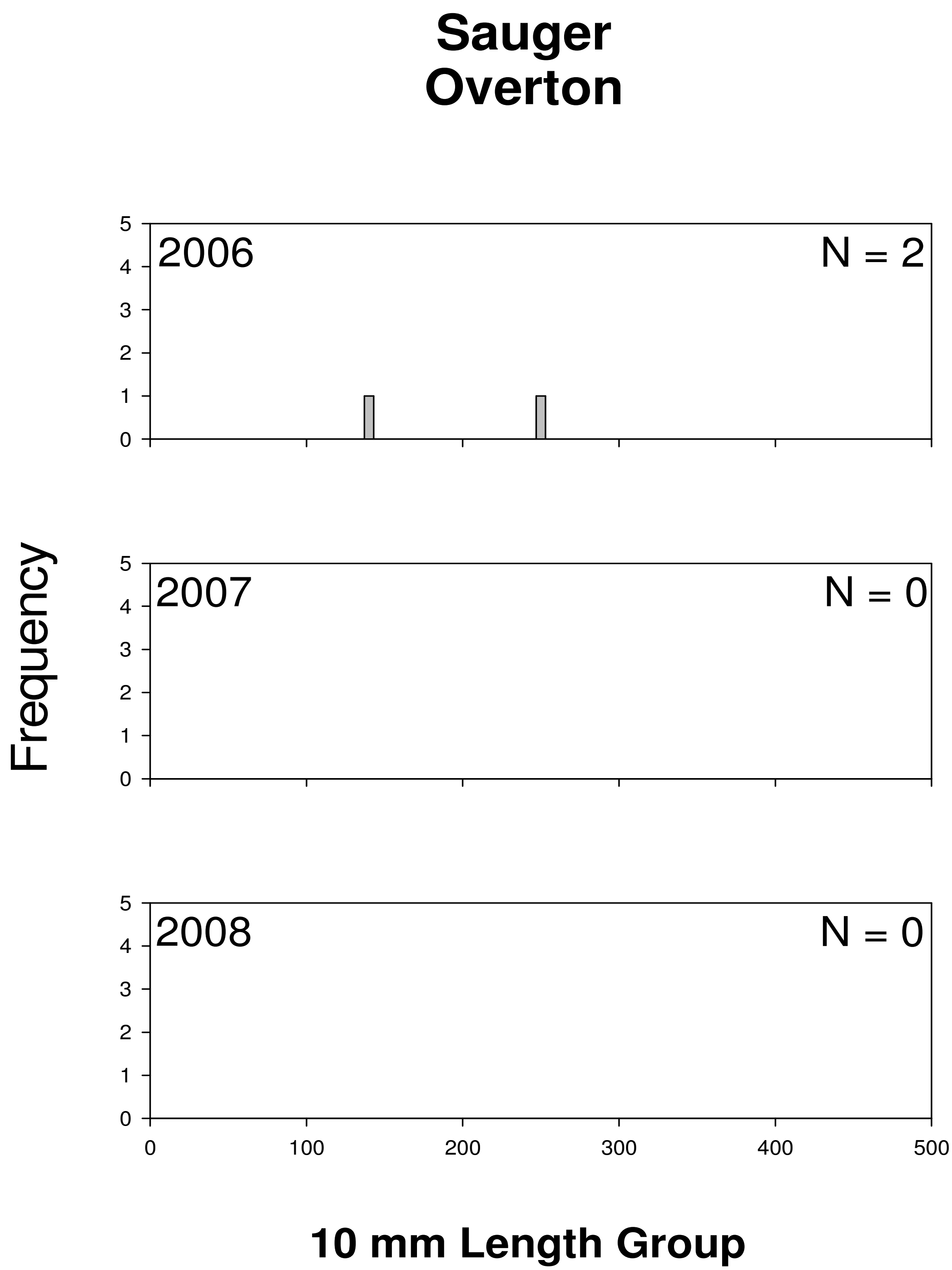


Figure III.10.15. Length frequency distribution of sauger in Overton chute by year. Length groups are in 10 mm intervals.

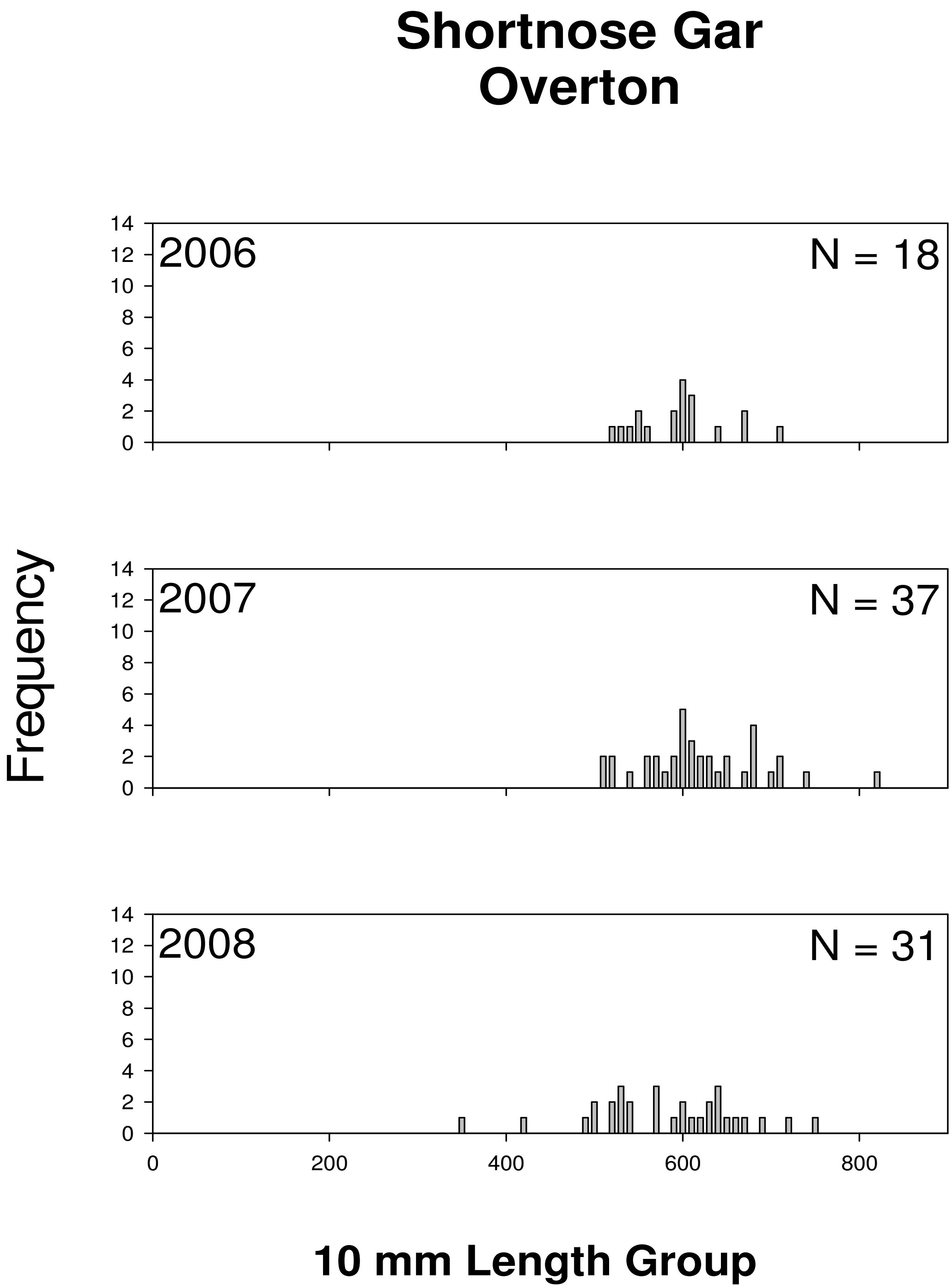


Figure III.10.16. Length frequency distribution of shortnose gar in Overton chute by year. Length groups are in 10mm intervals.

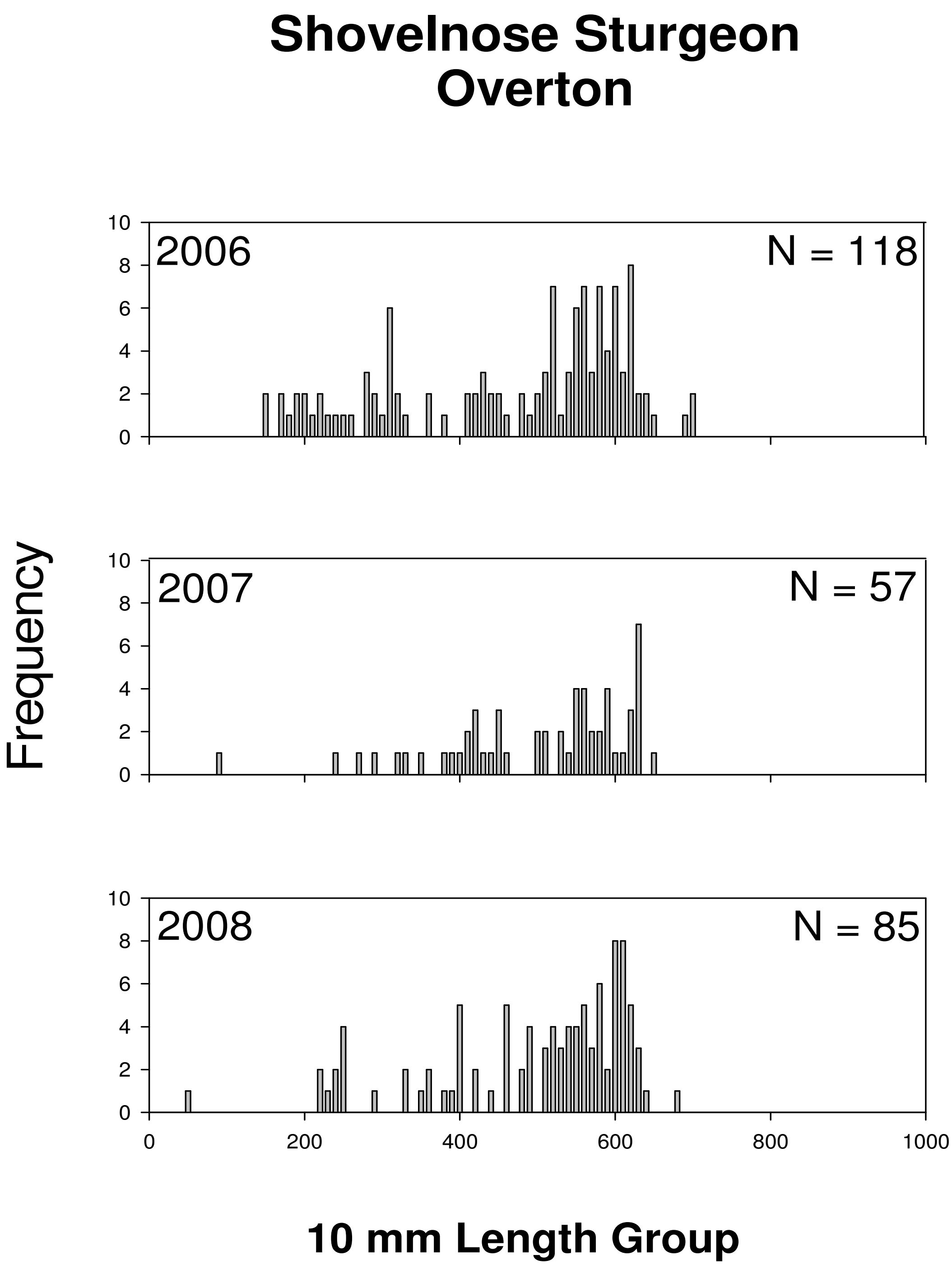


Figure III.10.17. Length frequency distribution of shovelnose sturgeon in Overton chute by year. Length groups are in 10 mm intervals.

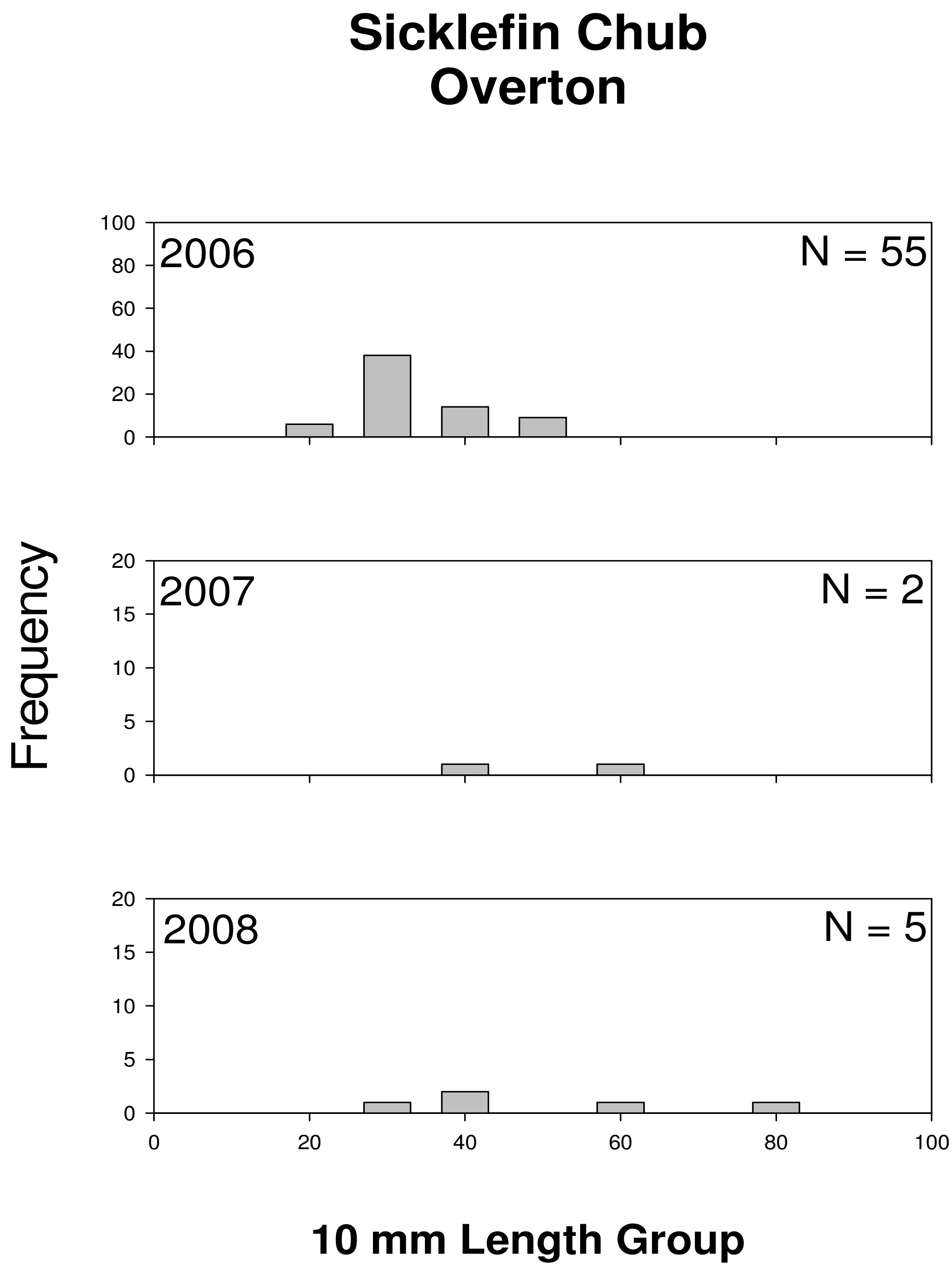


Figure III.10.18. Length frequency distribution of sicklefin chub in Overton chute by year. Length groups are in 10 mm intervals.

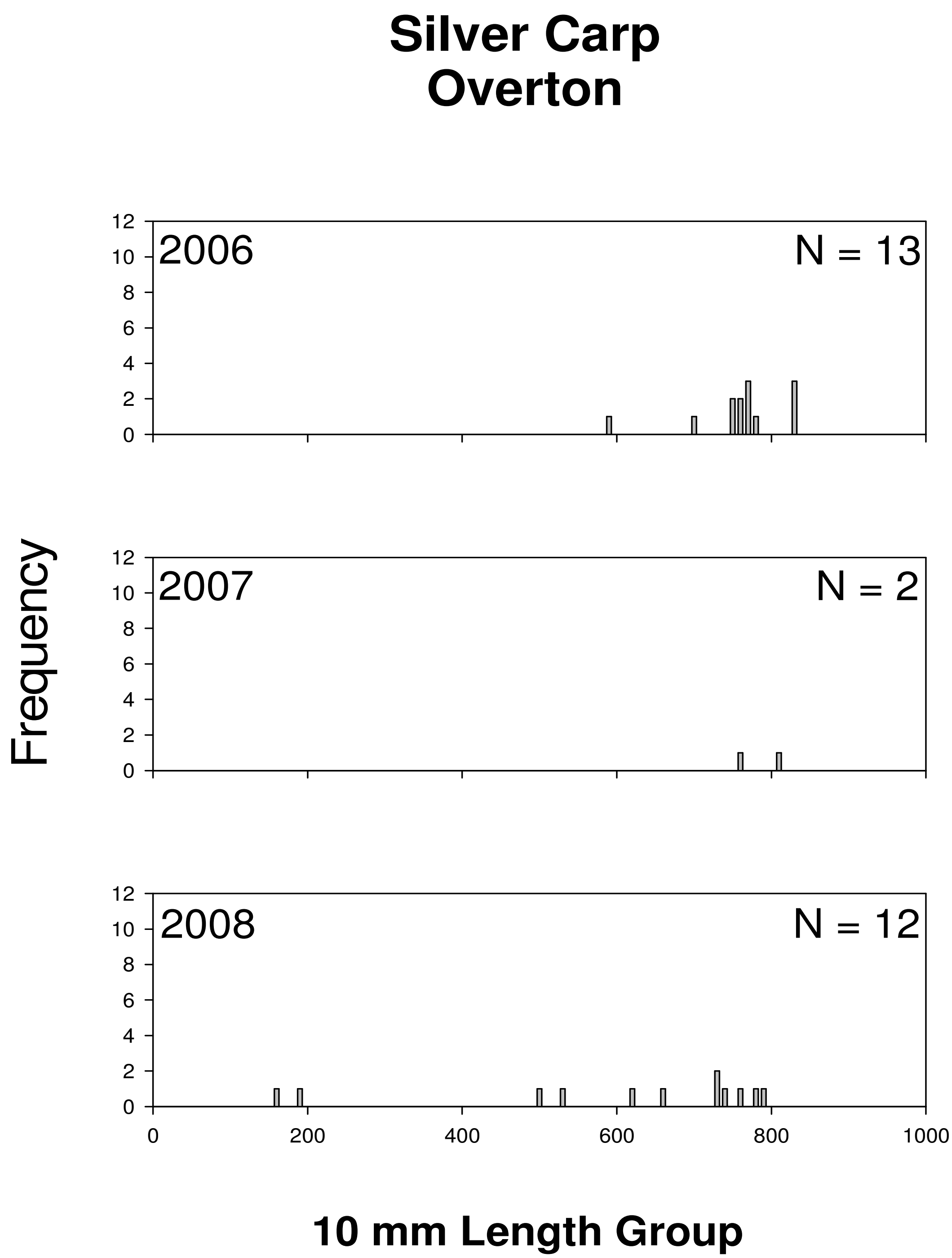


Figure III.10.19. Length frequency distribution of silver carp in Overton chute by year. Length groups are in 10 mm intervals.

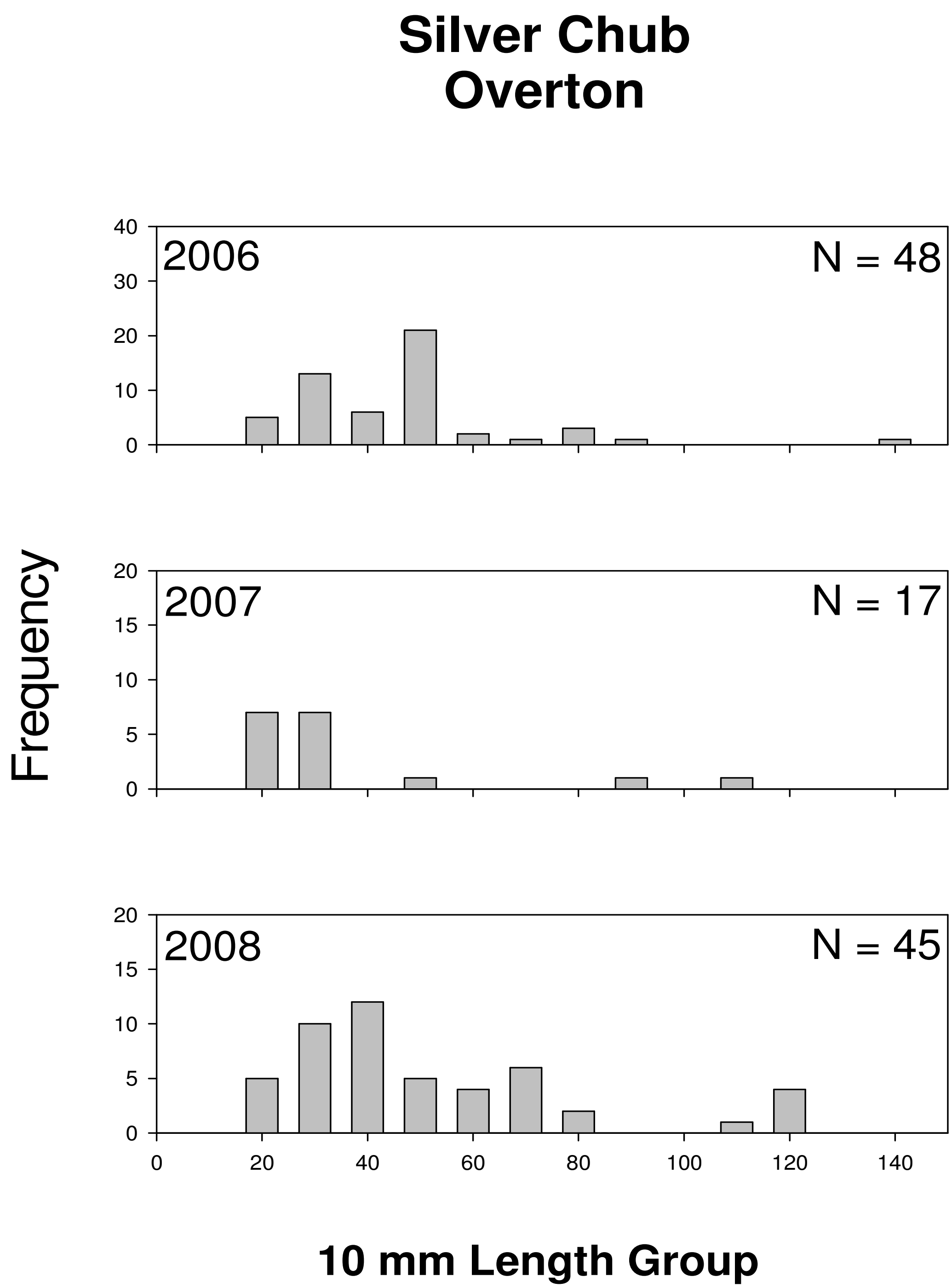


Figure III.10.20. Length frequency distribution of silver chub in Overton chute by year. Length groups are in 10 mm intervals.

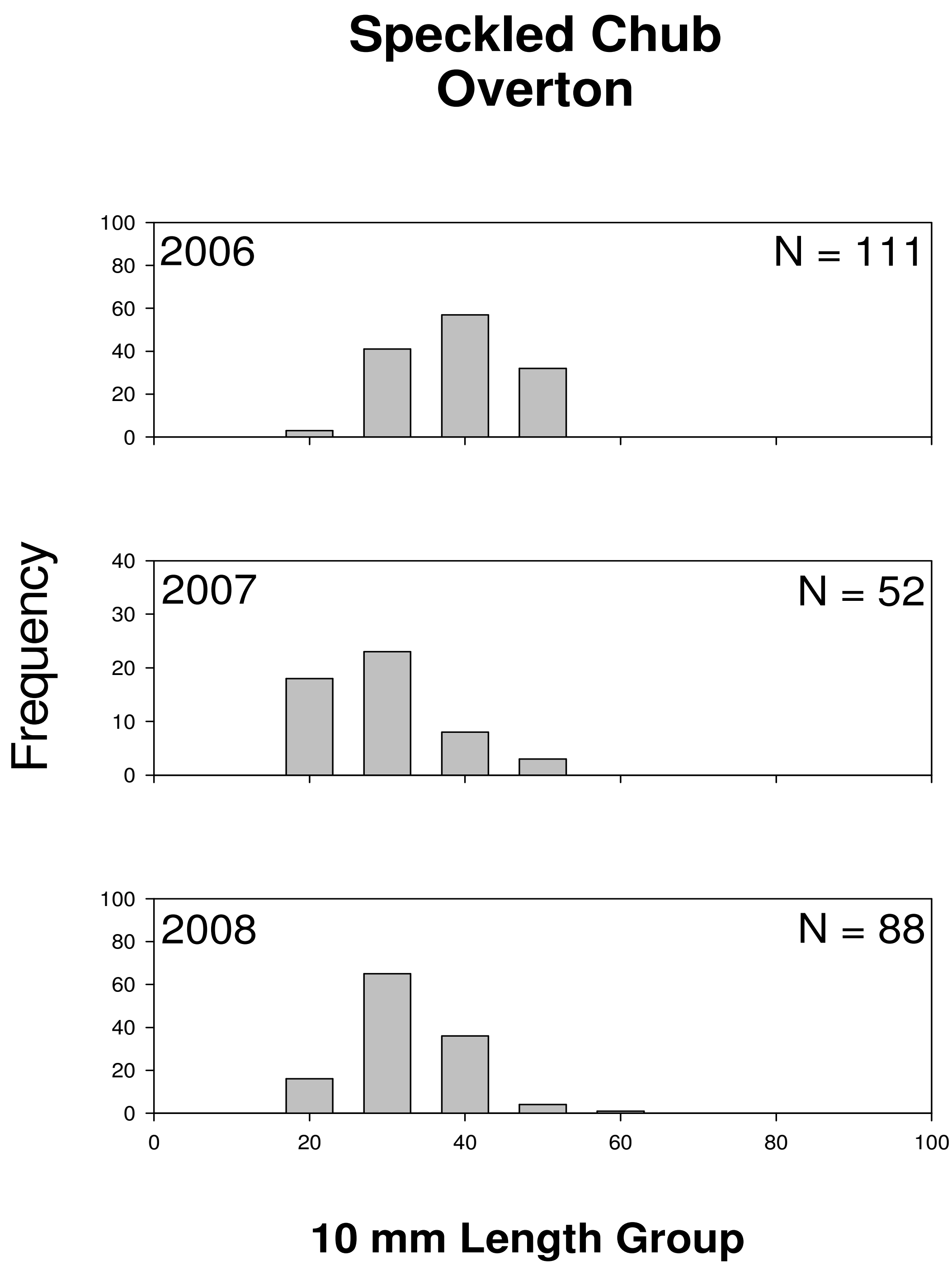


Figure III.10.21. Length frequency distribution of speckled chub in Overton chute by year. Length groups are in 10 mm intervals.

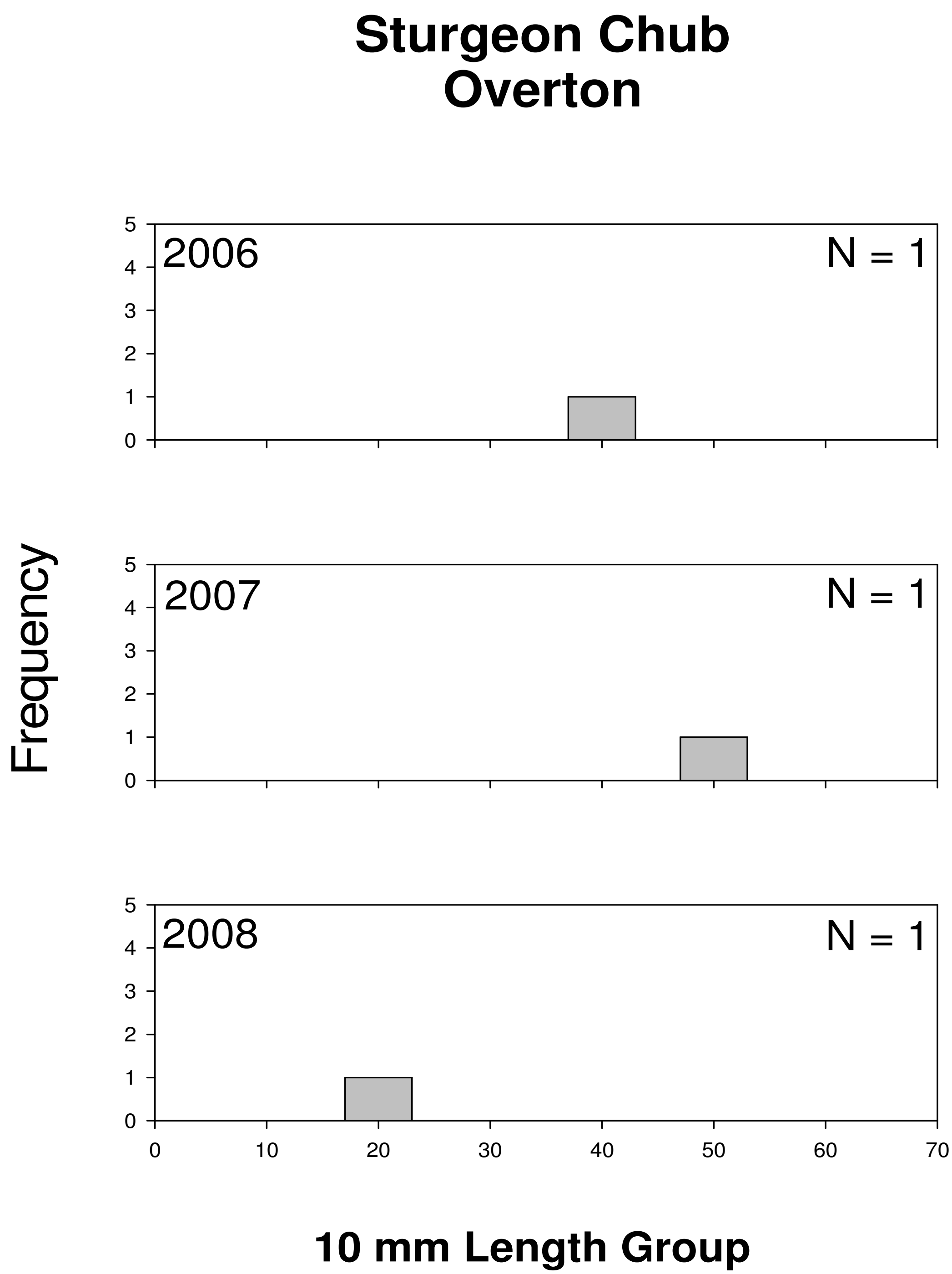


Figure III.10.22. Length frequency distribution of sturgeon chub in Overton chute by year. Length groups are in 10 mm intervals.

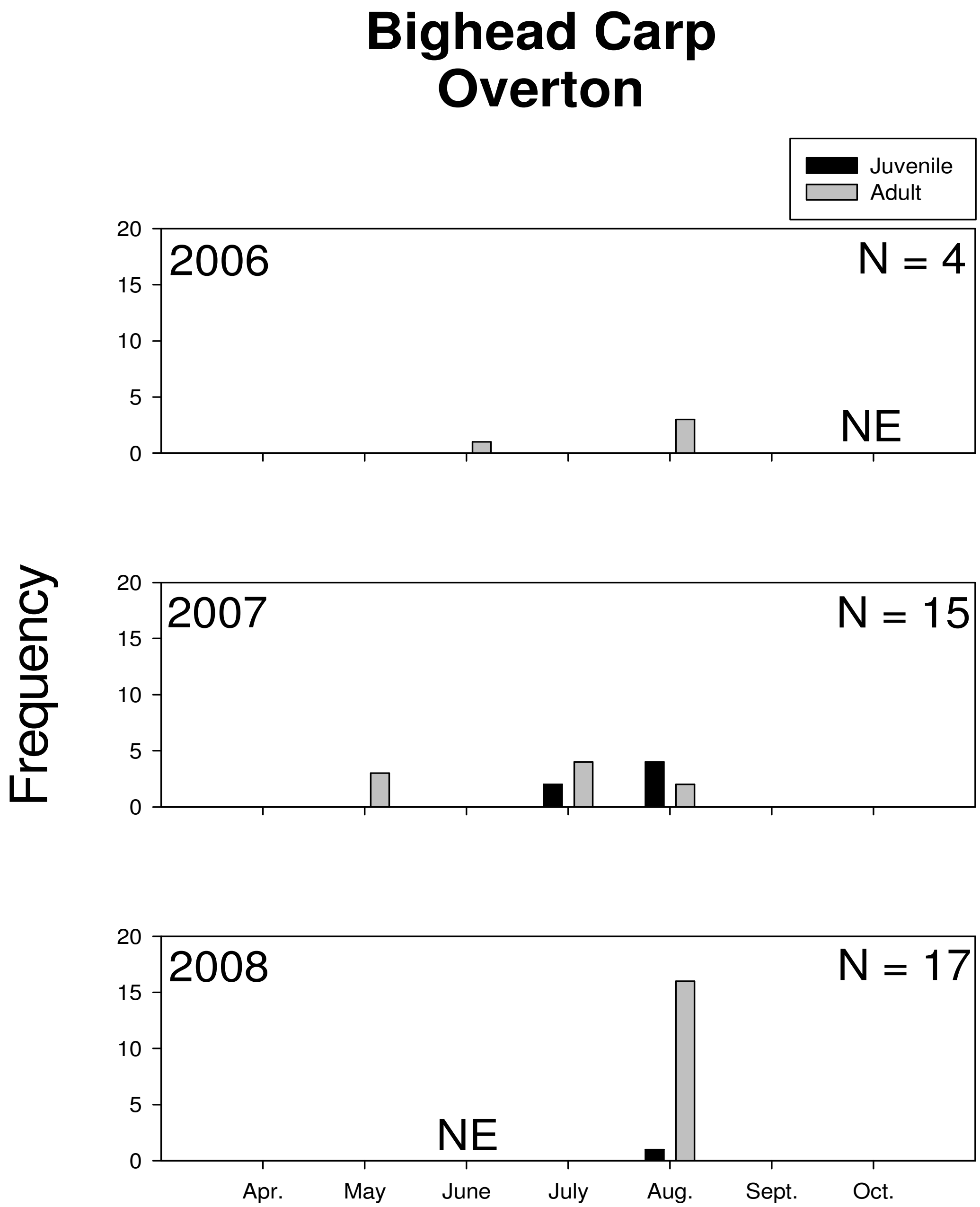


Figure III.10.23. Life stage frequency distribution of bighead carp in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

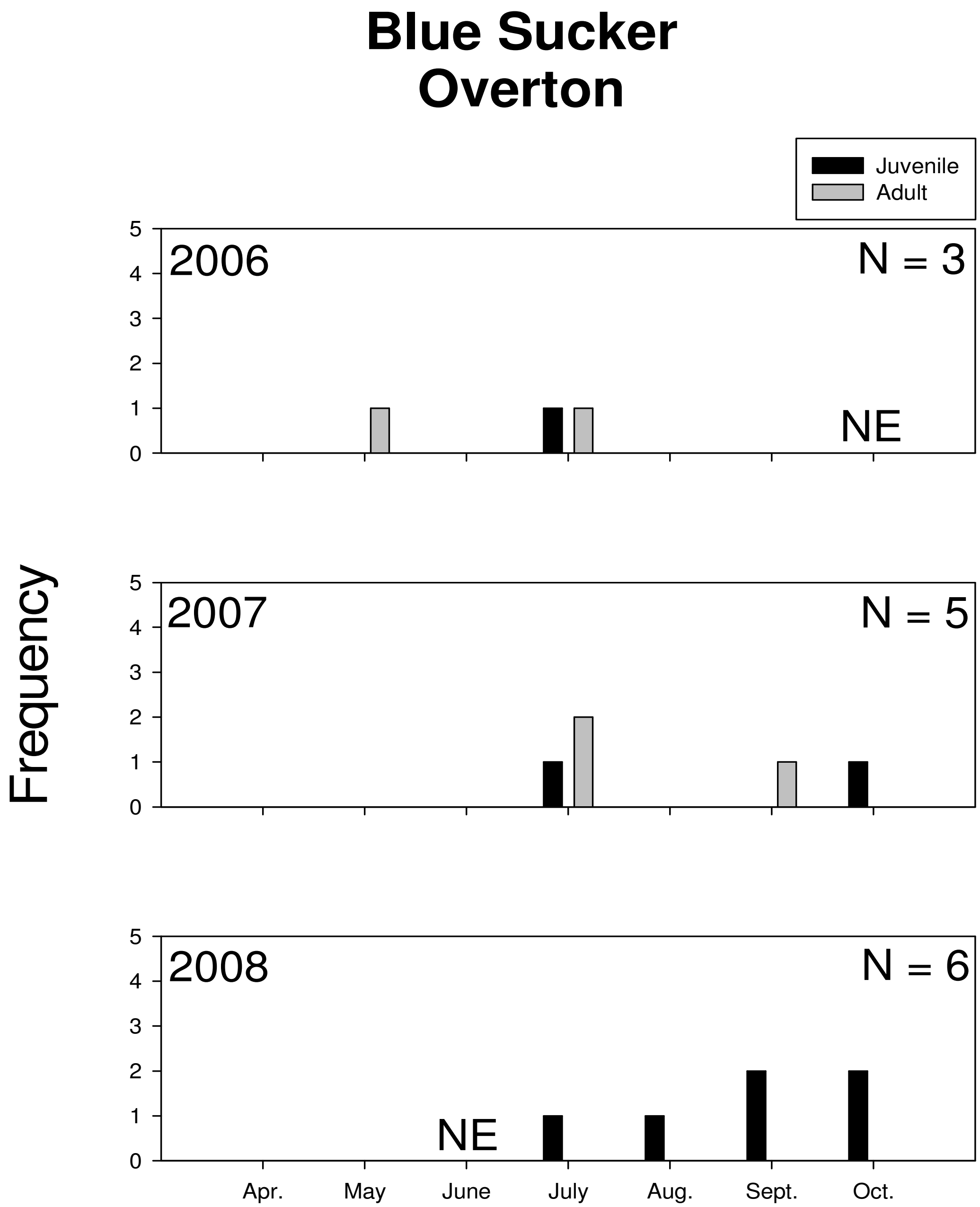


Figure III.10.24. Life stage frequency distribution of blue sucker in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

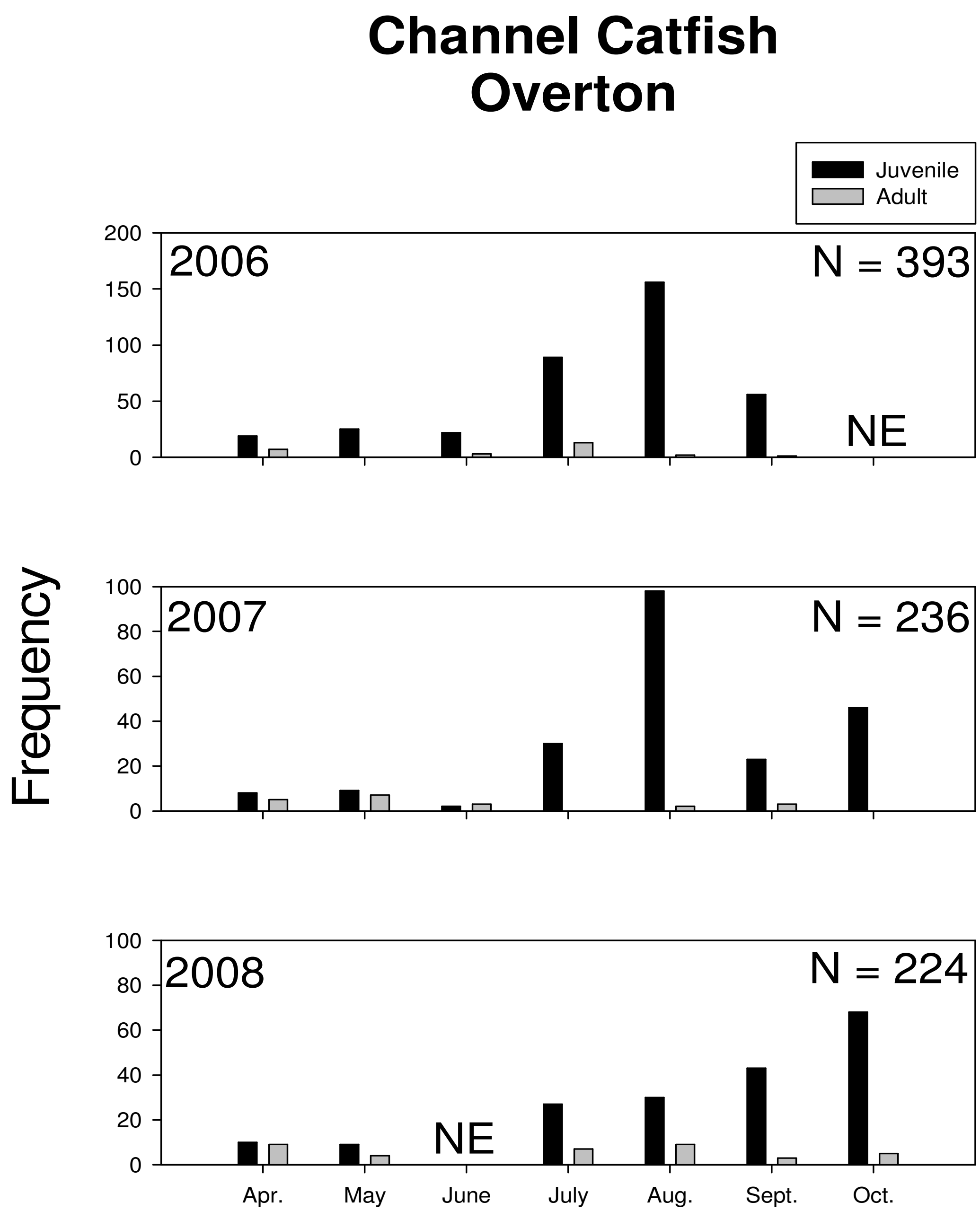


Figure III.10.25. Life stage frequency distribution of channel catfish in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

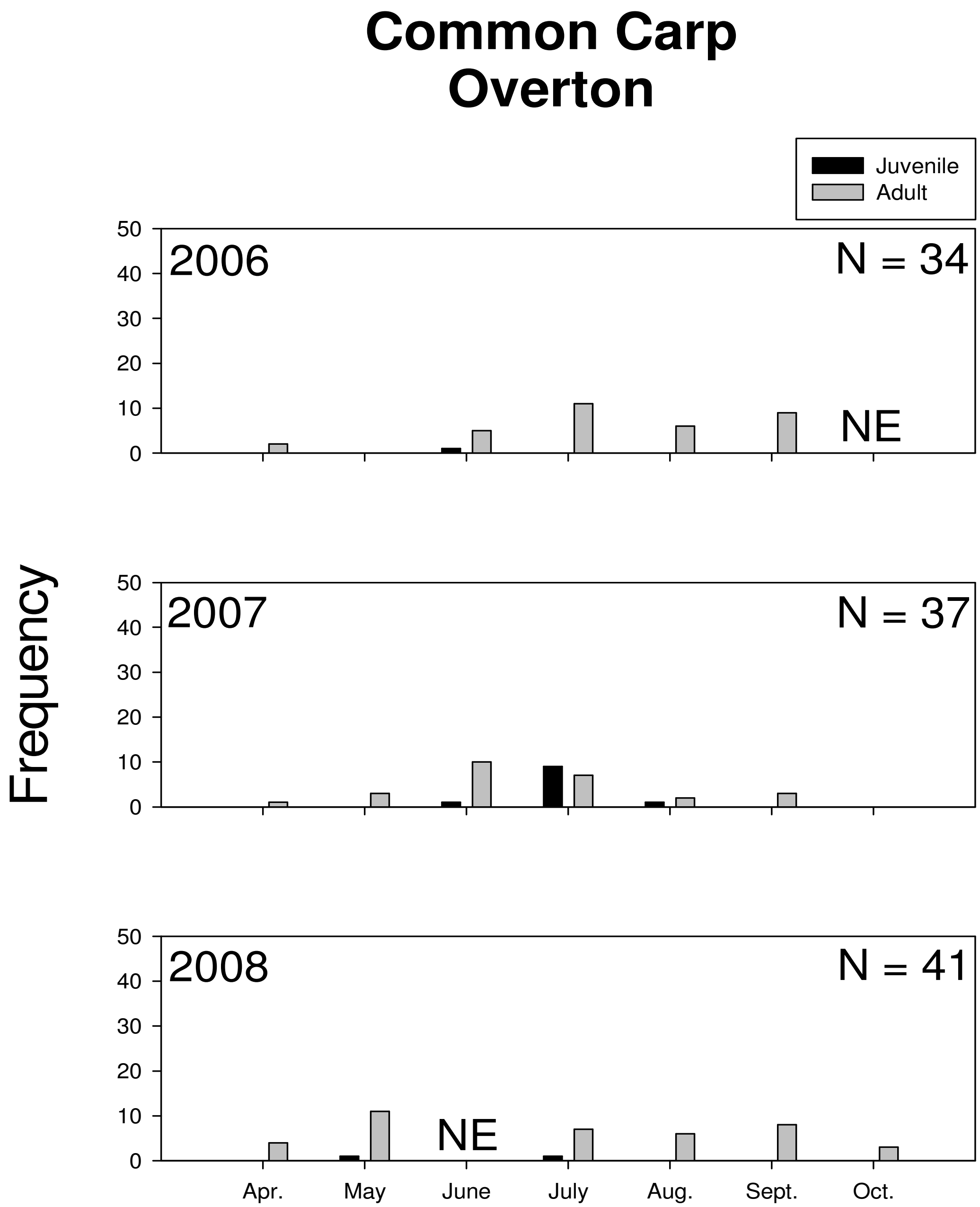


Figure III.10.26. Life stage frequency distribution of common carp in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

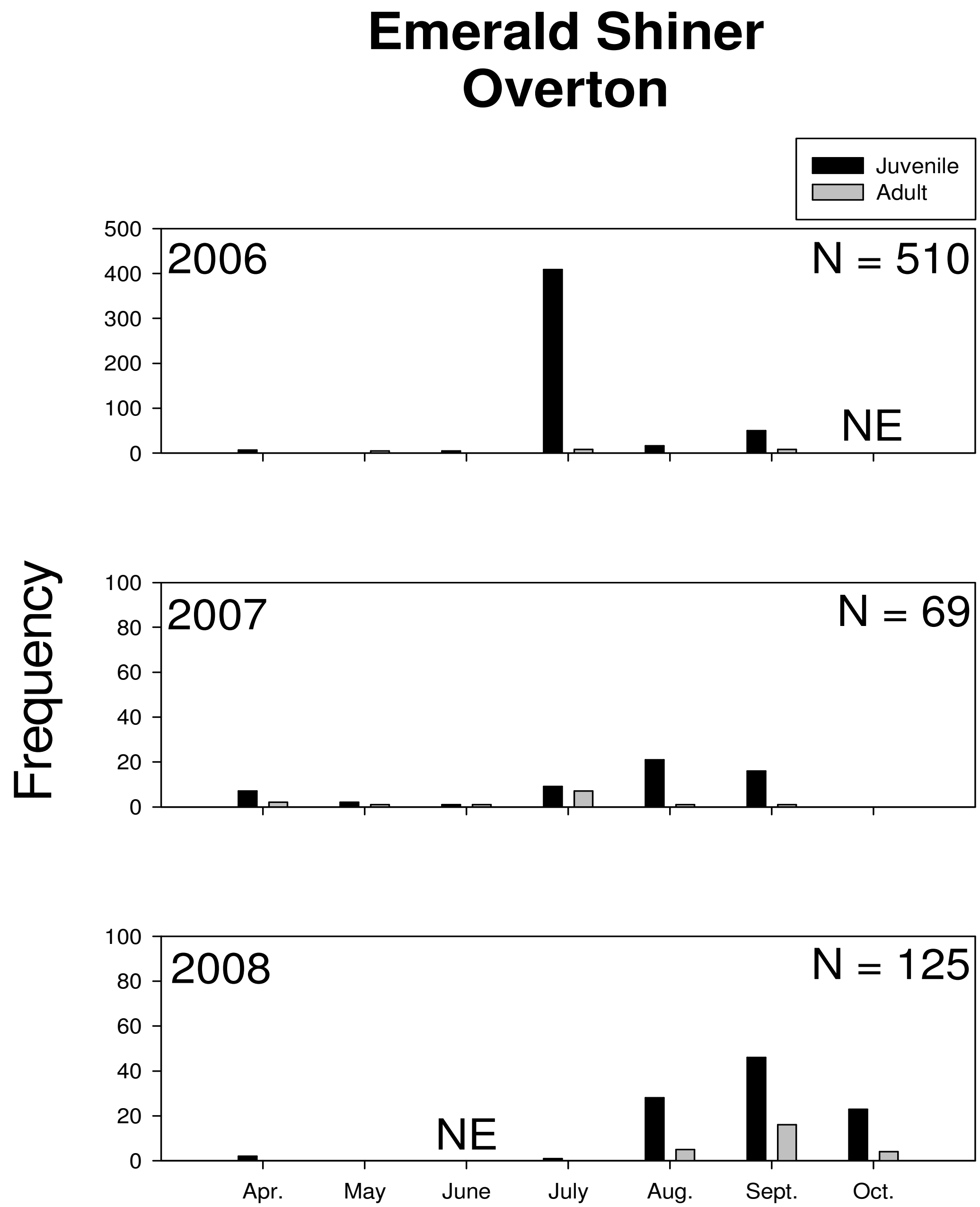


Figure III.10.27. Life stage frequency distribution of emerald shiner in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

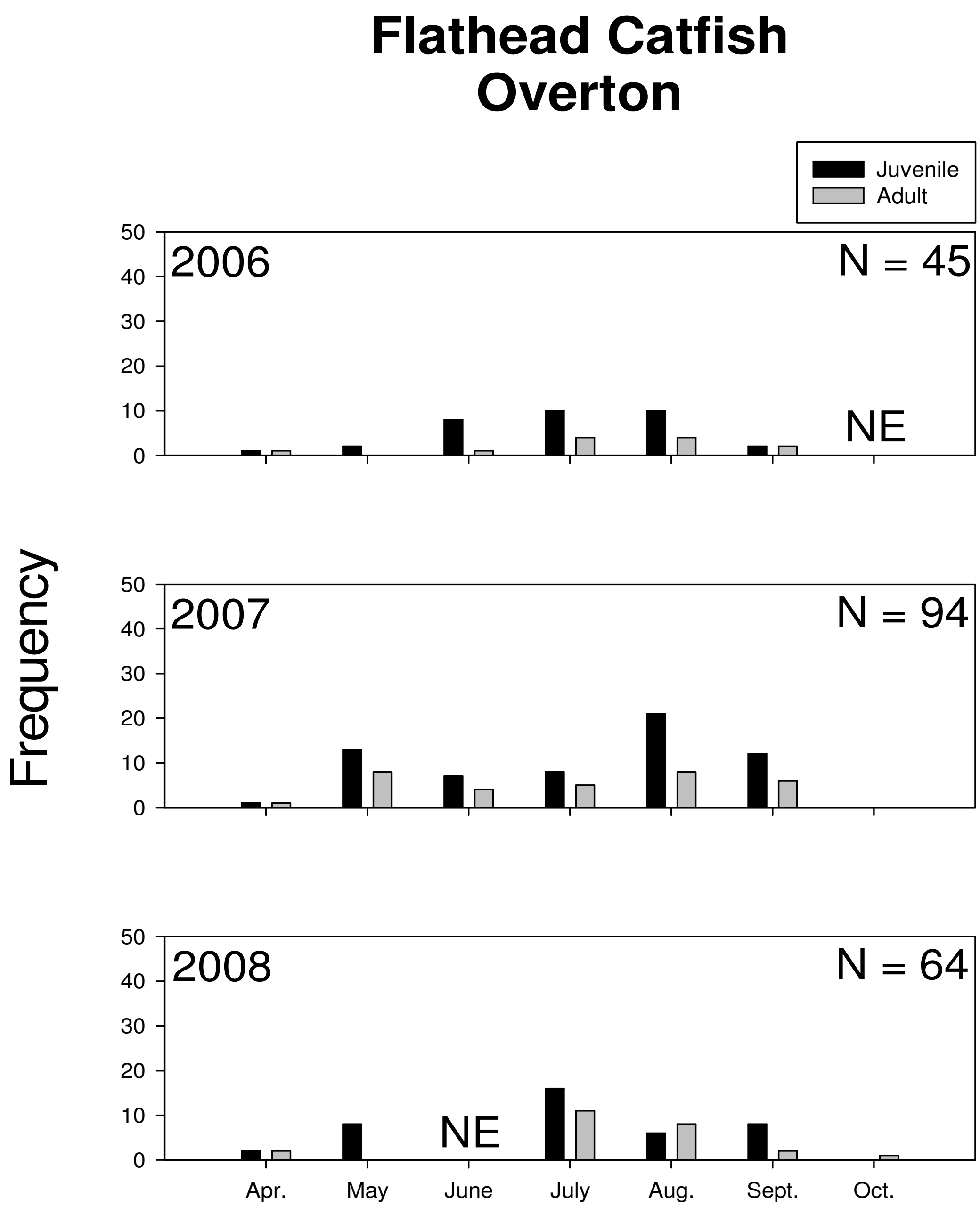


Figure III.10.28. Life stage frequency distribution of flathead catfish in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

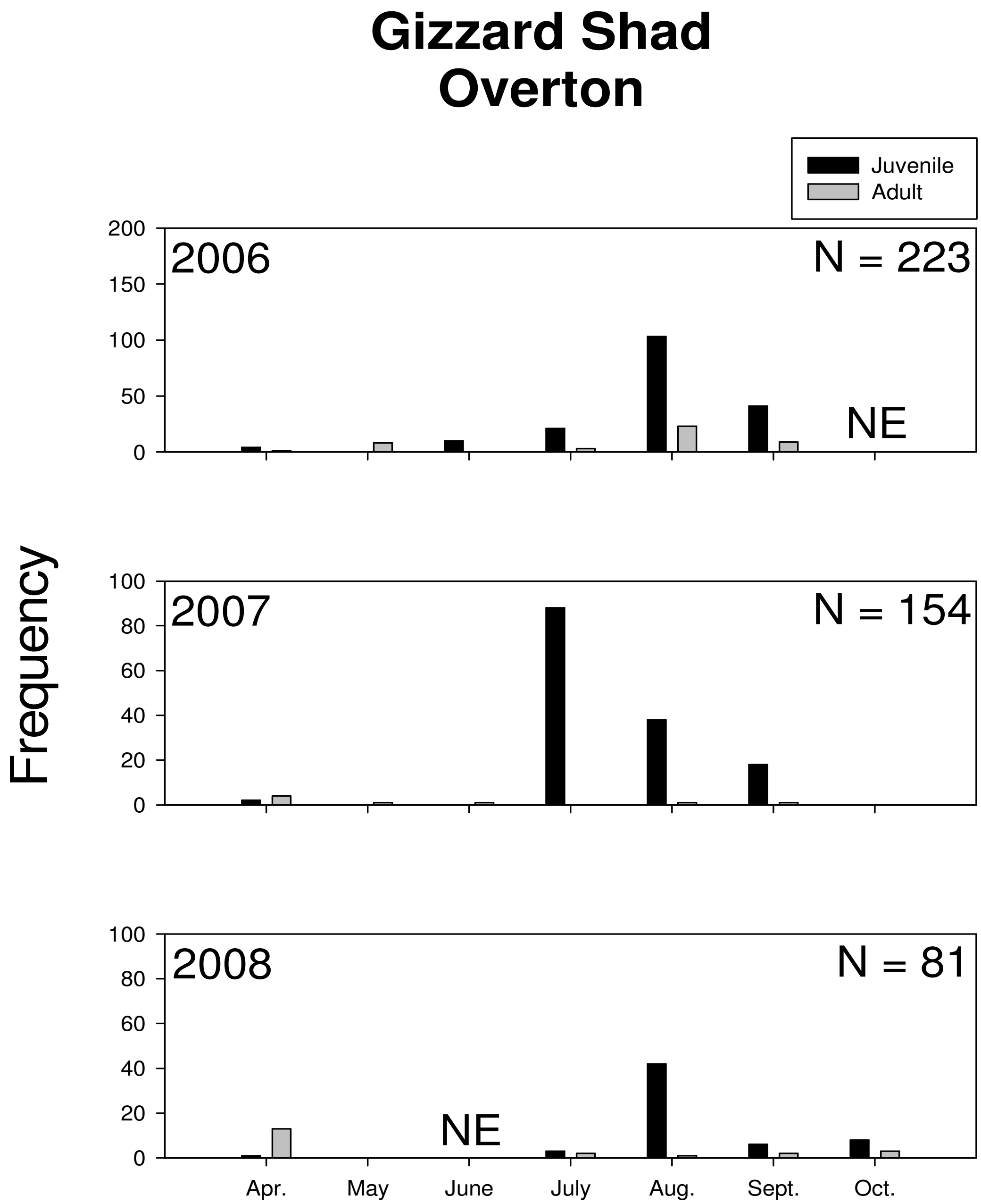


Figure III.10.29. Life stage frequency distribution of gizzard shad in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

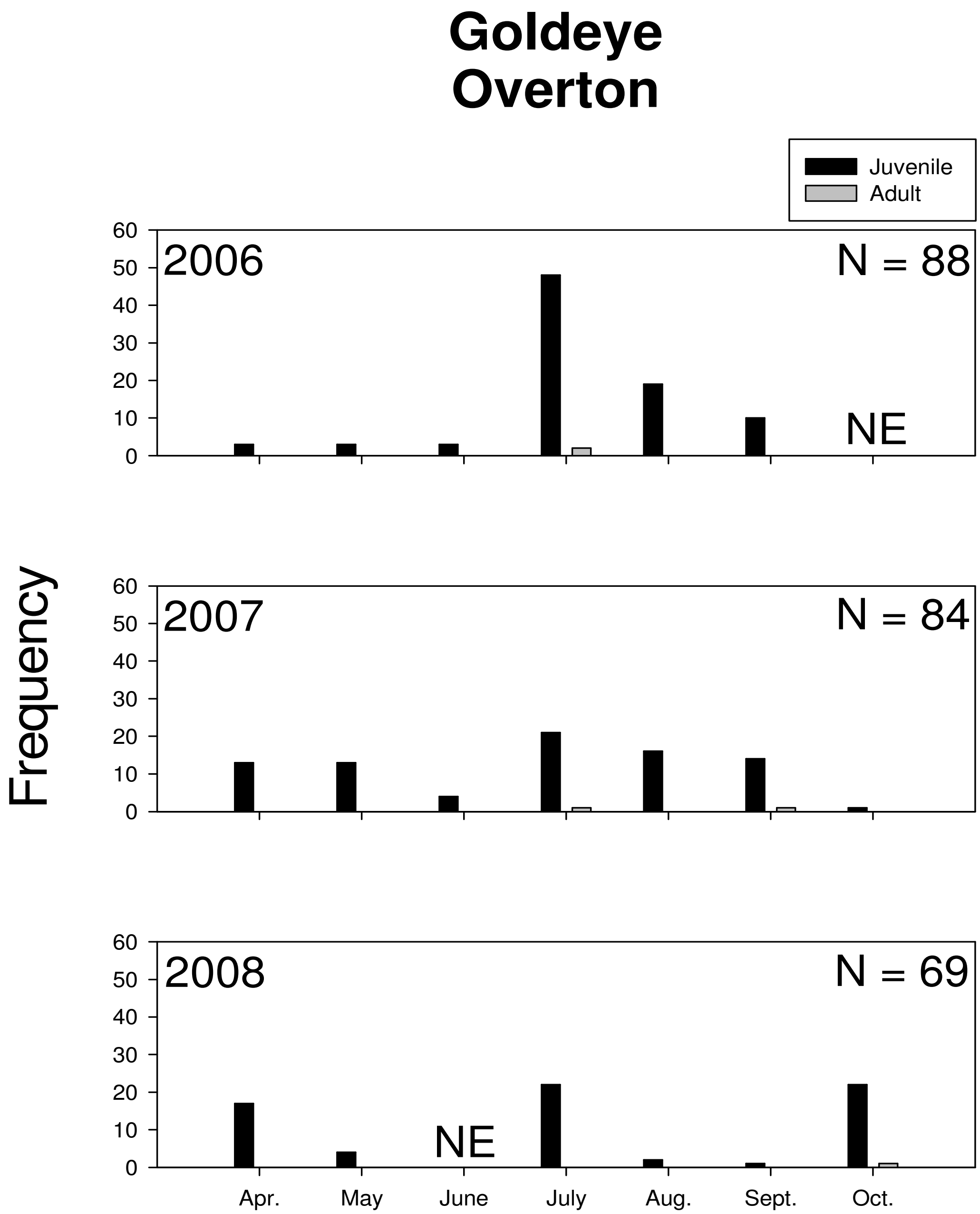


Figure III.10.30. Life stage frequency distribution of goldeye in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

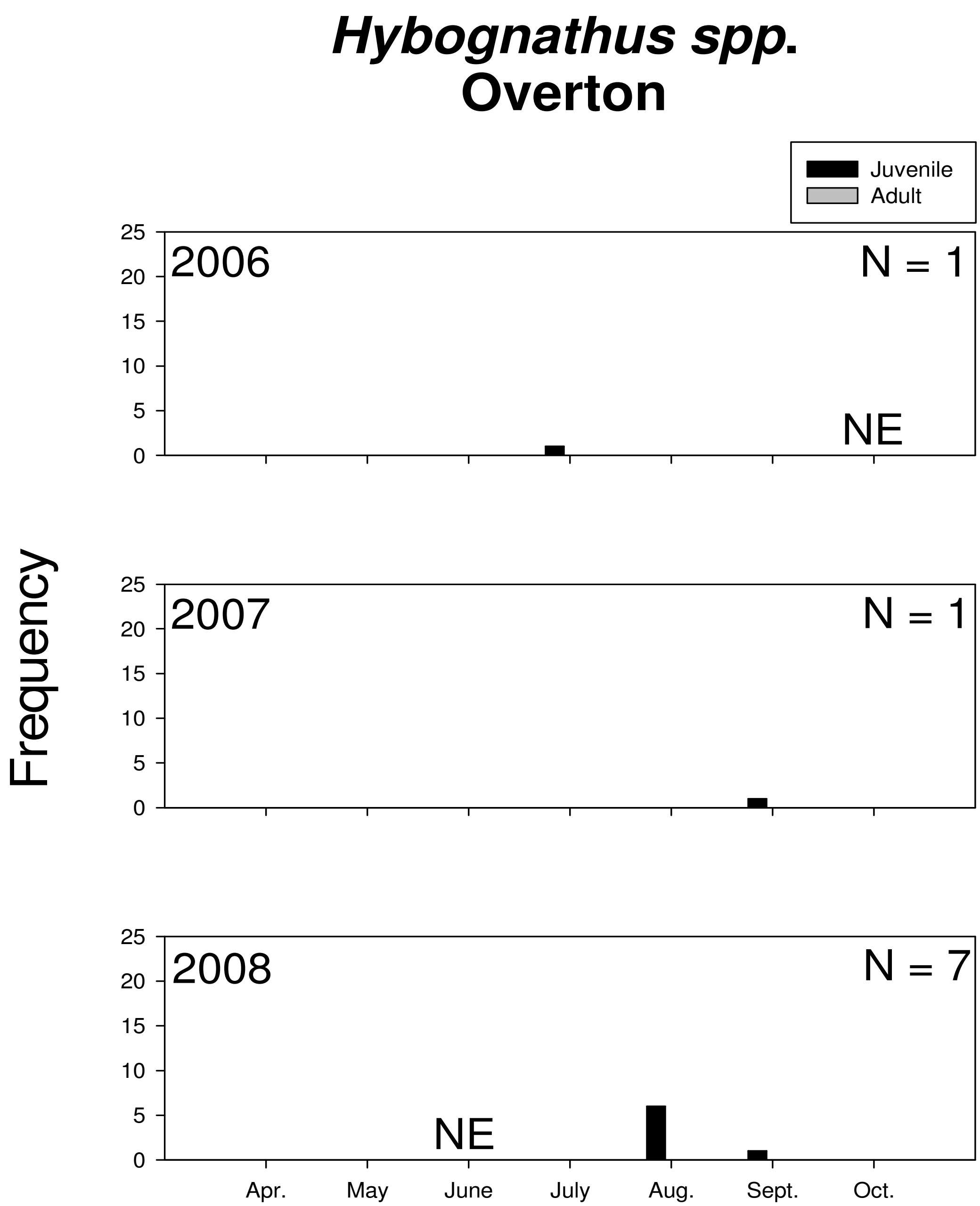


Figure III.10.31. Life stage frequency distribution of *Hybognathus spp*. in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

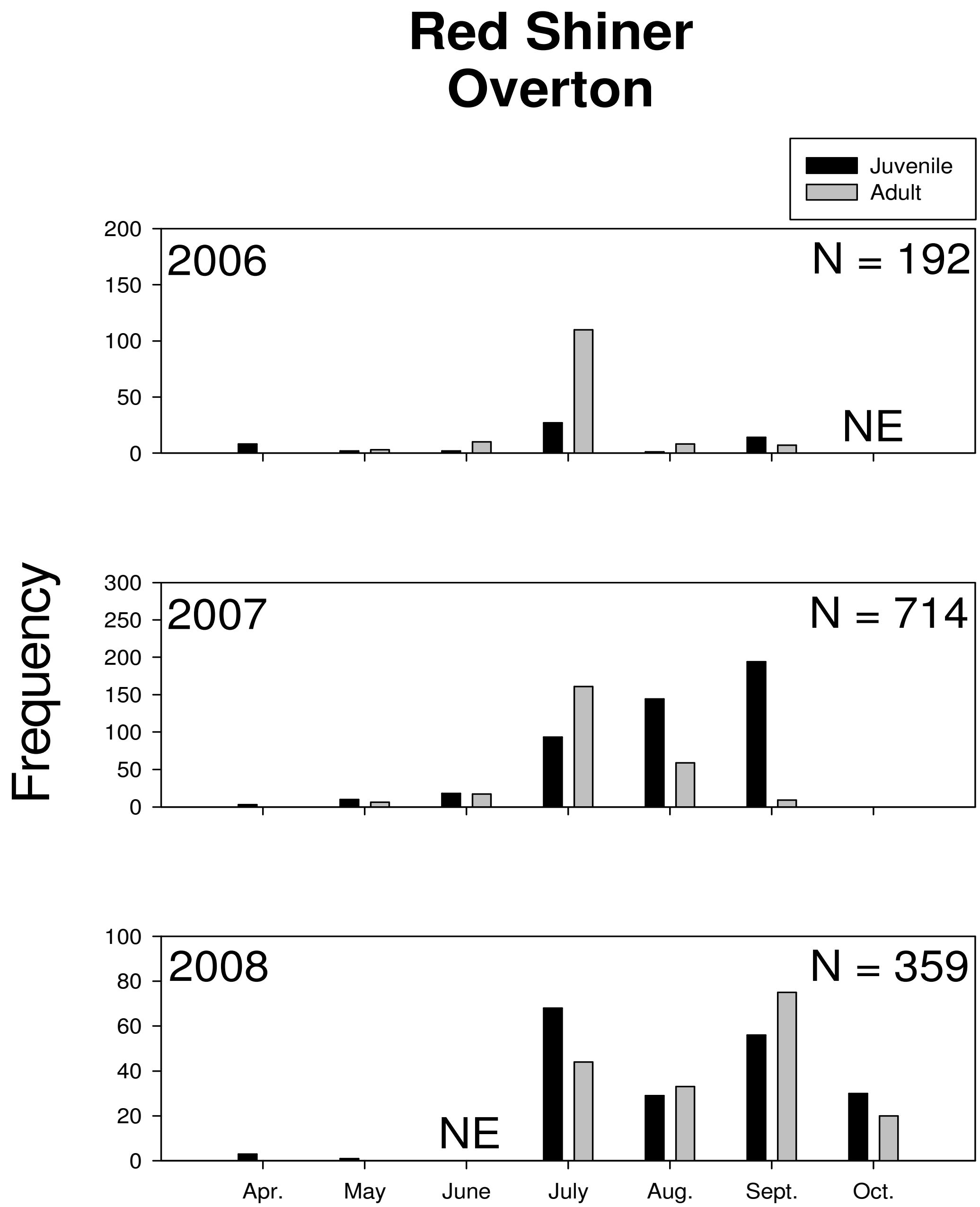


Figure III.10.32. Life stage frequency distribution of red shiner in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

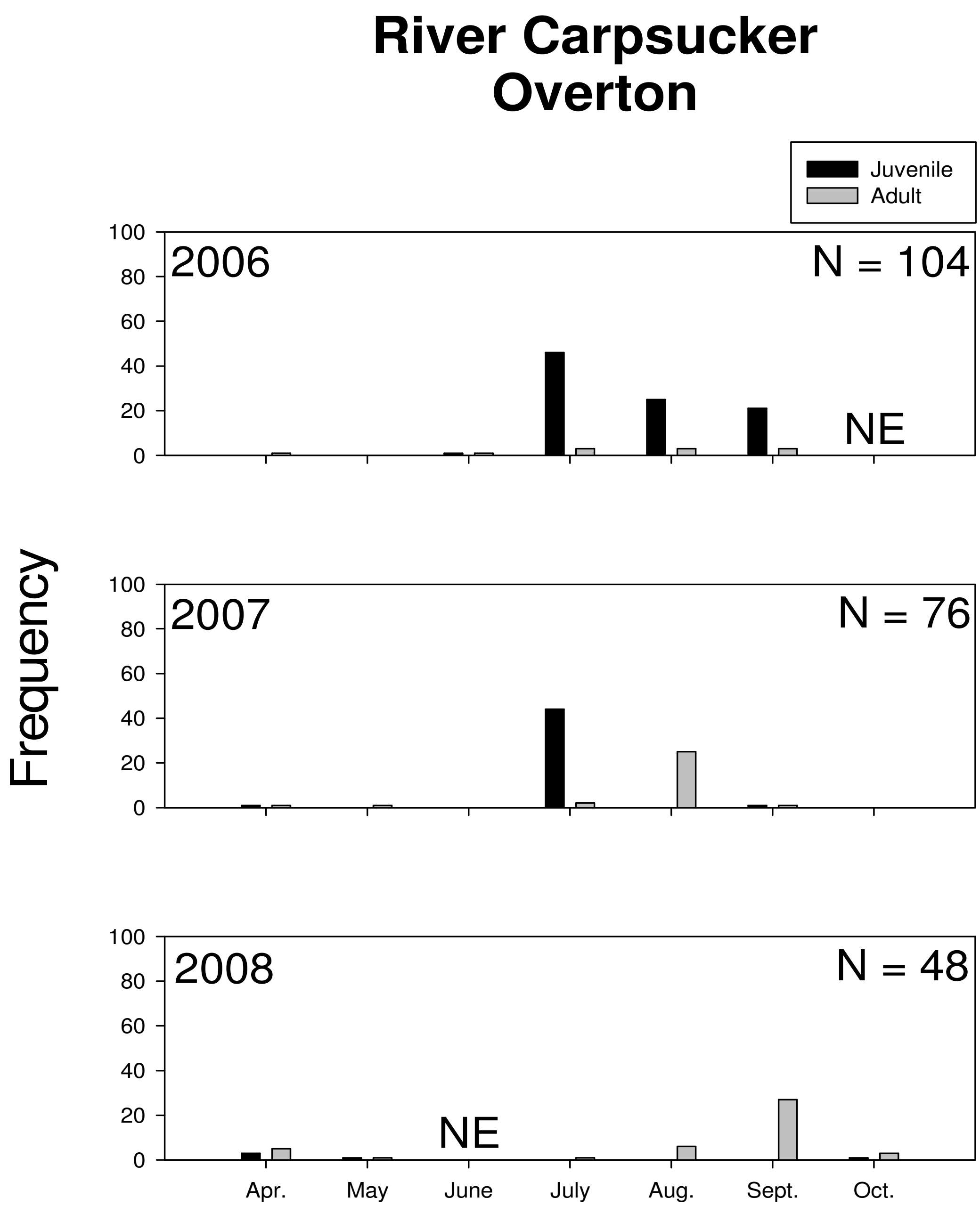


Figure III.10.33. Life stage frequency distribution of river carpsucker in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

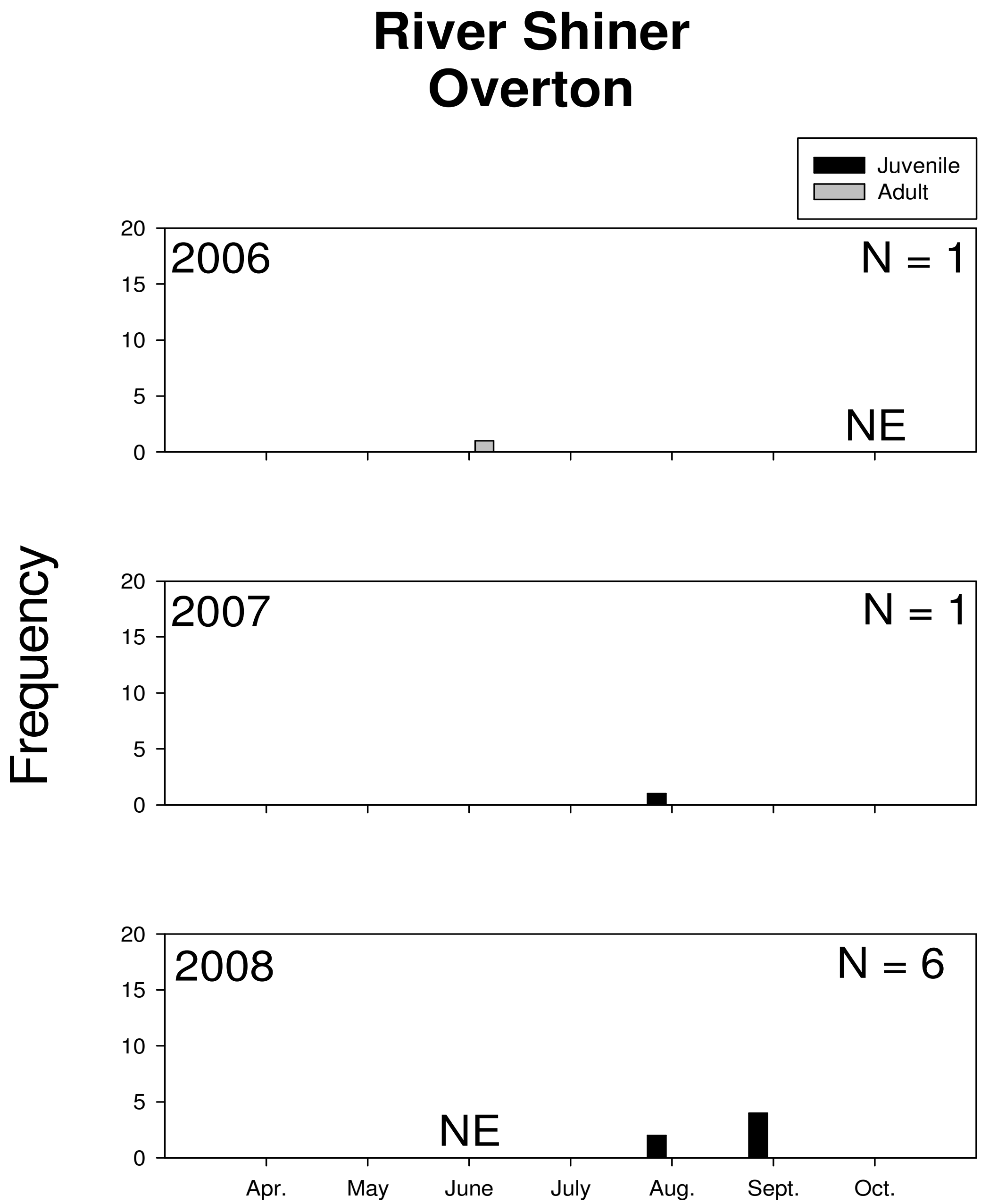


Figure III.10.34. Life stage frequency distribution of river shiner in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

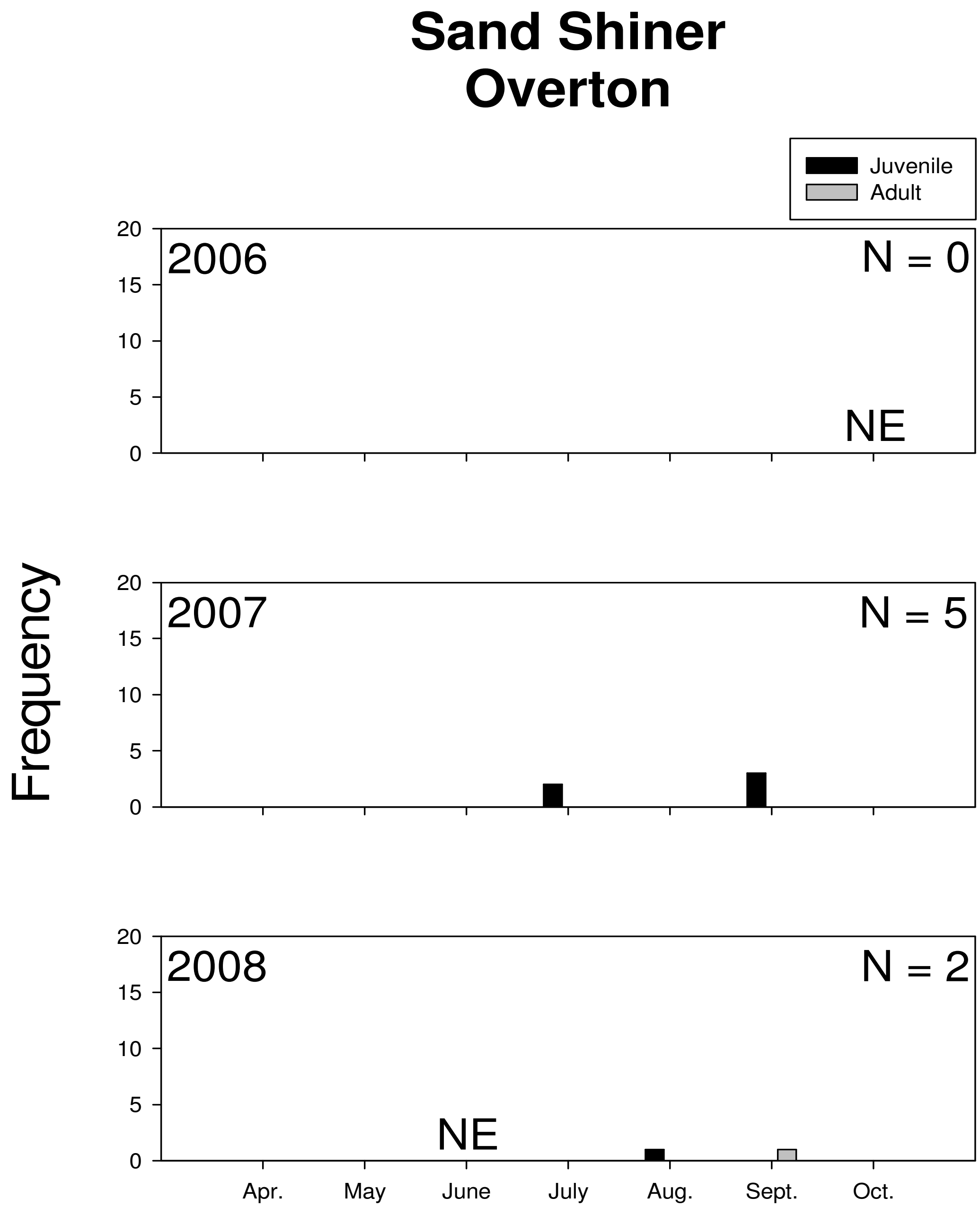


Figure III.10.35. Life stage frequency distribution of sand shiner in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

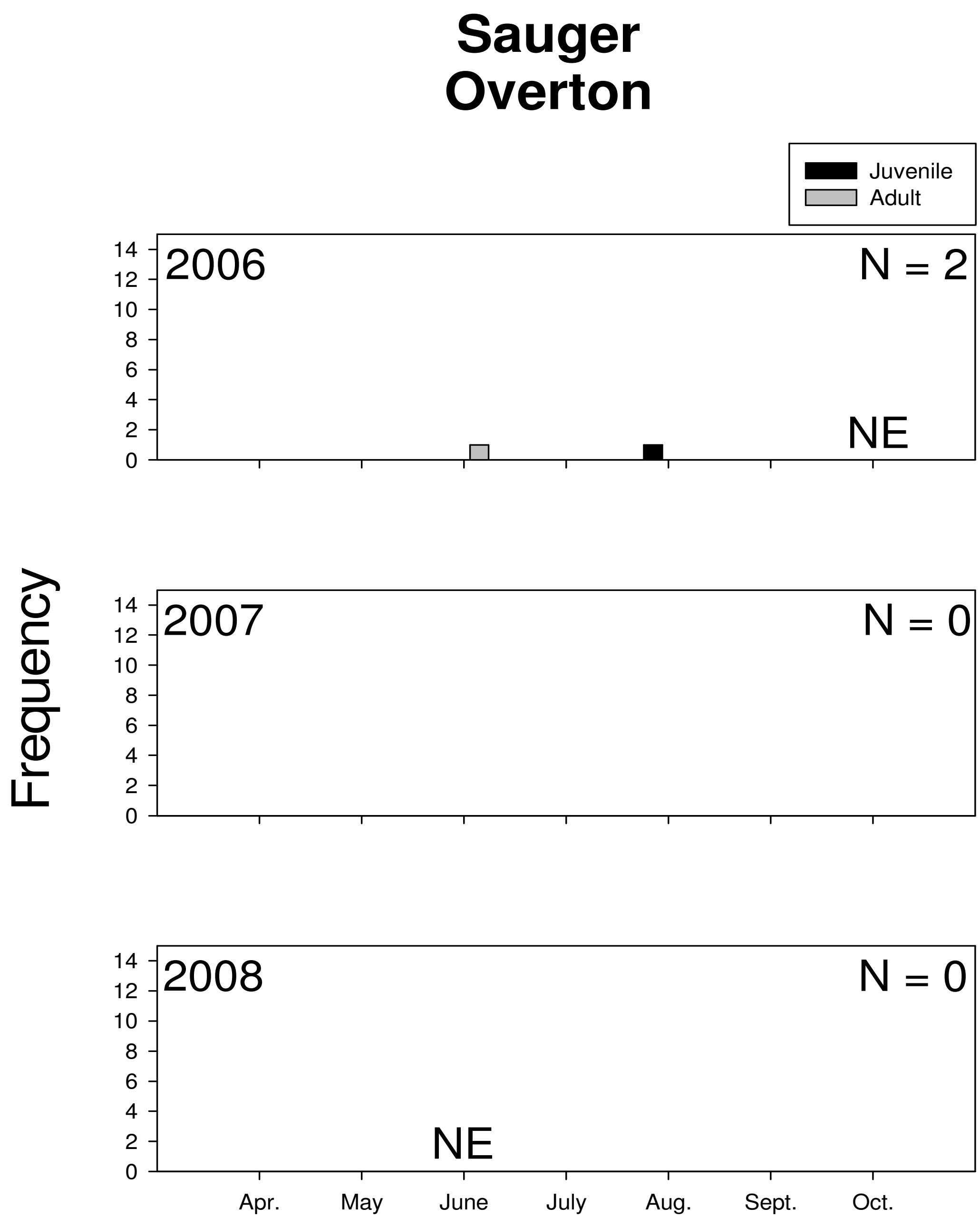


Figure III.10.36. Life stage frequency distribution of sauger in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

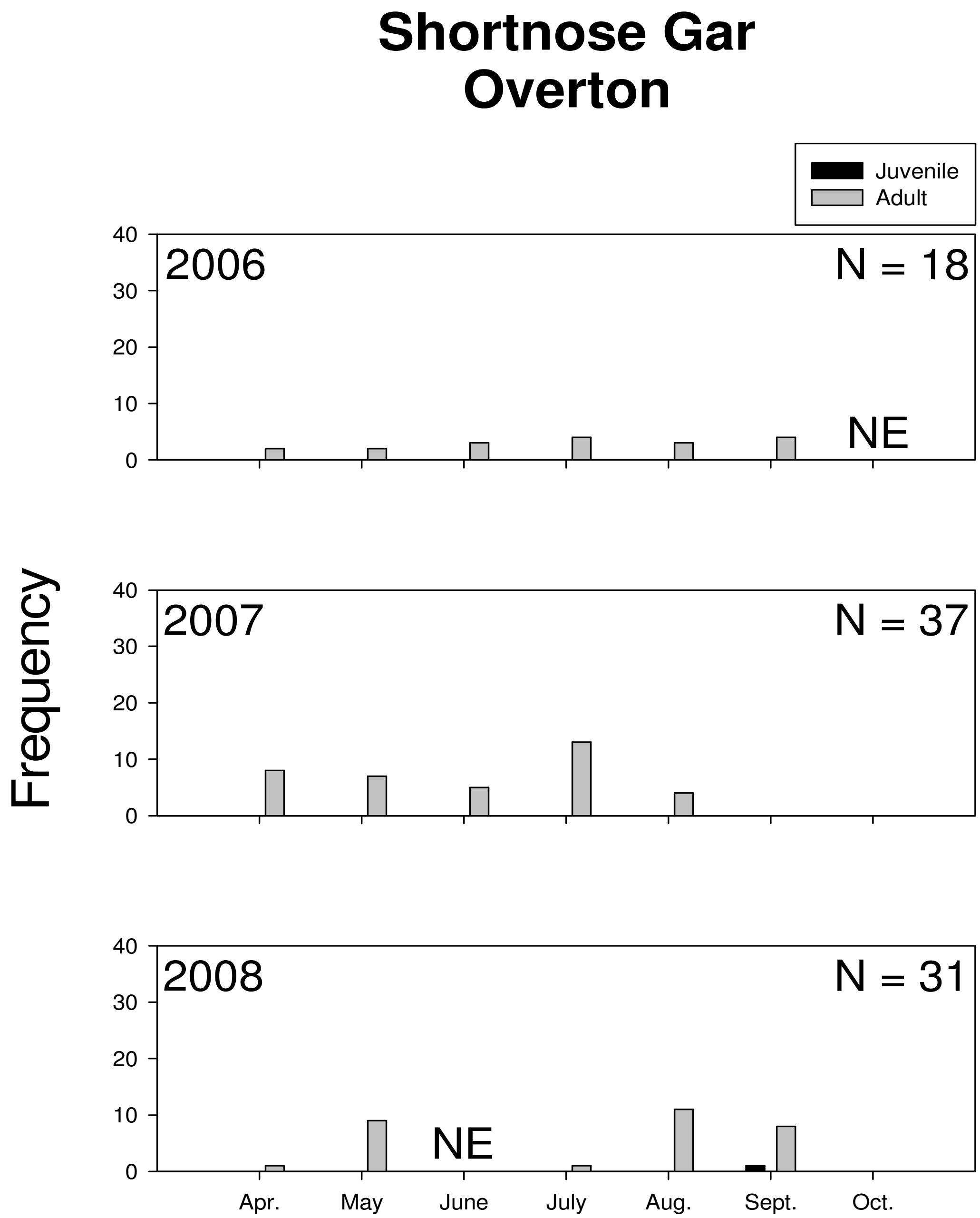


Figure III.10.37. Life stage frequency distribution of shortnose gar in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

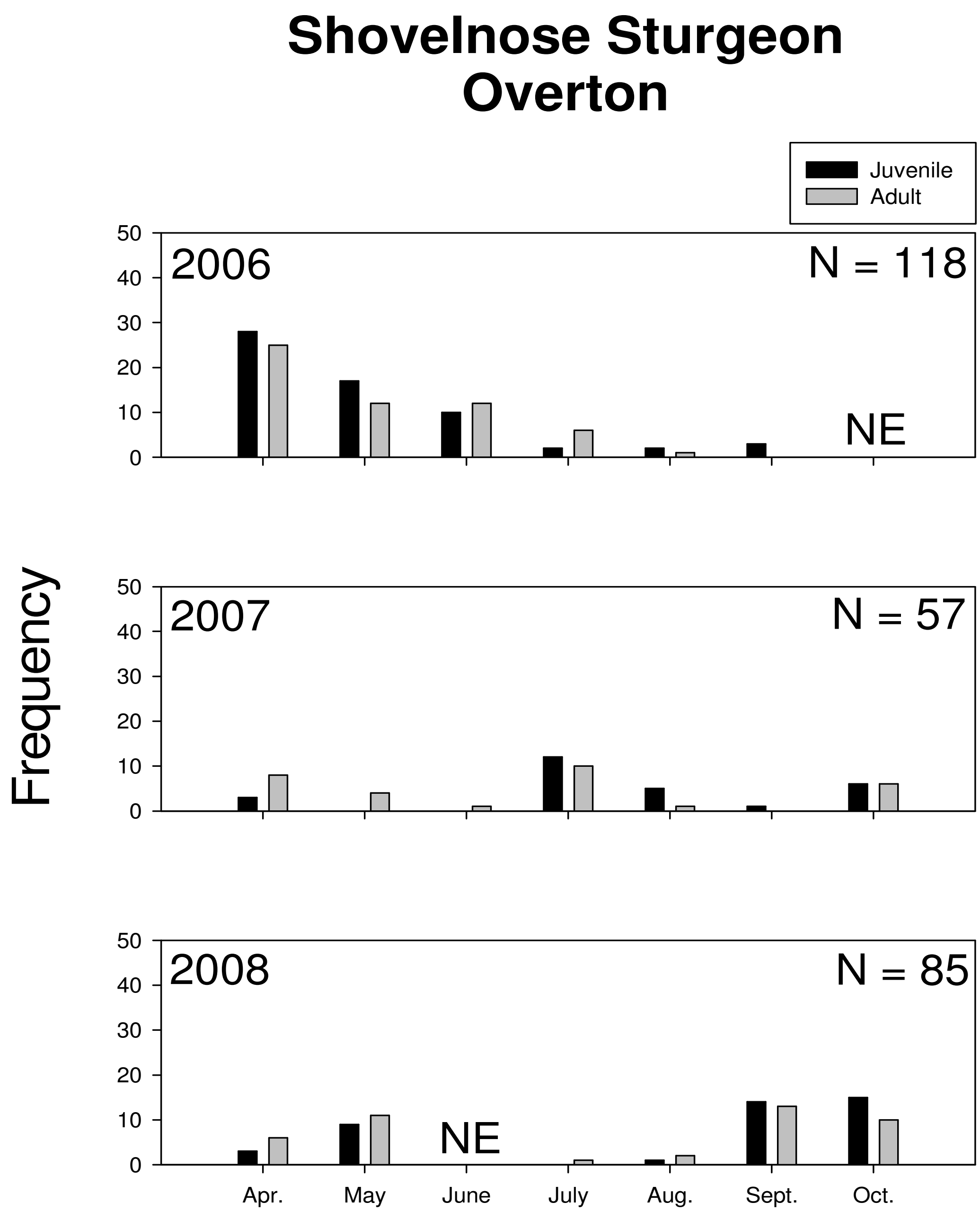


Figure III.10.38. Life stage frequency distribution of shovelnose sturgeon in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

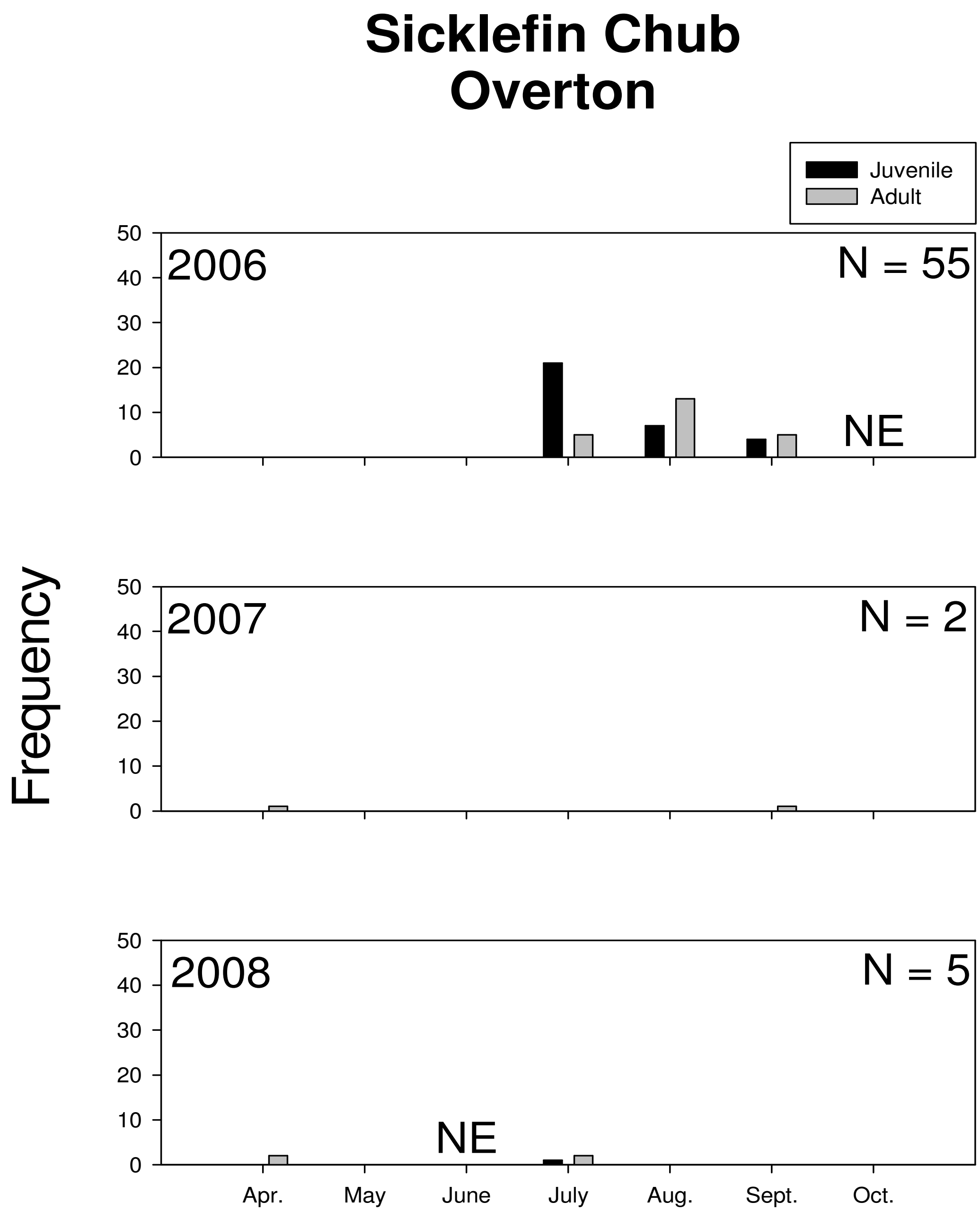


Figure III.10.39. Life stage frequency distribution of sicklefin chub in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

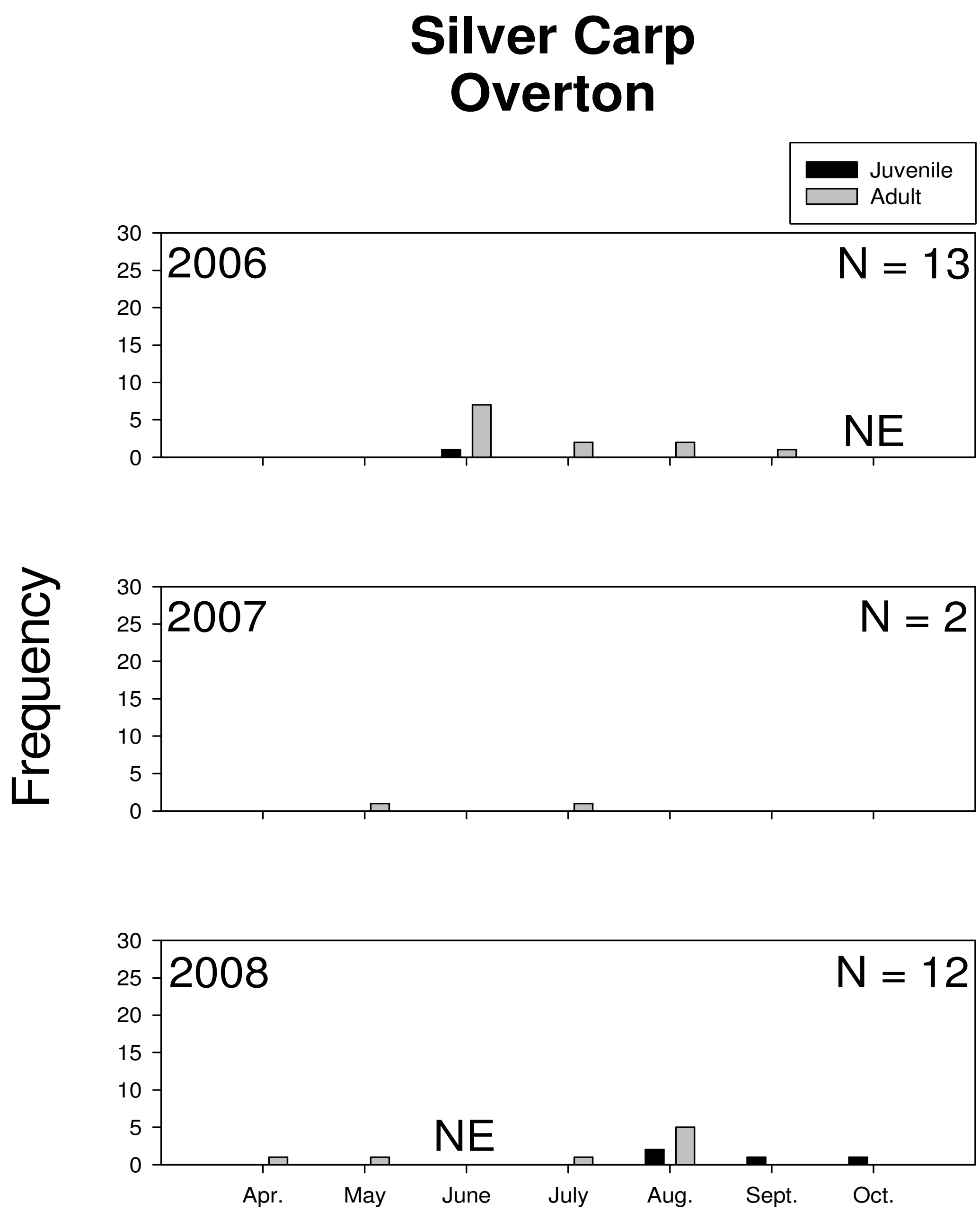


Figure III.10.40. Life stage frequency distribution of silver carp in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

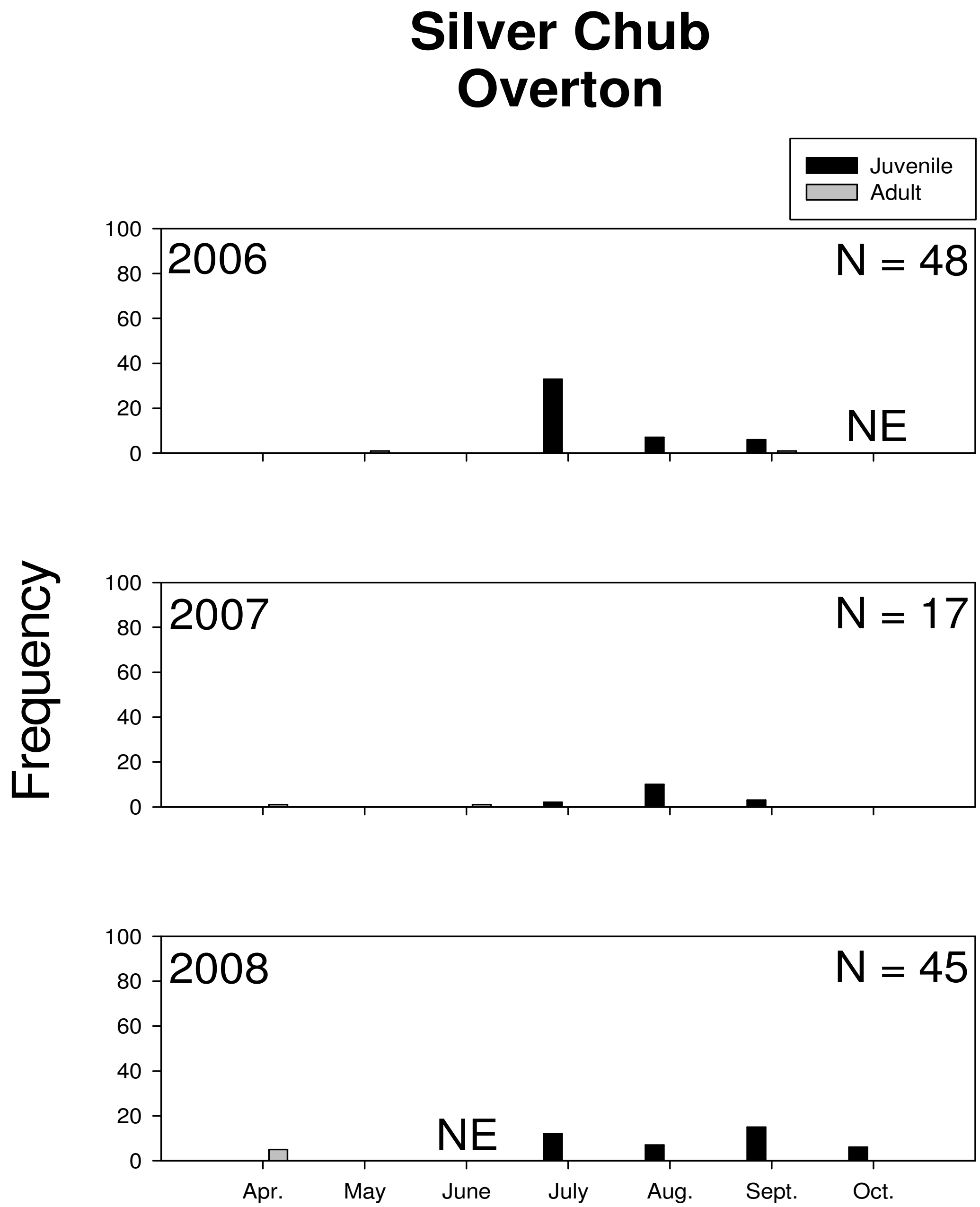


Figure III.10.41. Life stage frequency distribution of silver chub in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

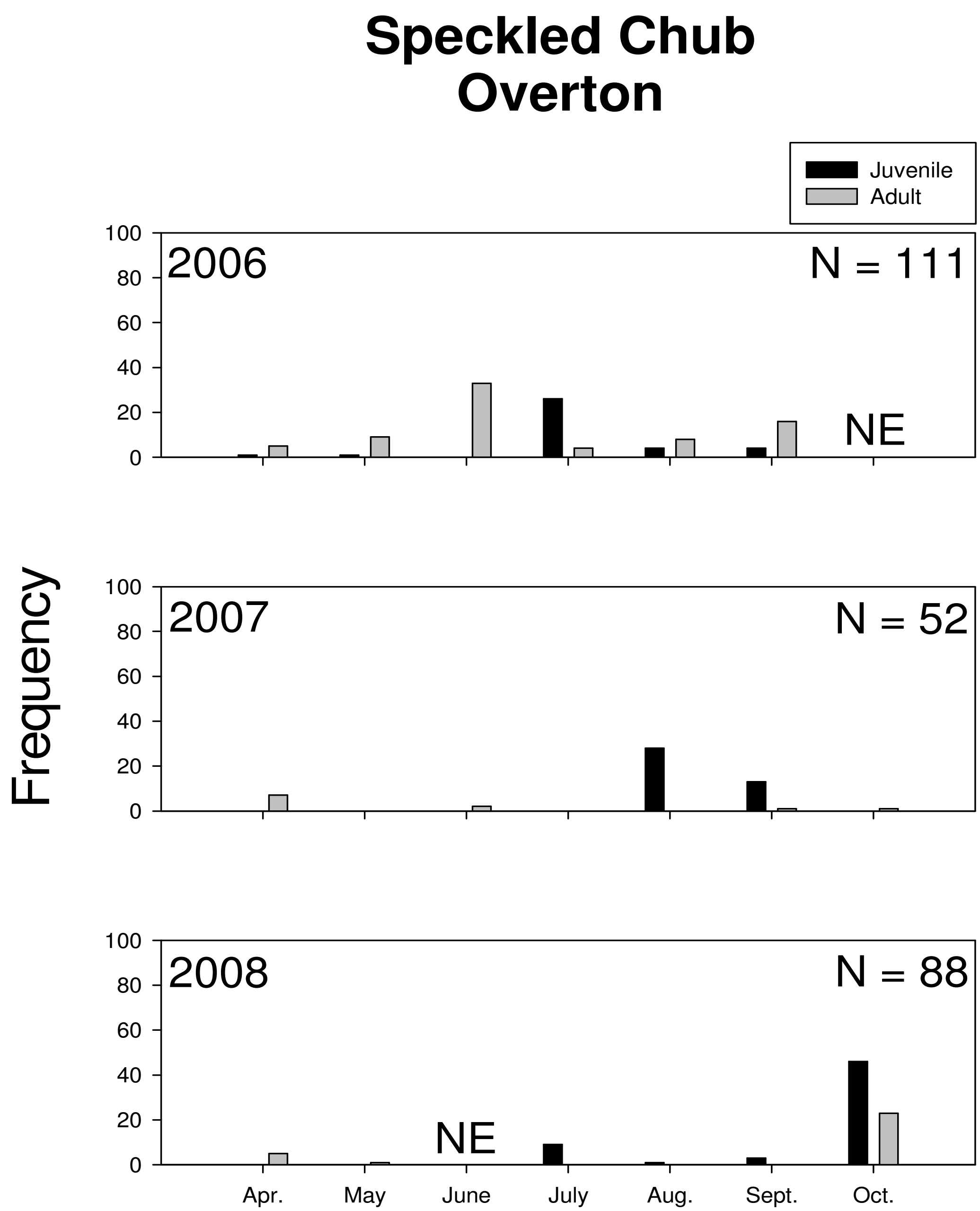


Figure III.10.42. Life stage frequency distribution of speckled chub in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

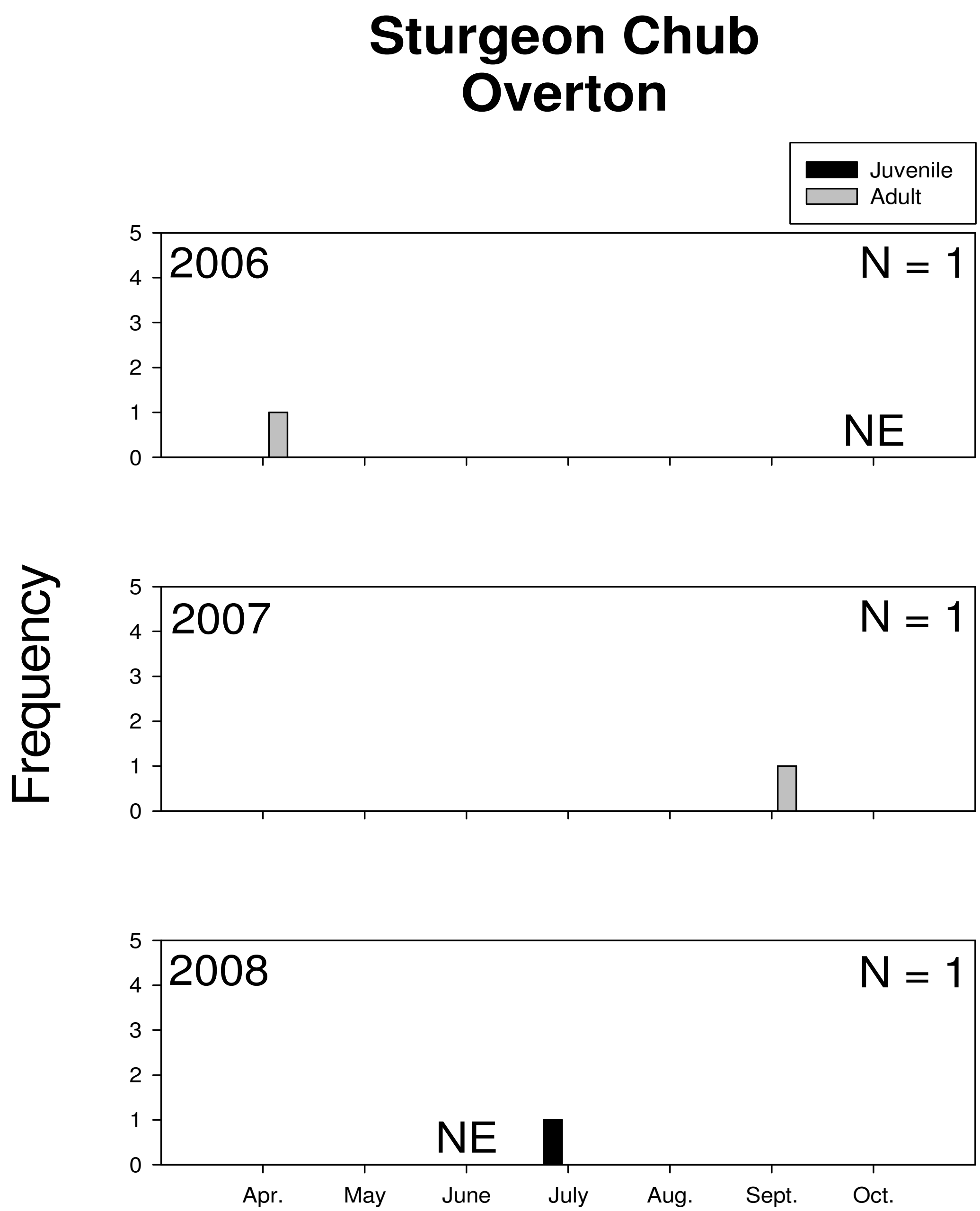
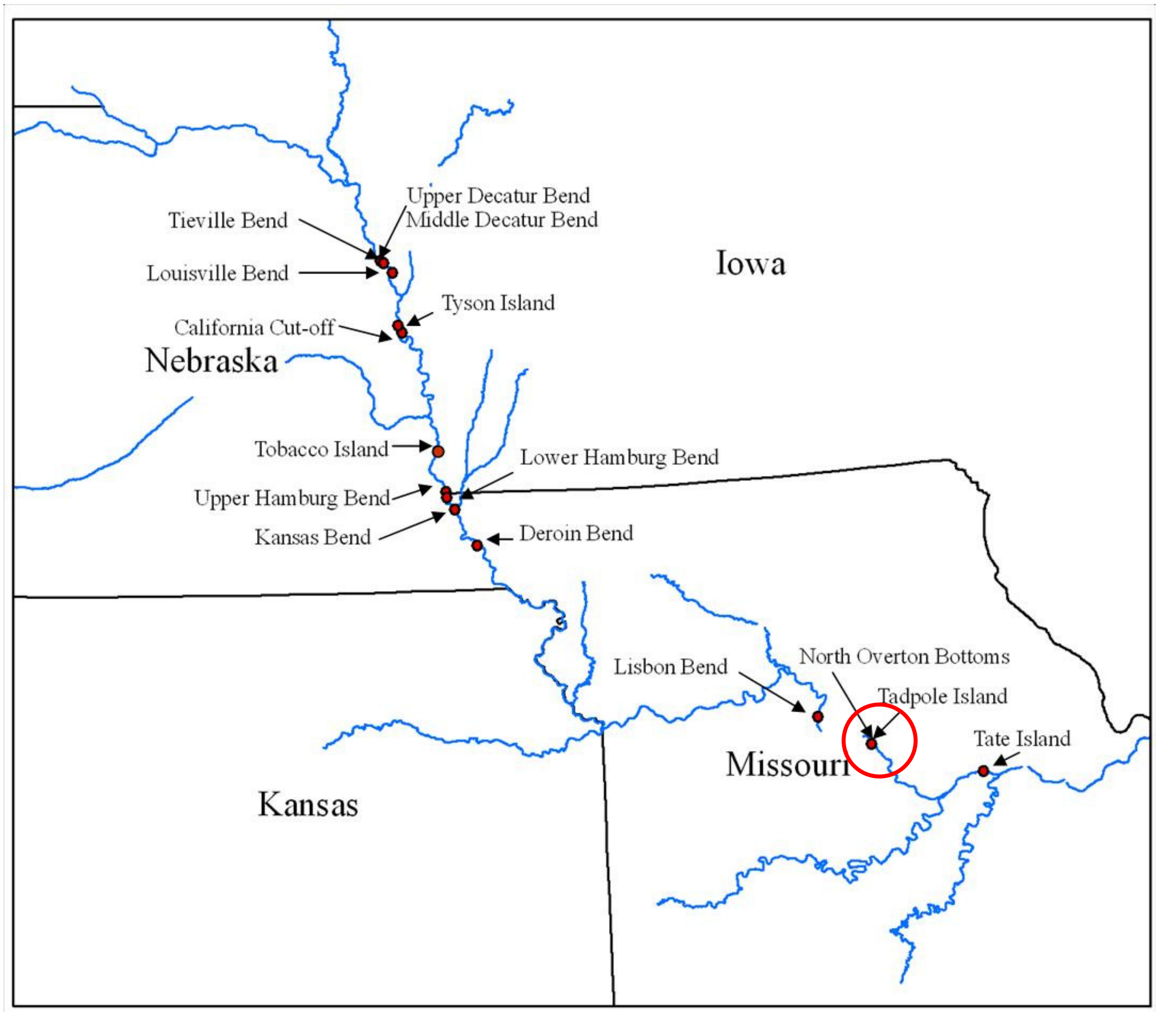


Figure III.10.43. Life stage frequency distribution of sturgeon chub in Overton chute by month and year. NE = No effort during this month due to river conditions or construction.

Section III
Chapter 11
Tadpole Island
Missouri



LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

Figure **Page #**

Key Findings

- The overall catch at Tadpole chute was relatively low, as was species richness compared to other lower Missouri River chutes, such as, Lisbon and Tate.
- Species richness progressively increased over the course of the study suggesting that Tadpole's habitat may be evolving and becoming more diverse.
- Some individual species were captured in high numbers within Tadpole chute, such as goldeye, emerald shiner and red shiner. However, emerald and red shiners are generalist species and low numbers of specialist species may be an indicator of less diverse habitat.
- Young of the year and other juvenile fish were detected in relatively low numbers in Tadpole chute. This may indicate that present chute conditions are not providing nursery habitat that older, more diverse chutes on the lower Missouri River (i.e., Lisbon and Tate chutes) do.
- The majority of juvenile fish that were collected in Tadpole chute were caught during 2006 and 2007.
- Riverine species such as shovelnose sturgeon, speckled chubs and channel catfish were found in Tadpole chute.
- No pallid sturgeon were captured in Tadpole chute.
- Two lake sturgeon were captured in Tadpole chute.
- Few *Hybognathus* species (i.e., Mississippi silvery minnow, plains minnow and western silvery minnow) were found in Tadpole chute.

- There were a few game species that were abundant in Tadpole chute including blue, channel and flathead catfish. Other species such as black and white crappie, paddlefish, sauger and white bass were captured in low numbers and infrequently.

Recommendations

- Avoid creating side channels characterized by homogeneous geomorphology, steep banks, uniform depth, high, uniform flows and narrow widths. These factors may be delaying the creation and evolution of habitat within Tadpole chute and should be taken into consideration when designing future side channel projects.
- Create additional habitat diversity within Tadpole chute by building additional backwater areas or tie channels or by destabilizing the high banks thereby increasing channel meandering, channel sinuosity and access to the floodplain.
- Steps should be taken to produce or promote shallow water habitat; shallower depths and slower velocities should be sought in Tadpole chute.
- The variation in fish abundances seen among the three years of sampling at Tadpole chute indicates that a long term monitoring effort would be needed to characterize fish population trends in the chute. Furthermore, fish data from the chute needs to be compared to that of the main channel to determine how the chute is functioning with respect to main channel fish use.
- Continued monitoring of Tadpole chute would be valuable in determining the rate at which the chute is evolving and how future manipulations affect the habitat and fish community.

- Because chute habitat availability and functionality is highly influenced by river stage long term monitoring is necessary to understand the ecological role of chute habitat under a range of conditions.
- Future monitoring could be streamlined with the information obtained from intense monthly sampling efforts. These data that document which gears and times of the year were most efficient for collecting an array of species make it possible to develop rapid bio-assessment technique that could be used for future monitoring.

Results

A total of 8,213 fish of 55 species, representing 15 families, were collected in Tadpole chute between 2006 and 2008 (Table III.11.1). A total of 240 fish were only identified to genus or family level and represented 2.9% of the total catch; all unidentified fish were juveniles, usually young of the year. The 2006 sampling season experienced the highest number of fish, 4,022 individuals, representing about 49% of the total catch at Tadpole chute. High numbers of fish in 2006 were due to large catches of small bodied fish such as emerald shiner, bullhead minnow and gizzard shad. However, species richness was lowest in 2006 with only 35 species represented (Table III.11.2; Fig III.11.1). Interestingly, 2008 had the lowest number of fish captured, with 1,696 individuals, about 20% of the total catch; however 2008 had the highest species richness with 55 species present. Prolonged flood events prohibited sampling during July of 2008 likely contributing to the decreased number of fish captured (Table III.11.3).

The most abundant species in Tadpole chute was emerald shiner, which represented 23.6% (N = 1,935) of the total catch from 2006 to 2008. Emerald shiner numbers were highest in 2006 when 85% of the total emerald shiner catch was collected (N = 1645). Other abundant species included red shiner (16.3%; N = 1,341), channel catfish (13%; N = 1,066), freshwater drum (8.9%; N = 728), bullhead minnow (5.2%; N = 424), gizzard shad (4.8%; N = 391), river carpsucker (4.1%; N = 334), goldeye (2.6%; N = 216), speckled chub (2.3%; N = 187) and silver chub (2.1%; N = 174). Bullhead minnow, gizzard shad and river carpsucker were most abundant during the 2006 season whereas red shiner, goldeye and silver chub were each most abundant during the 2007 season. Speckled chub was one of the few species to have greater numbers in 2008; channel catfish and freshwater drum had consistent numbers across all three years of sampling. Target species that were not included in the most abundant species at Tadpole included flathead catfish (1.7%; N = 140), shortnose gar (1.5%; N = 125), shovelnose sturgeon (1.5%; N = 125), sicklefin chub (1.4%; N = 112), common carp (0.8%; N = 64), bighead carp (0.5%; N = 37), silver carp (0.4% N = 30), river shiner (0.2%; N = 17), blue sucker (0.1%; N = 4), sauger (0.1%; N = 4), sturgeon chub (0.04%; N = 3), western silvery minnow (0.01%; N = 1), plains minnow (0.01%; N = 1) and sand shiner (0.01%; N = 1).

Target species' accounts for Tadpole chute are presented hereafter (Table III.11.1), in alphabetical order with analysis. Yearly mean catch per unit effort (CPUE) values for target species were analyzed with a Kruskal-Wallis test (Table III.11.4) to detect differences among years; mean CPUE values are presented in Table III.11.5 by month and year. Mean length values for target species were tested with analysis of

variance; mean length values and the results of analysis are presented in Table III.11.6. Length frequency distribution graphs for target species are presented in Figures III.11.2 through III.11.22 in alphabetical order by fish's common name. Proportions of adult and juvenile target species were analyzed with a z-test, the results of which are presented in Table III.11.7. Life stage frequency graphs for target species are presented in Figures III.11.23 through III.11.43 in alphabetical order by fish's common name. Tables and figures are not referenced hereafter. The contents of all tables are in alphabetical order by fish's common name. Figures and species accounts are ordered alphabetically, by fish's common name, with one exception; *Hybognathus* species (plains minnow, Mississippi silvery minnow and western silvery minnow) were combined and labeled as such because of extremely low numbers of these species.

Bighead carp

There were 37 bighead carp collected in Tadpole chute, most of which were captured in 2007 and 2008. Bighead carp were captured most effectively in large hoop nets but were collected in mini-fyke nets, and trammel nets as well. There was no difference in catch rates, mean lengths or life stage proportions of bighead carp among years. The catch of bighead carp was dominated by adults most years, with the exception of 2006 when only one fish was caught. The individual captured in 2006 represented the only young of the year specimen collected in Tadpole chute.

Blue sucker

Only four blue suckers were collected in Tadpole chute, one in 2007 and three in 2008. Blue suckers were collected in otter trawls and trammel nets. There was no difference in catch rates, mean lengths or life stage proportions of blue suckers among years. Of the four fish caught, two were adults and two were juveniles; fish were caught in April, July and September. No young of the year blue suckers were found in Tadpole chute.

Channel catfish

We caught 1,066 channel catfish in Tadpole chute, with the largest number of fish collected in 2007. Channel catfish were captured in every gear; the highest catch rates were in small hoop nets and mini-fyke nets but fish were regularly collected in every gear except trammel nets. Catch rates of channel catfish collected in otter trawls, small hoop nets and trammel nets varied among years, having the highest catch rates in 2006 and progressively lower catch rates in subsequent years. Catch rates of fish caught in push trawls had the opposite results with lowest catch rates in 2006 and progressively higher catch rates in subsequent years. Electrofishing had higher catch rates in 2006 than in 2007. The mean length of channel catfish collected while electrofishing, in mini-fyke nets and push trawls were greatest in 2006 and each gear caught progressively smaller fish over the next two years. The inverse was true for fish caught in push trawls, in which fish had the smallest mean lengths in 2006 and progressively larger lengths in subsequent years. Life stage proportions of channel catfish were different in 2006, when greater numbers of adults were caught than during other years. In general, channel

catfish catches were dominated by adults which were most commonly captured in August, September and October.

Common Carp

There were 64 common carp collected in Tadpole chute, with the highest numbers captured in 2006. Common carp were most effectively collected while electrofishing but were also caught in large and small hoop nets and mini-fyke nets. Catch rates of fish caught while electrofishing were lowest in 2008. There was no difference in mean lengths of common carp among years, with any gear. Life stage proportions of common carp were different in 2007, when juveniles made up a larger percentage of the total catch than in other years. Adults dominated common carp catches, no juveniles were captured in 2008. Adult fish were captured most mouths during all years of sampling; juveniles were only documented in June of 2006 and July of 2007.

Emerald shiner

Over 1,900 emerald shiners were collected in Tadpole chute; over 1,600 fish were collected in 2006. The highest catch rates for emerald shiners were in mini-fyke nets but fish were also collected while electrofishing and in otter and push trawls. Catch rates of fish collected while electrofishing and in mini-fyke nets and otter trawls, were highest in 2006. The mean lengths of emerald shiners caught while electrofishing and in mini-fyke nets were lower in 2007 than in other years. Life stage proportions of emerald shiners was different in 2006, when much larger numbers of juveniles were collected, particularly in mini-fyke nets, from June to August. Juveniles dominated emerald shiner

catches during all years; adults and juveniles were most commonly captured from June to October. Despite catching a larger number of juvenile fish in 2006, 2007 and 2008 actually produced a larger number of the smallest size classes of fish.

Flathead catfish

There were 140 flathead catfish caught in Tadpole chute, half of which were collected in 2007. Flathead catfish were caught with every gear; the highest catch rates were in mini-fyke nets but fish were most consistently caught while electrofishing and in large hoop nets. The only difference in catch rates of flathead catfish was in small hoop nets, where more fish were collected in 2007 than in 2008. The mean length of fish caught in small hoop nets varied as well, with larger fish being collected in 2006 than in 2007. There was no difference in life stage proportions of flathead catfish among years. Overall, juveniles were slightly more abundant than adults and both were caught throughout most years. Few flathead catfish were collected in Tadpole chute that could be considered young of the year.

Gizzard shad

There were 391 gizzard shad caught in Tadpole chute, most of which were collected in 2006. Electrofishing was the most effective gear for catching gizzard shad but all gears captured fish. Catch rates of gizzard shad collected while electrofishing and in trammel nets were highest in 2006. However, catch rates for fish captured in large hoop nets was greatest during 2007. The mean lengths of gizzard shad caught in large hoop nets varied among all years, with the smallest fish being captured in 2006, and

progressively larger fish being caught in subsequent years. The mean length of fish caught while electrofishing was lowest in 2007. Life stage proportions of gizzard shad were different in 2006, when juveniles made up a larger percentage of the total catch than in other years. However, in 2006 there were no samples taken in April and May, which is when the majority of adult fish were collected during 2007 and 2008. Overall, juveniles dominated gizzard shad catches, which were most frequently captured during July, August and September.

Goldeye

There were 216 goldeye caught in Tadpole chute, more than half of which were collected during 2007. Goldeye were captured in every gear except small hoop nets; the most effective gear for collecting goldeye was electrofishing. There was no difference in catch rates of goldeye among years, with any gear. The mean length of fish caught in large hoop nets was lower in 2006 than in subsequent years. Goldeye caught while electrofishing had smaller mean lengths in 2007 than in 2006 and those caught in push trawls had smaller mean lengths in 2007 than in 2008. There was no difference in life stage proportions of goldeye among years. Goldeye catches were completely dominated by juveniles; no adult goldeye were collected at Tadpole chute. Fish were most commonly collected in July and August.

***Hybognathus* species**

One plains minnow and one western silvery minnow were caught in Tadpole chute, both of which were collected in 2008. Several specimens that could only be

identified as *Hybognathus* species were also collected in 2008; no *Hybognathus* species were collected in 2006 or 2007. All specimens were collected in mini-fyke nets or push trawls. All individuals collected were considered juveniles and each was caught in August, September or October. There was no difference in catch rates, mean lengths or life stage proportions of *Hybognathus* species among years.

Pallid sturgeon

No pallid sturgeon were caught in Tadpole chute.

Red shiner

There were 1,341 red shiners caught in Tadpole chute, over half of which were collected in 2007. Red shiners were collected most effectively in mini-fyke nets and while electrofishing but were also caught in otter trawls, push trawls and small hoop nets. Catch rates of red shiners while electrofishing and in mini-fyke nets was lower in 2008 than in previous years. However, otter trawls had lower catch rates in 2006 than in other years. The mean lengths of fish caught while electrofishing and in mini-fyke nets were greatest in 2006 and smallest in 2007. Life stage proportions of red shiners were different in 2007, the only year when juveniles outnumbered adults. In general, adults were caught throughout most years, while juveniles were most commonly encountered during and after June.

River carpsucker

We caught 334 river carpsuckers in Tadpole chute, over 250 of which were collected in 2006. River carpsuckers were caught with every gear. Mini-fyke nets had the highest catch rates but fish were regularly collected while electrofishing as well. Catch rates of fish caught while electrofishing, in mini-fyke nets, otter trawls and push trawls were higher in 2006 than in other years. The mean length of river carpsuckers caught while electrofishing and in mini-fyke nets was higher in 2008 than in previous years. However, fish caught in push trawls had a greater mean length during 2006. Life stage proportions of river carpsuckers were different in 2006 when juveniles made up a much larger percentage of the total catch than in other years. In 2007 and 2008, river carpsucker catches were dominated by adults which were caught throughout the year, 2006 catches, on the other hand, were dominated by juveniles which were most commonly captured from June through September.

River shiner

Only 17 river shiners were caught in Tadpole chute, most of which were collected in 2007; no river shiners were caught in 2006. River shiners were collected while electrofishing and with push trawls. There was no difference in catch rates, mean lengths or life stage proportions of river shiners among years. All specimens collected were considered juveniles, although only one fish was caught that was less than 40 mm. River shiners were only caught in August in 2007 and in July and October of 2008.

Sand shiner

One sand shiner was collected in Tadpole chute. The one individual caught was a juvenile and was collected with a push trawl in June of 2007. There was no difference in catch rates, mean lengths or life stage proportions of sand shiners among years.

Sauger

Four sauger were collected in Tadpole chute. All fish were collected while electrofishing. There was no difference in catch rates, mean lengths or life stage proportions of sauger among years. There was one juvenile fish collected during each year; the only adult was captured in August of 2007. Juvenile fish were collected in July and September.

Shortnose gar

We caught 125 shortnose gar in Tadpole chute, approximately half of which were collected during 2007. Shortnose gar catch rates were highest in large hoop nets but were also captured while electrofishing, in mini-fyke nets, small hoop nets and trammel nets. Catch rates while electrofishing were lower in 2008 than in previous years, while catch rates with mini-fyke nets were lowest in 2006. There was no difference in the mean lengths or life stage proportions of shortnose gar among years. Overall, shortnose gar catches were dominated by adults, which were common throughout the year. The only juvenile shortnose gar caught in Tadpole chute was in October of 2008; there were no young of the year fish collected.

Shovelnose sturgeon

There were 125 shovelnose sturgeon caught in Tadpole chute, 84 of which were collected during 2008. Shovelnose sturgeon were captured in every gear with the exception of mini-fyke nets. Fish were most effectively captured in trammel nets and large and small hoop nets. Catch rates of fish collected with large hoop nets were highest in 2008, accounting for the increased overall catch in that year. The mean length of shovelnose sturgeon caught in trammel nets was greater in 2008 than in other years. There was no difference in life stage proportions of shovelnose sturgeon among years. Overall, adult and juvenile numbers were similar and fish were most commonly captured during May. There was only one fish caught in Tadpole chute that could be considered a young of the year.

Sicklefin chub

There were 112 sicklefin chubs caught in Tadpole chute, nearly all of which were collected in 2006. Most fish were collected in mini-fyke nets and otter trawls but a few were collected with push trawls. Sicklefin chubs caught in mini-fyke nets and otter trawls had higher catch rates in 2006 than in subsequent years. There was no difference in mean lengths or life stage proportions of sicklefin chubs among years. In general, sicklefin chub catches were dominated by juveniles which were most abundant in September and October. Most of the adult collections occurred during August and September of 2006.

Silver carp

We caught 30 silver carp in Tadpole chute. Fish were collected most effectively in mini-fyke nets but were also collected while electrofishing, with large hoop nets and trammel nets. There was no difference in catch rates, mean lengths or life stage frequency proportions of silver carp among years. Juvenile and adult numbers were similar. Most juvenile fish were collected in August but very few young of the year fish were collected.

Silver chub

There were 174 silver chubs caught in Tadpole chute, the majority of which were captured in 2006. Silver chubs were caught most effectively in mini-fyke nets but were also collected while electrofishing, in otter trawls, push trawls and small hoop nets. Silver chubs caught in otter trawls had higher catch rates in 2006 than in other years, accounting for the increase in silver chub numbers recorded during this year. The mean length of fish caught while electrofishing was greatest in 2007. However, fish collected with push trawls had the greatest mean lengths in 2008. Life stage proportions of silver chubs were different in 2006, when juveniles made up a larger percentage of the total catch than in 2008. In general, juveniles dominated silver chub catches and were most abundant in August and September. Only two adult fish were collected from Tadpole chute.

Speckled chub

There were 187 speckled chubs caught in Tadpole chute, most of which were collected in 2008. Speckled chubs were captured most effectively with mini-fyke nets but were captured while electrofishing and in otter and push trawls. The catch rates of fish collected with otter trawls were highest in 2006. There was no difference in mean lengths of speckled chubs among years, with any gear. Life stage proportions of speckled chubs were different in 2006, when adults made up a larger percentage of the total catch than in 2008. Overall, speckled chub catches were dominated by juveniles; speckled chubs were most commonly captured in September and October.

Sturgeon chub

There were only three sturgeon chubs collected in Tadpole chute, all of which were collected in 2008. All sturgeon chubs were collected in otter trawls, two in April and the other in August. All fish collected were adults. There was no difference in catch rates, mean lengths or life stage proportions of sturgeon chubs among years.

Table III.11.1. Common name, scientific name, family, number of fish collected and percent of total catch, of all species caught in Tadpole chute 2006 – 2008. Target species are bold

Common Name	Scientific Name	Family	2006	2007	2008	Total	% Catch
Bighead carp	***Hypophthalmichthys nobilis***	*Cyprinidae*	1	16	20	37	0.45
Bigmouth buffalo	*Ictiobus cyprinellus*	*Catostomidae*	0	3	11	14	0.17
Black crappie	*Pomoxis nigromaculatus*	*Centrarchidae*	0	0	1	1	0.01
Blue catfish	*Ictalurus furcatus*	*Ictaluridae*	10	48	43	101	1.23
Blue sucker	***Cycleptus elongatus***	*Catostomidae*	0	1	3	4	0.05
Bluegill	*Lepomis macrochirus*	*Centrarchidae*	65	38	29	132	1.61
Bluntnose minnow	*Pimephales notatus*	*Cyprinidae*	24	1	0	25	0.30
Brook silverside	*Labidesthes sicculus*	*Atherinidae*	4	0	0	4	0.05
Bullhead minnow	*Pimephales vigilax*	*Cyprinidae*	314	101	9	424	5.16
Channel catfish	***Ictalurus punctatus***	*Ictaluridae*	290	421	355	1066	12.98
Channel shiner	*Notropis wickliffi*	*Cyprinidae*	1	19	2	22	0.27
Chestnut lamprey	*Ichthyomyzon castaneus*	*Petromyzontidae*	0	0	1	1	0.01
Common carp	***Cyprinus carpio***	*Cyprinidae*	28	22	14	64	0.78
Creek chub	*Semotilus atromaculatus*	*Cyprinidae*	8	0	0	8	0.10
Emerald shiner	***Notropis atherinoides***	*Cyprinidae*	1645	160	130	1935	23.56
Flathead catfish	***Pylodictis olivaris***	*Ictaluridae*	23	70	47	140	1.70
Flathead chub	*Platygobio gracilis*	*Cyprinidae*	0	0	1	1	0.01
Freshwater drum	*Aplodinotus grunniens*	*Sciaenidae*	264	213	251	728	8.86
Gizzard shad	***Dorosoma cepedianum***	*Clupeidae*	237	116	38	391	4.76
Golden redhorse	*Moxostoma erythrurum*	*Catostomidae*	0	1	0	1	0.01
Goldeye	***Hiodon alosoides***	*Hiodontidae*	34	118	64	216	2.63
Grass carp	*Ctenopharyngodon idella*	*Cyprinidae*	10	4	7	21	0.26
Green sunfish	*Lepomis cyanellus*	*Centrarchidae*	0	16	24	40	0.49
Lake Sturgeon	*Acipenser fulvescens*	*Acipenseridae*	0	1	1	2	0.02
Largemouth bass	*Micropterus salmoides*	*Centrarchidae*	6	2	0	8	0.10
Longnose gar	*Lepisosteus osseus*	*Lepisosteidae*	9	14	10	33	0.40
Mimic shiner	*Notropis volucellus*	*Cyprinidae*	0	1	0	1	0.01
Orangespotted sunfish	*Lepomis humilis*	*Centrarchidae*	3	0	2	5	0.06
Paddlefish	*Polyodon spathula*	*Polyodontidae*	0	1	3	4	0.05
Plains minnow	***Hybognathus placitus***	*Cyprinidae*	0	0	1	1	0.01
Pugnose minnow	*Opsopoeodus emiliae*	*Cyprinidae*	1	0	0	1	0.01
Red shiner	***Cyprinella lutrensis***	*Cyprinidae*	488	682	171	1341	16.33
River carpsucker	***Carpiodes carpio***	*Catostomidae*	256	49	29	334	4.07
River shiner	***Notropis blennius***	*Cyprinidae*	0	12	5	17	0.21
Sand shiner	***Notropis stramineus***	*Cyprinidae*	0	1	0	1	0.01
Sauger	***Stizostedion canadense***	*Percidae*	1	2	1	4	0.05
Shortnose gar	***Lepisosteus platostomus***	*Lepisosteidae*	30	59	36	125	1.52

Table III.11.1 (continued). Common name, scientific name, family, number of fish collected and percent of total catch, of all species caught in Tadpole chute 2006 – 2008. Target species are bold.

Common Name	Scientific Name	Family	2006	2007	2008	Total	% Catch
Shovelnose sturgeon x Pallid sturgeon	*Scaphirhynchus platorynchus x albus*	*Acipenseridae*	0	1	0	1	0.01
Shovelnose sturgeon	***Scaphirhynchus platorynchus***	*Acipenseridae*	8	33	84	125	1.52
Sicklefin chub	***Macrhybopsis meeki***	*Cyprinidae*	96	1	15	112	1.36
Silver carp	***Hypophthalmichthys molitrix***	*Cyprinidae*	9	8	13	30	0.37
Silver chub	***Macrhybopsis storeriana***	*Cyprinidae*	98	41	35	174	2.12
Skipjack herring	*Alosa chrysochloris*	*Clupeidae*	1	0	0	1	0.01
Smallmouth buffalo	*Ictiobus bubalus*	*Catostomidae*	7	3	5	15	0.18
Speckled chub	***Macrhybopsis aestivalis***	*Cyprinidae*	14	54	119	187	2.28
Stonecat	*Noturus flavus*	*Ictaluridae*	0	11	3	14	0.17
Striped bass	*Morone saxatilis*	*Moronidae*	0	0	1	1	0.01
Striped bass x White bass	*Morone saxatilis x chrysops*	*Moronidae*	1	0	0	1	0.01
Sturgeon chub	***Macrhybopsis gelida***	*Cyprinidae*	0	0	3	3	0.04
Suckermouth minnow	*Phenacobius mirabilis*	*Cyprinidae*	1	0	0	1	0.01
Warmouth	*Lepomis Gulosus*	*Centrarchidae*	1	0	0	1	0.01
Western mosquitofish	*Gambusia affinis*	*Poeciliidae*	3	1	5	9	0.11
Western silvery minnow	***Hybognathus argyritis***	*Cyprinidae*	0	0	1	1	0.01
White bass	*Morone chrysops*	*Moronidae*	12	5	2	19	0.23
White crappie	*Pomoxis annularis*	*Centrarchidae*	0	4	3	7	0.09
White sucker	*Catostomus commersonii*	*Catostomidae*	0	0	1	1	0.01
Yellow bullhead	*Ameiurus natalis*	*Ictaluridae*	0	17	0	17	0.21
Unidentified[1] buffalo	*Ictiobus spp.*	*Catostomidae*	0	3	0	3	0.04
Unidentified catfish	*Ictaluridae*	*Ictaluridae*	0	7	54	61	0.74
Unidentified chub	*Macrhybopsis* spp.	*Cyprinidae*	18	18	13	49	0.60
Unidentified *Hybognathus spp.*	*Hybognathus spp.*	*Cyprinidae*	0	0	7	7	0.09
Unidentified minnow	*Cyprinidae*	*Cyprinidae*	0	30	1	31	0.38
Unidentified sucker	*Catostomidae*	*Catostomidae*	0	13	1	14	0.17
Unidentified sunfish	*Centrarchidae*	*Centrarchidae*	1	12	13	26	0.32
Unidentified	Unidentified		0	26	0	26	0.32
Young-of-year fish	Unidentified		0	15	8	23	0.28
		Total	4022	2495	1696	8213	

[1]Fish labeled as ‘unidentified’ were unidentifiable due to being in larval or juvenile life stages, damage, or disfigurement.

Table III.11.2. Species richness (S), species evenness (E), Shannon's diversity index (H) and Simpson's diversity index (D) for Tadpole chute by year

Year	S	E	H	D
2006	35	0.4916	1.7477	0.6239
2007	40	0.7301	2.6932	0.8834
2008	43	0.7880	2.9639	0.9206

Table III.11.3. Sampling effort (number of gear deployments) in Tadpole chute by year and gear.

Year	Gear	April	May	June	July	August	September	October
2006	EF			9	9	9	9	
	HN					8	8	
	MF			8	8	1	8	
	OT16						8	
	POT				8	5		
	SHN			7	8	8	8	
	TN			8	8	8		
2007	EF	8	8	8	8	16	8	
	HN	8	6	9	8	8	8	
	MF				8	8	7	
	OT16	8	8	8	8	8		8
	POT			8	8	8	8	
	SHN	8	8	8	8	8	7	
	TN	8	8	8	8	8		8
2008	EF	8	8		8	8	8	8
	HN	8	8		7	8	8	8
	MF					8	8	8
	OT16	8	8		8	8	8	8
	POT				8	8	8	8
	SHN	8	8		7	8	8	8
	TN	8	8		8	8	8	8

Gears: EF = electrofishing, HN = 4' diameter hoop nets, MF = mini-fyke, OT16 - 16' otter trawls, OT8 = 8' otter trawls, POT = 8' otter trawls pushed, SHN = 2' diameter hoop net, TN = the combined efforts of trammel nets in 25' increments either drifted or set stationary.

Table III.11.4. Yearly mean catch per unit effort (CPUE) and results of Kruskal-Wallis test of mean CPUE of target species caught in Tadpole chute by species and gear. Significant results are bold.

Species	Gear	Mean CPUE			06 v 07 v 08		06 v 07		06 v 08		07 v 08	
		2006	2007	2008	Chi	P	Chi	P	Chi	P	Chi	P
	HN	0.00	0.27	0.36	2.57	0.277						
Bighead Carp	MF	0.02	0.00	0.00	1.88	0.3906						
	TN	0.00	0.04	0.00	1.48	0.4773						
Blue Sucker	OT	0.00	0.00	0.03	2.36	0.3079						
	TN	0.00	0.12	0.09	0.48	0.7853						
	EF	0.57	0.30	0.39	**10.01**	**0.0067**	**9.11**	**0.0025**	3.65	0.056	2.88	0.0897
	HN	0.07	0.29	0.11	1.56	0.4582						
	MF	1.09	0.99	1.04	0.61	0.7381						
Channel Catfish	OT	0.98	0.53	0.45	**30.09**	**<0.0001**	**21.38**	**<0.0001**	**25.24**	**<0.0001**	**4.68**	**0.0305**
	POT	0.07	0.45	0.54	**6.96**	**0.0308**	**5.21**	**0.0225**	**6.50**	**0.0108**	0.10	0.751
	SHN	1.23	0.60	0.23	**20.11**	**<0.0001**	**7.50**	**0.0062**	**18.74**	**<0.0001**	**5.07**	**0.0244**
	TN	0.14	0.00	0.00	**12.74**	**0.0017**	**6.44**	**0.0111**	**6.44**	**0.0111**		
	EF	0.27	0.17	0.05	**6.21**	**0.0447**	0.35	0.553	**4.97**	**0.0258**	**5.06**	**0.0244**
Common Carp	HN	0.02	0.07	0.13	0.00	0.9979						
	MF	0.04	0.05	0.00	3.79	0.1504						
	SHN	0.02	0.02	0.04	0.34	0.8433						
	EF	2.18	1.47	0.55	**20.69**	**<0.0001**	**13.71**	**0.0002**	**18.96**	**<0.0001**	0.00	0.9741
Emerald Shiner	MF	38.45	0.46	1.07	**21.59**	**<0.0001**	**16.66**	**<0.0001**	**12.37**	**0.0004**	0.56	0.4532
	OT	0.17	0.02	0.00	**64.23**	**<0.0001**	**33.01**	**<0.0001**	**39.44**	**<0.0001**	1.00	0.3173
	POT	0.06	0.04	0.08	0.91	0.6333						
	EF	0.14	0.26	0.18	0.48	0.7849						
	HN	0.05	0.15	0.19	0.31	0.857						
	MF	0.00	0.06	0.00	4.32	0.1153						
Flathead Catfish	OT	0.00	0.06	0.03	0.69	0.7067						
	POT	0.00	0.00	0.01	**5.85**	**0.0536**			1.74	0.1872	4.20	0.0405
	SHN	0.17	0.61	0.29	**8.10**	**0.0175**	2.20	0.1377	2.04	0.1532	**7.42**	**0.0065**
	TN	0.03	0.00	0.00	4.17	0.1241						
	EF	2.20	0.80	0.32	**37.76**	**<0.0001**	**21.21**	**<0.0001**	**36.25**	**<0.0001**	1.57	0.2095
	HN	0.07	0.41	0.05	**6.30**	**0.043**	0.02	0.8988	4.12	0.0423	**5.80**	**0.0161**
	MF	6.73	0.12	0.05	0.89	0.6417						
Gizzard Shad	OT	0.00	0.01	0.00	1.17	0.558						
	POT	0.01	0.00	0.00	2.24	0.3263						
	SHN	0.04	0.00	0.00	**6.11**	**0.047**	3.07	0.0796	3.07	0.0796		
	TN	0.47	0.09	0.00	**14.11**	**0.0009**	**5.87**	**0.0154**	**11.05**	**0.0009**	2.02	0.1551
	EF	0.49	1.26	0.54	1.15	0.5623						
	HN	0.02	0.05	0.07	0.00	0.9992						
Goldeye	MF	0.04	0.00	0.00	3.81	0.1485						
	OT	0.00	0.08	0.00	3.57	0.1679						
	POT	0.00	0.03	0.00	**6.15**	**0.0463**	3.26	0.0709	0.83	0.3619	3.57	0.059
	TN	0.00	0.00	0.06	1.48	0.4773						
Plains Minnow	POT	0.00	0.00	0.00	1.41	0.495						
	EF	2.78	3.67	0.78	**14.09**	**0.0009**	1.70	0.1926	**16.04**	**<0.0001**	**4.81**	**0.0282**
	MF	5.11	3.59	0.64	**19.35**	**<0.0001**	1.44	0.2295	**15.50**	**<0.0001**	**12.68**	**0.0004**
Red Shiner	OT	0.90	0.00	0.00	**102.8**	**<0.0001**	**54.58**	**<0.0001**	**54.58**	**<0.0001**		
	POT	0.00	0.30	0.13	**18.23**	**0.0001**	**14.85**	**0.0001**	**11.80**	**0.0006**	3.88	0.0489
	SHN	0.02	0.02	0.02	0.12	0.9422						
	EF	1.60	0.16	0.13	**34.89**	**<0.0001**	**26.25**	**<0.0001**	**21.00**	**<0.0001**	0.56	0.4548
	HN	0.00	0.61	0.27	3.84	0.1465						
	MF	3.11	0.02	0.02	**15.65**	**0.0004**	**8.84**	**0.0029**	**9.25**	**0.0024**	0.00	0.9757
River Carpsucker	OT	0.19	0.00	0.00	**75.59**	**<0.0001**	**39.44**	**<0.0001**	**39.44**	**<0.0001**		
	POT	0.10	0.01	0.00	**17.42**	**0.0002**	**7.72**	**0.0055**	**13.48**	**0.0002**	2.03	0.154
	SHN	0.02	0.00	0.02	1.36	0.5074						
	TN	0.06	0.00	0.00	4.17	0.1241						
River Shiner	EF	0.00	0.10	0.04	1.95	0.3781						
	POT	0.00	0.00	0.00	1.41	0.495						
Sand Shiner	POT	0.00	0.00	0.00	1.41	0.495						
Sauger	EF	0.02	0.02	0.01	0.22	0.8955						

Table III.11.4 (continued). Yearly mean CPUE and results of Kruskal-Wallis test of mean CPUE of target species caught in Tadpole chute by species and gear. Significant results are bold.

Species	Gear	Mean CPUE			06 v 07 v 08		06 v 07		06 v 08		07 v 08	
		2006	2007	2008	Chi	P	Chi	P	Chi	P	Chi	P
Shortnose Gar	EF	0.20	0.40	0.05	**9.03**	**0.0109**	0.09	0.7592	**7.69**	**0.0055**	**7.51**	**0.0062**
	HN	0.04	0.33	0.44	3.45	0.1777						
	MF	0.21	0.00	0.04	**5.46**	**0.0652**	**5.03**	**0.0249**	1.33	0.2482	1.96	0.1616
	SHN	0.05	0.07	0.09	0.23	0.8932						
	TN	0.03	0.00	0.00	4.17	0.1241						
Shovelnose Sturgeon	EF	0.04	0.04	0.01	2.57	0.2771						
	HN	0.00	0.29	0.82	**9.83**	**0.0073**	1.05	0.3045	**4.91**	**0.0266**	**6.01**	**0.0142**
	OT	0.00	0.19	0.13	2.75	0.253						
	POT	0.01	0.00	0.00	2.24	0.3263						
	SHN	0.02	0.02	0.38	**5.36**	**0.0687**	0.09	0.7654	2.20	0.1381	3.97	0.0462
	TN	0.10	0.87	0.54	2.08	0.3535						
Sicklefin Chub	MF	0.75	0.02	0.02	**15.65**	**0.0004**	**8.84**	**0.0029**	**9.25**	**0.0024**	0.00	0.9757
	OT	0.50	0.00	0.00	**75.59**	**<0.0001**	**39.44**	**<0.0001**	**39.44**	**<0.0001**		
	POT	0.01	0.00	0.03	**6.37**	**0.0413**	**7.73**	**0.0054**	0.51	0.4749	4.19	0.0406
Silver Carp	EF	0.00	0.02	0.02	1.58	0.454						
	HN	0.00	0.10	0.20	2.47	0.2913						
	MF	1.14	0.00	0.00	1.88	0.3906						
	TN	0.00	0.06	0.00	1.48	0.4773						
Silver Chub	EF	0.11	0.02	0.07	4.41	0.1104						
	MF	0.13	0.09	0.02	2.82	0.2438						
	OT	0.70	0.02	0.00	**91.91**	**<0.0001**	**48.91**	**<0.0001**	**54.57**	**<0.0001**	1.00	0.3173
	POT	0.07	0.05	0.06	3.24	0.198						
	SHN	0.00	0.00	0.02	1.66	0.4361						
Speckled Chub	EF	0.01	0.03	0.00	1.69	0.4304						
	MF	0.04	0.04	0.46	**5.98**	**0.0502**	0.01	0.9313	4.00	0.0454	3.52	0.0605
	OT	0.08	0.04	0.07	**23.89**	**<0.0001**	**20.46**	**<0.0001**	**13.68**	**0.0002**	0.65	0.4217
	POT	0.01	0.09	0.27	4.09	0.1293						
Sturgeon Chub	OT	0.00	0.00	0.05	2.36	0.3079						
Western Silvery Minnow	MF	0.00	0.00	0.02	2.00	0.3679						

Gear : EF = electrofishing, HN = 4’ diameter hoop nets, SHN = 2’ diameter hoop nets, MF = mini-fyke nets, OT = 16’ otter trawls, POT = 8’ otter trawls pushed, TN = combined efforts of 1” trammel nets in 25’ increments.

Table III.11.5. Catch per unit effort (CPUE) in bold, and 2 standard errors (SE) of target species caught in Tadpole chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Bighead carp	HN						**0.13** 0.25					**0.25** 0.50	**0.43** 0.59		**1.63** 1.25	**2.00** 1.96						
	MF										**0.13** 0.25											
	TN					**0.25** 0.49																
Blue sucker	OT			**0.10** 0.19									**0.11** 0.21									
	TN			**0.63** 1.25																	**0.83** 1.67	
Channel catfish	EF			**0.09** 0.17		**0.17** 0.22	**0.10** 0.21	**0.54** 0.44	**0.11** 0.21		**0.33** 0.45	**0.26** 0.34	**0.07** 0.14	**0.73** 0.69	**1.48** 1.15	**0.91** 0.72	**2.40** 1.24	**0.10** 0.21	**0.89** 0.48			**0.66** 0.45
	HN		**0.13** 0.25	**0.25** 0.33		**1.67** 2.56	**0.25** 0.33		**0.11** 0.22					**0.50** 0.38	**0.13** 0.25	**0.13** 0.25						**0.13** 0.25
	MF							**0.13** 0.25			**1.25** 0.82	**1.38** 1.25			**3.88** 2.25	**1.75** 1.24	**6.25** 3.77	**1.71** 1.43	**0.25** 0.33			**5.25** 3.18
	OT		**0.37** 0.36	**0.26** 0.36		**0.27** 0.36	**0.20** 0.26		**0.13** 0.25			**0.73** 1.01			**1.19** 0.77		**6.83** 2.37		**0.78** 0.45		**1.00** 0.53	**1.92** 3.85
	POT								**0.15** 0.14		**0.08** 0.05	**0.24** 0.22	**0.24** 0.16	**0.38** 0.53	**1.97** 0.80	**0.83** 0.41		**0.81** 0.54	**0.44** 0.36			**2.24** 1.71
	SHN		**0.38** 0.37	**0.25** 0.33		**0.75** 0.82	**0.88** 0.59	**1.14** 1.41	**1.63** 1.46		**3.75** 1.84	**0.25** 0.50		**1.75** 1.24	**0.75** 0.50	**0.13** 0.25	**2.00** 2.62	**0.43** 0.40	**0.13** 0.25			**0.25** 0.50
	TN										**0.22** 0.45			**0.78** 1.02								
Common carp	EF		**0.08** 0.15	**0.17** 0.22		**0.25** 0.25					**1.35** 1.07	**0.49** 0.31	**0.14** 0.28	**0.13** 0.26	**0.15** 0.16	**0.07** 0.14	**0.39** 0.54	**0.20** 0.26				
	HN						**0.38** 0.75		**0.33** 0.47			**0.13** 0.25	**0.43** 0.86	**0.13** 0.25		**0.13** 0.25						
	MF							**0.25** 0.50				**0.38** 0.37										
	SHN			**0.13** 0.25		**0.13** 0.25	**0.13** 0.25	**0.14** 0.29														
Emerald shiner	EF		**0.22** 0.44	**1.29** 2.00		**0.74** 0.28	**0.11** 0.22	**1.14** 1.12			**2.77** 1.66	**6.87** 9.64	**0.97** 1.15	**5.18** 4.23	**2.21** 1.45	**0.70** 0.43	**6.20** 3.92	**0.26** 0.36	**0.23** 0.24			**0.57** 0.42
	MF							**2.75** 4.42			**109.25** 92.96	**0.13** 0.25		**82.00** 0.00	**1.50** 3.00	**3.88** 6.44	**75.13** 61.73	**1.57** 1.94				**3.63** 3.00
	OT		**0.13** 0.25														**1.21** 0.90					
	POT								**0.04** 0.05		**0.10** 0.09	**0.03** 0.04	**0.19** 0.20	**0.30** 0.51	**0.10** 0.09	**0.02** 0.03		**0.14** 0.12	**0.06** 0.06			**0.32** 0.22

Table III.11.5 (continued). CPUE in bold, and 2 SE of target species caught in Tadpole chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Flathead catfish	EF		**0.11** 0.22	**0.09** 0.17		**0.24** 0.35	**0.11** 0.22	**0.09** 0.17	**0.21** 0.28		**0.12** 0.25	**0.28** 0.56	**0.20** 0.29	**0.51** 0.39	**0.37** 0.31	**0.71** 0.53	**0.26** 0.35	**0.58** 0.48	**0.12** 0.16			
	HN					**0.33** 0.67	**0.13** 0.25						**0.86** 1.11	**0.25** 0.33	**0.25** 0.33	**0.13** 0.25	**0.13** 0.25	**0.50** 0.53	**0.25** 0.33			
	MF														**0.25** 0.50			**0.14** 0.29				
	OT			**0.09** 0.17		**0.17** 0.33						**0.15** 0.29			**0.11** 0.23	**0.14** 0.28						
	POT												**0.05** 0.07			**0.03** 0.04						
	SHN		**0.13** 0.25			**1.88** 1.28	**0.38** 0.53	**0.29** 0.37	**1.38** 0.92		**0.13** 0.25	**0.25** 0.50	**1.00** 1.31	**0.50** 0.38	**0.38** 0.37	**0.63** 0.84	**0.25** 0.33	**0.29** 0.37				
	TN										**0.24** 0.48											
Gizzard shad	EF			**0.91** 1.08		**0.42** 0.38		**0.96** 0.50			**2.09** 0.92	**1.81** 1.16	**0.13** 0.18	**1.94** 0.98	**2.69** 1.98	**0.58** 0.31	**10.38** 3.44	**0.65** 0.44	**0.31** 0.19			**0.29** 0.35
	HN		**2.13** 1.44	**0.13** 0.25			**0.13** 0.25		**0.11** 0.22			**0.25** 0.33		**0.38** 0.37	**0.38** 0.53	**0.13** 0.25	**0.13** 0.25					
	MF											**0.25** 0.33		**47.00** 0.00		**0.13** 0.25	**0.13** 0.25	**0.57** 0.86				**0.25** 0.33
	OT								**0.10** 0.21													
	POT											**0.02** 0.03		**0.08** 0.16								
	SHN													**0.13** 0.25			**0.13** 0.25					
	TN		**0.66** 0.87											**3.26** 2.41								
Goldeye	EF		**0.48** 0.38	**0.51** 0.42		**0.60** 0.69	**0.34** 0.48	**0.31** 0.24			**1.04** 1.02	**5.41** 3.21	**0.60** 0.31	**2.06** 1.17	**1.44** 0.81	**1.09** 0.50		**0.89** 0.78	**0.17** 0.17			**1.10** 0.56
	HN											**0.13** 0.25			**0.25** 0.33		**0.13** 0.25		**0.13** 0.25			**0.38** 0.53
	MF							**0.25** 0.33														
	OT											**0.28** 0.37			**0.25** 0.50							
	POT								**0.14** 0.13			**0.06** 0.08			**0.01** 0.02							**0.03** 0.04
	TN																					**0.39** 0.78
Plains minnow	POT																					**0.01** 0.03

Table III.11.5 (continued). CPUE in bold, and 2 SE of target species caught in Tadpole chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Red shiner	EF		**0.22**			**7.88**		**6.86**	**0.11**		**8.46**	**8.49**	**1.84**	**1.47**	**8.82**	**1.59**	**2.67**	**0.18**	**1.45**			**0.58**
			0.29			5.76		3.00	0.22		1.55	4.99	1.15	1.71	4.42	0.75	2.82	0.23	0.88			0.20
	MF							**11.00**			**10.38**	**8.38**		**1.00**	**7.88**	**2.75**	**13.38**	**8.86**	**0.75**			**1.00**
								10.30			7.91	8.30		0.00	10.10	2.64	6.20	5.55	0.82			0.85
	OT																**6.32**					
																	3.22					
	POT								**0.55**		**0.02**	**0.25**	**0.14**		**0.36**	**0.08**		**0.98**	**0.12**			**0.59**
									0.46		0.03	0.13	0.14		0.17	0.06		0.89	0.09			0.35
	SHN							**0.14**				**0.13**							**0.13**			
								0.29				0.25							0.25			
River carpsucker	EF			**0.58**				**0.26**	**0.13**		**3.54**	**0.97**	**0.06**	**0.26**	**0.05**	**0.14**	**7.14**					**0.10**
				0.62				0.34	0.25		2.05	1.00	0.13	0.34	0.10	0.28	2.31					0.13
	HN					**0.50**							**0.29**		**3.63**	**0.75**		**0.13**	**0.88**			
						0.68							0.37		2.90	0.73		0.25	0.80			
	MF							**2.75**			**0.38**			**17.00**	**0.13**	**0.13**	**1.63**					
								2.85			0.75			0.00	0.25	0.25	1.96					
	OT																**1.32**					
																	0.75					
	POT								**0.07**		**0.01**			**0.67**								
									0.09		0.02			0.69								
	SHN												**0.14**				**0.13**					
													0.29				0.25					
	TN													**0.42**								
														0.83								
River shiner	EF												**0.26**		**0.67**							
													0.28		1.07							
	POT																					**0.01**
																						0.03
Sand shiner	POT								**0.02**													
									0.03													
Sauger	EF											**0.10**			**0.05**		**0.14**		**0.04**			
												0.21			0.11		0.29		0.09			
Shortnose gar	EF		**0.57**			**1.94**	**0.18**	**0.24**			**0.92**		**0.09**		**0.29**		**0.27**		**0.10**			
			0.51			1.53	0.37	0.34			0.46		0.18		0.20		0.35		0.13			
	HN			**0.63**			**0.13**		**0.44**			**1.50**	**0.57**	**0.25**	**0.38**	**1.13**			**0.50**			**0.13**
				0.84			0.25		0.35			1.25	0.86	0.50	0.37	0.80			0.53			0.25
	MF										**0.38**			**1.00**		**0.13**	**0.13**					**0.13**
											0.37			0.00		0.25	0.25					0.25
	SHN											**0.25**	**0.29**	**0.25**	**0.25**	**0.38**	**0.13**					
												0.33	0.57	0.33	0.33	0.53	0.25					
	TN										**0.23**											
											0.45											

Table III.11.5 (continued). CPUE in bold, and 2 SE of target species caught in Tadpole chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Shovelnose sturgeon	EF					**0.17** 0.33		**0.17** 0.22						**0.12** 0.23				**0.09** 0.18				**0.05** 0.09
	HN			**0.75** 0.50		**1.67** 3.33	**4.75** 5.73		**0.11** 0.22				**0.14** 0.29					**0.25** 0.50				**0.13** 0.25
	OT		**0.13** 0.25	**0.20** 0.40		**0.17** 0.33	**0.10** 0.20		**0.10** 0.21			**0.44** 0.64				**0.58** 1.17					**0.50** 0.76	
	POT												**0.03** 0.05	**0.08** 0.16								
	SHN			**1.75** 1.95			**0.88** 0.96		**0.13** 0.25								**0.13** 0.25					
	TN		**0.39** 0.78	**0.63** 1.25			**2.80** 5.60	**0.72** 0.93				**2.39** 3.13			**1.77** 2.42						**1.52** 1.99	**0.39** 0.78
Sicklefin chub	MF							**0.88** 0.70							**0.13** 0.25		**4.38** 3.44					**0.13** 0.25
	OT																**3.48** 2.26					
	POT										**0.06** 0.06											**0.21** 0.21
Silver carp	EF		**0.15** 0.31	**0.10** 0.19									**0.06** 0.13									
	HN					**0.17** 0.33						**0.38** 0.53			**0.13** 0.25	**1.38** 0.75						
	MF													**8.00** 0.00								
	TN		**0.42** 0.83																			
Silver Chub	EF		**0.07** 0.14								**0.11** 0.21			**0.13** 0.25			**0.53** 0.59	**0.09** 0.18	**0.37** 0.32			**0.11** 0.14
	MF										**0.25** 0.50				**0.63** 0.65	**0.13** 0.25	**0.63** 0.53					
	OT		**0.13** 0.25														**4.93** 2.63					
	POT										**0.06** 0.07	**0.03** 0.05		**0.41** 0.23	**0.33** 0.16	**0.10** 0.14			**0.17** 0.34			**0.14** 0.13
	SHN			**0.13** 0.25																		
Speckled chub	EF					**0.19** 0.25		**0.08** 0.16														
	MF														**0.13** 0.25		**0.25** 0.33	**0.14** 0.29	**0.25** 0.33			**3.00** 2.75
	OT		**0.25** 0.33	**0.10** 0.20			**0.10** 0.20						**0.21** 0.43				**0.59** 0.43		**0.09** 0.19			
	POT												**0.05** 0.07	**0.08** 0.16	**0.02** 0.03	**0.02** 0.03		**0.61** 0.33	**0.04** 0.05			**1.80** 0.94

Table III.11.5 (continued). CPUE in bold, and 2 SE of target species caught in Tadpole chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Sturgeon chub	OT			**0.20** 0.40												**0.14** 0.29						
Western silvery minnow	MF															**0.13** 0.25						

Gears: EF = electrofishing, HN = 4' diameter hoop nets, MF = mini-fyke nets, OT = 16' otter trawls, SHN = 2' diameter hoop nets, POT = 8' otter trawls pushed, TN = combined efforts of 1" trammel nets in 25' increments.

Table III.11.6. Mean length (ML), standard error (SE) in parentheses and results of analysis of variance of mean length for target species caught in Tadpole chute, by year and gear. Significant results are bold.

Species	Gear	ML/SE 2006	ML/SE 2007	ML/SE 2008	06 v 07 v 08		2006 v 2007		2006 v 2008		2007 v 2008	
					F	P Value	F	P Value	F	P Value	F	P Value
Bighead carp	HN		667.4 (30.7)	722.9 (16.9)	2.84	0.1016						
	MF	44										
	TN		956									
Blue sucker	OT			437 (194)								
	TN		249	657								
Channel catfish	EF	172.8 (24.5)	115.8 (18.6)	99.3 (13.5)	**4.19**	**0.0177**	**2.07**	**0.0405**	**2.81**	**0.0059**	0.63	0.5296
	HN	439.8 (35.4)	485 (24.2)	492.2 (58.4)	0.37	0.697						
	SHN	243.2 (13.3)	277.2 (23.4)	222.1 (30.7)	1.36	0.2614						
	MF	97.3 (11.2)	60.5 (2.6)	49.5 (1.6)	**11.65**	**0.0001**	**3.56**	**0.0005**	**4.53**	**0.0001**	1.02	0.3098
	OT	75.3 (2.9)	125.3 (11.1)	139.6 (20.7)	**17.14**	**0.0001**	**-4.08**	**0.0001**	**-5.04**	**0.0001**	-0.92	0.3572
	POT	75 (9.2)	62.4 (1.7)	52.8 (0.9)	**13.28**	**0.0001**	**2.24**	**0.0258**	**3.88**	**0.0001**	**4.22**	**0.0001**
	TN	251.7 (57.1)										
Common carp	EF	520.8 (10.7)	427.9 (58.4)	515.8 (15.8)	2.33	0.1107						
	HN	532	645.3 (46.1)	626.1 (27.8)	0.8	0.4786						
	SHN	620	598	594.5 (39.5)	0.07	0.9346						
	MF	49.5 (9.5)	70.7 (27.5)	0.34	0.5999							
Emerald shiner	EF	57.1 (0.7)	53.4 (1.7)	58.7 (1.9)	**3.71**	**0.0258**	**2.15**	**0.0325**	-0.76	0.4451	**-2.48**	**0.0138**
	MF	45.1 (0.5)	36.6 (1.9)	47.5 (2.4)	**4.68**	**0.0101**	**2.85**	**0.0048**	-1.02	0.308	**-2.93**	**0.0037**
	OT	53.8 (2.9)	64		0.7	0.4151						
	POT	40.9 (1.5)	38.8 (2.6)	44.3 (2.4)	1.56	0.2164						
Flathead catfish	EF	270.3 (21.6)	292 (20)	274.6 (20.4)	0.3	0.7392						
	HN	451.3 (110.9)	585.6 (110.5)	487.4 (44.5)	0.57	0.5755						
	SHN	395.1 (38.8)	307.1 (14.8)	361.1 (36.6)	**2.99**	**0.0585**	**2.18**	**0.0334**	0.75	0.4569	-1.62	0.1109
	MF		304.7 (116.2)									
	OT		349.7 (66.1)	247.5 (149.5)	0.53	0.5193						
	POT			155.8 (20.4)								
	TN	312										

Table III.11.6 (continued). Mean length (ML), standard error (SE) in parentheses and results of analysis of variance of mean length for target species caught in Tadpole chute, by year and gear. Significant results are bold.

Species	Gear	ML/SE 2006	ML/SE 2007	ML/SE 2008	06 v 07 v 08		2006 v 2007		2006 v 2008		2007 v 2008	
					F	P Value	F	P Value	F	P Value	F	P Value
Gizzard shad	EF	144.2 (5.4)	118.2 (7.5)	163.4 (17.5)	**5.39**	**0.005**	**2.63**	**0.0091**	-1.35	0.1793	**-2.92**	**0.0038**
	HN	265 (5.9)	312.2 (10.6)	368.3 (23.7)	**4.09**	**0.0281**	**-1.84**	**0.077**	**-2.86**	**0.0081**	**-1.93**	**0.064**
	SHN	153.5 (13.5)										
	MF	72.3 (2.4)	84.7 (12.9)	69.3 (25.6)	0.8	0.464						
	OT		3									
	POT	79 (4)	80		0.02	0.9087						
	TN	200.5 (13.5)	244 (6)		2.37	0.1621						
Goldeye	EF	144.9 (13.4)	118.4 (3.3)	128.4 (6.2)	**3.99**	**0.0201**	**2.77**	**0.0061**	1.59	0.1136	-1.32	0.188
	HN	173	324.7 (19.4)	326.8 (13.7)	11.34	0.0139	-4.37	0.0072	-4.58	0.006	-0.09	0.9312
	MF	55 (5)										
	OT		214.8 (34.9)									
	POT		65.8 (7.6)	148.5 (7.5)	18.08	0.0011					-4.25	0.0011
	TN			269								
Plains minnow	POT			50								
Red shiner	EF	53 (0.9)	46.3 (0.7)	49 (0.8)	**20.32**	**0.0001**	**6.37**	**0.0001**	**2.69**	**0.0074**	**-1.94**	**0.0525**
	SHN	40	50	38								
	MF	45.4 (1)	38.5 (1)	48.1 (1.4)	**16.16**	**0.0001**	**5.18**	**0.0001**	-1.08	0.2828	**3.68**	**0.0003**
	OT	43.1 (1)										
	POT	46 (2)	36.1 (0.9)	38.5 (1.6)	1.6	0.2049						
River carpsucker	EF	144.1 (11.7)	97.5 (23.2)	306.9 (39.6)	**11.57**	**0.0001**	1.24	0.2168	**-4.5**	**0.0001**	**-4.23**	**0.0001**
	HN		378 (7.6)	357.6 (35.8)	0.6	0.4441						
	SHN	401		514								
	MF	38.1 (3.8)	67	371	**72.94**	**0.0001**	-1.05	0.3021	**-12.05**	**0.0001**	**-7.85**	**0.0001**
	OT	57.9 (4)										
	POT	54.3 (3.3)	23 (5.8)		**15.52**	**0.0007**	**3.94**	**0.0007**				
	TN	80										
River shiner	EF		42.8 (1.3)	44.8 (1.9)	0.66	0.4327						
	POT			48								
Sand shiner	POT		27									
Sauger	EF	182	215.5 (84.5)	162	0.07	0.9339						

Table III.11.6 (continued). Mean length (ML), standard error (SE) in parentheses and results of analysis of variance of mean length for target species caught in Tadpole chute, by year and gear. Significant results are bold.

Species	Gear	ML/SE 2006	ML/SE 2007	ML/SE 2008	06 v 07 v 08		2006 v 2007		2006 v 2008		2007 v 2008	
					F	P Value	F	P Value	F	P Value	F	P Value
Shortnose gar	EF	561.4 (12.1)	581.3 (8.5)	551.6 (33)	1.29	0.2839						
	HN	670 (2)	650.1 (11.3)	638 (10.1)	0.61	0.5471						
	SHN	602.3 (51.7)	588.5 (35.2)	551.6 (52.6)	0.3	0.7505						
	MF	576.2 (20.6)	488.5 (136.5)	1.2	0.3232							
	TN	578										
Shovelnose sturgeon	EF	577.3 (86.4)	585.3 (7.4)	642	0.14	0.8701						
	HN		584.9 (19.3)	565 (9.2)	**0.93**	**0.3378**						
	SHN	557	530	570.2 (14.6)	**0.19**	**0.8249**						
	OT		514 (38.2)	499.5 (54.7)	**0.05**	**0.8258**						
	POT	263.5 (147.5)	305	0.03	**0.8975**							
	TN	482 (84)	517.3 (25.3)	616.5 (26.4)	**4.42**	**0.0325**	-0.58	0.5695	**-2.25**	**0.0409**	**-2.54**	**0.0237**
Sicklefin chub	MF	26 (1.2)	32	28	0.4	0.6752						
	OT	32.7 (1.2)										
	POT	23 (0.4)		32 (1.2)	**19.27**	**0.0005**			**-4.39**	**0.0005**		
Silver carp	EF	754.3 (49.6)	516.5 (285.5)	329.5 (85.5)	3.07	0.135						
	HN		623.2 (101.6)	619.1 (25)	0	0.9575						
	MF	25.8 (2.7)										
	TN		750									
Silver chub	EF	63.8 (4.7)	100.5 (19.5)	72.3 (1.9)	**8.04**	**0.0053**	**-4.01**	**0.0015**	-1.39	0.1877	**3.19**	**0.0071**
	SHN			111								
	MF	68.3 (3.9)	30 (1.3)	40	29.42	0.0001	7.55	0.0001	3.05	0.0137	-1.05	0.3195
	OT	67.1 (1.3)	78		1.02	0.317						
	POT	39.2 (2.5)	34.1 (1.5)	51.3 (4.9)	8.21	0.0006	1.11	0.2689	-2.5	0.0148	-4.02	0.0001
Speckled chub	EF	42	32 (2)		8.33	0.2123						
	MF	38.5 (6.5)	37 (7)	36.5 (1.6)	0.07	0.9338						
	OT	39.4 (3.8)	51 (1)	48 (6.1)	2.22	0.151						
	POT	32.5 (2.5)	33.7 (1)	34.2 (0.6)	0.14	0.8654						
Sturgeon chub	OT			62.7 (3)								
Western silvery minnow	MF			45								

Gear : EF = electrofishing, HN = 4' diameter hoop nets, SHN = 2' diameter hoop nets, MF = mini-fyke nets, OT = 16' otter trawls, POT = 8' otter trawls pushed, TN = combined efforts of 1" trammel nets in 25' increments.

Table III.11.7. Results of z-test analysis of life stage proportions of target species caught in Tadpole chute. Significant results are bold.

Species	2006 v 2007 Z	2006 v 2008 Z	2007 v 2008 Z
Bighead carp	-	-	-
Blue sucker	-	-	1.15
Channel catfish	**-2.33**	**-2.99**	-0.96
Common carp	**-2.25**	1.02	**2.35**
Emerald shiner	**6.11**	**7.25**	0.70
Flathead catfish	-0.04	0.5	0.73
Gizzard shad	**4.08**	**5.07**	1.68
Goldeye	0.54	0.73	0.44
Plains minnow	-	-	-
Red shiner	**-5.98**	-1.12	**3.04**
River carpsucker	**10.22**	**9.95**	0.8
River shiner	-	-	-
Sand shiner	-	-	-
Sauger	0.87	-	-0.87
Shortnose gar	-	-0.92	-1.29
Shovelnose sturgeon	0.55	1.02	0.74
Sicklefin chub	-0.51	-1.3	0.27
Silver carp	1.28	0.08	-1.3
Silver chub	1.55	**2.38**	0.73
Speckled chub	-1.92	**-2.74**	-0.96
Sturgeon chub	-	-	-
Western silvery minnow	-	-	-

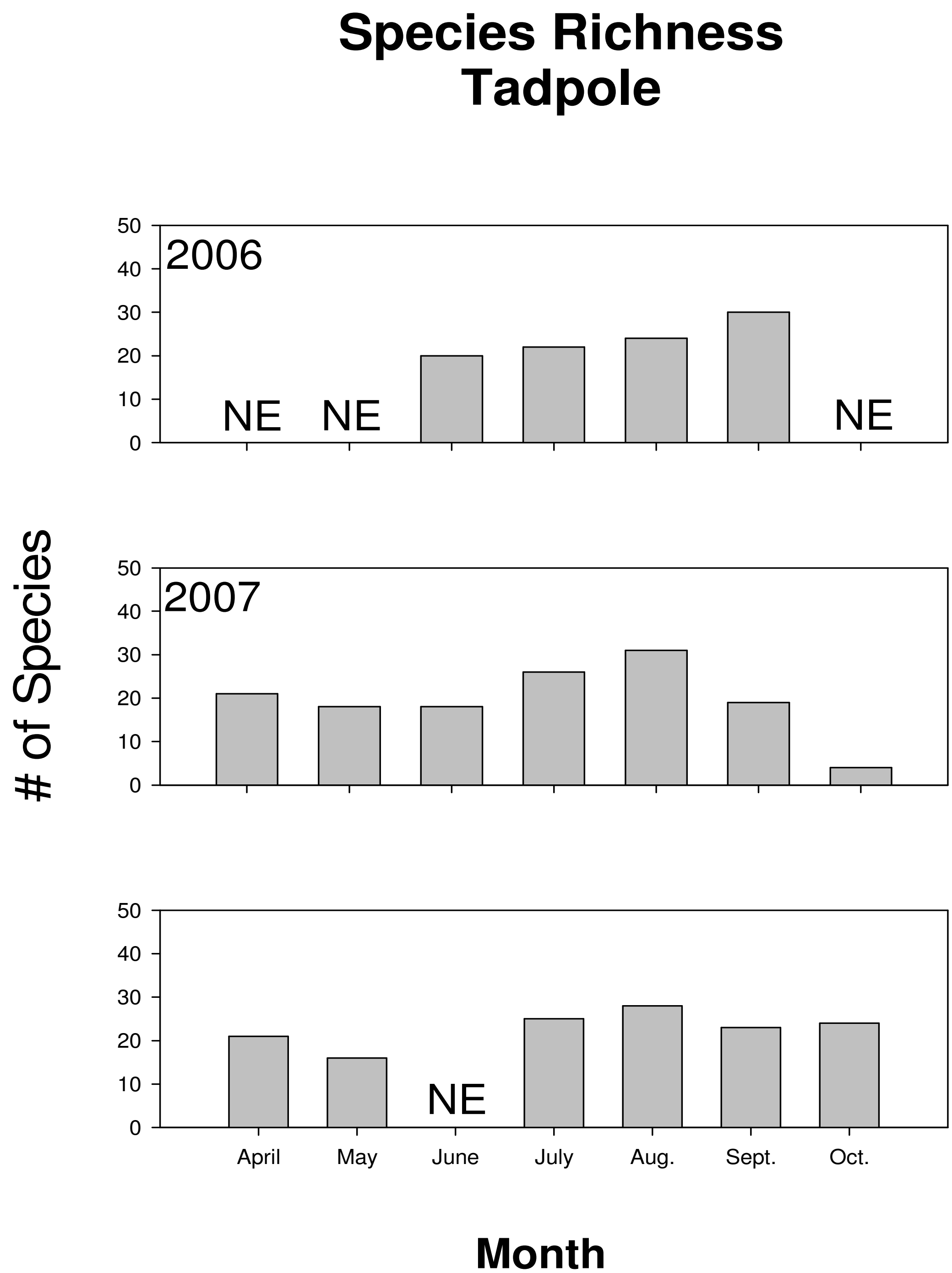


Figure III.11.1. Species richness in Tadpole chute by month and year.
NE = No effort during this month due to river conditions or construction.

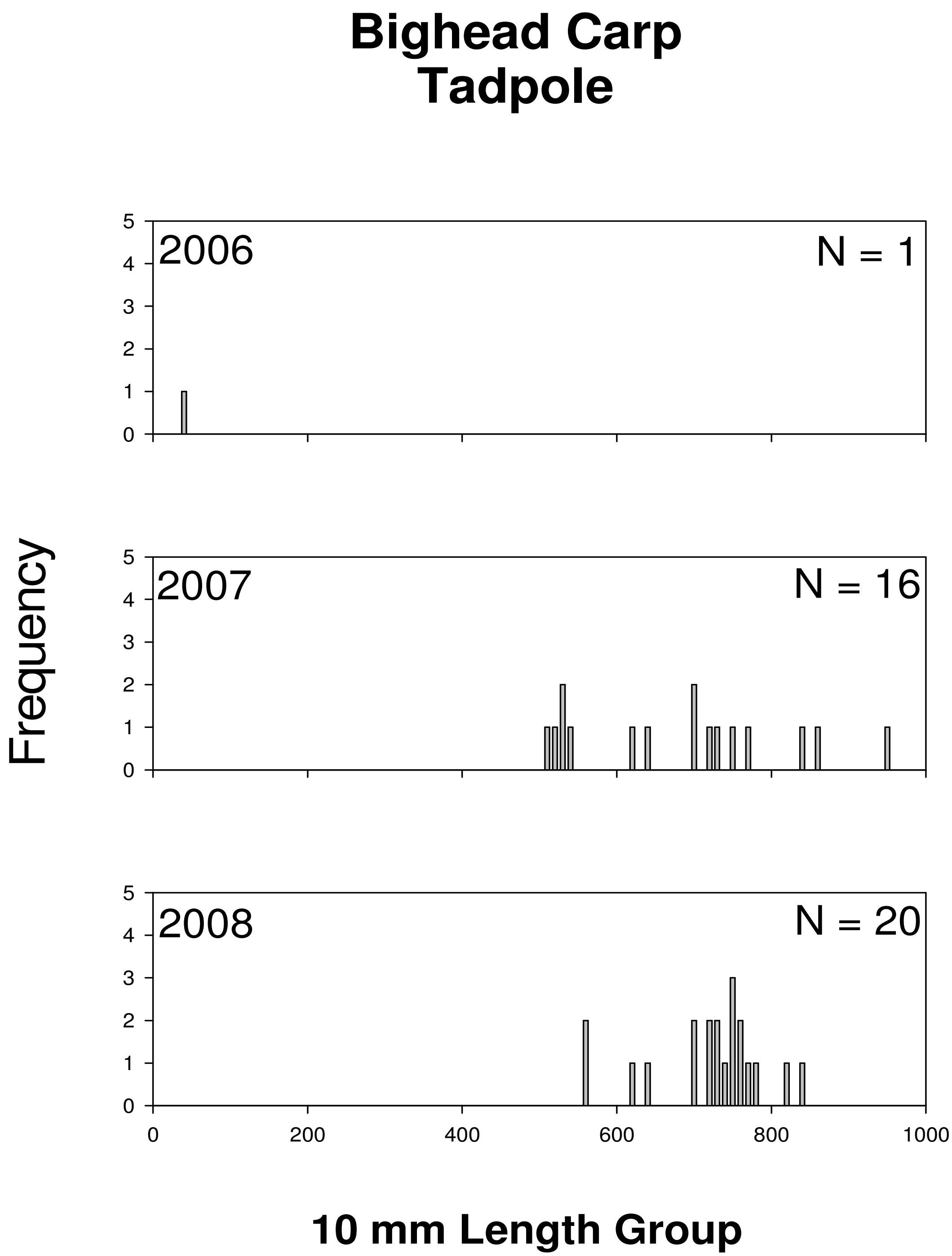


Figure III.11.2. Length frequency distribution of bighead carp in Tadpole chute by year. Length groups are in 10 mm intervals.

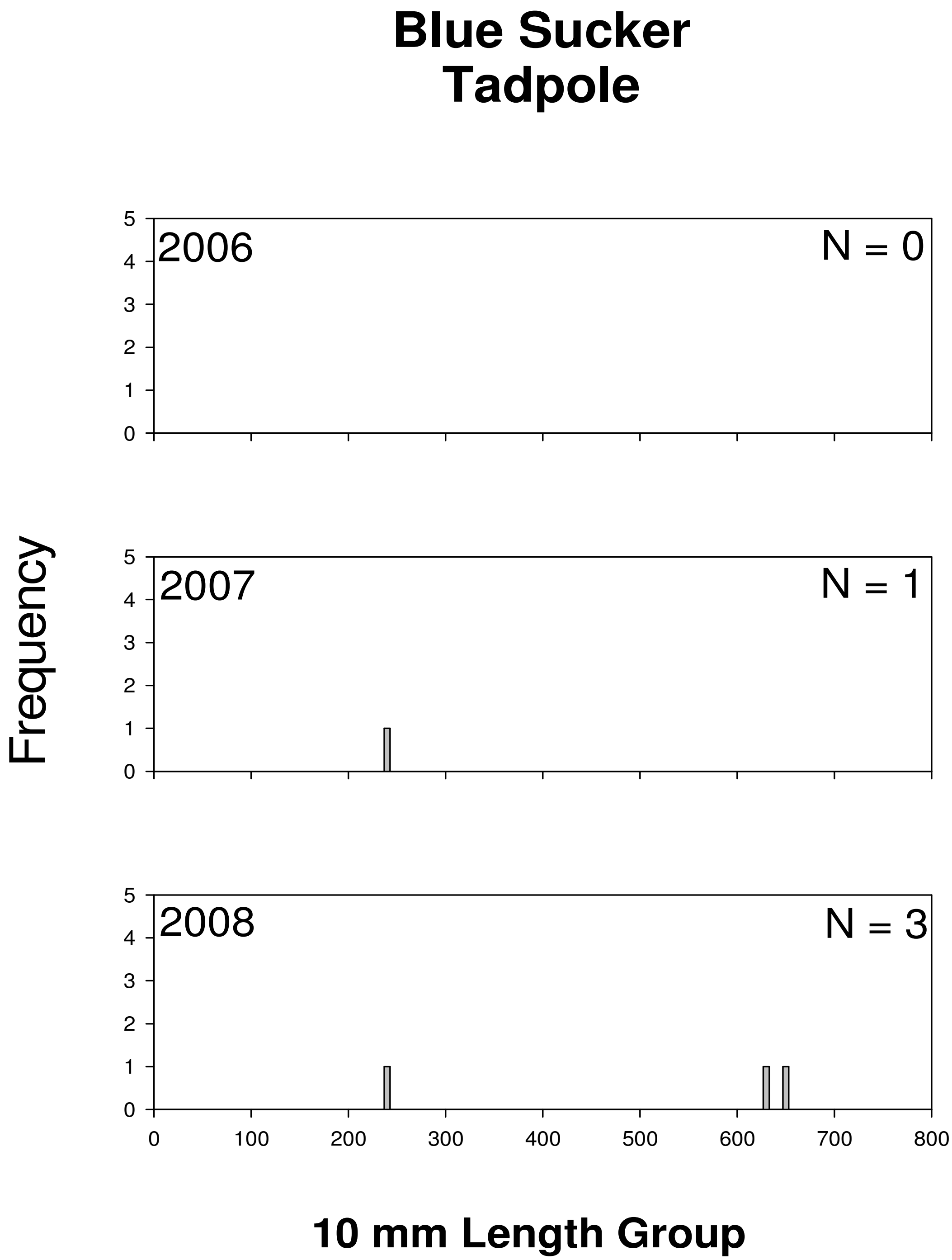


Figure III.11.3. Length frequency distribution of blue sucker in Tadpole chute by year. Length groups are in 10 mm intervals.

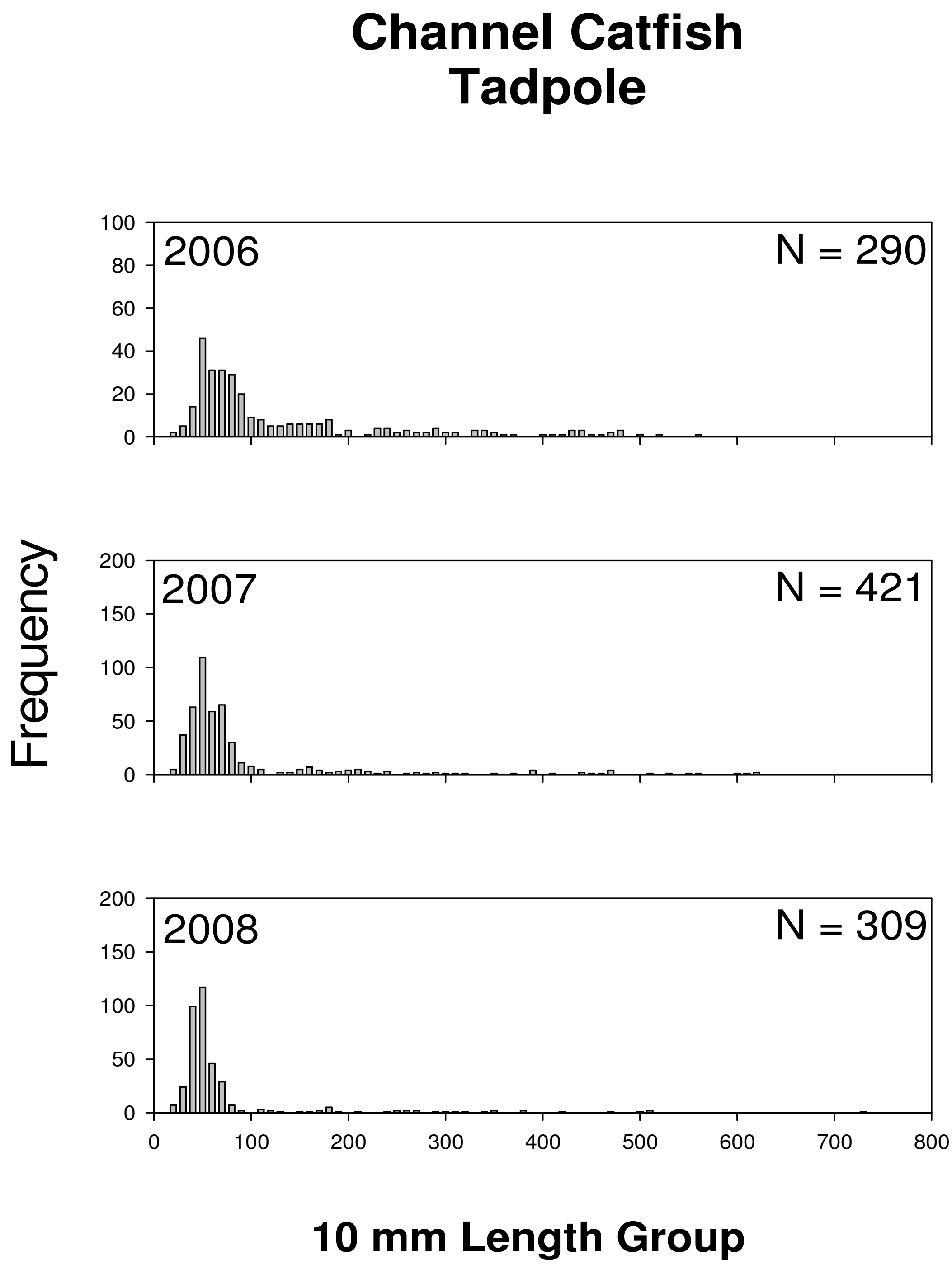


Figure III.11.4. Length frequency distribution of channel catfish in Tadpole chute by year. Length groups are in 10 mm intervals.

Common Carp
Tadpole

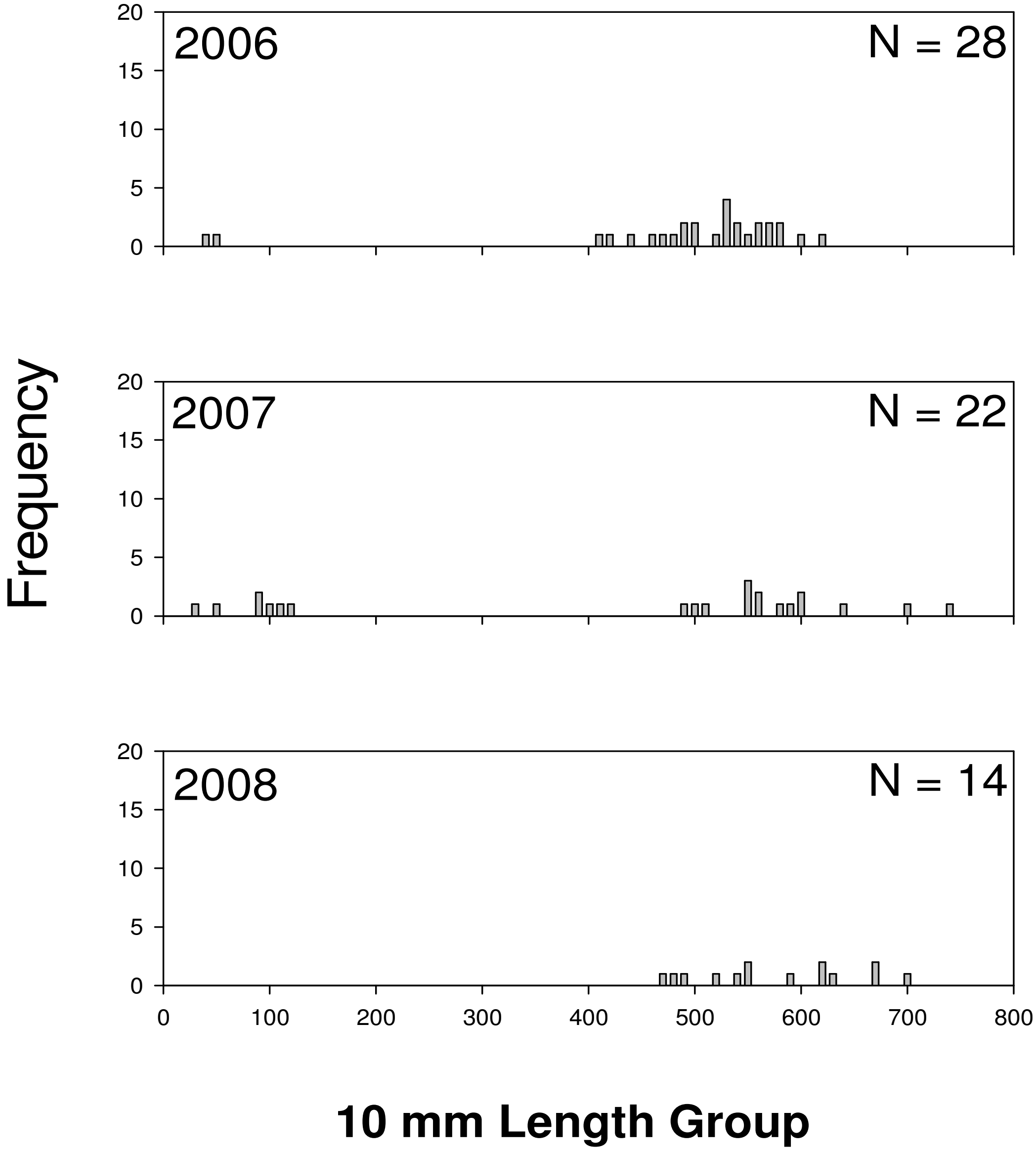


Figure III.11.5. Length frequency distribution of common carp in Tadpole chute by year. Length groups are in 10 mm intervals.

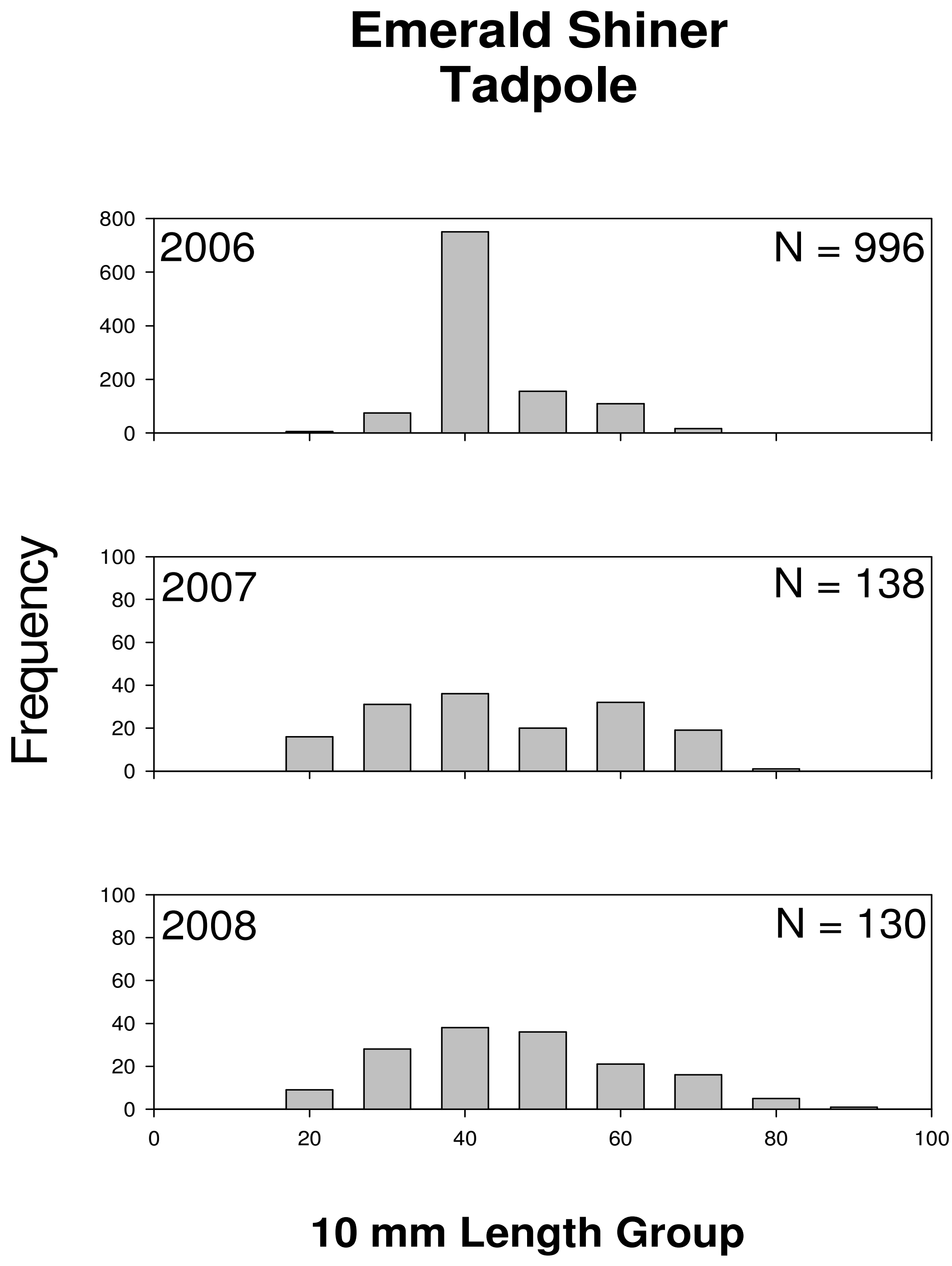


Figure III.11.6. Length frequency distribution of emerald shiner in Tadpole chute by year. Length groups are in 10 mm intervals.

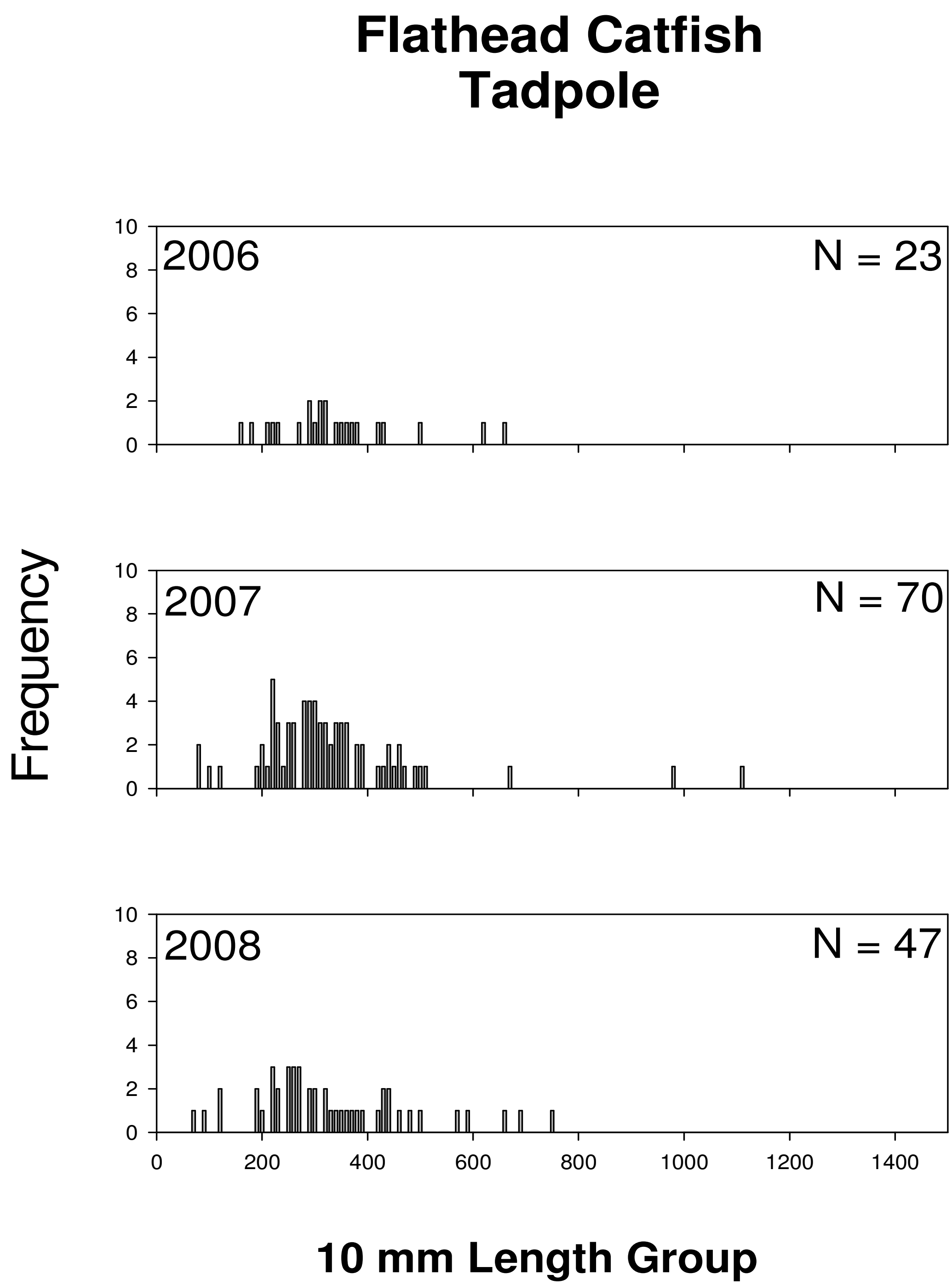


Figure III.11.7. Length frequency distribution of flathead catfish in Tadpole chute by year. Length groups are in 10 mm intervals.

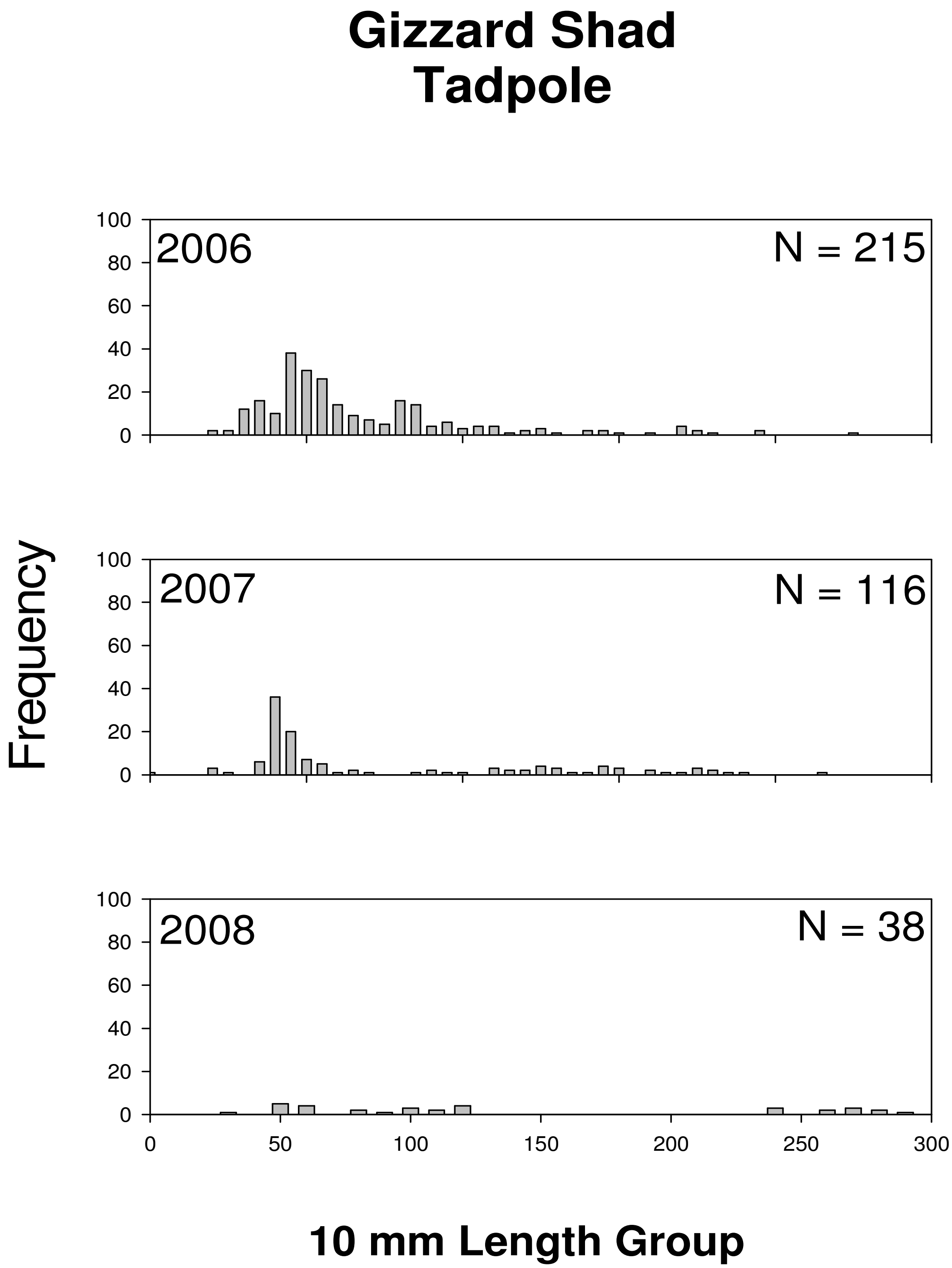


Figure III.11.8. Length frequency distribution of gizzard shad in Tadpole chute by year. Length groups are in 10 mm intervals.

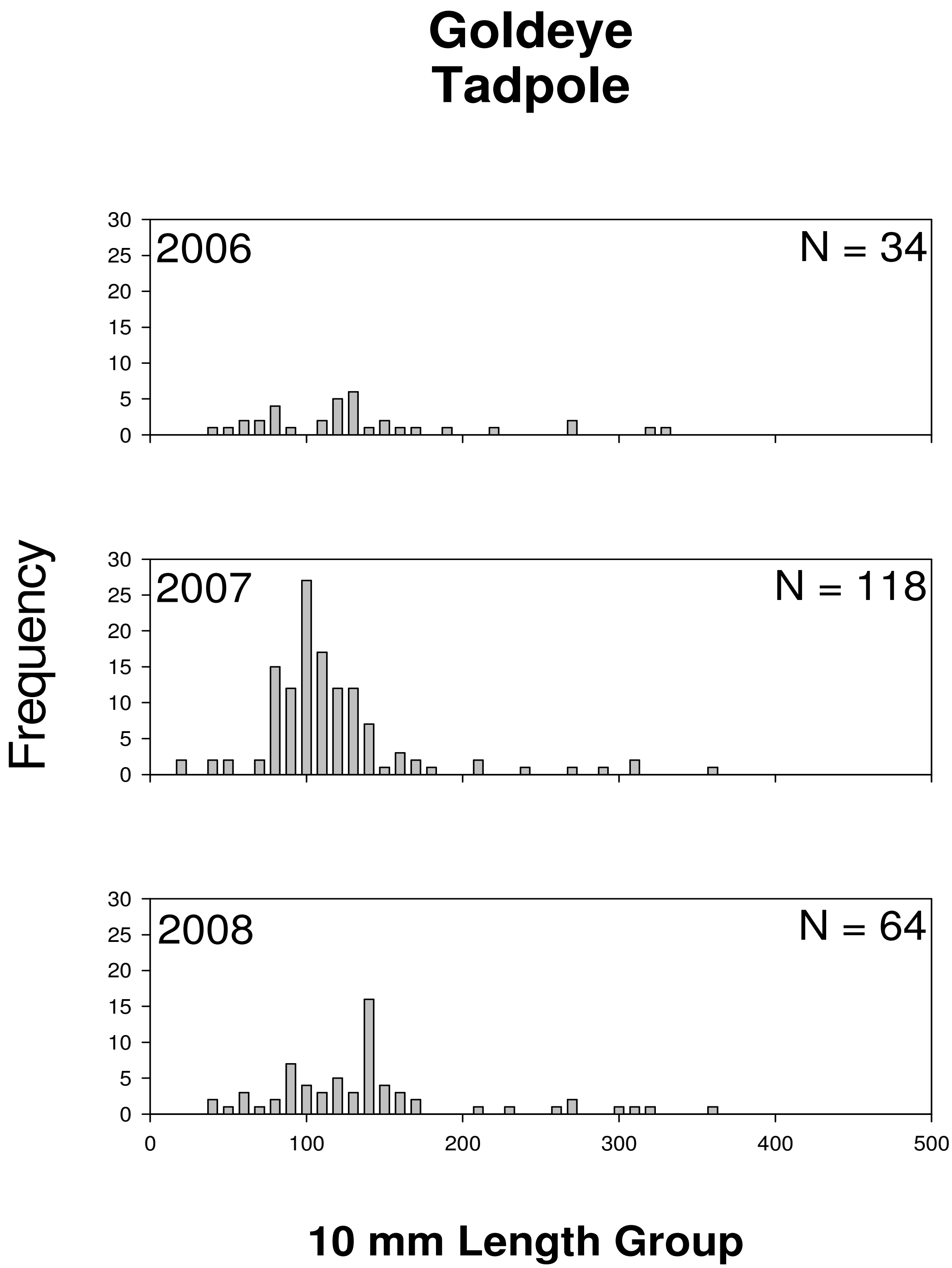


Figure III.11.9. Length frequency distribution of goldeye in Tadpole chute by year. Length groups are in 10 mm intervals.

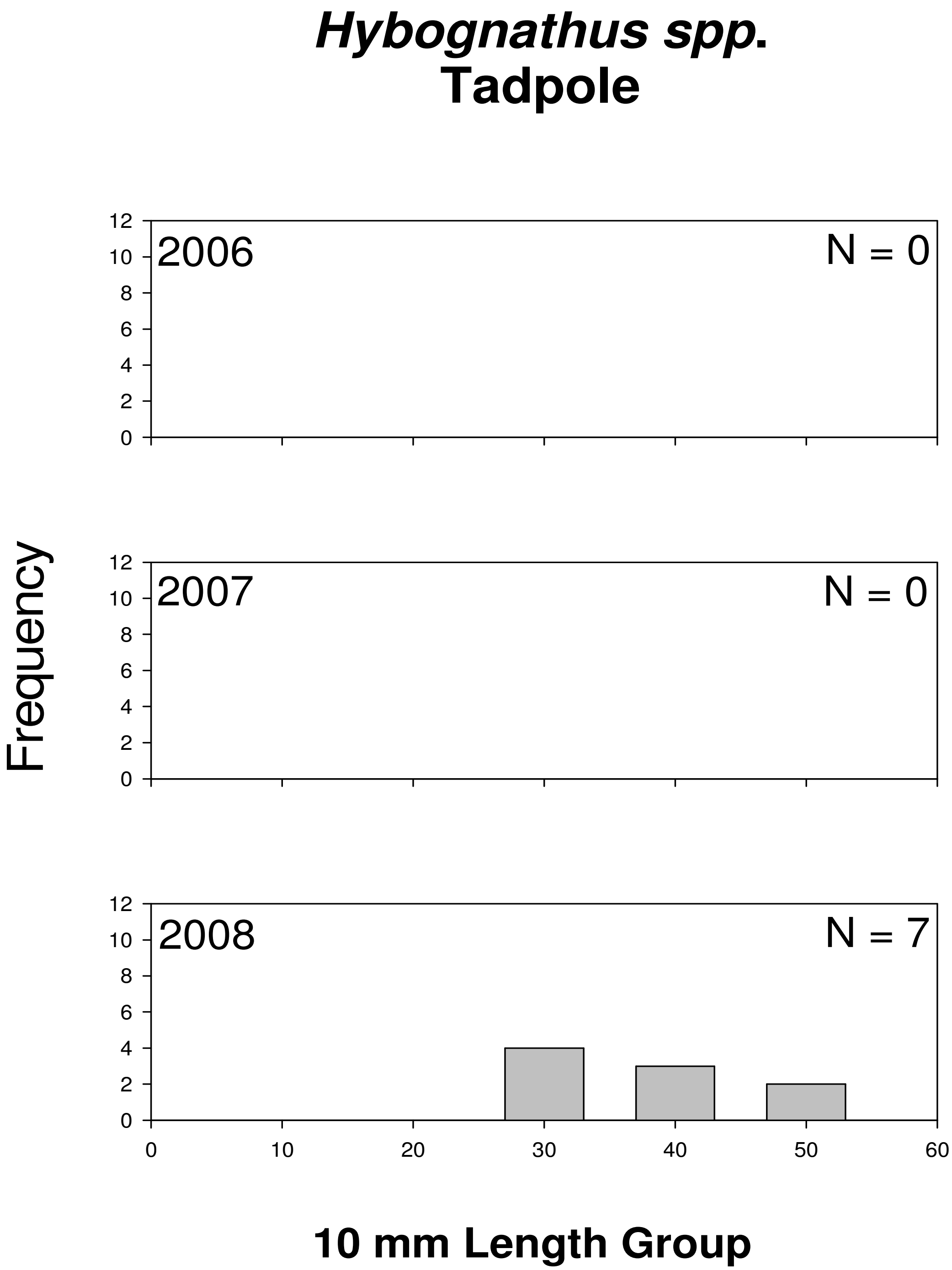


Figure III.11.10. Length frequency distribution of *Hybognathus spp*. in Tadpole chute by year. Length groups are in 10 mm intervals.

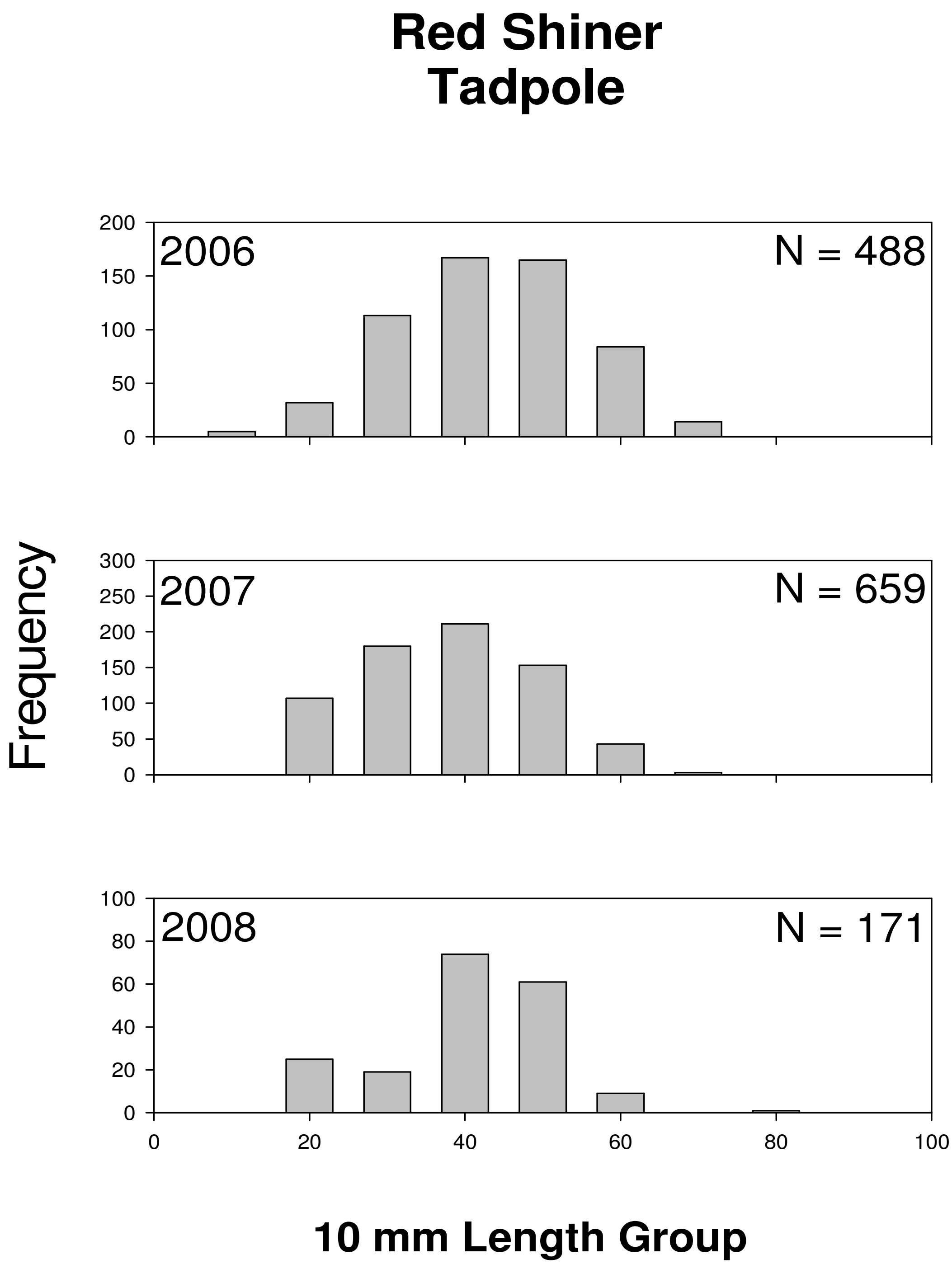


Figure III.11.11. Length frequency distribution of red shiner in Tadpole chute by year. Length groups are in 10 mm intervals.

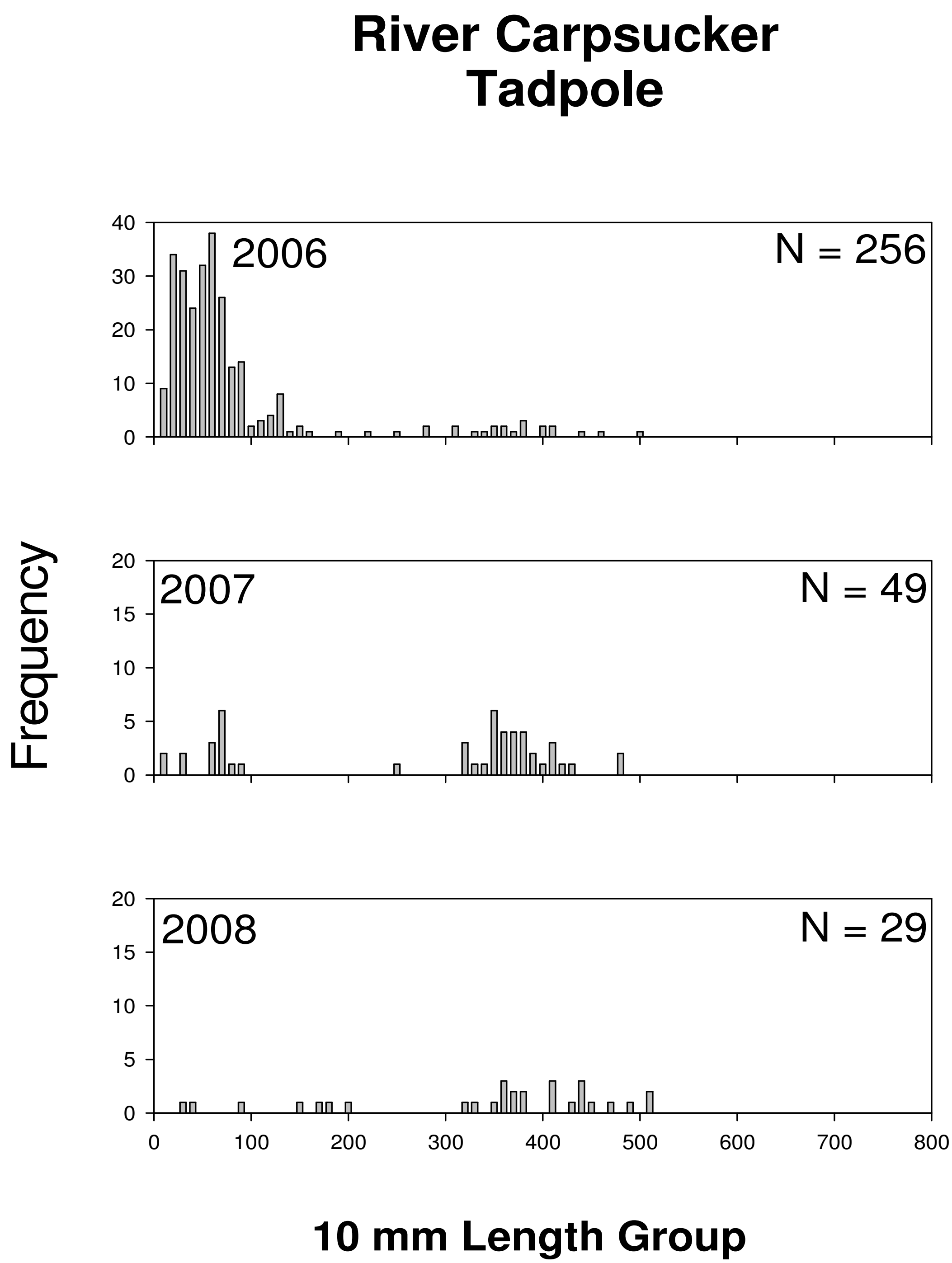


Figure III.11.12. Length frequency distribution of river carpsucker in Tadpole chute by year. Length groups are in 10 mm intervals.

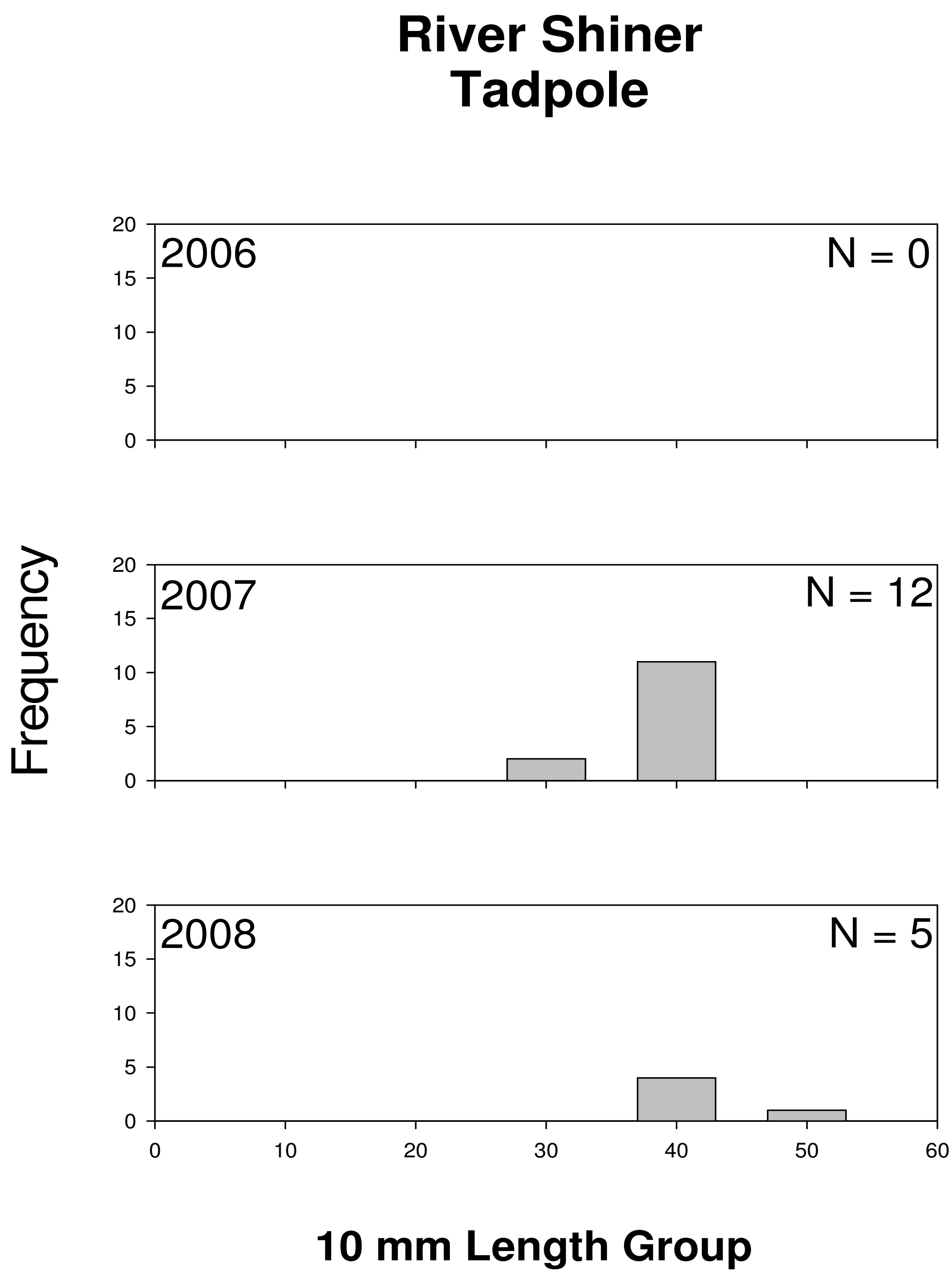


Figure III.11.13. Length frequency distribution of river shiner in Tadpole chute by year. Length groups are in 10 mm intervals.

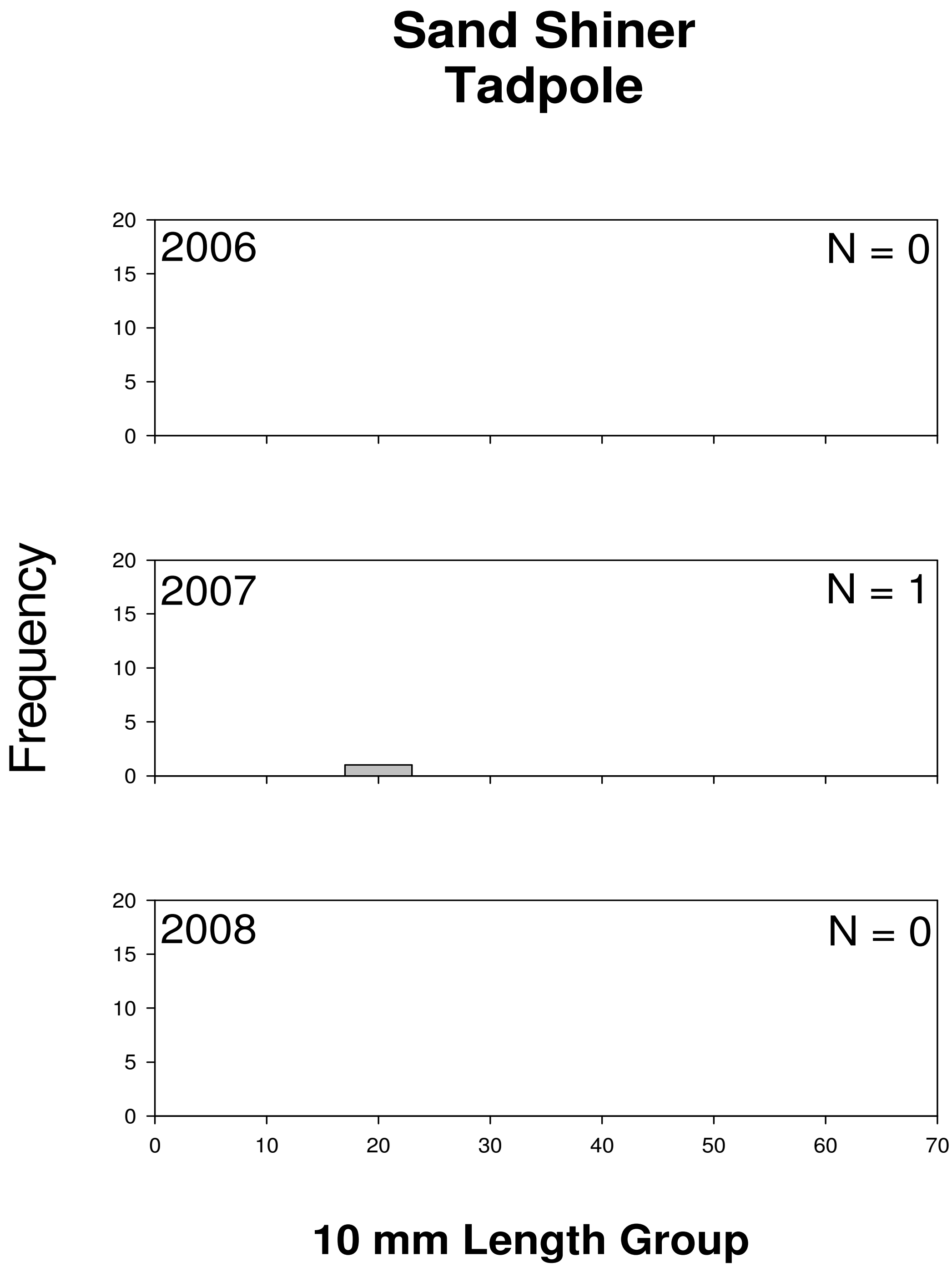


Figure III.11.14. Length frequency distribution of sand shiner in Tadpole chute by year. Length groups are in 10 mm intervals.

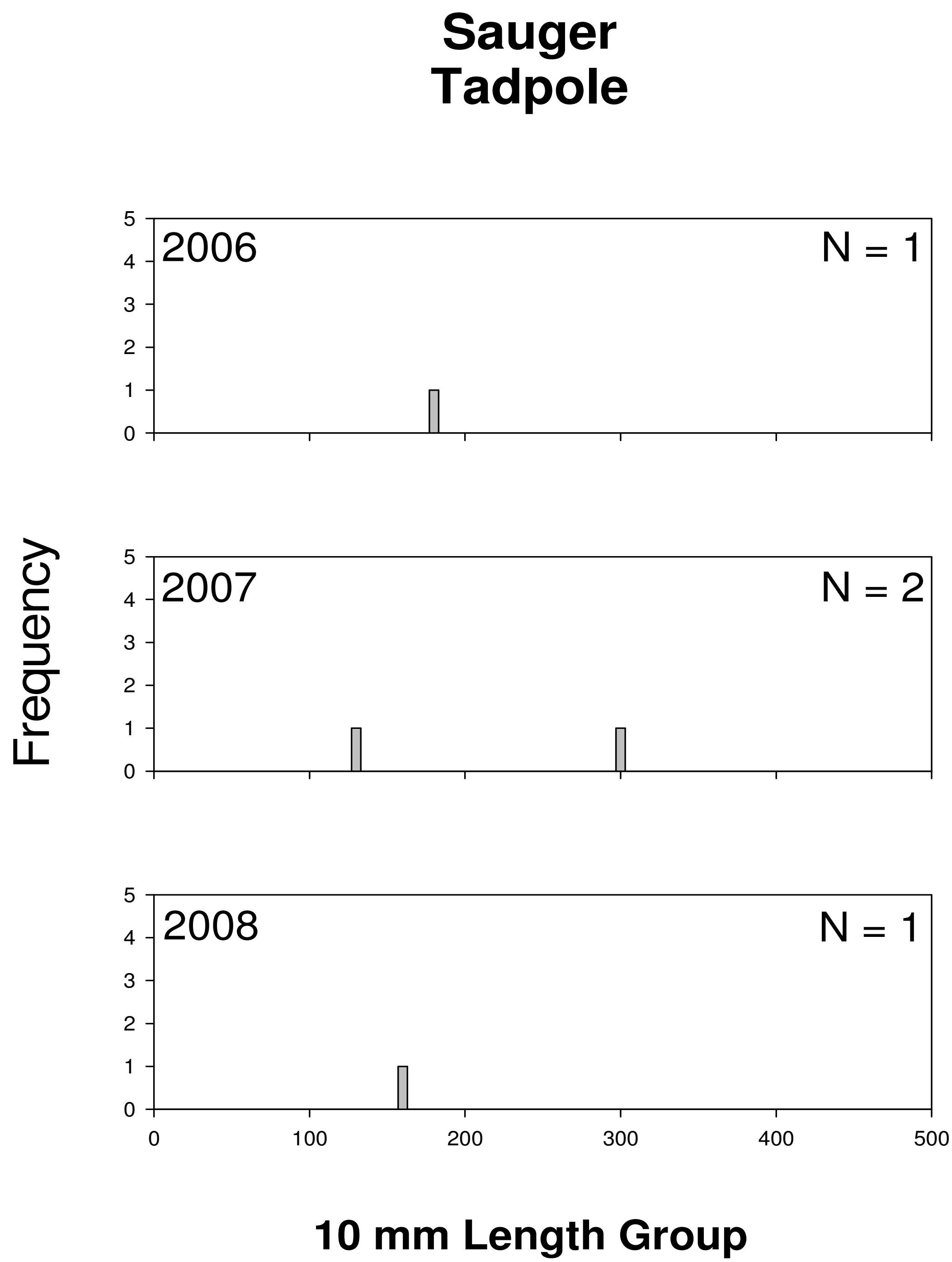


Figure III.11.15. Length frequency distribution of sauger in Tadpole chute by year. Length groups are in 10 mm intervals.

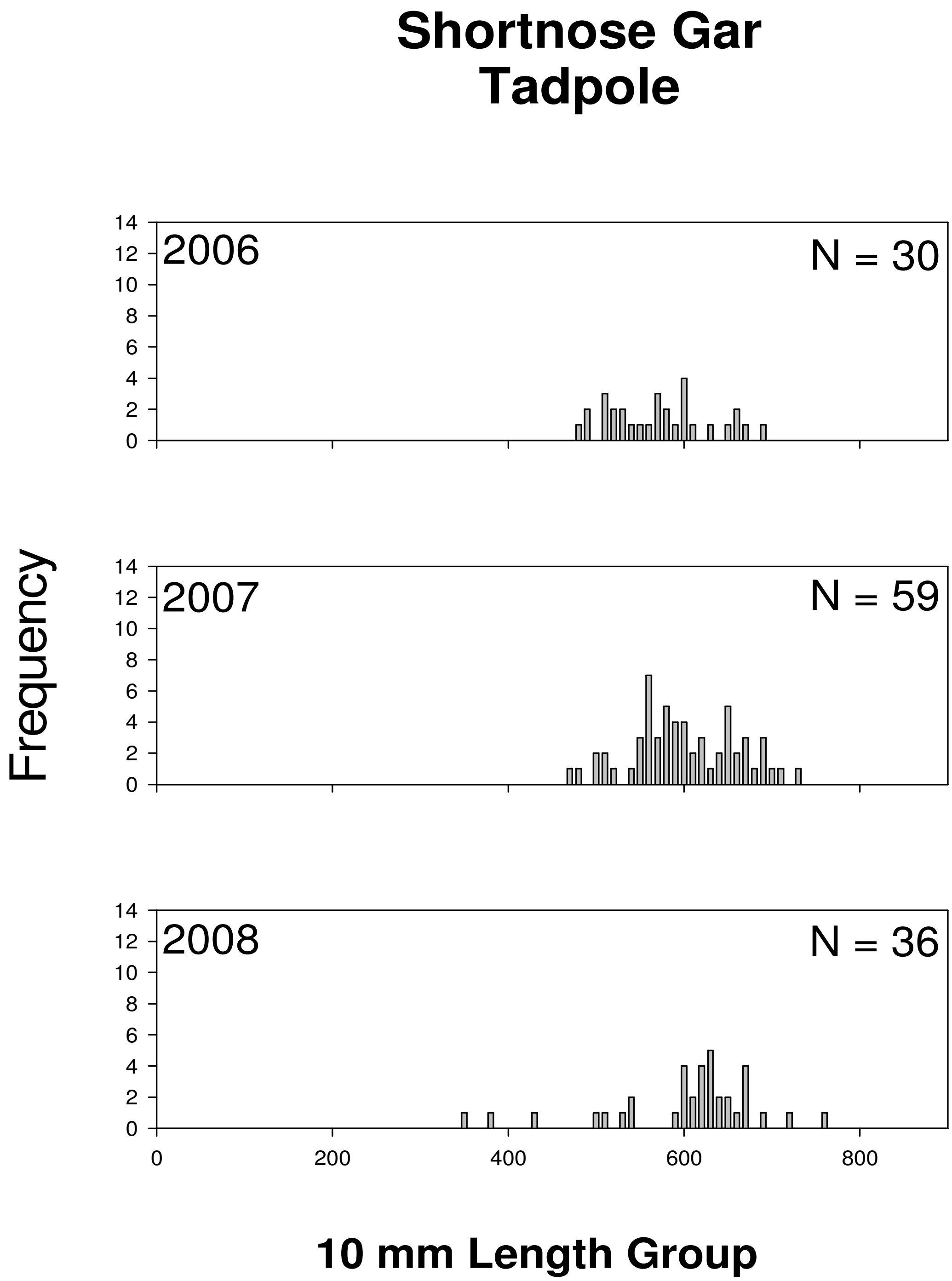


Figure III.11.16. Length frequency distribution of shortnose gar in Tadpole chute by year. Length groups are in 10 mm intervals.

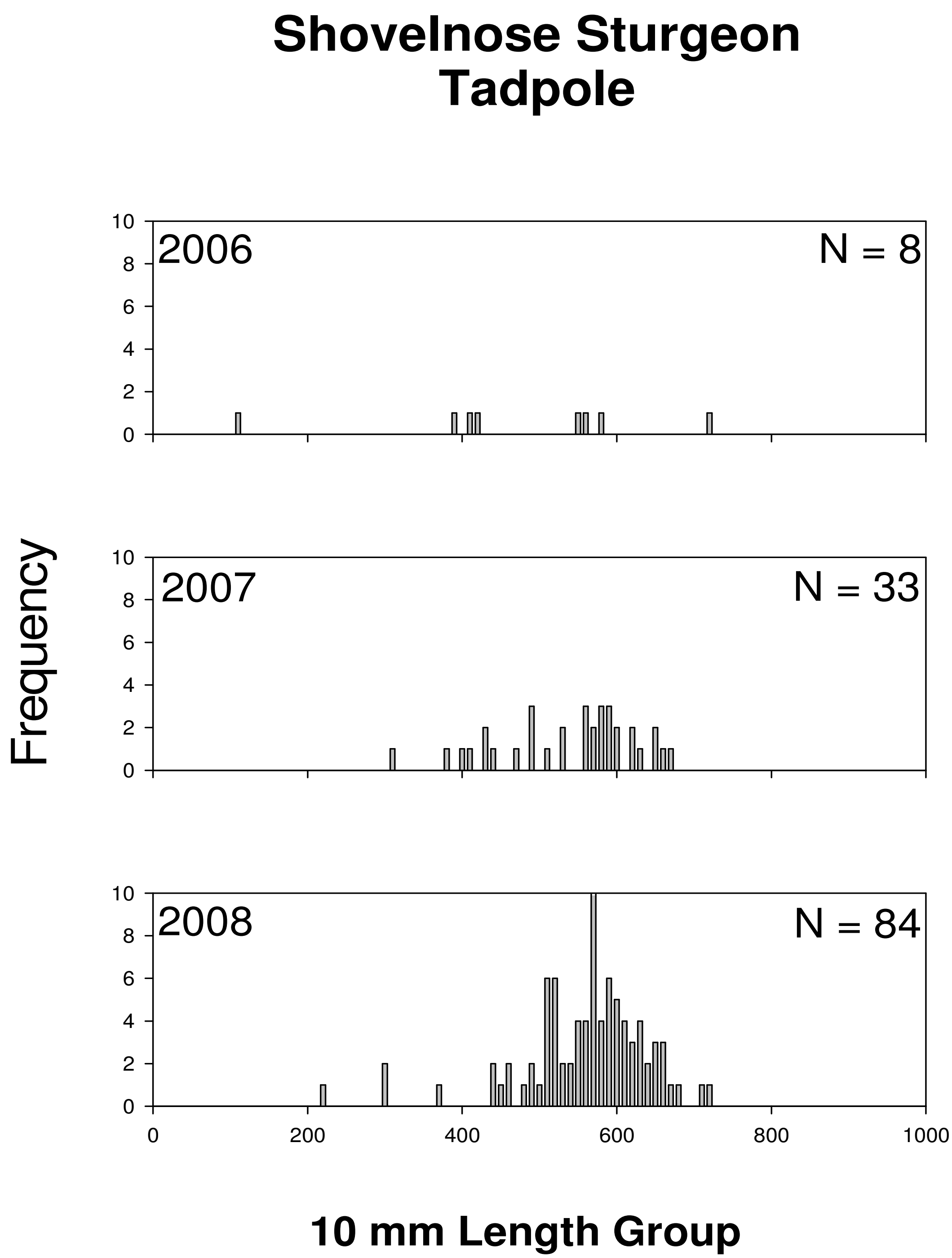


Figure III.11.17. Length frequency distribution of shovelnose sturgeon in Tadpole chute by year. Length groups are in 10 mm intervals.

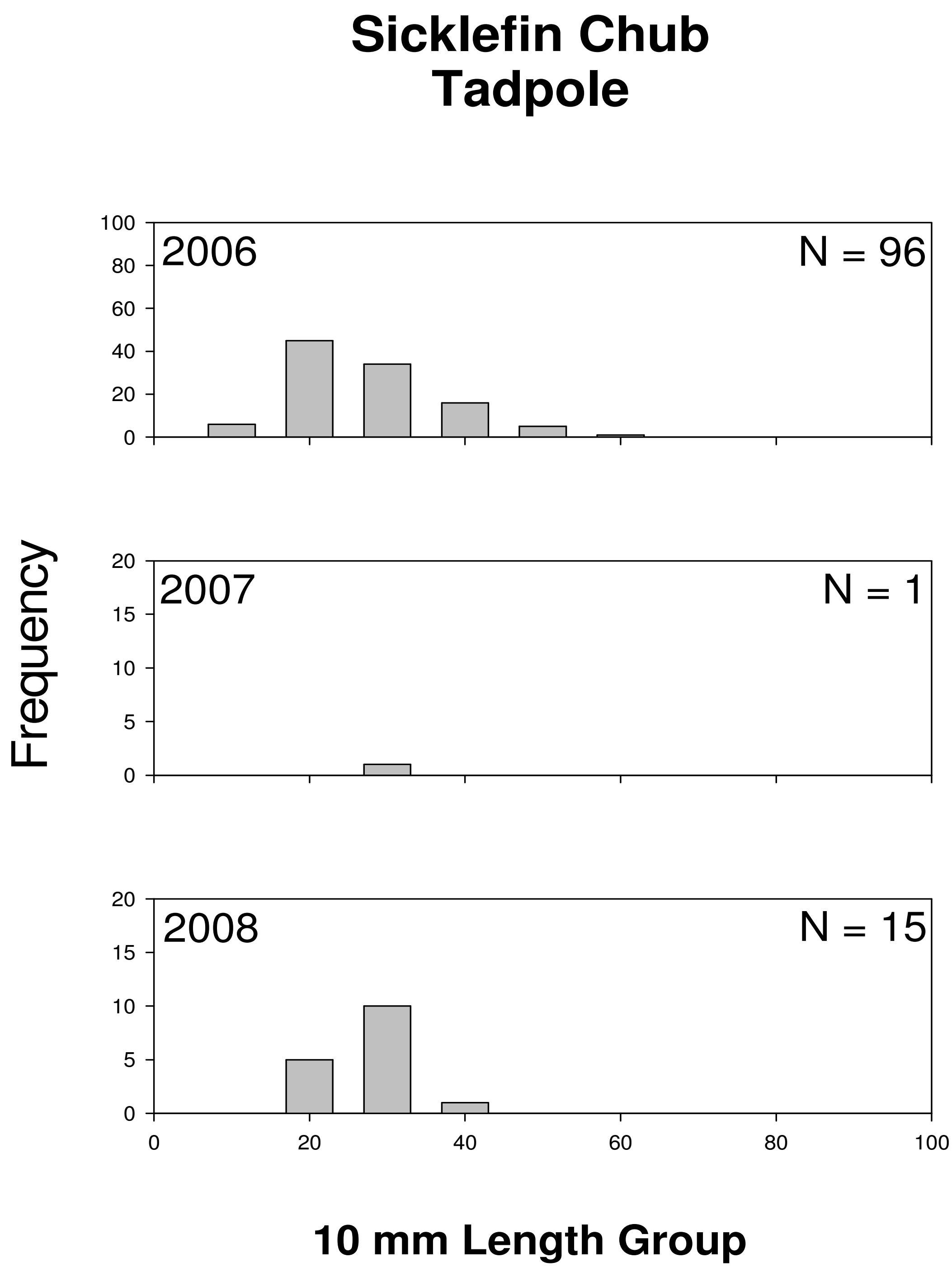


Figure III.11.18. Length frequency distribution of sicklefin chub in Tadpole chute by year. Length groups are in 10 mm intervals.

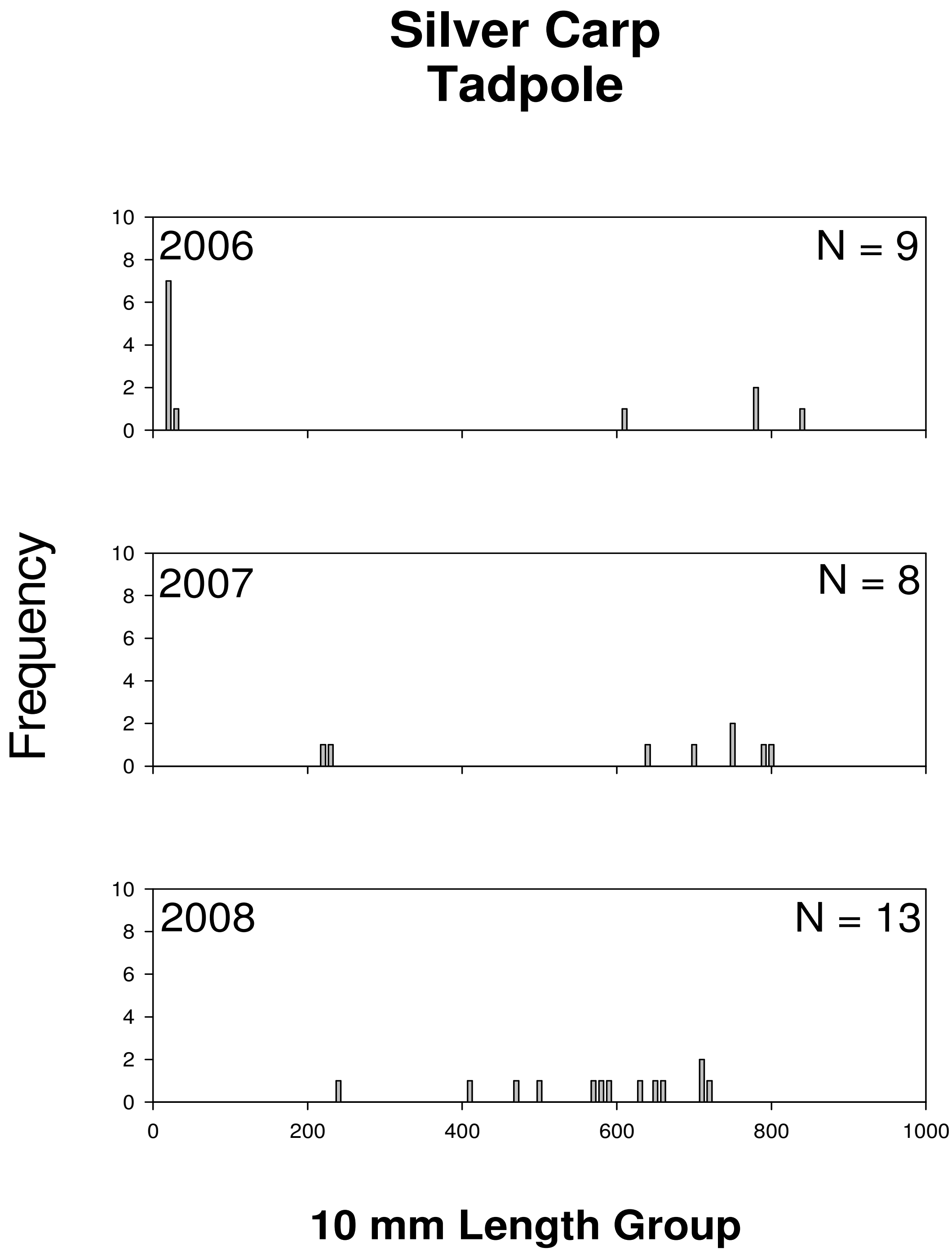


Figure III.11.19. Length frequency distribution of silver carp in Tadpole chute by year. Length groups are in 10 mm intervals.

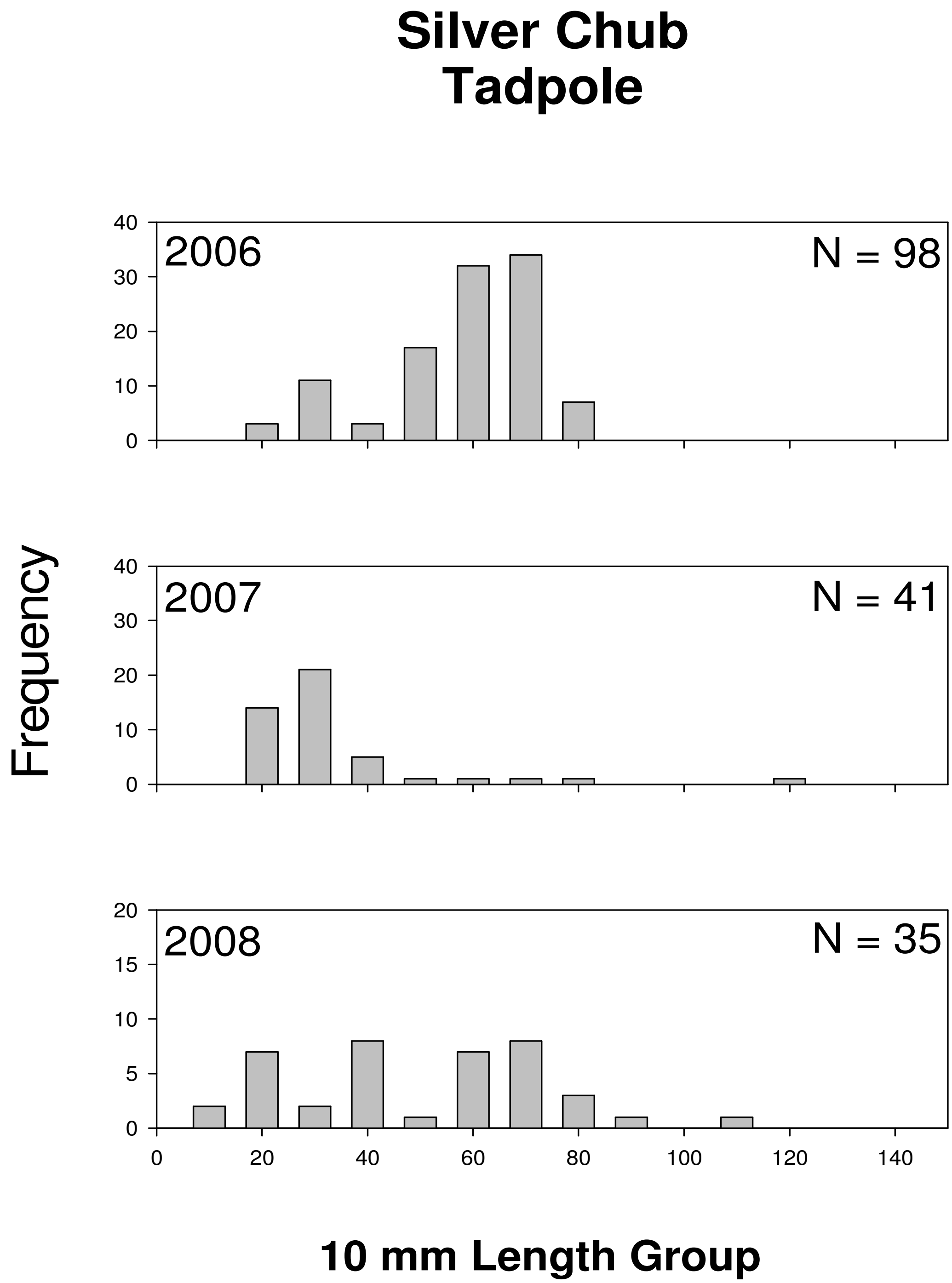


Figure III.11.20. Length frequency distribution of silver chub in Tadpole chute by year. Length groups are in 10 mm intervals.

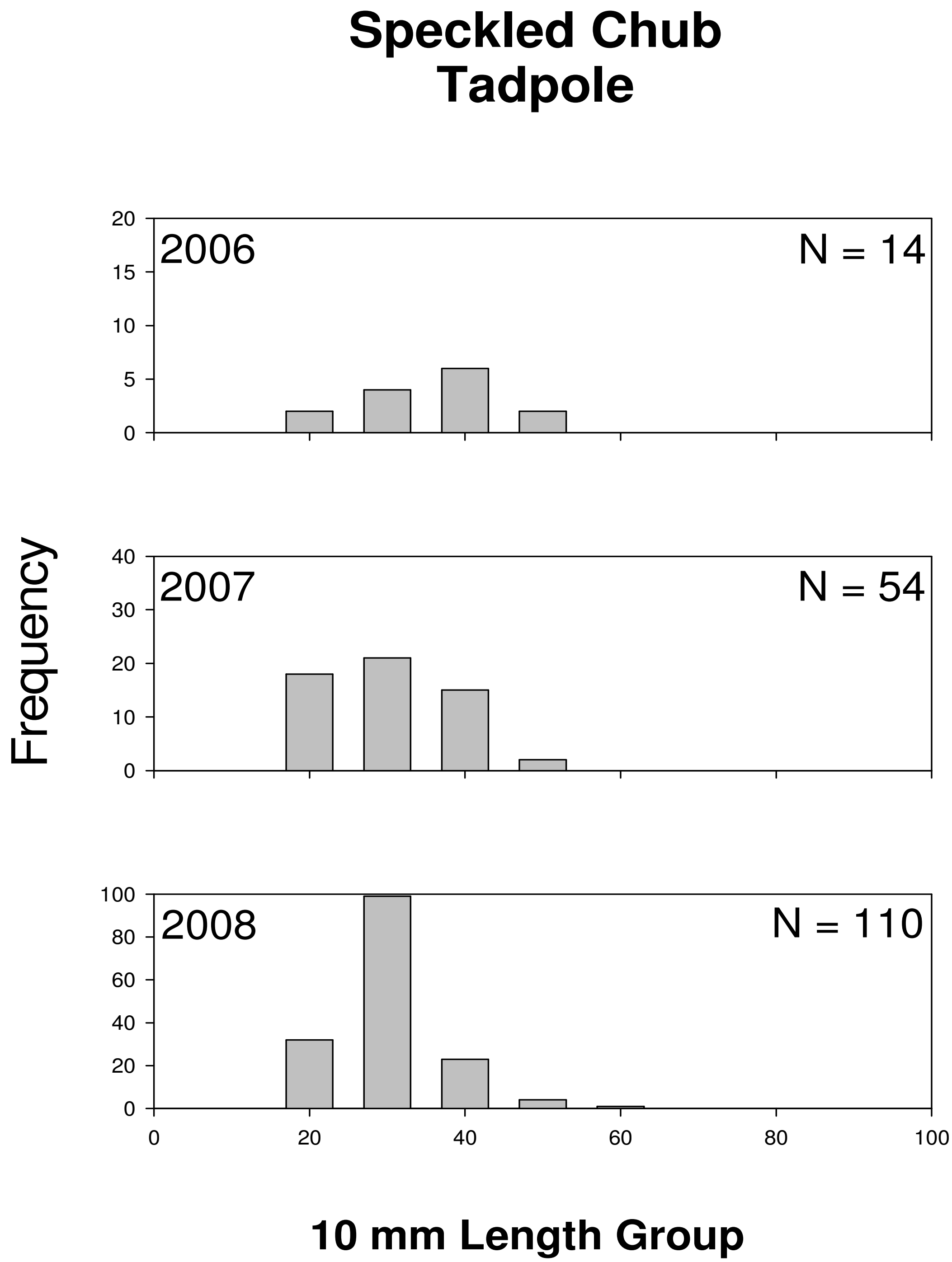


Figure III.11.21. Length frequency distribution of speckled chub in Tadpole chute by year. Length groups are in 10 mm intervals.

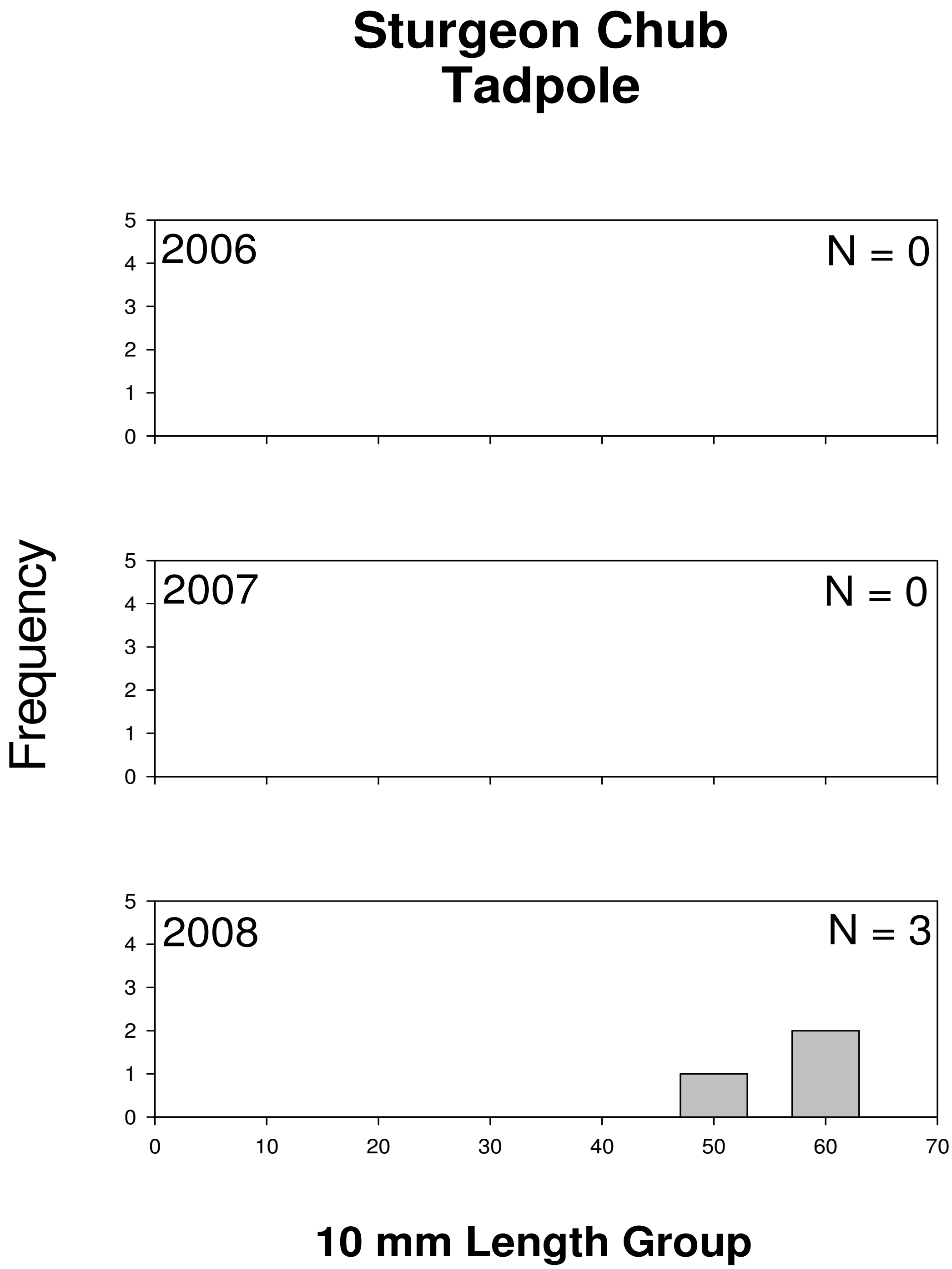


Figure III.11.22. Length frequency distribution of sturgeon chub in Tadpole chute by year. Length groups are in 10 mm intervals.

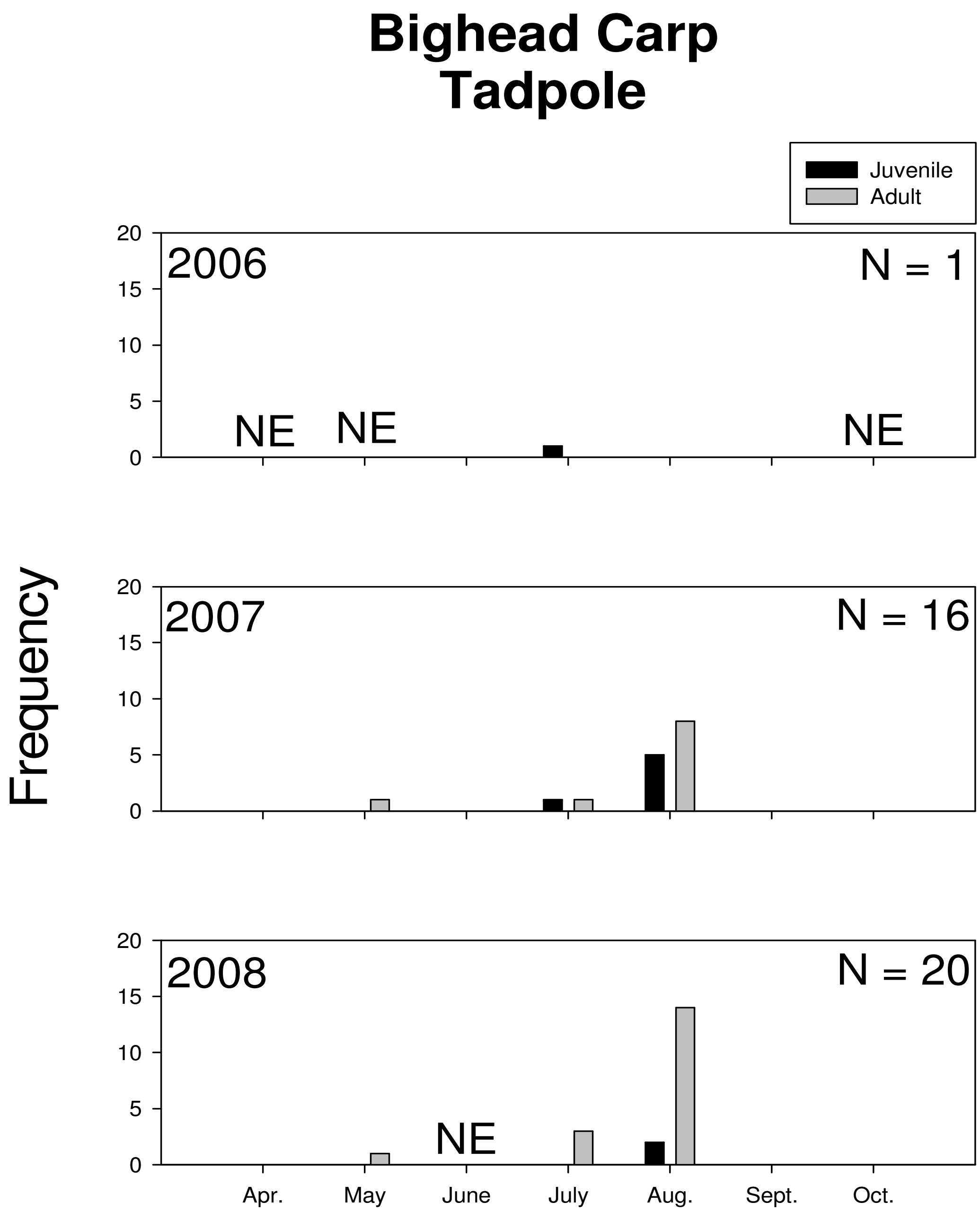


Figure III.11.23. Life stage frequency distribution of bighead carp in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

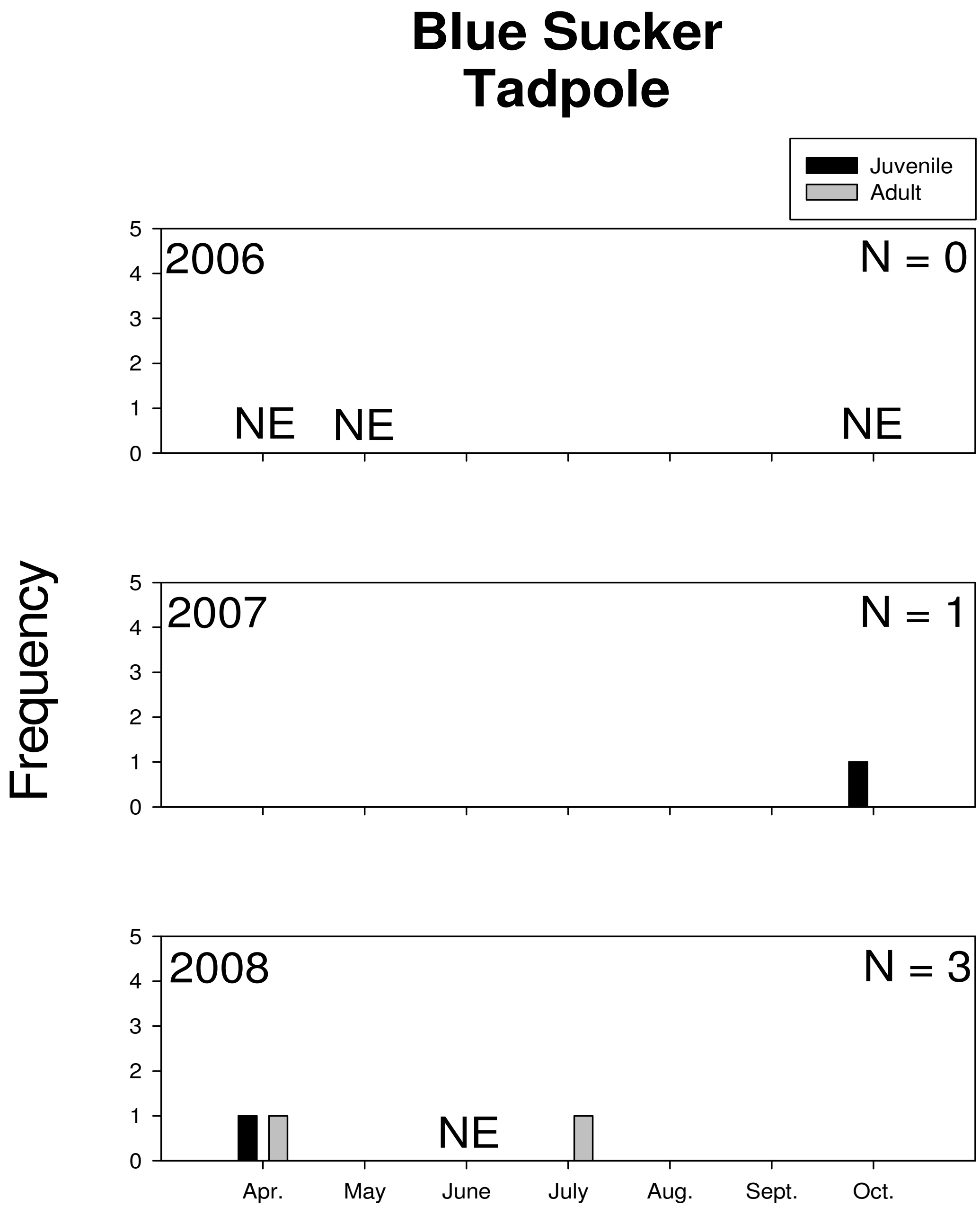


Figure III.11.24. Life stage frequency distribution of blue sucker in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

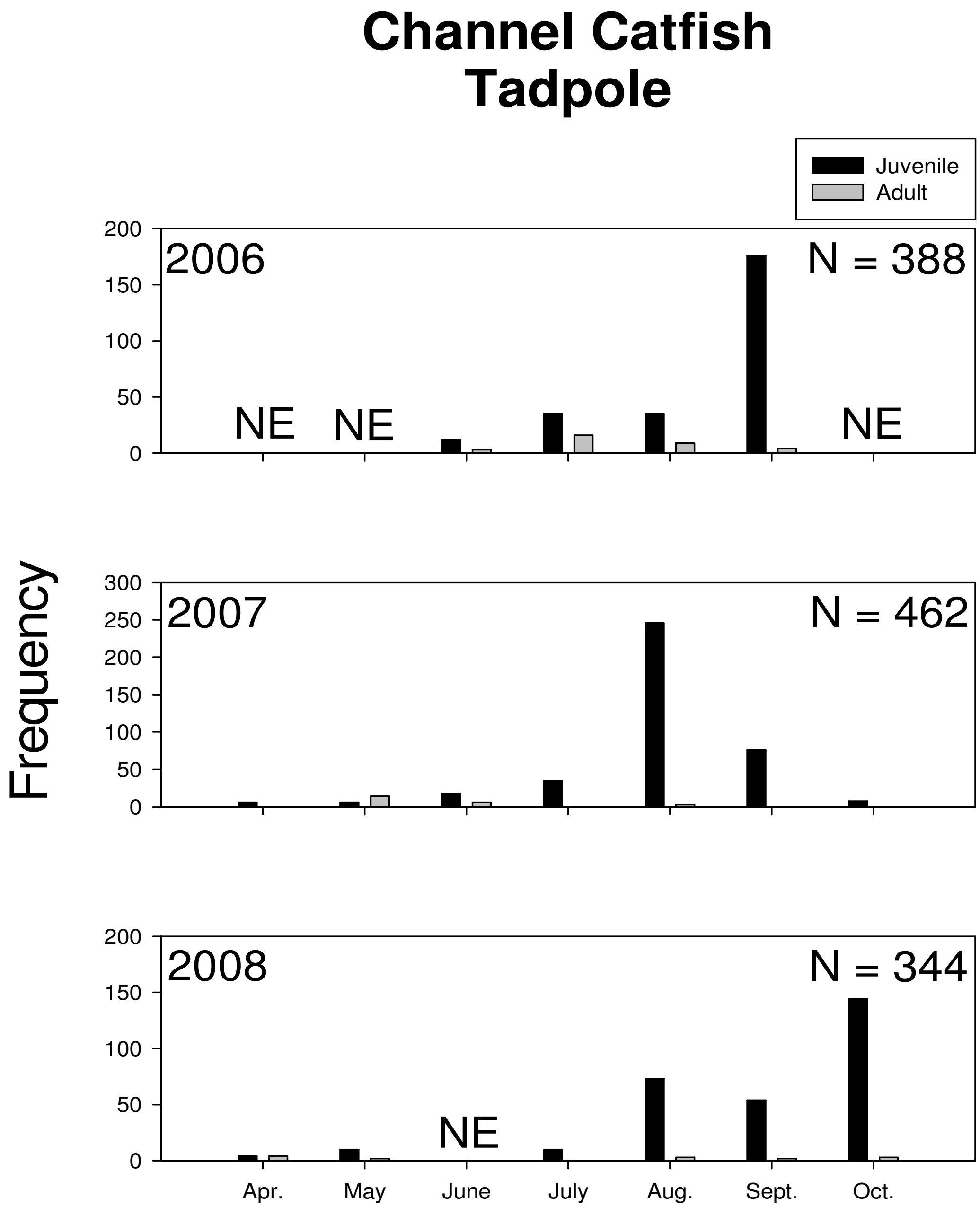


Figure III.11.25. Life stage frequency distribution of channel catfish in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

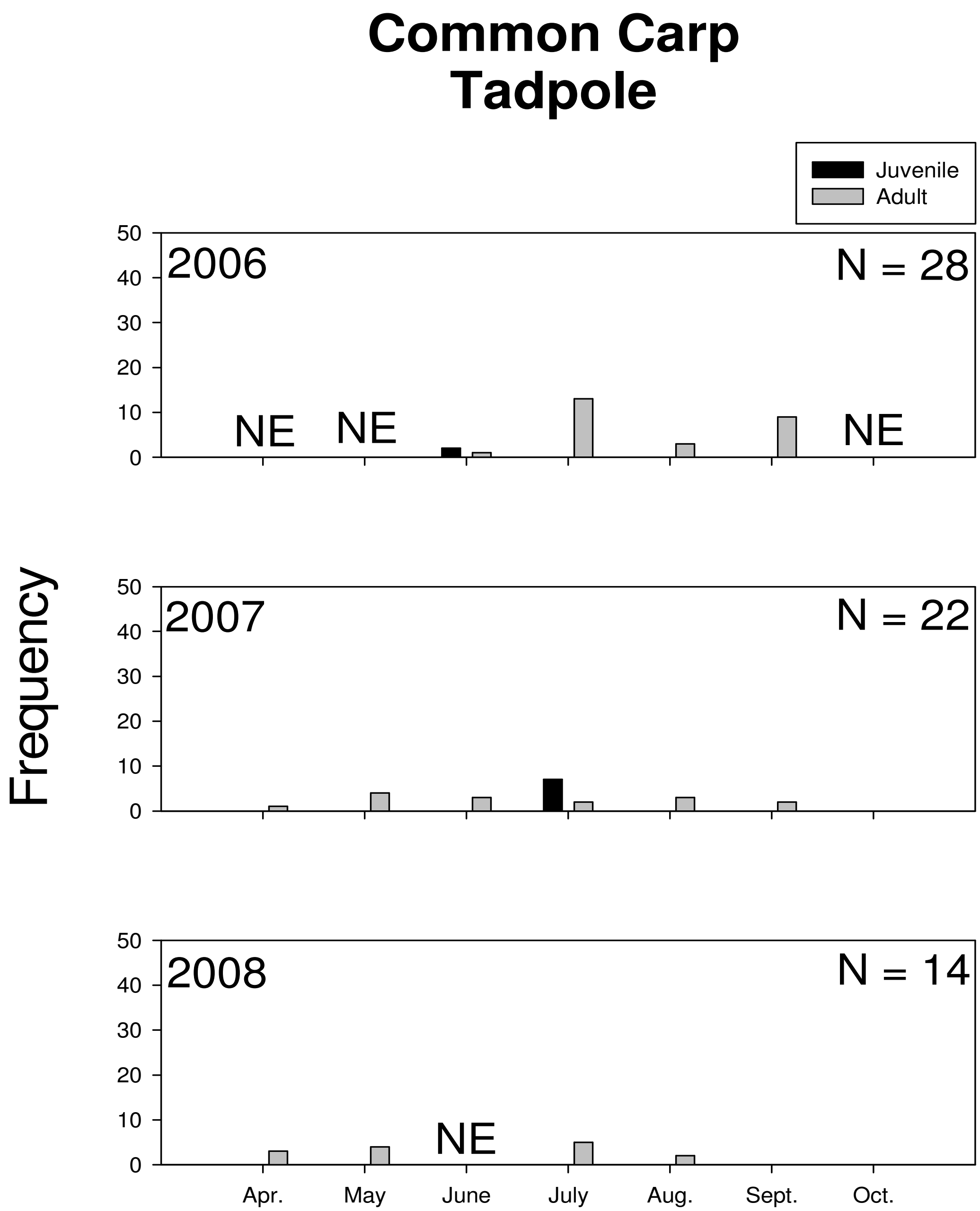


Figure III.11.26. Life stage frequency distribution of common carp in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

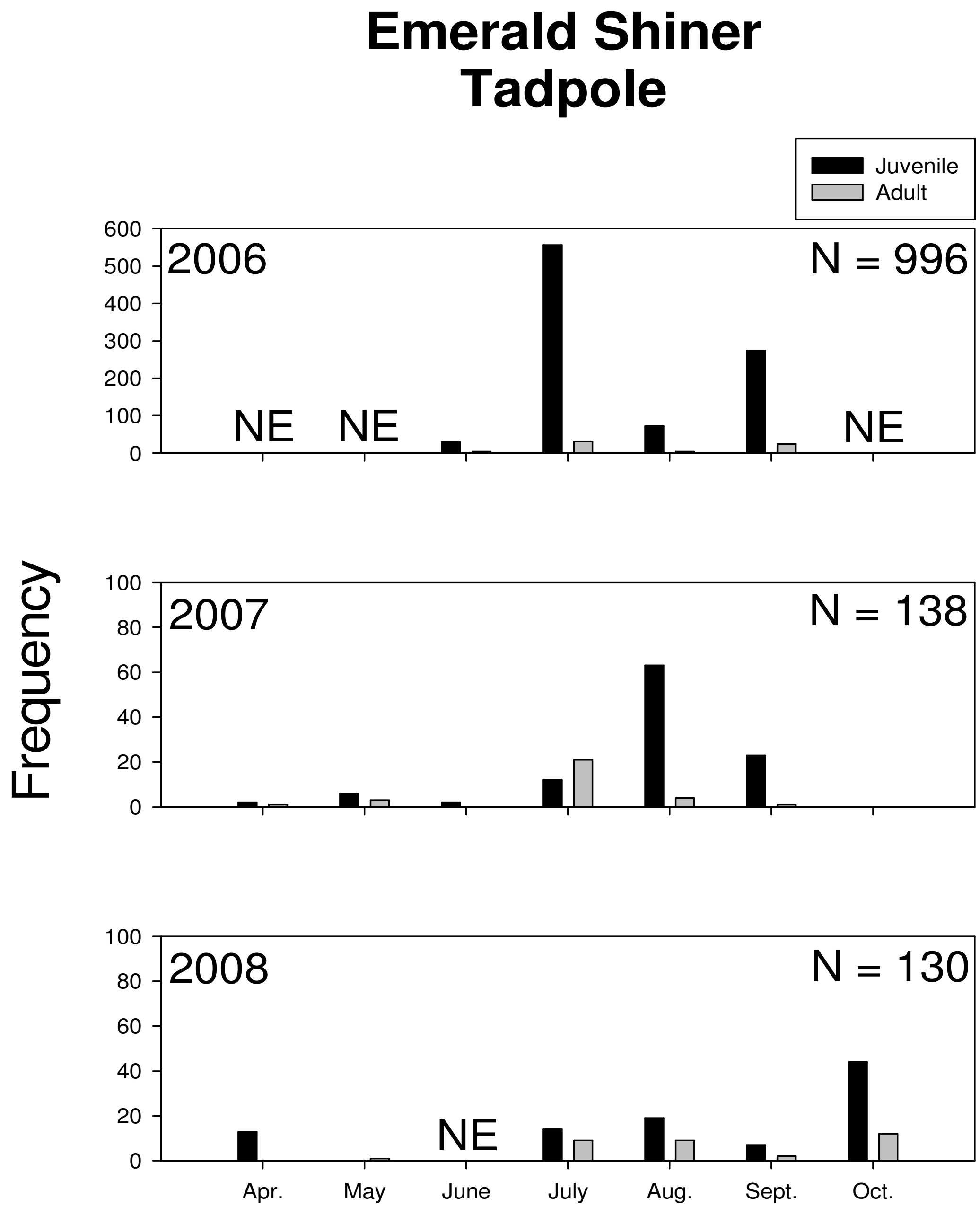


Figure III.11.27. Life stage frequency distribution of emerald shiner in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

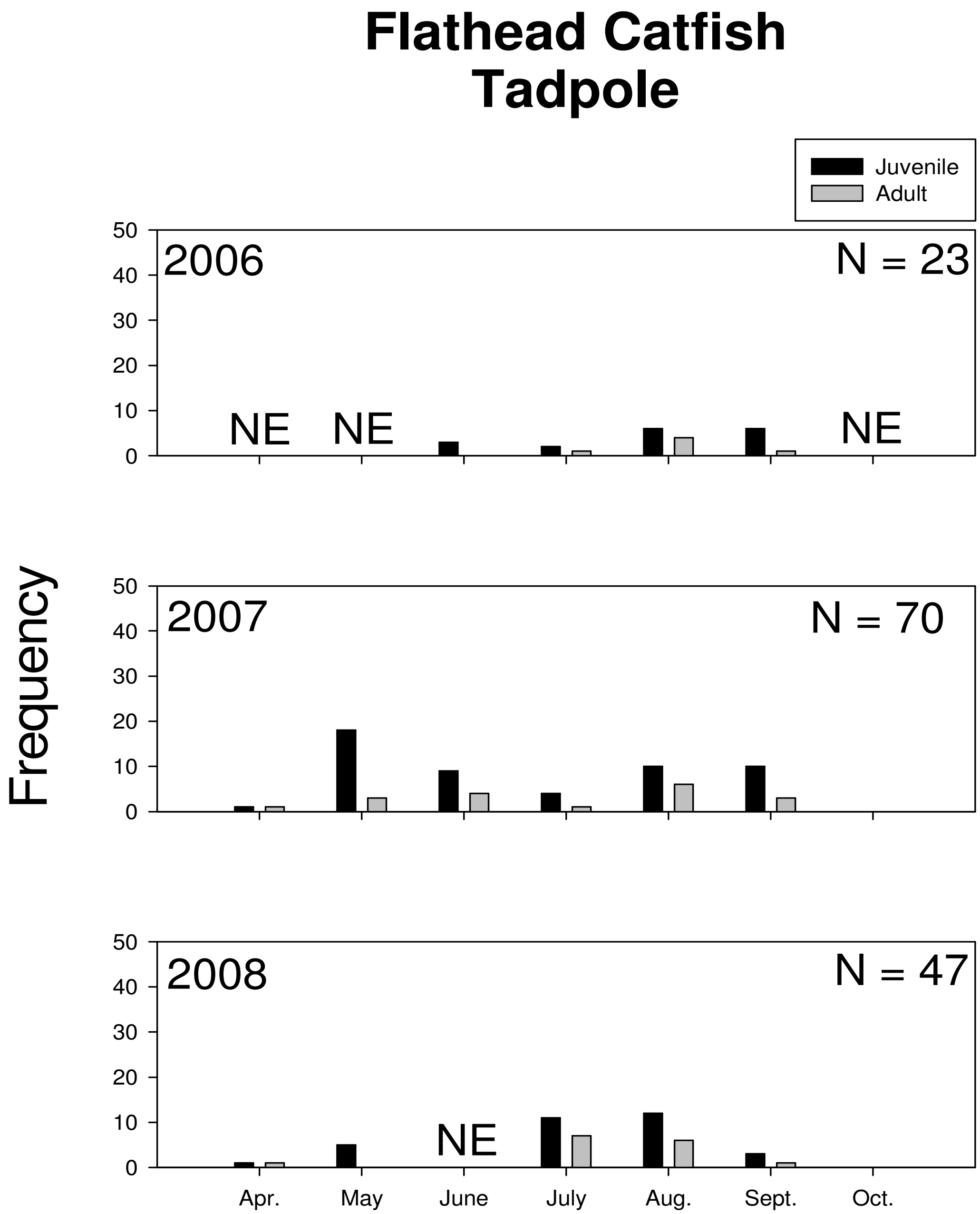


Figure III.11.28. Life stage frequency distribution of flathead catfish in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

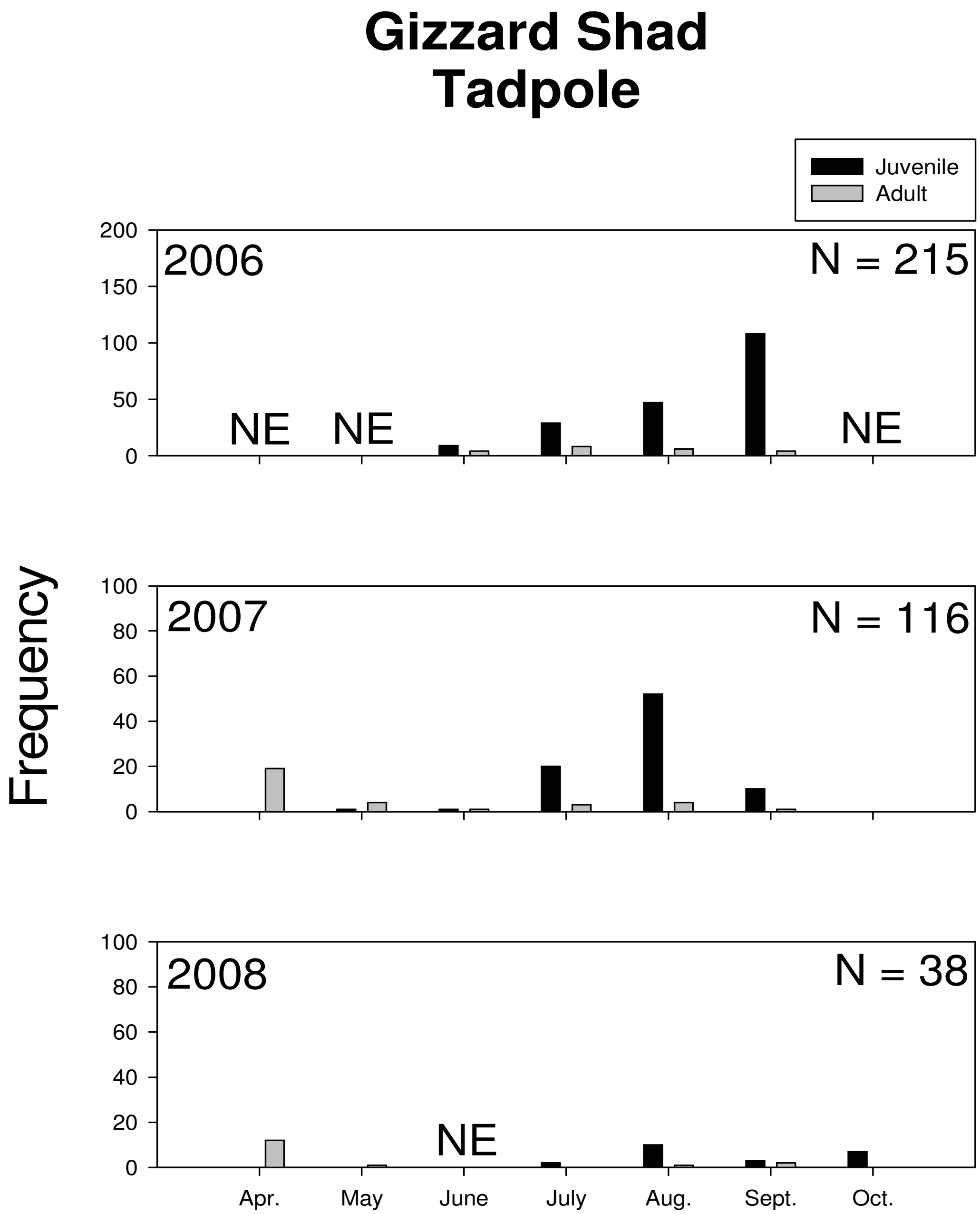


Figure III.11.29. Life stage frequency distribution of gizzard shad in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

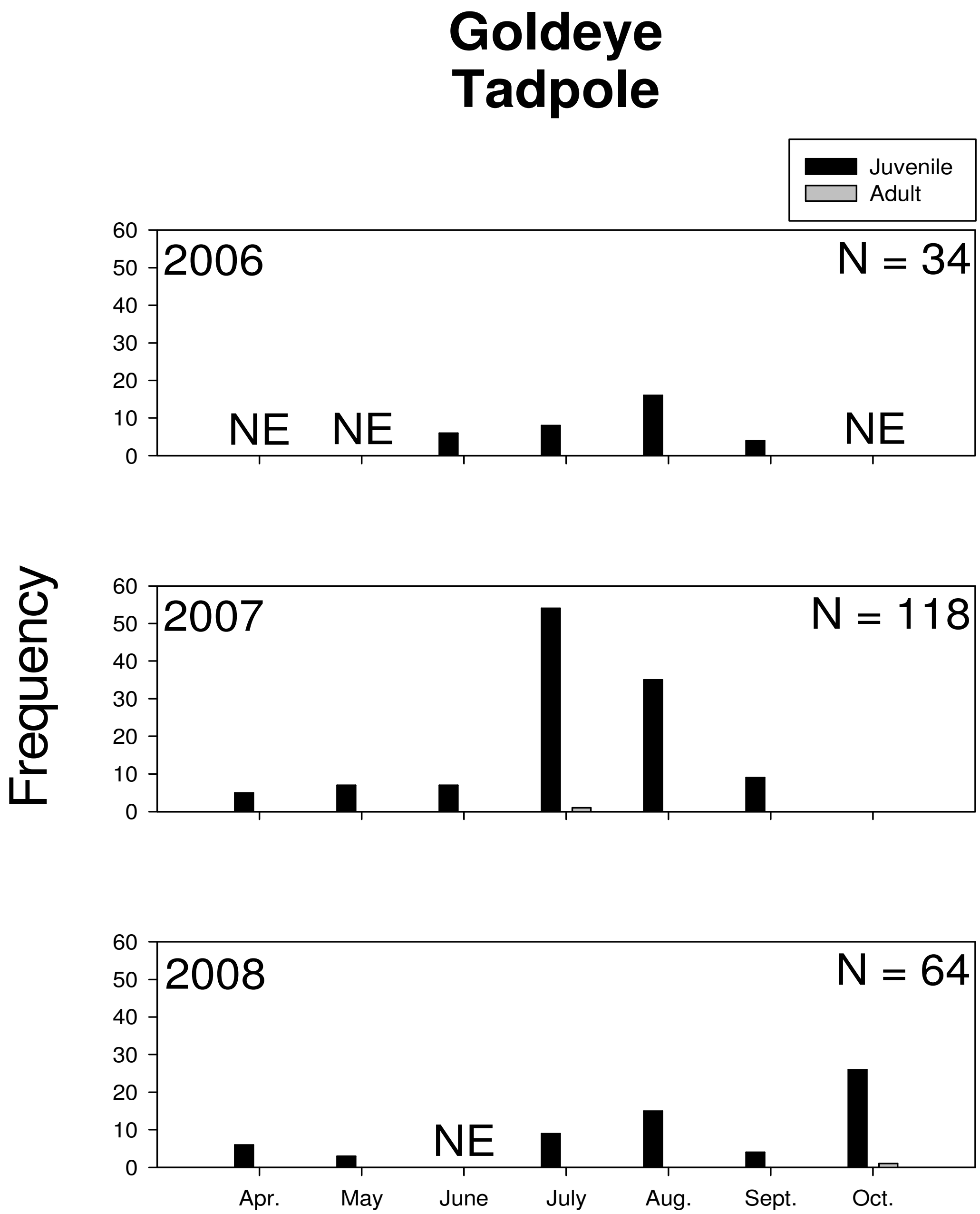


Figure III.11.30. Life stage frequency distribution of goldeye in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

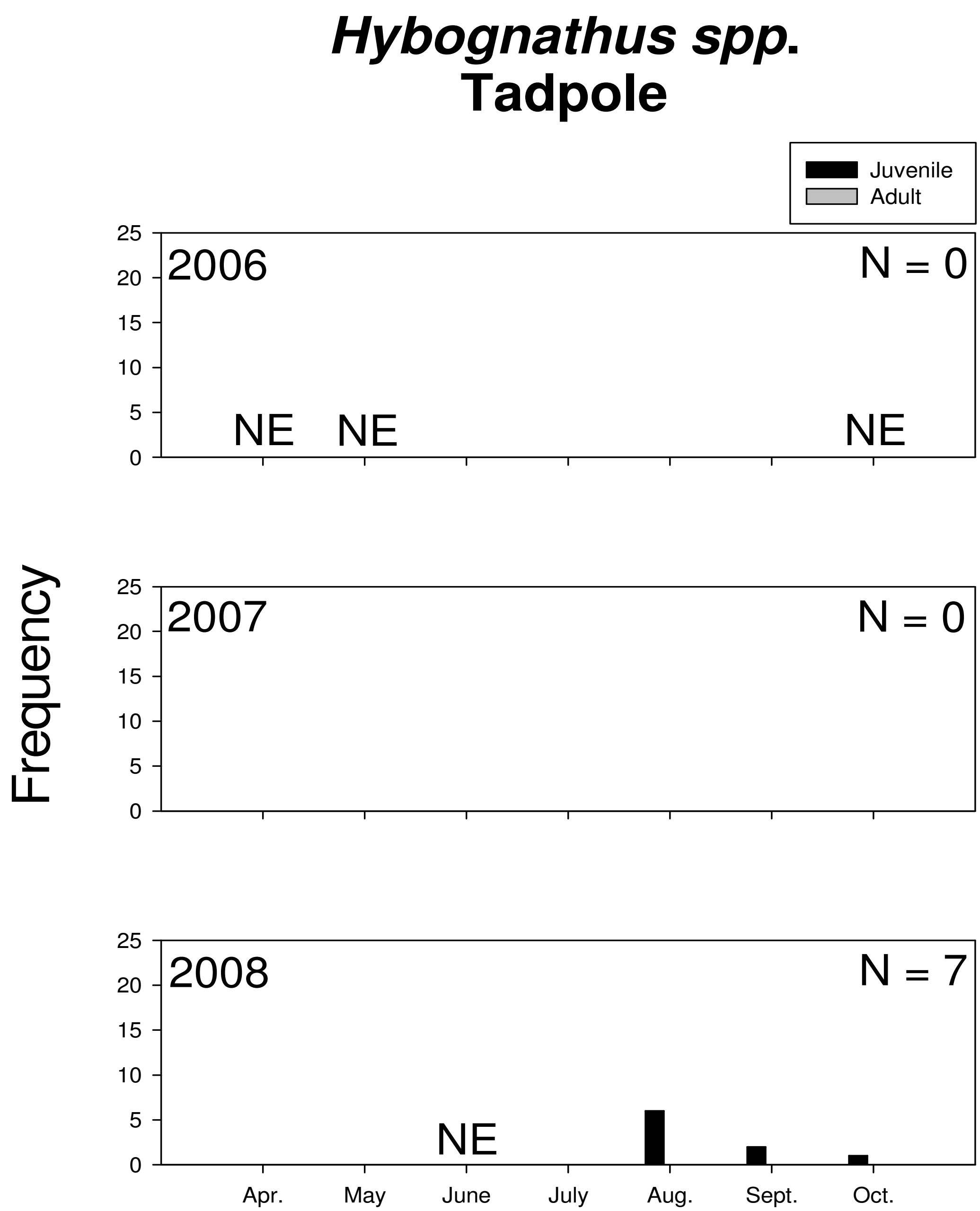


Figure III.11.31. Life stage frequency distribution of *Hybognathus spp*. in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

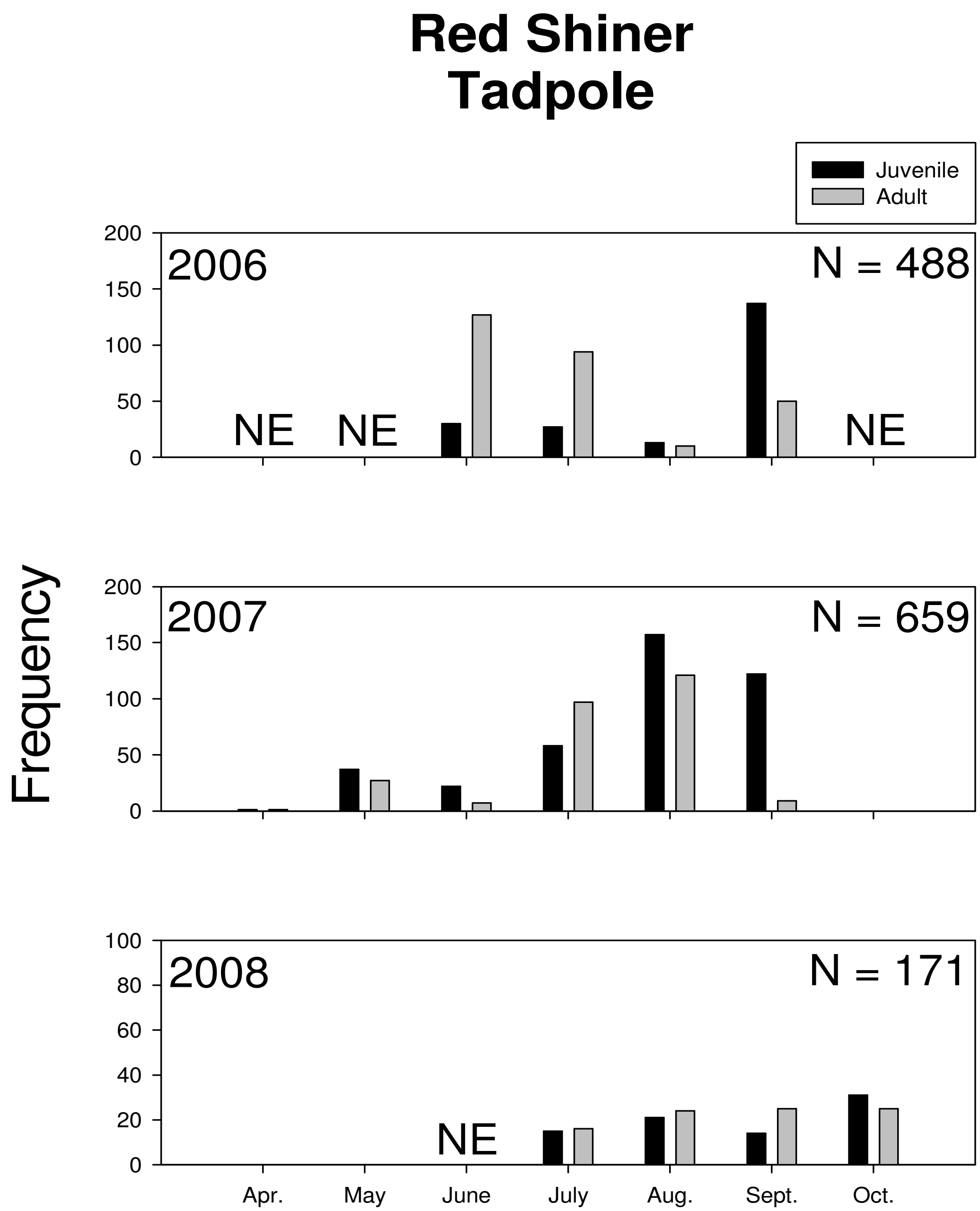


Figure III.11.32. Life stage frequency distribution of red shiner in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

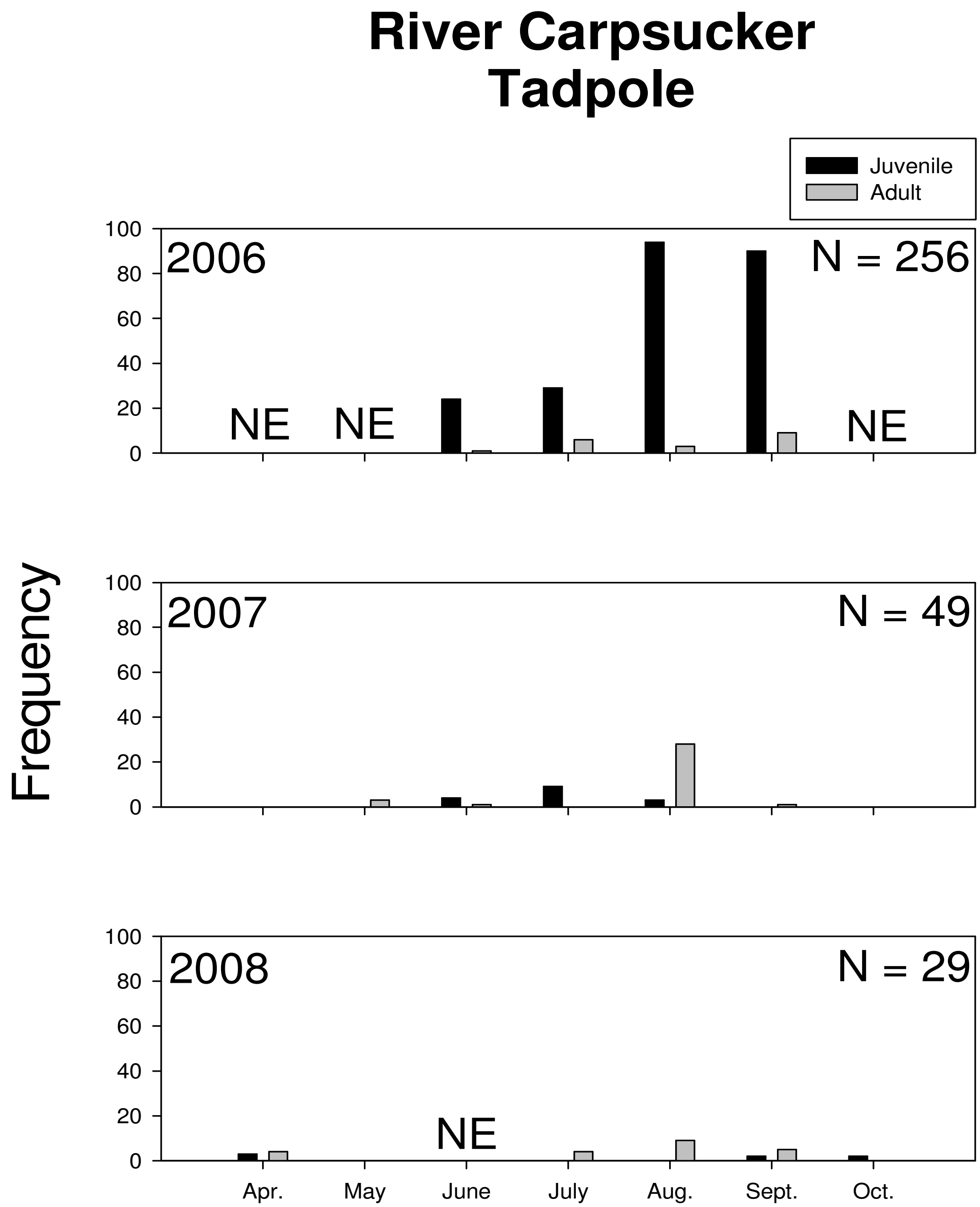


Figure III.11.33. Life stage frequency distribution of river carpsucker in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

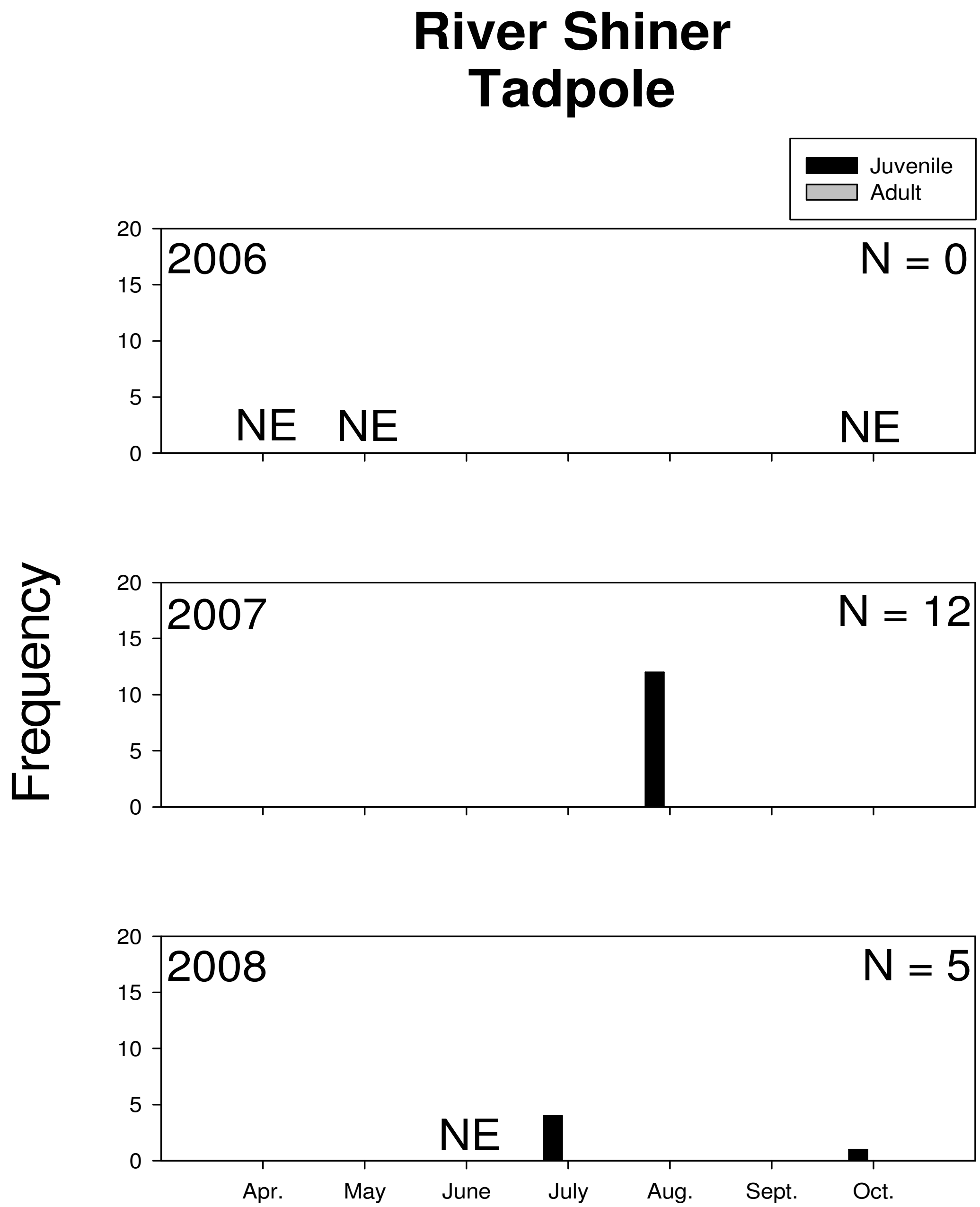


Figure III.11.34. Life stage frequency distribution of river shiner in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

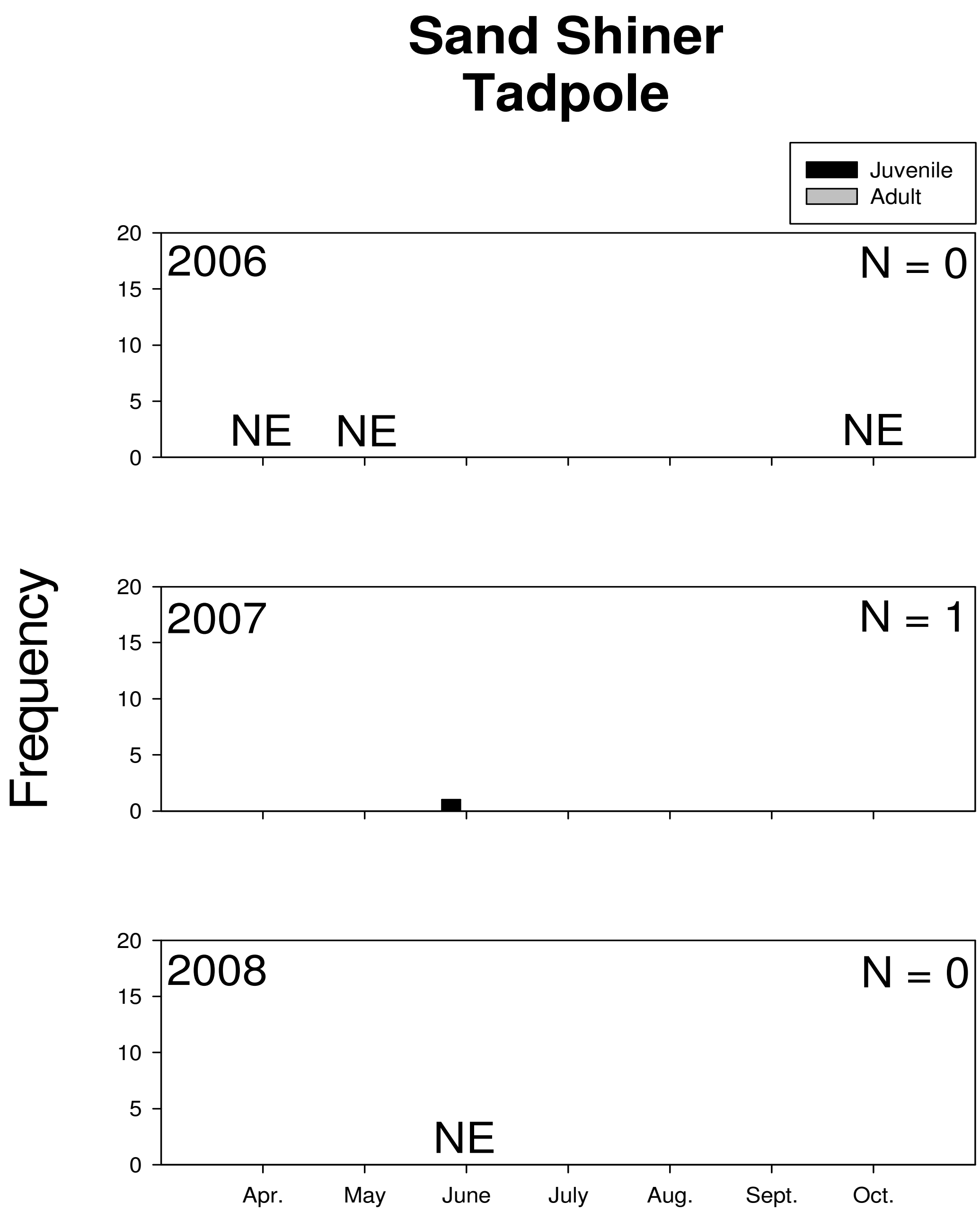


Figure III.11.35. Life stage frequency distribution of sand shiner in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

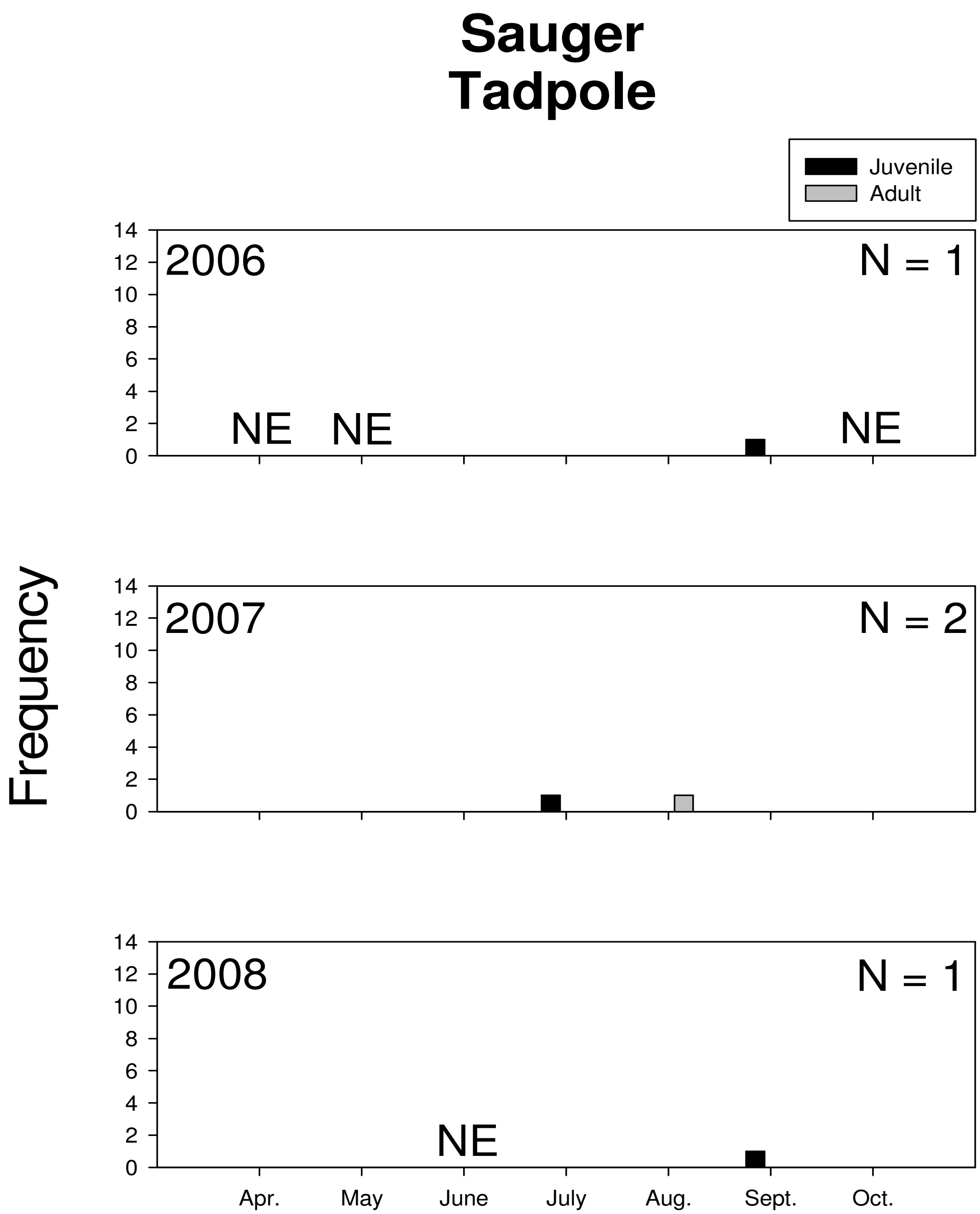


Figure III.11.36. Life stage frequency distribution of sauger in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

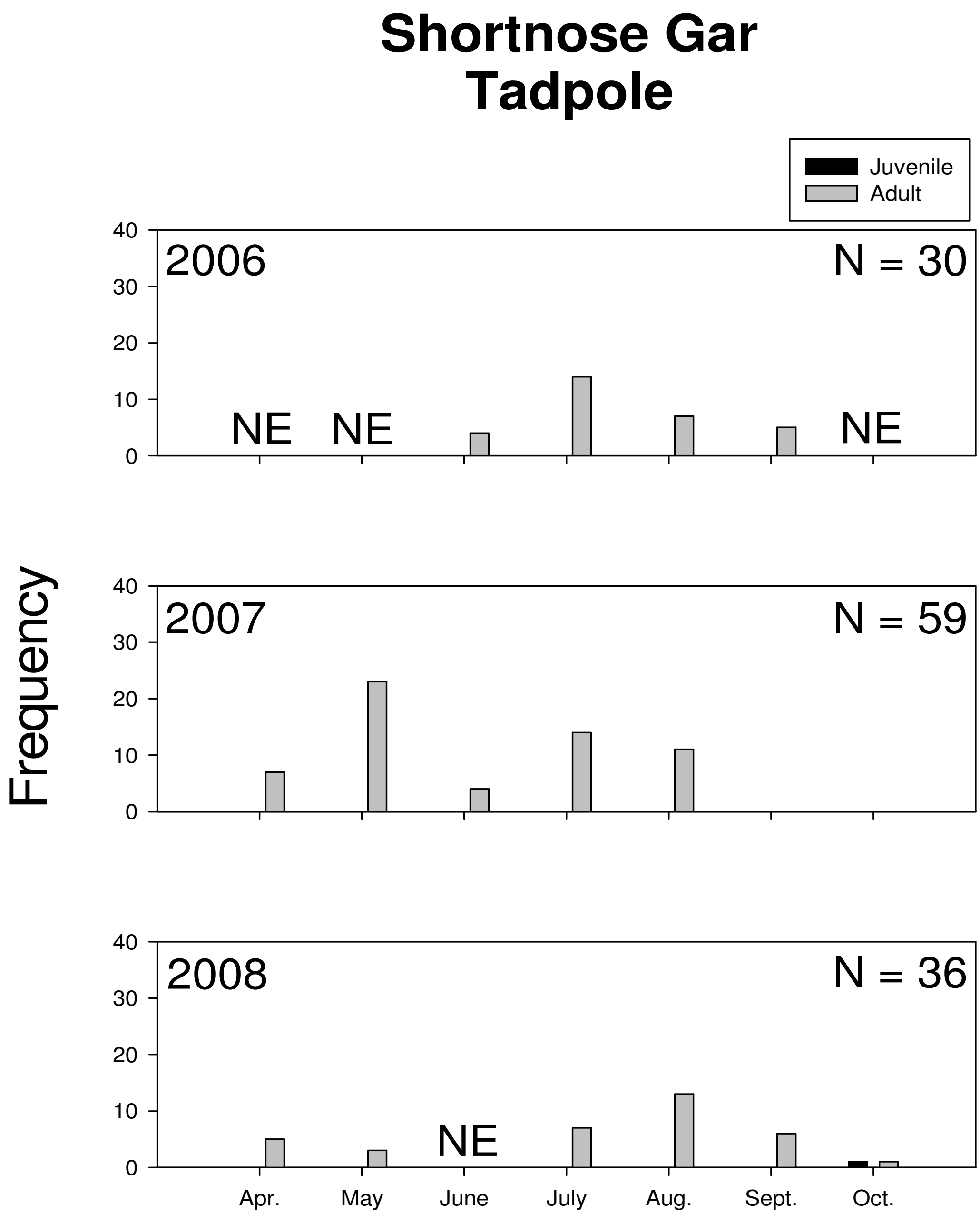


Figure III.11.37. Life stage frequency distribution of shortnose gar in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

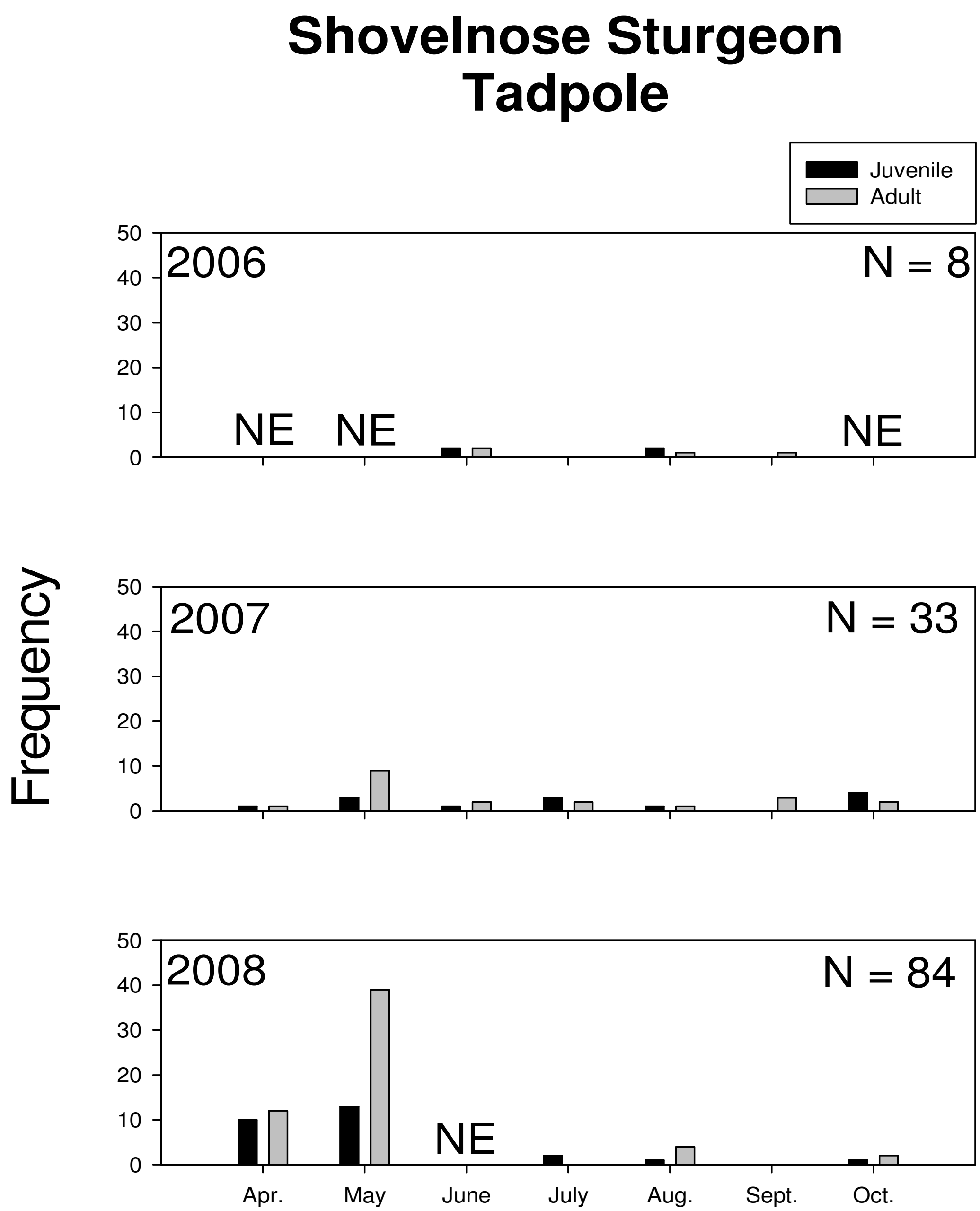


Figure III.11.38. Life stage frequency distribution of shovelnose sturgeon in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

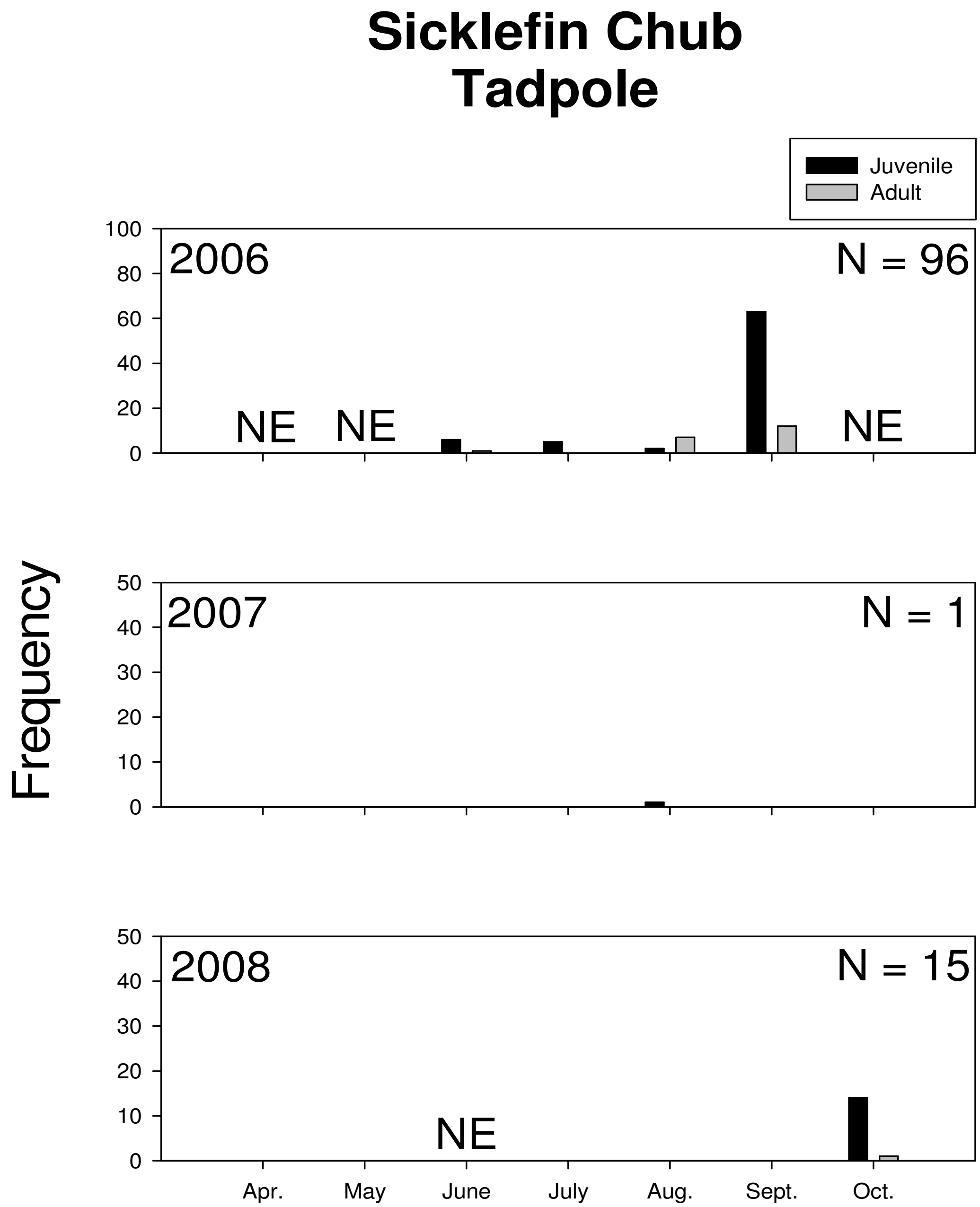


Figure III.11.39. Life stage frequency distribution of sicklefin chub in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

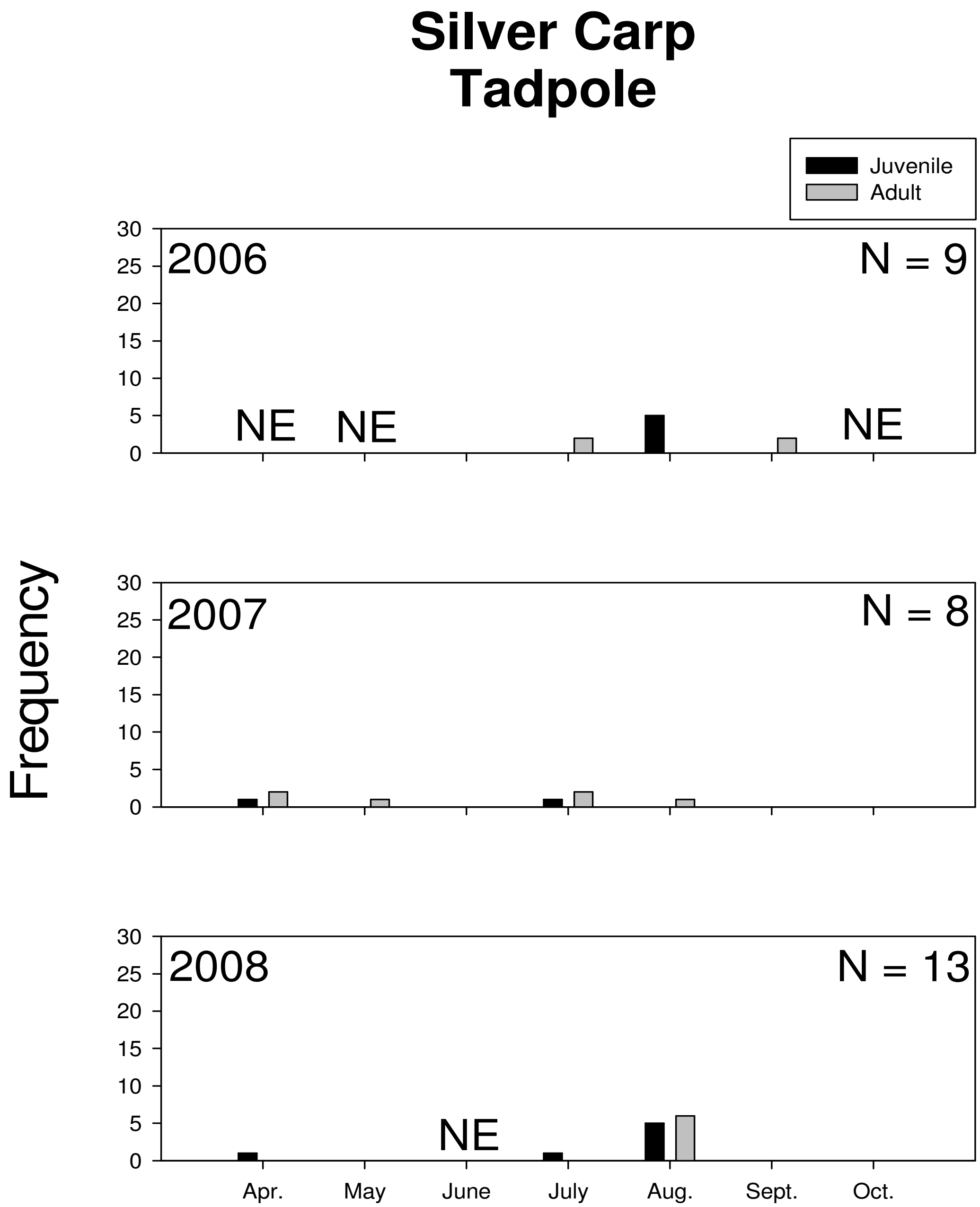


Figure III.11.40. Life stage frequency distribution of silver carp in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

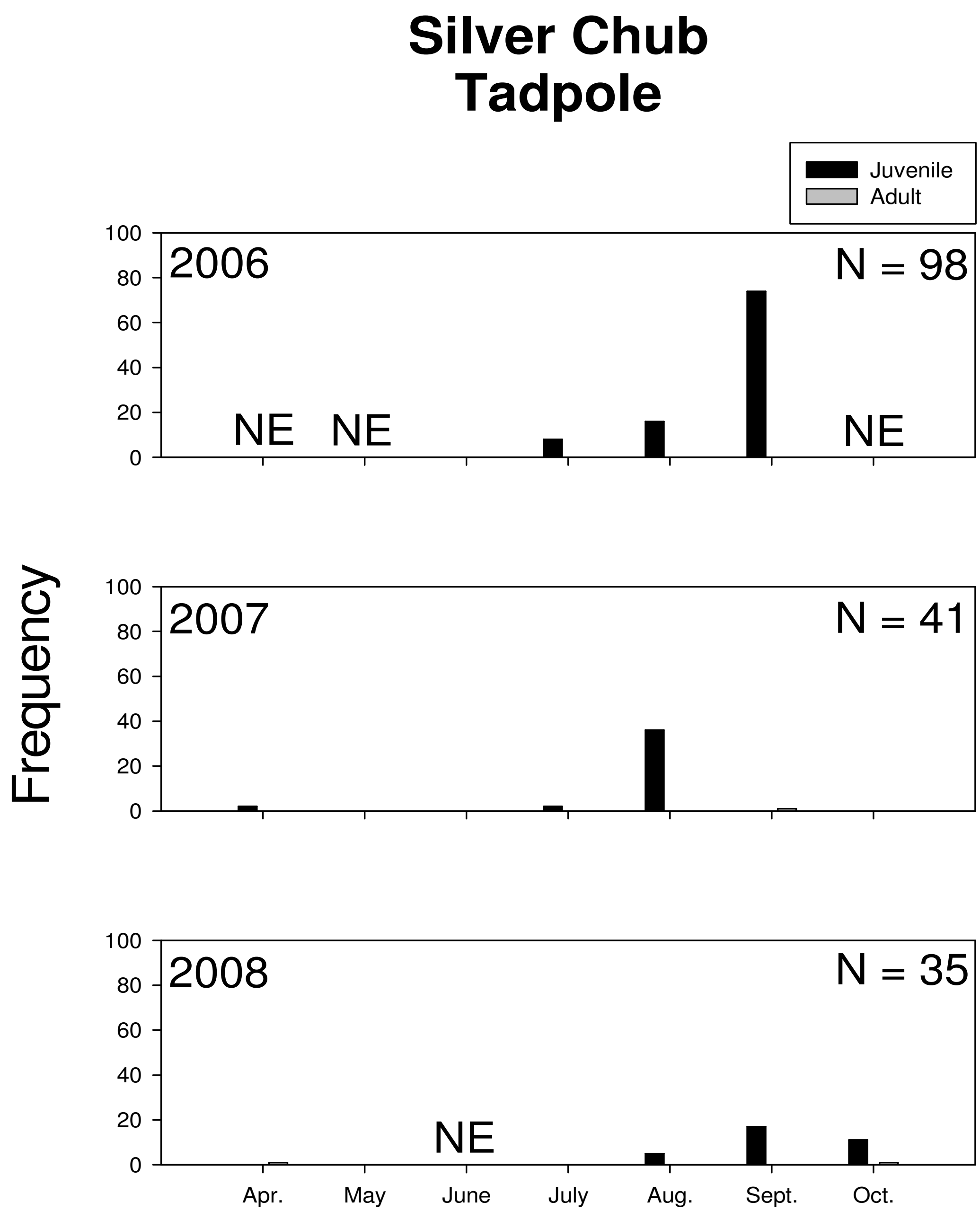


Figure III.11.41. Life stage frequency distribution of silver chub in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

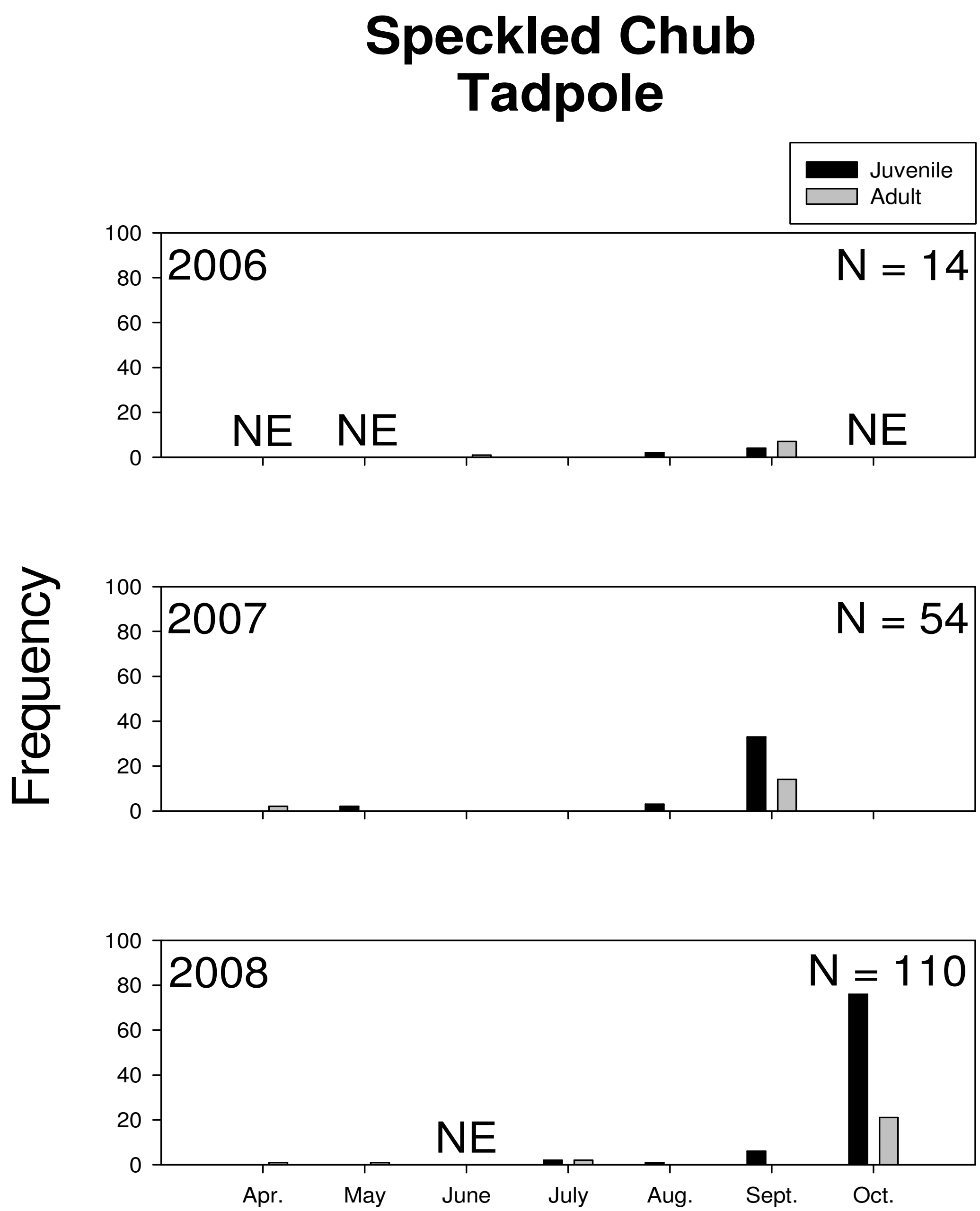


Figure III.11.42. Life stage frequency distribution of speckled chub in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

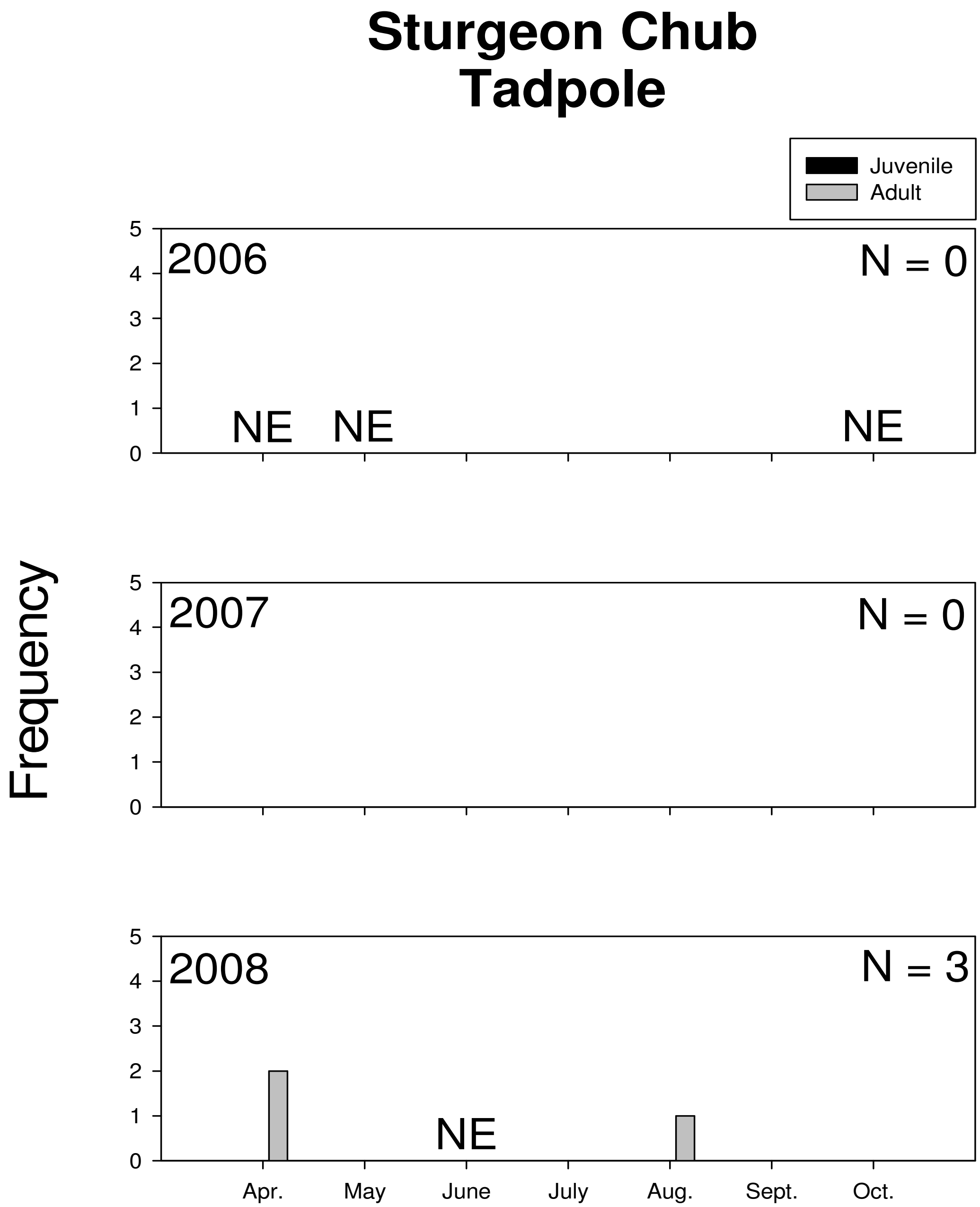
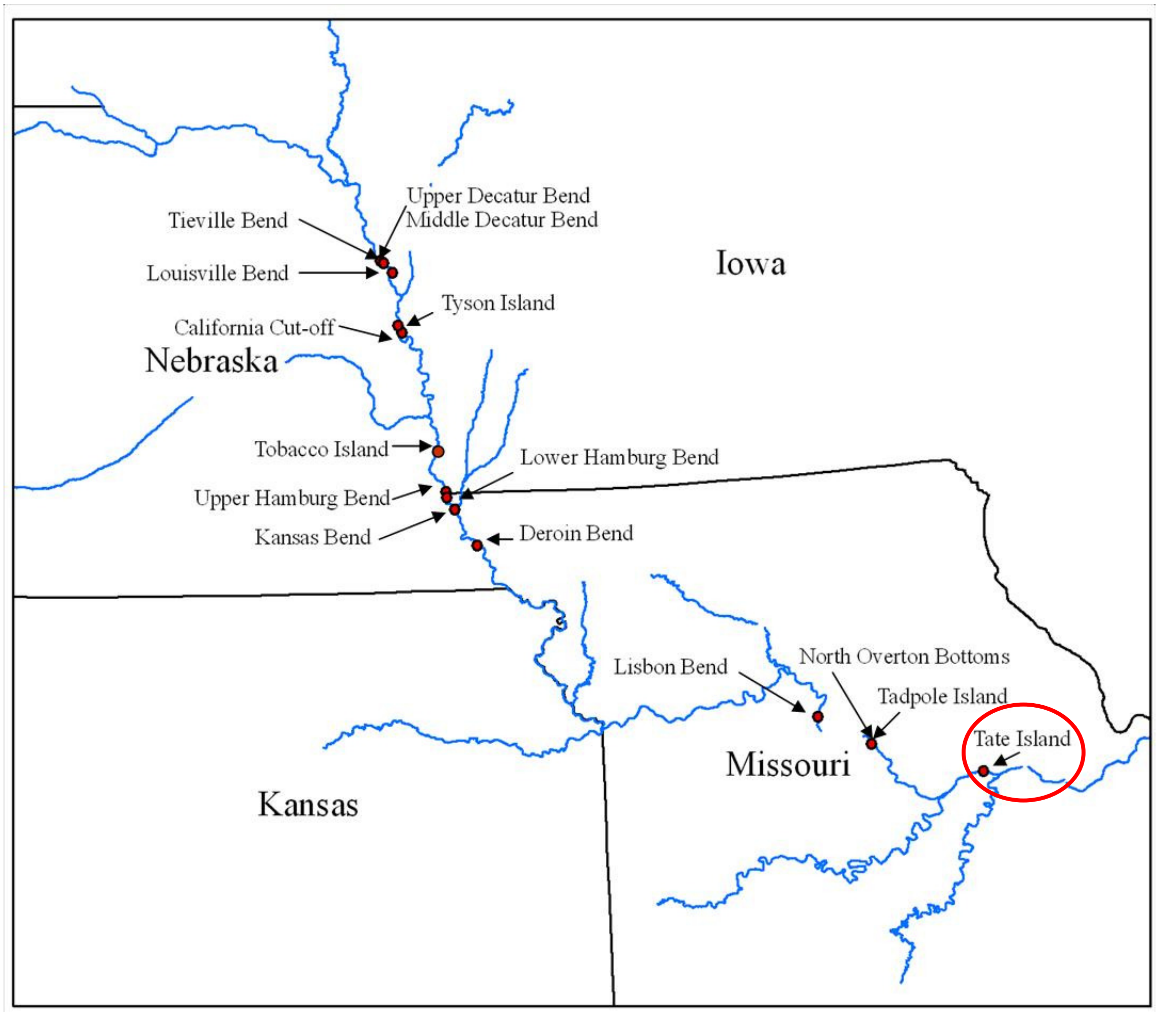


Figure III.11.43. Life stage frequency distribution of sturgeon chub in Tadpole chute by month and year. NE = No effort during this month due to river conditions or construction.

Section III
Chapter 12
Tate Island
Missouri



LIST OF TABLES

LIST OF FIGURES (continued)

Figure **Page #**

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

Key Findings

- Large numbers of riverine species such as shovelnose sturgeon, speckled chubs, red shiners and channel catfish were found in Tate chute.
- Tate supported large numbers of chub and minnow species, particularly young of the year and other juveniles.
- Tate chute was unique among side channel chutes, on the lower portions of the Missouri River, in that many young of the year sturgeon (*Scaphirhynchus spp.*) were captured there.
- No pallid sturgeon were caught in Tate chute but two hybrid sturgeon (shovelnose x pallid sturgeon) were found.
- Many pool and backwater associated species such as silver and bighead carp, shortnose gar and gizzard shad were collected in Tate chute. Large numbers of juvenile backwater species were also documented.
- Large numbers of game species were found in Tate chute including blue, channel and flathead catfish, largemouth bass, white bass, white crappie and bluegill.
- Species richness was higher at Tate chute than at other chutes on the lower Missouri River (Lisbon, Overton and Tadpole).
- Tributaries entering the chute likely influenced the species richness at Tate chute, as many species normally associated with tributaries were found in the chute, such as smallmouth bass, johnny and blackside darters (Pflieger 1987).
- Many non-target species were abundant in Tate chute including bluntnose minnow, bullhead minnow, freshwater drum, longnose gar and smallmouth buffalo.

- Tate Island's form is such that both shallow water habitat and backwater habitat are sometimes present adjacent to one another. Within and downstream of the tie channels shallow water habitat is created, while habitats upstream of the tie channels often function more like a backwater because of reduced flows. This feature may be a driving factor in the species richness found in Tate chute.
- Wide variations in abundance and size of fish species occurred throughout the three year sampling period. Influences of flow and population abundance in the main channel make it difficult to point to chute function as habitat.

Recommendations

- Create side channel habitat by building islands as opposed to digging channels, as was the case with Tate Island chute. Allow the water to create and form the chute.
- Use pilings, like those at Tate chute, instead of rip rap to create water control structures. Using pilings may increase the permeability of water structures at varying levels of the water column, particularly the benthos. As opposed to rock structures where water may only be passing through a notch at the top of the water column.
- Promote tie channels that not only increase the overall amount and diversity of side channel habitat but may also increase accessibility to that habitat by providing more area that is in contact with the main channel. Tie channels can also be used to direct flows to lower portions of the chute, allowing the upper portions to act more like backwater habitat.

- Design chutes that exhibit shallow water habitat and backwater habitat adjacent to each other.
- Opening existing, naturally formed side channels that are presently cut off from regular flows, should take priority over digging new chutes. Older, naturally formed side channels may possess a greater potential for providing side channel and shallow water habitat, in a smaller time frame than newly dug chutes. This process would also, likely be cheaper than digging new chutes, thereby providing a better product for less money. There are at least 13 historic chutes that exist on the lower Missouri River.
- Continued biological monitoring of reopened and recently created chutes is critical to determine the level of functionality that these chutes can attain and what value each chute has to different species.
- Tate chute, because of its unique origin, as well as its diversity of habitats and fish assemblages, should serve as a basis of comparison when evaluating the level of functionality in mitigated side-channels.
- Because chute habitat availability and functionality is highly influenced by river stage long term monitoring is necessary to understand the ecological role of chute habitat under a range of conditions.
- Future monitoring could be streamlined with the information obtained from intense monthly sampling efforts. This data that documents which gears and times of the year were most efficient at collecting an array of species would make it possible to develop rapid bio-assessment technique that could be used for future monitoring.

Results

A total of 17,678 fish of 68 species, representing 17 families, were captured in Tate chute between 2006 and 2008 (Table III.12.1). A total of 825 young of the year fish, representing 2.9% of the total catch could not be identified beyond genus or in some cases family. The majority of unidentified fish were young of the year chubs (*Macrhybopsis spp.*) and minnows (*Cyprinidae*). Among years, 2007 had the highest number of fish (N = 7,512), representing over 42% of the total catch at Tate chute. Species richness was also highest in 2007 with 54 species present (Table III.12.2; Fig III.12.1). Conversely, in 2008 the fewest fish were captured (N = 3,223), representing about 18% of the overall catch. Decreased catches in 2008 can be attributed to decreased sampling effort during July because of prolonged flood events (Table III.12.3).

Tate chute's most abundant species was gizzard shad which represented 30.3% (N = 5,363) of the total catch from 2006 to 2008. Gizzard shad numbers peaked in 2008 when more than three times as many individuals were captured than in any other year. Other abundant species included emerald shiner (12%; N = 2,119), freshwater drum (9.8%; N = 1,736), channel catfish (9.1%; N = 1,616), red shiner (6.6%; N = 1,165), bullhead minnow (4.9%; N = 860), river carpsucker (3.9%; N = 697), common carp (2.8%; N = 498), and speckled chubs (2%; N = 357). Several of the most abundant species experienced the highest captures in 2006 including all shiners, minnows, chubs, freshwater drum, and river carpsucker. Common carp and channel catfish each had the highest catches in 2007.

Target species' accounts for Tate chute are presented hereafter (Table III.12.1), in alphabetical order with analysis. Yearly mean catch per unit effort (CPUE) values for

target species were analyzed with a Kruskal-Wallis test (Table III.12.4) to detect differences among years; mean CPUE values are presented in Table III.12.5 by month and year. Mean length values for target species were tested with analysis of variance; mean length values and the results of analysis are presented in Table III.12.6. Length frequency distribution graphs for target species are presented in Figures III.12.2 through III.12.22 in alphabetical order by fish's common name. Proportions of adult and juvenile target species were analyzed with a z-test, the results of which are presented in Table III.12.7. Life stage frequency graphs for target species are presented in Figures III.12.23 through III.12.43 in alphabetical order by fish's common name. Tables and figures are not referenced hereafter. The contents of all tables are in alphabetical order by fish's common name. Figures and species accounts are ordered alphabetically, by fish's common name, with one exception; *Hybognathus* species (plains minnow, Mississippi silvery minnow and western silvery minnow) were combined and labeled as such because of extremely low numbers for these species.

Bighead carp

We caught 41 bighead carp in Tate chute between 2006 and 2008. Bighead carp numbers were similar among years, but were highest in 2007. Bighead carp were captured most effectively with large hoop nets, although the species was also collected while electrofishing, in mini-fyke nets and small hoop nets. There was no difference in catch rates or mean lengths of bighead carp among years, with any gear. All gears caught large adults, with the exception of mini-fyke nets, which was the only gear that captured

juvenile fish. There was no difference in life stage proportions of bighead carp among years; however 2006 was the only year when young of the year fish were collected.

Blue sucker

Only 12 blue suckers were captured in Tate chute over the course of the study, eight of which were encountered in 2007. There were no blue suckers collected in 2006. Blue suckers were most commonly collected while electrofishing although some individuals were caught in otter trawls and trammel nets. There was no difference in catch rates or mean lengths of blue suckers among years, with any gear. There was a difference in life stage proportions of blue suckers among years; 2008 was the only year when juvenile fish were collected. No young of the year blue suckers were caught in Tate chute.

Channel catfish

Channel catfish were among the most abundant species at Tate chute, over 1,600 individuals were collected, most during 2007 and 2008. Channel catfish were captured in all gears; otter trawls had the highest catch rates but fish were regularly collected while electrofishing, in mini-fyke nets, and small hoop nets. Catch rates of channel catfish caught in mini-fyke nets was different each year; catch rates were lowest in 2006 and peaked in 2007. Catch rates in push trawls were also lower in 2006. Mean length of channel catfish caught while electrofishing was lower in 2006. However, fish caught in mini-fyke nets and push trawls were larger in 2006 than in subsequent years. Life stage proportions of channel catfish were different in 2006, when juveniles made up a greater

percentage of the total catch than in 2007. Overall, adult fish were collected throughout the year, whereas juvenile fish were most common later in the year, during September and October. Channel catfish catches were dominated by juveniles each year.

Common Carp

Nearly 500 common carp were collected from Tate chute; 427 fish were collected in 2007, the majority of which were young of the year fish. Common carp were most consistently captured while electrofishing but mini-fyke nets recorded the highest catch rates. Fish were also caught in large and small hoop nets, as well as otter and push trawls. Catch rates of common carp caught while electrofishing was higher in 2006, while mini-fyke nets had the highest catch rates in 2007, when a large number of juveniles were captured. In 2006, the mean lengths of common carp captured in mini-fyke nets were larger than in other years. All years differed with respect to life stage proportions of common carp. In 2006, catches were dominated by adult fish, while 2007 included a much larger number of juvenile fish; in 2008 proportions of adults and juveniles were relatively equal. In general adult common carp were collected throughout the year, while juveniles were normally collected during and after June.

Emerald shiner

We caught over 2,100 emerald shiners at Tate chute, with nearly 1900 of those individuals being collected in 2006. Emerald shiners were collected most effectively in mini-fyke nets but were also consistently caught while electrofishing; fish were also collected in otter and push trawls. All gears had the highest catch rates in 2006. Fish

collected in mini-fyke nets varied among years with respect to mean length, with highest and lowest mean lengths occurring in 2007 and 2008, respectively. Life stage proportions of emerald shiners were different in 2007, when adults made up a larger percentage of the total catch than they did during other years. In general, emerald shiner catches were dominated by juvenile fish, which were most commonly encountered during and after August.

Flathead catfish

Nearly 250 flathead catfish were caught in Tate chute, over half of which were collected in 2007. Flathead catfish were captured in every gear; electrofishing was the most effective gear but small hoop nets also consistently caught fish. Catch rates in small hoop nets were higher in 2007 than during other years. The mean lengths of fish caught in small hoop nets varied among years; progressively smaller fish were captured over the course of the study. There was no difference in life stage proportions of flathead catfish among years. In general, proportions of adult and juvenile flathead catfish were equal during all years. Fish were captured during all months but were most common in August and September.

Gizzard shad

Over 5,300 gizzard shad were captured in Tate chute, the majority of which were collected during 2007. Gizzard shad were collected in all gears; fish were frequently captured while electrofishing and in small hoop nets but the highest catch rates were in mini-fyke nets. Catch rates of gizzard shad collected in mini-fyke nets was higher in

2007, when a large number of juveniles were caught in August; catch rates in large hoop nets were higher in 2007 than in 2008. Mean lengths of fish captured in mini-fyke nets varied among all years, with the greatest and lowest mean lengths occurring in 2006 and 2008, respectively. The mean length of fish collected in otter trawls was lower in 2007 than in 2008. Life stage proportions of gizzard shad varied among all years. In 2006 the catch consisted of equal numbers of adults and juveniles, whereas in 2007 and 2008, juveniles made up much larger percentages of the total catch. In general, adults were collected throughout the year, while juveniles were most abundant during July and August. However, a large number of juvenile fish were also encountered in April and May of 2006, indicating that 2005 young of the year fish may have had an above average survival rate.

Goldeye

Goldeye numbers in Tate chute were relatively low, 164 individuals were caught in the chute; goldeye numbers were fairly consistent among years. Goldeye were most effectively captured while electrofishing, although the species was caught in every gear except small hoop nets. Catch rates of goldeye while electrofishing were lower in 2006 than in other years. The mean length of goldeye caught while electrofishing was larger in 2006 than in other years. There was no difference in the proportions of adults and juveniles among years. In general, goldeye catches were dominated by juveniles of the species and fish were collected in every month of the year.

Hybognathus species

A plains minnow, caught in 2007, was the only *Hybognathus* specimen collected at Tate chute identified to species, several fish were caught that could only be identified to genus *Hybognathus*. All fish were collected in mini-fyke nets in September and all fish were considered juveniles. There was no difference in catch rates, mean lengths or life stage proportions for *Hybognathus* species.

Pallid sturgeon

There were no pallid sturgeon caught in Tate chute, although one hybrid (shovelnose sturgeon x pallid sturgeon) fish was collected in 2007.

Red shiner

We caught 1,165 red shiners in Tate chute, most were collected in 2006 and 2007. Red shiners were most effectively caught in mini-fyke nets but were consistently captured while electrofishing; otter trawls, push trawls and small hoop nets also collected red shiners. Red shiner catch rates while electrofishing and in mini-fyke nets were lower in 2008 than in other years. The mean length of red shiners caught while electrofishing were progressively larger over the course of the study. In general, electrofishing caught larger fish than mini-fyke nets, whereas push trawls captured the smallest fish. Life stage proportions of red shiners were different in 2008, when adults made up a larger percentage of the total catch than in previous years.

River carpsucker

Nearly 700 river carpsuckers were caught in Tate chute, with the majority of the catch occurring in 2006. River carpsuckers were captured with every gear but were most effectively captured while electrofishing and in mini-fyke nets. Catch rates of river carpsuckers collected while electrofishing, in mini-fyke nets and push trawls were higher in 2006 than in other years. The mean length of fish caught in mini-fyke nets and otter trawls was much larger in 2008 than in previous years. Fish caught in otter trawls in 2007 were larger than those caught in 2006; no fish were caught in otter trawls in 2008. Life stage proportions of river carpsuckers were different in 2006, when juveniles made up a larger proportion of the total catch than in other years. In general river carpsuckers were most commonly encountered in August and September and catches were dominated by adults, with the exception of 2006.

River shiner

Eight river shiners were collected in Tate chute. River shiners were caught exclusively in mini-fyke nets. There was no difference in catch rates, mean lengths or life stage proportions of river shiners among years. River shiner catches were dominated by juveniles of the species; only one adult was collected.

Sand shiner

There were 27 sand shiners captured in Tate chute, the majority of which were collected in 2006. Most fish were collected in mini-fyke nets, although fish were collected while electrofishing and in push trawls. Catch rates of sand shiners caught in

mini-fyke nets and push trawls were higher in 2006 than in other years. There were no differences in the mean lengths or life stage proportions of sand shiners among years.

Sauger

Few sauger were encountered in Tate chute. Fish were collected while electrofishing, in mini-fyke nets and push trawls. There was no difference in catch rates, mean lengths or life stage proportions of sauger among years. All sauger collected were juveniles, less than 200 mm.

Shortnose gar

Nearly 250 shortnose gar were captured in Tate chute. Fish were collected in all gears except push trawls. Electrofishing most effectively caught shortnose gar but fish were also consistently captured in large hoop nets and mini-fyke nets. Catch rates of shortnose gar collected in mini-fyke nets was higher in 2006 then during other years. The mean length of fish caught in mini-fyke nets was larger in 2006 than in other years and progressively decreased over the course of the study. Life stage proportions of shortnose gar were different in 2008 when juveniles made up a larger percentage of the catch than in other years. Shortnose gar catches were typically dominated by adults; juveniles were captured primarily in August, September and October.

Shovelnose sturgeon

We caught 181 shovelnose sturgeon in Tate chute; the highest catch occurred in 2008. Fish were most effectively captured in trammel nets and otter trawls but were also

collected while electrofishing and in large and small hoop nets. Catch rates of shovelnose sturgeon in small hoop nets was greatest in 2008. The mean lengths of shovelnose sturgeon caught in otter trawls and trammel nets were larger in 2006 than in subsequent years. Life stage proportions of shovelnose sturgeon were different in 2007 when juveniles made up a larger percentage of the catch than in other years. More young of the year fish were caught in 2007 than other years. In general, fish were captured throughout the year, regardless of life stage. Tate chute was unique among side channel chutes, on the lower portions of the Missouri River, in that many young of the year sturgeon (*Scaphirhynchus spp.*) were captured there.

Sicklefin chub

There were 58 sicklefin chubs collected in Tate chute, 35 of which were captured in 2006. The highest catch rates for sicklefin chubs were in otter trawls but the species was also caught in mini-fyke nets and push trawls. Catch rates in otter and push trawls were higher in 2006 than other years. Mean length of sicklefin chubs caught in mini-fyke nets was greater in 2006 and progressively smaller in subsequent years. Conversely, the mean length of fish caught in otter trawls was greatest in 2008. There was no difference in life stage proportions of sicklefin chubs among years. Overall, sicklefin chub catches were dominated by juveniles and most fish were caught in August and September.

Silver carp

We collected 113 silver carp in Tate chute, the majority of which were caught during 2008. Silver carp were captured most effectively while electrofishing but were

caught in all gears. There was no difference in catch rates or mean lengths of silver carp among years, with any gear. However, life stage proportions of silver carp were different in 2006, when adults made up the majority of the catch, while subsequent years had fairly even numbers of adults and juveniles. The 2006 season was the only year when young of the year fish were not collected.

Silver chub

There were 106 silver chubs caught in Tate chute, over half of which were collected in 2006. The highest catch rates of silver chubs were in otter trawls and fish were regularly captured in mini-fyke nets; few specimens were found while electrofishing or in push trawls. Otter trawls caught more fish in 2006 than in 2008. The mean length of silver chubs caught in otter trawls was greater in 2007 than during other years. The only year adult silver chubs were collected was 2007. Overall, silver chub catches were dominated by juveniles and most fish were collected in July, August and September.

Speckled chub

Over 350 speckled chubs were caught in Tate chute. As with silver chubs, the highest catches of speckled chubs occurred in 2006. Speckled chubs were collected most effectively with otter trawls, however specimens were also captured while electrofishing and in push trawls. There was no difference in catch rates of speckled chubs among years, with any gear. The mean length of fish caught in otter trawls varied among years; 2007 had the highest mean length while 2006 had the lowest. There was no difference in

life stage proportions of speckled chubs among years. Overall, speckled chub catches were dominated by juvenile fish. Fish were most commonly encountered in September and October; however in 2006 a large catch occurred in April.

Sturgeon chub

Only five sturgeon chubs were caught in Tate chute, none were collected during 2007. Fish were captured while electrofishing and with otter and push trawls. There was no difference in catch rates, mean lengths or life stage proportion of sturgeon chubs among years. Four adult fish were captured, the only juvenile was caught in 2008. Sturgeon chubs were collected in May, September and October.

Table III.12.1. Common name, scientific name, family, number of fish collected and percent of total catch, of all species caught in Tate chute 2006 – 2008. Target species are bold.

Common Name	Scientific Name	Family	2006	2007	2008	Total	% Catch
Alabama shad	*Alosa alabamae*	*Clupeidae*	0	1	0	1	0.01
American eel	*Anguilla rostrata*	*Anguillidae*	0	0	1	1	0.01
Bighead carp	***Hypophthalmichthys nobilis***	*Cyprinidae*	11	19	11	41	0.23
Bigmouth buffalo	*Ictiobus cyprinellus*	*Catostomidae*	1	5	24	30	0.17
Black buffalo	*Ictiobus niger*	*Catostomidae*	0	1	0	1	0.01
Black crappie	*Pomoxis nigromaculatus*	*Centrarchidae*	1	0	1	2	0.01
Blackside darter	*Percina maculata*	*Percidae*	2	0	1	3	0.02
Blackstripe topminnow	*Fundulus olivaceus*	*Cyprinidae*	2	0	1	3	0.02
Blue catfish	*Ictalurus furcatus*	*Ictaluridae*	28	60	74	162	0.92
Blue sucker	***Cycleptus elongatus***	*Catostomidae*	0	8	4	12	0.07
Bluegill	*Lepomis macrochirus*	*Centrarchidae*	72	32	28	132	0.75
Bluntnose minnow	*Pimephales notatus*	*Cyprinidae*	176	6	5	187	1.06
Brook silverside	*Labidesthes sicculus*	*Atherinidae*	4	3	0	7	0.04
Bullhead minnow	*Pimephales vigilax*	*Cyprinidae*	682	154	24	860	4.86
Channel catfish	***Ictalurus punctatus***	*Ictaluridae*	179	828	609	1616	9.14
Channel shiner	*Notropis wickliffi*	*Cyprinidae*	7	5	0	12	0.07
Chestnut lamprey	*Ichthyomyzon castaneus*	*Petromyzontidae*	4	2	6	12	0.07
Common carp	***Cyprinus carpio***	*Cyprinidae*	54	427	17	498	2.82
Creek chub	*Semotilus atromaculatus*	*Cyprinidae*	1	1	0	2	0.01
Emerald shiner	***Notropis atherinoides***	*Cyprinidae*	1896	149	74	2119	11.99
Fathead minnow	*Pimephales promelas*	*Cyprinidae*	0	2	0	2	0.01
Flathead catfish	***Pylodictis olivaris***	*Ictaluridae*	69	125	50	244	1.38
Freckled madtom	*Noturus nocturnus*	*Ictaluridae*	0	1	0	1	0.01
Freshwater drum	*Aplodinotus grunniens*	*Sciaenidae*	1013	377	346	1736	9.82
Gizzard shad	***Dorosoma cepedianum***	*Clupeidae*	536	3727	1100	5363	30.34
Golden redhorse	*Moxostoma erythrurum*	*Catostomidae*	1	0	0	1	0.01
Golden shiner	*Notemigonus crysoleucas*	*Cyprinidae*	0	0	1	1	0.01
Goldeye	***Hiodon alosoides***	*Hiodontidae*	44	67	53	164	0.93
Grass carp	*Ctenopharyngodon idella*	*Cyprinidae*	7	12	8	27	0.15
Green sunfish	*Lepomis cyanellus*	*Centrarchidae*	5	3	3	11	0.06
Highfin carpsucker	*Carpiodes velifer*	*Catostomidae*	0	3	1	4	0.02
Johnny darter	*Etheostoma nigrum*	*Percidae*	3	3	0	6	0.03
Largemouth bass	*Micropterus salmoides*	*Centrarchidae*	5	59	0	64	0.36
Logperch	*Percina caprodes*	*Percidae*	8	0	0	8	0.05
Longnose gar	*Lepisosteus osseus*	*Lepisosteidae*	28	31	25	84	0.48
Mimic shiner	*Notropis volucellus*	*Cyprinidae*	5	7	0	12	0.07
Orangespotted sunfish	*Lepomis humilis*	*Centrarchidae*	57	27	5	89	0.50

Table III.12.1 (continued). Common name, scientific name, family, number of fish collected and percent of total catch, of all species caught in Tate chute 2006 – 2008. Target species are bold.

Common Name	Scientific Name	Family	2006	2007	2008	Total	% Catch
Orangethroat darter	*Etheostoma spectabile*	*Percidae*	0	6	3	9	0.05
Paddlefish	*Polyodon spathula*	*Polyodontidae*	2	2	1	5	0.03
Plains minnow	***Hybognathus placitus***	*Cyprinidae*	0	1	0	1	0.01
Quillback	*Carpiodes cyprinus*	*Catostomidae*	1	0	1	2	0.01
Red shiner	***Cyprinella lutrensis***	*Cyprinidae*	611	463	91	1165	6.59
Redear sunfish	*Lepomis microlophus*	*Centrarchidae*	0	1	0	1	0.01
River carpsucker	***Carpiodes carpio***	*Catostomidae*	390	193	114	697	3.94
River redhorse	*Moxostoma carinatum*	*Catostomidae*	1	0	0	1	0.01
River shiner	***Notropis blennius***	*Cyprinidae*	2	4	2	8	0.05
Sand shiner	***Notropis stramineus***	*Cyprinidae*	20	6	1	27	0.15
Sauger	***Stizostedion canadense***	*Percidae*	3	2	2	7	0.04
Shorthead redhorse	*Moxostoma macrolepidotum*	*Catostomidae*	5	0	1	6	0.03
Shortnose gar	***Lepisosteus platostomus***	*Lepisosteidae*	111	75	63	249	1.41
Shovelnose sturgeon x Pallid sturgeon	*Scaphirhynchus platorynchus x albus*	*Acipenseridae*	0	1	0	1	0.01
Shovelnose sturgeon	***Scaphirhynchus platorynchus***	*Acipenseridae*	59	40	82	181	1.02
Sicklefin chub	***Macrhybopsis meeki***	*Cyprinidae*	35	11	12	58	0.33
Silver carp	***Hypophthalmichthys molitrix***	*Cyprinidae*	19	29	65	113	0.64
Silver chub	***Macrhybopsis storeriana***	*Cyprinidae*	54	32	20	106	0.60
Slender madtom	*Noturus exilis*	*Ictaluridae*	1	1	1	3	0.02
Slenderhead darter	*Percina phoxocephala*	*Percidae*	1	0	0	1	0.01
Smallmouth bass	*Micropterus dolomieu*	*Centrarchidae*	1	0	0	1	0.01
Smallmouth buffalo	*Ictiobus bubalus*	*Catostomidae*	39	95	39	173	0.98
Speckled chub	***Macrhybopsis aestivalis***	*Cyprinidae*	129	116	112	357	2.02
Spotfin shiner	*Cyprinella spiloptera*	*Cyprinidae*	0	4	1	5	0.03
Spotted bass	*Micropterus punctulatus*	*Centrarchidae*	8	7	5	20	0.11
Stonecat	*Noturus flavus*	*Ictaluridae*	0	2	3	5	0.03
Striped bass	*Morone saxatilis*	*Moronidae*	0	0	1	1	0.01
Striped bass x White bass	*Morone saxatilis x chrysops*	*Moronidae*	1	1	2	4	0.02
Sturgeon chub	***Macrhybopsis gelida***	*Cyprinidae*	2	0	3	5	0.03
Western mosquitofish	*Gambusia affinis*	*Poeciliidae*	42	2	6	50	0.28
White bass	*Morone chrysops*	*Moronidae*	22	19	16	57	0.32
White crappie	*Pomoxis annularis*	*Centrarchidae*	3	7	5	15	0.08
Yellow bullhead	*Ameiurus natalis*	*Ictaluridae*	0	1	0	1	0.01
Unidentified[1] catfish	*Ictaluridae*	*Ictaluridae*	18	7	2	27	0.15
Unidentified chub	*Macrhybopsis* spp.	*Cyprinidae*	421	79	49	549	3.11
Unidentified *Hybognathus spp.*	*Hybognathus spp.*	*Cyprinidae*	0	3	1	4	0.02

Table III.12.1 (continued). Common name, scientific name, family, number of fish collected and percent of total catch, of all species caught in Tate chute 2006 – 2008. Target species are bold.

Common Name	Scientific Name	Family	2006	2007	2008	Total	% Catch
Unidentified minnow	*Cyprinidae*	*Cyprinidae*	34	74	11	119	0.67
Unidentified sturgeon	*Acipenseridae*	*Acipenseridae*	5	0	1	6	0.03
Unidentified sucker	*Catostomidae*	*Catostomidae*	0	11	2	13	0.07
Unidentified sunfish	*Centrarchidae*	*Centrarchidae*	0	51	26	77	0.44
Unidentified temperate bass	*Morone* spp.	*Moronidae*	0	2	0	2	0.01
Unidentified	Unidentified		0	6	0	6	0.03
Young-of-year fish	Unidentified		2	13	7	22	0.12
		Total	6943	7512	3223	17678	

[1]Fish labeled as 'unidentified' were unidentifiable due to being in larval or juvenile life stages, damage, or disfigurement.

Table III.12.2. Species richness (S), species evenness (E), Shannon's diversity index (H) and Simpson's diversity index (D) for Tate chute by year.

Year	S	E	H	D
2006	53	0.5408	2.1472	0.7720
2007	54	0.4296	1.7137	0.5974
2008	50	0.6159	2.4094	0.7973

Table III.12.3. Sampling effort (number of gear deployments) in Tate chute by year and gear.

Year	Gear	April	May	June	July	August	September	October
2006	EF	7	10		5	7	9	
	HN	4	4	3	8	7	5	
	MF	4	1	2	4	7	6	
	OT16			4	4		4	
	POT	8				5		
	SHN	4	5	6	8	8	8	
	TN	8	10	4	5	6	4	
2007	EF		8	8	8	16	8	
	HN		8	8	8	5	8	
	MF			8	8		16	
	OT16	8		8	8	8	8	
	POT			8	8		16	
	SHN		8	8	8	10	8	
	TN	8		8	8	2	14	
2008	EF	8	8			8	8	8
	HN	8	8		8	8	8	8
	MF					8	8	8
	OT16	8	8		8	8	8	8
	POT					8	8	8
	SHN	8	8		8	8	8	8
	TN	8	8		8	8	8	8

Gears: EF = electrofishing, HN = 4’ diameter hoop nets, MF = mini-fyke, OT16 - 16’ otter trawls, OT8 = 8’ otter trawls, POT = 8’ otter trawls pushed, SHN = 2’ diameter hoop net, TN = the combined efforts of trammel nets in 25’ increments either drifted or set stationary.

Table III.12.4. Yearly mean catch per unit effort (CPUE) and results of Kruskal-Wallis test of mean CPUE of target species caught in Tate chute by species and gear. Significant results are bold.

Species	Gear	Mean CPUE			06 v 07 v 08		06 v 07		06 v 08		07 v 08	
		2006	2007	2008	Chi	P	Chi	P	Chi	P	Chi	P
Bighead Carp	**EF**	0.01	0.01	0.00	1.60	0.4501						
	HN	0.15	0.30	0.20	1.66	0.4354						
	MF	0.07	0.00	0.00	2.33	0.3114						
	SHN	0.00	0.03	0.00	2.07	0.355						
Blue Sucker	**EF**	0.00	0.03	0.02	3.51	0.173						
	OT	0.00	0.04	0.00	3.03	0.2198						
	TN	0.00	0.06	0.12	0.49	0.7841						
Channel Catfish	**EF**	0.33	0.37	0.30	2.76	0.2521						
	HN	0.04	0.04	0.05	0.71	0.7025						
	MF	0.45	0.74	2.38	**21.85**	**<0.0001**	**5.57**	**0.0183**	**18.05**	**<0.0001**	**10.46**	**0.0012**
	OT	0.93	1.99	1.86	4.50	0.1055						
	POT	0.00	0.58	0.73	**8.49**	**0.0144**	**4.67**	**0.0307**	**7.84**	**0.0051**	2.04	0.1529
	SHN	0.46	0.33	0.52	0.27	0.8735						
	TN	0.02	0.07	0.04	0.42	0.8117						
Common Carp	**EF**	0.42	0.15	0.09	**13.15**	**0.0014**	**9.02**	**0.0027**	**9.88**	**0.0017**	0.04	0.8506
	HN	0.00	0.13	0.02	**7.84**	**0.0198**	4.45	0.0349	0.65	0.4216	4.15	0.0416
	MF	0.02	6.97	0.02	**8.15**	**0.017**	**4.67**	**0.0306**			**4.67**	**0.0306**
	OT	0.00	0.02	0.00	1.50	0.4724						
	POT	0.00	0.01	0.00	2.81	0.2453						
	SHN	0.02	0.05	0.02	0.61	0.7375						
Emerald Shiner	**EF**	1.50	0.31	0.14	**5.52**	**0.0632**	3.60	0.0579	**4.61**	**0.0319**	0.19	0.6591
	MF	43.35	1.30	0.79	**14.50**	**0.0007**	**10.69**	**0.0011**	**10.82**	**0.001**	0.17	0.6764
	OT	0.45	0.02	0.01	**33.32**	**<0.0001**	**18.03**	**<0.0001**	**21.54**	**<0.0001**	0.02	0.8839
	POT	0.39	0.02	0.02	**19.01**	**<0.0001**	**15.68**	**<0.0001**	**15.77**	**<0.0001**	0.02	0.8789
Flathead Catfish	**EF**	0.49	0.48	0.18	**20.98**	**<0.0001**	**12.83**	**0.0003**	0.09	0.7668	**16.05**	**<0.0001**
	HN	0.00	0.19	0.07	4.40	0.1107						
	MF	0.00	0.01	0.05	4.29	0.1172						
	OT	0.00	0.04	0.00	3.03	0.2198						
	POT	0.00	0.00	0.00	1.84	0.398						
	SHN	0.19	0.61	0.27	**9.90**	**0.0071**	**7.43**	**0.0064**	0.26	0.6116	**6.12**	**0.0134**
	TN	0.00	0.06	0.13	0.49	0.7841						
Gizzard Shad	**EF**	5.34	11.61	8.04	0.25	0.881						
	HN	0.00	0.07	0.00	**8.77**	**0.0125**	3.51	0.0611			**5.38**	**0.0204**
	MF	0.07	21.46	0.48	**21.46**	**<0.0001**	**17.42**	**<0.0001**	3.31	0.0689	**9.07**	**0.0026**
	OT	0.00	0.18	0.09	1.26	0.5319						
	POT	0.00	0.07	0.01	3.04	0.2182						
	SHN	0.02	0.00	0.00	2.31	0.3154						
	TN	1.35	0.00	0.00	4.35	0.1136						
Goldeye	**EF**	0.11	0.46	0.33	**11.52**	**0.0032**	**11.15**	**0.0008**	**6.96**	**0.0083**	0.57	0.4497
	HN	0.00	0.00	0.04	2.86	0.2395						
	MF	0.00	0.06	0.00	**4.62**	**0.0995**	2.33	0.1266			2.33	0.1266
	OT	0.11	0.00	0.00	**7.33**	**0.0256**	3.33	0.0679	4.00	0.0455		
	POT	0.00	0.00	0.00	1.84	0.398						
	TN	0.00	0.07	0.18	2.69	0.2604						
Plains Minnow	**MF**	0.00	0.01	0.00	1.50	0.4724						
Red Shiner	**EF**	1.32	1.31	0.22	**18.95**	**<0.0001**	3.12	0.0774	2.77	0.0961	**20.57**	**<0.0001**
	MF	19.74	2.76	0.80	**13.16**	**0.0014**	2.49	0.1149	**10.90**	**0.001**	**7.34**	**0.0067**
	OT	0.02	0.02	0.00	3.39	0.1833						
	POT	0.01	0.08	0.03	0.36	0.8334						
	SHN	0.02	0.00	0.00	2.31	0.3154						
River Carpsucker	**EF**	2.28	0.79	0.58	**18.37**	**0.0001**	**14.63**	**0.0001**	**13.99**	**0.0002**	0.13	0.7237
	HN	0.11	0.51	0.20	1.67	0.4343						
	MF	2.84	0.16	0.09	**24.21**	**<0.0001**	**19.54**	**<0.0001**	**10.24**	**0.0014**	2.80	0.0941
	OT	0.13	0.10	0.00	**9.89**	**0.0071**	1.60	0.2063	**12.41**	**0.0004**	**4.97**	**0.0258**
	POT	0.19	0.00	0.01	**12.95**	**0.0015**	**11.82**	**0.0006**	**7.25**	**0.0071**	0.65	0.4217
	SHN	0.00	0.70	0.02	3.72	0.1557						
	TN	0.00	0.00	0.04	1.23	0.5409						
River Shiner	**MF**	0.29	0.04	0.04	0.51	0.7763						

Table III.12.4 (continued). Yearly mean CPUE and results of Kruskal-Wallis test of mean CPUE of target species caught in Tate chute by species and gear. Significant results are bold.

Species	Gear	Mean CPUE			06 v 07 v 08		06 v 07		06 v 08		07 v 08	
		2006	2007	2008	Chi	P	Chi	P	Chi	P	Chi	P
Sand Shiner	EF	0.02	0.01	0.00	2.33	0.3121						
	MF	0.45	0.07	0.00	**6.79**	**0.0335**	2.56	0.1096	**5.45**	**0.0196**	1.53	0.2165
	POT	0.00	0.00	0.00	**5.30**	**0.0706**	**6.40**	**0.0114**	1.40	0.237	1.33	0.2482
Sauger	EF	0.01	0.01	0.01	0.08	0.961						
	MF	0.04	0.00	0.02	1.35	0.509						
	POT	0.00	0.00	0.00	0.91	0.6356						
Shortnose Gar	EF	0.59	0.25	0.37	3.07	0.2156						
	HN	0.11	0.19	0.20	1.82	0.4032						
	MF	0.87	0.03	0.05	**21.09**	**<0.0001**	**16.27**	**<0.0001**	**9.99**	**0.0016**	0.65	0.4212
	OT	0.00	0.02	0.00	1.50	0.4724						
	SHN	0.15	0.11	0.09	1.15	0.5626						
	TN	0.05	0.30	0.12	1.49	0.4755						
Shovelnose Sturgeon	EF	0.09	0.05	0.04	0.31	0.8581						
	HN	0.04	0.02	0.07	0.78	0.6775						
	OT	0.06	0.42	0.70	3.47	0.1763						
	SHN	0.04	0.00	0.27	**13.10**	**0.0014**	1.08	0.2994	**5.57**	**0.0183**	**8.63**	**0.0033**
	TN	1.06	0.37	1.13	**5.69**	**0.058**	4.50	0.0339	3.69	0.0546	0.16	0.6887
Sicklefin Chub	EF	0.01	0.00	0.00	2.75	0.2528						
	MF	0.06	0.06	0.02	0.37	0.8315						
	OT	0.71	0.00	0.12	**5.14**	**0.0765**	3.33	0.0679	0.09	0.7654	**5.30**	**0.0214**
	POT	0.05	0.01	0.01	**16.92**	**0.0002**	**13.01**	**0.0003**	**11.17**	**0.0008**	0.01	0.92
Silver Carp	EF	0.17	0.07	0.39	**18.01**	**0.0001**	0.38	0.5351	**7.86**	**0.0051**	**15.58**	**<0.0001**
	HN	0.00	0.00	0.05	4.33	0.115						
	MF	0.00	0.23	0.00	**4.61**	**0.0995**	2.33	0.1267			2.33	0.1267
	OT	0.00	0.00	0.01	1.08	0.5818						
	POT	0.00	0.00	0.00	0.91	0.6356						
	SHN	0.04	0.00	0.00	2.31	0.3154						
	TN	0.00	0.04	0.00	1.74	0.4182						
Silver Chub	EF	0.01	0.01	0.00	1.60	0.4501						
	MF	0.27	0.08	0.11	3.65	0.1613						
	OT	0.40	0.16	0.07	**8.86**	**0.0119**	2.65	0.1039	**9.32**	**0.0023**	2.94	0.0865
	POT	0.00	0.02	0.02	2.96	0.2274						
Speckled Chub	EF	0.02	0.00	0.00	2.75	0.2528						
	MF	0.04	0.03	0.11	2.81	0.2453						
	OT	2.45	0.08	0.24	1.86	0.3948						
	POT	0.01	0.12	0.28	0.52	0.7724						
Sturgeon Chub	EF	0.01	0.00	0.00	2.75	0.2528						
	OT	0.00	0.00	0.03	2.19	0.3348						
	POT	0.00	0.00	0.00	1.54	0.4626						

Gear : EF = electrofishing, HN = 4’ diameter hoop nets, SHN = 2’ diameter hoop nets, MF = mini-fyke nets, OT = 16’ otter trawls, POT = 8’ otter trawls pushed, TN = combined efforts of 1” trammel nets in 25’ increments.

Table III.12.5. Catch per unit effort (CPUE) and 2 standard errors (SE) of target species caught in Tate chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Bighead carp	EF					**0.05** 0.10									**0.03** 0.06		**0.07** 0.13				**0.00** 0.00	
	HN	**0.25** 0.50		**0.13** 0.25					**0.88** 0.70		**0.25** 0.50	**0.63** 0.53		**0.57** 0.59	**0.60** 1.20	**0.13** 0.25			**0.13** 0.25			**1.00** 1.00
	MF										**0.50** 1.00											
	SHN														**0.20** 0.40							
Blue sucker	EF														**0.05** 0.07			**0.16** 0.16	**0.04** 0.09			**0.09** 0.11
	OT								**0.15** 0.29						**0.12** 0.24							
	TN						**0.83** 1.67		**0.39** 0.78													
Channel catfish	EF	**0.31** 0.33		**0.64** 0.22	**0.04** 0.08	**0.54** 0.96	**0.15** 0.20				**0.12** 0.25	**0.24** 0.24		**0.23** 0.33	**0.65** 0.44	**0.49** 0.23	**1.59** 1.04	**1.20** 0.89	**0.37** 0.19			**0.42** 0.30
	HN			**0.13** 0.25	**0.25** 0.50		**0.13** 0.25		**0.25** 0.50										**0.13** 0.25			
	MF	**0.25** 0.50							**0.13** 0.25		**0.75** 1.50	**1.38** 0.75		**2.14** 1.71		**2.38** 1.81		**3.69** 3.24	**3.38** 2.00			**10.88** 6.42
	OT		**5.07** 5.12	**1.83** 2.45			**0.43** 0.36	**1.15** 1.62	**0.90** 0.91		**0.41** 0.49	**0.15** 0.29	**0.36** 0.50		**6.79** 2.47	**0.23** 0.31	**4.93** 6.26	**1.00** 0.53	**0.63** 0.70			**9.54** 5.31
	POT								**0.61** 0.45			**0.02** 0.03		**0.01** 0.02		**0.31** 0.25		**3.43** 2.40	**2.51** 1.24			**2.29** 1.89
	SHN	**1.00** 2.00		**0.38** 0.37	**0.20** 0.40	**0.50** 0.76	**1.00** 0.76	**0.17** 0.33	**0.50** 0.65			**0.25** 0.33	**0.38** 0.53	**1.63** 1.46	**0.90** 0.87	**1.25** 2.50	**0.25** 0.33	**0.13** 0.25	**0.13** 0.25			**0.50** 0.65
	TN				**0.14** 0.29													**0.51** 1.03	**0.31** 0.63			
Common carp	EF	**0.48** 0.62		**0.05** 0.10	**0.18** 0.19				**0.10** 0.13		**0.84** 1.05	**0.23** 0.46		**1.09** 0.98	**0.05** 0.07	**0.15** 0.15	**0.37** 0.26	**0.65** 0.53	**0.04** 0.09			**0.40** 0.43
	HN					**0.38** 0.75			**0.25** 0.33									**0.25** 0.33				**0.13** 0.25
	MF								**48.50** 60.51			**0.25** 0.50					**0.17** 0.33	**0.06** 0.13	**0.13** 0.25			
	OT		**0.13** 0.25																			
	POT								**0.06** 0.08			**0.02** 0.03										
	SHN					**0.25** 0.50	**0.13** 0.25		**0.13** 0.25								**0.13** 0.25					

Table III.12.5 (continued). CPUE) and 2 SE of target species caught in Tate chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Emerald shiner	EF	**0.13** 0.16		**0.29** 0.20	**0.05** 0.10	**0.53** 0.79			**0.80** 1.30		**0.12** 0.25	**0.63** 0.44		**0.85** 0.77	**0.09** 0.10	**0.29** 0.35	**9.37** 5.13	**0.10** 0.20	**0.28** 0.24			**0.10** 0.20
	MF	**3.75** 2.87			**60.00** 0.00			**1.00** 2.00	**1.50** 1.41		**2.75** 2.75	**5.63** 8.39		**181.14** 261.10		**0.38** 0.53	**54.83** 54.98	**2.00** 1.81	**3.50** 3.93			**1.63** 1.00
	OT			**0.10** 0.19				**0.43** 0.55	**0.11** 0.22		**0.25** 0.50						**2.47** 3.05					
	POT								**0.02** 0.04					**2.75** 2.22		**0.01** 0.03		**0.15** 0.10	**0.05** 0.08			**0.08** 0.09
Flathead catfish	EF	**0.07** 0.15		**0.03** 0.07	**0.35** 0.30	**0.42** 0.29	**0.15** 0.30		**0.49** 0.39		**0.12** 0.25	**0.57** 0.39		**0.07** 0.14	**0.79** 0.31	**0.36** 0.15	**2.80** 4.67	**1.10** 0.35	**0.41** 0.30			**0.28** 0.18
	HN			**0.13** 0.25		**0.50** 1.00	**0.13** 0.25		**0.13** 0.25						**0.60** 0.80	**0.13** 0.25		**0.13** 0.25				**0.13** 0.25
	MF															**0.25** 0.33		**0.06** 0.13	**0.13** 0.25			
	OT								**0.15** 0.29			**0.15** 0.29										
	POT								**0.02** 0.03									**0.01** 0.01				
	SHN			**0.25** 0.33		**1.88** 1.33	**0.50** 0.38	**0.33** 0.42	**0.75** 0.50		**0.38** 0.53	**0.13** 0.25	**0.63** 0.84	**0.25** 0.50	**0.30** 0.31	**0.38** 0.53	**0.38** 0.53	**1.25** 1.18	**0.13** 0.25			
	TN						**0.93** 1.87		**0.39** 0.78													
Gizzard shad	EF	**7.35** 4.46		**2.36** 0.89	**5.98** 3.20	**0.41** 0.35	**0.34** 0.51		**0.20** 0.40		**16.23** 9.75	**21.12** 7.85		**7.00** 2.66	**38.20** 38.21	**29.81** 18.02	**0.79** 0.72	**21.36** 10.04	**19.38** 21.64			**4.38** 2.33
	HN								**0.50** 0.38													
	MF								**141.13** 212.87			**5.75** 4.50				**0.13** 0.25	**0.50** 0.68	**3.38** 3.78	**2.88** 4.65			**0.38** 0.37
	OT			**0.30** 0.43											**0.13** 0.25			**1.13** 2.25				**0.31** 0.41
	POT								**0.02** 0.04			**0.11** 0.15				**0.08** 0.11		**0.40** 0.39	**0.01** 0.03			
	SHN													**0.13** 0.25								
	TN													**9.48** 18.97								

Table III.12.5 (continued). CPUE) and 2 SE of target species caught in Tate chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Goldeye	EF	**0.16**		**1.19**		**1.52**	**0.07**		**0.39**		**0.24**	**0.40**		**0.07**	**0.15**	**0.36**	**0.28**	**0.73**	**0.16**			**0.50**
		0.32		0.59		0.40	0.14		0.40		0.28	0.24		0.14	0.10	0.37	0.30	0.64	0.17			0.32
	HN															**0.25**						
																0.33						
	MF								**0.38**									**0.06**				
									0.53									0.13				
	OT										**0.75**											
											1.50											
	POT								**0.02**									**0.01**				
									0.04									0.01				
	TN															**0.31**		**0.51**				**0.95**
																0.63		1.03				0.97
Plains minnow	MF																	**0.06**				
																		0.13				
Red shiner	EF			**0.10**	**0.51**	**1.62**	**0.09**		**2.59**			**2.83**		**0.47**	**1.51**	**0.53**	**8.27**	**0.61**	**0.75**			**0.06**
				0.13	0.46	2.34	0.17		2.19			1.76		0.65	0.91	0.42	6.29	0.23	0.75			0.12
	MF	**1.00**			**66.00**			**16.00**	**7.63**		**9.50**	**5.25**		**22.86**		**1.13**	**22.83**	**6.44**	**3.00**			**1.50**
		1.41			0.00			32.00	6.40		4.20	4.91		22.45		1.75	16.29	3.36	2.42			1.69
	OT								**0.17**		**0.13**											
									0.33		0.25											
	POT													**0.07**				**0.56**	**0.15**			**0.09**
														0.09				0.82	0.14			0.13
	SHN										**0.13**											
											0.25											
River carpsucker	EF	**2.27**		**0.76**	**3.01**	**0.17**	**0.12**		**0.14**		**2.13**	**1.79**		**1.57**	**0.65**	**0.96**	**7.00**	**2.80**	**1.11**			**1.13**
		2.54		0.46	2.32	0.25	0.16		0.21		1.64	1.07		1.34	0.33	0.41	4.36	1.70	0.53			0.53
	HN			**0.13**	**0.25**		**0.63**		**2.00**		**0.13**	**0.38**		**0.43**	**1.20**	**0.13**			**0.13**			**0.38**
				0.25	0.50		0.53		2.62		0.25	0.53		0.59	1.94	0.25			0.25			0.53
	MF	**0.50**						**1.00**	**1.13**		**12.00**			**5.57**		**0.38**	**0.83**		**0.25**			
		0.58						0.00	2.25		19.44			3.80		0.37	1.31		0.50			
	OT		**0.33**								**0.16**						**0.72**	**0.38**				
			0.67								0.31						0.90	0.37				
	POT													**1.33**				**0.02**	**0.01**			**0.03**
														1.14				0.02	0.03			0.03
	SHN						**0.13**								**4.80**			**0.13**				
							0.25								7.98			0.25				
	TN																		**0.31**			
																			0.63			
River shiner	MF				**2.00**											**0.25**		**0.25**				
					0.00											0.33		0.29				

Table III.12.5 (continued). CPUE) and 2 SE of target species caught in Tate chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Sand shiner	EF														**0.04** 0.06		**0.12** 0.16					
	MF							**0.50** 1.00	**0.50** 0.76		**2.50** 3.11						**0.17** 0.33					
	POT													**0.01** 0.02		**0.01** 0.03						
Sauger	EF															**0.05** 0.09	**0.05** 0.10	**0.07** 0.14				
	MF	**0.25** 0.50																				**0.13** 0.25
	POT																	**0.01** 0.01				
Shortnose gar	EF	**0.07** 0.15		**0.15** 0.15	**1.91** 1.53	**0.76** 0.46	**2.10** 1.35		**0.11** 0.15		**1.39** 1.05			**0.07** 0.14	**0.75** 0.43	**0.11** 0.11	**0.69** 0.47	**0.15** 0.29	**0.19** 0.19			**0.05** 0.10
	HN			**0.63** 1.25					**0.63** 0.37		**0.13** 0.25	**0.38** 0.53		**0.43** 0.59	**0.20** 0.40	**0.13** 0.25	**0.20** 0.40	**0.13** 0.25	**0.38** 0.37			**0.25** 0.33
	MF	**0.75** 1.50			**1.00** 0.00			**1.50** 1.00	**0.13** 0.25		**1.50** 1.29			**0.86** 1.11			**0.50** 0.45	**0.06** 0.13	**0.25** 0.33			**0.13** 0.25
	OT														**0.13** 0.25							
	SHN						**0.13** 0.25	**0.17** 0.33				**0.50** 0.38		**0.63** 0.75	**0.30** 0.43	**0.13** 0.25	**0.25** 0.33		**0.38** 0.53			
	TN				**0.37** 0.74							**2.08** 2.50				**0.83** 1.67						
Shovelnose sturgeon	EF	**0.08** 0.16		**0.10** 0.13	**0.17** 0.33						**0.11** 0.22				**0.15** 0.26	**0.07** 0.14	**0.27** 0.54	**0.19** 0.19	**0.08** 0.10			**0.06** 0.11
	HN	**0.25** 0.50		**0.13** 0.25		**0.13** 0.25										**0.38** 0.53						
	OT		**0.30** 0.39	**1.25** 1.72			**0.17** 0.22	**0.44** 0.88	**2.17** 3.01				**0.61** 0.81		**0.50** 0.53	**0.17** 0.33			**1.79** 1.27			**0.94** 1.55
	SHN	**0.25** 0.50		**0.63** 0.75			**1.13** 0.96									**0.13** 0.25						
	TN			**1.03** 2.07	**5.57** 8.00		**2.80** 5.60	**0.97** 1.12	**1.02** 2.04			**0.42** 0.83	**0.97** 1.93	**0.86** 1.72				**1.15** 1.66	**0.78** 1.56			**2.34** 3.06
Sicklefin chub	EF																**0.05** 0.10					
	MF								**0.13** 0.25					**0.43** 0.59				**0.31** 0.63	**0.13** 0.25			
	OT			**0.10** 0.19			**0.08** 0.17										**5.00** 10.00					**0.63** 0.47
	POT													**0.35** 0.53				**0.04** 0.05	**0.04** 0.08			**0.04** 0.07

Table III.12.5 (continued). CPUE) and 2 SE of target species caught in Tate chute by month, year and gear.

Species	Gear	April			May			June			July			August			September			October		
		2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Silver carp	EF			**1.22** 0.55	**0.21** 0.31	**0.18** 0.25	**0.12** 0.16		**0.03** 0.07		**0.59** 1.17	**0.08** 0.15		**0.31** 0.31	**0.19** 0.19	**0.57** 0.49	**0.07** 0.13		**0.33** 0.35			**0.50** 0.60
	HN						**0.13** 0.25									**0.13** 0.25			**0.13** 0.25			
	MF								**1.50** 2.00			**0.13** 0.25										
	OT						**0.08** 0.17															
	POT								**0.02** 0.04													
	SHN	**0.25** 0.50																				
	TN		**0.27** 0.54																			
Silver chub	EF														**0.05** 0.07		**0.07** 0.14					
	MF										**0.75** 0.96	**0.50** 1.00		**1.14** 1.11		**0.25** 0.33		**0.06** 0.13	**0.50** 0.38			
	OT		**0.65** 0.76						**0.22** 0.43								**2.77** 1.26	**0.25** 0.33				**0.47** 0.66
	POT											**0.12** 0.09				**0.01** 0.03		**0.05** 0.03	**0.15** 0.22			
Speckled chub	EF																**0.15** 0.29					
	MF	**0.25** 0.50																**0.19** 0.27				**0.75** 0.63
	OT		**0.48** 0.36	**0.10** 0.19			**0.08** 0.17		**0.11** 0.22				**0.09** 0.18				**17.13** 22.98					**1.38** 1.45
	POT								**0.20** 0.41			**0.01** 0.02		**0.05** 0.08				**0.61** 0.62	**0.14** 0.17			**1.79** 3.45
Sturgeon chub	EF																**0.07** 0.14					
	OT						**0.08** 0.17															**0.16** 0.31
	POT																		**0.01** 0.03			

Gears: EF = electrofishing, HN = 4' diameter hoop nets, MF = mini-fyke nets, OT = 16' otter trawls, SHN = 2' diameter hoop nets, POT = 8' otter trawls pushed, TN = combined efforts of 1" trammel nets in 25' increments.

Table III.12.6. Mean length (ML), standard error (SE) in parentheses and results of analysis of variance of mean length for target species caught in Tate chute, by year and gear. Significant results are bold.

Species	Gear	ML/SE 2006	ML/SE 2007	ML/SE 2008	06 v 07 v 08		2006 v 2007		2006 v 2008		2007 v 2008	
					F	P value	F	P value	F	P value	F	P value
Bighead carp	EF	810	745 (20)		3.52	0.3117						
	HN	732.7 (24.2)	722.5 (11.7)	722.3 (25.1)	0.07	0.9308						
	SHN		676.5 (10.5)									
	MF	32.5 (0.5)										
Blue sucker	EF		610 (18.3)	483 (43.9)	**9.92**	**0.0198**					**3.15**	**0.0198**
	OT		559.5 (34.5)									
	TN		535	555								
Channel catfish	EF	158.5 (20.8)	303.6 (22)	302.2 (23.9)	**12.81**	**0.0001**	**-4.64**	**0.0001**	**-4.2**	**0.0001**	0.04	0.9561
	HN	374	447.5 (57.5)	476 (75)	0.29	0.7667						
	SHN	227.7 (24.6)	283.4 (27.6)	271.3 (21.6)	1.35	0.2672						
	MF	127.8 (28.8)	60.3 (4.4)	58.1 (1.2)	**21.31**	**0.0001**	**5.93**	**0.0001**	**6.43**	**0.0001**	0.33	0.7431
	OT	95 (6.9)	93.2 (5.9)	89.4 (4.7)	0.2	0.8159						
	POT	76	52.4 (1.7)	58 (1.2)	**2.71**	**0.0675**	0.73	0.4664	0.55	0.5793	**-2.23**	**0.0264**
	TN	188 (87)	195	313	0.37	0.7564						
Common carp	EF	554.9 (8.8)	552.7 (25.5)	500.6 (28.1)	2.26	0.1104						
	HN		640.6 (32.9)	660	0.04	0.8415						
	SHN	610	615.3 (20.2)	670	1.03	0.492						
	MF	510	53.1 (9.3)	51	10.71	0.0001	4.63	0.0001	3.3	0.0018	0.02	0.9835
	OT		537									
	POT		62.8 (18.1)									
Emerald shiner	EF	52.5 (1.1)	54.1 (2.7)	51.6 (2.8)	0.26	0.7737						
	MF	47.6 (1.5)	51.9 (1.9)	41.6 (1.3)	**3.93**	**0.0207**	**-1.69**	**0.0931**	**1.83**	**0.0687**	**2.78**	**0.0058**
	OT	42.6 (3.4)	76	42	2.56	0.1087						
	POT	35.3 (1)	27.8 (2.2)	39.6 (5.9)	**5.76**	**0.0045**	**2.94**	**0.0042**	-1.19	0.2392	**-2.9**	**0.0048**
Flathead catfish	EF	242 (31.9)	258.3 (12.1)	324.4 (25.9)	**3.01**	**0.0531**	-0.64	0.5256	**-2.42**	**0.0172**	**-2.01**	**0.0465**
	HN		651.4 (38.2)	706.5 (105.7)	0.39	0.547						
	SHN	485 (25.3)	398.1 (22.5)	306.6 (37.7)	**5.85**	**0.0049**	**1.87**	**0.0667**	**3.37**	**0.0014**	**2.29**	**0.026**
	MF		51	278.7 (41.7)	7.45	0.1121						
	OT		281.5 (117.5)									
	POT		168 (143)									
	TN		206	220								

Table III.12.6 (continued). Mean length (ML), standard error (SE) in parentheses and results of analysis of variance of mean length for target species caught in Tate chute, by year and gear. Significant results are bold.

Species	Gear	ML/SE 2006	ML/SE 2007	ML/SE 2008	06 v 07 v 08		2006 v 2007		2006 v 2008		2007 v 2008	
					F	P value	F	P value	F	P value	F	P value
Gizzard shad	EF	221.1 (3.5)	88.2 (2.2)	115.8 (3.6)	**459.6**	**0.0001**	**30.3**	**0.0001**	**18.19**	**0.0001**	**-6.03**	**0.0001**
	HN		283.3 (24.6)									
	SHN	240										
	MF	136.7 (43.4)	43.4 (1.7)	76.1 (6.6)	32.67	0.0001	6.1	0.0001	3.74	0.0003	-5.54	0.0001
	OT		71.9 (2.8)	87.4 (1.6)	14.22	0.0023					-3.77	0.0023
	POT		66.4 (2.2)	57.7 (6.4)	1.51	0.2245						
	TN	212.6 (8.8)										
Goldeye	EF	202.1 (17)	160.7 (8.8)	166.7 (9.7)	**3.32**	**0.0391**	**2.51**	**0.0133**	**2.05**	**0.0419**	-0.42	0.6774
	HN			335.5 (14.5)								
	MF		72.3 (23)									
	OT	65.2 (3.4)										
	POT		89 (27)									
	TN		228	260.5 (18)	0.65	0.4782						
Plains minnow	MF		56									
Red shiner	EF	40.6 (1.1)	45.4 (0.8)	51.7 (1.3)	**14.95**	**0.0001**	**-3.73**	**0.0002**	**-4.86**	**0.0001**	**-2.76**	**0.0061**
	SHN	60										
	MF	40.1 (0.7)	38.3 (0.9)	39.8 (1.5)	1.44	0.2375						
	OT	59	26									
	POT	30.2 (3.6)	32.1 (1.4)	32.5 (3.3)	0.08	0.9206						
River carpsucker	EF	231.3 (10.2)	350 (10.1)	363.1 (10.1)	**46.65**	**0.0001**	**-7.61**	**0.0001**	**-7.91**	**0.0001**	-0.68	0.4989
	HN	397.4 (19.2)	419.7 (11.8)	432.5 (26.6)	0.49	0.6167						
	SHN		389.9 (6.3)	456	2.59	0.115						
	MF	38.7 (4.3)	33.5 (3.5)	228.6 (90.3)	**24.98**	**0.0001**	0.24	0.811	**-7.03**	**0.0001**	**-5.83**	**0.0001**
	OT	109 (39.8)	303.6 (75.6)		**5.19**	**0.0523**	**-2.28**	**0.0523**				
	POT	44.4 (2.8)	54.3 (12.4)	110 (59.8)	**6.88**	**0.0029**	-0.56	0.5778	**-3.7**	**0.0007**	**-2.3**	**0.0269**
	TN	440	413									
River shiner	MF	49 (3)	38.3 (3.2)	43 (1)	2.77	0.1548						
Sand shiner	EF	50 (2.5)	43 (9)		0.88	0.4169						
	MF	44 (2.3)	41 (8.4)		**0.24**	**0.6324**						
	POT	51		35								

Table III.12.6 (continued). Mean length (ML), standard error (SE) in parentheses and results of analysis of variance of mean length for target species caught in Tate chute, by year and gear. Significant results are bold.

Species	Gear	ML/SE 2006	ML/SE 2007	ML/SE 2008	06 v 07 v 08		2006 v 2007		2006 v 2008		2007 v 2008	
					F	P value	F	P value	F	P value	F	P value
Sauger	**EF**	191	184	122								
	MF	197		198								
	POT		172									
Shortnose gar	**EF**	564.2 (6.6)	579.1 (7.3)	553.7 (15.2)	1.64	0.1973						
	HN	653 (13.1)	642.1 (20.4)	619.1 (7.1)	1.21	0.3152						
	SHN	574.3 (13.8)	598.6 (24.5)	583.6 (16.5)	0.46	0.6406						
	MF	567.8 (10.7)	310.5 (288.5)	329 (3)	**12.69**	**0.0002**	**3.54**	**0.0019**	**3.94**	**0.0007**	-0.21	0.8385
	OT		535									
	TN	490	626 (29.7)	596.5 (49.5)	1.72	0.2702						
Shovelnose sturgeon	**EF**	484 (32)	558.9 (20)	574 (51.4)	2.11	0.1413						
	HN	595	635	606.8 (14.8)	0.51	0.6451						
	SHN	550		565.2 (27)	0.02	0.8884						
	OT	561 (32.5)	156.3 (49.7)	342.4 (35.3)	**7.41**	**0.0013**	**2.96**	**0.0045**	1.64	0.1072	0.0024	
	TN	524.6 (16.3)	416.3 (36.6)	503.9 (26.5)	**3.44**	**0.039**	**2.62**	**0.0112**	0.7	0.4881	**-1.96**	**0.0547**
Sicklefin chub	**EF**	26										
	MF	37.7 (2.8)	26 (1.9)	25	7.3	0.0328	3.59	0.0158	2.58	0.0497	0.21	0.8419
	OT	23 (0.9)		40.8 (3.8)	33.32	0.0001			-5.77	0.0001		
	POT	27.4 (1.5)	27.3 (1.3)	32.8 (3.5)	2.22	0.1406						
Silver carp	**EF**	758.9 (20.8)	663.6 (59.9)	415.2 (37.8)	**14.91**	**0.0001**	1.02	0.3107	**4.99**	**0.0001**	**3.17**	**0.0021**
	HN			620.3 (65.3)								
	SHN	790										
	MF		34.2 (1.4)									
	OT			819								
	POT		61									
	TN		745									
Silver chub	**EF**	72.3 (3.5)	61 (6)		3.15	0.1739						
	MF	51 (4.3)	45.3 (3.9)	54.3 (4.4)	0.65	0.5334						
	OT	60.4 (2.7)	79.3 (4.5)	62.7 (14.3)	5.6	0.0112	-3.28	0.0036	-0.27	79.17	1.88	0.0745
	POT		46.2 (3.3)	42.2 (4.4)	0.55	0.4662						

Table III.12.6 (continued). Mean length (ML), standard error (SE) in parentheses and results of analysis of variance of mean length for target species caught in Tate chute, by year and gear. Significant results are bold.

Species	Gear	ML/SE 2006	ML/SE 2007	ML/SE 2008	06 v 07 v 08		2006 v 2007		2006 v 2008		2007 v 2008	
					F	P value	F	P value	F	P value	F	P value
Speckled chub	EF	27.3 (1.2)										
	MF	42	30.7 (1.5)	33.4 (2.2)	**2.54**	**0.1589**						
	OT	27.3 (0.8)	49.2 (5.4)	40.8 (2.8)	**33.56**	**0.0001**	-6.9	0.0001	**-5.64**	**0.0001**	2.33	0.0246
	POT	24 (1)	32.3 (1.1)	32.9 (1.1)	0.71	0.4968						
Sturgeon chub	EF	55										
	OT			44.5 (2.5)								
	POT			31								

Gear : EF = electrofishing, HN = 4' diameter hoop nets, SHN = 2' diameter hoop nets, MF = mini-fyke nets, OT = 16' otter trawls, POT = 8' otter trawls pushed, TN = combined efforts of 1" trammel nets in 25' increments.

Table III.12.7. Results of z-test analysis of life stage proportions of target species caught in Tate chute. Significant results are bold.

Species	2006 v 2007 Z	2006 v 2008 Z	2007 v 2008 Z
Bighead carp	-	-	-
Blue sucker	-	-	**-2.19**
Channel catfish	**-2.22**	-1.19	1.24
Common carp	**-9.77**	**-2.56**	**5.58**
Emerald shiner	**6.12**	0.4	**-2.98**
Flathead catfish	0.49	0.35	-0.05
Gizzard shad	**-28.69**	**-11.58**	**8.25**
Goldeye	-0.43	-1.57	-1.27
Plains minnow	-	-	-
Red shiner	1.03	**2.97**	**2.31**
River carpsucker	**10.63**	**8.69**	-0.21
River shiner	-1.55	-1.15	
Sand shiner	-0.93	-1.07	-0.68
Sauger	-	-	-
Shortnose gar	-0.28	**-3.38**	**-2.69**
Shovelnose sturgeon	**-2.15**	0.1	**2.36**
Sicklefin chub	-1	2.08	2.11
Silver carp	**-3.73**	**-4.2**	-0.13
Silver chub	**2.29**	-	-1.41
Speckled chub	-1.5	-0.51	0.63
Sturgeon chub	-	-0.91	-

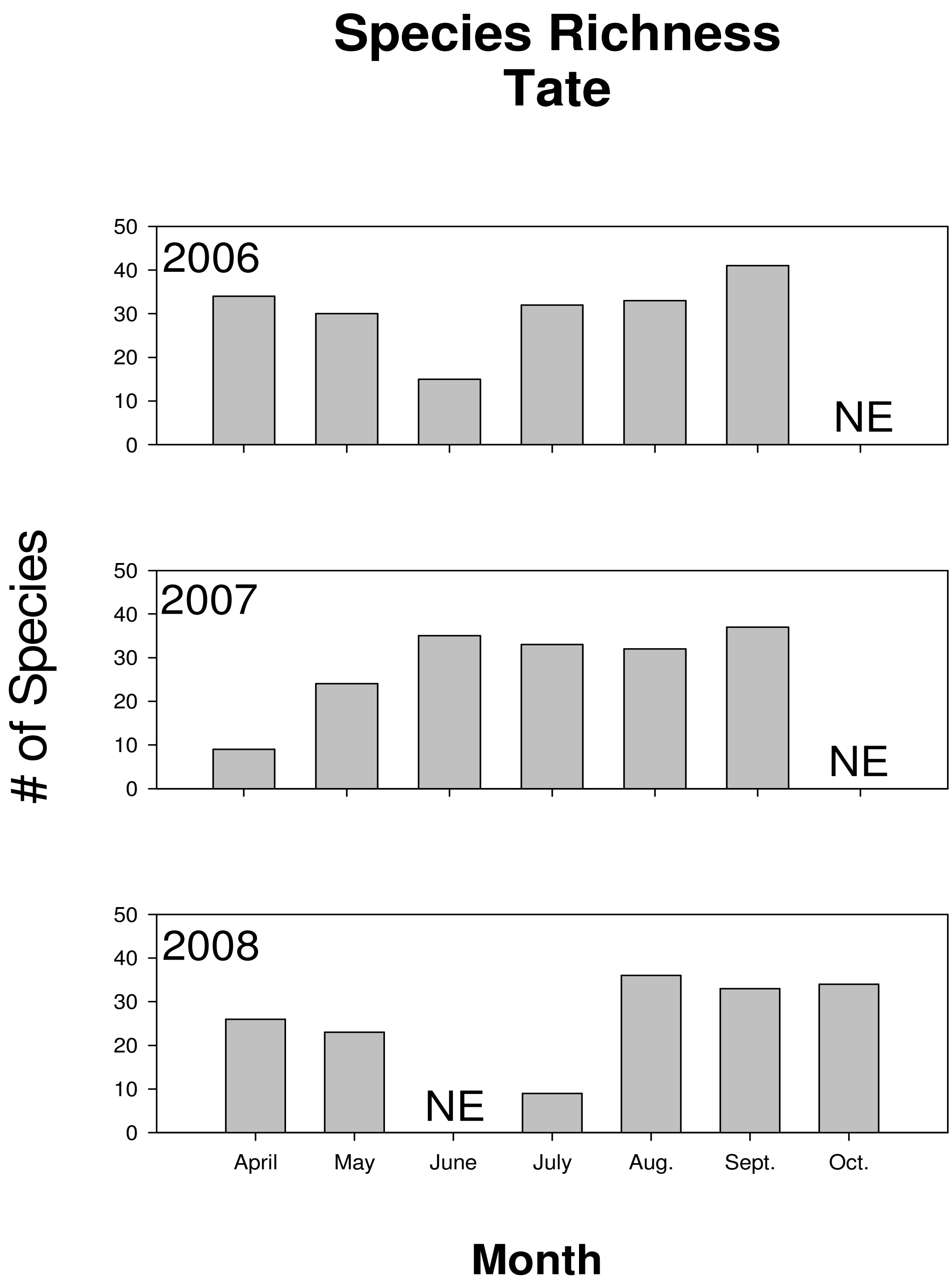


Figure III.12.1. Species richness in Tate chute by month and year.
NE = No effort during this month due to river conditions or construction.

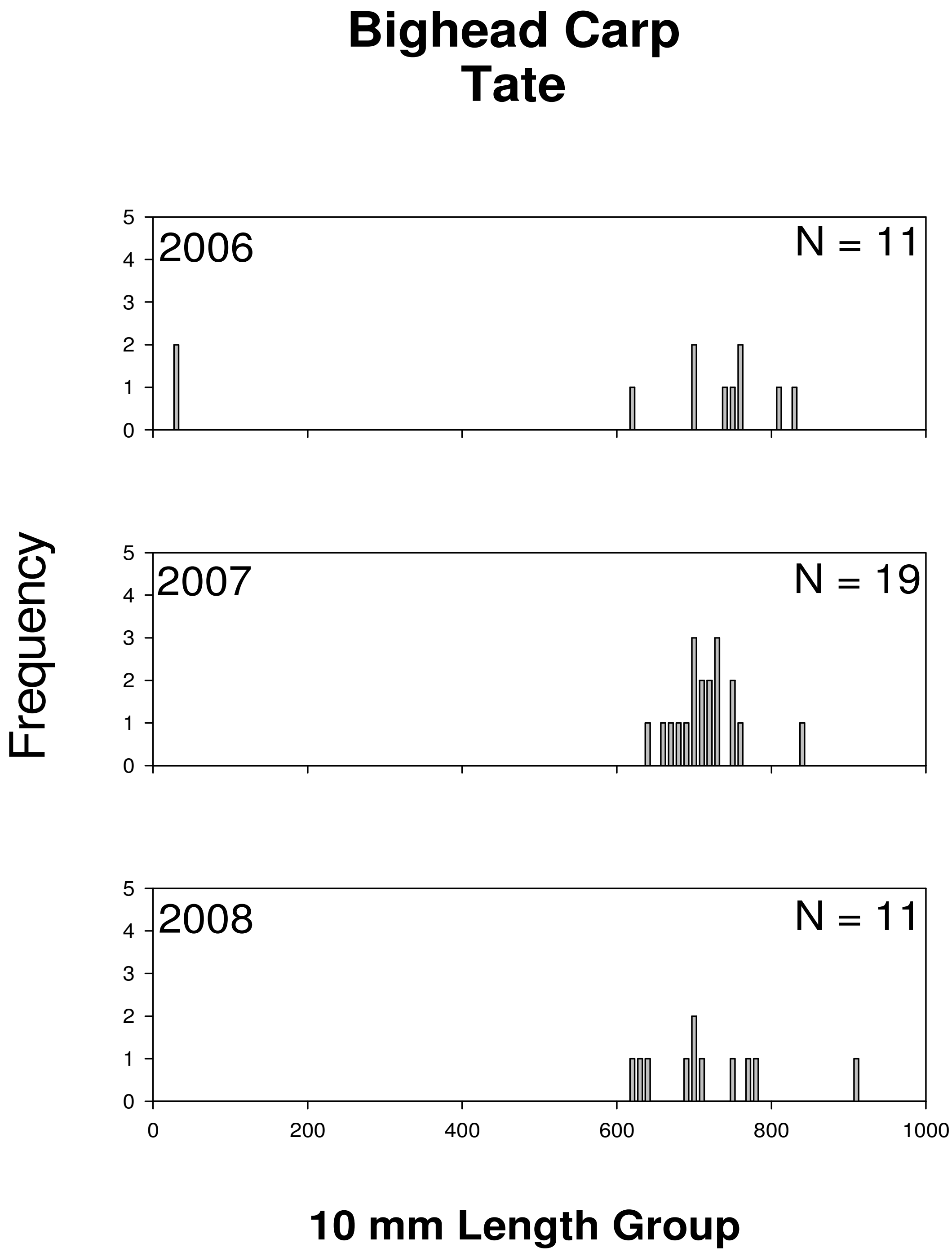


Figure III.12.2. Length frequency distribution of bighead carp in Tate chute by year. Length groups are in 10 mm intervals.

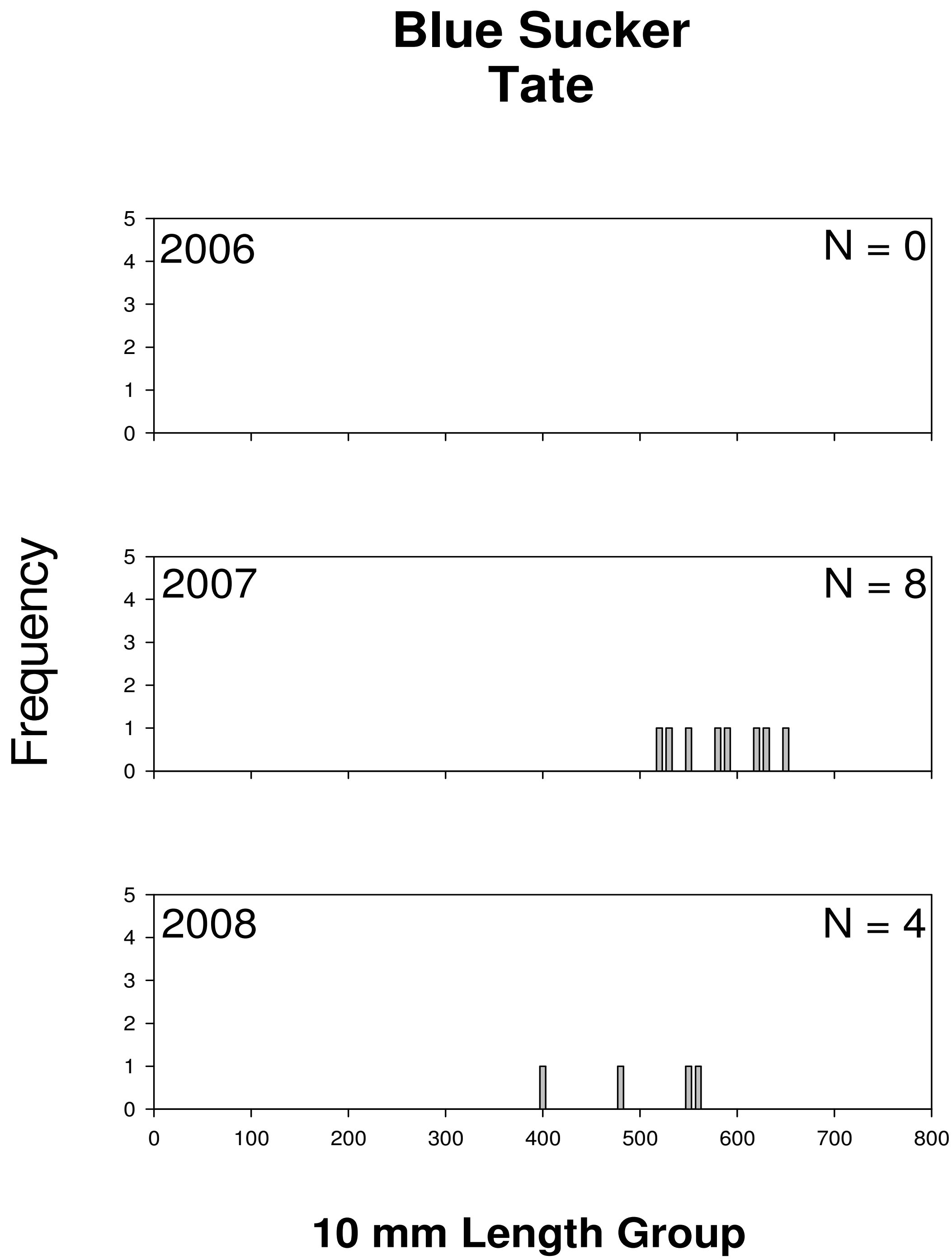


Figure III.12.3. Length frequency distribution of blue sucker in Tate chute by year. Length groups are in 10 mm intervals.

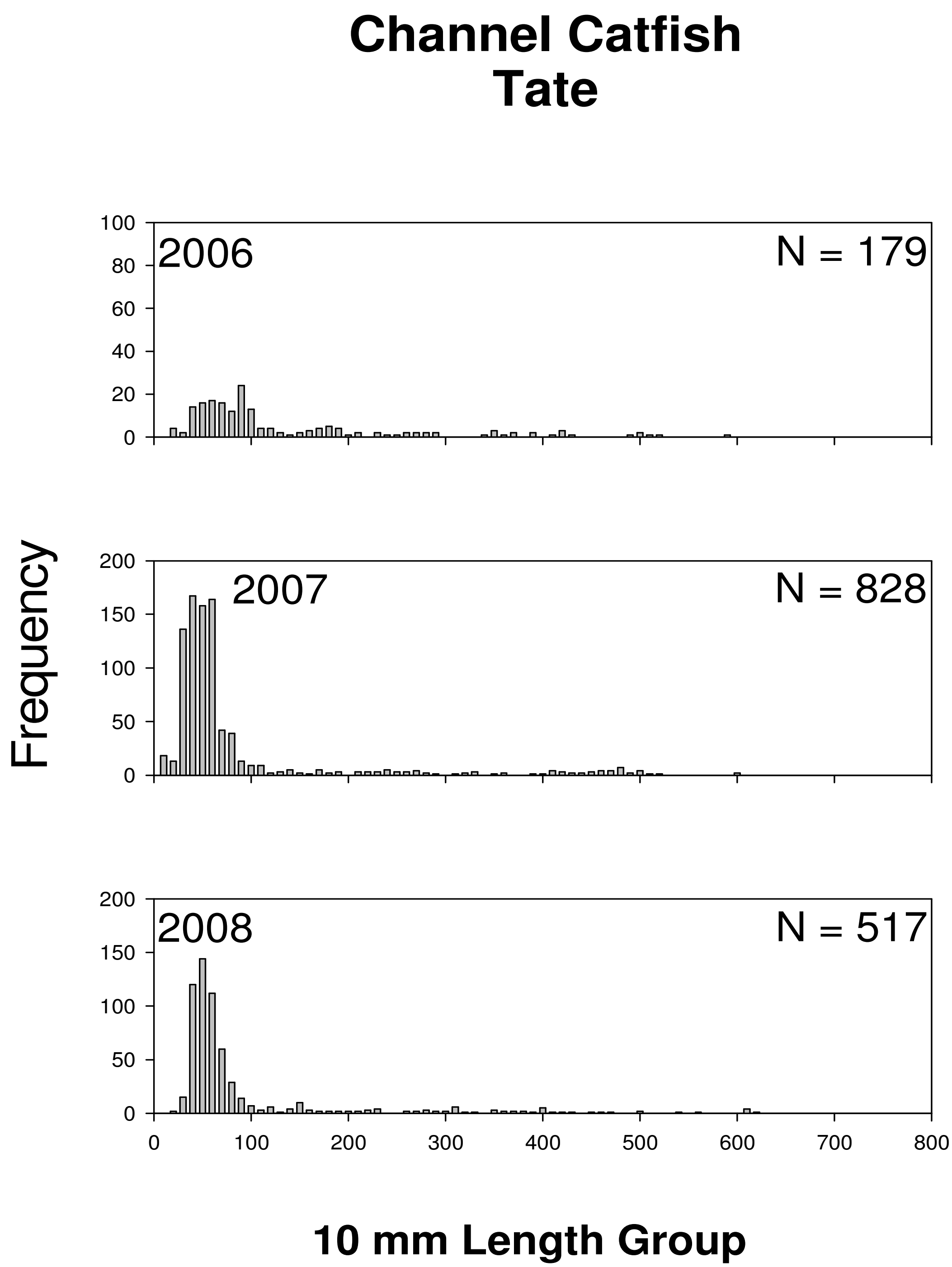


Figure III.12.4. Length frequency distribution of channel catfish in Tate chute by year. Length groups are in 10 mm intervals.

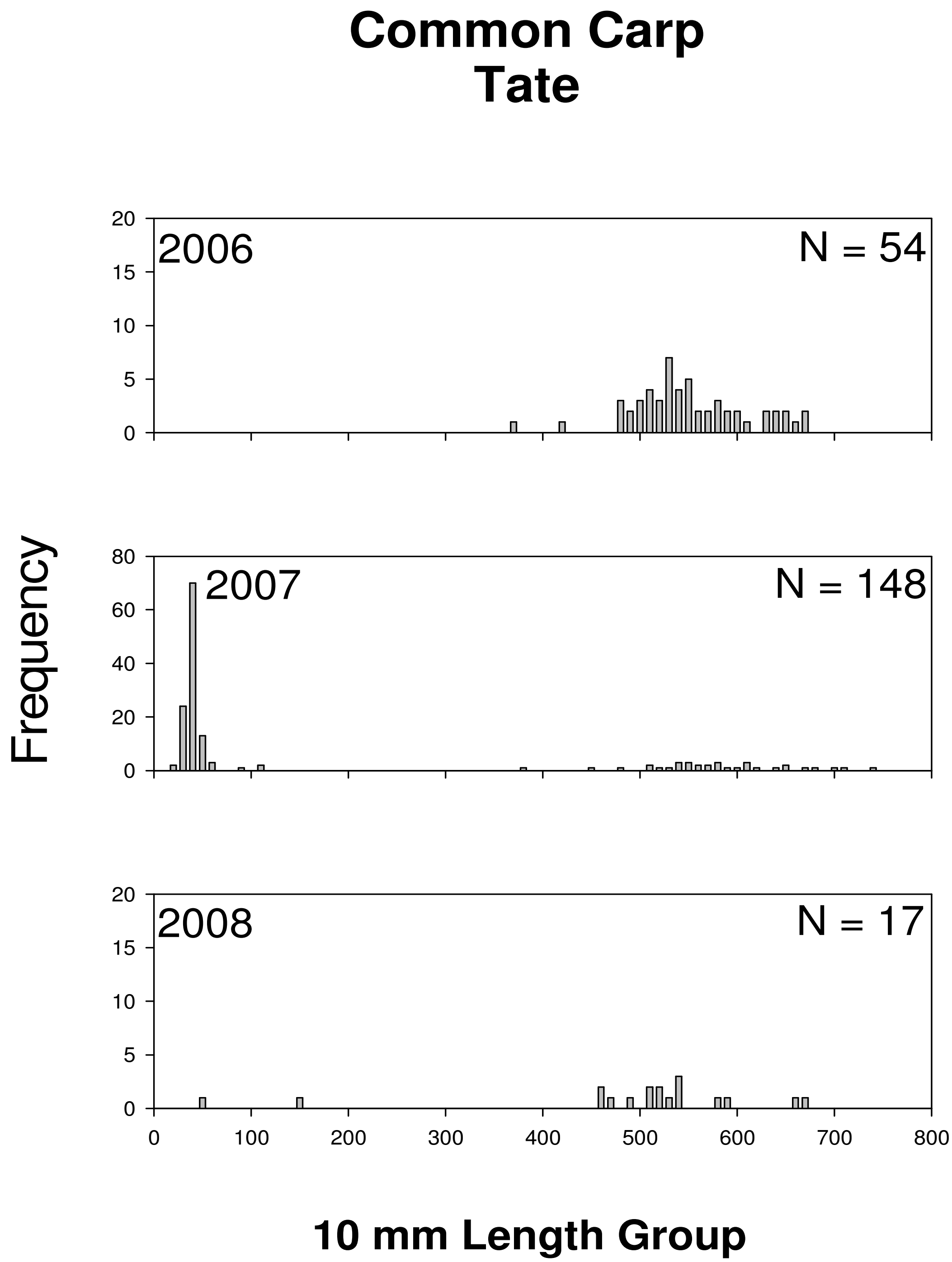


Figure III.12.5. Length frequency distribution of common carp in Tate chute by year. Length groups are in 10 mm intervals.

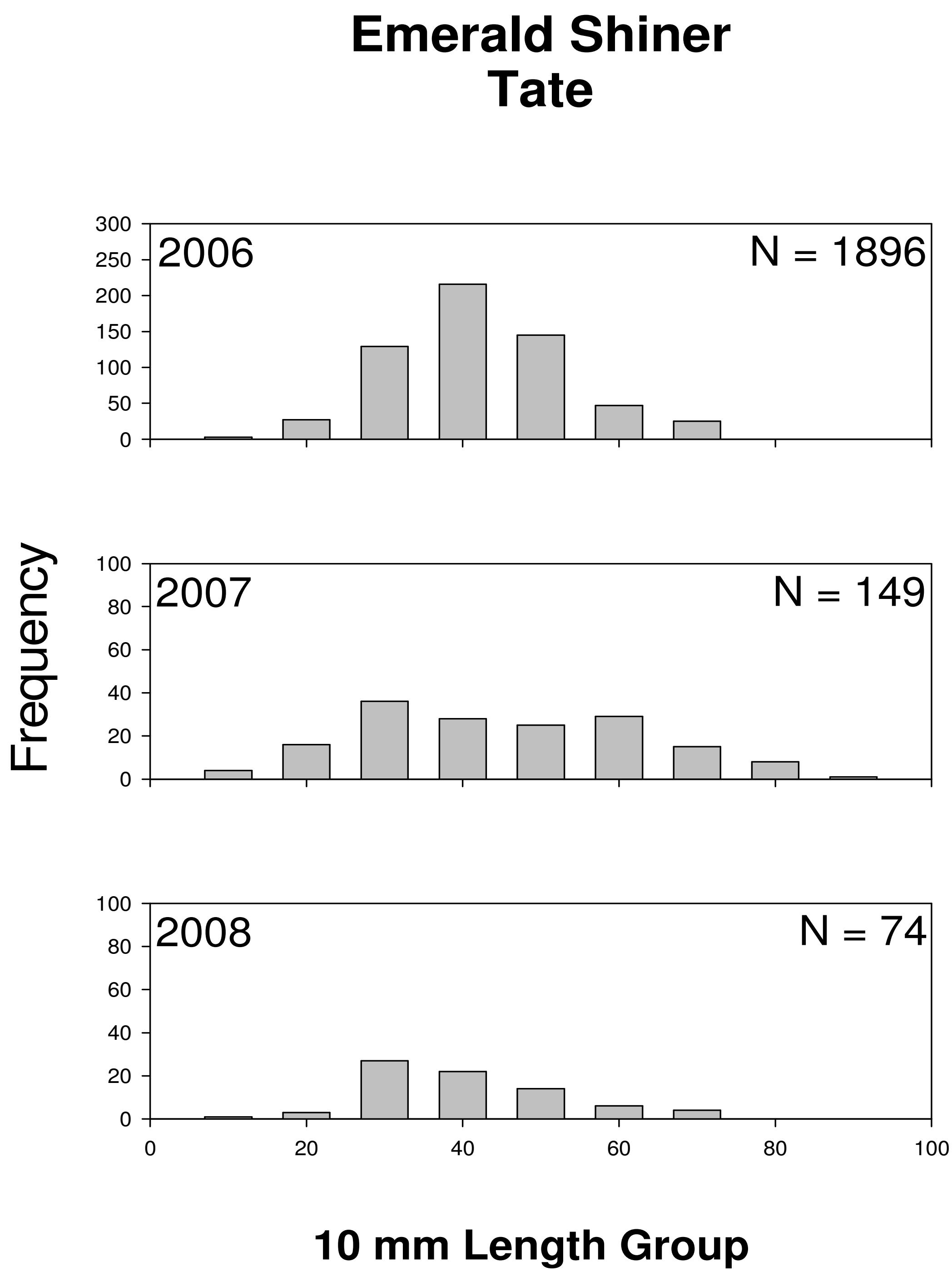


Figure III.12.6. Length frequency distribution of emerald shiner in Tate chute by year. Length groups are in 10 mm intervals.

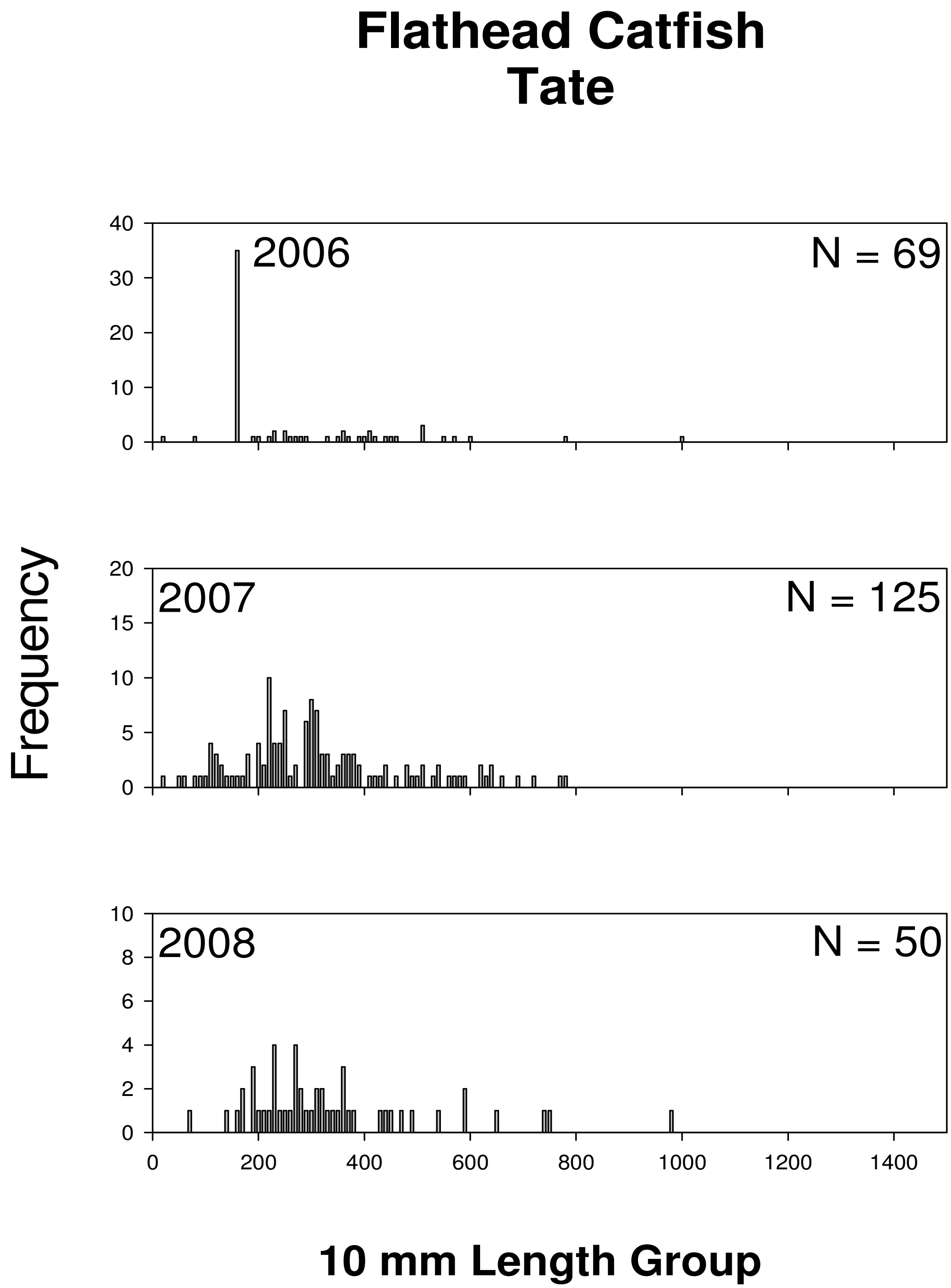


Figure III.12.7. Length frequency distribution of flathead catfish in Tate chute by year. Length groups are in 10 mm intervals.

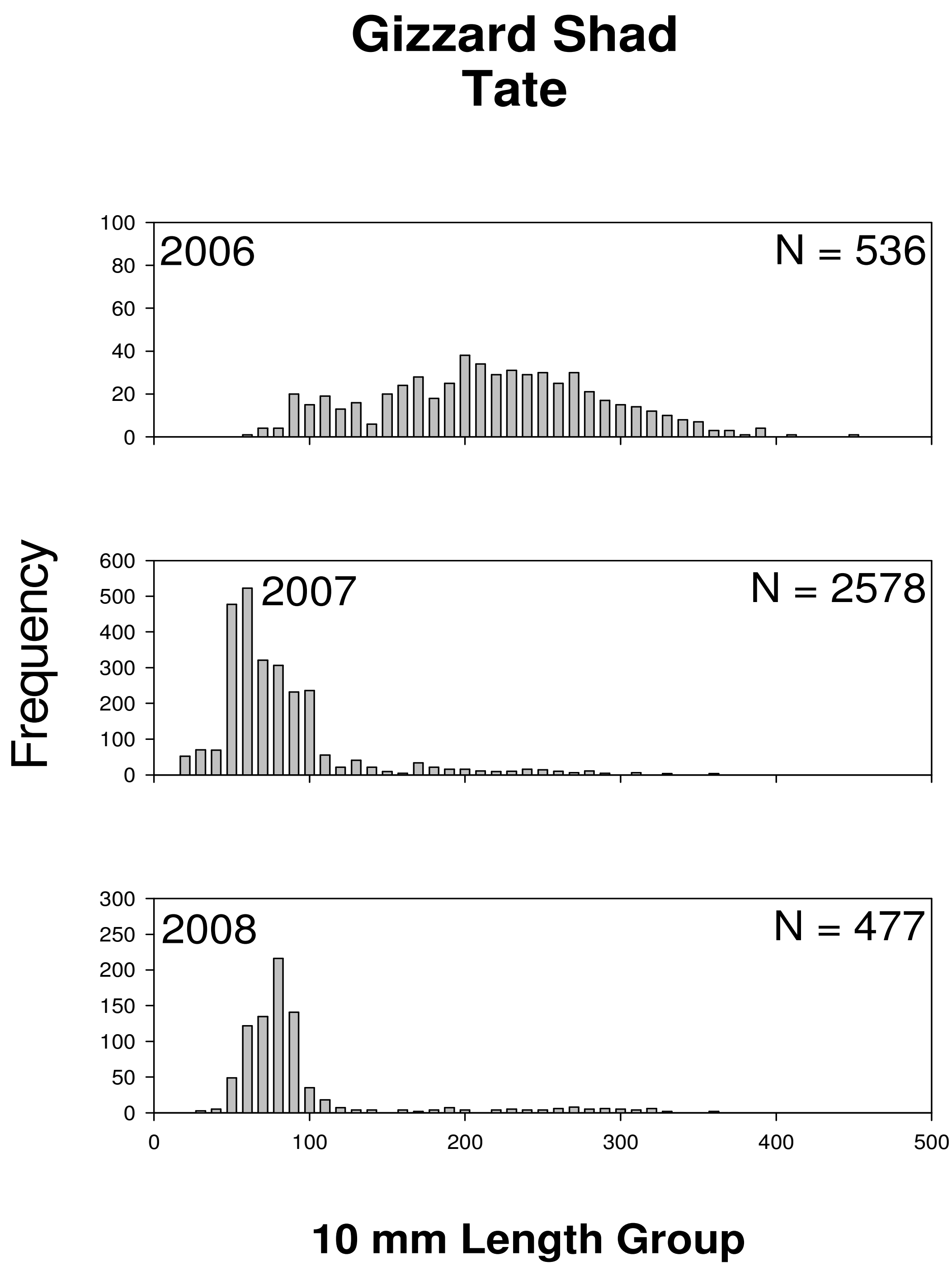


Figure III.12.8. Length frequency distribution of gizzard shad in Tate chute by year. Length groups are in 10 mm intervals.

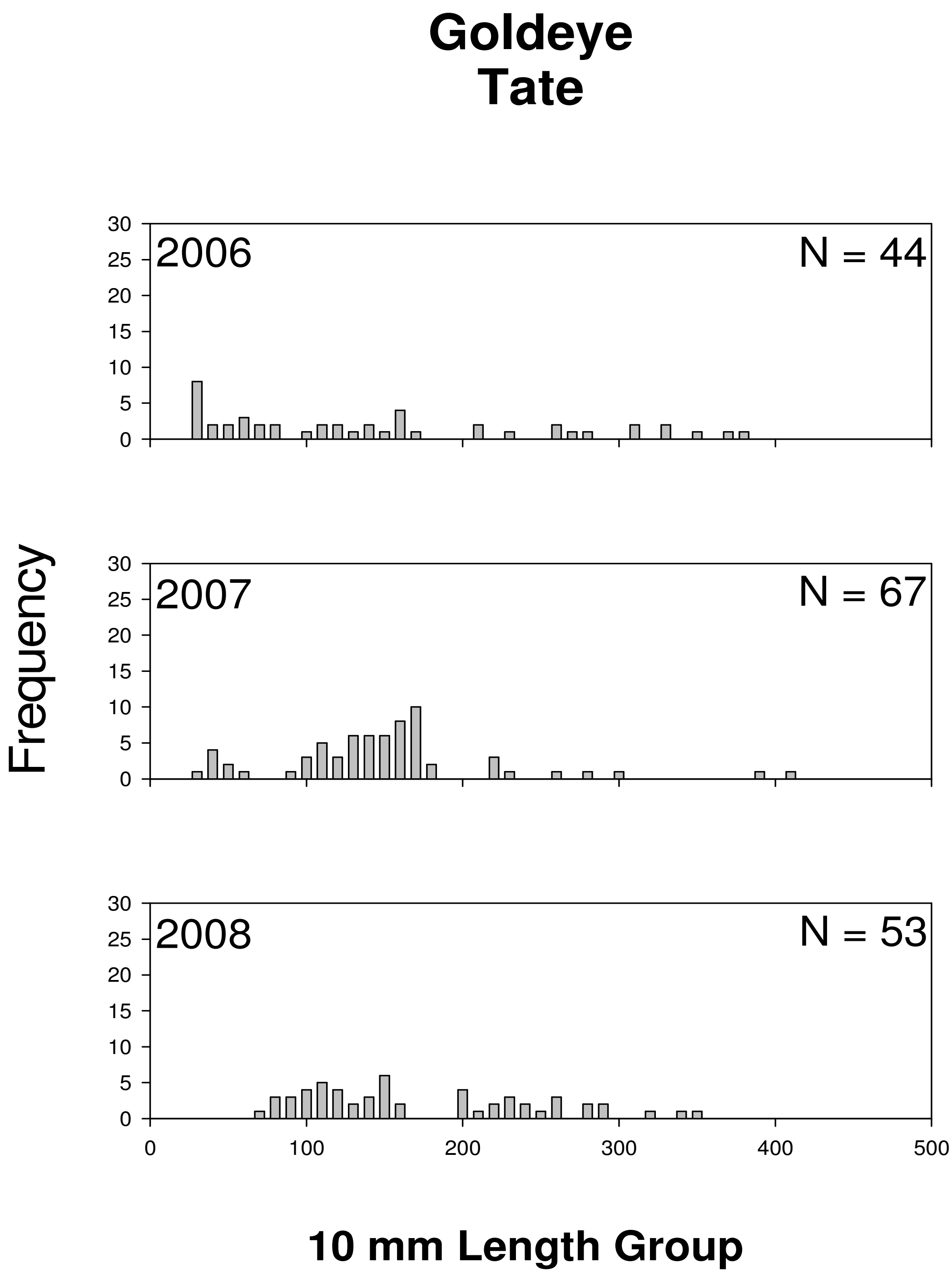


Figure III.12.9. Length frequency distribution of goldeye in Tate chute by year. Length groups are in 10 mm intervals.

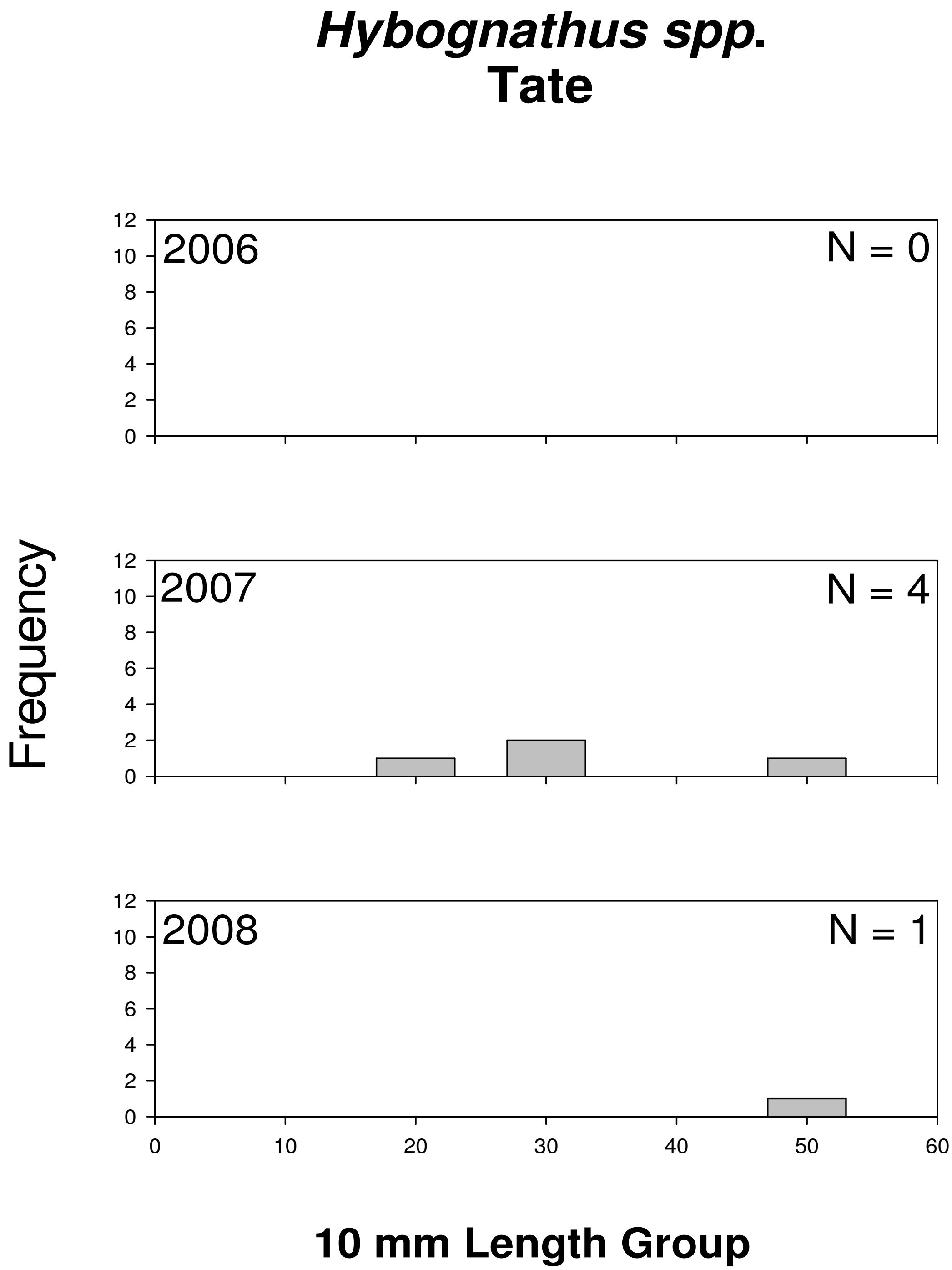


Figure III.12.10. Length frequency distribution of *Hybognathus spp*. in Tate chute by year. Length groups are in 10 mm intervals.

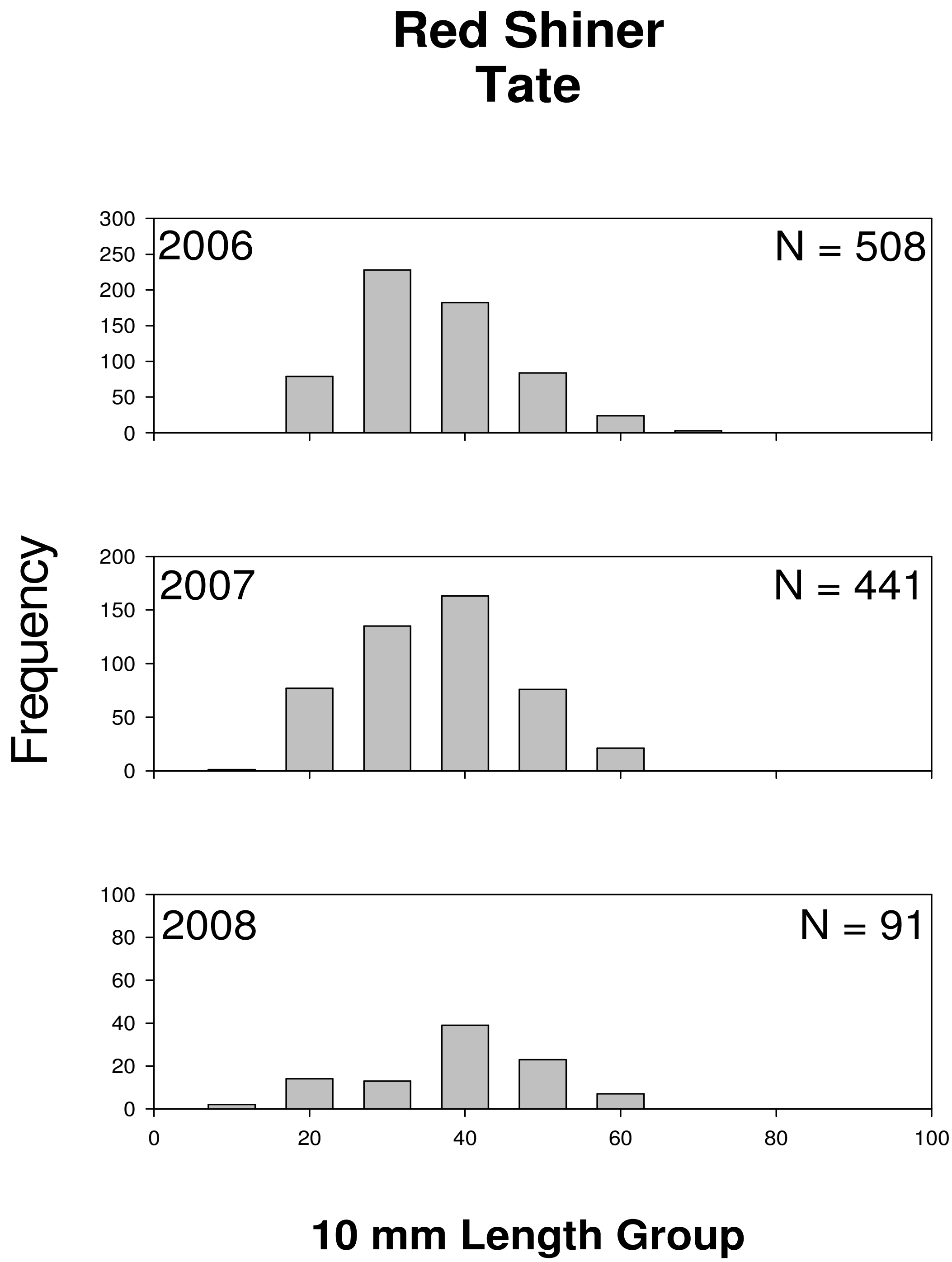


Figure III.12.11. Length frequency distribution of red shiner in Tate chute by year. Length groups are in 10 mm intervals.

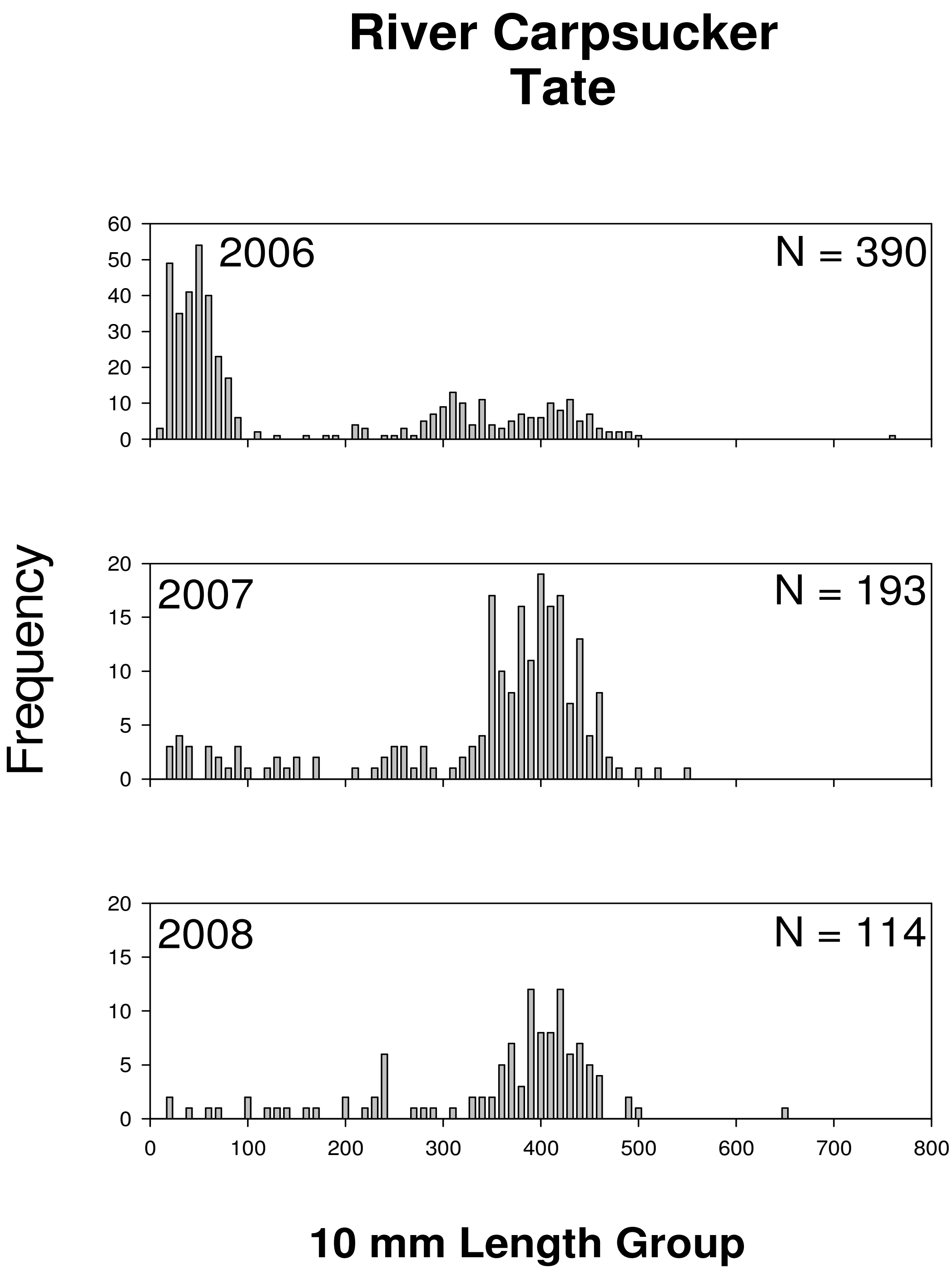


Figure III.12.12. Length frequency distribution of river carpsucker in Tate chute by year. Length groups are in 10 mm intervals.

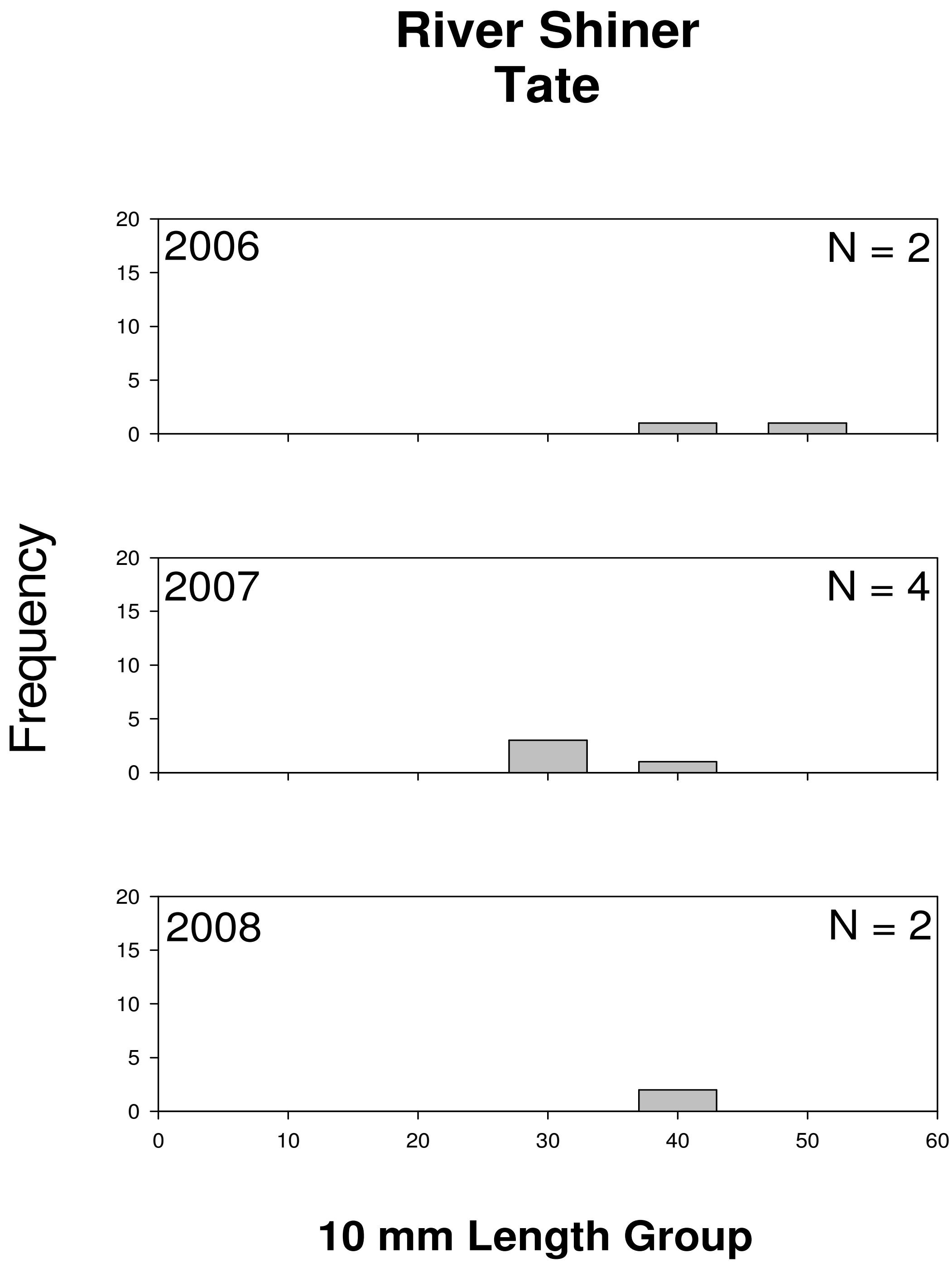


Figure III.12.13. Length frequency distribution of river shiner in Tate chute by year. Length groups are in 10 mm intervals.

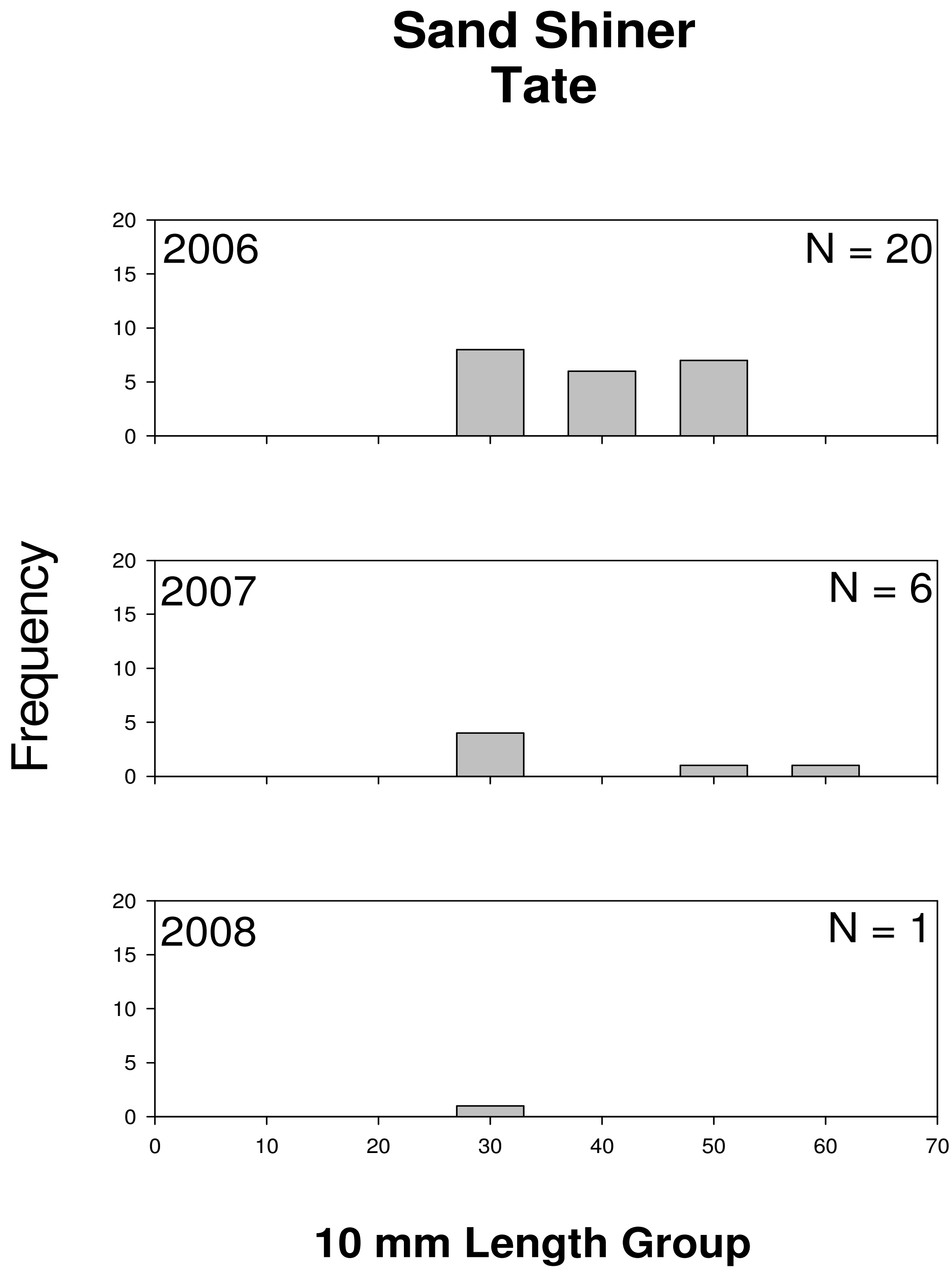


Figure III.12.14. Length frequency distribution of sand shiner in Tate chute by year. Length groups are in 10 mm intervals.

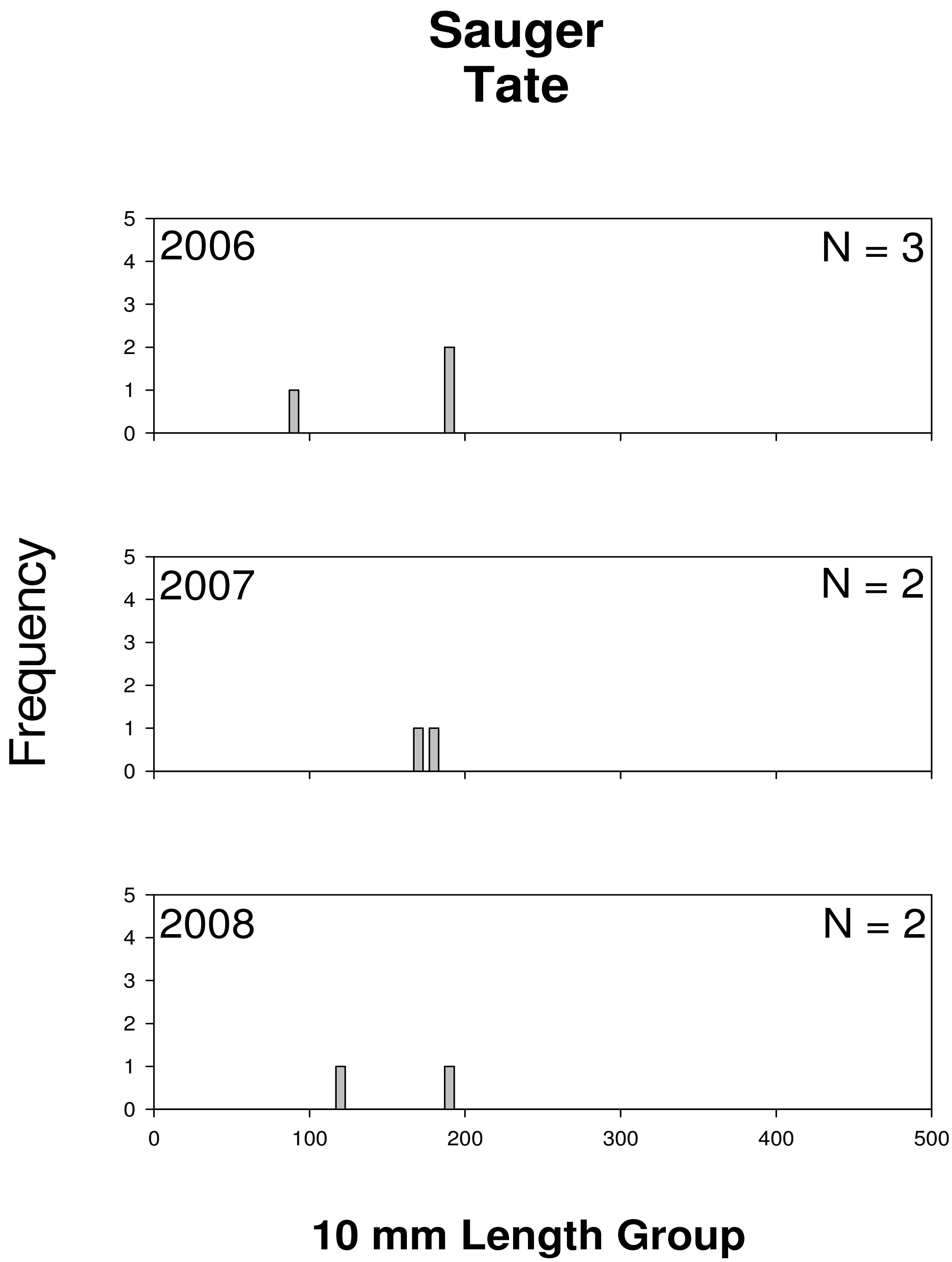


Figure III.12.15. Length frequency distribution of sauger in Tate chute by year. Length groups are in 10 mm intervals.

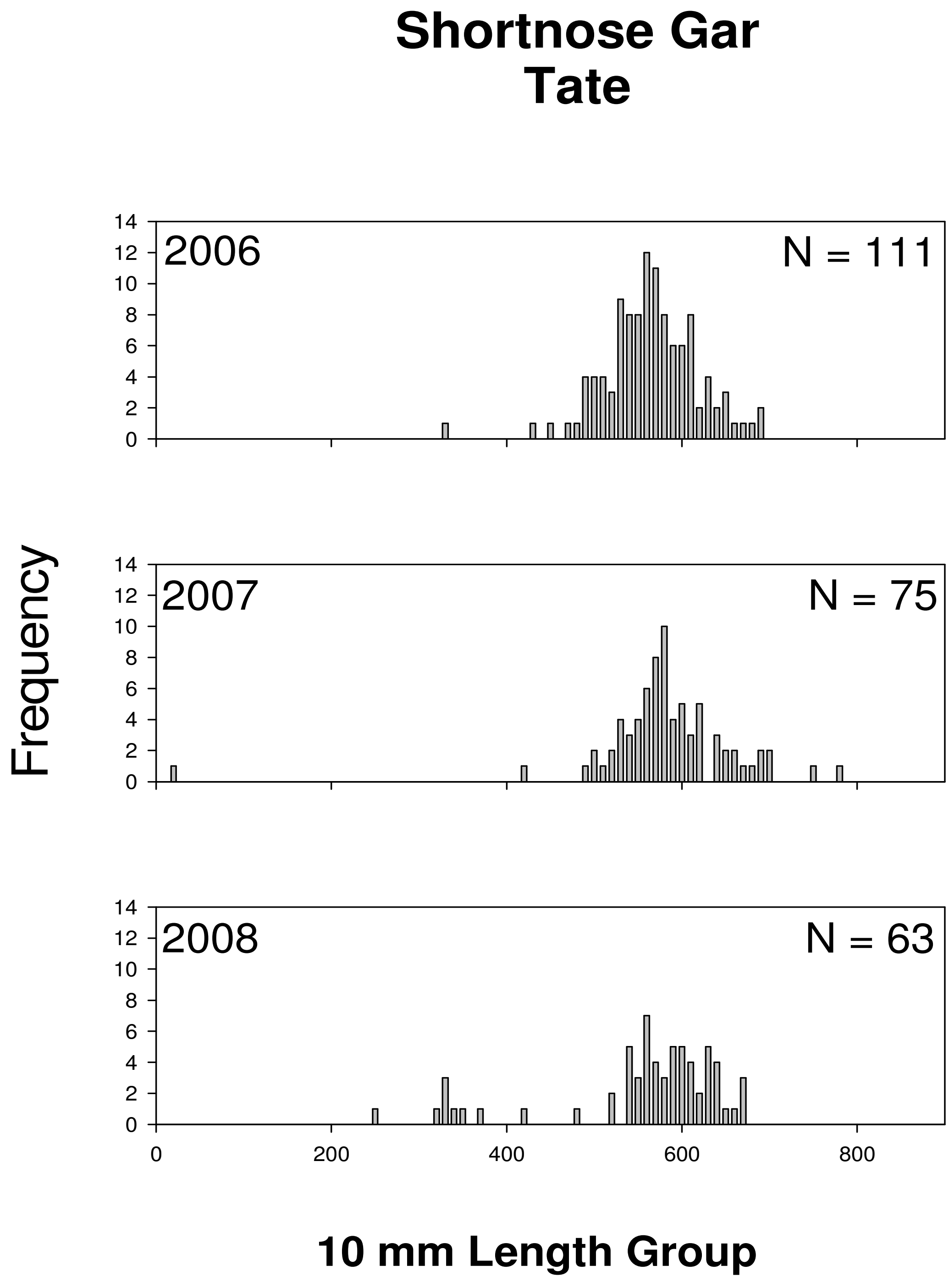


Figure III.12.16. Length frequency distribution of shortnose gar in Tate chute by year. Length groups are in 10 mm intervals.

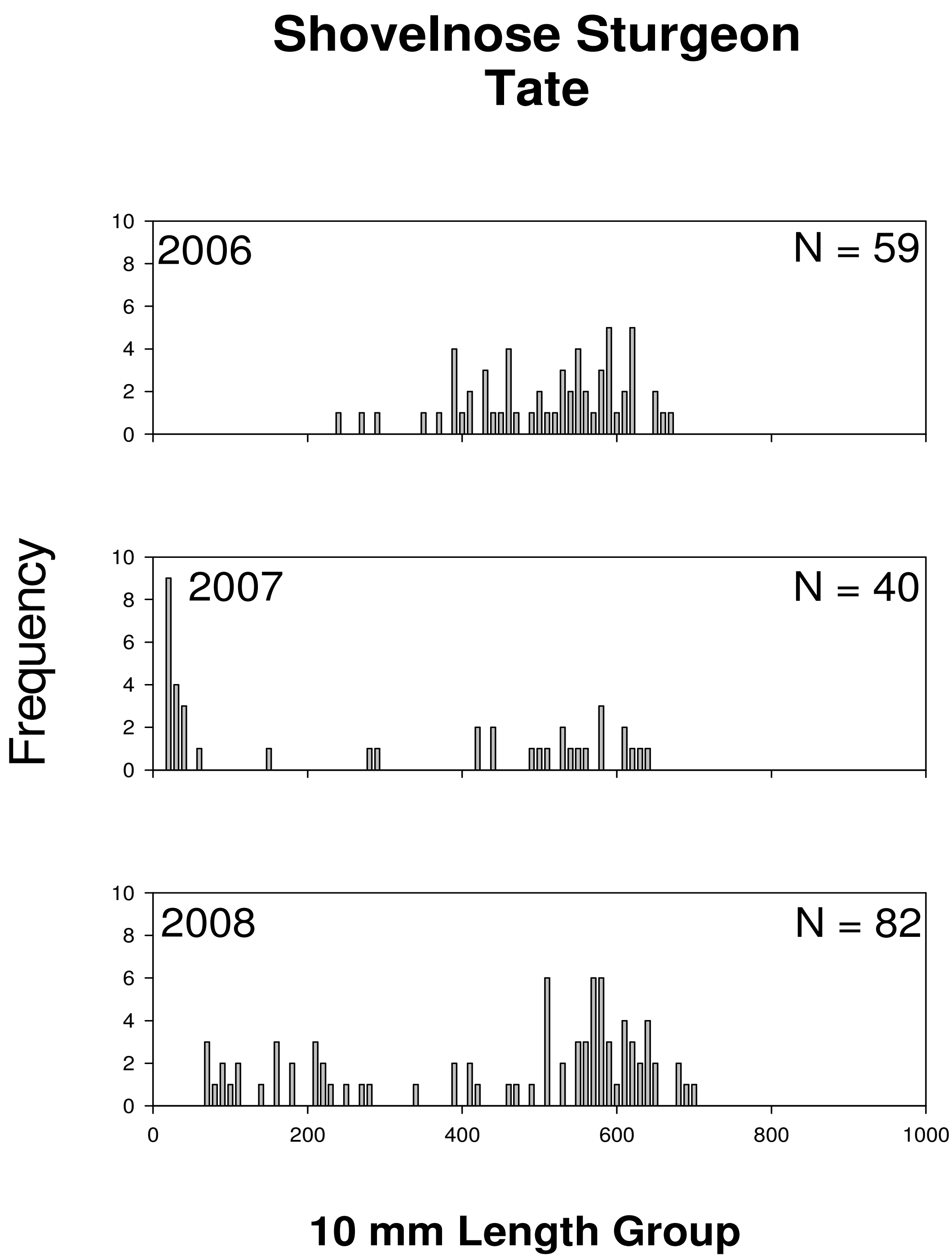


Figure III.12.17. Length frequency distribution of shovelnose sturgeon in Tate chute by year. Length groups are in 10 mm intervals.

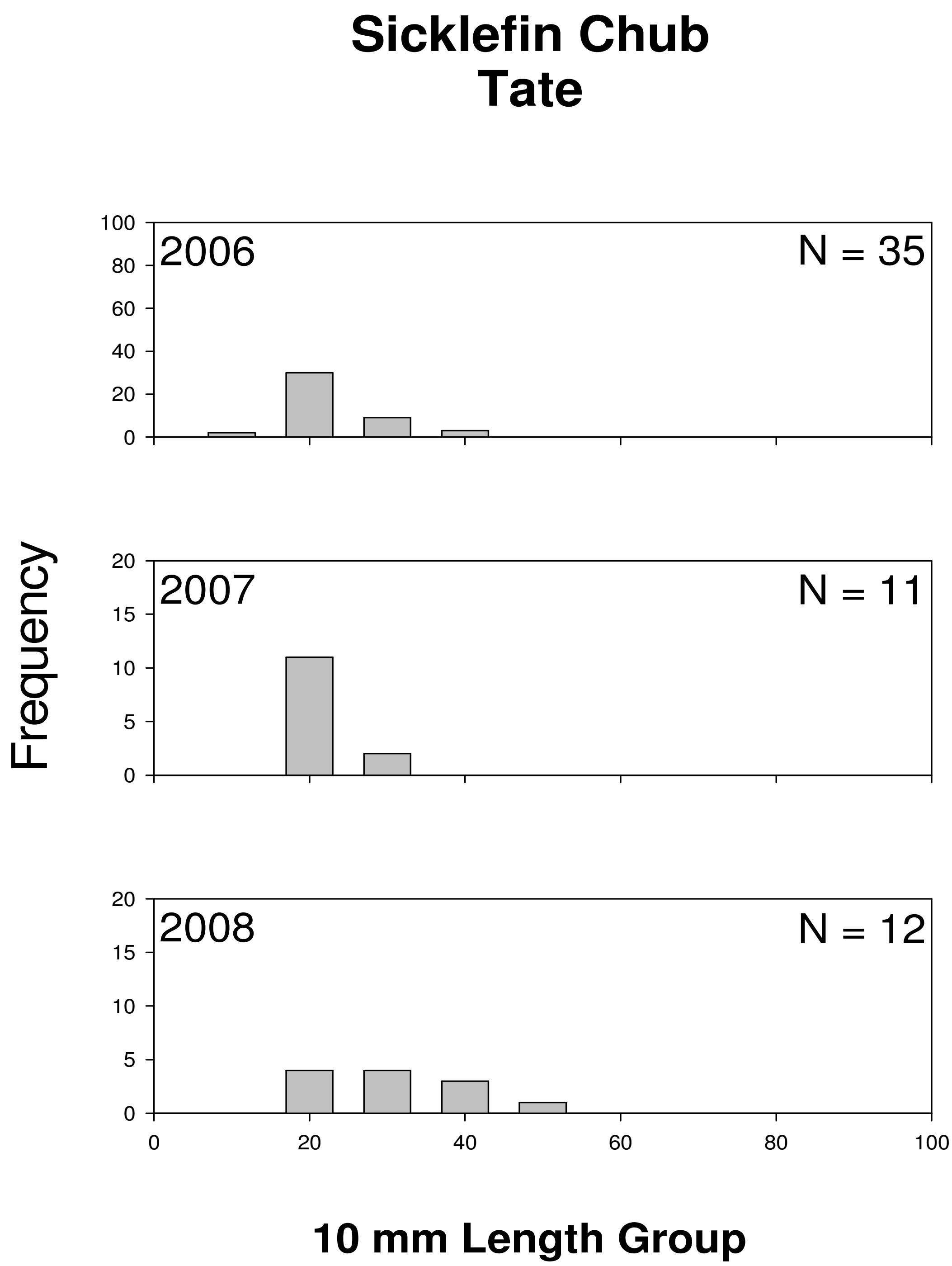


Figure III.12.18. Length frequency distribution of sicklefin chub in Tate chute by year. Length groups are in 10 mm intervals.

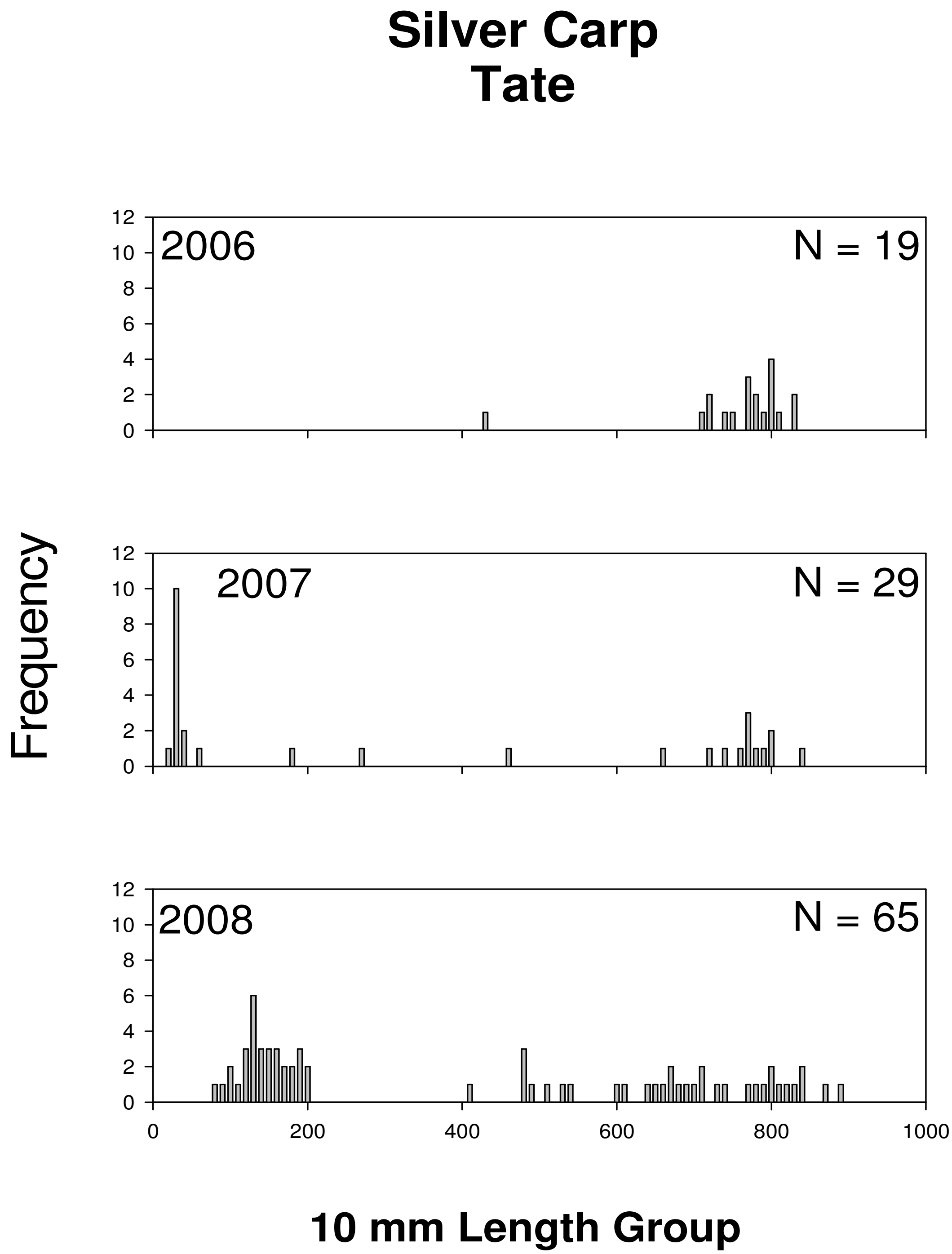


Figure III.12.19. Length frequency distribution of silver carp in Tate chute by year. Length groups are in 10 mm intervals.

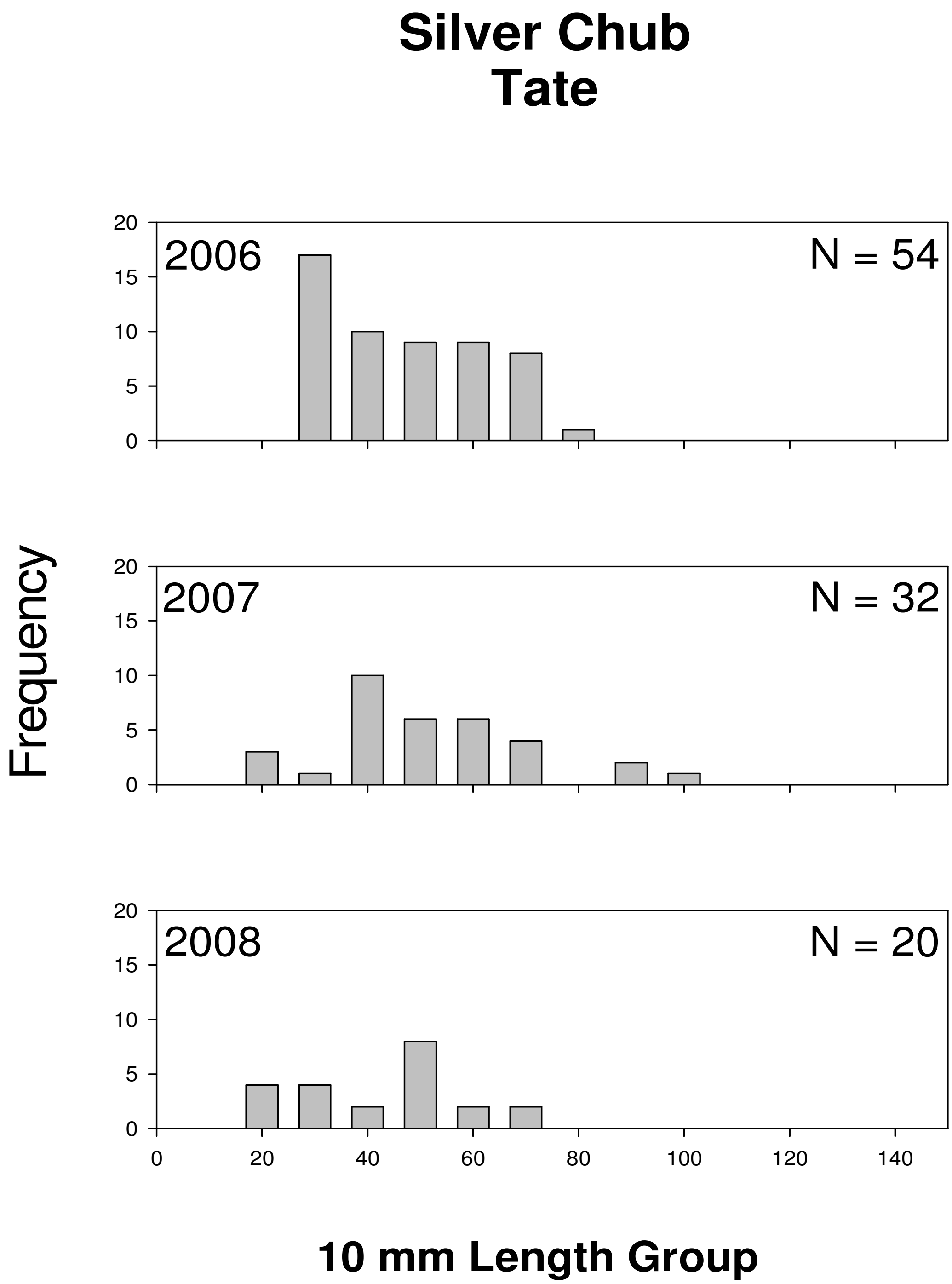


Figure III.12.20. Length frequency distribution of silver chub in Tate chute by year. Length groups are in 10 mm intervals.

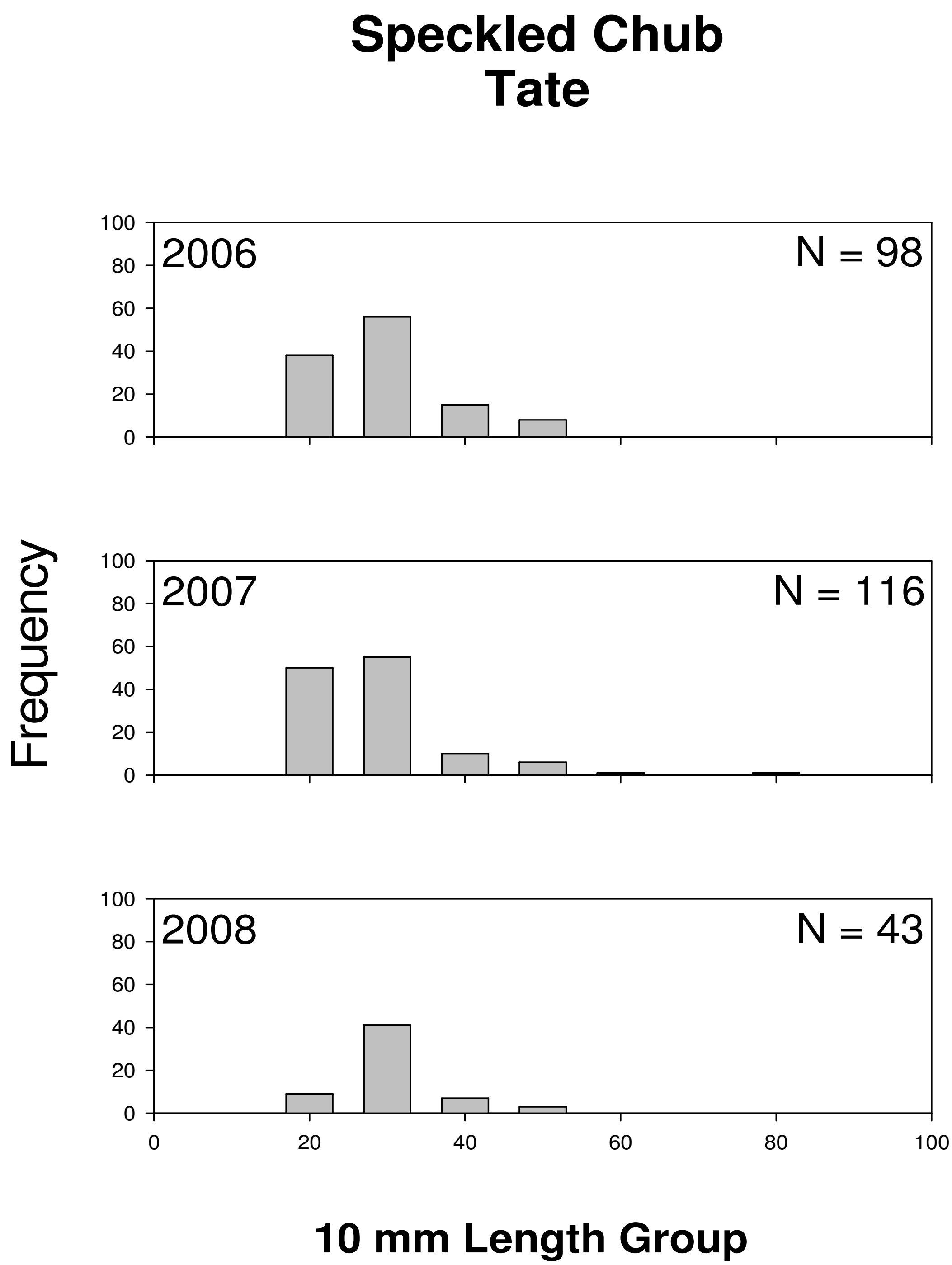


Figure III.12.21. Length frequency distribution of speckled chub in Tate chute by year. Length groups are in 10 mm intervals.

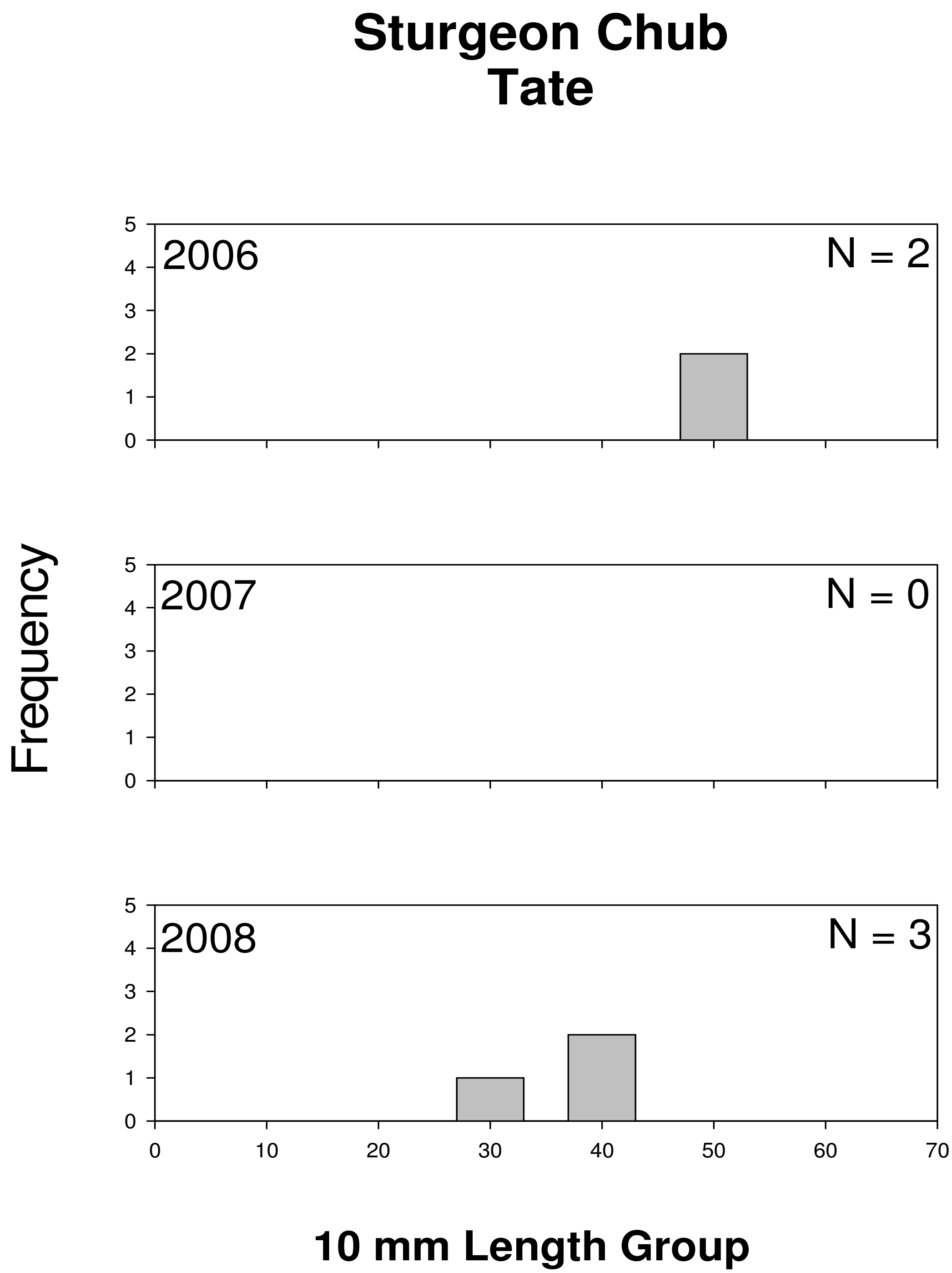


Figure III.12.22. Length frequency distribution of sturgeon chub in Tate chute by year. Length groups are in 10 mm intervals.

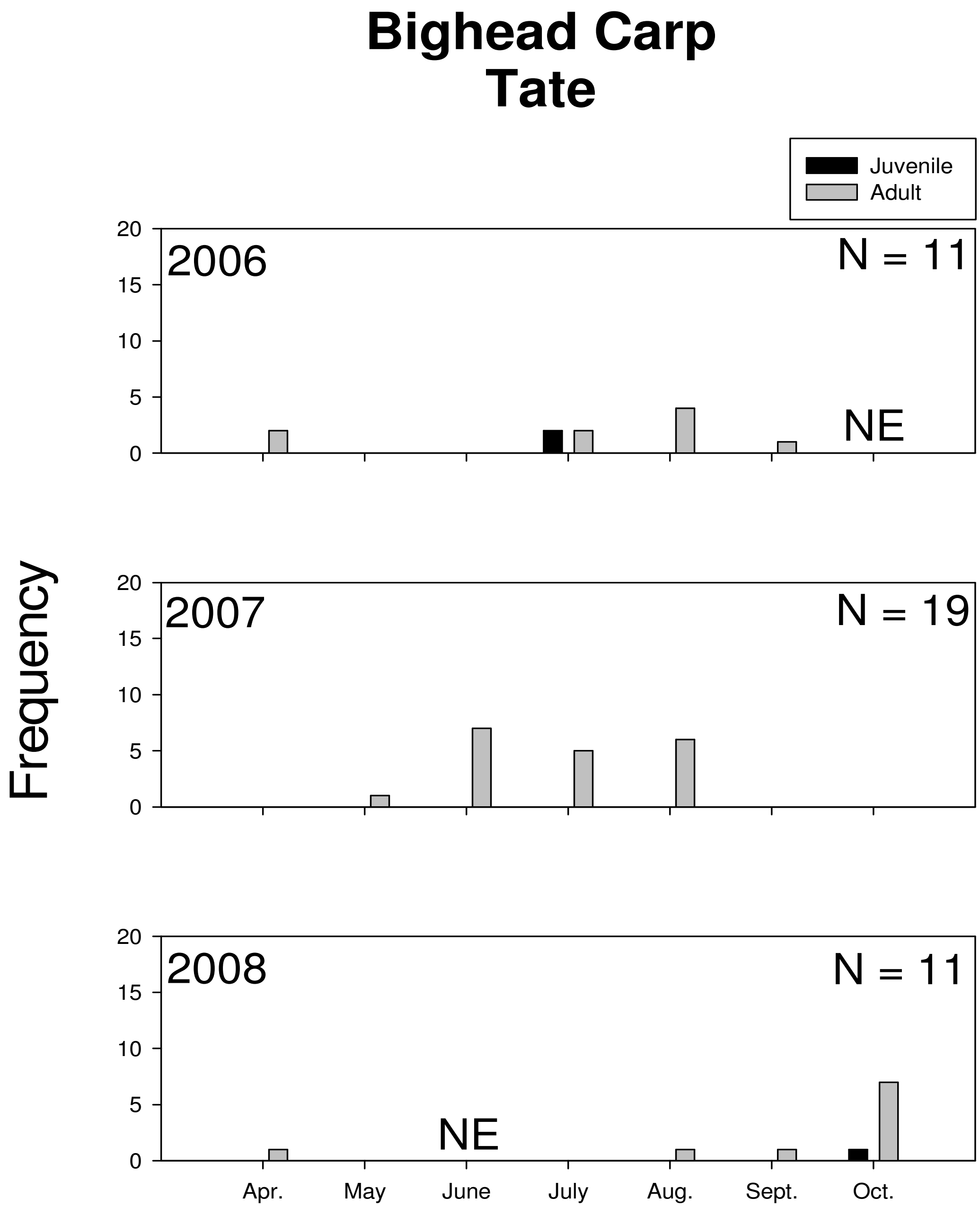


Figure III.12.23. Life stage frequency distribution of bighead carp in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

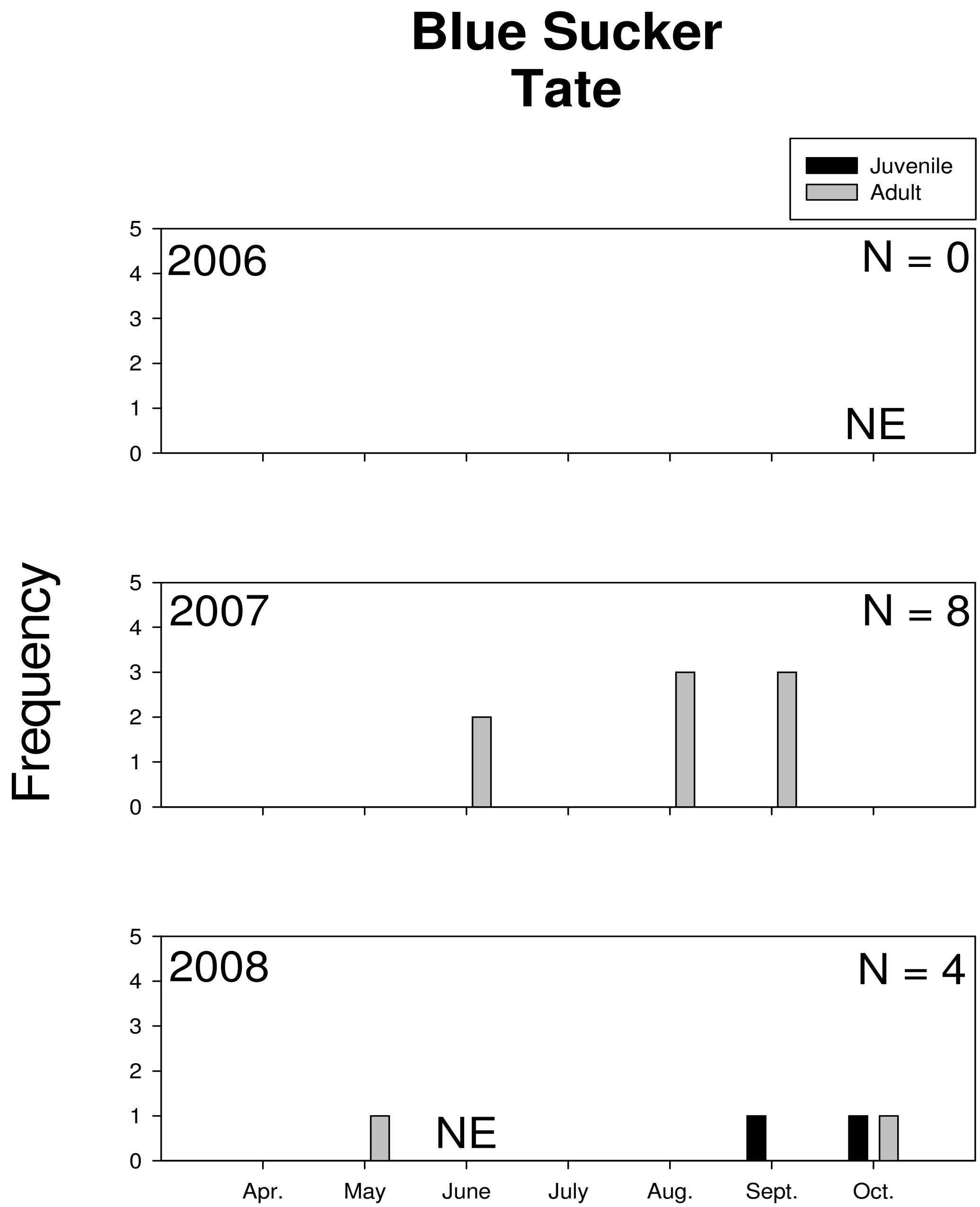


Figure III.12.24. Life stage frequency distribution of blue sucker in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

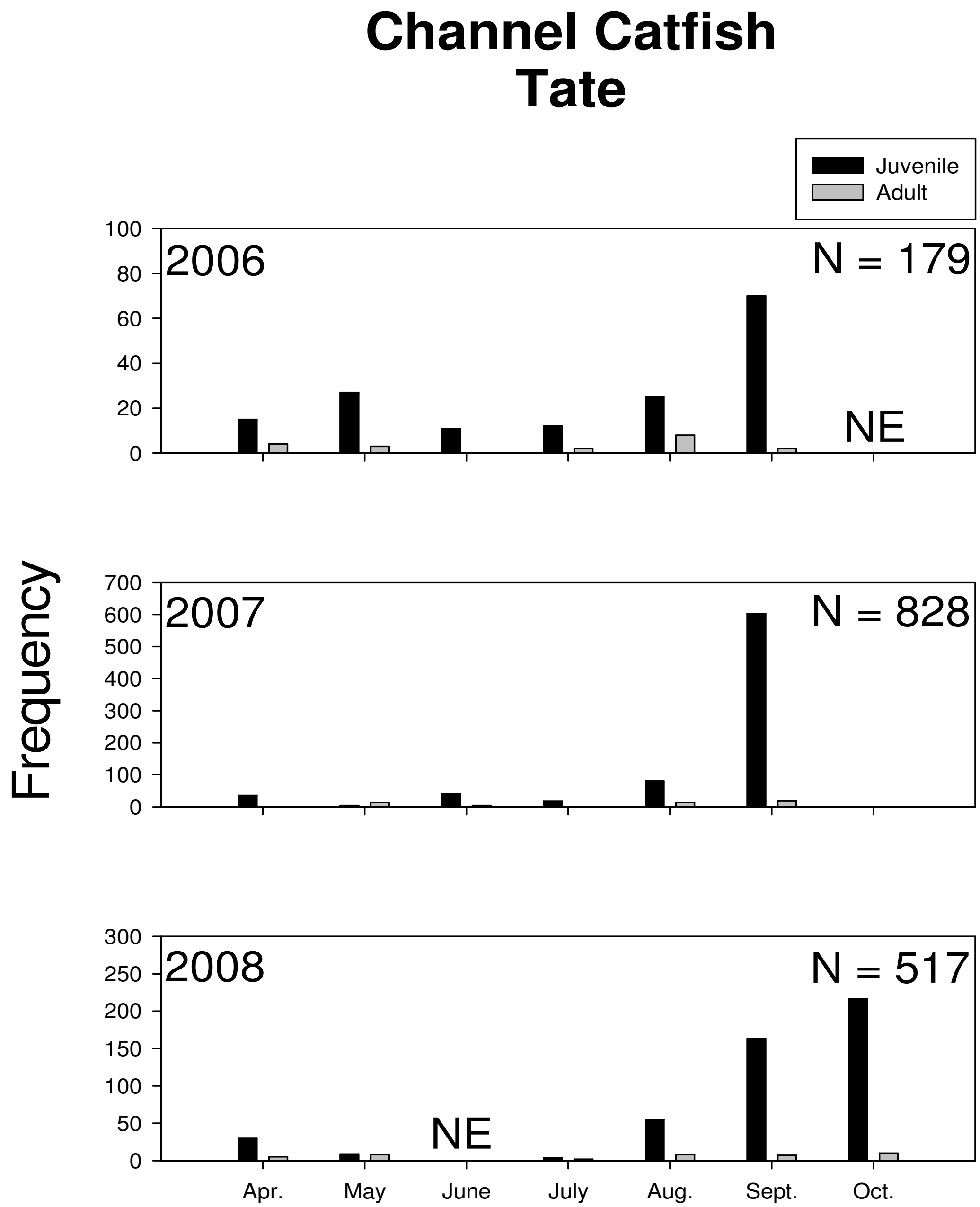


Figure III.12.25. Life stage frequency distribution of channel catfish in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

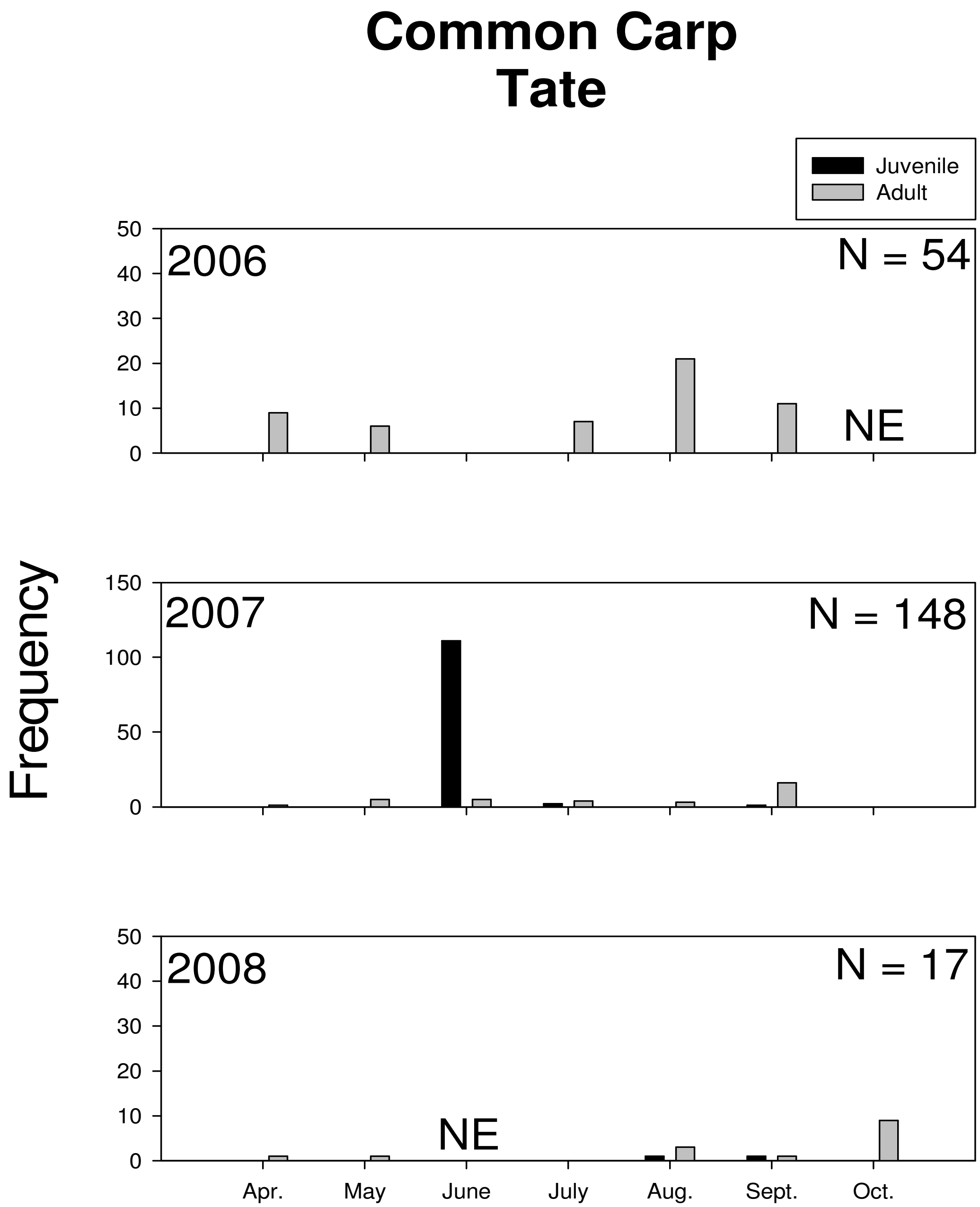


Figure III.12.26. Life stage frequency distribution of common carp in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

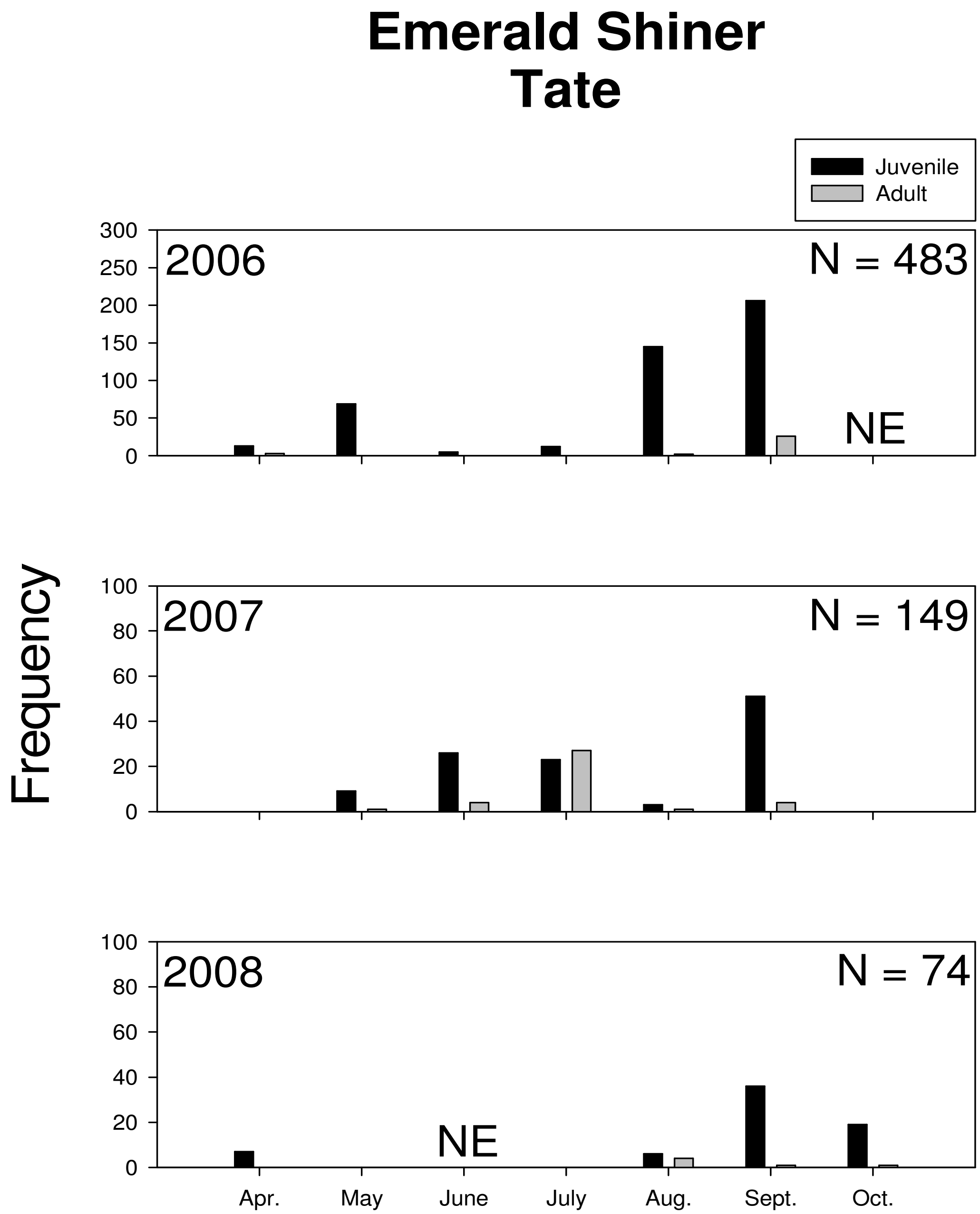


Figure III.12.27. Life stage frequency distribution of emerald shiner in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

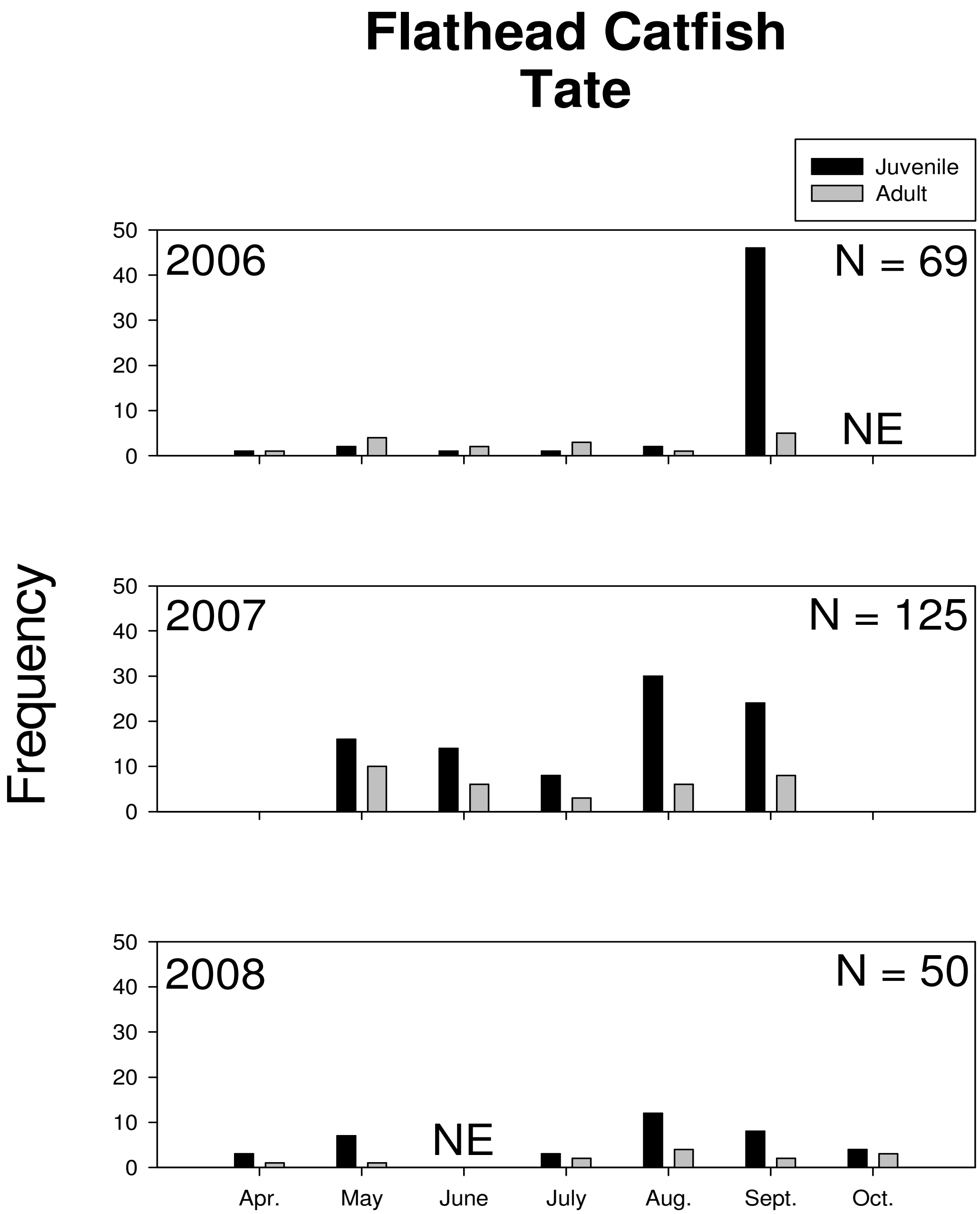


Figure III.12.28. Life stage frequency distribution of flathead catfish in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

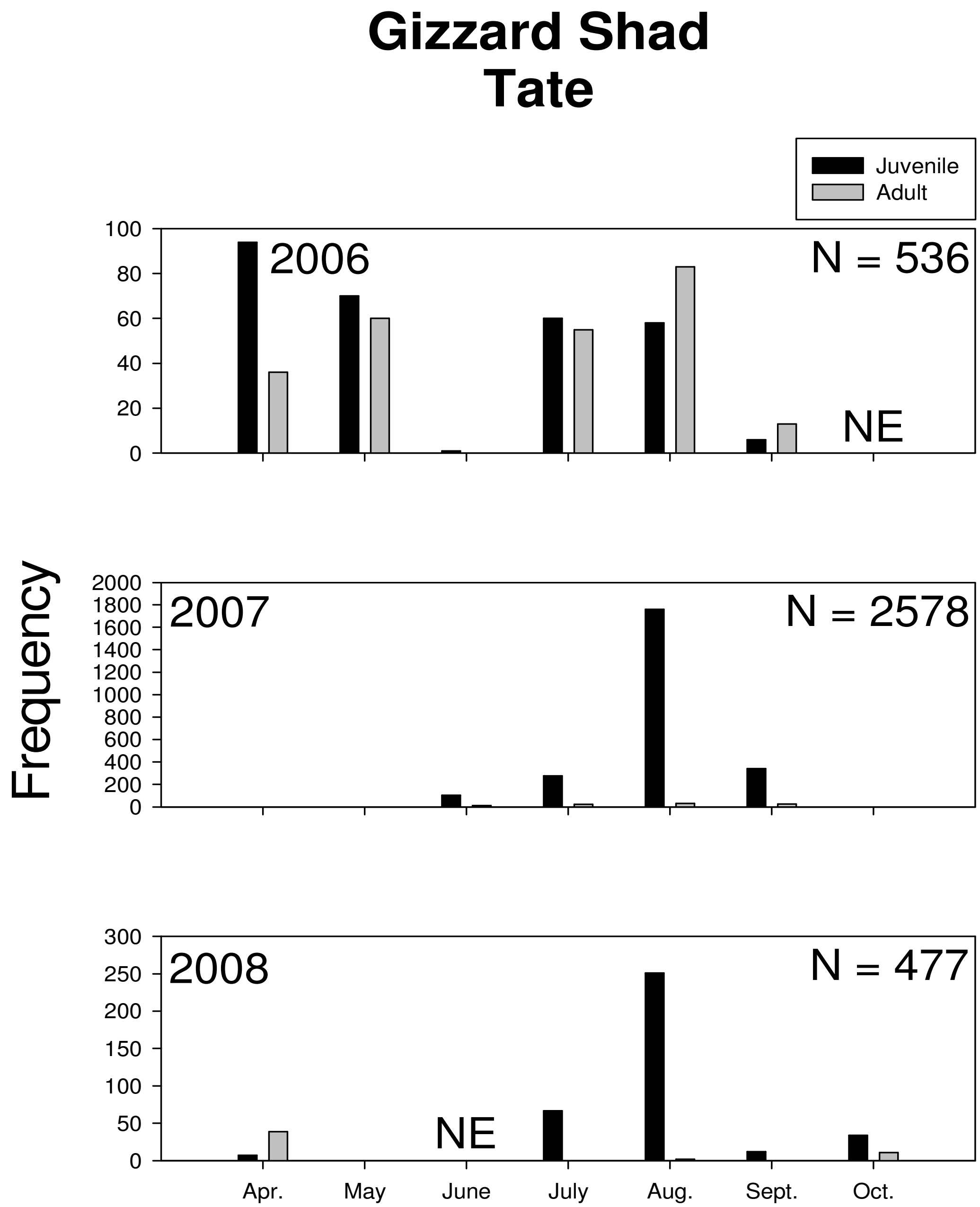


Figure III.12.29. Life stage frequency distribution of gizzard shad in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

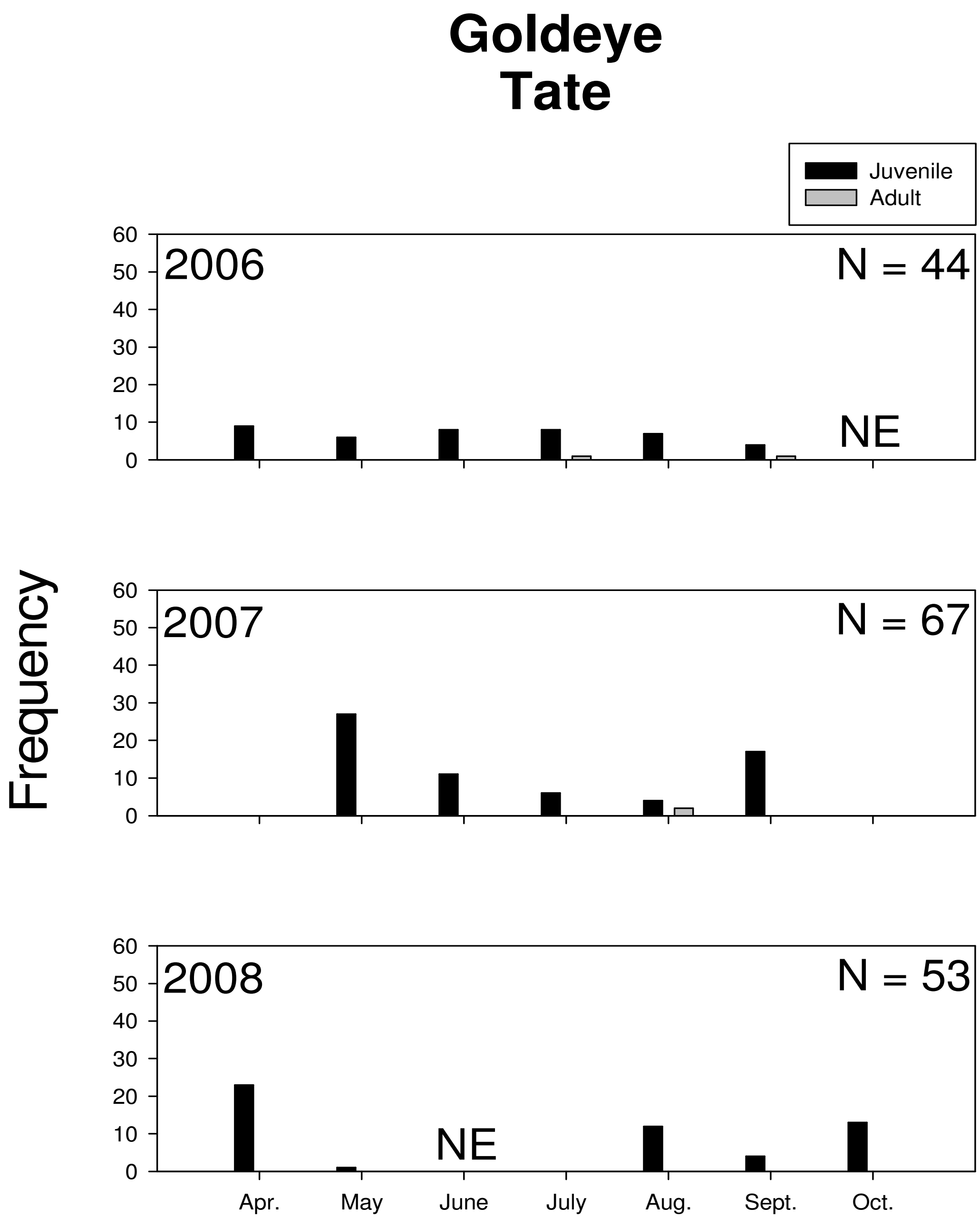


Figure III.12.30. Life stage frequency distribution of goldeye in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

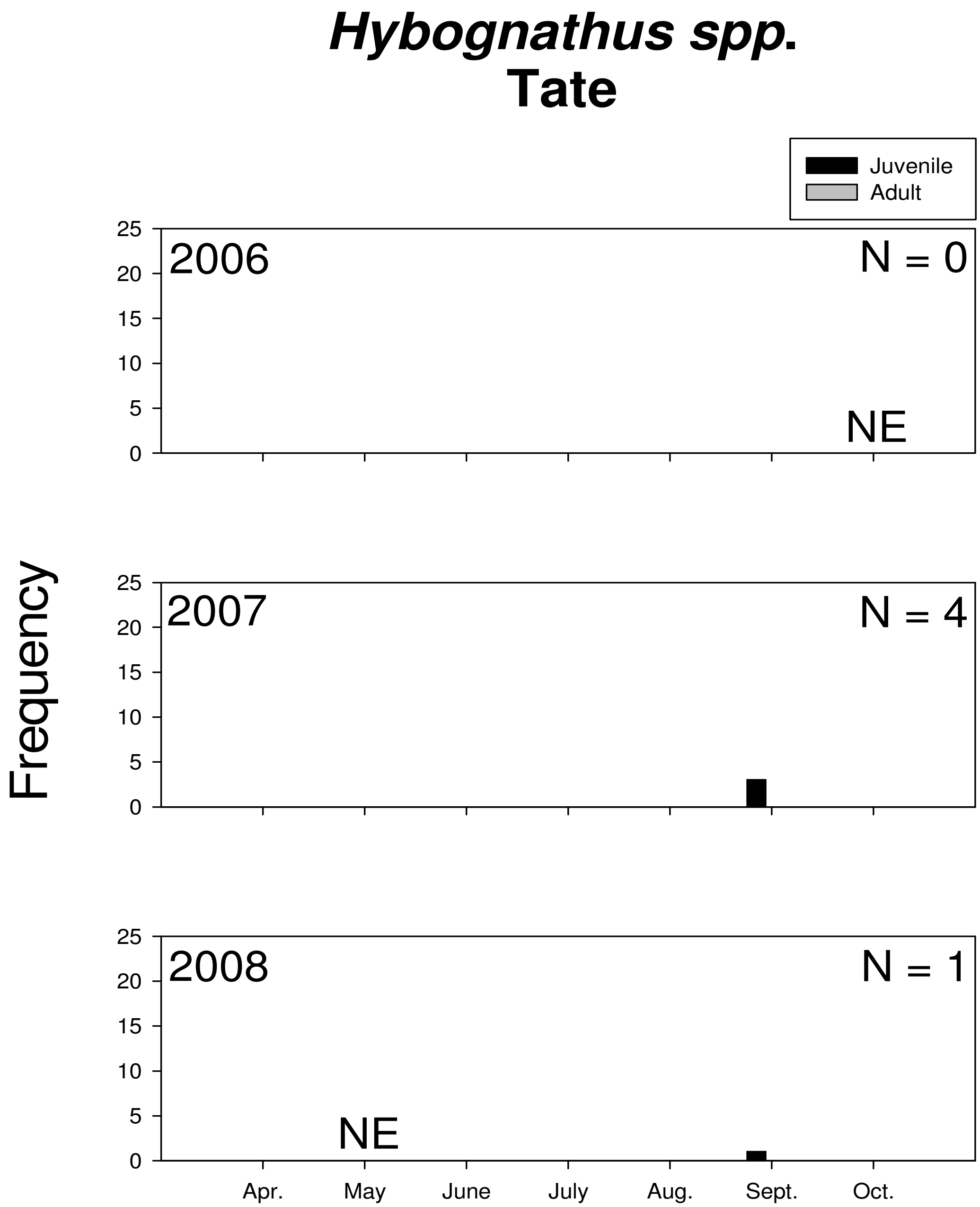


Figure III.12.31. Life stage frequency distribution of *Hybognathus spp*. in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

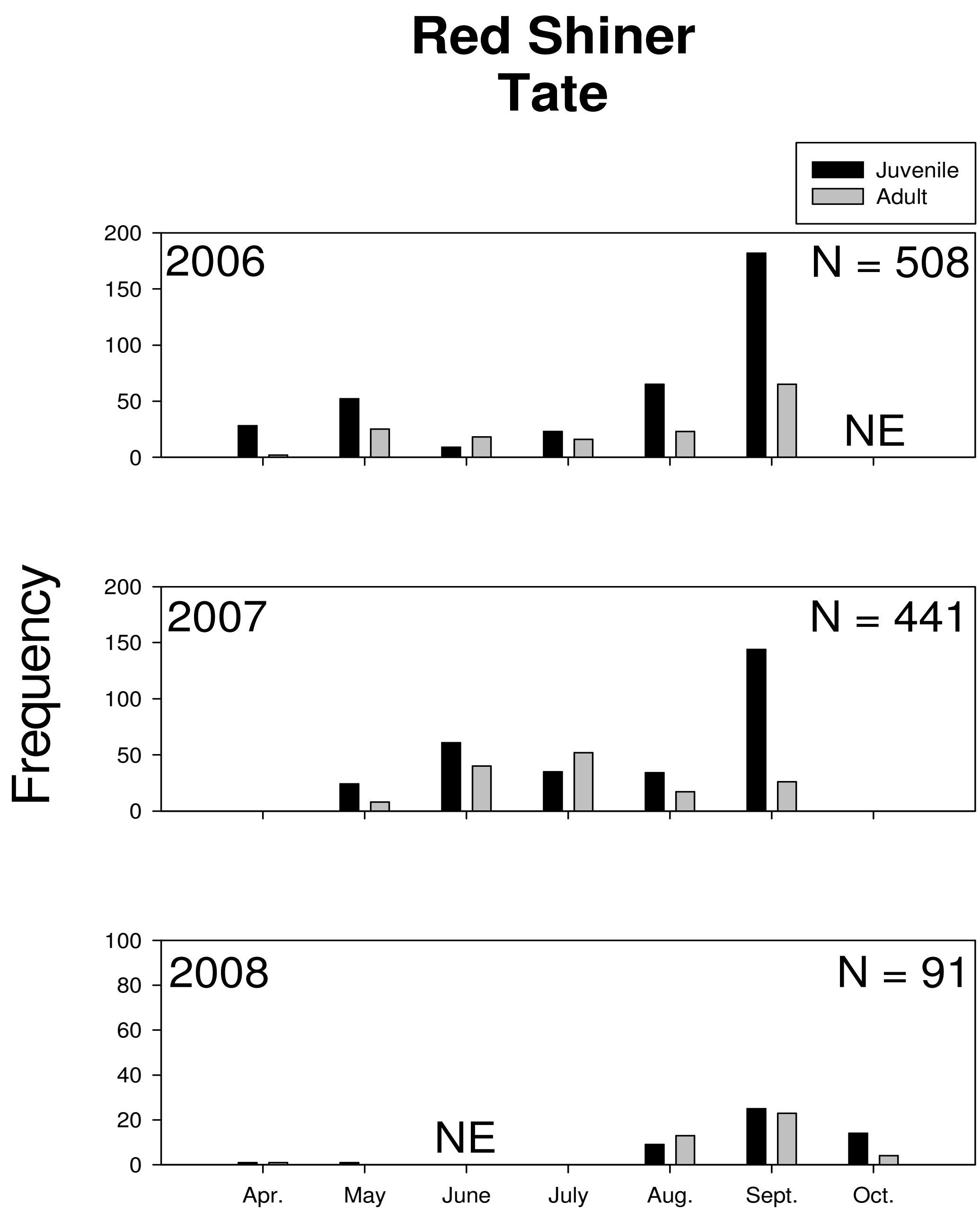


Figure III.12.32. Life stage frequency distribution of red shiner in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

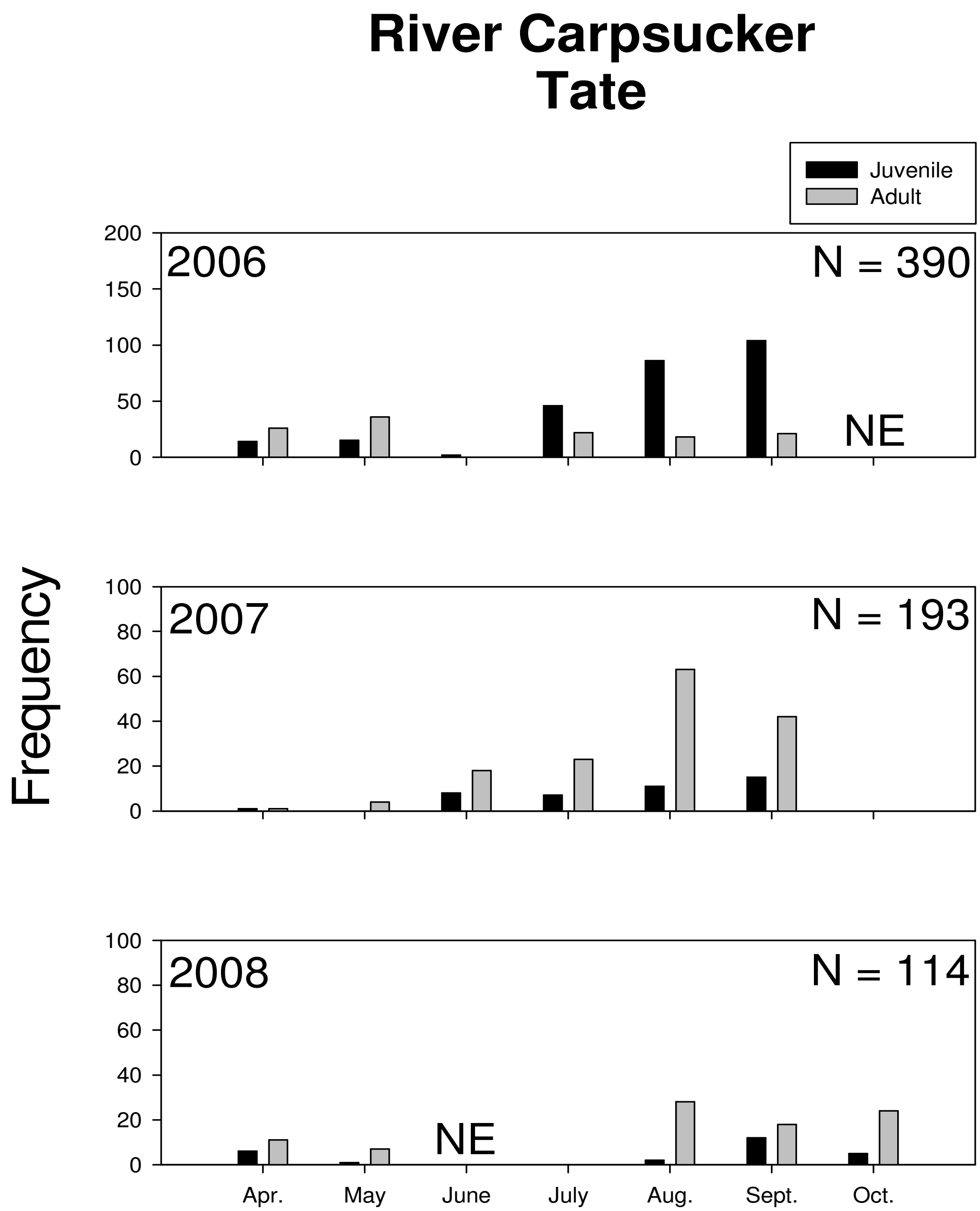


Figure III.12.33. Life stage frequency distribution of river carpsucker in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

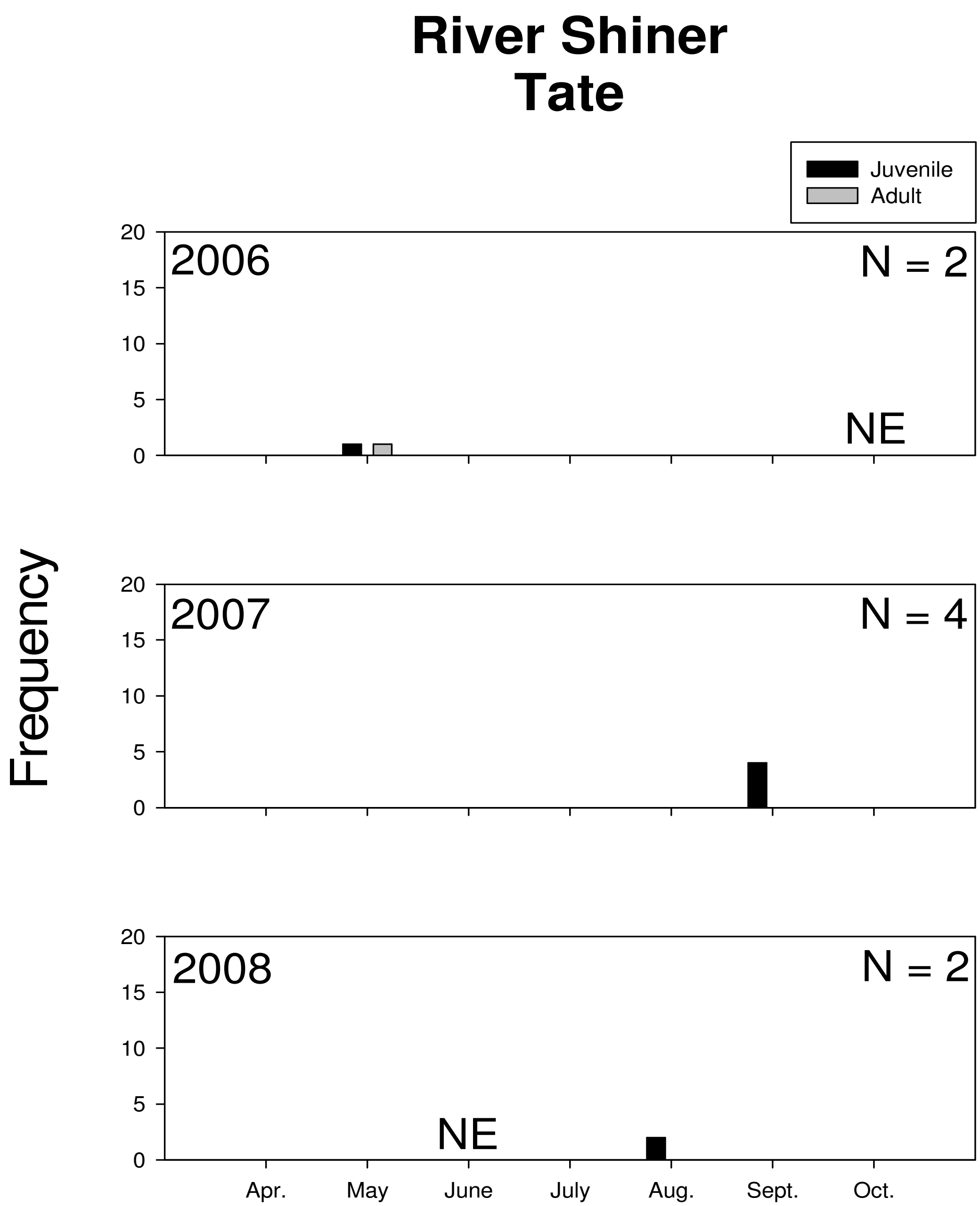


Figure III.12.34. Life stage frequency distribution of river shiner in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

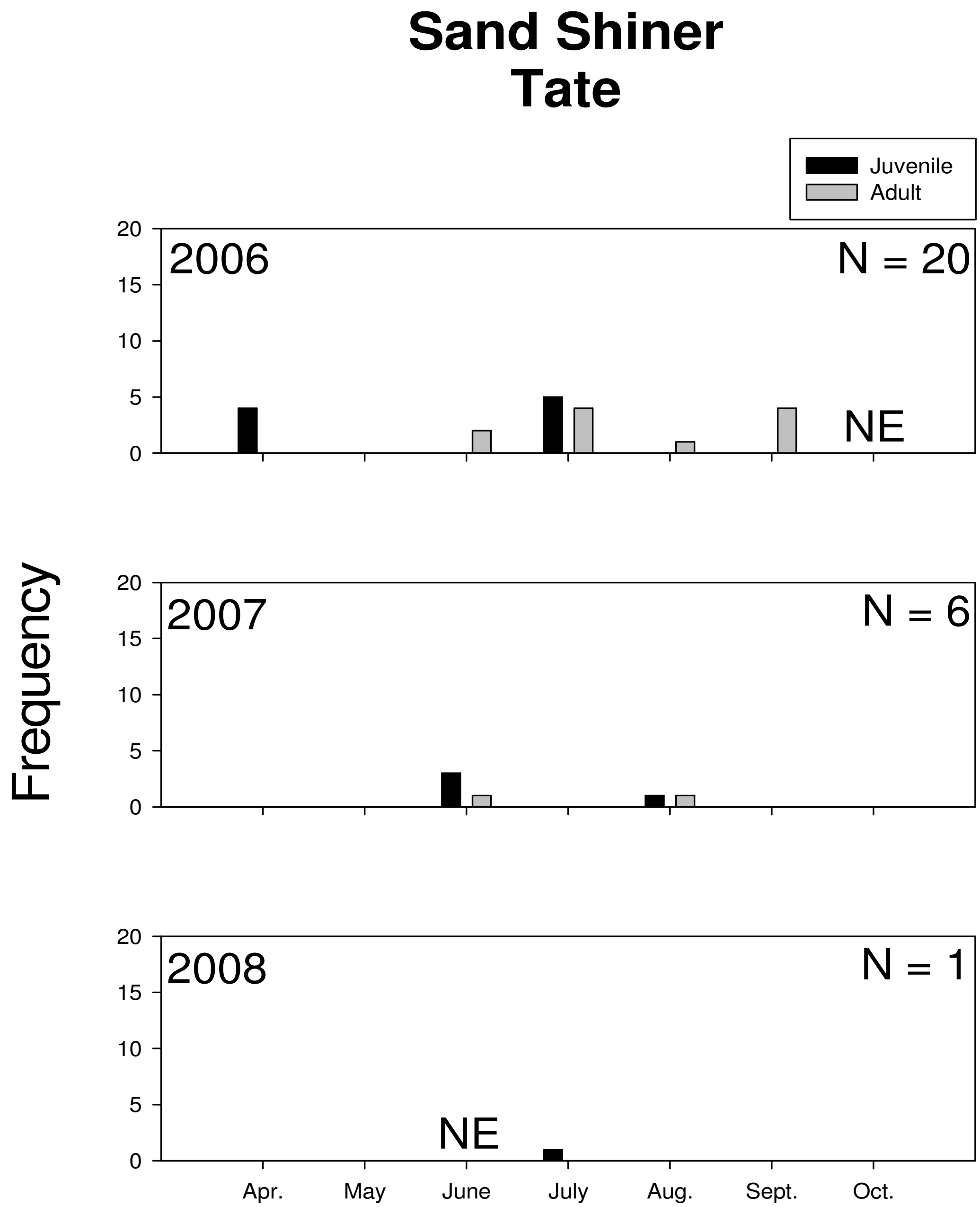


Figure III.12.35. Life stage frequency distribution of sand shiner in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

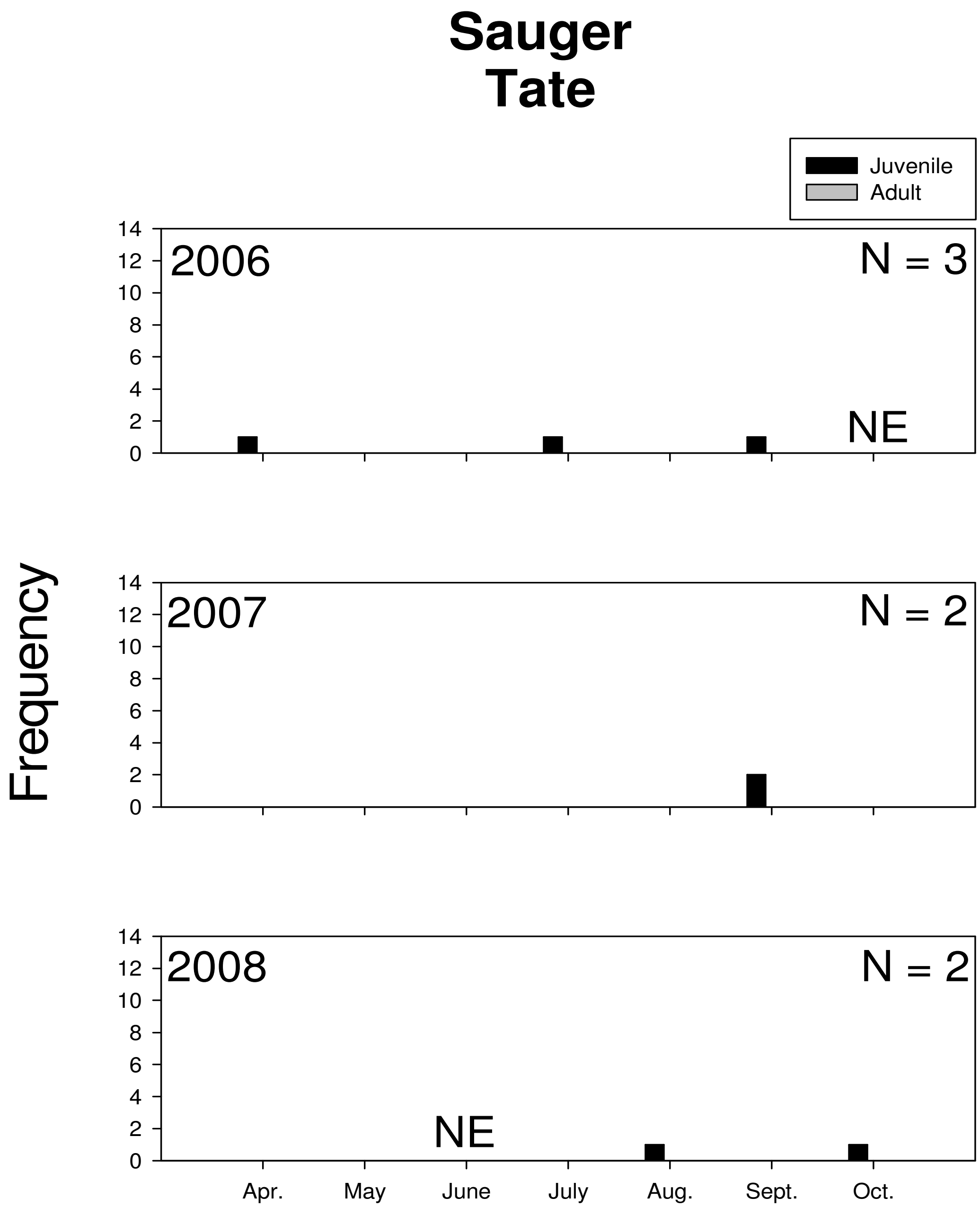


Figure III.12.36. Life stage frequency distribution of sauger in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

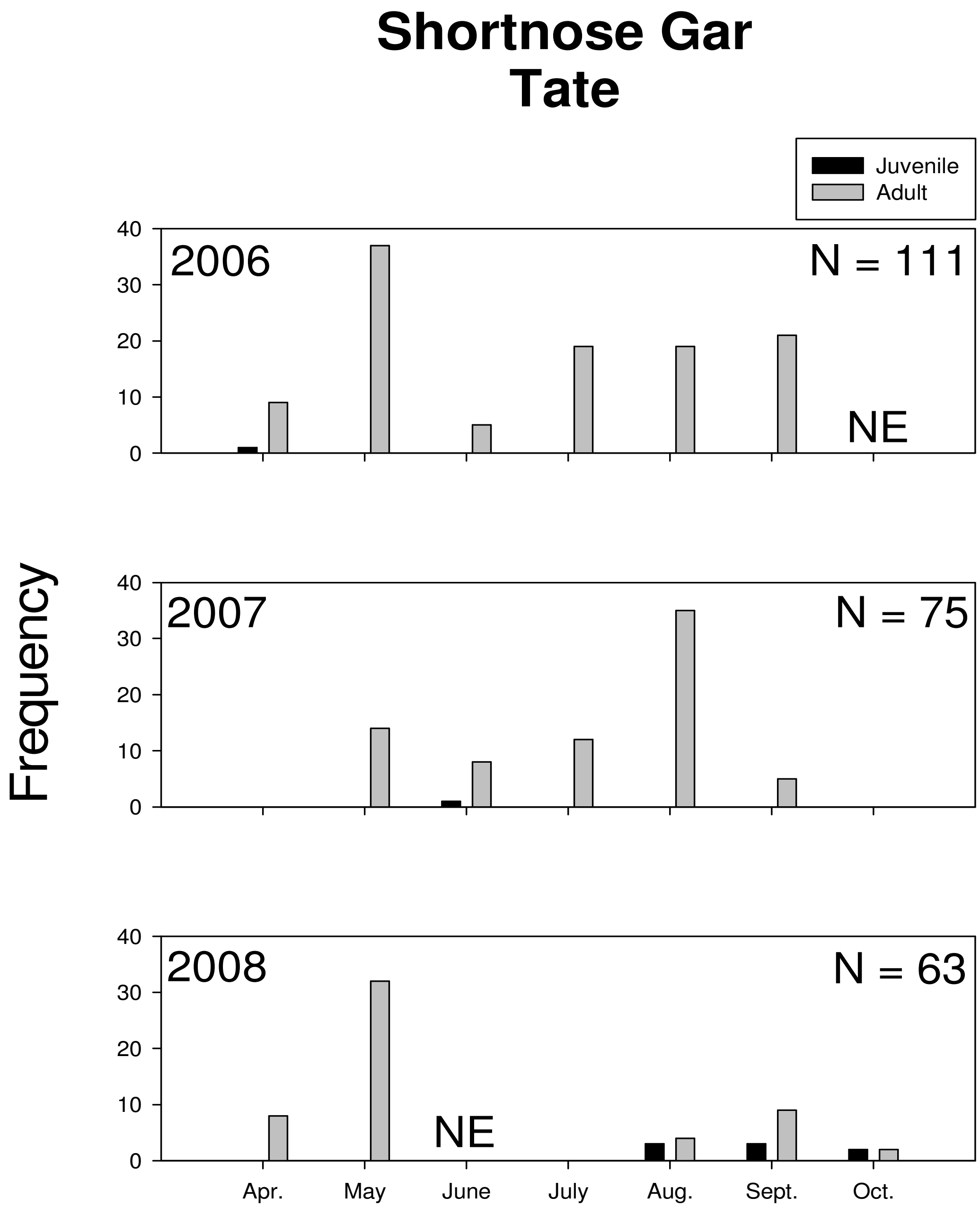


Figure III.12.37. Life stage frequency distribution of shortnose gar in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

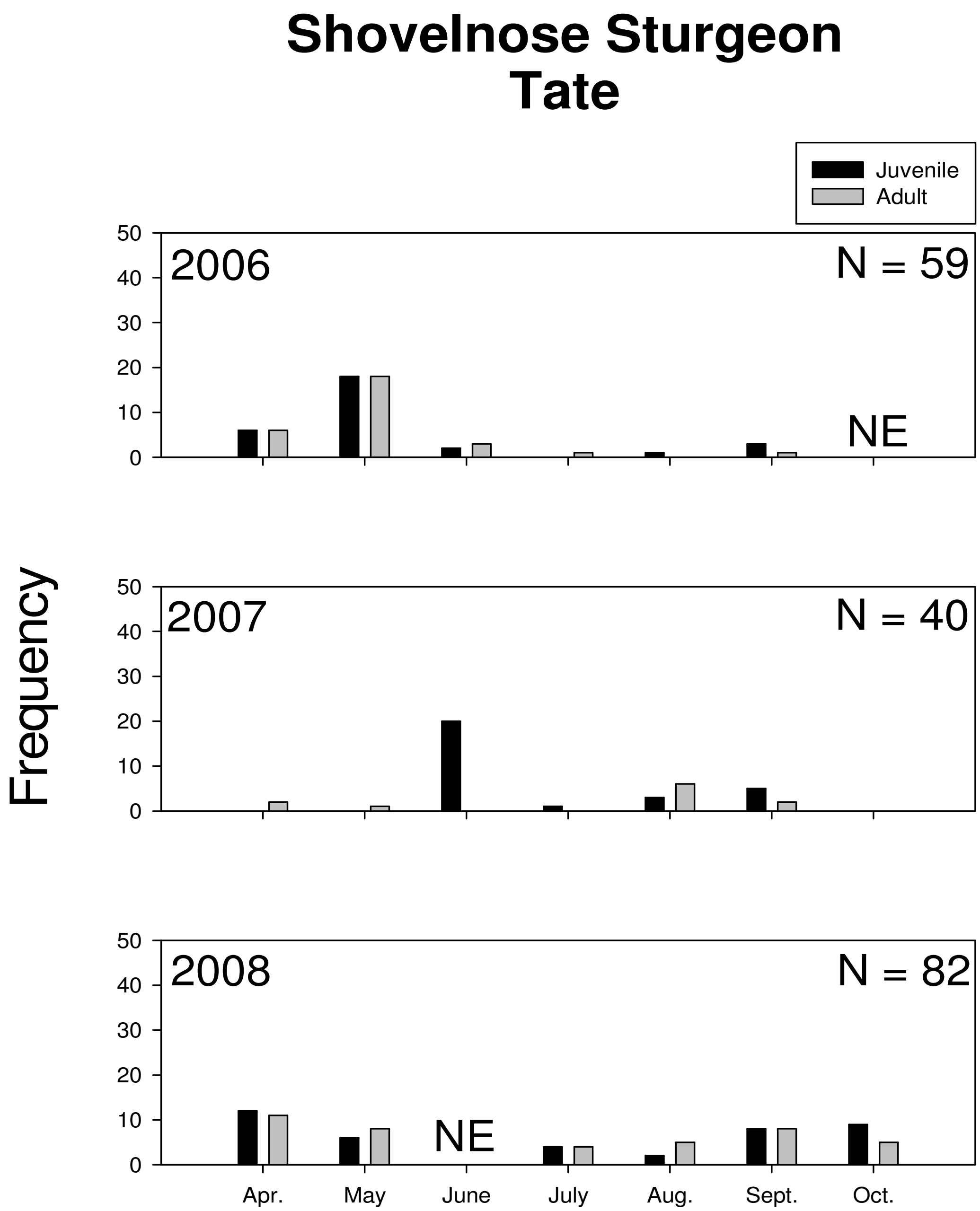


Figure III.12.38. Life stage frequency distribution of shovelnose sturgeon in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

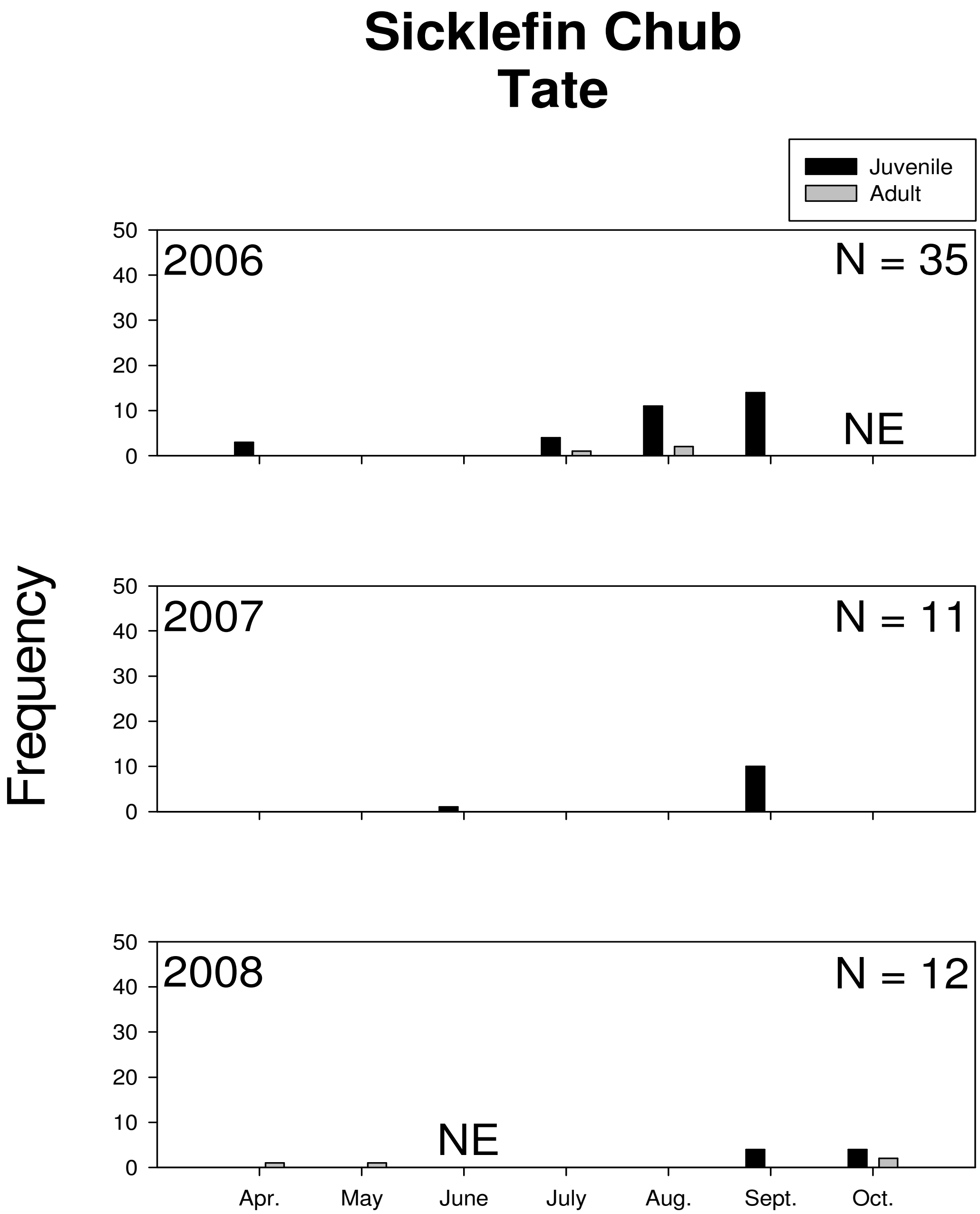


Figure III.12.39. Life stage frequency distribution of sicklefin chub in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

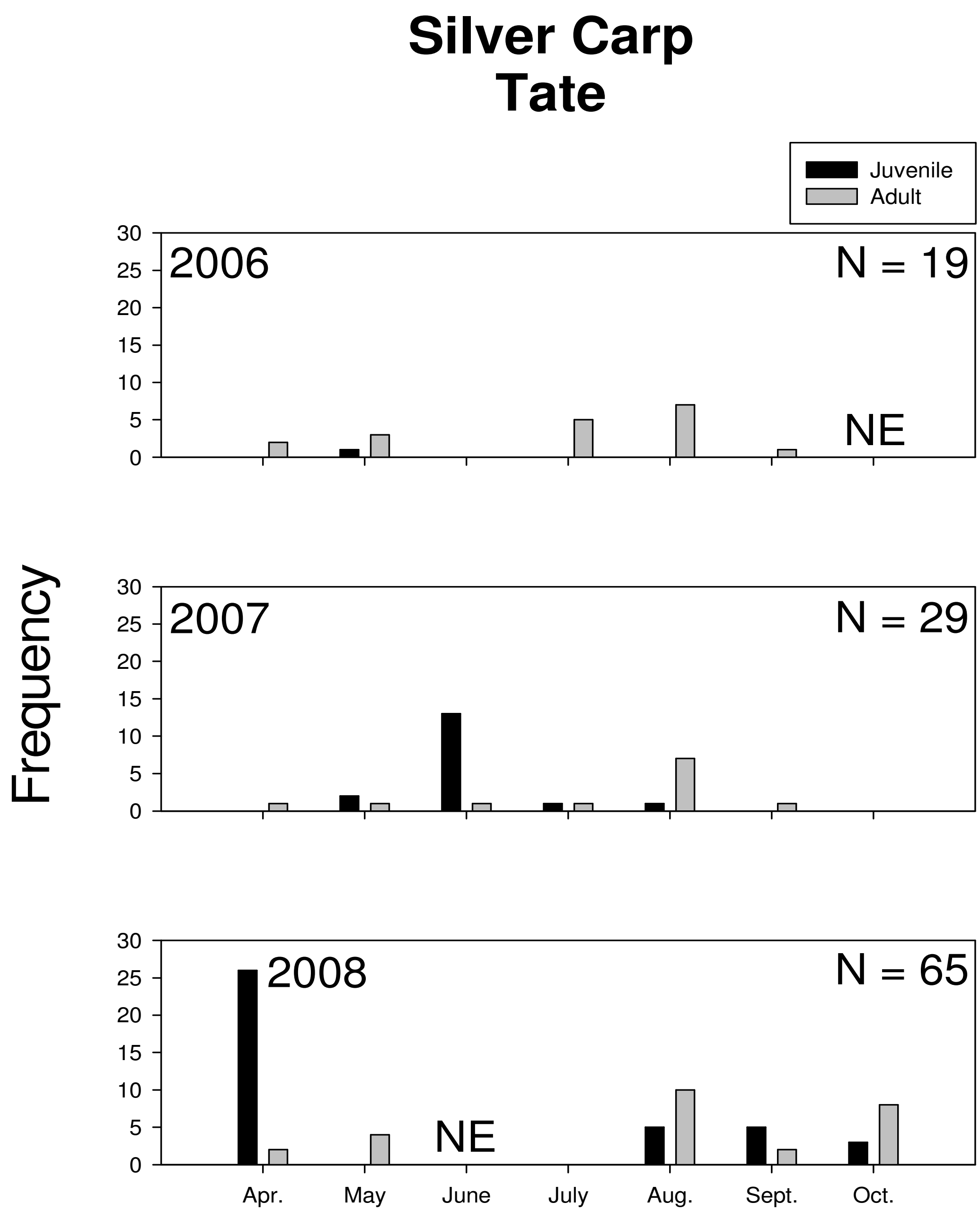


Figure III.12.40. Life stage frequency distribution of silver carp in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

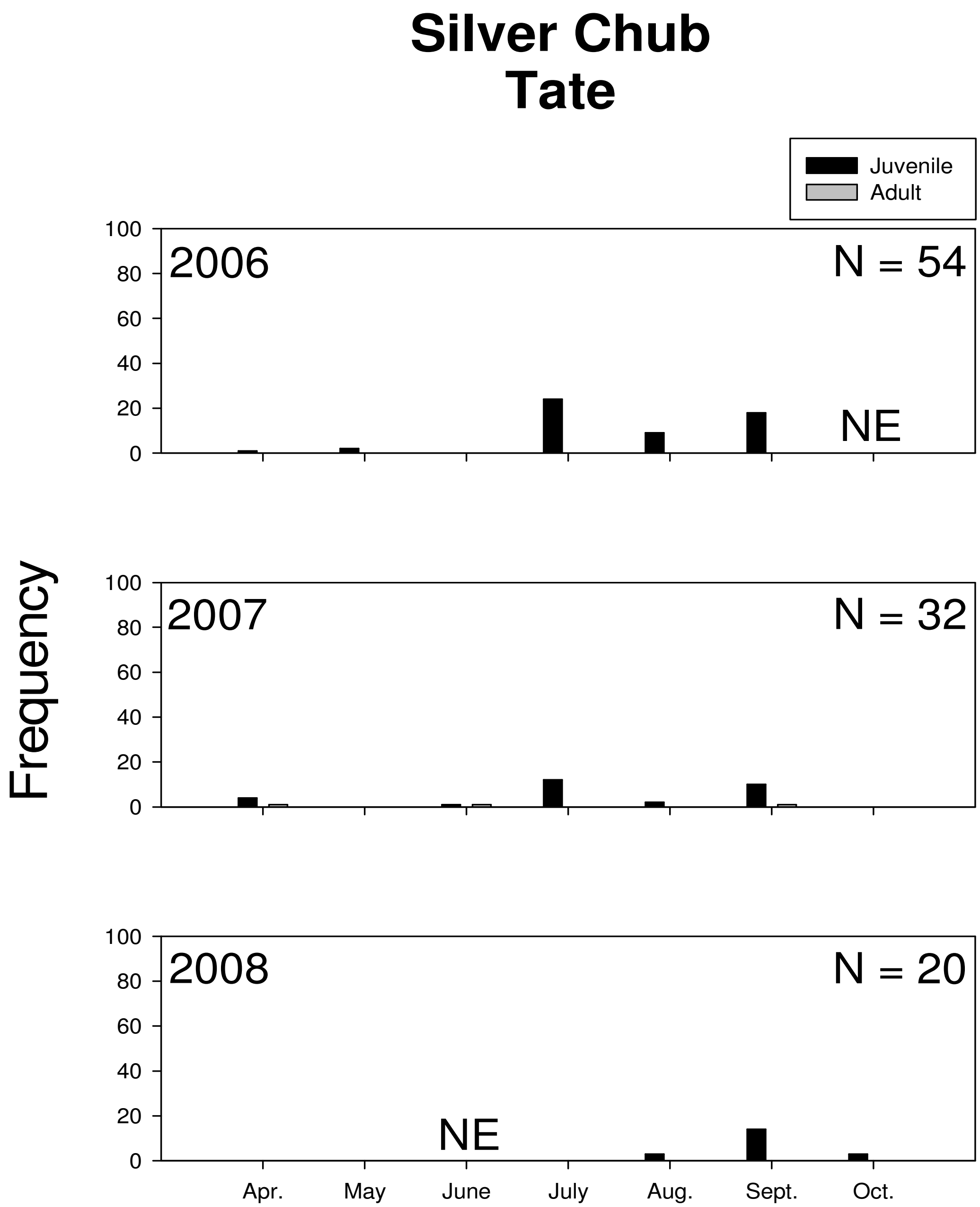


Figure III.12.41. Life stage frequency distribution of silver chub in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

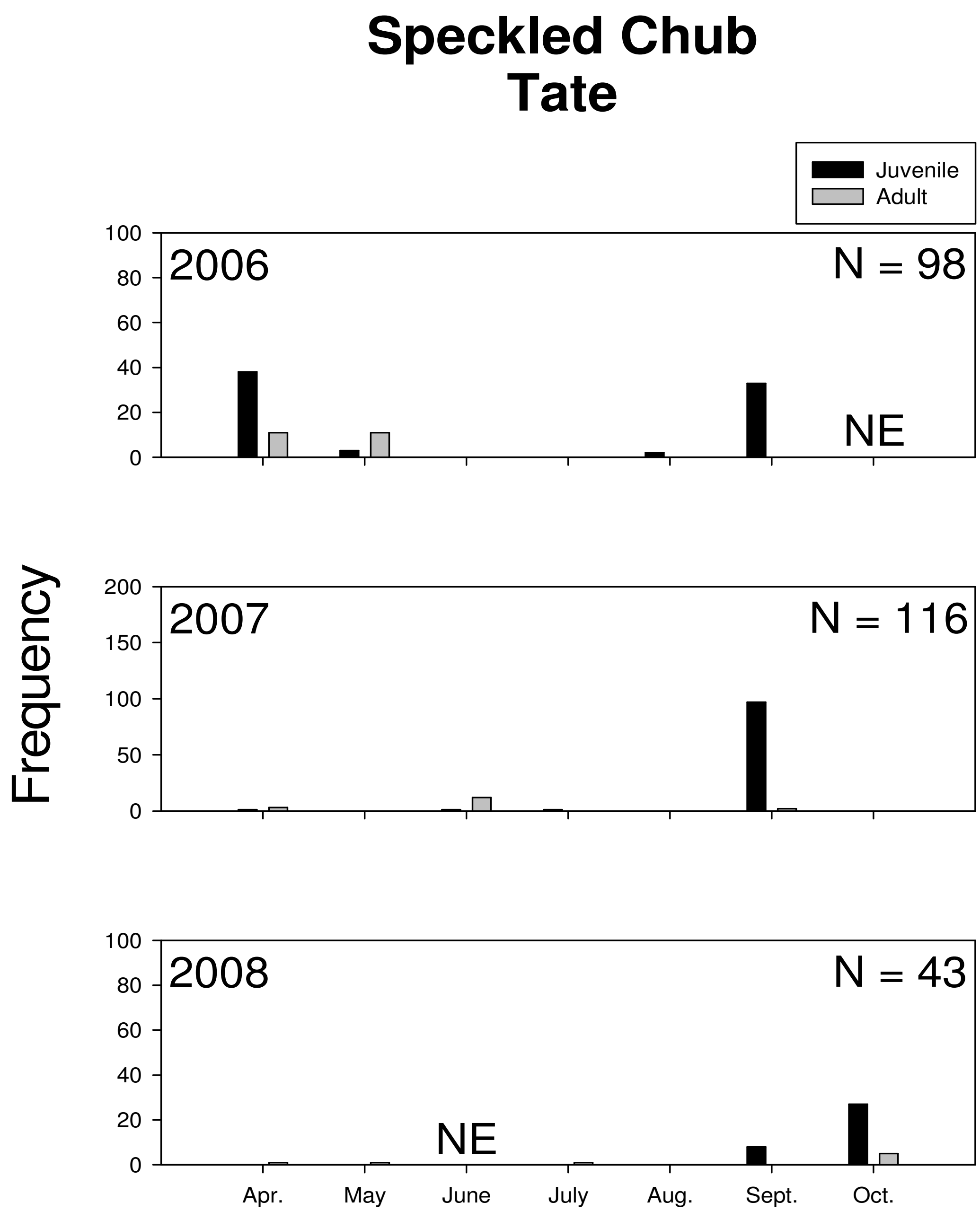


Figure III.12.42. Life stage frequency distribution of speckled chub in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

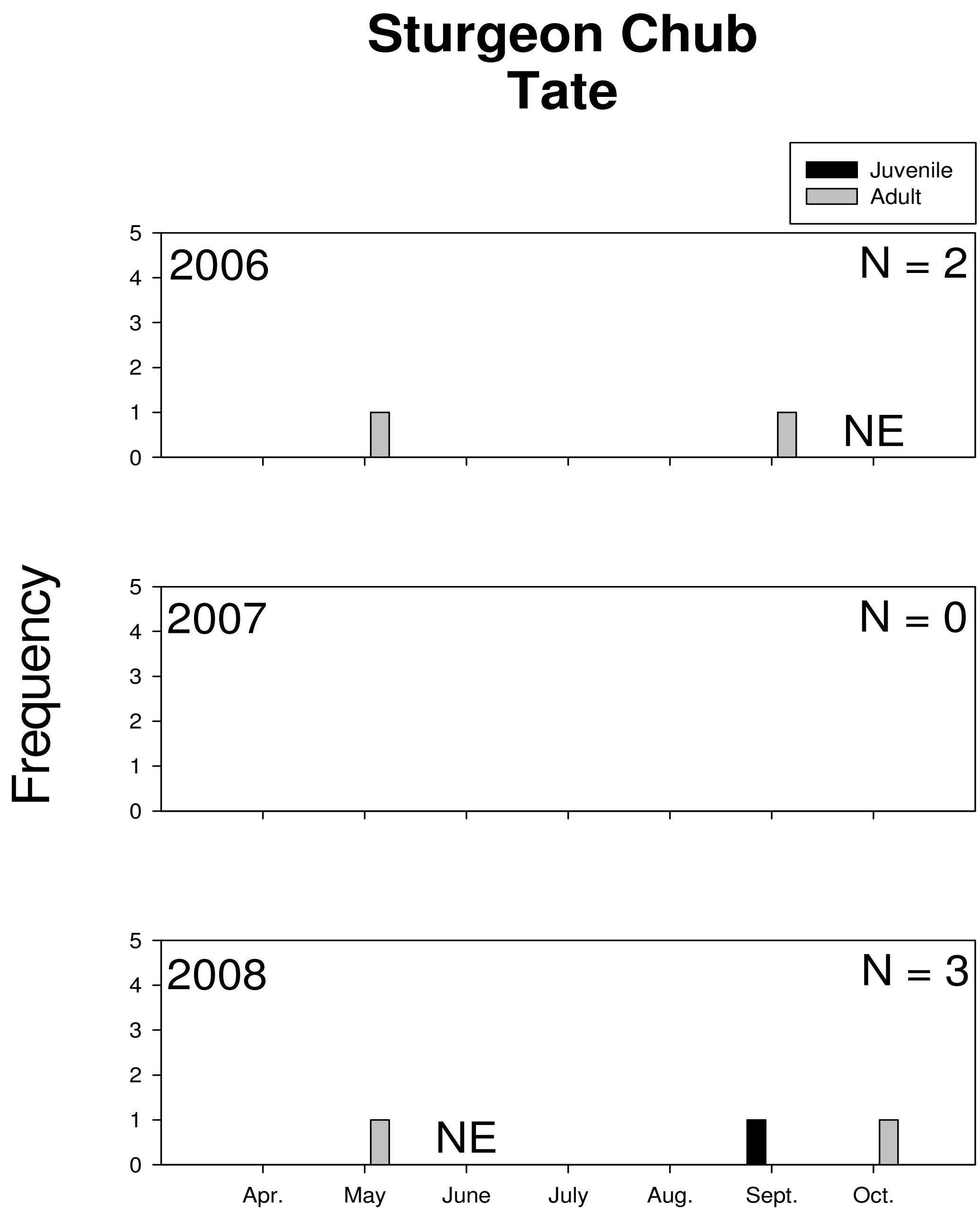


Figure III.12.43. Life stage frequency distribution of sturgeon chub in Tate chute by month and year. NE = No effort during this month due to river conditions or construction.

FINAL REPORT

Missouri River Fish and Wildlife Mitigation Program

Fish Community Monitoring and Habitat Assessment of Off-channel Mitigation Sites

Section IV Association of Fish Assemblages to Physical Habitats

Tieville-Decatur Bend[1], Louisville Bend[1], Tyson Island[1], California Cut-Off[1,2], Tobacco Island[2], Upper and Lower Hamburg Bend[2,3], Kansas Bend[2,3], Deroin Bend[2,3], Lisbon Bottom[4], North Overton Bottoms[4], Tadpole Island[4] and Tate Island[4]

Prepared for the U.S. Army Corps of Engineers

By:

[1]Van Sterner and Royce Bowman
[2]Brandon Eder, Sabrina Negus and Gerald Mestl
[3]Kasey Whiteman, Darrick Garner and Vince Travnichek
[4]Joshua Schloesser, Joseph McMullen and Tracy Hill

April 2009

[1]Van Sterner and Royce Bowman
Contract number –
Iowa Department of Natural Resources
607 10th St
Onawa, Iowa 51040

[2]Brandon Eder, Sabrina Negus and Gerald Mestl
Contract number – W9128F-05-P-0171
Nebraska Game and Parks Commission
Missouri River Program – Fisheries Division
2200 North 33rd Street
Lincoln, NE 68503

[3]Kasey Whiteman, Darrick Garner and Vince Travnichek
Contract number – W912DQ-07-D-0001
Missouri Department of Conservation
Nodaway Valley CA
21999 Hwy B
Maitland, MO 64466

[4]Joshua Schloesser, Joseph McMullen and Tracy Hill
Contract number - W59XQG83460940
U.S. Fish and Wildlife Service
Columbia National Fish & Wildlife Conservation Office
101 Park DeVille Drive, Suite A
Columbia, MO 65203-0057

Executive Summary

The Missouri River has been developed for flood control, commercial navigation, irrigation, fish and wildlife conservation, municipal water supply, water quality control and hydropower production through a series of congressional acts. However, prior to development, the lower Missouri River was characterized by a highly sinuous to braided channel with abundant log jams, sand bars, secondary channels and cut-off channels. Construction of the Bank Stabilization and Navigation Project (BSNP) converted the lower Missouri River into a narrow, self scouring channel. The active channel downstream of Sioux City, Iowa was as wide as 1.8 km before river modification, but is now confined to a 91.4 m channel. Total river and floodplain habitat altered or destroyed by the BSNP is estimated at 211,246 hectares.

The Missouri River Fish and Wildlife Mitigation Project (Mitigation Project) was established to restore fish and wildlife habitat lost by the construction, operation and maintenance of the BSNP. The Water Resources Development Act of 1986 authorized the United States Army Corps of Engineers (COE) to acquire and develop habitat on 12,100 hectares of non public lands and the development of 7,365 hectares of habitat on existing public lands to mitigate habitat losses. The Water Resources Development Act of 1999 authorized an additional 48,016 hectares to the program. The Final Supplemental Environmental Impact Statement (FSEIS) for the expanded Mitigation Project was issued in March of 2003, and it included a preferred alternative proposing the creation of additional shallow water habitat (defined as areas less than 1.5 m deep with a current velocity of less than 0.76 m/s). The preferred action in the FSEIS for the expanded

Mitigation Project included creation of 2,833 to 8,094 hectares of shallow water habitat (SWH).

In 2005, the Iowa Department of Natural Resources, Nebraska Game and Parks Commission (NGPC), Missouri Department of Conservation and U.S. Fish and Wildlife Service, Columbia Fisheries Resource Office (renamed to Columbia National Fish and Wildlife Conservation Office) were contracted by the COE to monitor and evaluate fish communities of select off-channel aquatic habitat sites that were constructed through the Mitigation Project. Additionally, the NGPC was contracted to collect physical habitat information from the secondary channels that were selected for biological monitoring in the upper channelized section above Kansas City. Sixteen sites selected for monitoring covered a range of aquatic habitats including backwaters and secondary channels with varying levels of engineering and development. Sites from upstream to downstream included Tieville-Decatur Bend (two backwaters), Louisville Bend (backwater), Tyson Island (backwater), California Bend (chute on the Nebraska bank and a chute with connected backwater on the Iowa bank), Tobacco Island (chute), Upper and Lower Hamburg Bends (one chute each), Kansas Bend (two small chutes, treated as one), Deroin Bend (chute), Lisbon Bottom (natural chute), North Overton Bottoms (chute), Tadpole Island (chute) and Tate Island (chute). The study was designed to include three field sampling seasons, but due to delays implementing contracts in 2005 another complete year of sampling was added. Thus, fish community monitoring and habitat assessment of off-channel mitigation sites began in April, 2006 and concluded in October, 2008. The objective of this project was to determine biological performance and functionality of chutes and backwaters and to compare chutes and backwaters in an effort to identify

designs most beneficial to native Missouri River fish species. Additionally, this project was designed to help determine if additional modifications are needed at existing mitigation sites, if existing designs are providing a range of habitats, if these habitats are of value to the biological diversity of the Missouri River and if these habitats are of specific value to species of concern or importance, such as pallid sturgeon.

Chutes and backwaters were sampled monthly from April thru October 2006 – 2008. Each chute was divided into 16 sampling segments, and eight segments were randomly chosen without replacement each month for each gear type used. The standard gears used for this project include; trammel nets, large and small otter trawls, push trawls, bag seines, electrofishing, large and small diameter hoop nets and mini-fyke nets. Additional gears used only in backwaters include experimental gill nets and large frame trap nets. Set lines and hook and line were used as wild gears (gears in addition to those required for standard sampling), these gears were used to target pallid sturgeon.

Chutes and backwaters provided habitat for different fish communities. Chutes were found to have more riverine species while these species were lacking in backwaters. Contiguous backwaters had greater species diversity and richness than those that were impounded. This connection to the river allowed species to access these areas that they otherwise could not have.

Chutes separated themselves out geographically. The available fish community in the main channel affected the fish community in the chutes. Chutes that were located farther up the Missouri River tended to benefit different species than those on the lower end of the river. Therefore, the benefit of a chute to the overall fish community probably depended on if the chute provided something different than what was already found in the

main channel. Also more diverse fish communities were found in the older constructed and natural chutes. This is probably due to the greater habitat diversity these chutes have developed compared to the younger chutes.

Overall, the fish communities in most sites were dominated by juveniles of most species. The habitat that has been developed via chutes and backwaters therefore are functioning as refuges for smaller fish. This is a valuable asset to the fish communities in the Missouri River. Currently little is known if these juveniles are spawned or drifted into the chutes and backwaters. It is also unknown if these juveniles are able to move out of the chutes and backwaters and into the main channel.

Predictive models indicated that chutes had different probabilities of presence for target species. In general, chutes that were relatively longer, wider, shallower and had greater sinuosity were more likely to have target species present. Conversely, chutes that were short, had low width to depth ratios and low sinuosity were less likely to have target species present.

Important predictor variables for species presence were year (85% of species models), water depth (80%), turbidity (65%), water temperature (60%), month (60%) and water velocity (50%). A year effect, likely related to river discharge, for many species supports the need for multiple year assessment programs. Water depth and, to some extent, water velocity were recognized as two variables that can be manipulated by river engineers and we found that the selected range of depths and velocities varied by species, which was expected with a diverse fish community. Many juvenile and small-bodied fishes utilized shallow water habitats (<1.0 m) over a broad range of water velocities (0.0-1.0 m/s), but large-bodied fishes tended to orient towards relatively deeper water. Therefore, creating

shallow water habitats with a range of velocities would likely benefit many juvenile native species.

Mitigation Project designs are providing a range of habitats. Backwater habitats are creating a habitat not currently available in most reaches of the Missouri River. Different backwater designs do not appear to be creating different habitats from each other; however, backwaters can only be used by riverine fish if they are connected to the river. All chutes are providing some habitat diversity, however, some chutes, including; California (NE), Upper Hamburg, Lisbon and Tate contain more habitat diversity, and therefore, are providing much needed habitat complexity to that reach of the river.

Backwater and chute habitats appear to be beneficial to the biodiversity of the Missouri River system; however, it is important to note that different reaches of the river have different needs. The highly modified middle Missouri River, from Sioux City, IA to Kansas City, MO has very little habitat diversity available within the main channel and many different habitats may be necessary to restore the healthy function of the river system. While the lower Missouri River has greater habitat diversity within the main channel, there are still habitats that may be limited, such as habitat diverse chutes (e.g., Lisbon or Tate) or backwaters that may be needed to restore a fully functioning river.

General Recommendations

- Promote natural side channel creation on suitable public lands. Allowing the river to naturally create side channel habitat may provide the most suitable habitat for riverine fish.
- We recommend constructing chutes that allow for floodplain connectivity, encourage natural river processes and maintain greater complexities of habitats (i.e. high width to depth ratios, diverse substrates, diverse depths, diverse velocities, shallow sandbars, woody debris and vegetated sandbars)
- Construction of longer chutes should receive higher priority than short chutes
- If a short chute must be built, build width, sinuosity and habitat diversity (deep scour holes, bar features and large woody debris).
- Promote channel movement through the use of structures or large woody debris.
- Soil type should be an important consideration in chute design, sites with clay or compacted soils need to be built to finished width or with wider pilot channels to hasten evolution.
- Slope banks when possible to allow large woody debris to accumulate in chutes rather than on high banks.
- Promote capture of large woody debris to increase habitat diversity and secondary productivity.
- Avoid designing chute entrances that may block upstream migration of fish (e.g., high sills or constricted entrances with high velocities and turbulence).
- Evaluate entrance structures to determine if certain life stages of some species (e.g., young of the year sturgeon) are being excluded from entering the chute.
- Avoid designs that promote sedimentation at chute entrances; keep entrances open so desired flows can be achieved.
- If a chute is intended to widen with increased main channel discharge, avoid designs where velocities decrease as main channel discharges increase such as at California (IA) and Kansas (upper).
- Use pilings, like those at Tate chute, instead of rip rap to create water control structures. Using pilings, as opposed to rock structures, may increase the permeability of water structures at varying levels of the water column, particularly the benthos.
- Include tie-channels and braids in chute designs to increase the amount of shallow, slow moving water at sites and provide more area that is in contact with the main channel.
- Design tie-channels, braids and connected backwaters to limit sedimentation.
- Tie channels can be used to direct flows to lower portions of the chute, allowing the upper portions to act more like backwater habitat.

- Create side channel habitat by building islands as opposed to digging channels, as was the case with Tate Island chute.
- Consider reopening existing, naturally formed side channels that are presently cut off from regular flows; there are at least 13 historic chutes that may be considered on the lower Missouri River.
- Contiguous dredged backwaters (such as Tyson Island and California (IA)) are recommended over impounded (disconnected) wetlands (such as Tieville, Louisville and Decatur). Contiguous sites provide connectivity that allows fish access to spawning and nursery habitat. Pumping did not provide accessible floodplain fish habitat.
- Backwaters should maintain a consistent, direct river connection. Open river connections are preferred over water control structures (culverts).
- Connectivity introduces sediment that will eventually fill backwaters. Siltation must be addressed by mechanical removal or improved backwater design.
- Backwaters of the upper channelized river become dewatered and isolated during winter discharges, backwaters should maintain adequate depth to prevent winter fish kills (approximately 3 m deep from December through February)
- Continued monitoring of chutes and backwaters would allow the determination of the rate at which the chute or backwater is evolving, the level of functionality that they can attain, value each chute has to different species, and how future manipulations affect the habitat and fish community.
- The variation in fish abundances seen among the three years of sampling indicates that a long term monitoring effort would be needed to detect population trends in chutes or backwaters. Furthermore, fish data from the chutes and backwaters should be compared to data from the main channel to determine how the chutes and backwaters are functioning with respect to main channel fish use.

TABLE OF CONTENTS

Section IV. Association of Fish Assemblages to Physical Habitats
Chapter 1
Modeling Target Species' Presence in Side-Channel Chutes

Section IV, Chapter 1: Table of Contents

INTRODUCTION

The Missouri River historically was shallow and wide with a meandering channel consisting of islands, sand bars, and course woody debris that supported a diverse and abundant native fish community (National Research Council 2002). With inception of the Missouri River Bank Stabilization and Navigation Project (BSNP) on the lower Missouri River, this diverse ecosystem was lost and many native fishes declined in abundance (Pflieger and Grace 1987). One method engineers have used to mitigate for fish and wildlife habitat losses was to construct side-channels (i.e., chutes) throughout the lower Missouri River.

Naturally formed chutes exhibit some of the habitat complexity that historically existed in the main channel Missouri River; newly constructed chutes are typically excavated pilot channels expected to evolve and widen over time with high water events. Biologists expect natural chutes to provide a variety of habitats necessary to support large river fishes, whereas new chutes may have relatively little habitat diversity. The range of chute development stages throughout the lower Missouri River provides an opportunity to understand habitat selection of target species and evaluate chute construction as a means to mitigate for loss of native fish habitat.

Understanding habitat conditions that fishes need to survive is critical to effectively recover declining populations. To better understand target species' habitat needs, we examined two questions: 1) Which habitat variables are most important for predicting species presence in a large river? 2) Are there water depths and water velocities that target species select? Answers to these two questions should guide future

river engineering efforts to develop effective mitigation strategies for habitat loss of native fishes.

METHODS

Study Area and Data Collection

Data were collected during 2006-2008 according to a standardized sampling protocol that was adopted from the Missouri River Standard Operating Procedures for Sampling and Data Collection (Drobish 2008), that was fully described in Section I. Samples used for analysis in this chapter were collected at twelve chute locations including California (IA), California (NE), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate using electrofishing, otter trawls, push trawls, mini fyke nets, large hoop nets and trammel nets to collect fishes. Gear and chute descriptions can be found in Sections I and II.2-13, respectively.

Logistic Regression Modeling

We constructed logistic regression models using SAS 9.2 (PROC LOGISTIC, SAS Institute Inc. 2008) to investigate influence of habitat variables on presence of each target species. Habitat variables used to predict species presence were measured at the chute and sample level (Table IV.1.1). Chute level variables were measured according to procedures described in Section II.1 and sample level variables according to procedures described in Section I. Samples that contained missing data for any variable could not be used to develop the logistic model and were deleted from the dataset. Percentages of substrate classifications (e.g., silt, sand and gravel) were summarized into mean substrate

size (D_g). Mean substrate size was calculated as $D_g = D_1^{w1} \times D_2^{w2} \times D_3^{w3}$, where D_i was the median size of the substrate category (i.e., 0.03 mm for silt, 1.03 for sand and 33 mm for gravel) and w_i was the proportion of the substrate sample in each category (McMahon et al. 1996, Ridenour et al. 2008).

One gear type was chosen to represent each species based upon the gear that had the highest proportion of samples that contained at least one individual (i.e., presence) for the target species of interest to develop the logistic model. Data from multiple gears were not combined for the logistic model due to gear bias, additionally, most species were best represented with only one gear. Multiple gears were examined in the case of chub sp. and pallid sturgeon because of similar catches in multiple gears. A stepwise selection procedure was used to determine which habitat variables entered and remained in the model using a selection cut-off of $P \leq 0.3$. Odds ratios were calculated for variables that significantly contributed to each species' model. Only significant odds ratio comparisons were reported. The Hosmer and Lemeshow Test was used to evaluate each model for lack-of-fit (i.e., small P-values indicate lack-of-fit, SAS Institute Inc. 2008).

Table IV.1.1. Habitat variables used to predict species presence in Missouri River chutes.

Chute Level	Sample Level
Chute	Depth
Length	Bottom or Column velocity
Width	Temperature
Length to width ratio	Turbidity
Sinuosity	Dissolved oxygen
<5 years old	Availability of cobble
Backwaters available	Availability of organic matter
Tie channel present	Mean substrate size
	Discharge
	Month
	Year

Kernel Density Estimation of Habitat Use

Water depth and water velocity are important habitat variables for many fish species and can also be most easily manipulated by river engineers. We calculated kernel density estimates using SAS 9.2 (PROC KDE, SAS Institute Inc. 2008) for species presence based on the water depth (m) and water velocity (m/s) where they were captured. Kernel density estimates were calculated by species based on the three gear types that had the highest proportion of samples that contained at least one individual (i.e., presence) for the target species of interest. Species were further divided into juveniles and adults to assess habitat use by life stage. Kernel density estimates were also calculated for all gears combined to assess habitat use over a broad range of habitat types. Density estimates were displayed on contour plots to illustrate water depth and water velocity conditions where each species was most commonly collected. Kernel density estimates were also calculated for only the habitats where samples were collected for each gear individually and all gears combined. The combination of species presence and sample location plots allowed for identifying if fish captures differed in proportion to habitats sampled. If density of fish presence differed from density of habitats sampled, habitat selection was occurring.

INTERPRETING THE LOGISTIC REGRESSION MODEL

To help interpret the logistic model and results presented for each species, we briefly explain basics of the logistic function and logistic regression models. The simple logistic function is:

$$P = 1/(1+e^{-Z}),$$

where P is probability of an event occurring and Z is calculated from the logistic regression model;

$$Z = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k.$$

In this report, we modeled probability that a species was present in a sample, which was defined as one gear deployment. Important variables were included and retained in the model if they significantly explained ($P < 0.3$) variation in species' presence. A model was then constructed using the important variables and the estimated model coefficients. For example, the sturgeon chub logistic equation was (Table IV.1.2):

$$Z = -5.849 + 1.3075*2006 - 1.1959*2007 + 0.00136*\text{Turbidity} +$$

$$1.6562*\text{Bottom Velocity} + 0.00199*\text{Chute Length} - 6.439*\text{Chute Sinuosity}$$

Table IV.1.2. Example table for the sturgeon chub logistic regression model.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	-5.849	3.7904	1	2.3813	0.1228
Year			2	14.5638	0.0007
2006	1.3075	0.4638			
2007	-1.1959	0.7985			
Turbidity	0.00136	0.000716	1	3.6308	0.0567
Bottom velocity	1.6562	1.0314	1	2.5785	0.1083
Chute length	0.00199	0.000502	1	15.6414	<.0001
Chute sinuosity	-6.439	4.3202	1	2.2214	0.1361
R-square = 0.3287					
Goodness-of-fit test			8	4.5948	0.7999

To calculate the final probability of presence, a 1 is used to include categorical regression coefficients. Categorical variables that should not be included receive a 0 to exclude that regression coefficient. For continuous variables, the measured value is entered directly into the equation. To expand on the sturgeon chub example, an example sample was collected during 2007 and habitat measurements were measured that resulted in this equation:

$$Z = -2.23 = -5.849 + 1.3075*0 - 1.1959*1 + 0.00136*1746 +$$

$$1.6562*0.93 + 0.00199*5094 – 6.439*1.22.$$

Therefore, probability of a sturgeon chub being present in this sample was:

$$P = 1/(1+e^{2.23}) = 0.097.$$

One way the logistic equation is useful is that each regression coefficient describes the size of the contribution to overall probability of an event occurring. A positive coefficient indicates that the variable increases probability of the species being present, whereas a negative coefficient indicates the variable decreases probability of the species being present in a particular sample. A large coefficient means the variable strongly influences probability of a species' presence, whereas a near-zero coefficient would indicate the variable has little influence on probability of species' presence.

It is important to note that predictive ability of the model does not apply to conditions that occur outside of conditions from which the model was derived. This essentially implies that if otter trawls did not sample water depths <0.5 m, the model should not be used to predict species presence in otter trawls deployed in water 0.25 m deep.

TARGET SPECIES HABITAT USE

Channel Catfish

Channel catfish presence was fit to a logistic model using samples collected with the otter trawl. The model contained three categorical variables (month, year and chute) and three continuous variables (temperature, turbidity and depth), explained 17.5% of the variability in channel catfish presence and showed no lack-of-fit to the data (P = 0.5457; Table IV.1.3). With this model, there were several observations made: 1) months of April, May, September and October had greater odds of detecting channel catfish than other months (Table IV.1.4), 2) presence during 2006 was more likely than 2007 or 2008 and 3) the Hamburg chutes (lower and upper) were the most favorable for channel catfish presence. A positive relationship was found with turbidity, where greater odds of presence occur in more turbid waters. A negative relationship was found for water depth, where greater odds occurred near the shallow range of depths fishable by the otter trawl. This was not a strong relationship because odds of presence increased only 1.1 times for every 0.25 m decrease in water depth.

Water temperature was a significant variable that was estimated to increase probability of occurrence, especially in warmer waters. However, all regression coefficients for month were negative, indicating that the variables water temperature and month are likely interacting with each other to balance out estimated probability of presence.

Table IV.1.3. Results of the logistic regression model for channel catfish caught otter trawling. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: April (Month), 2008 (Year) and California (NE) (Chute). No otter trawl samples were collected in California (IA), Tobacco Island, Kansas (upper) and Kansas (lower) chutes. The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	-0.0722	0.7270	1	0.0099	0.9208
Month			6	17.0981	0.0089
May	-0.8541	0.4242			
June	-1.7523	0.6083			
July	-1.8348	0.7027			
August	-2.0346	0.7031			
September	-0.4837	0.4515			
October	-0.1562	0.3891			
Year			2	7.4134	0.0246
2006	0.5785	0.2304			
2007	0.0377	0.2271			
Chute			7	17.3909	0.0150
Upper Hamburg	-0.0213	0.3166			
Lower Hamburg	1.2658	0.7391			
Deroin	-0.5890	0.3223			
Lisbon	-0.6216	0.3429			
Overton	-0.7220	0.3631			
Tadpole	-0.6754	0.3957			
Tate	-0.0986	0.3706			
Temperature	0.1044	0.0454	1	5.2809	0.0216
Turbidity	0.0014	0.0004	1	9.9037	0.0016
Depth	-0.5257	0.1208	1	18.9528	<.0001
R-square = 0.1751					
Goodness-of-fit test			8	6.9163	0.5457

Table IV.1.4. Odds ratios for habitat variables that significantly contributed to the channel catfish logistic regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
Turbidity (NTU)	+100	1.2	Turbid water
Depth (m)	-0.25	1.1	Shallower water
Categorical Variables	*NA*		
April vs May	-	2.3	April
April vs June	-	5.8	April
April vs July	-	6.3	April
April vs August	-	7.6	April
May vs June	-	2.5	May
May vs August	-	3.3	May
May vs October	-	2.0	October
June vs September	-	3.6	September
June vs October	-	4.9	October
July vs September	-	3.9	September
July vs October	-	5.3	October
August vs September	-	4.7	September
August vs October	-	6.5	October
2006 vs 2007	-	1.7	2006
2006 vs 2008	-	1.8	2006
California (NE) vs Overton	-	2.1	California (NE)
Deroin vs Lower Hamburg	-	6.4	Lower Hamburg
Lisbon vs Lower Hamburg	-	6.6	Lower Hamburg
Overton vs Lower Hamburg	-	7.3	Lower Hamburg
Tadpole vs Lower Hamburg	-	7.0	Lower Hamburg
Overton vs Upper Hamburg	-	2.0	Upper Hamburg

Kernel density estimate plots indicate that channel catfish were present in similar proportions to habitats sampled with mini fyke nets, push trawls and otter trawls (Figure IV.1.1). The logistic model indicated a weak negative relationship with water depth, and for juveniles, the greatest density of presence generally occurred near shallow water. Adult channel catfish were able to occupy deeper water relative to juveniles.

Water velocity was not an important variable in the logistic model, and KDE plots indicate most channel catfish can be found in water velocities up to 0.8 m/s. Juvenile

presence in habitats with velocities up to 0.8 m/s indicated they can tolerate strong currents.

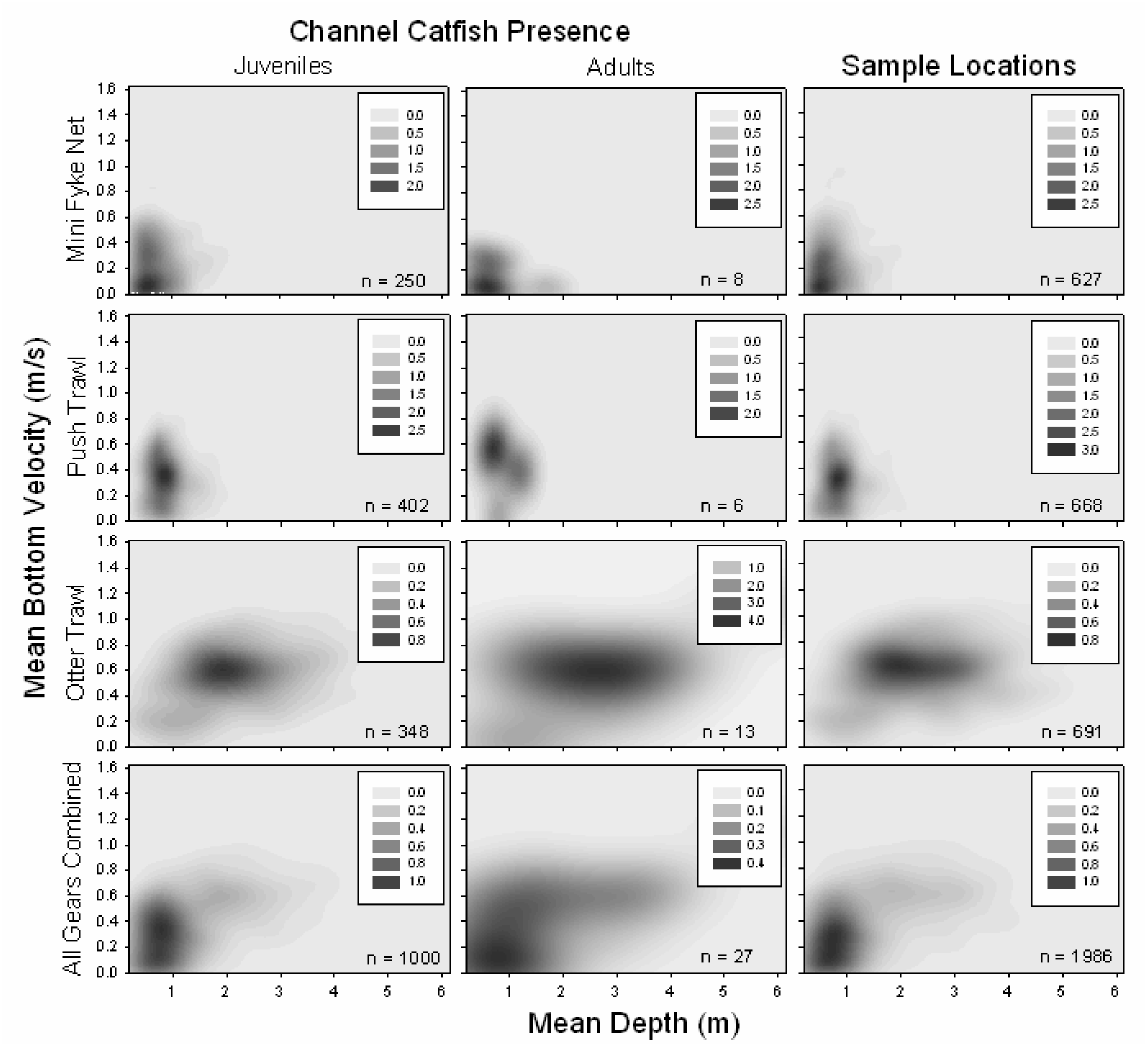


Figure IV.1.1. Kernel density estimates of mean depth (m) and mean bottom velocity (m/s) locations where juvenile (<305 mm) and adult (≥305 mm) channel catfish were present and where mini fyke net, push trawls and otter trawls were deployed. All samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008, except otter trawls were not used in California (IA), Tobacco Island, Kansas (upper) and Kansas (lower).

Sauger

Sauger presence was fit to a logistic model using electrofishing samples. The model consists of three categorical variables (month, chute and organic) and two continuous variables (turbidity and bottom velocity). The model explained 23.0% of variability in sauger presence and showed no lack of fit to the data (P = 0.8831; Table IV.1.5).

The greatest odds of capturing sauger occurred during September and October in California (NE) and Lisbon chutes (Table IV.1.6). Sauger presence was less likely in areas that contained incidental organic materials compared to areas with no organic materials. A positive relationship with turbidity indicated sauger preferred more turbid waters. However, a negative relationship existed with bottom velocity, where for every 0.2 m/s decrease in water velocity the odds of presence increased 1.5 times.

Table IV.1.5. Results of the logistic regression model for sauger caught while electrofishing. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: April (Month), California (IA) (Chute) and no organic material (Organic). The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	-3.1450	1.0069	1	9.7558	0.0018
Month			6	8.5155	0.2027
May	0.2941	0.6954			
June	0.9905	0.7114			
July	0.3636	0.7107			
August	0.5843	0.6955			
September	1.2559	0.6547			
October	1.4689	0.7214			
Chute			11	34.0970	0.0003
California (NE)	2.1118	0.7870			
Tobacco Island	-0.0263	0.8758			
Upper Hamburg	-12.1477	483.2			
Lower Hamburg	0.1647	1.2779			
Kansas (upper)	-12.1597	673.7			
Kansas (lower)	-12.5039	845.0			
Deroin	-12.4201	453.6			
Lisbon	0.6995	0.8833			
Overton	-1.6411	1.2925			
Tadpole	-0.4343	0.9788			
Tate	-0.6356	1.0237			
Organic			1	1.8419	0.1747
Incidental	-1.4775	1.0887			
Turbidity	0.0017	0.0009	1	3.2749	0.0703
Bottom velocity	-1.9999	0.9880	1	4.0971	0.0430
R-square = 0.2298					
Goodness-of-fit test			8	3.6999	0.8831

Table IV.1.6. Odds ratios for habitat variables that significantly contributed to the sauger logistic regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
Bottom velocity (m/s)	-0.2	1.5	Slower velocity water
Categorical Variables	*NA*		
April vs October	-	4.3	October
California (IA) vs California (NE)	-	8.3	California (NE)
California (NE) vs Tobacco Island	-	8.5	California (NE)
California (NE) vs Lisbon	-	4.1	California (NE)
California (NE) vs Overton	-	42.6	California (NE)
California (NE) vs Tadpole	-	12.8	California (NE)
California (NE) vs Tate	-	15.6	California (NE)
Lisbon vs Overton	-	10.4	Lisbon

Kernel density plots indicated sauger were generally captured in proportion to habitats where electrofishing, mini fyke net and otter trawl samples were used (Figure IV.1.2). Although water depth was not a significant variable in the logistic regression model, few sauger were found at depths >3 m. Water velocity was a significant variable, but it was difficult to verify from KDE plots that sauger preferred slower velocity water as predicted from the model. Adults were most commonly found at water velocities >0.2 m/s, but juveniles caught with mini fyke nets were in velocities <0.2 m/s.

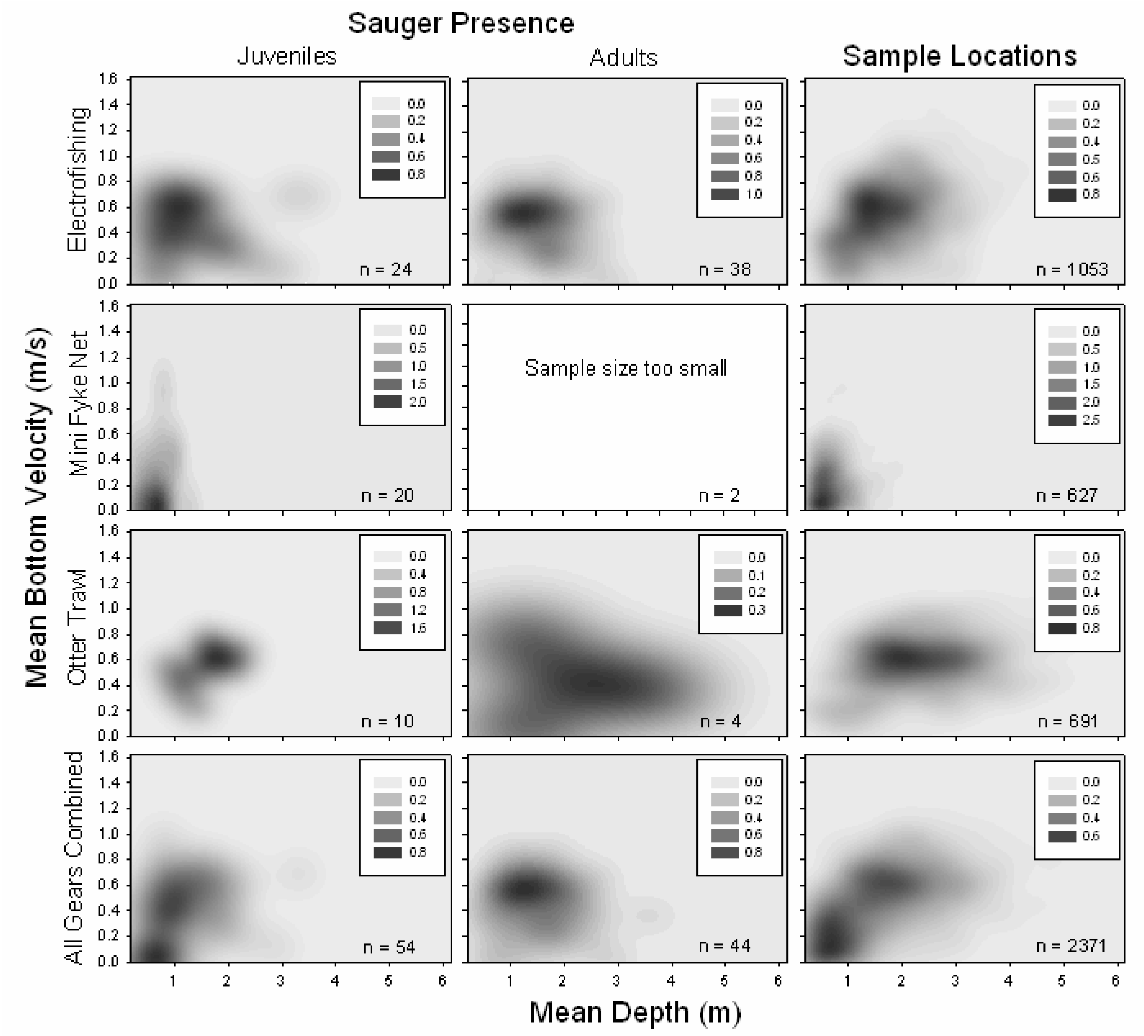


Figure IV.1.2. Kernel density estimates of mean depth (m) and mean bottom velocity (m/s) locations where juvenile (<229 mm) and adult (≥229 mm) sauger were present and where electrofishing, mini fyke net and otter trawl samples were taken. All samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008, except otter trawls were not used in California (IA), Tobacco Island, Kansas (upper) and Kansas (lower).

Silver Carp

Silver carp presence was fit to a logistic regression model using samples collected while electrofishing. The best model included four categorical variables (year, chute, presence of cobble and presence of organic materials) and two continuous variables (dissolved oxygen and water depth), it explained 58.0% of the variability in silver carp presence and exhibited no lack-of-fit to the data ($P = 0.6167$; Table IV.1.7).

The model predicted more than 20 times greater odds of silver carp presence during 2008 and 2006 than 2007 (Table IV.1.8). Additionally, silver carp were most likely to be found in Tate and Lisbon chutes, with Deroin, Overton and Tadpole chutes exhibiting strong positive regression coefficients as well. Substrates that contained cobble and no organic material were most likely to have silver carp present. Habitats with deeper water and low dissolved oxygen were also productive areas.

Table IV.1.7. Results of the logistic regression model for silver carp caught while electrofishing. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: 2008 (Year), California (IA) (Chute), no cobble (Cobble) and no organic material (Organic). The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	-12.8765	151.6	1	0.0072	0.9323
Year			2	14.1562	0.0008
2006	-0.1287	0.6661			
2007	-3.2304	0.8629			
Chute			11	32.6310	0.0006
California (NE)	-0.9687	197.3			
Tobacco Island	-0.5065	195.3			
Upper Hamburg	-1.3836	305.9			
Lower Hamburg	-0.9374	327.9			
Kansas (upper)	-1.1874	402.5			
Kansas (lower)	-2.1248	514.6			
Deroin	10.9747	151.6			
Lisbon	12.2510	151.6			
Overton	9.5402	151.6			
Tadpole	8.4911	151.6			
Tate	13.8379	151.6			
Cobble			2	4.2114	0.1218
Incidental	1.8583	0.9055			
Dominant	1.1082	616.4			
Organic			1	2.1829	0.1396
Incidental	-0.9538	0.6456			
Dissolved oxygen	-0.3456	0.1441	1	5.7504	0.0165
Depth	1.1286	0.3712	1	9.2457	0.0024
R-square = 0.5803					
Goodness-of-fit test			4	2.6573	0.6167

Table IV.1.8. Odds ratios for habitat variables that significantly contributed to the silver carp logistic regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
DO (mg/L)	-0.5	1.2	Lower oxygen water
Depth (m)	+0.25	1.3	Deeper water
Categorical Variables	*NA*		
2006 vs 2007	-	22.2	2006
2007 vs 2008	-	25.0	2008
Deroin vs Tate	-	17.5	Tate
Lisbon vs Overton	-	15.0	Lisbon
Lisbon vs Tadpole	-	42.9	Lisbon
Lisbon vs Tate	-	4.9	Tate
Overton vs Tate	-	71.4	Tate
Tadpole vs Tate	-	200.0	Tate
No Cobble vs Incidental Cobble	-	6.4	Incidental Cobble

Kernel density estimates of silver carp presence were proportionally greater in habitats with slow velocities (<0.5 m/s) and deeper water (>1.0 m) than were sampled (Figure IV.1.3). All three gears indicate that both juvenile and adult silver carp selected for deep, slow-velocity water.

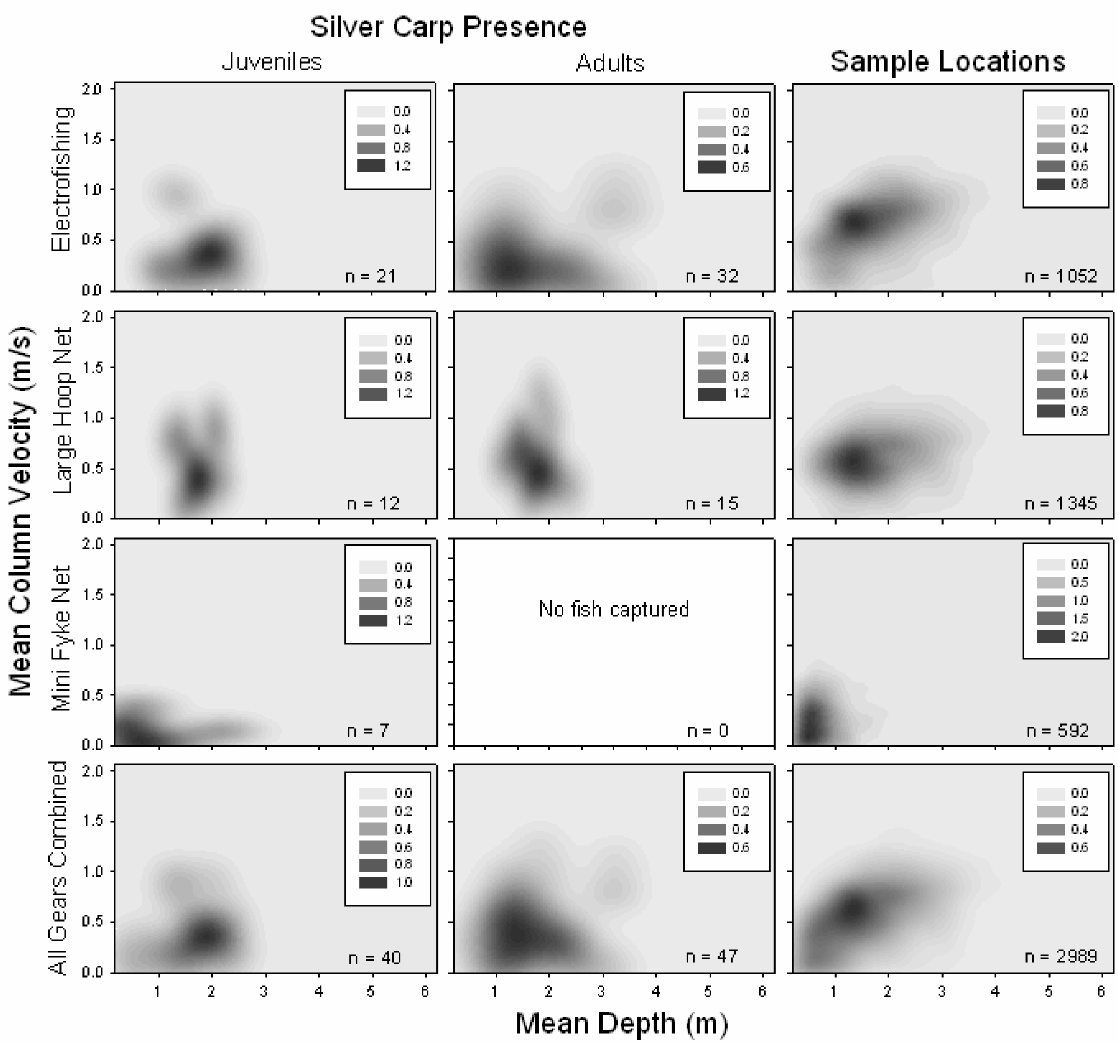


Figure IV.1.3. Kernel density estimates of mean depth (m) and mean column velocity (m/s) locations where juvenile (<600 mm) and adult (≥600 mm) silver carp were present and where electrofishing, large hoop net and mini fyke net samples were taken. Samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008.

Grass Carp

Grass carp presence was fit to a logistic regression model using samples collected while electrofishing. The final model included three categorical variables (year, cobble and if the chute was <5 years old) and five continuous variables (water temperature, water depth, column velocity, chute width and chute sinuosity), that explained 19.5% of variability in grass carp presence and exhibited no lack-of-fit to the data (P = 0.5213; Table IV.1.9).

Odds of grass carp being present during 2008 were 4.8 and 6.6 times lower than 2006 and 2007, respectively (Table IV.1.10). Availability of cobble increased probability of grass carp presence. A positive regression coefficient for depth indicates the probability of presence is greater in deeper water, whereas a negative coefficient for velocity indicates grass carp prefer slower velocity waters. At the chute level, those that were wider and had greater sinuosity were more likely to have grass carp present.

Table IV.1.9. Results of the logistic regression model for grass carp caught while electrofishing. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: 2008 (Year), no cobble (Cobble) and >five years old (Chute Age). The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	-11.6238	4.9546	1	5.5041	0.0190
Year			2	15.7872	0.0004
2006	1.5779	0.5050			
2007	1.8867	0.4789			
Cobble			2	11.0448	0.0040
Incidental	1.4700	0.5604			
Dominant	1.9981	0.9202			
Chute age			1	1.5766	0.2093
<5 years old	0.6564	0.5228			
Temperature	-0.1045	0.0285	1	13.4284	0.0002
Depth	0.4673	0.2545	1	3.3700	0.0664
Column velocity	-2.4461	0.8528	1	8.2280	0.0041
Chute width	0.0069	0.0035	1	3.8152	0.0508
Chute sinuosity	8.5490	4.2037	1	4.1359	0.0420
R-square = 0.1952					
Goodness-of-fit test			8	7.1432	0.5213

Table IV.1.10. Odds ratios for habitat variables that significantly contributed to the grass carp logistic regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
Temperature (°C)	-2	1.2	Colder water
Column velocity (m/s)	-0.2	1.6	Slower velocity water
Chute width (m)	+15	1.1	Wider chutes
Chute sinuosity	+0.05	1.5	More sinuous chutes
Categorical Variables	*NA*		
2006 vs 2008	-	4.8	2006
2007 vs 2008	-	6.6	2007
No Cobble vs Incidental Cobble	-	4.3	Incidental Cobble
No Cobble vs Dominant Cobble	-	7.4	Dominant Cobble

Kernel density estimates of grass carp presence did not indicate a strong habitat selection for either juvenile or adult grass carp (Figure IV.1.4). The logistic model predicted a greater probability of presence in deeper and slower velocity waters. In general, most adults were found at depths >1.0 m but over a wide range of velocities.

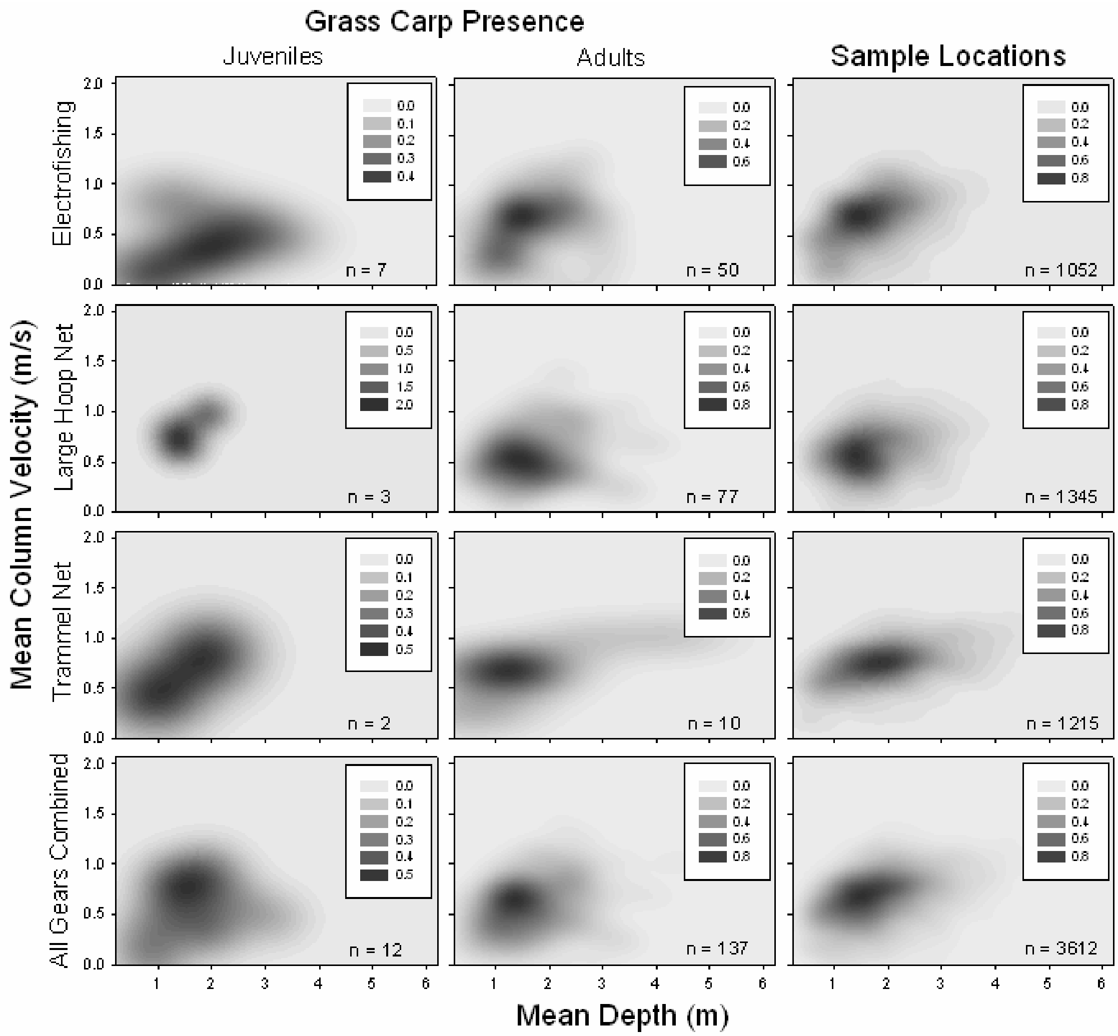


Figure IV.1.4. Kernel density estimates of mean depth (m) and mean column velocity (m/s) locations where juvenile (<600 mm) and adult (≥600 mm) grass carp were present and where electrofishing, large hoop net and trammel net samples were taken. Samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008.

Paddlefish

No logistic regression model could be fit for paddlefish due to low catches using electrofishing, large hoop nets and otter trawls (n = 11, 11 and 1, respectively). However, an interesting pattern was revealed in the KDE plots (Figure IV.1.5) for juvenile paddlefish while electrofishing. The greatest density of electrofished habitats occurred in waters 1.5 m deep and velocities of 0.7 m/s. Whereas, juvenile paddlefish presence had the greatest density in waters 1.6 m deep with water velocities of 0.3-0.4 m/s, which differed from habitats where most eletrofishing samples were taken. Difference in peak density locations indicated that paddlefish may select deep water areas (>1.5m) with moderate water velocities (0.2-0.5 m/s). Biologists observed paddlefish most commonly in pool type holes with moderate velocities as opposed to broad deep open waters, such as in the thalweg. No adult paddlefish (≥1,070 mm) were observed in the study chutes, possibly because the habitat they require was not available.

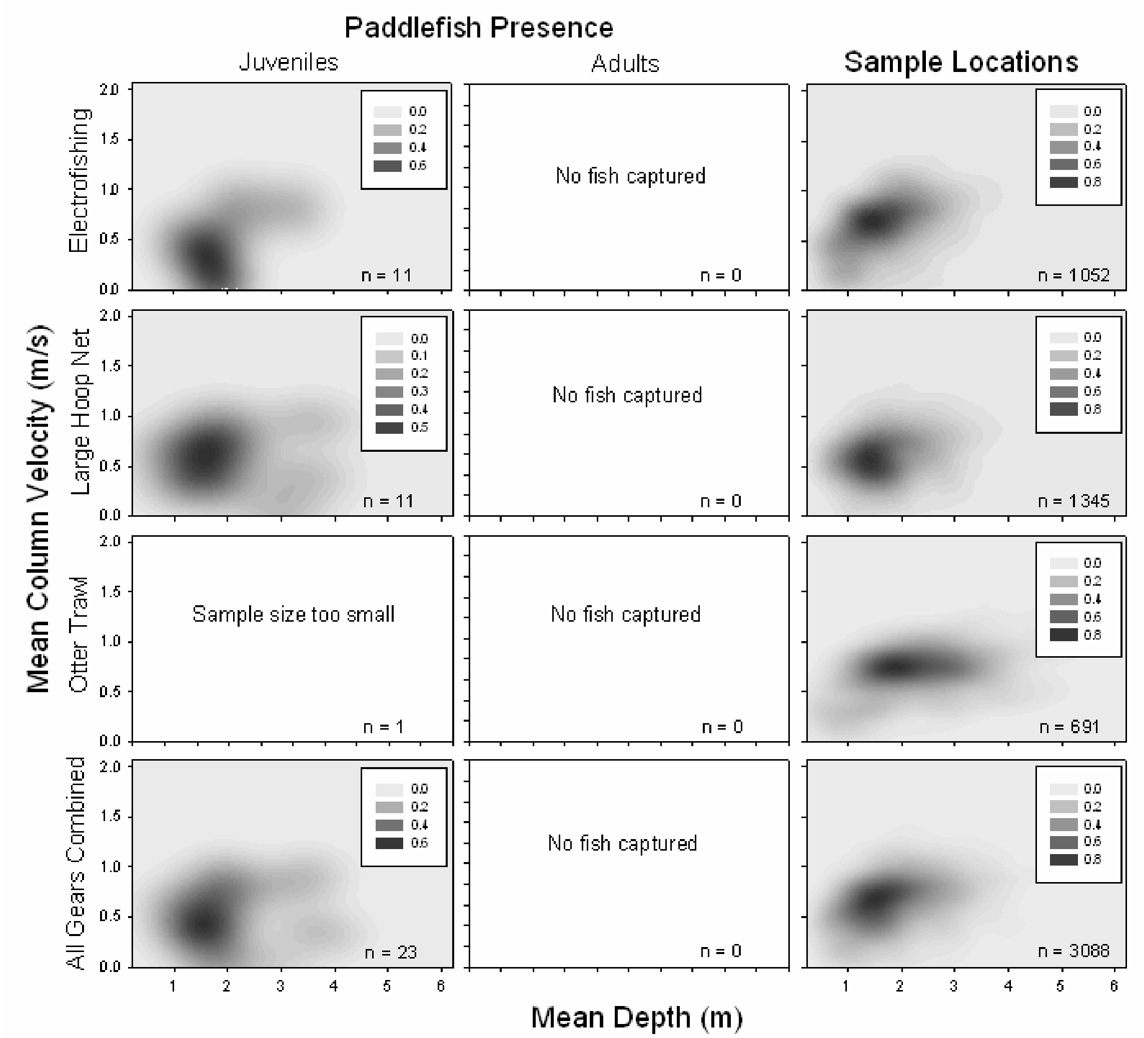


Figure IV.1.5. Kernel density estimates of mean depth (m) and mean column velocity (m/s) locations where juvenile (<1070 mm) paddlefish were present and where electrofishing, large hoop net and otter trawl samples were taken. All samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008, except otter trawls were not used in California (IA), Tobacco Island, Kansas (upper) and Kansas (lower).

Shovelnose Sturgeon

Shovelnose sturgeon presence was fit to a logistic regression model using samples collected with the otter trawl. The final model included three categorical variables (month, year and chute) and two continuous variables (water temperature and water depth), and it explained 24.5% of the variability in shovelnose sturgeon presence and exhibited no lack-of-fit to the data (P = 0.1330; Table IV.1.11).

The model and odds ratios indicate that August was the worst month for shovelnose sturgeon presence in otter trawls and that April, May, September and October were the best (Table IV.1.12). River conditions during 2008 were more productive for shovelnose sturgeon presence than 2006 or 2007. Additionally, four chutes (Upper Hamburg, Lower Hamburg, Deroin and Lisbon chutes) had greater odds of presence than the others, especially Tadpole chute. Tadpole chute was the most recently constructed chute (during 2006) and has not had the time to develop as other constructed or natural chutes. The model indicated that shovelnose sturgeon should occur in deeper waters by the positive regression coefficient of 0.2080.

Water temperature was a significant variable that was estimated to increase probability of occurrence, especially in warmer waters. However, all regression coefficients for month were negative, indicating that variables water temperature and month were likely interacting with each other to balance out estimated probability of presence.

Table IV.1.11. Results of the logistic regression model for shovelnose sturgeon caught otter trawling. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: April (Month), 2008 (Year) and California (NE) (Chute). No otter trawl samples were collected in California (IA), Tobacco Island, Kansas (upper) and Kansas (lower) chutes. The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	-3.0274	0.7997	1	14.3296	0.0002
Month			6	10.8680	0.0925
May	-0.3341	0.4383			
June	-0.7689	0.6300			
July	-0.9070	0.7368			
August	-1.7776	0.7577			
September	-0.3708	0.4622			
October	-0.3063	0.4003			
Year			2	7.9719	0.0186
2006	-0.6366	0.2431			
2007	-0.5129	0.2400			
Chute			7	83.9931	<.0001
Upper Hamburg	1.9052	0.3529			
Lower Hamburg	3.1041	0.8565			
Deroin	1.2434	0.3561			
Lisbon	0.9423	0.3719			
Overton	0.2309	0.4033			
Tadpole	-1.2322	0.5203			
Tate	0.2325	0.4047			
Temperature	0.1058	0.0483	1	4.8074	0.0283
Depth	0.2080	0.1129	1	3.3915	0.0655
R-square = 0.2450					
Goodness-of-fit test			8	12.4305	0.1330

Table IV.1.12. Odds ratios for habitat variables that significantly contributed to the shovelnose sturgeon logistic regression model.

Variable	The odds of presence increase X times	Greater odds in
Categorical Variables		
April vs August	5.9	April
May vs August	4.2	May
June vs August	2.7	June
July vs August	2.4	July
September vs August	4.1	September
October vs August	4.3	October
2006 vs 2008	1.9	2008
2007 vs 2008	1.7	2008
California (NE) vs Deroin	3.5	Deroin
California (NE) vs Lisbon	2.6	Lisbon
California (NE) vs Lower Hamburg	22.2	Lower Hamburg
California (NE) vs Tadpole	3.4	California (NE)
California (NE) vs Upper Hamburg	6.7	Upper Hamburg
Deroin vs Lower Hamburg	6.4	Lower Hamburg
Deroin vs Overton	2.8	Deroin
Deroin vs Tadpole	11.9	Deroin
Deroin vs Tate	2.7	Deroin
Deroin vs Upper Hamburg	1.9	Upper Hamburg
Lisbon vs Lower Hamburg	8.7	Lower Hamburg
Lisbon vs Tadpole	8.8	Lisbon
Lisbon vs Upper Hamburg	2.6	Upper Hamburg
Lower Hamburg vs Overton	17.7	Lower Hamburg
Lower Hamburg vs Tadpole	76.4	Lower Hamburg
Lower Hamburg vs Tate	17.7	Lower Hamburg
Overton vs Tadpole	4.3	Overton
Overton vs Upper Hamburg	5.3	Upper Hamburg
Tadpole vs Tate	4.3	Tate
Tadpole vs Upper Hamburg	23.3	Upper Hamburg
Tate vs Upper Hamburg	5.3	Upper Hamburg

The kernel density estimates did not reveal any strong pattern that would suggest shovelnose sturgeon preferred a specific range of water depths or velocities (Figure IV.1.6). It is important to mention that the three gears (i.e., electrofishing, otter trawl and trammel net) that caught the most shovelnose sturgeon were generally limited to fishing deeper (>1.0 m) waters. Additionally, most shovelnose sturgeon captured were greater than 250 mm and were considered older than 1 year. Therefore, we are limited in

describing habitat needs for young-of-year shovelnose sturgeon. The logistic model predicted a greater probability of presence in deeper water, but again, we feel this prediction is limited by the gear used (i.e., otter trawl) and size of most fish sampled. While water velocity was not a significant variable, most juvenile and adult shovelnose sturgeon were found in velocities of 0.3-0.8 m/s, indicating flowing water was important for their presence.

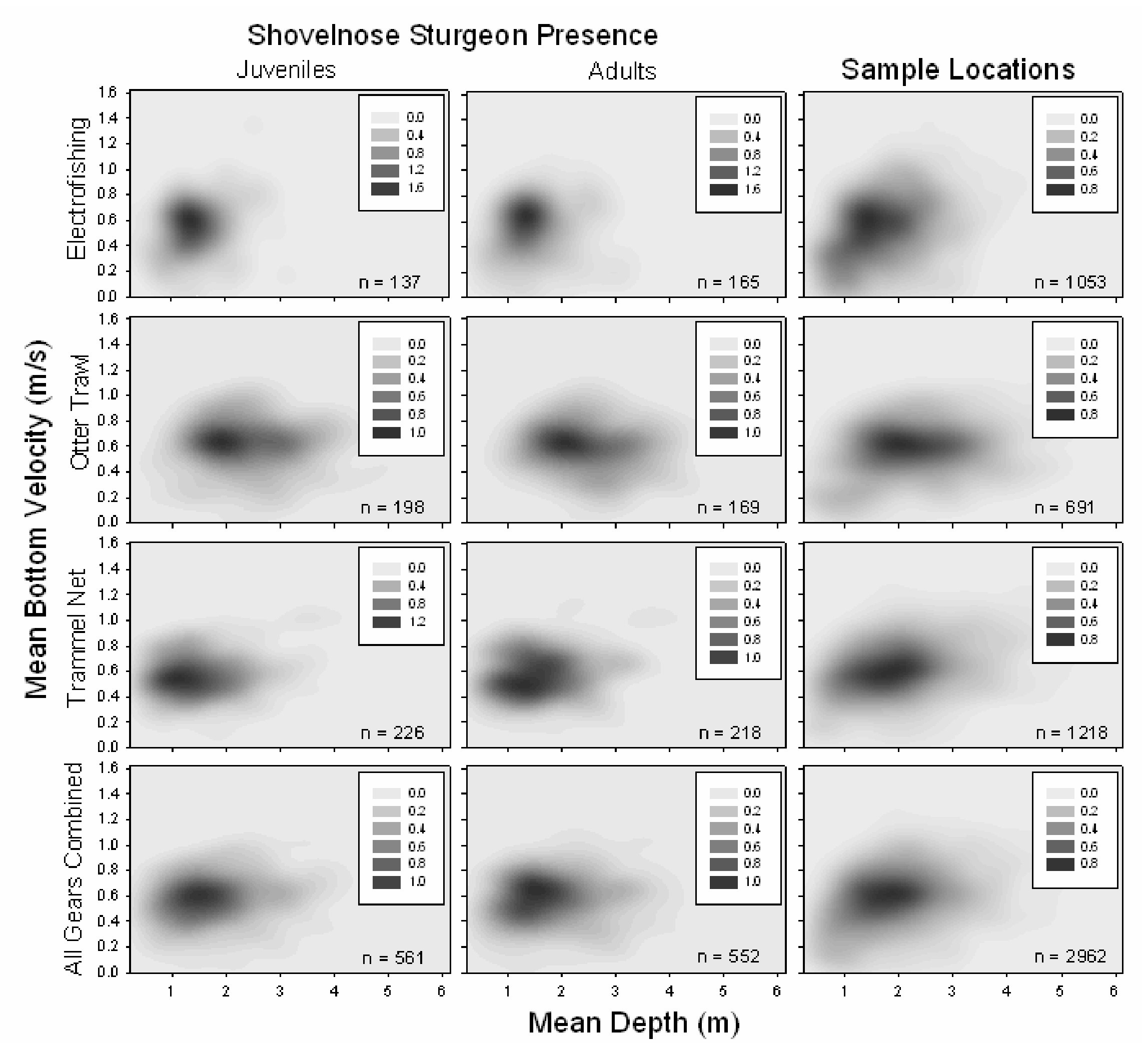


Figure IV.1.6. Kernel density estimates of mean depth (m) and mean bottom velocity (m/s) locations where juvenile (<540 mm) and adult (≥540 mm) shovelnose sturgeon were present and where electrofishing, otter trawl and trammel net samples were taken. All samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008, except otter trawls were not used in California (IA), Tobacco Island, Kansas (upper) and Kansas (lower).

Pallid Sturgeon

No logistic regression models could be developed for pallid sturgeon due to low sample size with electrofishing, otter trawling and trammel netting (n = 4, 3 and 7, repectively). As was described for the shovelnose sturgeon, the suite of gears that caught the most pallid sturgeon were limited to sampling deeper (>1.0) waters. The greatest density of juvenile pallid sturgeon presence ranged from waters 1.0-2.5 m deep with water velocities of 0.5-0.8 m/s (Figure IV.1.7). Few, if any, pallid sturgeon were captured in waters with velocities <0.2 m/s, suggesting flowing water was important. Because only 14 pallid sturgeon were caught, we are limited in describing preferred habitat types.

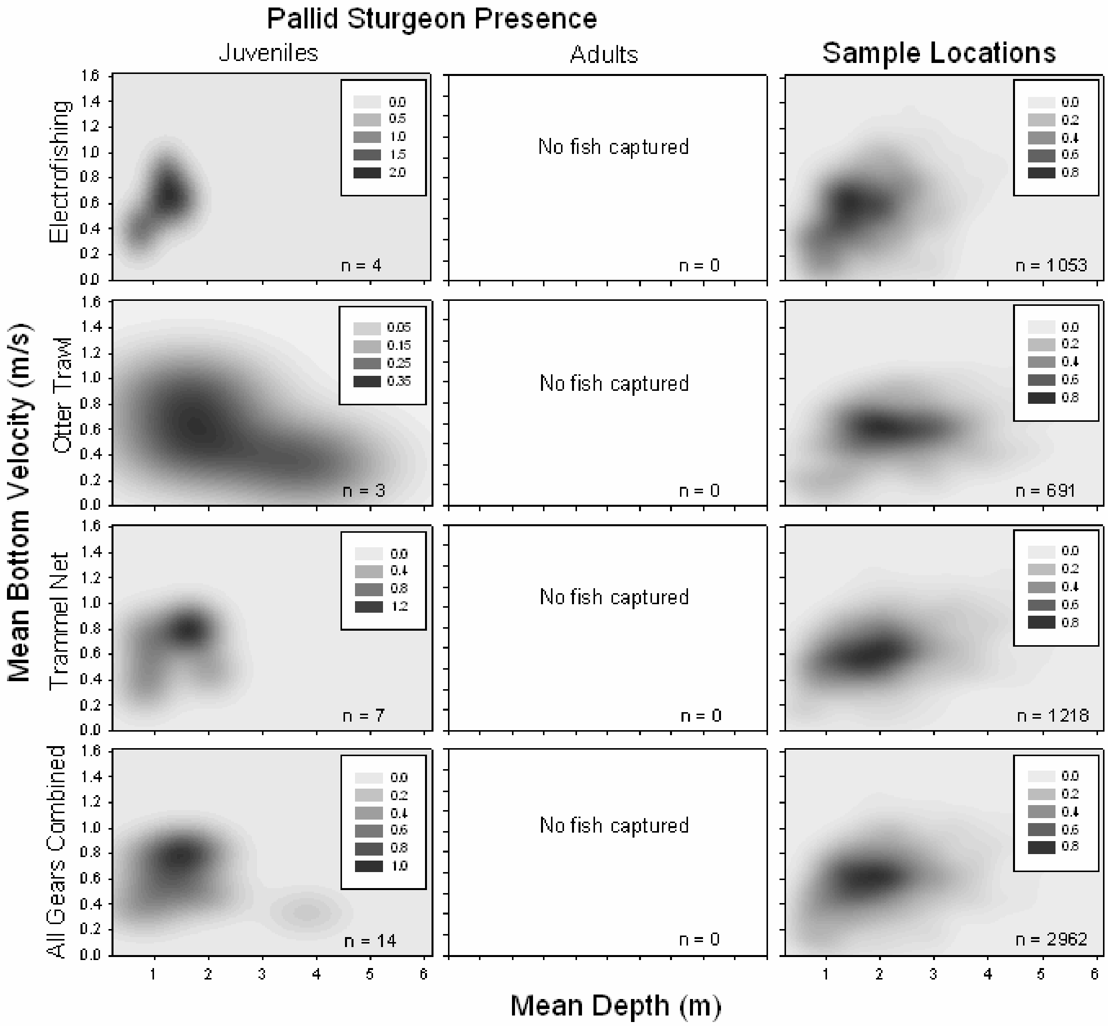


Figure IV.1.7. Kernel density estimates of mean depth (m) and mean bottom velocity (m/s) locations where juvenile (<750 mm) pallid sturgeon were present and where electrofishing, otter trawl and trammel net samples were taken. All samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008, except otter trawls were not used in California (IA), Tobacco Island, Kansas (upper) and Kansas (lower).

Bigmouth Buffalo

Bigmouth buffalo presence was fit to a logistic regression model using samples collected with electrofishing. The final model included two categorical variables (year and chute) and three continuous variables (water temperature, turbidity and water depth); it explained 21.4% of the variability in bigmouth buffalo presence and exhibited no lack-of-fit to the data (P = 0.3282; Table IV.1.13).

Odds of bigmouth buffalo presence were 6.6 and 5.5 times greater during 2007 and 2008 than 2006, respectively (Table IV.1.14). Additionally, three chutes (California (IA), Tobacco Island and Tate chutes) had 4.7-18.4 times greater odds of bigmouth buffalo presence than Lisbon, Overton and Tadpole chutes. The Hamburg and Kansas chutes had zero to very low catches of bigmouth buffalo, and the odds of a presence were expected to be very low when sampling these chutes. The continuous variables water temperature and water depth indicated the greatest odds of bigmouth buffalo presence at colder temperatures and in deeper water.

Table IV.1.13. Results of the logistic regression model for bigmouth buffalo caught while electrofishing. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: 2008 (Year) and California (IA) (Chute). The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	-1.9104	0.8151	1	5.4931	0.0191
Year			2	5.8230	0.0544
2006	-1.6955	0.7805			
2007	0.1902	0.3758			
Chute			11	15.1136	0.1774
California (NE)	-1.0306	0.5838			
Tobacco Island	-0.3626	0.5059			
Upper Hamburg	-14.3837	505.2			
Lower Hamburg	-14.4040	511.3			
Kansas (upper)	-15.4042	622.6			
Kansas (lower)	-15.5425	939.6			
Deroin	-1.6843	0.8906			
Lisbon	-1.7703	0.7502			
Overton	-2.9129	1.1095			
Tadpole	-1.9163	0.7653			
Tate	-0.6744	0.6001			
Temperature	-0.0643	0.0271	1	5.6452	0.0175
Turbidity	0.0009	0.0007	1	1.7749	0.1828
Depth	0.8689	0.2747	1	10.0040	0.0016
R-square = 0.2143					
Goodness-of-fit test			8	9.1697	0.3282

Table IV.1.14. Odds ratios for habitat variables that significantly contributed to the bigmouth buffalo logistic regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
Temperature (°C)	-2	1.1	Colder water
Depth (m)	+0.25	1.2	Deeper water
Categorical Variables	*NA*		
2006 vs 2007	-	6.6	2007
2006 vs 2008	-	5.5	2008
California (IA) vs Lisbon	-	5.9	California (IA)
California (IA) vs Overton	-	18.4	California (IA)
California (IA) vs Tadpole	-	6.8	California (IA)
Overton vs Tate	-	9.3	Tate
Overton vs Tobacco Island	-	12.8	Tobacco Island
Tadpole vs Tobacco Island	-	4.7	Tobacco Island

Kernel density estimates indicate that bigmouth buffalo were generally present in similar proportions to habitats sampled by electrofishing, mini fyke nets and push trawls (Figure IV.1.8). However, it was obvious that juveniles were more likely in shallow (<1.0 m), slow velocity (<0.5 m/s) habitats, whereas adults were present in deeper (>1.0 m), faster velocity (0.3-0.8 m/s) waters when all gears were pooled together.

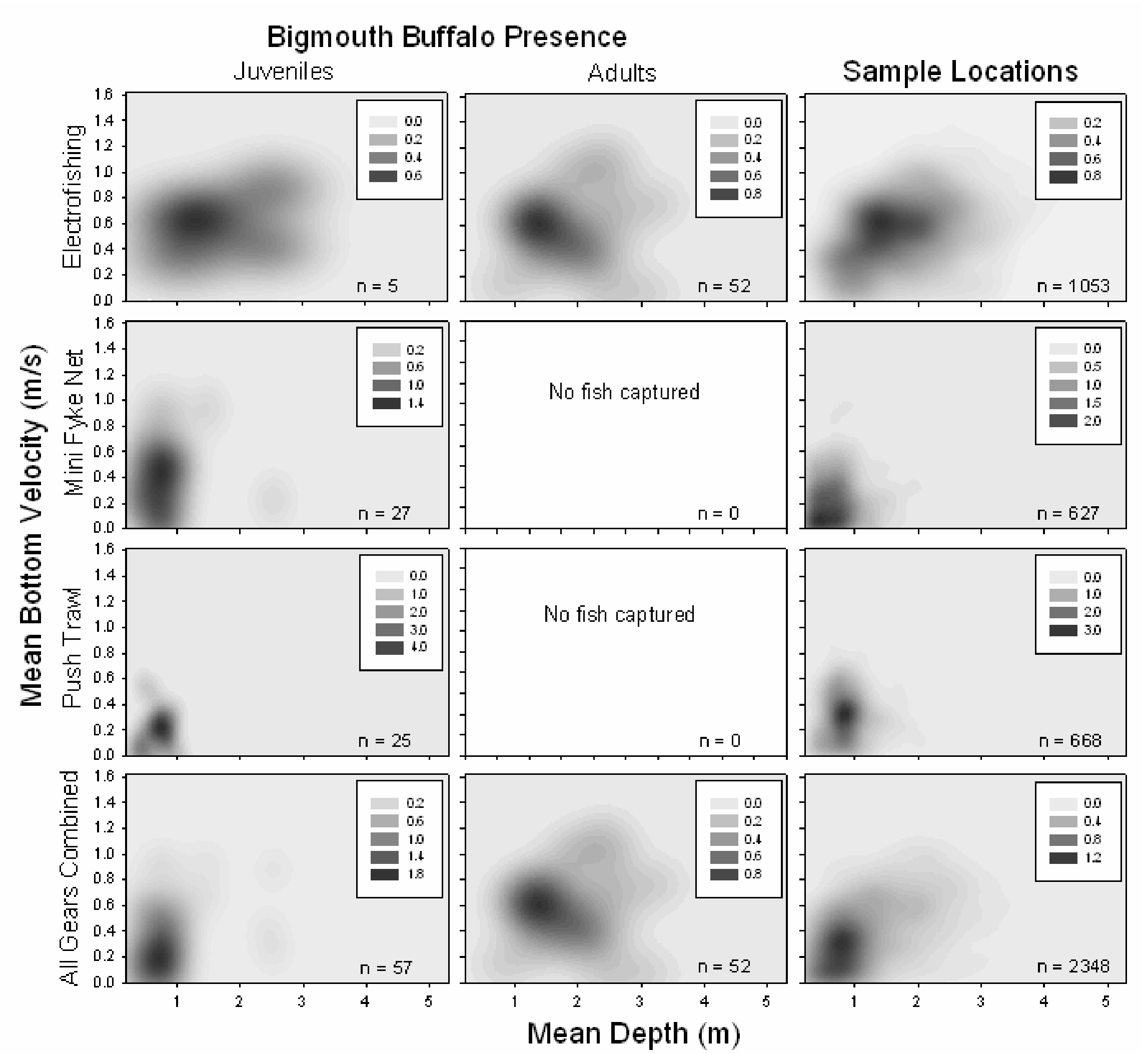


Figure IV.1.8. Kernel density estimates of mean depth (m) and mean bottom velocity (m/s) locations where juvenile (<381 mm) and adult (≥381 mm) bigmouth buffalo were present and where electrofishing, mini fyke net and push trawl samples were taken. Samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008.

Smallmouth Buffalo

The logistic regression model of smallmouth buffalo presence was fit using samples collected while electrofishing. The final model consisted of two categorical (month and chute) and two continuous variables (water depth and bottom velocity), explained 22.2% of the variability in smallmouth buffalo presence and exhibited no lack-of-fit to the data (P = 0.7917; Table IV.1.15).

The months of September and October had more than 7 times greater odds of smallmouth buffalo presence than April and also had the largest regression coefficients (Table IV.1.16). Chute was an influential variable (P = 0.0701), where Tobacco Island and Tate chutes had greater odds over all chutes. The Kansas (lower), Deroin and Tadpole chutes had relatively strong negative regression coefficients indicating very low odds of smallmouth buffalo presence in these chutes. The odds of smallmouth buffalo presence were expected to increase 1.1 times for every 0.25 m increase in depth. The model also estimated that strong water velocities would decrease probability of smallmouth buffalo presence.

Table IV.1.15. Results of the logistic regression model for smallmouth buffalo caught while electrofishing. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: April (Month) and California (IA) (Chute). The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	-5.8087	1.3998	1	17.2208	<.0001
Month			6	7.9891	0.2389
May	1.7196	0.8122			
June	1.8590	0.8551			
July	1.5758	0.8151			
August	1.5566	0.8013			
September	2.0728	0.7933			
October	2.0042	0.8578			
Chute			11	18.5262	0.0701
California (NE)	1.9245	1.0775			
Tobacco Island	2.3823	1.0744			
Upper Hamburg	0.9255	1.4549			
Lower Hamburg	0.9130	1.4556			
Kansas (upper)	1.3428	1.5103			
Kansas (lower)	-11.3534	779.8			
Deroin	-11.2335	410.7			
Lisbon	1.7273	1.1171			
Overton	1.3080	1.1401			
Tadpole	-11.3337	233.1			
Tate	2.8971	1.0862			
Depth	0.5173	0.2376	1	4.7413	0.0294
Bottom velocity	-1.6135	0.8261	1	3.8149	0.0508
R-square = 0.2217					
Goodness-of-fit test			7	3.8939	0.7919

Table IV.1.16. Odds ratios for habitat variables that significantly contributed to the smallmouth buffalo logistic regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
Depth (m)	+0.25	1.1	Deeper water
Categorical Variables	*NA*		
April vs May	-	5.6	May
April vs June	-	6.4	June
April vs September	-	7.9	September
April vs October	-	7.4	October
California (IA) vs Tate	-	18.2	Tate
California (IA) vs Tobacco Island	-	10.9	Tobacco Island
Lisbon vs Tate	-	3.2	Tate
Overton vs Tate	-	4.9	Tate

The KDE plots revealed that density of smallmouth buffalo presence was proportionally greater in slow velocity (<0.6 m/s) habitats than where electrofishing occurred (Figure IV.1.9), which was expected from the logistic regression model. The large hoop net and mini fyke net exhibited a similar proportion between fish presence and the sampled habitat. When all gears were combined, juveniles were more likely to be found at water depths <1.0 m with velocities <0.6 m/s, whereas adults were expected at depths >1.0 m with water velocities up to 0.8 m/s. Adults accounted for >70% of all smallmouth buffalo captures and were present in waters up to 3.0 m deep, complimenting the logistic regression model that predicted greater probability of presence in deep waters.

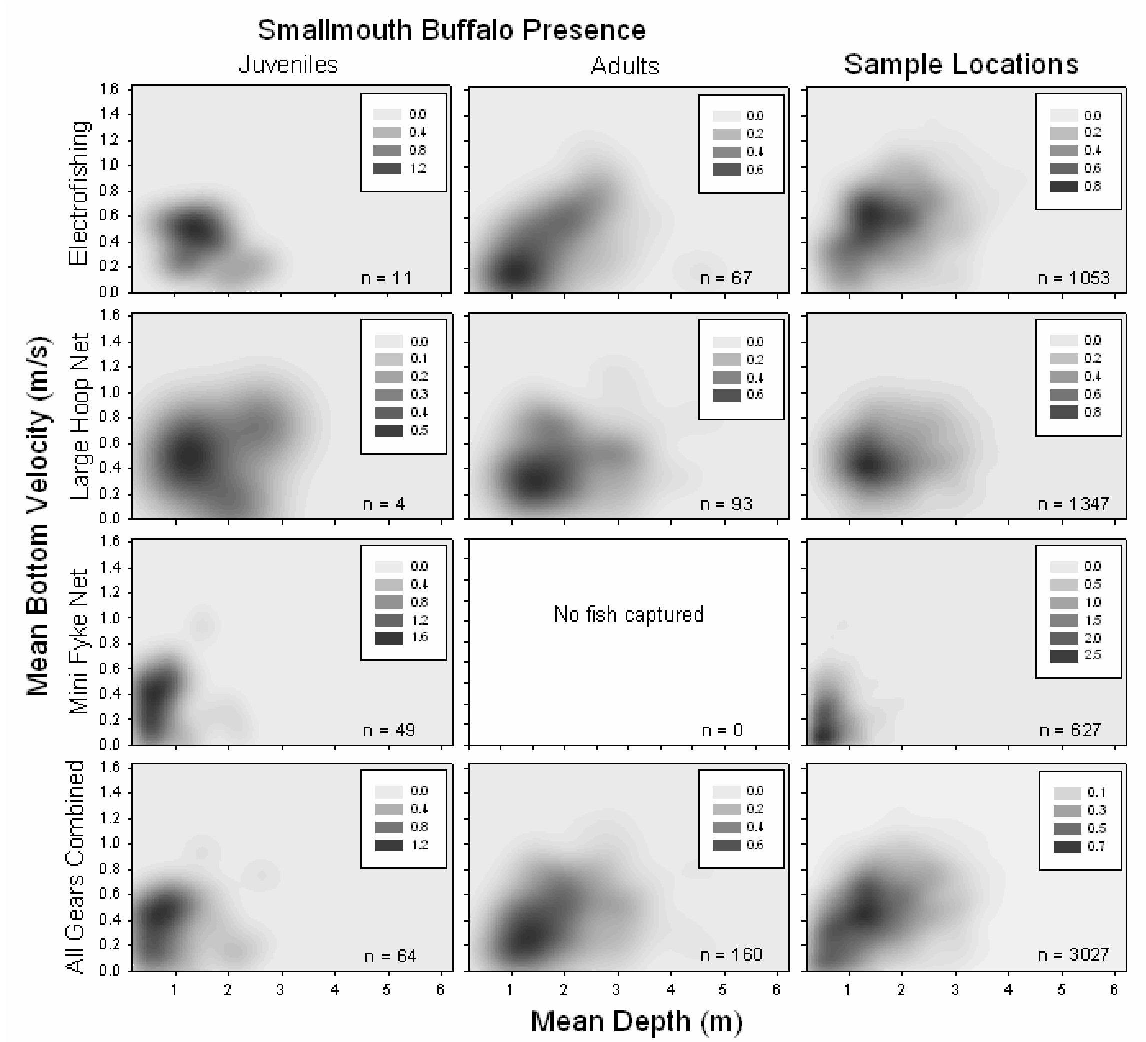


Figure IV.1.9. Kernel density estimates of mean depth (m) and mean bottom velocity (m/s) locations where juvenile (<381 mm) and adult (≥381 mm) smallmouth buffalo were present and where electrofishing, large hoop net and mini fyke net samples were taken. Samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008.

River Carpsucker

River carpsucker presence was fit to a logistic regression model using samples collected while electrofishing. The fitted model contained three categorical variables (year, chute and cobble) and four continuous variables (water temperature, turbidity, water depth and bottom velocity), that explained 40.1% of variability in river carpsucker presence and exhibited no lack-of-fit to the data (P = 0.5521; Table IV.1.17).

River conditions during 2006 allowed for 1.7 and 2.4 times greater odds of catching river carpsucker than 2007 and 2008, respectively (Table IV.1.18). The most productive chutes were Tate, Lisbon and Tobacco Island chutes. Kansas (lower) chute may also be considered productive but exhibited greater variability in river carpsucker presence. However, Kansas (upper) and Deroin chutes were strongly negatively associated with river carpsucker. Presence of cobble increased probability of river carpsucker presence, but the odds did not significantly differ among cobble categories.

The four continuous variables all exhibited negative regression coefficients. This indicates that river carpsucker presence has greater odds in relatively colder, clearer, shallow and slower velocity waters.

Table IV.1.17. Results of the logistic regression model for river carpsucker caught while electrofishing. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: 2008 (Year), California (IA) (Chute) and no cobble (Cobble). The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	1.9984	0.6147	1	10.5673	0.0012
Year			2	10.8775	0.0043
2006	0.8745	0.2659			
2007	0.3602	0.2383			
Chute			11	52.7847	<.0001
California (NE)	0.1863	0.3661			
Tobacco Island	0.3974	0.3695			
Upper Hamburg	-1.0518	0.7016			
Lower Hamburg	-1.1115	0.7076			
Kansas (upper)	-14.2722	522			
Kansas (lower)	0.5321	0.9347			
Deroin	-13.9177	377.9			
Lisbon	1.5441	0.4416			
Overton	-0.3859	0.4208			
Tadpole	-0.4211	0.4102			
Tate	1.7840	0.4762			
Cobble			2	8.4733	0.0145
Incidental	1.2667	0.4793			
Dominant	1.4470	1.1221			
Temperature	-0.0384	0.0164	1	5.4730	0.0193
Turbidity	-0.0025	0.0005	1	23.6783	<.0001
Depth	-0.4799	0.1720	1	7.7840	0.0053
Bottom velocity	-1.3993	0.5334	1	6.8809	0.0087
R-square = 0.4013					
Goodness-of-fit test			8	6.8569	0.5521

Table IV.1.18. Odds ratios for habitat variables that significantly contributed to the river carpsucker logistic regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
Temperature (°C)	-2	1.1	Colder water
Turbidity (NTU)	-100	1.3	Clearer water
Depth (m)	-0.25	1.1	Shallower water
Bottom velocity (m/s)	-0.2	1.3	Slower velocity water
Categorical Variables	*NA*		
2006 vs 2007	-	1.7	2006
2006 vs 2008	-	2.4	2006
California (IA) vs Lisbon	-	4.7	Lisbon
California (IA) vs Tate	-	6.0	Tate
California (NE) vs Lisbon	-	3.9	Lisbon
California (NE) vs Tate	-	5.0	Tate
Lisbon vs Lower Hamburg	-	14.2	Lisbon
Lisbon vs Overton	-	6.9	Lisbon
Lisbon vs Tadpole	-	7.1	Lisbon
Lisbon vs Tobacco Island	-	3.1	Lisbon
Lisbon vs Upper Hamburg	-	13.4	Lisbon
Lower Hamburg vs Tate	-	18.2	Tate
Lower Hamburg vs Tobacco Island	-	4.5	Tobacco Island
Overton vs Tate	-	8.8	Tate
Overton vs Tobacco Island	-	2.2	Tobacco Island
Tadpole vs Tate	-	9.1	Tate
Tadpole vs Tobacco Island	-	2.3	Tobacco Island
Tate vs Tobacco Island	-	4.0	Tate
Tate vs Upper Hamburg	-	17.0	Tate
Tobacco Island vs Upper Hamburg	-	4.3	Tobacco Island

Kernel density estimate plots for electrofishing helped validate the logistic regression model, where river carpsuckers were more likely to be found in shallower and slower velocity habitats (Figure IV.1.10). Juvenile presence for mini fyke nets and push trawls were generally proportional to habitats sampled. When all gears were combined, juveniles were most commonly found in <1.0 m deep water with water velocities <0.5 m/s. Adults were found in deeper water with velocities up to ~0.8 m/s. This combination

of habitats for juveniles and adults was similar to the buffalo species previously described.

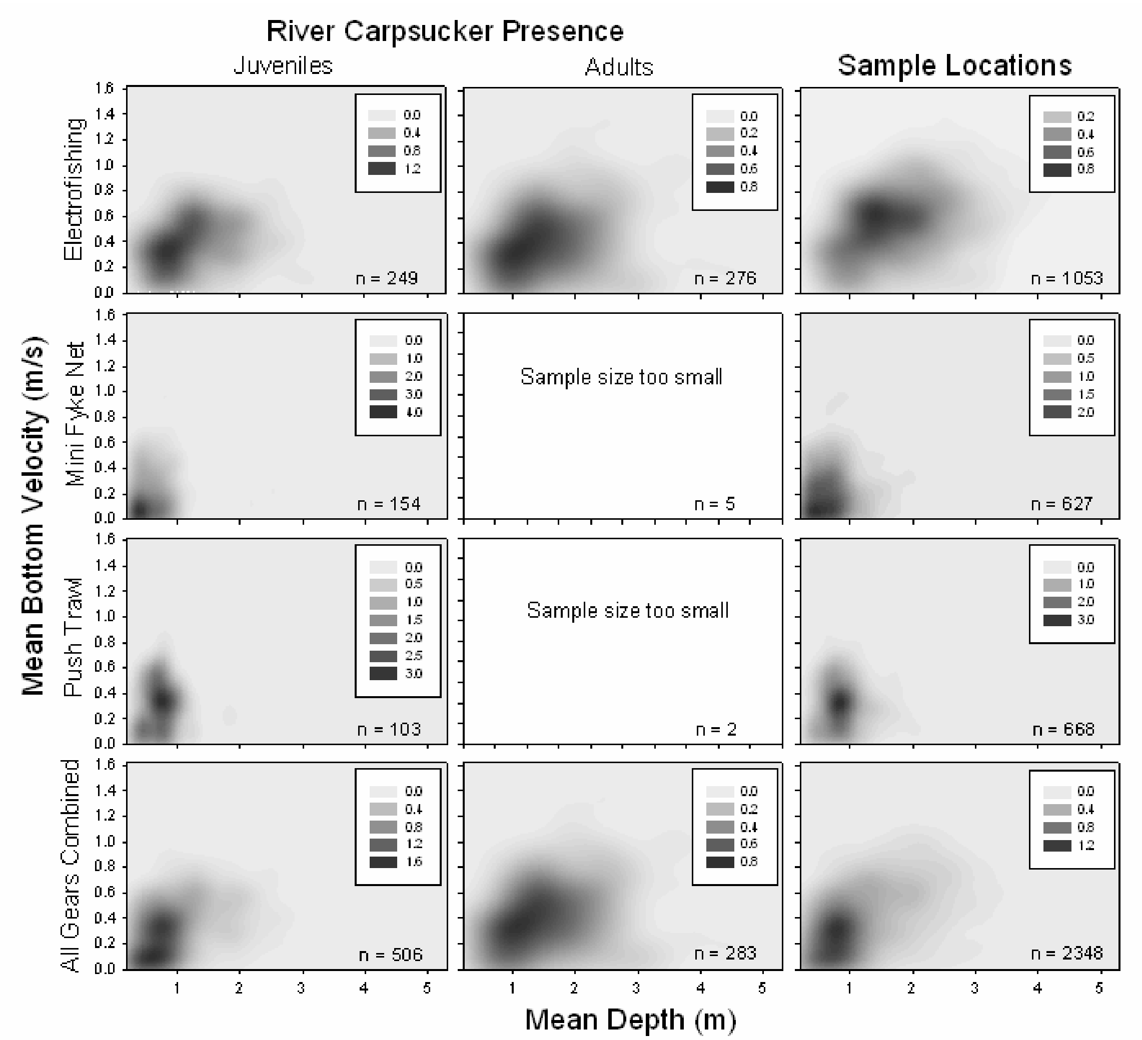


Figure IV.1.10. Kernel density estimates of mean depth (m) and mean bottom velocity (m/s) locations where juvenile (<305 mm) and adult (≥305 mm) river carpsucker were present and where electrofishing, mini fyke net and push trawl samples were taken. Samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008.

Bullhead Minnow

A logistic regression model was fit to bullhead minnow presence in mini fyke nets but the model exhibited extreme lack-of-fit to the data. Therefore, the model was not reported because it did not represent the data. The lack-of-fit in the model was likely due to low catches (n = 94) and presence in only four chutes. Kernel density estimate plots for mini fyke nets and push trawls did not reveal any habitat selection preferences for bullhead minnow, but they were generally only deployed in shallow slow velocity habitats (Figure IV.1.11). However, KDE plots for electrofishing revealed a strong habitat selection for shallow water (<1.5 m) with low velocities (<0.6 m/s). When comparing all three gears together, it was clear that bullhead minnow were most likely to be found in shallow, slow velocity habitats. There were no distinguishable differences between juveniles and adults.

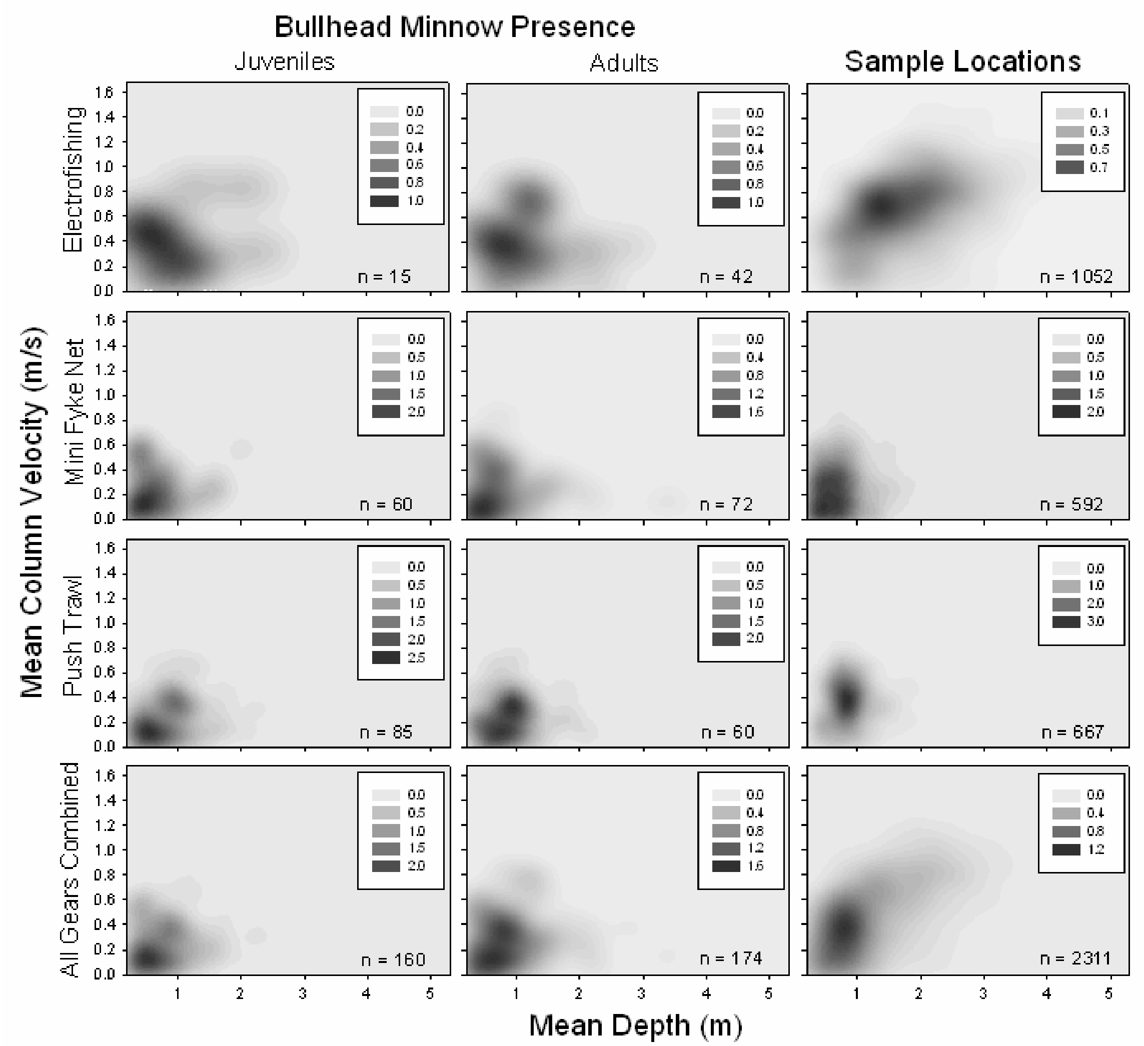


Figure IV.1.11. Kernel density estimates of mean depth (m) and mean column velocity (m/s) locations where juvenile (<38 mm) and adult (≥38 mm) bullhead minnow were present and where electrofishing, mini fyke net and push trawl samples were taken. Samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008.

Hybognathus sp.

No model could be developed for *Hybognathus* sp. (including western silvery and plains minnow) due to low catches (n = 6, 16 and 11) for electrofishing, mini fyke nets and push trawls, respectively. Due to low catches, it was difficult to fully understand habitat conditions necessary for *Hybognathus* species. *Hybognathus* species were found in water depths up to 3.0 m, but rarely in water velocities >0.6 m/s (Figure IV.1.12).

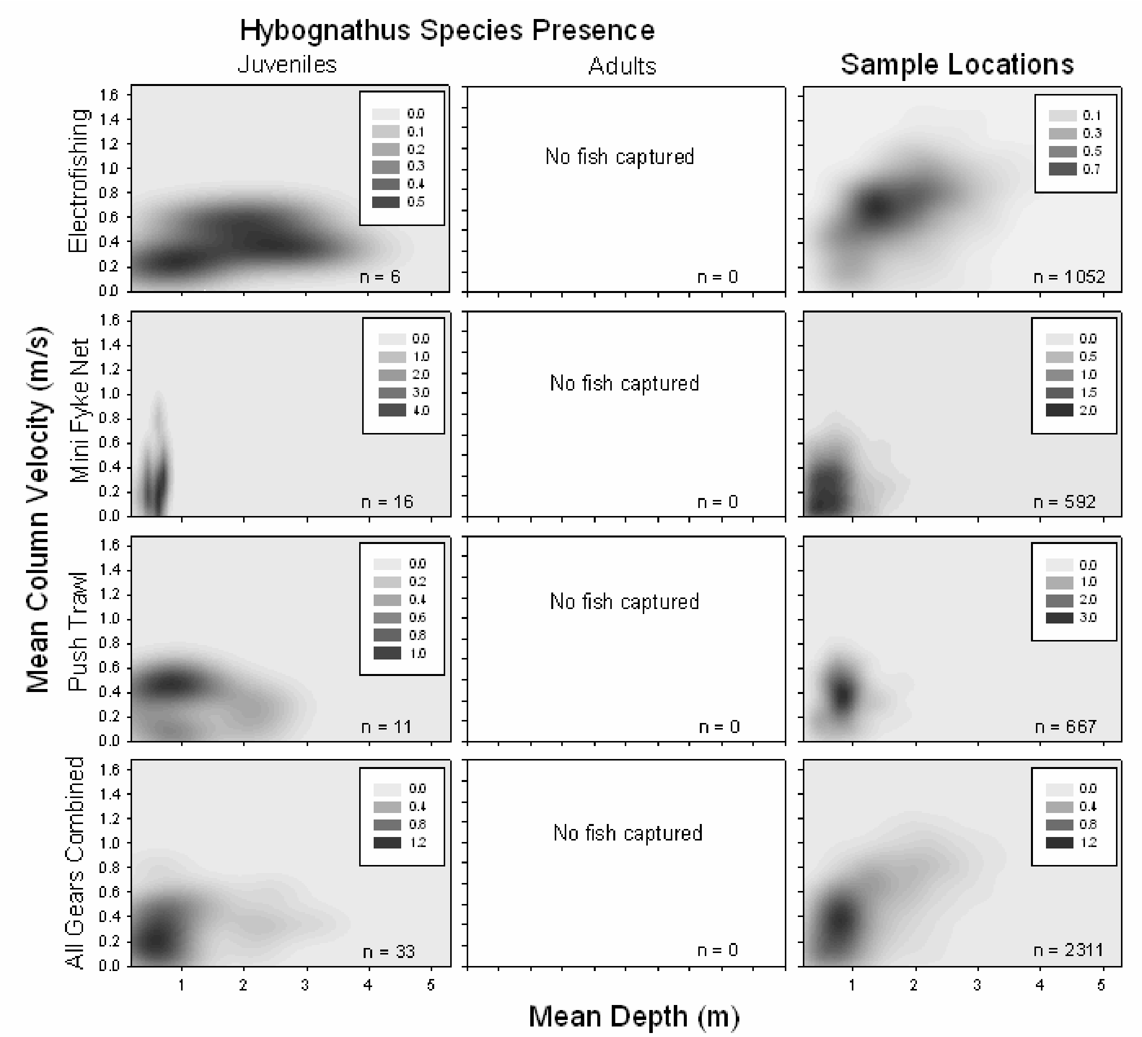


Figure IV.1.12. Kernel density estimates of mean depth (m) and mean column velocity (m/s) locations where juvenile (<74 mm) *Hybognathus* sp. were present and where electrofishing, mini fyke net and push trawl samples were taken. Samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008.

Speckled Chub

A logistic regression model was fit to speckled chub presence using samples collected with otter trawls. A second model was fit with push trawls, but it did not fit the data as well as the otter trawl model and therefore, was not reported (P = 0.3671). The otter trawl model consisted of three categorical variables (month, year and tie channels present) and five continuous variables (water temperature, turbidity, water depth, mean substrate size and chute length), explained 19.0% of the variability in speckled chub presence and showed no lack-of-fit to the data (P = 0.9864; Table IV.1.19).

May and June had the greatest odds of presence, while July and August had the lowest probability of presence (Table IV.1.20). Speckled chub had 1.8 and 3.1 times greater odds of being present during 2006 than 2007 or 2008, respectively. Chutes without tie channels had 1.8 times greater odds of containing speckled chubs than chutes with tie channels. Although chute was not a significant variable, chutes are categorized based on the presence or absence of tie channels. We can therefore interpret the odds ratio for tie channels as Tate, Upper Hamburg and California (NE) chutes were less likely to have speckled chubs.

The logistic model estimated that probability of presence was greater during colder water periods, which was indicated with a negative regression coefficient for temperature. This corresponded to the positive regression coefficients for months with colder water temperatures. Speckled chubs were more likely to be present towards the shallow range of depths fished by the otter trawl and with smaller substrate sizes. Speckled chub presence was also estimated to be greater in more turbid waters and in longer chutes.

Table IV.1.19. Results of the logistic regression model for speckled chub caught otter trawling. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: April (Month), 2008 (Year) and tie channels absent (Tie Channels). No otter trawl samples were collected in California (IA), Tobacco Island, Kansas (upper) and Kansas (lower) chutes. The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	0.0515	1.1226	1	0.0021	0.9634
Month			6	12.5501	0.0508
May	0.6911	0.4818			
June	0.5250	0.6894			
July	-1.2483	0.9153			
August	-0.3561	0.8462			
September	0.0856	0.5241			
October	0.1976	0.4403			
Year			2	12.9479	0.0015
2006	1.1155	0.3147			
2007	0.5219	0.3407			
Tie channels			1	5.7650	0.0163
Tie channels present	-0.5939	0.2474			
Temperature	-0.0695	0.0548	1	1.6111	0.2043
Turbidity	0.0011	0.0005	1	5.7208	0.0168
Depth	-0.5709	0.1435	1	15.8185	<.0001
Mean substrate size	-0.1968	0.1021	1	3.7173	0.0539
Chute length	0.0002	0.0002	1	2.5707	0.1089
R-square = 0.1900					
Goodness-of-fit test			8	1.8047	0.9864

Table IV.1.20. Odds ratios for habitat variables that significantly contributed to the speckled chub logistic regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
Turbidity (NTU)	+100	1.1	Turbid water
Depth (m)	-0.25	1.2	Shallower water
Categorical Variables	*NA*		
May vs July	-	7.0	May
June vs July	-	5.9	June
2006 vs 2007	-	1.8	2006
2006 vs 2008	-	3.1	2006
Tie Channels Absent vs Tie Channels Present	-	1.8	Tie Channels Absent

Kernel density estimates of speckled chub presence were generally proportional to habitats sampled with mini fyke nets and push trawls (Figure IV.1.13). However, juvenile speckled chubs caught in otter trawls were more likely to be caught in shallower and slower velocity waters than was sampled. Adults were caught in similar velocities but had a slightly lower density in waters deeper that 2.5 m than was sampled with otter trawls. When all gears were combined, juveniles were found in shallow flowing waters, but adults were able to utilize a wider range of habitats. With over half of the speckled chubs caught being juveniles in shallow water, KDE plots helped validate the logistic regression model that predicted greater probability of presence in shallow waters.

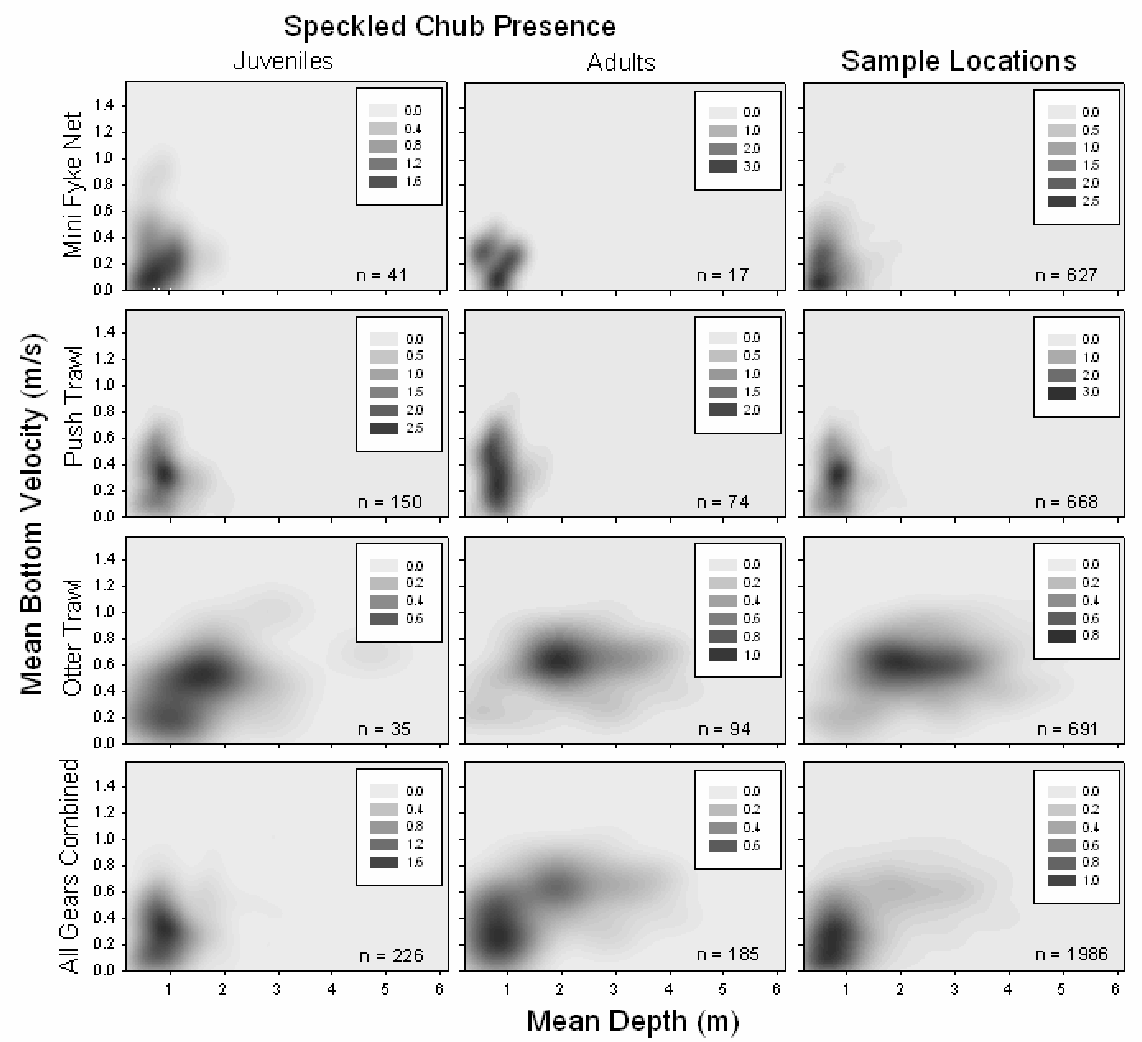


Figure IV.1.13. Kernel density estimates of mean depth (m) and mean bottom velocity (m/s) locations where juvenile (<40 mm) and adult (≥40 mm) speckled chub were present and where mini fyke net, push trawl and otter trawl samples were taken. All samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008, except otter trawls were not used in California (IA), Tobacco Island, Kansas (upper) and Kansas (lower).

Sturgeon Chub

A logistic model was fit to sturgeon chub presence using samples collected with otter trawls. A second model was fit with push trawls but it did not fit the data as well as the otter trawl model and therefore, was not reported (P = 0.4952). The otter trawl model consisted of one categorical variable (year) and four continuous variables (turbidity, bottom velocity, chute length and chute sinuosity), explained 32.9% of variability in sturgeon chub presence and showed no lack-of-fit to the data (P = 0.7999; Table IV.1.21).

Year was the only categorical variable that significantly contributed to the model, where 2006 had 12.2 and 3.7 times greater odds of sturgeon chub presence than 2007 or 2008, respectively (Table IV.1.22). The continuous variables turbidity, bottom velocity and chute length all had positive regression coefficients indicating sturgeon chub presence was more probable in turbid waters, faster velocity waters and in longer chutes. Chute sinuosity negatively influenced presence where less sinuous chutes had greater probability of sturgeon chub presence.

Table IV.1.21. Results of the logistic regression model for sturgeon chub caught otter trawling. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The level of the categorical variable used as reference variables was 2008 for Year. No otter trawl samples were collected in California (IA), Tobacco Island, Kansas (upper) and Kansas (lower) chutes. The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	-5.8490	3.7904	1	2.3813	0.1228
Year			2	14.5638	0.0007
2006	1.3075	0.4638			
2007	-1.1959	0.7985			
Turbidity	0.0014	0.0007	1	3.6308	0.0567
Bottom velocity	1.6562	1.0314	1	2.5785	0.1083
Chute length	0.0020	0.0005	1	15.6414	<.0001
Chute sinuosity	-6.4390	4.3202	1	2.2214	0.1361
R-square = 0.3287					
Goodness-of-fit test			8	4.5948	0.7999

Table IV.1.22. Odds ratios for habitat variables that significantly contributed to the sturgeon chub logistic regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
Chute length (m)	+500	2.7	Longer chutes
Categorical Variables	*NA*		
2006 vs 2007	-	12.2	2006
2006 vs 2008	-	3.7	2006

KDE plots for sturgeon chub revealed a strong habitat selection preference for water velocities of 0.5-0.8 m/s (Figure IV.1.14). The logistic model complements the KDE plots because the strong positive regression coefficient for bottom velocity indicated that sturgeon chub were more likely to be present at higher bottom velocity than slow velocity habitats. It appears as if adult sturgeon chub were able to utilize a variety of water depths, but juveniles were found mainly at depths <1.5 m.

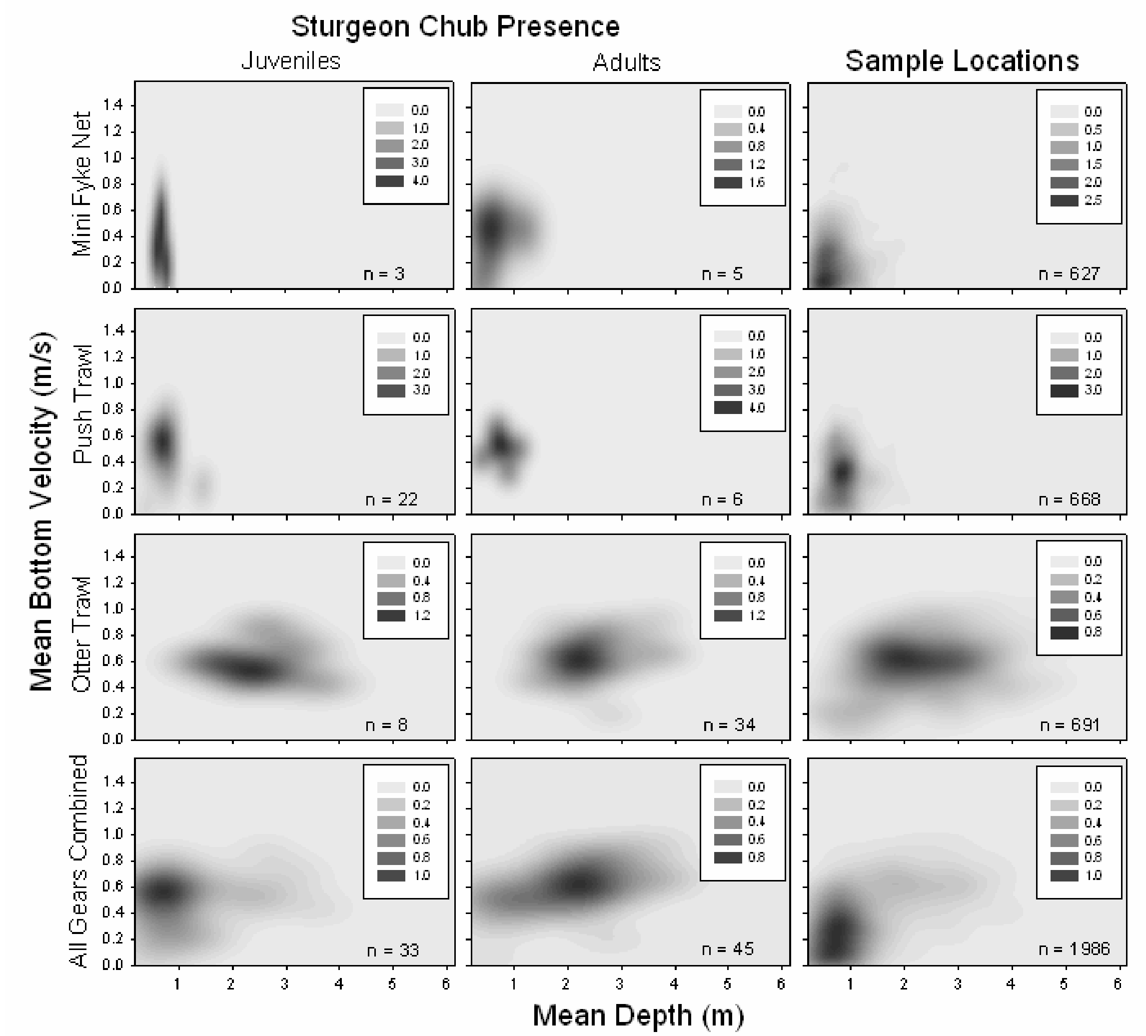


Figure IV.1.14. Kernel density estimates of mean depth (m) and mean bottom velocity (m/s) locations where juvenile (<40 mm) and adult (≥40 mm) sturgeon chub were present and where mini fyke net, push trawl and otter trawl samples were taken. All samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008, except otter trawls were not used in California (IA), Tobacco Island, Kansas (upper) and Kansas (lower).

Sicklefin Chub

Sicklefin chub presence was fit to a logistic regression model using samples taken with the otter trawl. A second model was fit with push trawls but did not fit the data as well as the otter trawl model and therefore, was not reported (P = 0.5678). The final otter trawl model included two categorical variables (year and presence of tie channels) and three continuous variables (water temperature, water depth and chute sinuosity), explained 53.8% of the variability in sicklefin chub presence and exhibited no lack-of-fit to the data (P = 0.8074; Table IV.1.23).

Like other chub species, 2006 had higher odds than other years for sicklefin chub presence (Table IV.1.24). Chutes without tie channels also had 8.6 times greater odds of sicklefin chub presence than chutes with tie channels (Tate, Upper Hamburg and California (NE) chutes).

Sicklefin chub presence exhibited negative relationships with water temperature, water depth and chute sinuosity, where they were more likely to be present during periods of colder water, shallower water and in straight chutes.

Table IV.1.23. Results of the logistic regression model for sicklefin chub caught otter trawling. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: 2008 (Year) and tie channels present (Tie Channels). No otter trawl samples were collected in California (IA), Tobacco Island, Kansas (upper) and Kansas (lower) chutes. The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	54.6683	17.3760	1	9.8985	0.0017
Year			2	7.0524	0.0294
2006	2.5727	0.9692			
2007	-11.3596	158.5			
Tie channels			1	6.3626	0.0117
Tie channels present	-2.1493	0.8521			
Temperature	-0.2069	0.0954	1	4.7025	0.0301
Depth	-1.2612	0.4127	1	9.3395	0.0022
Chute sinuosity	-48.8666	15.1988	1	10.3372	0.0013
R-square = 0.5378					
Goodness-of-fit test			5	2.2921	0.8074

Table IV.1.24. Odds ratios for habitat variables that significantly contributed to the sicklefin chub logistic regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
Temperature (°C)	-2	1.5	Colder water
Depth (m)	-0.25	1.4	Shallower water
Chute sinuosity	-0.05	11.5	Straighter chutes
Categorical Variables	*NA*		
2006 vs 2008	-	13.1	2006
Tie Channels Absent vs Tie Channels Present	-	8.6	Tie Channels Absent

Juvenile sicklefin chubs generally exhibited a preference for shallow water (<1.0 m) habitats (Figure IV.1.15). Adults also tended to be more common in shallow habitats, except they were also able to occupy a wider range of water depths. The logistic model supports the conclusion that sicklefin chub presence is more likely in shallow waters. Low water velocity (<0.4 m/s) habitats had the greatest density of presence for juveniles and adults were most common in shallower waters.

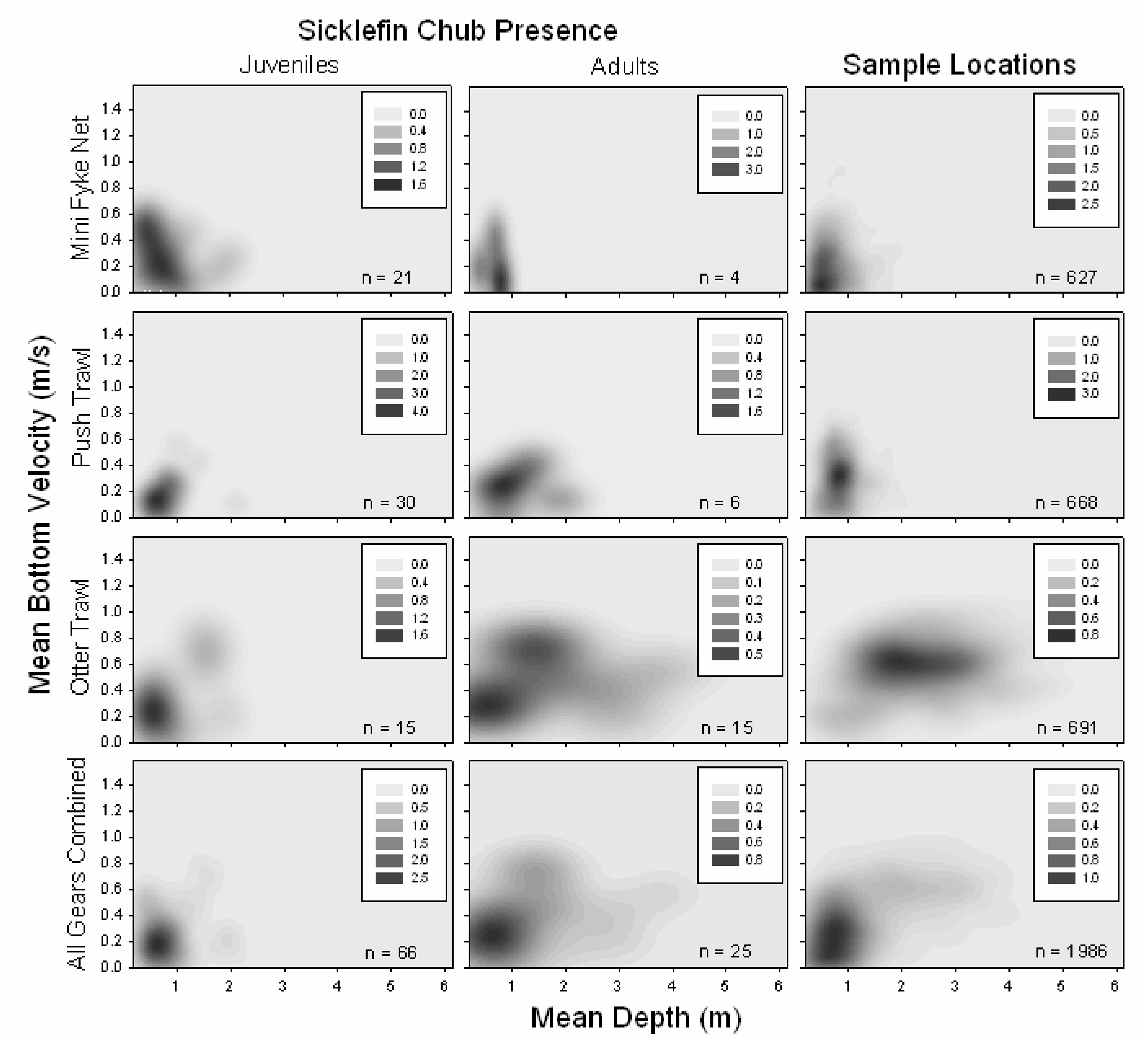


Figure IV.1.15. Kernel density estimates of mean depth (m) and mean bottom velocity (m/s) locations where juvenile (<40 mm) and adult (≥40 mm) sicklefin chub were present and where mini fyke net, push trawl and otter trawl samples were taken. All samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008, except otter trawls were not used in California (IA), Tobacco Island, Kansas (upper) and Kansas (lower).

Silver Chub

Silver chub presence was fit to a logistic regression model using samples collected with the otter trawl. The otter trawl model included four categorical variables (month, year, chute and presence of organic matter) and four continuous variables (water temperature, turbidity, water depth and bottom velocity), explained 43.1% of variability in silver chub presence but did not fit the data well (P = 0.0271; Table IV.1.25). We present the model results but urge caution when trying to use the model to predict silver chub presence. A second model was fit using push trawl samples but showed a slight lack-of-fit to the data (P = 0.1020) and explained less variation in presence (30.8%) than the otter trawl model. For consistency with other chub species, the push trawl model was not reported.

Categorical variables month and year showed similar results for silver chub as other chub species. Months of April, May, September and October, as well as 2006 had greater odds of presence than other months and years (Table IV.1.26). Chutes in the upper portion of the study were more likely to have silver chubs present than those in the lower portions of the river. Lower Hamburg and California (NE) chutes exhibited the strongest potential for silver chub presence, whereas Overton, Tadpole and Tate chutes exhibited the lowest. The model also estimated greater probability of presence when organic materials were available. Silver chub presence was expected to be greater in waters that were more turbid, shallower and had slower velocities. We emphasize again that the best model did not fit the data well and should be used to predict silver chub presence with caution.

Table IV.1.25. Results of the logistic regression model for silver chub caught otter trawling. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: April (Month), 2008 (Year), California (NE) (Chute) and no organic (Organic). No otter trawl samples were collected in California (IA), Tobacco Island, Kansas (upper) and Kansas (lower) chutes. The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	1.3877	1.0074	1	1.8978	0.1683
Month			6	8.2860	0.2179
May	0.0311	0.5293			
June	-1.7158	0.7723			
July	-1.3092	0.8909			
August	-1.6527	0.9150			
September	-0.5595	0.5513			
October	-0.2652	0.4688			
Year			2	33.4689	<.0001
2006	1.4815	0.2977			
2007	0.0066	0.3441			
Chute			7	45.0441	<.0001
Upper Hamburg	-0.7376	0.3587			
Lower Hamburg	0.3151	0.7537			
Deroin	-1.1292	0.3855			
Lisbon	-1.8122	0.4110			
Overton	-3.6267	0.804			
Tadpole	-2.0638	0.6527			
Tate	-2.3469	0.5415			
Organic			1	1.2052	0.2723
Incidental	1.0607	0.9662			
Temperature	0.0740	0.0598	1	1.5308	0.2160
Turbidity	0.0030	0.0006	1	22.4348	<.0001
Depth	-1.1889	0.2029	1	34.3399	<.0001
Bottom velocity	-1.4370	0.6360	1	5.1044	0.0239
R-square = 0.4312					
Goodness-of-fit test			8	17.3051	0.0271

Table IV.1.26. Odds ratios for habitat variables that significantly contributed to the silver chub logistic regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
Turbidity (NTU)	+100	1.4	Turbid water
Depth (m)	-0.25	1.3	Shallower water
Bottom velocity (m/s)	-0.2	1.3	Slower velocity water
Categorical Variables	*NA*		
April vs June	-	5.6	April
May vs June	-	5.7	May
May vs August	-	5.4	May
June vs September	-	3.2	September
June vs October	-	4.3	October
2006 vs 2007	-	4.4	2006
2006 vs 2008	-	4.4	2006
California (NE) vs Deroin	-	3.1	California (NE)
California (NE) vs Lisbon	-	6.1	California (NE)
California (NE) vs Overton	-	37.6	California (NE)
California (NE) vs Tadpole	-	7.9	California (NE)
California (NE) vs Tate	-	10.5	California (NE)
California (NE) vs Upper Hamburg	-	2.1	California (NE)
Deroin vs Overton	-	12.2	Deroin
Deroin vs Tate	-	3.4	Deroin
Lisbon vs Lower Hamburg	-	8.4	Lower Hamburg
Lisbon vs Overton	-	6.1	Lisbon
Lisbon vs Upper Hamburg	-	2.9	Upper Hamburg
Lower Hamburg vs Overton	-	51.5	Lower Hamburg
Lower Hamburg vs Tadpole	-	10.8	Lower Hamburg
Lower Hamburg vs Tate	-	14.3	Lower Hamburg
Overton vs Upper Hamburg	-	17.9	Upper Hamburg
Tadpole vs Upper Hamburg	-	3.8	Upper Hamburg
Tate vs Upper Hamburg	-	5.0	Upper Hamburg

Density of silver chub presence in general resembled density plots of each gear individually (Figure IV.1.16). However, when all gears were combined, juvenile silver chubs were mainly found in shallow water (<1.0 m), but adults were mainly found in deeper water (1.0-2.5 m). It was difficult to decipher a pattern for water velocity, but adults tended to have a greater density of presence in velocities of 0.4-0.8 m/s. Silver

chub catches were dominated by juveniles, suggesting the logistic regression model that predicted the greatest probability of presence in shallow and slow velocity habitats most likely represents needs of juvenile fishes.

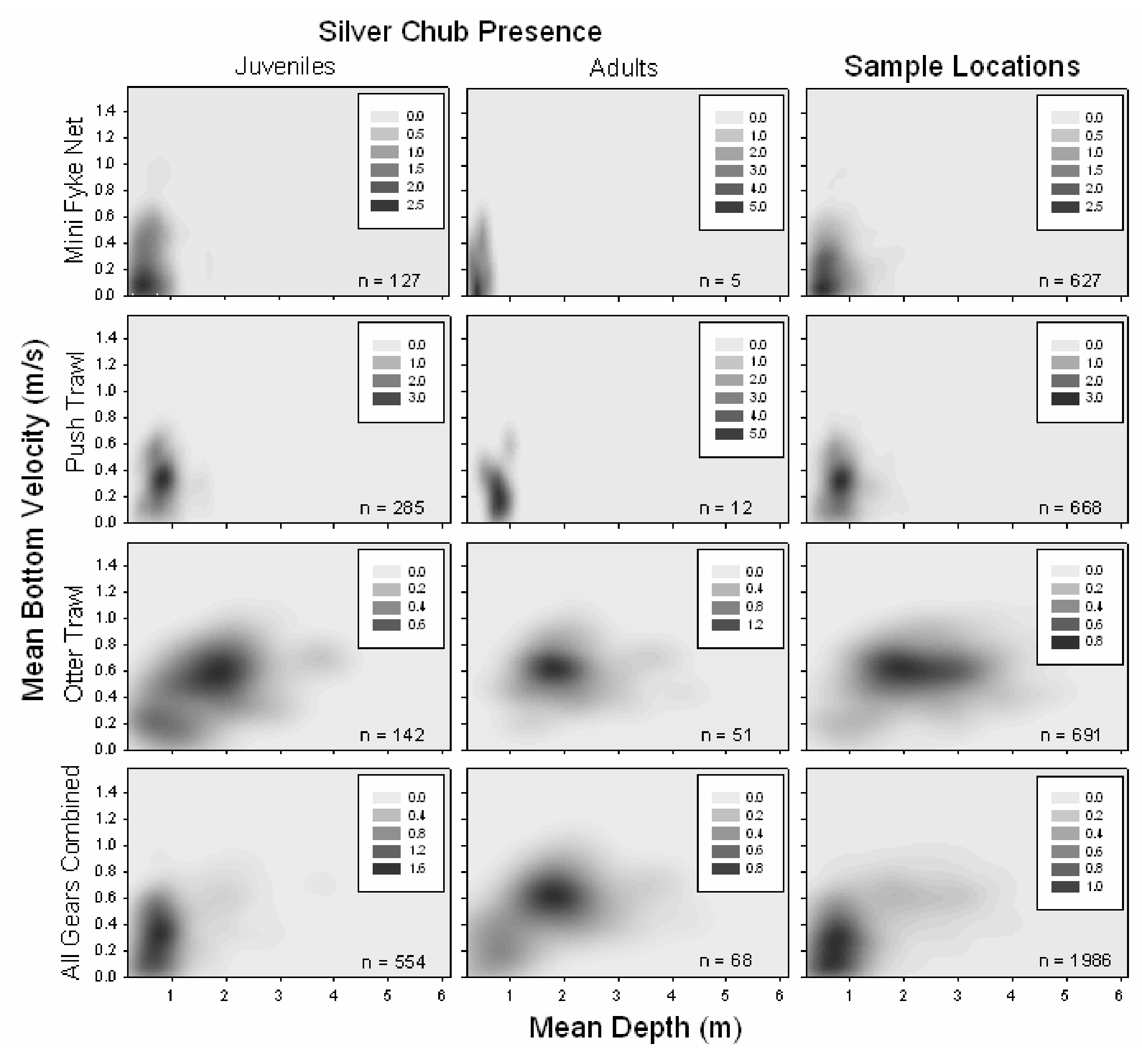


Figure IV.1.16. Kernel density estimates of mean depth (m) and mean bottom velocity (m/s) locations where juvenile (<89 mm) and adult (≥89 mm) silver chub were present and where mini fyke net, push trawl and otter trawl samples were taken. All samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008, except otter trawls were not used in California (IA), Tobacco Island, Kansas (upper) and Kansas (lower).

Gizzard Shad

Gizzard shad presence was fit to a logistic regression model using samples collected with electrofishing. The final model included four categorical variables (month, year, chute and presence of organic matter) and five continuous variables (water temperature, turbidity, water depth, column velocity and mean substrate size), explained 52.7% of the variability in gizzard shad presence but did not fit the data well ($P = 0.0482$; Table IV.1.27). We present the model results but again, urge caution when trying to use the model to predict gizzard shad presence.

The model estimated the months of August, September and October to have the greatest odds of presence, likely due to recruitment of young of year gizzard shad to catchable sizes (Table IV.1.28). Greater odds were also estimated during 2006 and 2007 compared to 2008. Chutes in the lower portion of the river (Tate, Tadpole, Overton and Lisbon) had a greater probability of presence than other chutes. Habitats with incidental organic materials increased probability of presence compared with habitats without organic matter. Turbidity and column velocity were the two strongest continuous predictor variables, where gizzard shad presence was most likely in clear water and slow velocity habitats.

Table IV.1.27. Results of the logistic regression model for gizzard shad caught while electrofishing. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: April (Month), 2008 (Year), California (IA) (Chute) and no organic material (Organic). The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	0.9298	0.8139	1	1.3053	0.2532
Month			6	24.2747	0.0005
May	0.8655	0.5180			
June	0.9428	0.8931			
July	0.9431	1.0398			
August	2.2848	1.0078			
September	1.2759	0.7107			
October	1.5997	0.5467			
Year			2	40.0834	<.0001
2006	2.0375	0.3262			
2007	1.3776	0.3099			
Chute			11	57.0373	<.0001
California (NE)	0.0143	0.4148			
Tobacco Island	0.3242	0.4199			
Upper Hamburg	-2.9461	1.2683			
Lower Hamburg	-1.1102	0.7506			
Kansas (upper)	-15.8556	802.0			
Kansas (lower)	-0.0568	1.1811			
Deroin	0.0760	0.7319			
Lisbon	3.1798	0.6172			
Overton	1.5100	0.5180			
Tadpole	1.6792	0.4792			
Tate	3.1944	0.6469			
Organic			1	2.4199	0.1198
Incidental	0.6166	0.3964			
Temperature	-0.1025	0.0592	1	2.9987	0.0833
Turbidity	-0.0041	0.0006	1	42.3800	<.0001
Depth	-0.2646	0.1934	1	1.8723	0.1712
Column velocity	-1.1595	0.5760	1	4.0521	0.0441
Mean substrate size	0.0890	0.0489	1	3.3095	0.0689
R-square = 0.5269					
Goodness-of-fit test			8	15.6174	0.0482

Table IV.1.28. Odds ratios for habitat variables that significantly contributed to the gizzard shad logistic regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
Turbidity (NTU)	-100	1.5	Clearer water
Column velocity (m/s)	-0.2	1.3	Slower velocity water
Categorical Variables	*NA*		
April vs August	-	9.8	August
April vs October	-	5.0	October
May vs August	-	4.1	August
June vs August	-	3.8	August
July vs August	-	3.8	August
August vs September	-	2.7	August
2006 vs 2007	-	1.9	2006
2006 vs 2008	-	7.7	2006
2007 vs 2008	-	4.0	2007
California (IA) vs Lisbon	-	23.8	Lisbon
California (IA) vs Overton	-	4.5	Overton
California (IA) vs Tadpole	-	5.3	Tadpole
California (IA) vs Tate	-	24.4	Tate
California (IA) vs Upper Hamburg	-	19.0	California (IA)
California (NE) vs Lisbon	-	23.8	Lisbon
California (NE) vs Overton	-	4.5	Overton
California (NE) vs Tadpole	-	5.3	Tadpole
California (NE) vs Tate	-	23.8	Tate
California (NE) vs Upper Hamburg	-	19.3	California (NE)
Deroin vs Lisbon	-	22.2	Lisbon
Deroin vs Tadpole	-	5.0	Tadpole
Deroin vs Tate	-	22.7	Tate
Deroin vs Upper Hamburg	-	20.5	Deroin
Lisbon vs Lower Hamburg	-	73.0	Lisbon
Lisbon vs Kansas (lower)	-	25.4	Lisbon
Lisbon vs Overton	-	5.3	Lisbon
Lisbon vs Tadpole	-	4.5	Lisbon
Lisbon vs Tobacco Island	-	17.4	Lisbon
Lisbon vs Upper Hamburg	-	457.6	Lisbon
Lower Hamburg vs Overton	-	13.7	Overton
Lower Hamburg vs Tadpole	-	16.4	Tadpole
Lower Hamburg vs Tate	-	71.4	Tate
Lower Hamburg vs Tobacco Island	-	4.2	Tobacco Island
Kansas (lower) vs Tate	-	25.6	Tate
Overton vs Tate	-	5.4	Tate
Overton vs Tobacco Island	-	3.3	Overton
Overton vs Upper Hamburg	-	86.1	Overton
Tadpole vs Tate	-	4.5	Tate
Tadpole vs Tobacco Island	-	3.9	Tadpole
Tadpole vs Upper Hamburg	-	102.0	Tadpole

Tate vs Tobacco Island	-	17.6	Tate
Tate vs Upper Hamburg	-	464.3	Tate
Tobacco Island vs Upper Hamburg	-	26.3	Tobacco Island

Density of gizzard shad presence in regard to water depth and velocity was proportional to the habitats sampled with mini fyke nets and push trawls but differed for electrofishing (Figure IV.1.17). In general, juveniles and adults were found in shallower and slower velocity habitats than was sampled while electrofishing. Since the logistic regression model was developed from electrofishing samples, this was expected. When all gears were combined, it illustrated that gizzard shad were still able to occupy water depths up to 3.0 m and water velocities of 1.2 m/s.

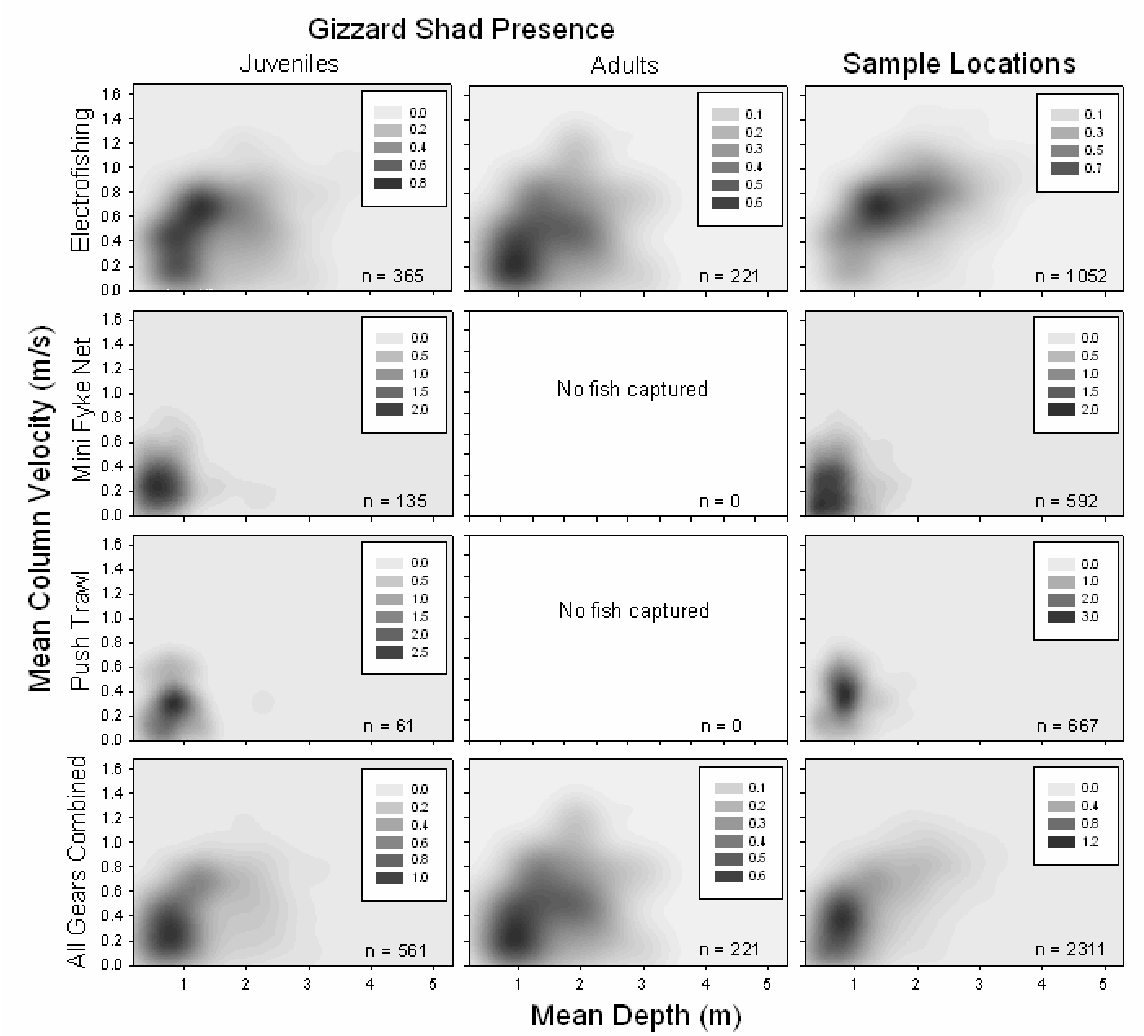


Figure IV.1.17. Kernel density estimates of mean depth (m) and mean column velocity (m/s) locations where juvenile (<229 mm) and adult (≥229 mm) gizzard shad were present and where electrofishing, mini fyke net and push trawl samples were taken. Samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008.

Goldeye

Goldeye presence was fit to a logistic regression model using samples taken while electrofishing. The final model included four categorical variables (month, year, chute and presence of organic matter) and five continuous variables (water temperature, turbidity, dissolved oxygen, column velocity and mean substrate size), explained 17.1% of variability in goldeye presence and exhibited no lack-of-fit to the data (P = 0.2439; Table IV.1.29).

The model estimated that goldeye presence was more likely during the months of April, May, June and July, as well as during 2007 and 2008 than 2006 (Table IV.1.30). Chute was a highly significant variable, where the most productive chutes were Lisbon, Overton, Tadpole and Tate. Two chutes in the upper portion of the study area, California (NE) and Tobacco Island, also had higher probabilities of goldeye presence than other unmentioned chutes. The variable organic material was only marginally significant (P = 0.2607) but predicted a greater probability of presence in habitats without organic materials as opposed to those with organic materials.

Water Temperature and turbidity were two continuous variables that were negatively related to goldeye presence, where goldeye were more likely to be found at lower water temperatures and in clearer waters. Three continuous variables (dissolved oxygen, column velocity and mean substrate size) were positively related to goldeye presence, where they were more likely to be found in oxygen rich waters, relatively high velocity waters and near larger diameter substrates.

Table IV.1.29. Results of the logistic regression model for goldeye caught while electrofishing. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: April (Month), 2008 (Year), California (IA) (Chute) and no organic material (Organic). The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	-0.1416	0.8389	1	0.0285	0.8660
Month			6	25.5171	0.0003
May	0.2927	0.4673			
June	0.4589	0.7229			
July	0.6832	0.8545			
August	-0.1824	0.8358			
September	-0.4789	0.5988			
October	-0.9412	0.4759			
Year			2	7.9026	0.0192
2006	-0.5931	0.2677			
2007	0.0433	0.2388			
Chute			11	44.9533	<.0001
California (NE)	0.9267	0.3778			
Tobacco Island	0.9684	0.3764			
Upper Hamburg	-0.2222	0.5964			
Lower Hamburg	-0.2973	0.5905			
Kansas (upper)	-0.9066	0.7980			
Kansas (lower)	-0.4927	0.9528			
Deroin	-1.2663	0.7050			
Lisbon	1.7670	0.4657			
Overton	2.1372	0.4777			
Tadpole	1.6427	0.4510			
Tate	1.4311	0.4939			
Organic			1	1.2651	0.2607
Incidental	-0.3531	0.3140			
Temperature	-0.0755	0.0484	1	2.4344	0.1187
Turbidity	-0.0013	0.0004	1	8.2132	0.0042
Dissolved oxygen	0.0632	0.0595	1	1.1290	0.2880
Column velocity	1.0900	0.4535	1	5.7768	0.0162
Mean substrate size	0.0546	0.0282	1	3.7392	0.0531
R-square = 0.1713					
Goodness-of-fit test			8	10.3099	0.2439

Table IV.1.30. Odds ratios for habitat variables that significantly contributed to the goldeye logistic regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
Turbidity (NTU)	-100	1.1	Clearer water
Column velocity (m/s)	+0.2	1.2	Higher velocity water
Categorical Variables	*NA*		
April vs October	-	2.6	April
May vs October	-	3.4	May
June vs September	-	2.6	June
June vs October	-	4.1	June
July vs August	-	2.4	July
July vs September	-	3.2	July
July vs October	-	5.1	July
2006 vs 2007	-	1.9	2007
2006 vs 2008	-	1.8	2008
California (IA) vs California (NE)	-	2.5	California (NE)
California (IA) vs Lisbon	-	5.8	Lisbon
California (IA) vs Overton	-	8.5	Overton
California (IA) vs Tadpole	-	5.2	Tadpole
California (IA) vs Tate	-	4.2	Tate
California (IA) vs Tobacco Island	-	2.6	Tobacco Island
California (NE) vs Deroin	-	9.0	California (NE)
California (NE) vs Lisbon	-	2.3	Lisbon
California (NE) vs Lower Hamburg	-	3.4	California (NE)
California (NE) vs Overton	-	3.4	Overton
California (NE) vs Upper Hamburg	-	3.2	California (NE)
California (NE) vs Kansas (upper)	-	6.3	California (NE)
Deroin vs Lisbon	-	20.8	Lisbon
Deroin vs Overton	-	30.3	Overton
Deroin vs Tadpole	-	18.2	Tadpole
Deroin vs Tate	-	14.9	Tate
Deroin vs Tobacco Island	-	9.3	Tobacco Island
Lisbon vs Lower Hamburg	-	7.9	Lisbon
Lisbon vs Kansas (lower)	-	9.6	Lisbon
Lisbon vs Tobacco Island	-	2.2	Lisbon
Lisbon vs Upper Hamburg	-	7.3	Lisbon
Lisbon vs Kansas (upper)	-	14.5	Lisbon
Lower Hamburg vs Overton	-	11.4	Overton
Lower Hamburg vs Tadpole	-	6.9	Tadpole
Lower Hamburg vs Tate	-	5.6	Tate
Lower Hamburg vs Tobacco Island	-	3.5	Tobacco Island
Kansas (lower) vs Overton	-	13.9	Overton
Kansas (lower) vs Tadpole	-	8.5	Tadpole
Kansas (lower) vs Tate	-	6.8	Tate
Overton vs Tobacco Island	-	3.2	Overton
Overton vs Upper Hamburg	-	10.6	Overton

Overton vs Kansas (upper)	-	21.0	Overton
Tadpole vs Upper Hamburg	-	6.5	Tadpole
Tadpole vs Kansas (upper)	-	12.8	Tadpole
Tate vs Upper Hamburg	-	5.2	Tate
Tate vs Kansas (upper)	-	10.4	Tate
Tobacco Island vs Upper Hamburg	-	3.3	Tobacco Island
Tobacco Island vs Kansas (upper)	-	6.5	Tobacco Island

Density of goldeye presence was generally proportional to the habitats sampled by all gears in KDE plots (Figure IV.1.18). The electrofishing logistic regression model estimated greater probabilities of presence in faster velocity waters, and when compared to the KDE plots, few goldeye were found in habitats with water velocities <0.3 m/s.

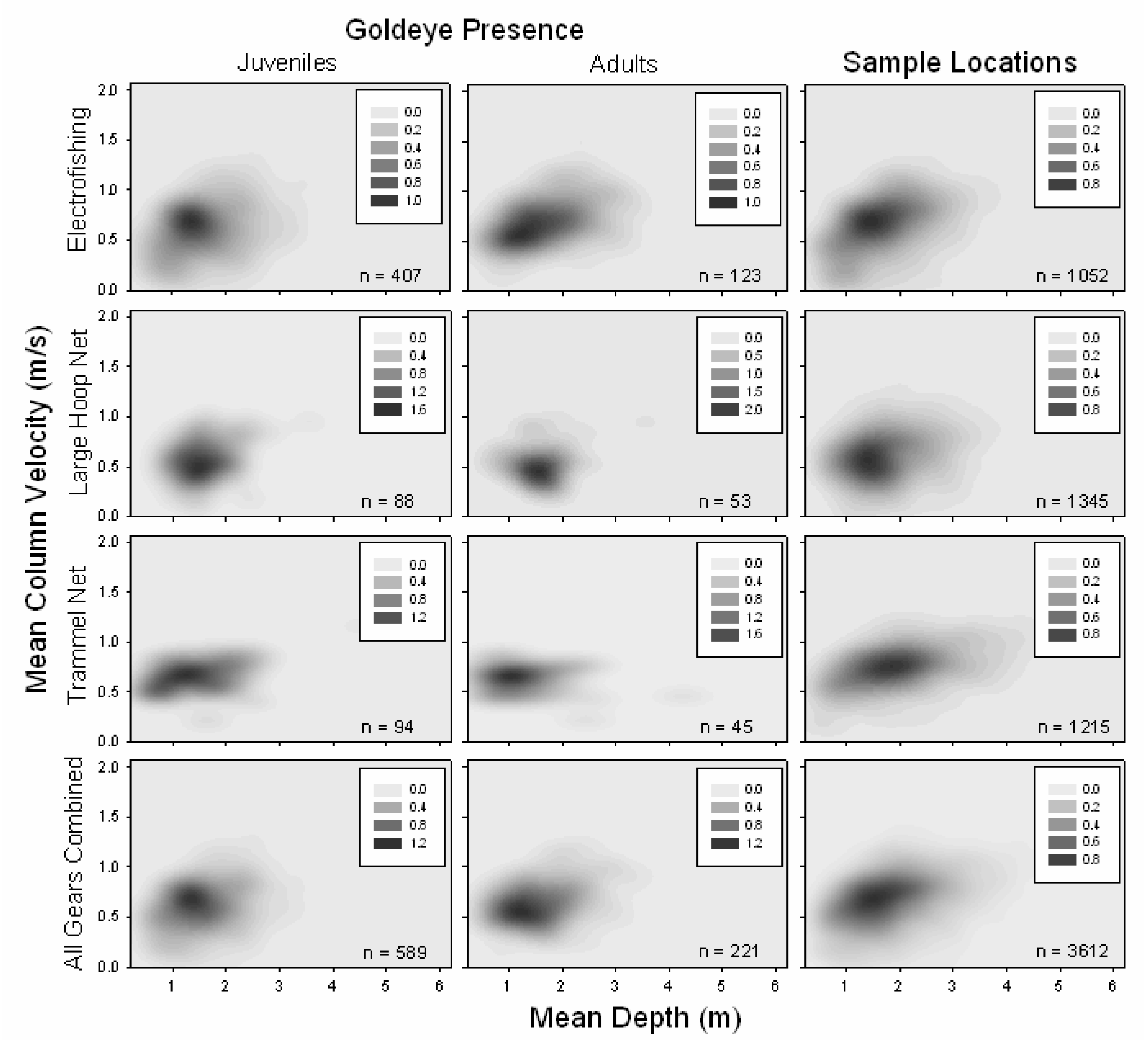


Figure IV.1.18. Kernel density estimates of mean depth (m) and mean column velocity (m/s) locations where juvenile (<356 mm) and adult (≥356 mm) goldeye were present and where electrofishing, large hoop net and trammel net samples were taken. Samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008.

Blue Sucker

The presence of blue sucker was fit to a logistic regression model using samples collected while electrofishing. The final model included four categorical variables (month, year, chute and presence of cobble) and four continuous variables (turbidity, dissolved oxygen, water depth and mean substrate size), explained 35.9% of variability in blue sucker presence and exhibited no lack-of-fit to the data (P = 0.8858; Table IV.1.31).

The months of September and October had the greatest odds of blue sucker presence while April had the lowest (Table IV.1.32). River conditions during 2007 were more favorable than 2006 for blue sucker presence. Chute was a highly significant variable where California (NE), Tobacco Island and Upper Hamburg chutes had the greatest odds of presence. The presence of cobble was an important variable, where the odds of blue sucker presence were 12.5 times greater when cobble was dominant compared to habitats with no cobble.

Presence of blue sucker was more likely in waters that contained more dissolved oxygen, were deeper and had larger diameter substrates. Turbidity was marginally significant (P = 0.2368) but high turbidity was predicted to decrease the probability of blue sucker presence.

Table IV.1.31. Results of the logistic regression model for blue sucker caught while electrofishing. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: April (Month), 2008 (Year), California (IA) (Chute) and no cobble (Cobble). The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	-6.8346	1.7291	1	15.6231	<.0001
Month			6	34.5969	<.0001
May	1.0911	0.7397			
June	2.1007	0.7436			
July	1.7568	0.7165			
August	1.6793	0.7009			
September	3.0702	0.6995			
October	2.8470	0.7176			
Year			2	6.0302	0.0490
2006	-0.7689	0.3927			
2007	0.1102	0.3011			
Chute			11	37.5061	<.0001
California (NE)	2.1649	0.8016			
Tobacco Island	2.3262	0.8088			
Upper Hamburg	1.5120	0.9275			
Lower Hamburg	0.7637	0.9987			
Kansas (upper)	0.8996	1.1326			
Kansas (lower)	0.9806	1.4046			
Deroin	1.0917	0.9926			
Lisbon	-0.1213	0.9495			
Overton	0.2419	0.9586			
Tadpole	-12.6845	292.4			
Tate	0.3474	0.9385			
Cobble			2	5.1472	0.0763
Incidental	0.4201	0.5535			
Dominant	2.5315	1.1653			
Turbidity	-0.0012	0.0010	1	1.3997	0.2368
Dissolved oxygen	0.2037	0.1264	1	2.5950	0.1072
Depth	0.3156	0.2394	1	1.7374	0.1875
Mean substrate size	0.0588	0.0331	1	3.1448	0.0762
R-square = 0.3586					
Goodness-of-fit test			8	3.6677	0.8858

Table IV.1.32. Odds ratios for habitat variables that significantly contributed to the blue logistic regression model.

Variable	The odds of presence increase X times	Greater odds in
Categorical Variables		
April vs June	8.2	June
April vs July	5.8	July
April vs August	5.3	August
April vs September	21.7	September
April vs October	17.2	October
May vs September	7.2	September
May vs October	5.8	October
July vs September	3.7	September
July vs October	3.0	October
August vs September	4.0	September
August vs October	3.2	October
2006 vs 2007	2.4	2007
California (IA) vs California (NE)	8.7	California (NE)
California (IA) vs Tobacco Island	10.2	Tobacco Island
California (NE) vs Lisbon	9.8	California (NE)
California (NE) vs Overton	6.8	California (NE)
California (NE) vs Tate	6.2	California (NE)
Lisbon vs Tobacco Island	11.5	Tobacco Island
Lisbon vs Upper Hamburg	5.1	Upper Hamburg
Lower Hamburg vs Tobacco Island	4.8	Tobacco Island
Overton vs Tobacco Island	8.1	Tobacco Island
Tate vs Tobacco Island	7.2	Tobacco Island
No Cobble vs Dominant Cobble	12.5	Dominant Cobble

Density of blue sucker presence was generally proportional to the habitats sampled for all gears (Figure IV.1.19). Blue suckers were found in a very broad range of habitats, from water depths up to 4.0 m and water velocities up to 1.2 m/s. The logistic model estimated greater odds of presence near cobble substrates that are generally created by scouring from high velocity water. KDE plots indicated that few blue suckers were found in habitats with velocities <0.3 m/s.

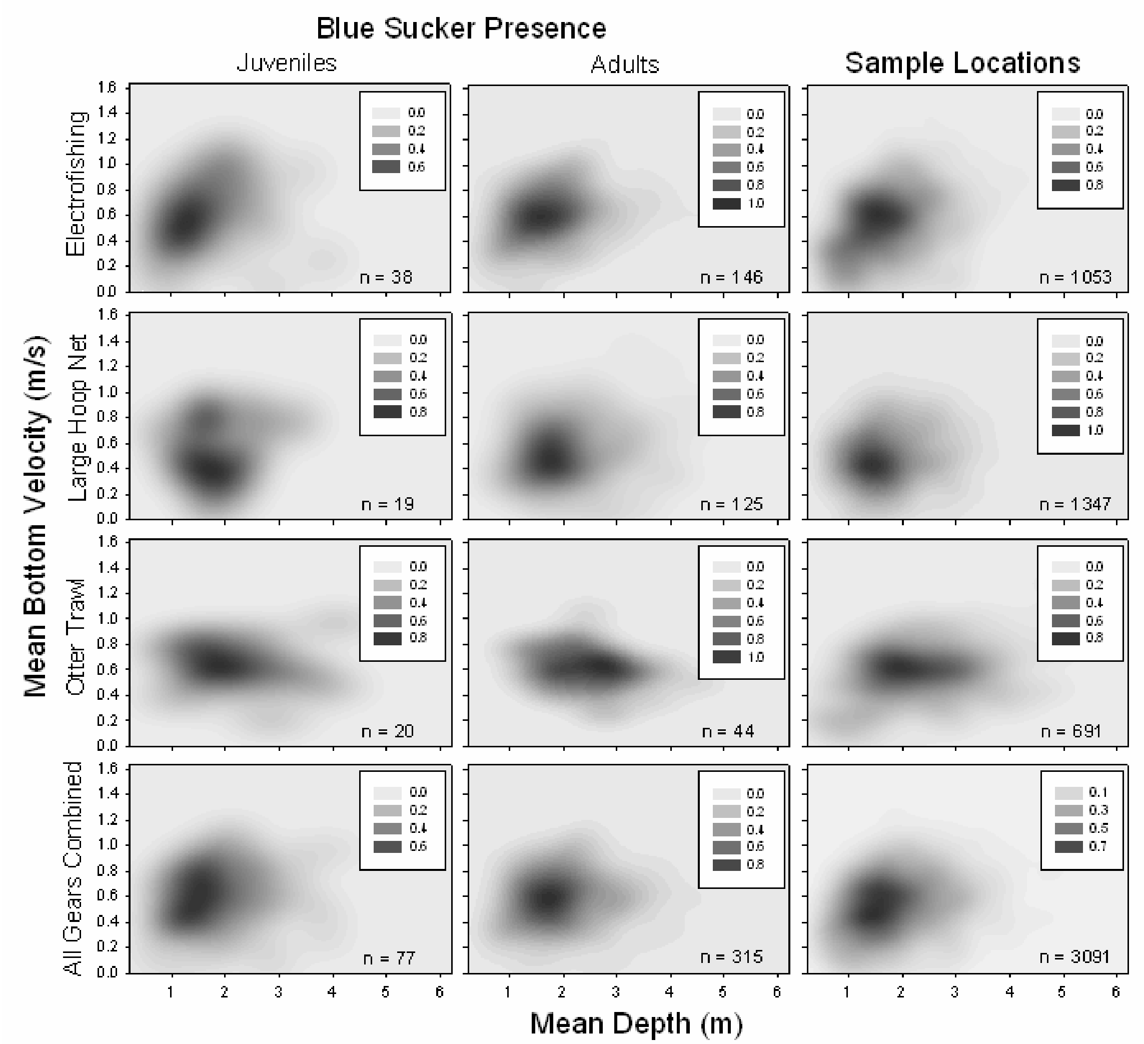


Figure IV.1.19. Kernel density estimates of mean depth (m) and mean bottom velocity (m/s) locations where juvenile (<508 mm) and adult (≥508 mm) blue sucker were present and where electrofishing, large hoop net and otter trawl samples were taken. All samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008, except otter trawls were not used in California (IA), Tobacco Island, Kansas (upper) and Kansas (lower).

Emerald Shiner

Presence of emerald shiners was fit to a logistic regression model using samples collected with mini fyke nets. The final model included three categorical variables (month, year and chute) and three continuous variables (water temperature, water depth and column velocity), explained 30.7% of variability in emerald shiner presence and exhibited no lack-of-fit to the data (P = 0.3304; Table IV.1.33).

Month was a significant variable, but no pattern could be discerned from regression coefficients. The month of August had the greatest probability of presence, whereas October had the lowest (Table IV.1.34). River conditions during 2006 were more favorable for presence than 2008. Presence of emerald shiners was greater in California (NE), Lisbon and Tate chutes than other chutes. Odds of presence increased when sampling occurred in shallower water. It is important to recognize that mini fyke nets generally cannot be set in water velocities >0.4 m/s without collapsing, therefore, using column velocity as a predictor variable has limitations.

Table IV.1.33. Results of the logistic regression model for emerald shiners caught in mini fyke nets. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: April (Month), 2008 (Year) and California (NE) (Chute). The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	3.7871	1.0728	1	12.4628	0.0004
Month			6	13.9603	0.0301
May	-0.6576	1.1175			
June	-0.9174	1.3007			
July	-0.9403	1.4564			
August	0.3270	1.4714			
September	-0.3806	1.1725			
October	-1.3873	0.9226			
Year			2	8.2886	0.0159
2006	1.1810	0.4170			
2007	0.8101	0.3942			
Chute			10	17.5123	0.0638
Tobacco Island	-0.3080	0.4476			
Upper Hamburg	-15.2319	721.2			
Lower Hamburg	-1.8504	0.8157			
Kansas (upper)	-0.4094	0.7390			
Kansas (lower)	-0.1487	1.2514			
Deroin	-1.1809	0.8679			
Lisbon	0.3185	0.4757			
Overton	-0.5957	0.5246			
Tadpole	-1.1148	0.5129			
Tate	0.1225	0.4712			
Temperature	-0.1200	0.0715	1	2.8186	0.0932
Depth	-1.1769	0.3824	1	9.4695	0.0021
Column velocity	1.8388	0.7445	1	6.1004	0.0135
R-square = 0.3067					
Goodness-of-fit test			8	9.1431	0.3304

Table IV.1.34. Odds ratios for habitat variables that significantly contributed to the emerald shiner regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
Depth (m)	-0.25	1.3	Shallower water
Column velocity (m/s)	+0.2	1.4	Faster velocity water
Categorical Variables	*NA*		
June vs August	-	3.5	August
July vs August	-	3.5	August
2006 vs 2008	-	3.3	2006
2007 vs 2008	-	2.2	2007
California (NE) vs Lower Hamburg	-	6.4	California (NE)
California (NE) vs Tadpole	-	3.0	California (NE)
Lisbon vs Lower Hamburg	-	8.7	Lisbon
Lisbon vs Tadpole	-	4.2	Lisbon
Lower Hamburg vs Tate	-	7.2	Tate
Tadpole vs Tate	-	3.4	Tate

The greatest density of emerald shiner presence was located near waters 0.5 m deep with water velocities ~0.6 m/s (Figure IV.1.20). In general, emerald shiner density of presence was in similar proportion to habitats sampled for each gear. The mini fyke net logistic regression model estimated greatest probability of presence in shallow fast velocity habitats. However, it is difficult to validate this prediction looking at the KDE plots.

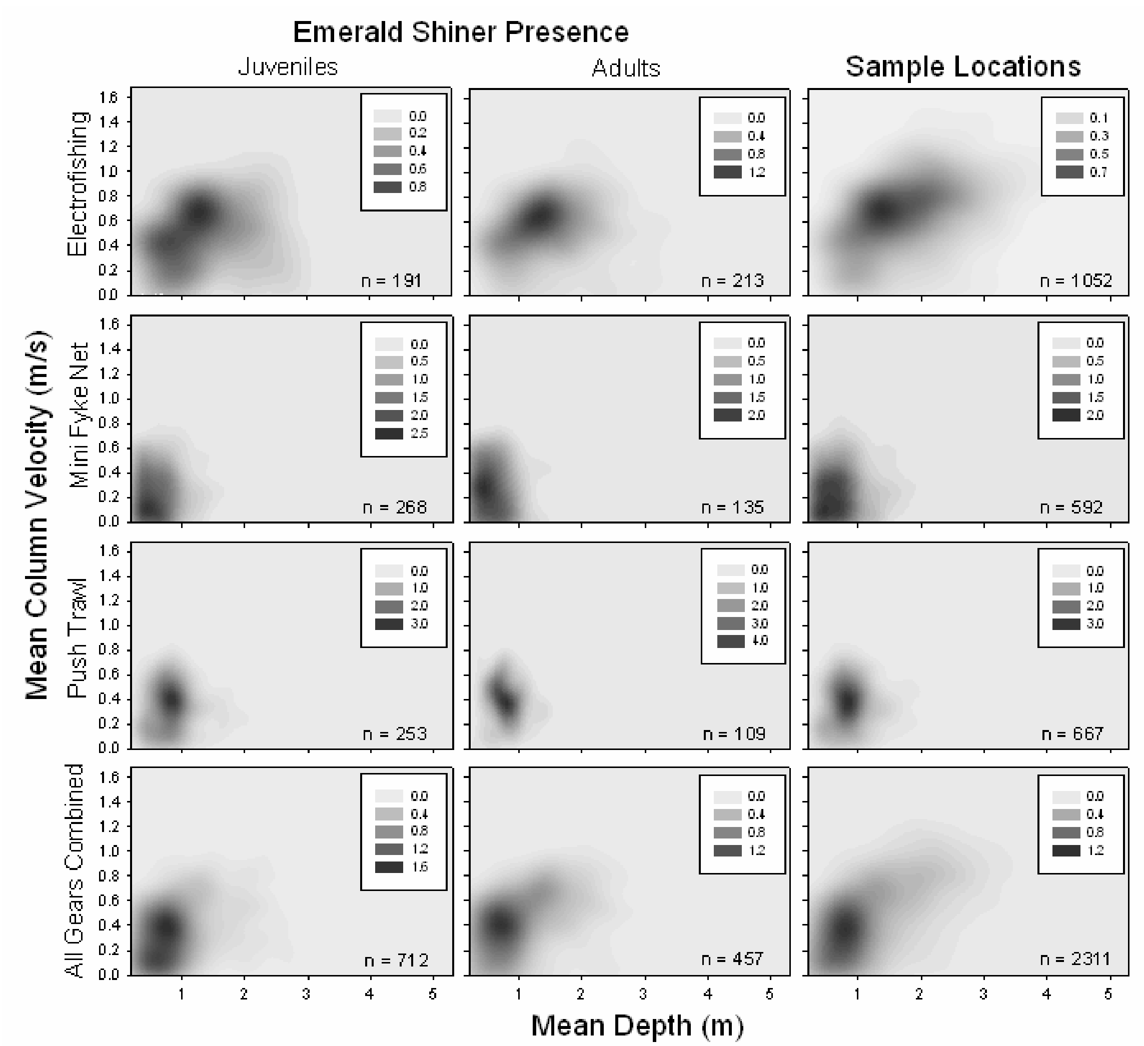


Figure IV.1.20. Kernel density estimates of mean depth (m) and mean column velocity (m/s) locations where juvenile (<64 mm) and adult (≥64 mm) emerald shiners were present and where electrofishing, mini fyke net and push trawl samples were taken. Samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008.

River Shiner

Presence of river shiners was fit to a logistic regression model using samples collected with mini fyke nets. The final model included two categorical variables (year and chute) and four continuous variables (turbidity, water depth, column velocity and mean substrate size), explained 66.8% of the variability in river shiner presence and exhibited no lack-of-fit to the data (P = 0.2526; Table IV.1.35).

River shiner presence was 3.1 times greater during 2007 and 2008 than during 2006 (Table IV.1.36). Greater odds were also estimated for California (NE) and Tobacco Island chutes over all other chutes. The logistic model predicted that less turbid, shallow, higher velocity and small substrate habitats were most conducive to river shiner presence. To avoid misinterpreting the model, it is necessary to remember the range of habitats where data were collected. Mini fyke nets generally sampled shallow (<1.0 m) and low velocity (<0.5 m/s) waters. Extending the model past this range of habitats would not be recommended.

Table IV.1.35. Results of the logistic regression model for river shiners caught in mini fyke nets. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: 2008 (Year) and California (NE) (Chute). The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	2.9140	0.7396	1	15.5249	<.0001
Year			2	6.8495	0.0326
2006	-1.1396	0.4959			
2007	-0.0171	0.4551			
Chute			10	62.1249	<.0001
Tobacco Island	0.5779	0.5170			
Upper Hamburg	-16.4065	1256.5			
Lower Hamburg	-2.3581	0.9194			
Kansas (upper)	-16.9003	627.1			
Kansas (lower)	-1.1975	1.1251			
Deroin	-1.8524	0.9294			
Lisbon	-2.6902	0.5825			
Overton	-4.0829	1.1091			
Tadpole	-16.1252	326.7			
Tate	-2.9865	0.6066			
Turbidity	-0.0022	0.0011	1	4.4063	0.0358
Depth	-2.3150	0.8137	1	8.0947	0.0044
Column velocity	1.5049	0.9919	1	2.3018	0.1292
Mean substrate size	-0.3904	0.2062	1	3.5829	0.0584
R-square = 0.6677					
Goodness-of-fit test			7	9.0004	0.2526

Table IV.1.36. Odds ratios for habitat variables that significantly contributed to the river shiner regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
Turbidity (NTU)	-100	1.3	Clearer water
Depth (m)	-0.25	1.8	Shallower water
Categorical Variables	*NA*		
2006 vs 2007	-	3.1	2007
2006 vs 2008	-	3.1	2008
California (NE) vs Deroin	-	6.4	California (NE)
California (NE) vs Lisbon	-	14.7	California (NE)
California (NE) vs Lower Hamburg	-	10.6	California (NE)
California (NE) vs Overton	-	59.3	California (NE)
California (NE) vs Tate	-	19.8	California (NE)
Deroin vs Tobacco Island	-	11.4	Tobacco Island
Lisbon vs Tobacco Island	-	26.3	Tobacco Island
Lower Hamburg vs Tobacco Island	-	18.9	Tobacco Island
Overton vs Tobacco Island	-	111.1	Tobacco Island
Tate vs Tobacco Island	-	35.7	Tobacco Island

When all gears were combined in the KDE plots, presence of river shiners was generally restricted to waters <1.0 m deep, that corresponded to logistic model predictions (Figure IV.1.21). However, it was difficult to identify a range of velocities that were selected for by river shiners.

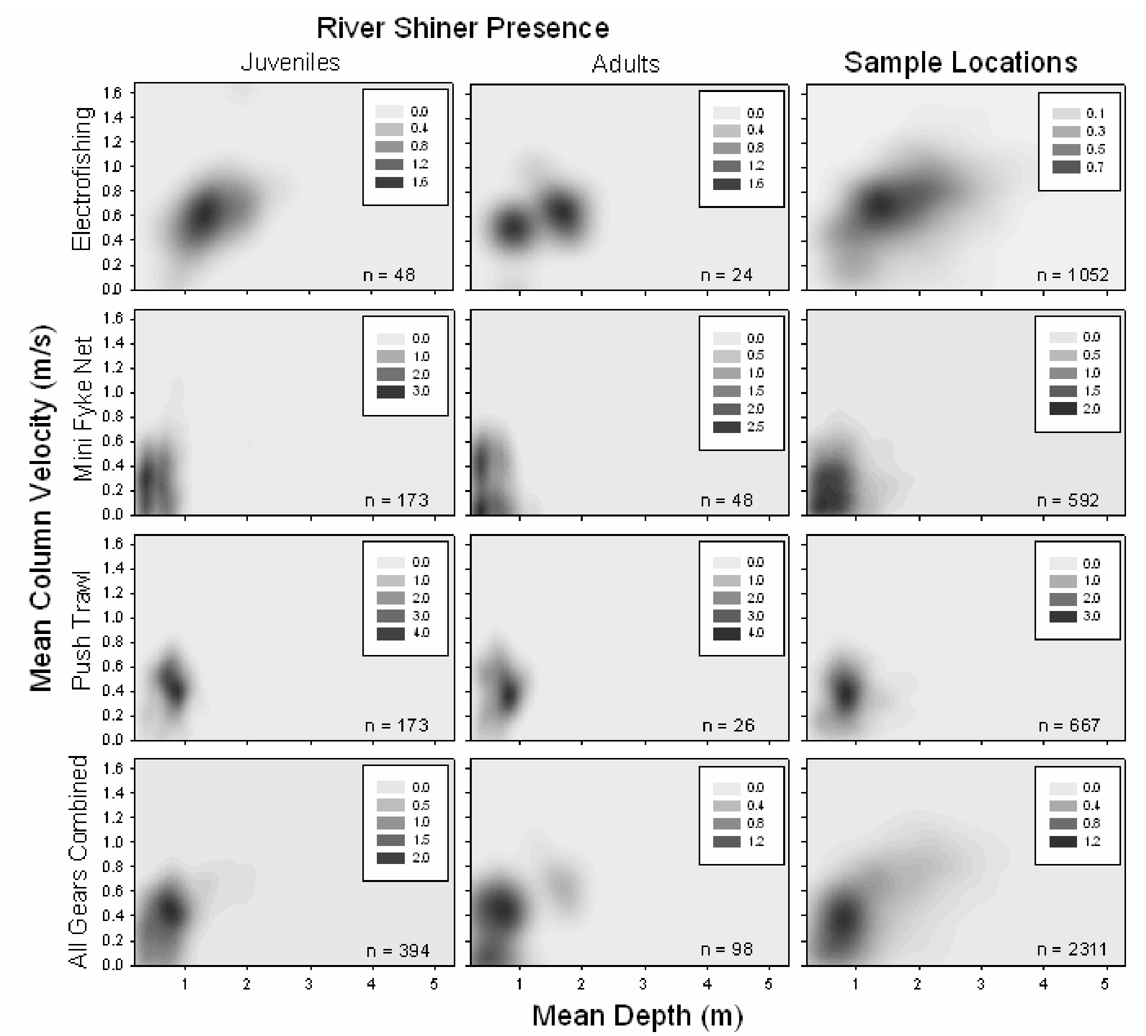


Figure IV.1.21. Kernel density estimates of mean depth (m) and mean column velocity (m/s) locations where juvenile (<51 mm) and adult (≥51 mm) river shiners were present and where electrofishing, mini fyke net and push trawl samples were taken. Samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008.

Red Shiner

Presence of red shiners was fit to a logistic regression model using samples collected with mini fyke nets. The final model included three categorical variables (month, year and chute) and two continuous variables (water depth and mean substrate size), explained 30.3% of variability in red shiner presence and exhibited slight lack-of-fit to the data (P = 0.1666; Table IV.1.37).

Red shiners were best collected during April, June and July and had 2.9 times greater odds of being present during 2006 than 2008 (Table IV.1.38). Chutes that had the greatest odds of presence were Overton, Tadpole, Tate and Lisbon. Upper Hamburg and Kansas (upper) chutes were the least likely. Habitats that had relatively shallow water and larger mean substrate size were more likely to have red shiners.

Table IV.1.37. Results of the logistic regression model for red shiners caught in mini fyke nets. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: April (Month), 2008 (Year) and California (NE) (Chute). The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	2.2129	0.8120	1	7.4273	0.0064
Month			6	16.6695	0.0106
May	-1.9819	0.9003			
June	-0.9429	0.8784			
July	-0.5461	0.8766			
August	-1.8970	0.8187			
September	-1.4797	0.8310			
October	-2.2347	0.8394			
Year			2	7.5385	0.0231
2006	1.0719	0.4172			
2007	0.6279	0.3272			
Chute			10	25.0876	0.0052
Tobacco Island	0.3087	0.4582			
Upper Hamburg	-16.0476	816.3			
Lower Hamburg	-0.5101	0.7491			
Kansas (upper)	-2.9787	0.9031			
Kansas (lower)	0.4001	1.2383			
Deroin	-2.1148	0.9652			
Lisbon	0.5531	0.5084			
Overton	1.1626	0.5878			
Tadpole	0.8218	0.5577			
Tate	0.5637	0.4950			
Depth	-0.9972	0.3561	1	7.8438	0.0051
Mean substrate size	0.5966	0.3348	1	3.1766	0.0747
R-square = 0.3028					
Goodness-of-fit test			8	11.6683	0.1666

Table IV.1.38. Odds ratios for habitat variables that significantly contributed to the red shiner regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
Depth (m)	-0.25	1.3	Shallower water
Categorical Variables	*NA*		
April vs May	-	7.3	April
April vs August	-	6.7	April
April vs October	-	9.3	April
May vs July	-	4.2	July
June vs October	-	3.6	June
July vs August	-	3.9	July
July vs October	-	5.4	July
2006 vs 2008	-	2.9	2006
California (NE) vs Deroin	-	8.3	California (NE)
California (NE) vs Overton	-	3.2	Overton
California (NE) vs Kansas (upper)	-	19.7	California (NE)
Deroin vs Lisbon	-	14.5	Lisbon
Deroin vs Overton	-	26.3	Overton
Deroin vs Tadpole	-	18.9	Tadpole
Deroin vs Tate	-	14.5	Tate
Deroin vs Tobacco Island	-	11.2	Tobacco Island
Lisbon vs Kansas (upper)	-	34.2	Lisbon
Lower Hamburg vs Overton	-	5.3	Overton
Lower Hamburg vs Kansas (upper)	-	11.8	Lower Hamburg
Kansas (lower) vs Kansas (upper)	-	29.3	Kansas (lower)
Overton vs Kansas (upper)	-	62.9	Overton
Tadpole vs Kansas (upper)	-	44.7	Tadpole
Tate vs Kansas (upper)	-	34.5	Tate
Tobacco Island vs Kansas (upper)	-	26.8	Tobacco Island

Kernel density estimate plots of red shiner presence for mini fyke nets and push trawls did not reveal any strong habitat selection (Figure IV.1.22). However, samples with electrofishing indicated that density of red shiner presence was greater in shallower habitats than was sampled with electrofishing. The mini fyke logistic regression model predicted greater probability of presence in shallow habitat and the electrofishing KDE plots confirmed this prediction. No strong selection for any specific range of water velocities could be identified.

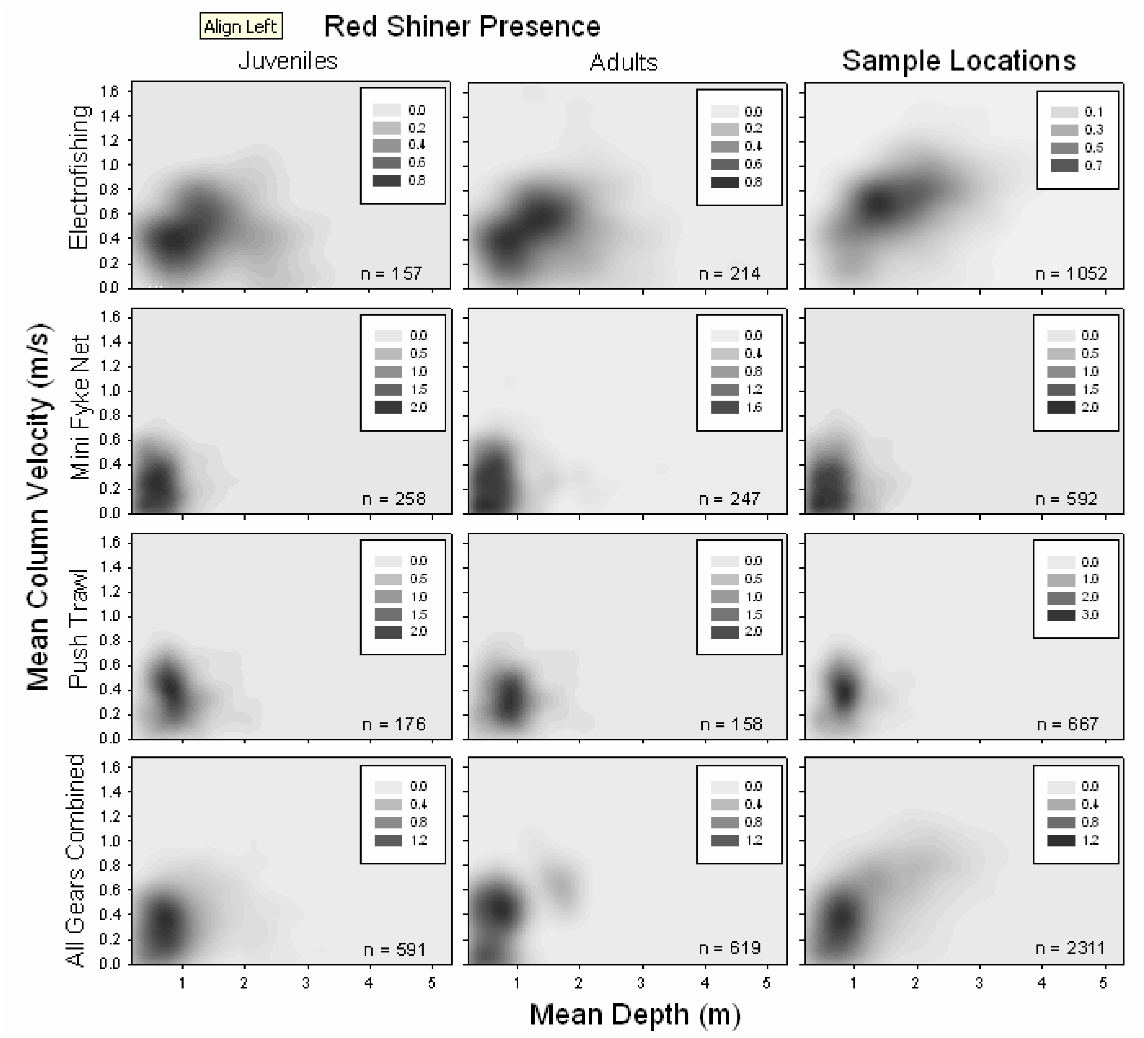


Figure IV.1.22. Kernel density estimates of mean depth (m) and mean column velocity (m/s) locations where juvenile (<46 mm) and adult (≥46 mm) red shiners were present and where electrofishing, mini fyke net and push trawl samples were taken. Samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008.

Sand Shiner

Sand shiners were captured during sampling with mini fyke nets and their presence was fit to a logistic regression model. The final model included two categorical variables (chute and presence of organic material) and four continuous variables (water temperature, turbidity, water depth and mean substrate size), explained 56.3% of the variability in sand shiner presence and exhibited no lack-of-fit to the data (P = 0.2554; Table IV.1.39).

The model estimated the greatest odds of presence in Kansas (lower), Deroin, Tobacco Island and California (NE) chutes (Table IV.1.40). Additionally, greater odds of presence were expected for habitats that were dominated with organic matter as opposed to those without. All four continuous variables had negative regression coefficients, meaning probability of sand shiner presence decreased with increasing water temperature, turbidity, water depth and mean substrate size.

Table IV.1.39. Results of the logistic regression model for sand shiners caught in mini fyke nets. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: California (NE) (Chute) and no organic material (Organic). The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	2.6098	0.7726	1	11.4121	0.0007
Chute			10	32.9869	0.0003
Tobacco Island	0.0601	0.4051			
Upper Hamburg	-1.2099	1.2687			
Lower Hamburg	-1.1125	0.7727			
Kansas (upper)	-1.6055	0.7566			
Kansas (lower)	0.7835	1.2323			
Deroin	0.3904	0.8486			
Lisbon	-1.9520	0.5666			
Overton	-15.0119	349.2			
Tadpole	-15.5231	341.7			
Tate	-2.7877	0.7125			
Organic			2	9.4996	0.0087
Incidental	-1.1554	1.1277			
Dominant	2.6585	0.9577			
Temperature	-0.0479	0.0281	1	2.9046	0.0883
Turbidity	-0.0014	0.0009	1	2.7446	0.0976
Depth	-1.1927	0.6327	1	3.5536	0.0594
Mean substrate size	-0.2199	0.1684	1	1.7046	0.1917
R-square = 0.5633					
Goodness-of-fit test			7	8.9619	0.2554

Table IV.1.40. Odds ratios for habitat variables that significantly contributed to the sand shiner regression model.

Variable	The odds of presence increase X times	Greater odds in
Categorical Variables		
California (NE) vs Lisbon	7.0	California (NE)
California (NE) vs Tate	16.2	California (NE)
California (NE) vs Kansas (upper)	5.0	California (NE)
Deroin vs Lisbon	10.4	Deroin
Deroin vs Tate	24.0	Deroin
Lisbon vs Tobacco Island	7.5	Tobacco Island
Kansas (lower) vs Tate	35.6	Kansas (lower)
Tate vs Tobacco Island	17.2	Tobacco Island
Tobacco Island vs Kansas (upper)	5.3	Tobacco Island
No Organic vs Dominant Organic	14.3	Dominant Organic
Incidental Organic vs Dominant Organic	45.5	Dominant Organic

Presence of sand shiners was mostly limited to water depths less than 1.0 m when all gears were combined (Figure IV.1.23). The mini fyke net logistic regression model estimated greater probability of presence in shallow habitats that was also supported by KDE plots. Sand shiners caught while electrofishing were found in water depths up to 2.5 m, but few specimens were collected. It is difficult to determine if a specific range of water velocities was selected for, but it seems as if sand shiner related to flowing water.

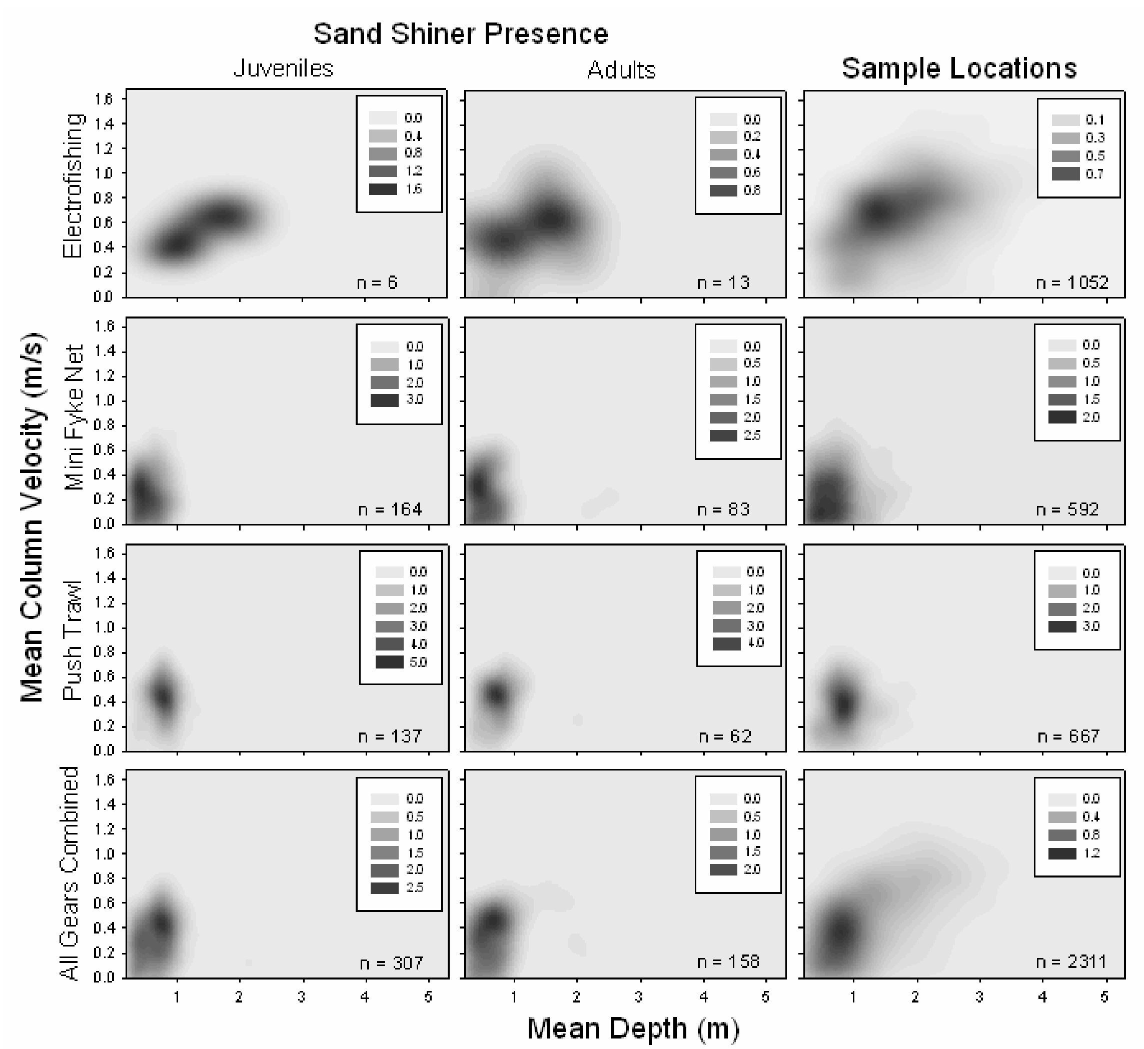


Figure IV.1.23. Kernel density estimates of mean depth (m) and mean column velocity (m/s) locations where juvenile (<43 mm) and adult (≥43 mm) sand shiners were present and where electrofishing, mini fyke net and push trawl samples were taken. Samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008.

Spotfin Shiner

Presence of spotfin shiners was fit to a logistic regression model using samples collected with mini fyke nets. The final model included three categorical variables (month, year and chute) and one continuous variable (turbidity), explained 57.9% of variability in spotfin shiner presence and exhibited no lack-of-fit to the data (P = 0.8937; Table IV.1.41).

Spotfin shiners were most likely to be present during the months of July and August and during 2007 (Table IV.1.42). Most chutes either had no spotfin shiners present or very few occurrences. Only California (NE) and Tobacco Island chutes had meaningful regression coefficients, indicating they had greater odds of presence than other chutes. Turbidity was the only significant continuous variable, and spotfin shiner presence was expected to increase as turbidity increased.

Table IV.1.41. Results of the logistic regression model for spotfin shiners caught in mini fyke nets. The results shown are the coefficient estimates, standard errors (SE), the main effects degrees of freedom, chi-square value and P-value. The levels of categorical variables used as reference variables are: April (Month), 2008 (Year) and California (NE) (Chute). The Hosmer and Lemeshow goodness-of-fit test was used to evaluate the model's fit, where a small P-value suggests the fitted model is not adequate.

Coefficient	Estimate	SE	*df*	X^2	P-value
Intercept	-0.3809	0.6982	1	0.2975	0.5854
Month			6	12.5182	0.0514
May	-2.6850	1.3830			
June	-2.8364	1.1171			
July	0.1364	0.8178			
August	0.2038	0.9252			
September	-0.0728	0.8574			
October	-0.7346	1.0489			
Year			2	13.5802	0.0011
2006	-2.8608	1.0889			
2007	1.0921	0.5772			
Chute			10	17.3381	0.0672
Tobacco Island	-1.8314	0.6038			
Upper Hamburg	-16.2057	924.4			
Lower Hamburg	-16.4611	436.6			
Kansas (upper)	-15.5713	496.9			
Kansas (lower)	-16.4766	666.8			
Deroin	-17.0732	689			
Lisbon	-17.3406	236.1			
Overton	-16.5523	317.5			
Tadpole	-16.6192	297.8			
Tate	-5.1267	1.3089			
Turbidity	0.0050	0.0018	1	7.8009	0.0052
R-square = 0.5794					
Goodness-of-fit test			5	1.6615	0.8937

Table IV.1.42. Odds ratios for habitat variables that significantly contributed to the spotfin shiner regression model.

Variable	For every X units of change	The odds of presence increase X times	Greater odds in
Continuous Variables			
Turbidity (NTU)	+100	1.6	Turbid water
Categorical Variables	*NA*		
April vs June	-	17.1	April
May vs July	-	16.7	July
May vs August	-	17.9	August
May vs September	-	13.7	September
June vs July	-	19.6	July
June vs August	-	20.8	August
June vs September	-	15.9	September
2006 vs 2007	-	52.6	2007
2006 vs 2008	-	17.5	2008
California (NE) vs Tobacco Island	-	6.2	California (NE)
Tate vs Tobacco Island	-	27.0	Tobacco Island

While neither depth nor velocity were important variables in the mini fyke net logistic regression model, KDE plots indicated that spotfin shiners orient towards water velocities between 0.3 and 0.6 m/s (Figure IV.1.24). A specific water depth selection was not evident, but few (n = 123) spotfin shiners were collected that may limit our understanding of specific habitat selection.

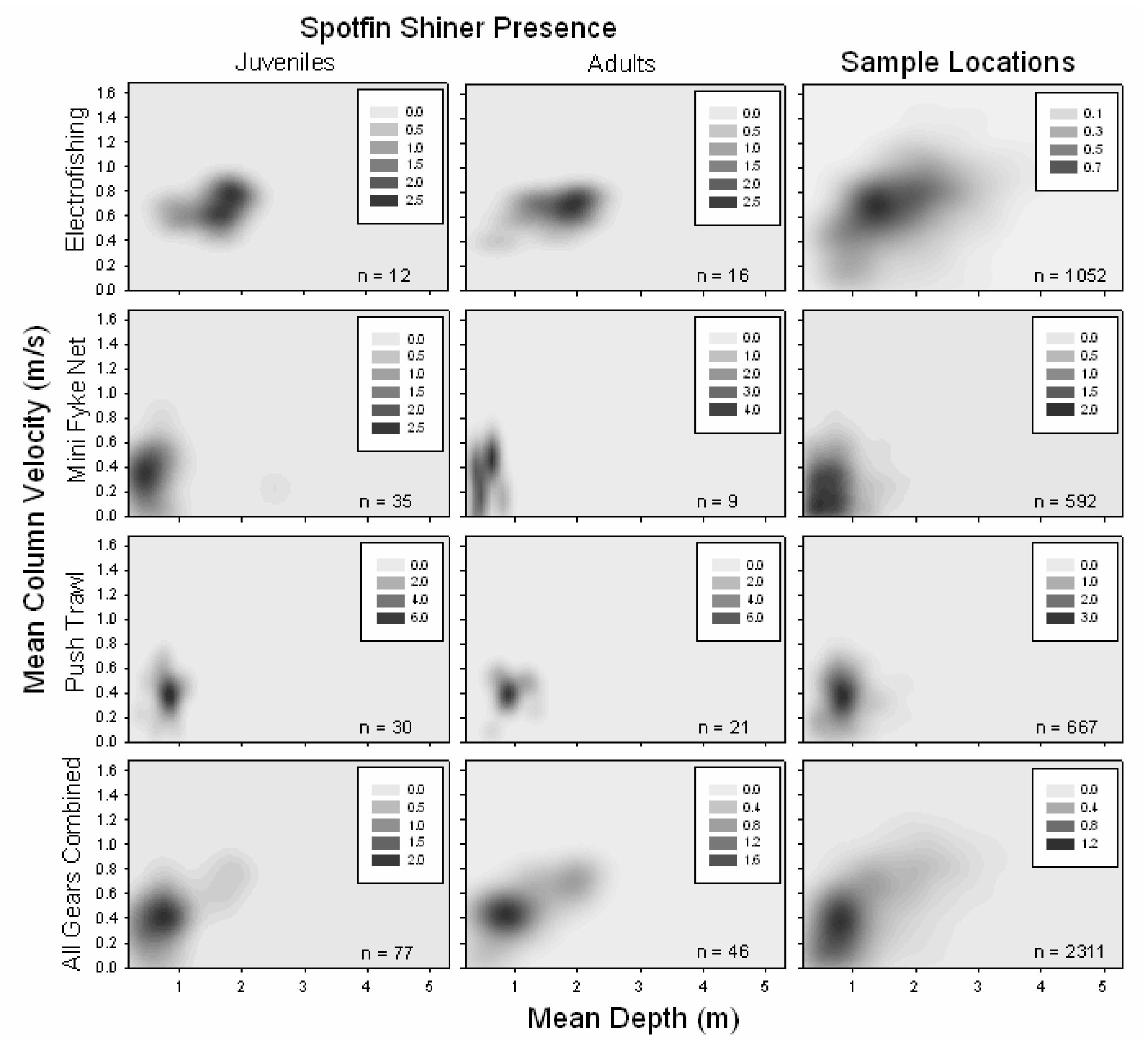


Figure IV.1.24. Kernel density estimates of mean depth (m) and mean column velocity (m/s) locations where juvenile (<64 mm) and adult (≥64 mm) spotfin shiners were present and where electrofishing, mini fyke net and push trawl samples were taken. Samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008.

Channel Shiner

No model could be developed for channel shiners due to low catches. Kernel density estimate plots showed that channel shiner presence was proportionally greater for water depths up to 2.0 m compared with that sampled by mini fyke nets or push trawls, indicating that this species can utilize a range of depths (Figure IV.1.25). Most channel shiners were present in velocities <0.6 m/s, but no strong selection was evident.

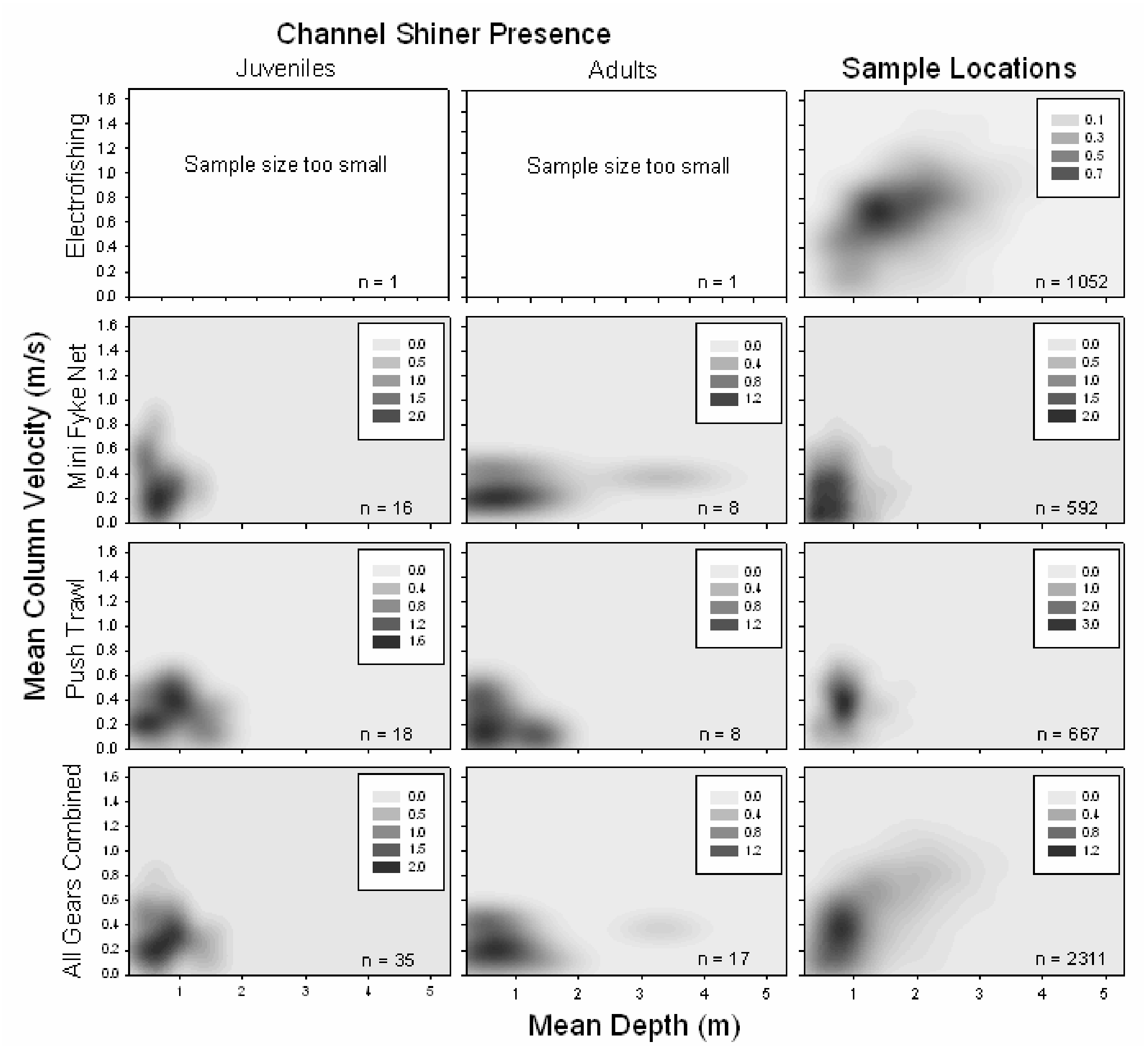


Figure IV.1.25. Kernel density estimates of mean depth (m) and mean column velocity (m/s) locations where juvenile (<43 mm) and adult (≥43 mm) channel shiners were present and where electrofishing, mini fyke net and push trawl samples were taken. Samples were collected in twelve side-channel chutes (California (NE), California (IA), Tobacco Island, Upper Hamburg, Lower Hamburg, Kansas (upper), Kansas (lower), Deroin, Lisbon, Overton, Tadpole and Tate) during 2006-2008.

SUMMARY OF RESULTS AND DISCUSSION

Mitigating for habitat loss of an entire fish community requires consideration of habitat requirements from multiple guilds in order to effectively recover an ecosystem. Models developed for target species represent a variety of species guilds that collectively require a diverse set of habitats to maintain sustainable populations. As we proceed through the discussion, we will identify significant habitat predictor variables at the chute and sample level, and discuss how these variables can affect mitigation efforts.

The overarching goal of this chapter was to apply predictive models in order to guide mitigation strategies for habitat loss on the main-stem Missouri River. However, only a select group of variables can be easily modified by river engineers (e.g., depth, velocity, turbidity and substrate). Other variables may be predictors for natural environmental changes (e.g., year, temperature, dissolved oxygen and discharge), species habitat use or a function of gear catchability (e.g., turbidity).

Few chute level variables (i.e., length, width and sinuosity) were important predictors for target species presence, except for the categorical variable chute, which was a significant variable for 16 of the 20 (80%) target species' logistic regression models (Table IV.1.43). Sinuosity was the second best chute level variable but only occurred in three species' models. What this implies is that individual chute level characteristics may not be adequate species predictors but collectively were important for determining species presence.

Because chute was an important predictor variable, it indicates that some species were more likely to be present in some chutes than others. Why is this though? It has become obvious that the selected chutes that we studied have different geomorphic

features with variable habitats (Section II.2-14). Some chutes provide diverse habitat conditions, while others may not. We can be certain that chutes are mitigating for fish habitat loss because all chutes had target species present. However, all chutes are not equally mitigating for habitat loss that native target species depend upon. Constructing chutes that satisfy the habitat needs of a diverse native fish community would be the most effective mitigation strategy.

Four chutes consistently ranked in the top three for the greatest probability of species presence for the 16 species where chute was a significant predictor variable. California (NE) and Tate chutes ranked in the top three for 50% of the models and Tobacco Island and Lisbon chutes for 38% of the models. The Hamburg Bend chutes ranked in the top three chutes for 25% of the species' models. By relating species presence models to habitat multivariate analysis for chutes (II.14; Figure II.14.4), we can better understand why the top six chutes were important for a large river fish assemblage. Block four (Figure II.14.4) was considered the target condition for physical characteristics of chutes and was characterized as long and wide with high width to depth ratios. Lisbon, Tate and Upper Hamburg chutes were grouped into block four and were also three of the top six chutes for the greatest probability of target species presence. Chutes in blocks two and three were considered to have some favorable as well as un-favorable habitat conditions. California (NE), Tobacco Island and Lower Hamburg chutes fell into blocks two and three and also had relatively higher probability of target species presence than other chutes. Chutes in block one were considered unfavorable to target species and the logistic models indicated the probability of species presence was generally lower for this group of chutes. As a general conclusion, chutes that were

longer, wider, shallower and had greater sinuosity were more likely to have target species present.

Sample level variables occurred as significant predictor variables more often than individual chute level variables. The most important variables were year (85% of species models), water depth (80%), turbidity (65%), water temperature (60%), month (60%) and water velocity (50%; Table IV.1.43). The other variables tested may have been important predictors for some species but not necessarily the entire target species community.

Table IV.1.43. Habitat variables used to model the presence of 20 target Missouri River species and the number of times each variable was a significant predictor.

Chute Level	Number of Models	Sample Level	Number of Models
Chute	16	Depth	16
Length	2	Bottom or Column velocity	10
Width	1	Temperature	12
Length to width ratio	0	Turbidity	13
Sinuosity	3	Dissolved oxygen	3
<5 years old	1	Availability of cobble	4
Backwaters available	0	Availability of organic matter	6
Tie channel present	2	Mean substrate size	7
		Discharge	0
		Month	12
		Year	17

Year was a significant variable in 85% of the species models, indicating that probability of species presence varied on an annual basis. Obviously, year is not a variable that can be modified by river engineers. Instead, it serves as an indicator for overall river conditions that may drive ecological processes (e.g., success of recruitment, habitat availability, condition or mortality). Chub species (speckled chub, sturgeon chub and sicklefin chub) are important Missouri River fishes because they were a group that experienced significant declines in abundance with river modifications (Pflieger and Grace 1987; Galat et al. 2005). For all chubs, odds of presence were greatest during 2006 than other years. Other species like channel catfish, river carpsucker, gizzard shad,

emerald shiner and red shiner also had the greatest odds during 2006. So what was different about 2006 than 2007 or 2008? Mean annual discharge during 2006 was the lowest over the last 50 years according to the Boonville, MO gauge (USGS 2009; Figure IV.1.26). We expect that low water conditions allow sampling gears a greater chance of catching fish in a constrained side-channel compared to flood periods where fish may be spread over a larger area. It is unlikely that drought-like conditions actually increase abundance of target species, just that biologists were more likely to detect their presence.

The month when sampling occurred was significant for 60% of species models. Like year, month is a variable that can't be manipulated but still aids in the understanding of when we can expect a species to be present in a chute. Presence of a species may be due to seasonal habitat selection and ecology or a function of gear efficiency during certain months of the year (e.g., low detection probability during spring flooding and high water). Based on species model estimates, we observed two general patterns that address both possibilities. Fishes that reached larger sizes (>400 mm), speckled chubs and silver chubs were generally more likely to be present during fall months (i.e., September and October) than summer months (i.e., June, July and August). Whether this seasonal selection is due to gear efficiencies while electrofishing and otter trawling, movement into chutes or a combination of the two is unclear. Small bodied fishes (i.e., emerald shiner, red shiner, spotfin shiner), gizzard shad and goldeye were most likely to be present during summer months. It is likely that recruitment of small bodied fishes into catchable sizes during the summer would increase probability of being present simply because more fish would be available for capture. Gizzard shad are notorious for producing large numbers of young of year (YOY) that survive through the summer but

experience large die-offs during late fall into the winter (Willis 1987; Haines 2000). This is likely why we see the greatest probability of gizzard shad presence during August. From these two general observations, it can be concluded that seasonal use of chutes is likely for at least a portion of the fish community. However, seasonal use varied among species, indicating target species used chutes throughout the study months.

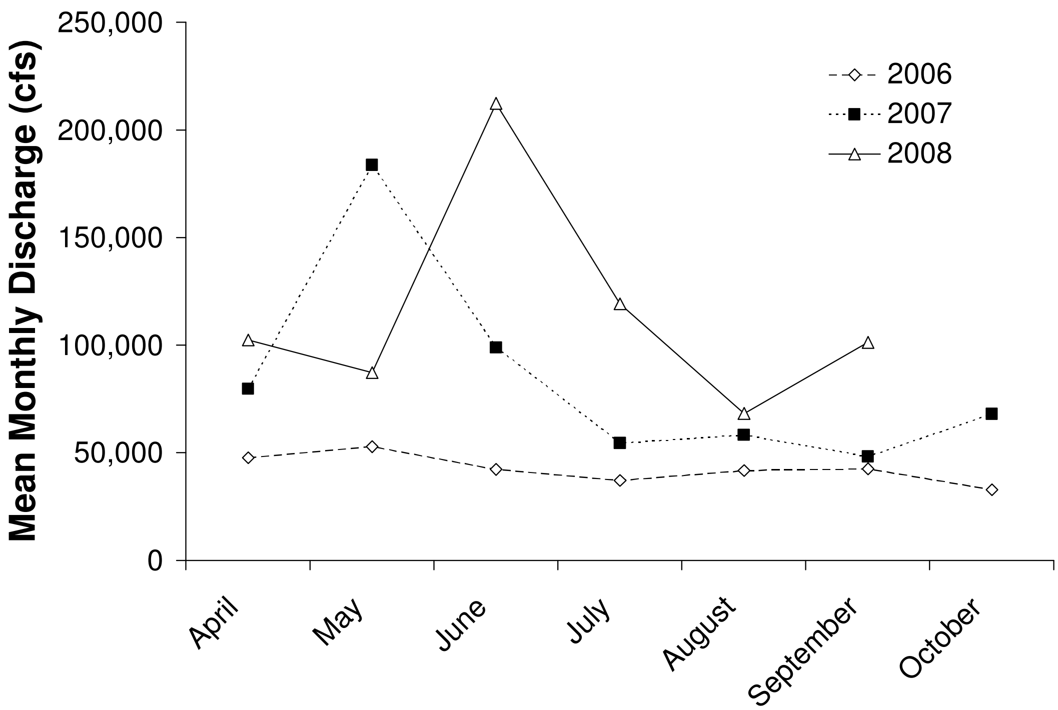


Figure IV.1.26. Mean monthly discharge (cfs) at Boonville, MO during the study period (USGS 2009). October 2008 was not available when this report was written.

Water temperature and month are variables that may be correlated, but each variable models a different response in species presence. For example, a species may have greater odds of presence during cold water (i.e., during early spring and late fall months). However, the same model might estimate greater odds of presence during only the fall months, that indicates a seasonal effect and not a temperature effect. When these two variables are included in the same model, they can interact in different ways as seen in the following species; channel catfish, shovelnose sturgeon, speckled chub, silver

chub, gizzard shad, goldeye and emerald shiner. Some models estimated greater odds during colder months but also in warmer water temperatures. In this scenario, the two variables likely interact to balance probability of presence. Conversely, a model that estimates greater odds of presence during cold months as well as during cold temperatures has a compounding increase in probability since direction of the effect is the same.

Water temperature was a significant variable in twelve species' models, and the estimated regression coefficients were negative for nine species, indicating they had greater odds of presence in colder waters. The Missouri River is a warmwater river that has seen a decrease in water temperatures with river impoundments and hypolimnetic water release (Hesse and Sheets 1993; National Research Council 2002). Decrease in water temperatures is one of many factors implicated in the decline of native fishes (Pflieger and Grace 1987; Galat et al. 2005). Therefore, we do not interpret our models as cold water is better for native fishes, but that the negative regression coefficients are interacting with month and may only indicate the best temperature conditions to collect the species.

The Missouri River is naturally a very turbid river, hence the reason for the nickname "Big Muddy". With river modification and bank stabilization, sediments have been trapped in reservoirs and retained in the floodplain, that reduced turbidity in the river and altered the unique geomorphologic processes that maintained critical habitats for native fishes (Jacobson and Galat 2006). Turbidity was included in thirteen species' models as a significant predictor of presence, where seven species exhibited a positive response to turbid water and six to relatively clearer water. Species that related to turbid

water included channel catfish, sauger, bigmouth buffalo, speckled chub, sturgeon chub, silver chub and spotfin shiner, whereas river carpsucker, gizzard shad, goldeye, blue sucker, river shiner and sand shiner were expected in relatively clearer water. The modeled expectations generally correspond to life histories and habitat requirements as described in Pflieger (1997), where sight feeding species were present in clearer water and taste sensing species in turbid water. One thing to recognize is that turbidity changes latitudinally in the lower Missouri River as tributaries from agricultural lands in lower portions of the river feed sediment into the main river. Therefore, it might be expected to find more sight feeding fishes near Gavins Point Dam. Blue suckers did not match our expected pattern because they are a species tolerant of high turbidity (Pflieger 1997), but they were found in clearer water. This contrasting response from blue suckers may be a product of greater abundance in upriver side-channels that ultimately leads to an estimated greater probability of presence.

We recognize water depth and water velocity as two variables that can be most easily manipulated by river engineers. The combination of logistic regression modeling and kernel density estimation plots helps explain selected depths and velocities for a variety of species. Water depth was a significant predictor variable for 80% of species models and water velocity for 50%. However, the selected range of depths and velocities varied by species, which would be expected with a diverse fish community.

Shallow water, which is relative for each gear (e.g., mini fyke nets can be fished at depths of 0.1 m whereas otter trawls at a minimum depth of ~1.0 m), was preferred for 11 of the 16 species (69%) where water depth was a significant variable. Species such as silver carp, shovelnose sturgeon, bigmouth buffalo, smallmouth buffalo and blue sucker

were the only species that had greater odds of being present in deeper water habitats. A general observation related to depth is that many juveniles and small-bodied fishes in general had greater probabilities of presence near the shallow range of depths (generally <1.0 m). Conversely, large-bodied fishes tended to orient towards relatively deeper water. As stated earlier, shallow chutes with high width to depth ratios (Figure II.14.4) tended to be the most productive chutes for a variety of species.

A relatively slower water velocity was preferred for six out of ten species where velocity was a significant variable. The four species that were present in faster velocity waters were sturgeon chub, goldeye, emerald shiner and river shiner, all of which Pflieger (1997) expected to find in moving waters. The six species most likely to be found in slow velocity water were sauger, grass carp, smallmouth buffalo, river carpsucker, silver chub and gizzard shad, all of which are generalist species except sauger. Sauger are a fish of flowing waters and KDE plots indicated that most presences were in water velocities of 0.5-0.6 m/s. The other 50% of species models indicated that water velocity was not a significant predictor variable for species presence, indicating they may be present in a wide range of velocities. Essentially what this exercise indicates is that a variety of velocities are needed to support the community of target species.

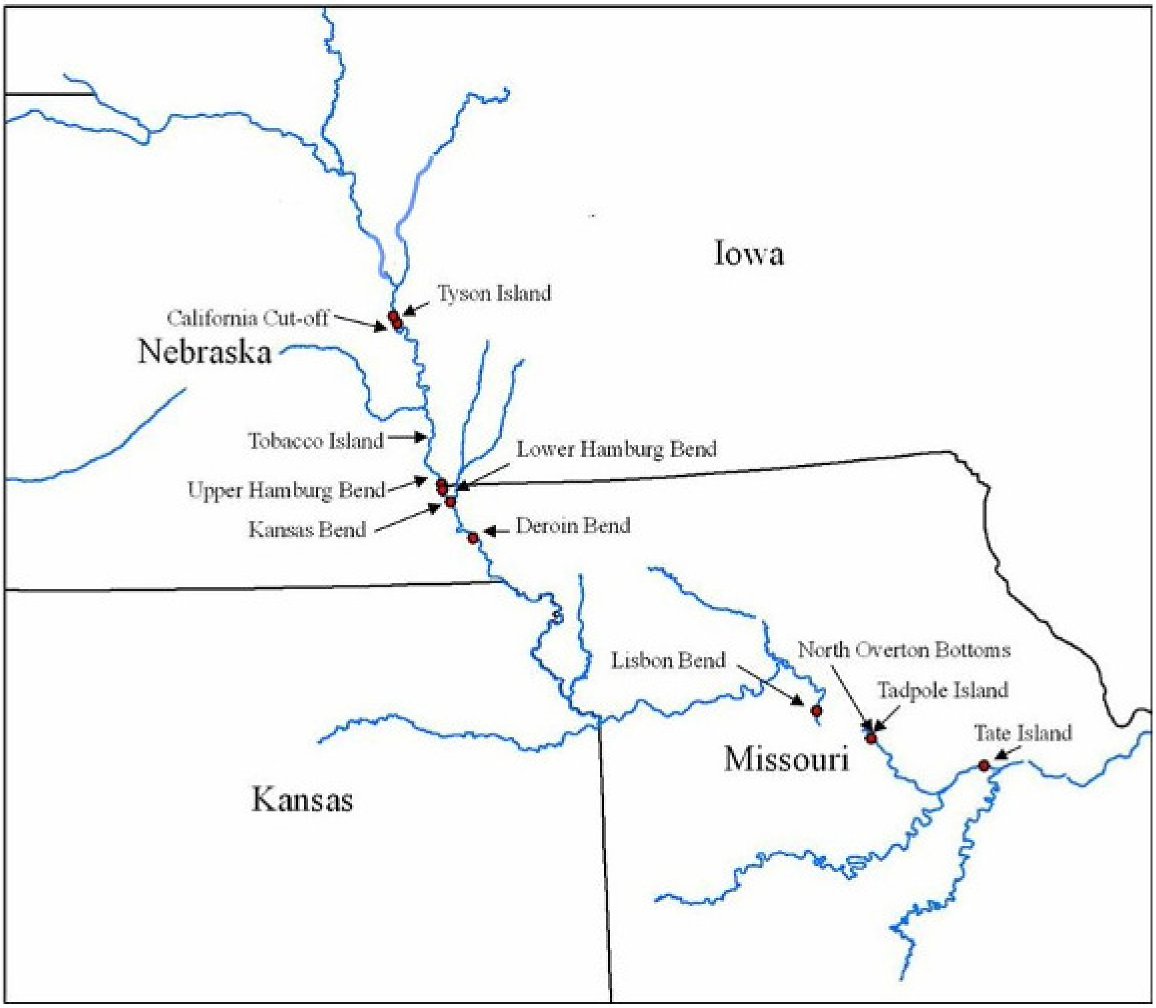
The combination of logistic regression models and kernel density estimate plots generally resulted in the same conclusion regarding depth and velocity habitat selection, and this helps confirm our conclusions by the use of two different analytical techniques. The modeling approach produced quantitative probability estimates whereas kernel density estimates produced a qualitative assessment of the data. When interpreted in tandem, selection of water depths and water velocities for target species can be better

understood. One main lesson we learned is that many juvenile fishes utilized shallow water habitats (<1.0 m) over a broad range of water velocities (0.0-1.0 m/s). Therefore, it would be reasonable to conclude that creating shallow water habitats with a range of velocities would likely benefit many juvenile native species.

We feel the modeling and kernel density estimate approach serves as an exploratory technique for identifying important variables to predict presence of large river fishes. We urge caution in interpreting stepwise logistic regression models as true models to predict species presence because they have not been validated through statistical procedures or additional field testing. All models generally had low R^2 values, indicating other variation was present in the data, likely environmental and sampling variability.

In conclusion, the diverse community of target species clearly utilizes a variety of habitat conditions within side-channel chutes. One of the most important findings from this modeling exercise was that longer, wider, shallower and more sinuous chutes were more likely to have target species present. Newly constructed chutes generally did not exhibit these characteristics, and the target species community typically had lower probabilities of presence in this group of chutes. While all side-channels contained native large-river fishes, lack of habitat diversity and shallow water habitats (<1.0 m) in narrow and deep chutes relative to older more developed chutes may limit effectiveness of habitat mitigation for native large-river fishes.

Section IV
Chapter 2
Biological Comparison



List of Tables

List of Figures

Figure Page

Methods

We compared fish communities from all of our sites (chutes and backwaters), and we also made comparisons just among the flow-through chutes using the total number of each species collected. We used nonmetric multidimensional scaling (NMS) ordinations for both comparisons and methodology used was the same for both ordinations. Data were relativized (maximum, by species) to reduce the influence of highly abundant species. To account for rare species, those species not present in at least three sites were removed from the data set. An outlier analysis was conducted and outliers (species) were removed from the data set. We chose to use Sorenson's distance measure because it is known to work well with community data and gives less weight to outliers than other distance measures (McCune and Medford 1999). The final version of both ordinations was run with 50 iterations of real data along with 250 iterations of randomized data serving as a Monte Carlo significance test.

Species richness, evenness, Shannon's diversity index, and Simpson's diversity index were calculated using Primer software (Clarke and Warwick 2001). We compared proportions of juveniles among chutes using multidimensional scaling (MDS; Clarke and Warwick 2001) for species that comprised >1% of the communities. Juvenile size classes were defined using Pflieger (1997).

Results

For the first NMS ordination we chose to interpret a two-dimensional solution with a final stress of 6.94. The ordinations graph was rotated -30 degrees for ease of interpretation. The plot of all sites (NMS1) using the total number of each species is

presented in Figure IV.2.1. There is a clear geographical separation of sites from upstream to downstream with backwaters also grouping out separately from chutes. Species that were present in high numbers in backwaters but were rare or absent from chutes included: quillback (Figure IV.2.2), slender madtom (Figure IV.2.3), walleye (Figure IV.2.4), yellow bass (Figure IV.2.5), and yellow perch (Figure IV.2.6). Species that were present in large numbers in the chutes but were rare or absent in the backwaters included: blue suckers (Figure IV.2.7), flathead catfish (Figure IV.2.8), sicklefin chubs (Figure IV.2.9) and shovelnose sturgeon (Figure IV.2.10).

A second NMS ordination (NMS2) was run comparing only chutes (Figure IV.2.11). For NMS2 we chose to interpret a two-dimensional solution with a final stress of 14.0. A separation between the lower and upper river is apparent along Axis 1. Species that were present in high numbers in the lower end of the sampling area (Lisbon, Tate, Overton, Tadpole) and rare or absent in the upper end of the sampling area include: bullhead minnows ($r = -0.864$) (Figure IV.2.12), red shiners ($r = -0.819$) (Figure IV.2.13), bluntnose minnows ($r = -0.799$) (Figure IV.2.14), freshwater drum ($r = -0.788$) (Figure IV.2.15) and sicklefin chubs ($r = -0.760$) (Figure IV.2.9). Species that were present in the upper section of the sampling area (California (NE), Tobacco, Upper Hamburg, Lower Hamburg, Kansas and Deroin) and rare or absent in the lower end of the sampling area included: blue suckers ($r = 0.658$) (Figure IV.2.7) and shovelnose sturgeon ($r = 0.579$) (Figure IV.2.10). The chute at California (IA) separated from all other sites (Figure IV.2.11) due to high catches of bighead carp (Figure IV.2.16) and low catches of channel catfish (Figure IV.2.17) and shovelnose sturgeon (Figure IV.2.10).

Juveniles of most species were found in all chutes. Over half of the chutes (Lisbon, Upper Hamburg, Deroin, Tadpole, Overton and Kansas) had similar proportions of juveniles (Figure IV.2.18). The other five chutes had different proportions of juveniles with California (NE) and Tobacco chutes separating out together (Figure IV.2.18). Juvenile channel catfish, gizzard shad, river shiner, and silver chub were found in large proportions in all chutes (Table IV.2.2). Emerald shiner juveniles were found in lower proportions in Lower Hamburg compared to the other chutes (Figure IV.2.19). Freshwater drum juveniles were found in low proportions in Tobacco, California (NE) and California (IA) chutes (Figure IV.2.20). Red shiner juveniles had their lowest proportions in Lower Hamburg and California (IA) but were very high in Tobacco and California (NE) (Figure IV.2.21). Juvenile river carpsucker proportions were very low in California (IA) and Tate chutes. Lower Hamburg, Tobacco, and California (NE) chutes conversely had high proportions of juvenile river carpsuckers (Figure IV.2.22). Shovelnose sturgeon juveniles were rarely found in Lower Hamburg. Juvenile shovelnose sturgeon were found in greater proportions in Tobacco, California (NE) and California (IA) (Figure IV.2.23). Tate Island had the lowest proportions of juvenile sand shiners compared to the other chutes (Figure IV.2.24).

Lisbon, Tate, and Upper Hamburg chutes had both the most species and the highest species richness (Table IV.2.1). Kansas chute had the fewest species and the lowest species richness for any chute. Among backwaters, Tyson Island and California backwater had the highest number of species and the greatest richness and diversity. These two sites are contiguous backwaters that have an open connection to the main channel during all of the year allowing riverine species to access these sites. This open

connection most likely accounts for their similarity to chutes. The other three backwater sites (Tieville, Middle Decatur, and Louisville) had the lowest number of species, richness and diversity among all sites. These sites are impounded wetlands that were heavily developed with dike and water control structures.

Discussion

Backwaters had fewer species and less diversity than most chutes. Among backwaters, impounded wetlands had fewer species and less diversity than contiguous backwaters. The greatest number of species and highest diversity was found in Lisbon, Tate Island and Upper Hamburg Bend, chutes that were all classified as Block 4 chutes (Figure II.14.4). These chutes can be described as long, wide, and generally shallow, with a high width to depth ratio and a low length to width ratio. Differences between backwater and chute fish communities were the result of the almost complete lack of riverine species in impounded backwaters and more specifically a lack of benthic riverine species such as blue sucker, shovelnose sturgeon, and chub species in the contiguous backwaters. Instead of these riverine species, backwaters contained large numbers of centrarchids, clupeids, temperate basses, and percids. Miranda (2005) found similar results when sampling oxbow lakes with connectivity to the Mississippi River.

There was geographical separation in the fish communities among chutes in the Middle Missouri River (i.e., chutes in Nebraska and northern Missouri) and Lower Missouri River chutes (Lisbon, Tate, Overton, and Tadpole), that tended to have greater numbers of sicklefin and speckled chub. Grady and Milligan (1998) found that sicklefin chub were sampled primarily in the lower 371 km of the Missouri River and Dieterman

and Galat (2004) determined that sicklefin chub occurred more frequently in areas that were over 301 km downstream from an impoundment and in areas with sandbar shorelines. The Lower Missouri River chutes exhibit both criteria. Sturgeon chub were found in higher numbers in Middle Missouri River chutes. This lack of overlap is surprising considering that they occupy similar habitats (Pflieger 1997). A possible explanation is that there may be more gravel substrate in Middle Missouri River chutes than in the lower chutes. Sturgeon chub have been noted as having an affinity for gravel substrates (Bailey and Allum 1962; Pflieger 1997).

The northernmost sites, specifically Tobacco and California (NE), tended to have higher proportions of juveniles than their southern counterparts (Table IV.2.2). Blue sucker and shovelnose sturgeon were found in greater numbers in the northernmost chutes as well. Several studies have shown that the Missouri River upstream of Kansas City tends to have less habitat diversity (Schlosser 1987; Peterson and Rabeni 2001; Shea and Peterson 2007). Wildhaber et al. (2003) reported that shovelnose sturgeon were more frequently sampled in shallow and smooth (i.e., more uniform) depths. Ellis et al. (1979) reported that side channels with more habitat diversity had more fish diversity. Therefore, chutes above Kansas City may be adding to habitat diversity of their reach of river more so than chutes below Kansas City

The California (IA) chute separated itself from other chutes because of large numbers of bighead carp that were sampled there (Figure IV.2.2). Asian carp tend to inhabit pools and backwaters (Pflieger 1997). This chute was also different due to its low proportions of juvenile freshwater drum, red shiner, and river carpsucker. While shovelnose sturgeon, in general, were rare at California (IA), shovelnose sturgeon

juveniles were found in higher proportions than at other chutes. It was determined that as flows increase in the main channel, flows in the chute at California (IA) chute actually decrease and the chute functions like a backwater (see Section II, Chapter 2).

Overall, Lisbon, Tate and Upper Hamburg seem to be different from the more recently constructed chutes. These three sites are older, have experienced more high water events and have more natural/favorable habitat characteristics that results in greater number of species, diversity and numbers of fish. The younger chutes (i.e., Overton, Kansas, and Lower Hamburg) have experienced two major floods, but they have not had the expected evolution due to these events. In constructing these newer side channel chutes, grade control structures were installed to help reduce deepening and widening of the channel. By doing this, newer chutes have steep banks with a trapezoidal channel, and provide little habitat that has reduced water velocities and/or shallow areas. Hesse and Sheets (1993) said that grade control structures may impede or preclude recovery of natural morphology of side channels. Therefore, the most recently constructed chutes are developing slowly. Soil chemistry also plays an integral role in the evolution of chute morphology and habitat creation. Heavier soils can be harder to erode and need the hydraulic energy of a larger pilot channel in order to continue to develop (Remus 2007). Hard or compacted soil types (clays and heavy silts) may be responsible for the lack of evolution. Younger, less evolved chutes tended to lack or have low numbers of certain species possibly due to the lack of habitat creation due to these factors.

The fish community and the available habitat in the main river channel probably has a large influence on how chutes are utilized by species in different parts of the river. The lower section of the Missouri River has a wider channel and larger sandbars than the upper section. More available habitat in the main channel of the lower river may explain

why some species are not utilizing Lower Missouri River chutes in a similar manner as Middle Missouri River chutes. Therefore, location may influence the contribution of a chute or backwater. Koel (2004) showed that side channels and contiguous backwaters had higher species richness than habitats in the main channel. More research comparing the main channel fish community to those in side channels and backwaters should be done to gain a more accurate description of how these mitigated habitats are benefiting the Missouri River.

Key Points

- Natural and older, more developed chutes have greater numbers of species and richness.
- The available main channel habitat and fish community may determine the utilization of a chute.
- Chutes are acting as juvenile habitat for most species.
- Connection to the main channel results in backwaters with greater numbers of species, richness and diversity.
- Backwaters have very different fish communities compared to chutes.
- Consideration should be given to the target fish species or community when choosing the type of habitat restoration project.

Table IV.2.1. Number of species (S), number of fish (N), species richness (d), evenness (J'), Shannon's diversity (H'), and Simpson's (D) for all sites.

Sample	S	N	d	J'	H'	D
Lisbon	60	17301	6.046	0.6843	2.802	0.9119
Tate Island	59	16827	5.960	0.6036	2.461	0.8511
Upper Hamburg	54	10563	5.720	0.7142	2.849	0.9233
Tobacco Island	52	24381	5.049	0.6678	2.638	0.8802
California (NE)	52	15887	5.272	0.6892	2.723	0.9054
Tadpole Island	52	7967	5.677	0.6442	2.545	0.8761
Overton	52	6777	5.781	0.7016	2.772	0.9059
Deroin	50	5781	5.657	0.7692	3.009	0.9323
Lower Hamburg	49	5582	5.564	0.7478	2.910	0.9200
Tyson Island	46	14082	4.711	0.7026	2.690	0.8908
California BW	44	26745	4.218	0.6770	2.562	0.8865
California (IA)	44	2909	5.391	0.7719	2.921	0.9266
Kansas	43	7502	4.707	0.5908	2.222	0.7780
Middle Decatur	41	31357	3.864	0.5051	1.876	0.7341
Louisville	39	33968	3.642	0.6135	2.248	0.8461
Tieville	38	68098	3.325	0.3840	1.397	0.6708

Table IV.2.2. Percentage of juveniles in each chute for species that comprised >1% of the fish communities.

Species	Upper Hamburg	Lower Hamburg	Kansas	Deroin	Tobacco	California (NE)	California (IA)	Tadpole	Overton	Lisbon	Tate
Channel catfish	94.89	79.64	82.30	92.81	100.00	96.65	82.64	92.94	90.27	89.86	92.87
Emerald shiner	78.67	62.53	74.00	80.67	97.35	93.11	92.05	89.95	91.34	88.37	89.24
Freshwater drum	91.79	85.66	81.48	91.14	62.83	62.78	58.21	84.48	70.57	85.50	89.85
Gizzard shad	89.52	85.38	76.92	85.87	99.03	97.74	83.01	81.03	84.06	83.03	88.86
Red shiner	56.39	41.67	63.89	65.35	96.12	87.92	30.77	51.97	55.57	76.53	67.98
River carpsucker	87.35	84.42	66.67	71.51	92.88	91.70	53.57	77.84	63.16	81.96	48.06
River shiner	94.04	84.68	89.63	94.59	99.80	98.73	95.17	100.00	87.50	94.01	87.50
Shovelnose sturgeon	40.15	27.13	34.61	41.99	87.71	73.98	70.93	35.20	50.38	53.04	55.25
Sand shiner	84.84	71.79	81.50	88.75	99.08	96.24	89.47	100.00	85.71	78.00	51.85
Silver chub	86.96	95.14	95.42	87.31	99.46	98.11	99.51	98.28	91.82	99.35	97.17

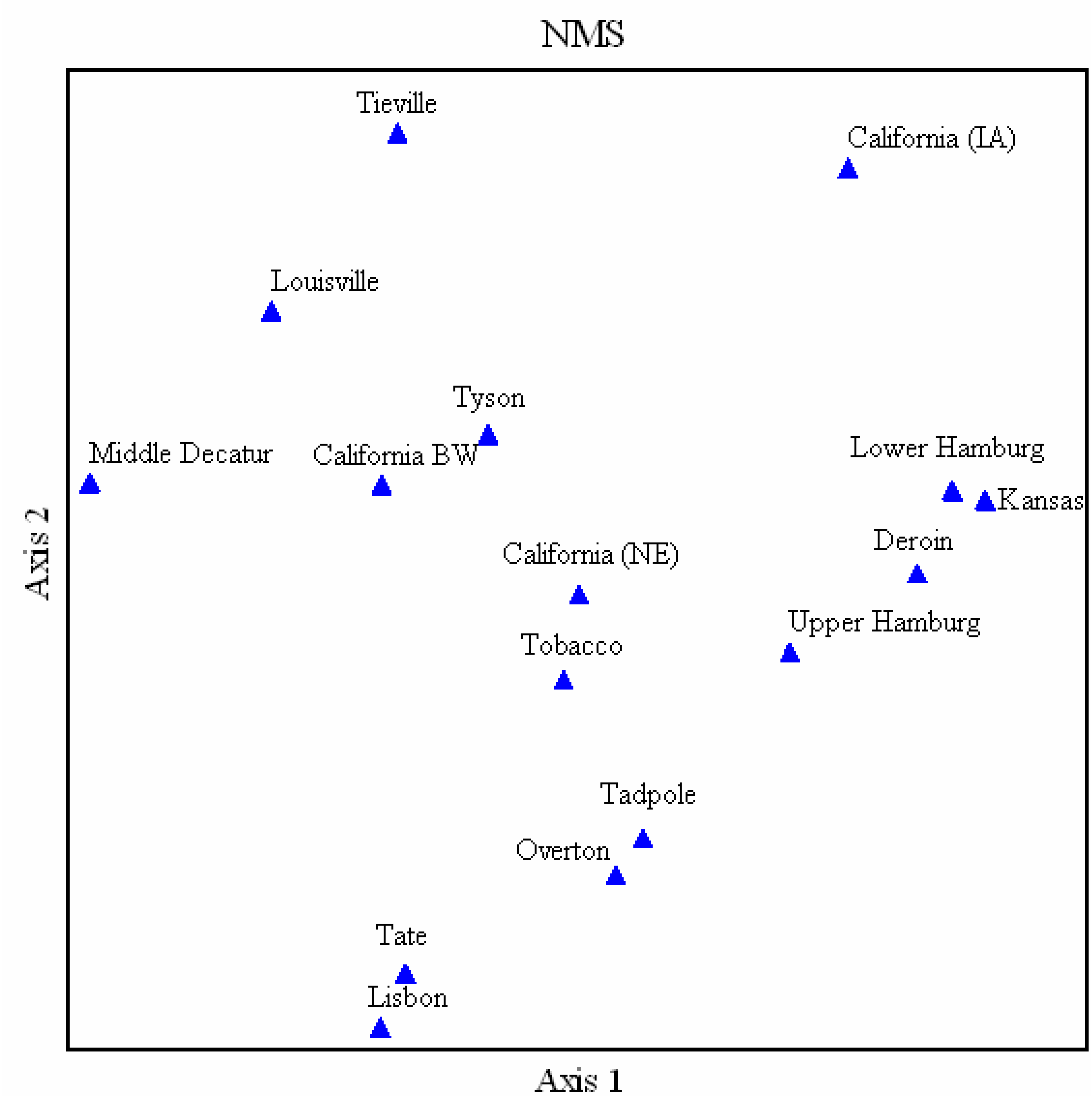


Figure IV.2.1. Non-parametric multidimensional scaling (NMS) plot of all sites by fish community.

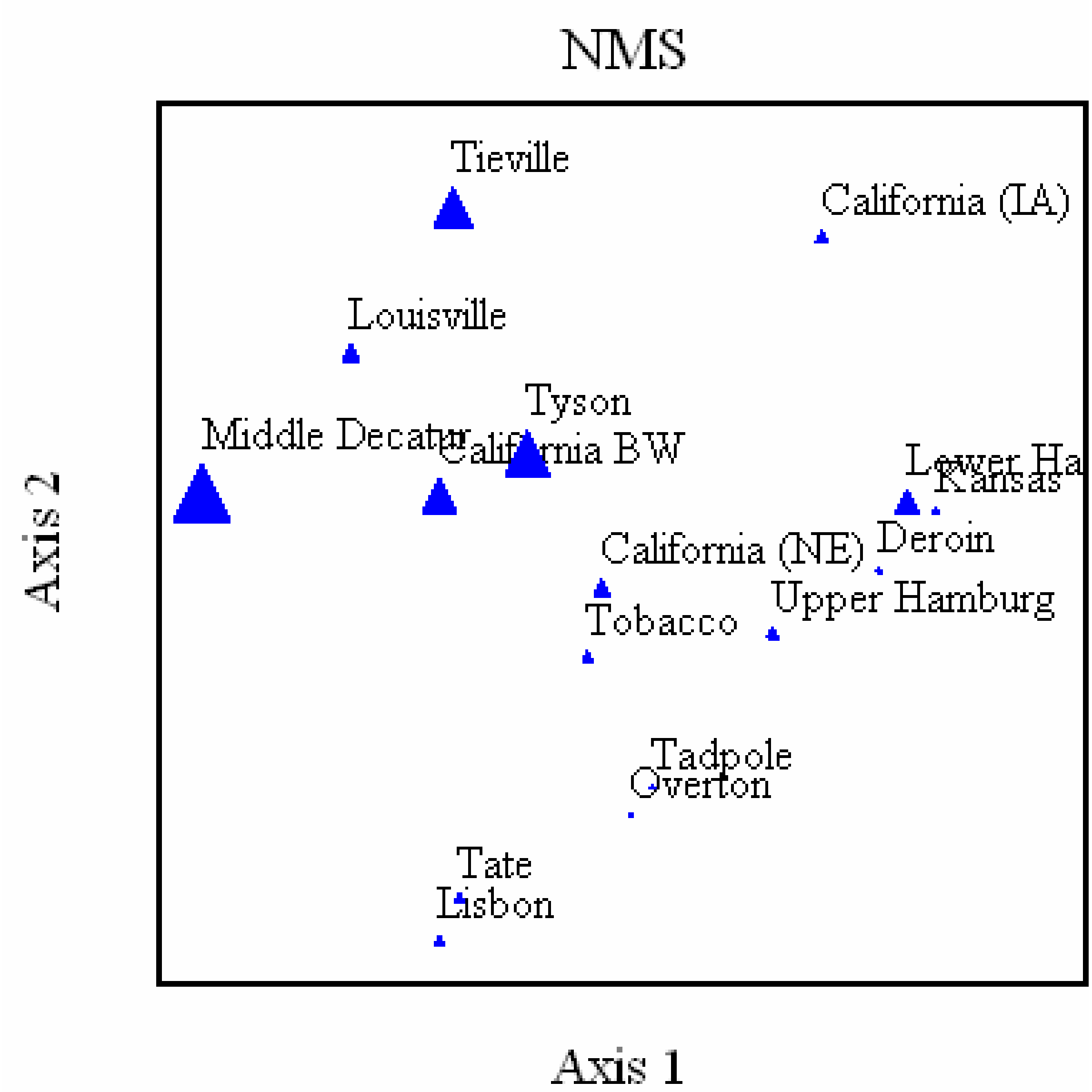


Figure IV.2.2. Quillback affect on Non-parametric multidimensional scaling (NMS) plot of all sites. Large triangles represent greater influence.

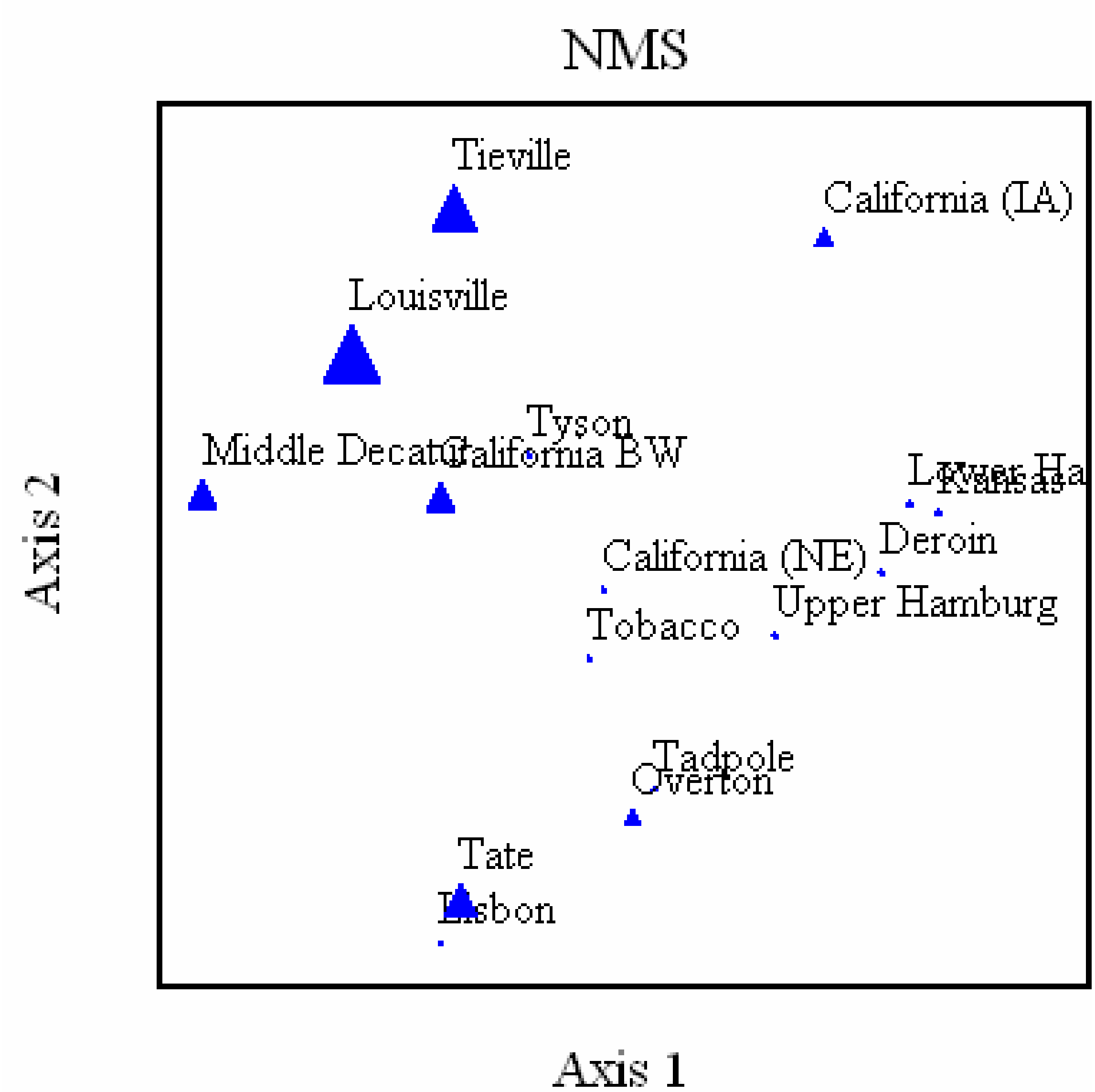


Figure IV.2.3. Slender madtom affect on Non-parametric multidimensional scaling (NMS) plot of all sites. Large triangles represent greater influence.

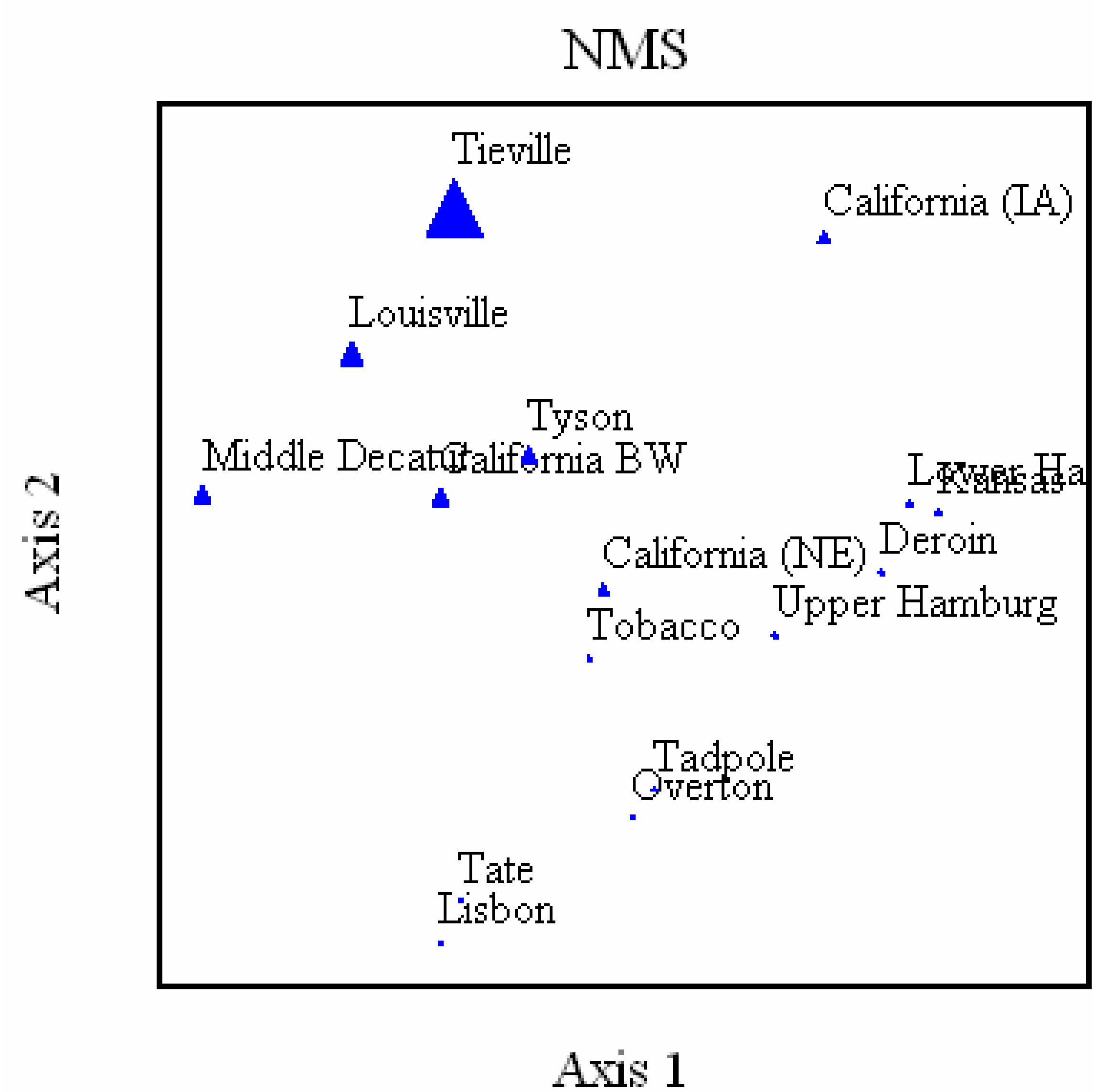


Figure IV.2.4. Walleye affect on Non-parametric multidimensional scaling (NMS) plot of all sites. Large triangles represent greater influence.

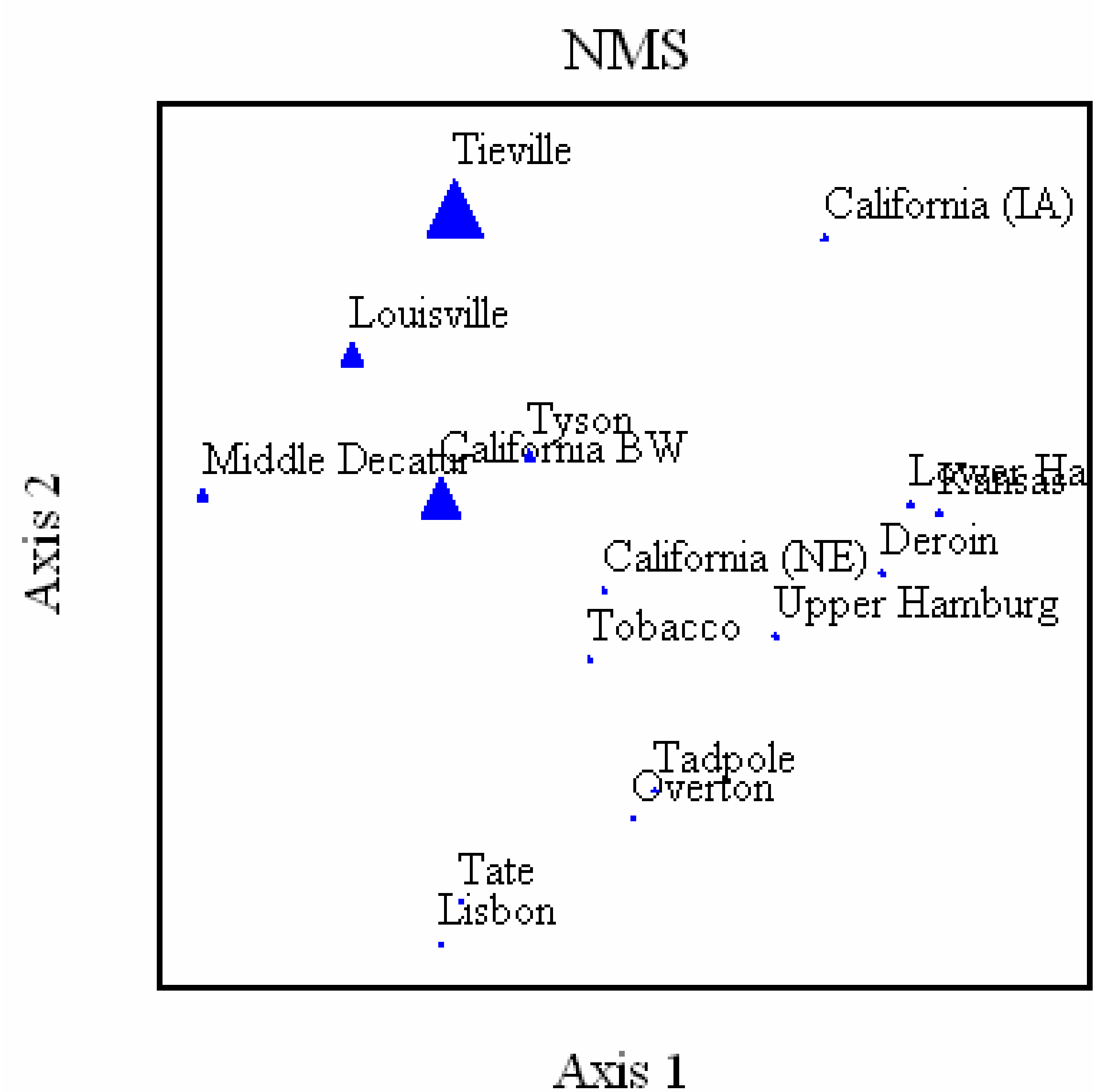


Figure IV.2.5. Yellow bass affect on Non-parametric multidimensional scaling (NMS) plot of all sites. Large triangles represent greater influence.

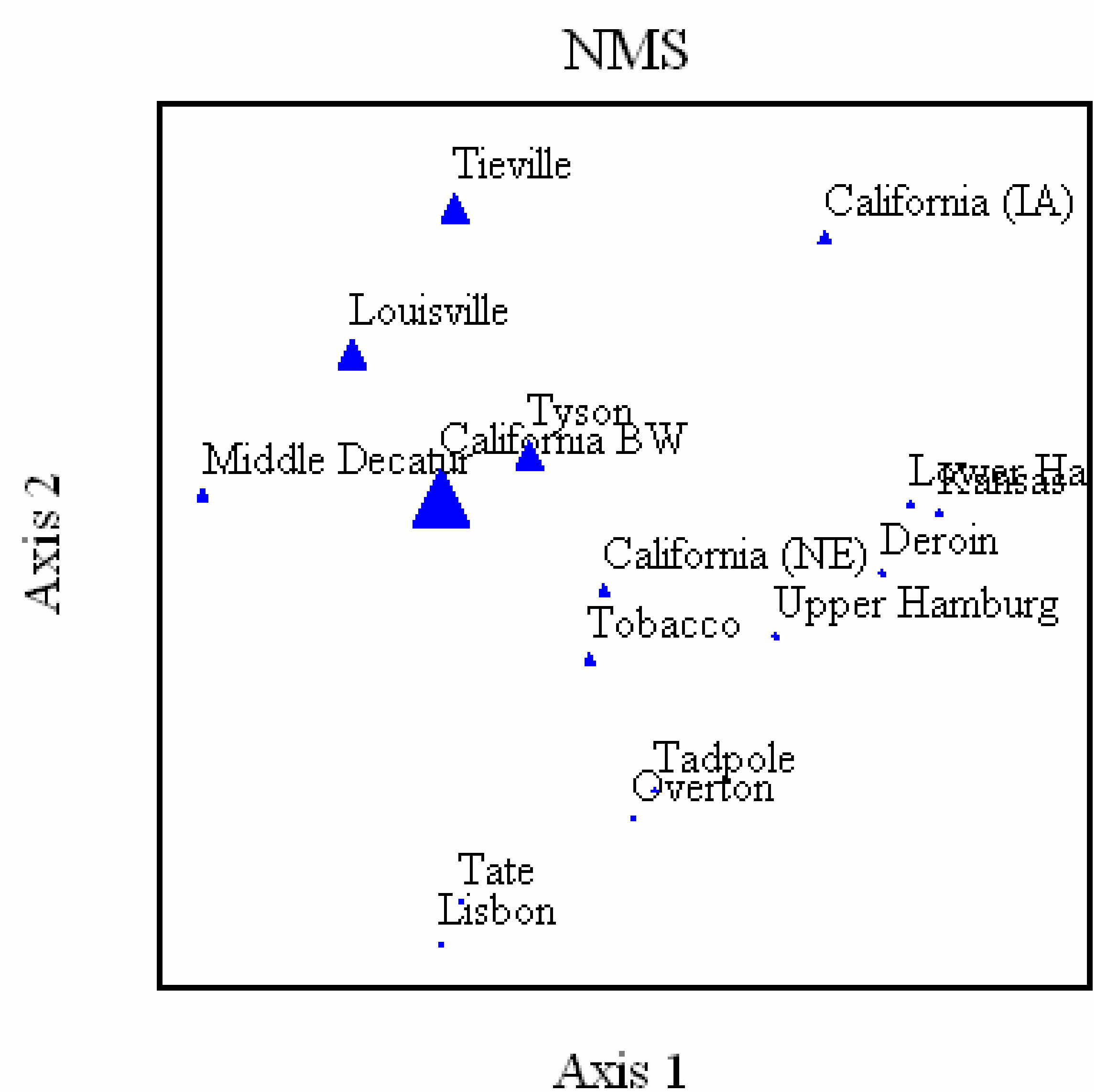


Figure IV.2.6. Yellow perch affect on Non-parametric multidimensional scaling (NMS) plot of all sites. Large triangles represent greater influence.

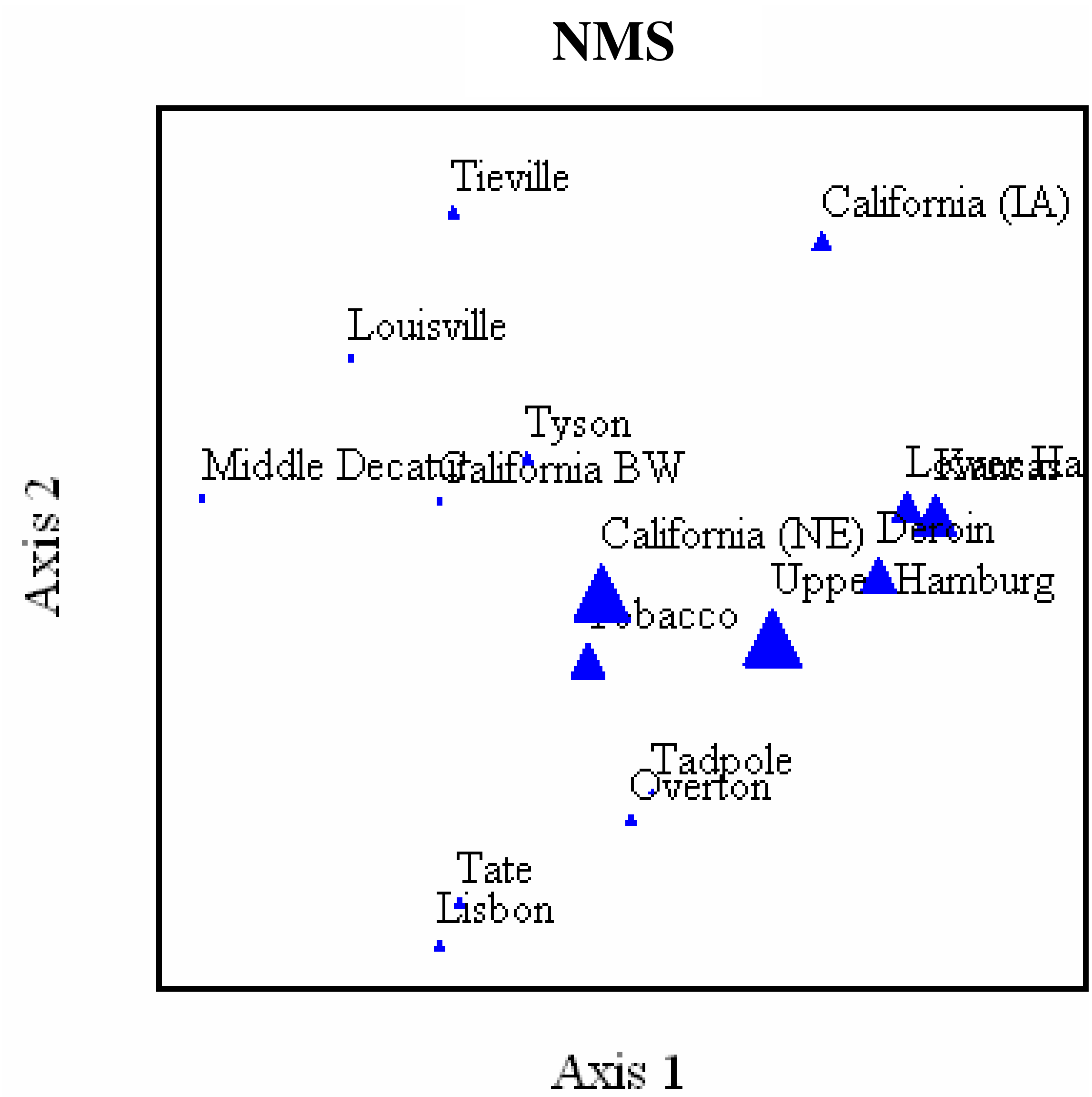


Figure IV.2.7. Blue sucker affect on Non-parametric multidimensional scaling (NMS) plot of all sites. Large triangles represent greater influence.

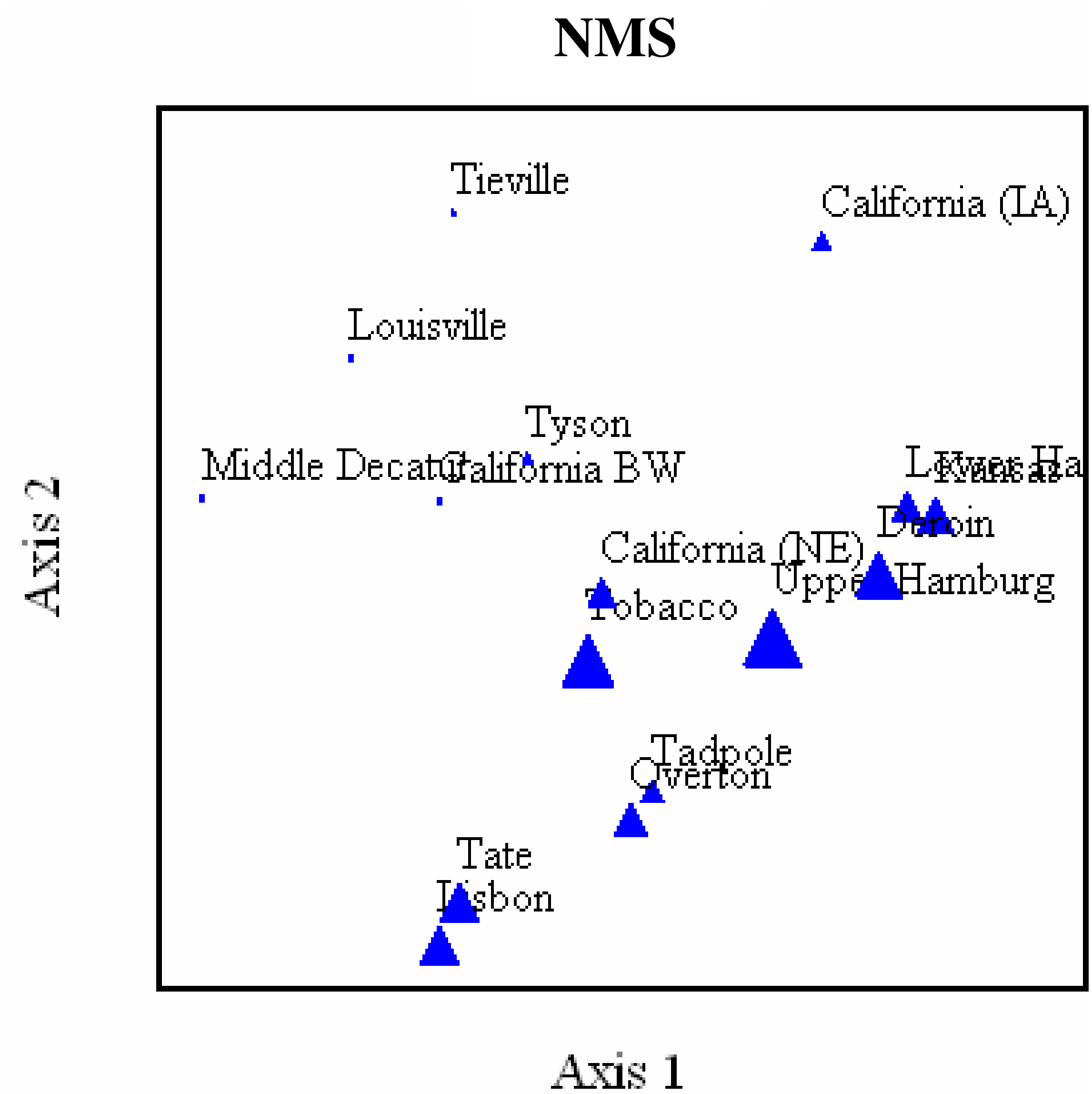


Figure IV.2.8. Flathead catfish affect on Non-parametric multidimensional scaling (NMS) plot of all sites. Large triangles represent greater influence.

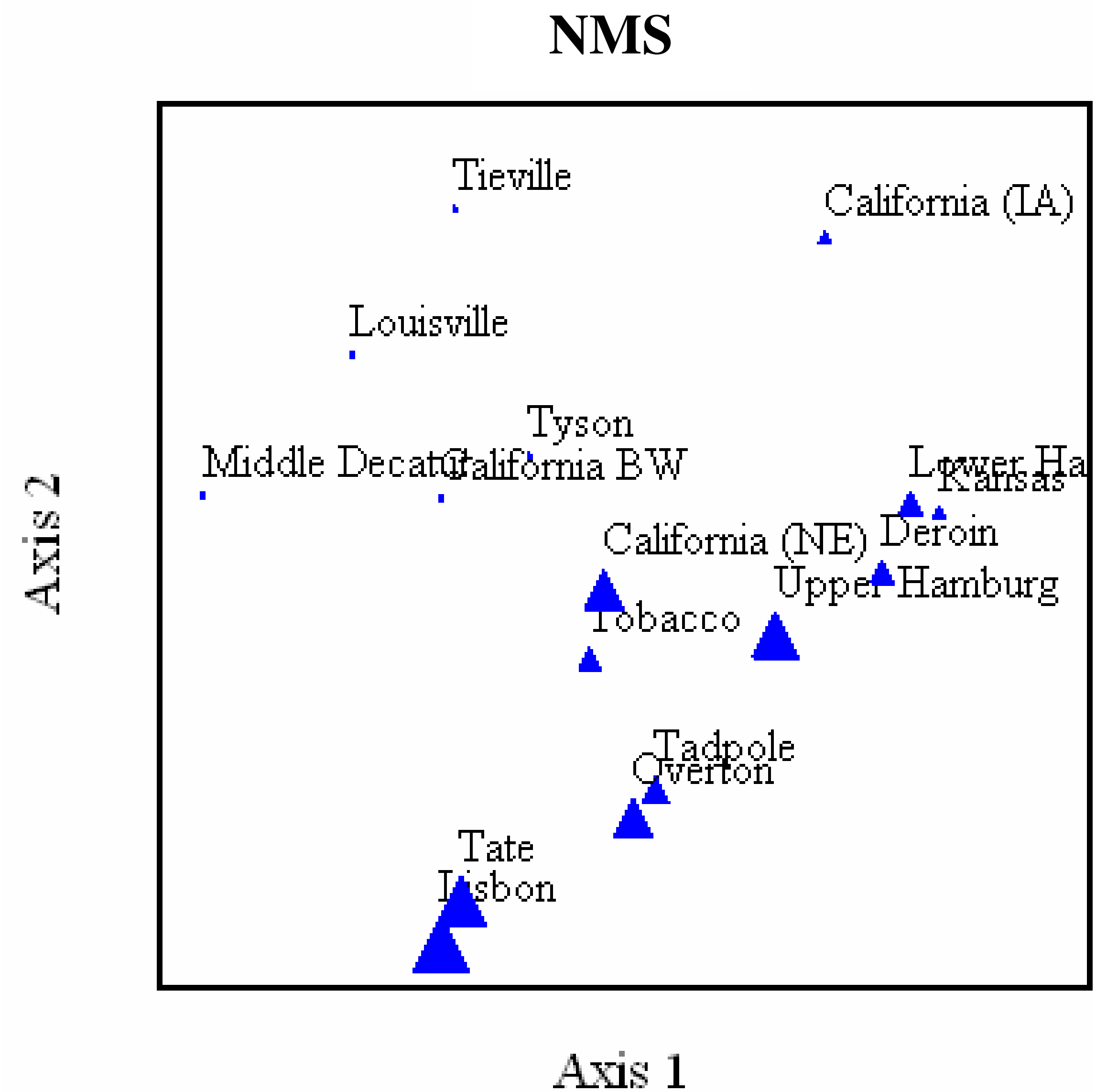


Figure IV.2.9. Sicklefin chub affect on Non-parametric multidimensional scaling (NMS) plot of all sites. Large triangles represent greater influence.

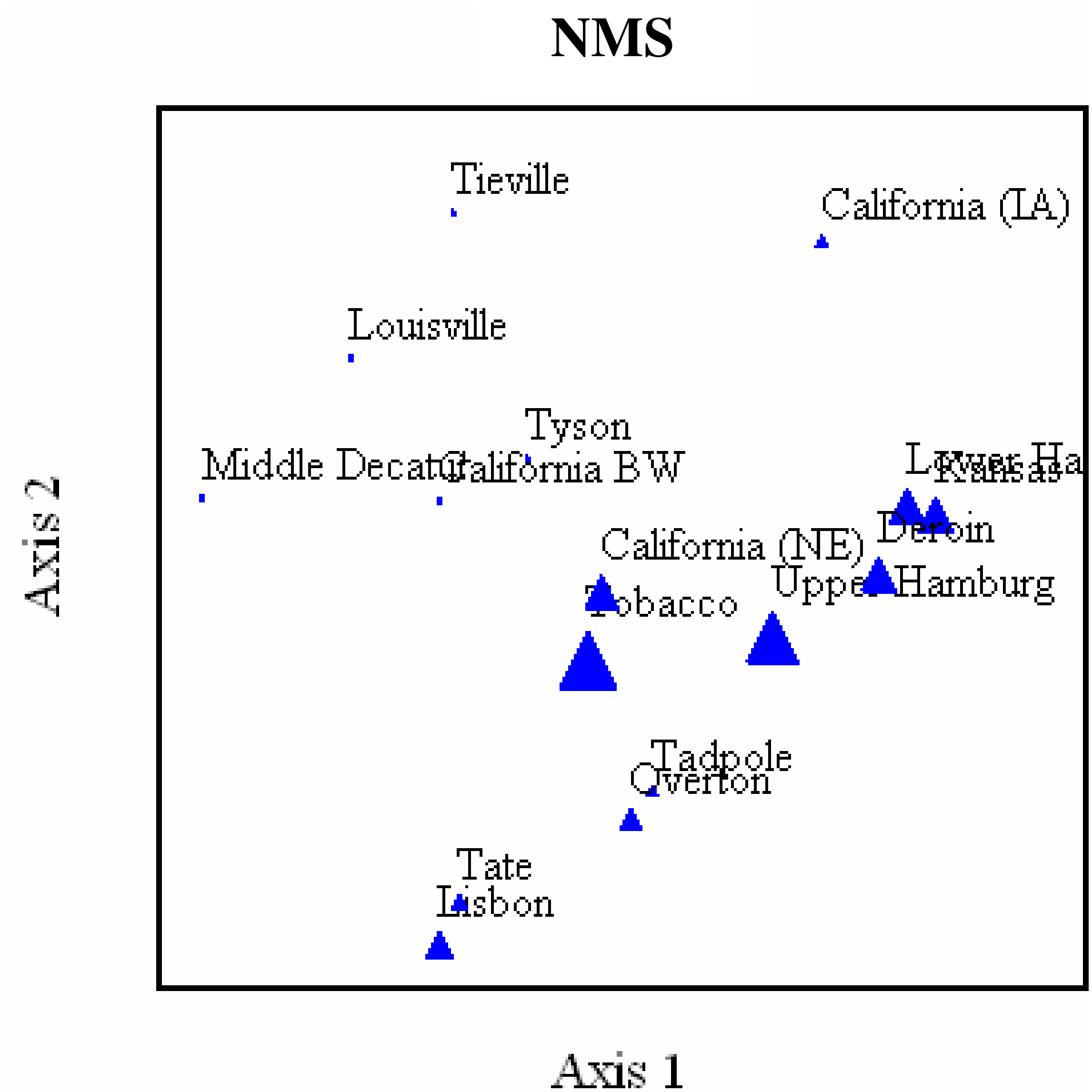


Figure IV.2.10. Shovelnose sturgeon affect on Non-parametric multidimensional scaling (NMS) plot of all sites. Large triangles represent greater influence.

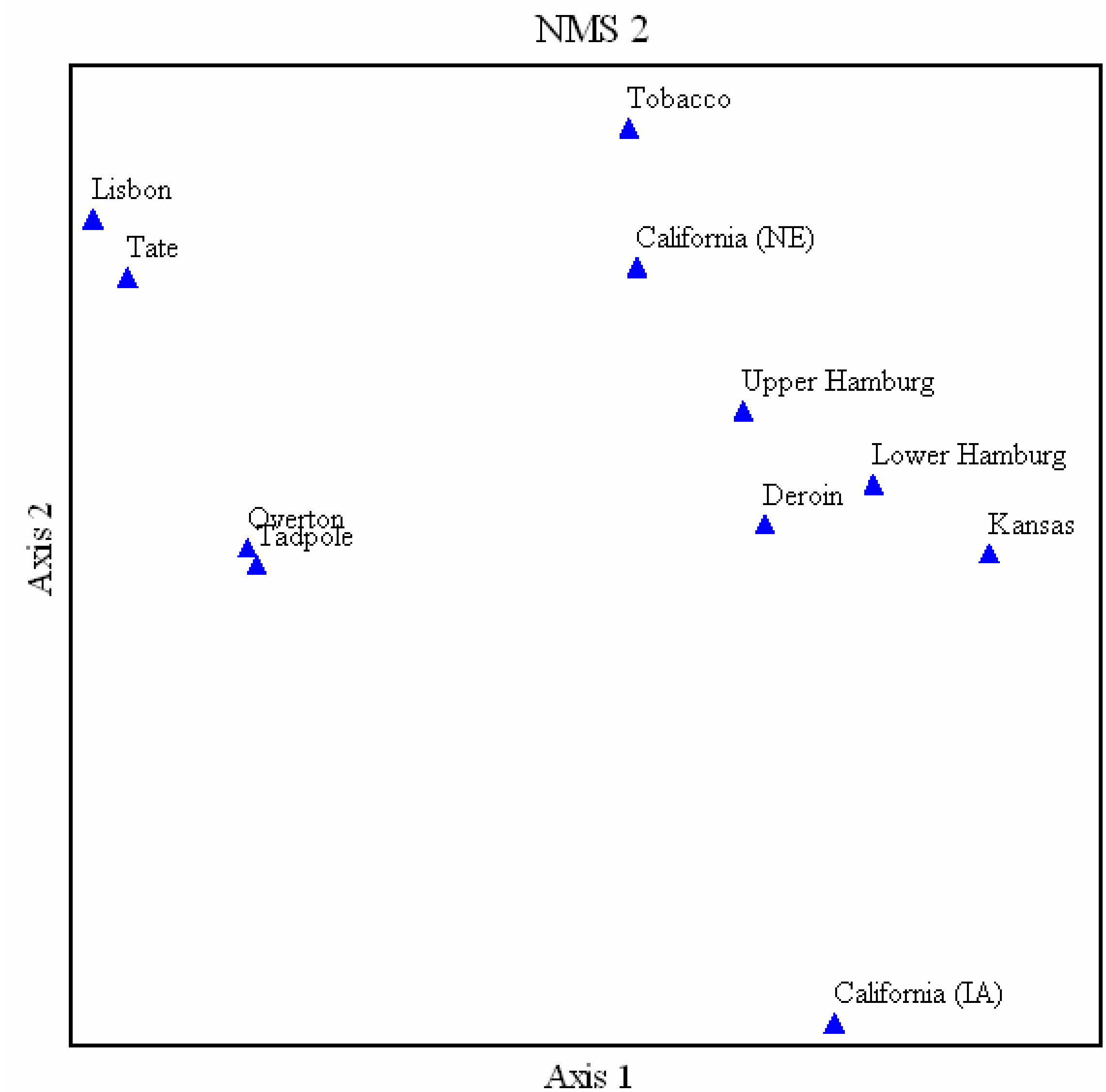


Figure IV.2.11. Non-parametric multidimensional scaling (NMS) plot of chute sites by fish community.

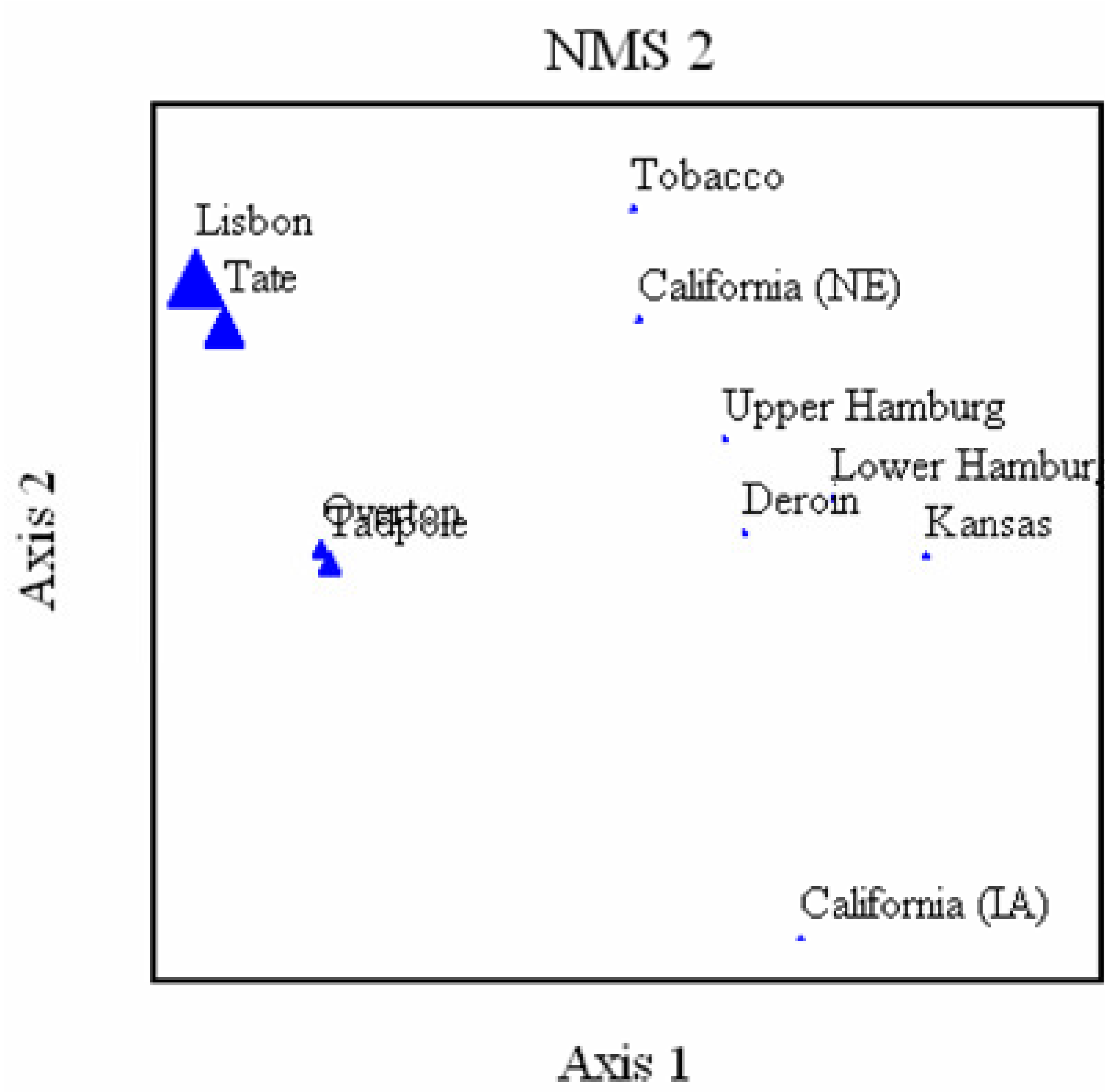


Figure IV.2.12. Bullhead minnow affect on Non-parametric multidimensional scaling (NMS) plot of all chutes. Large triangles represent greater influence.

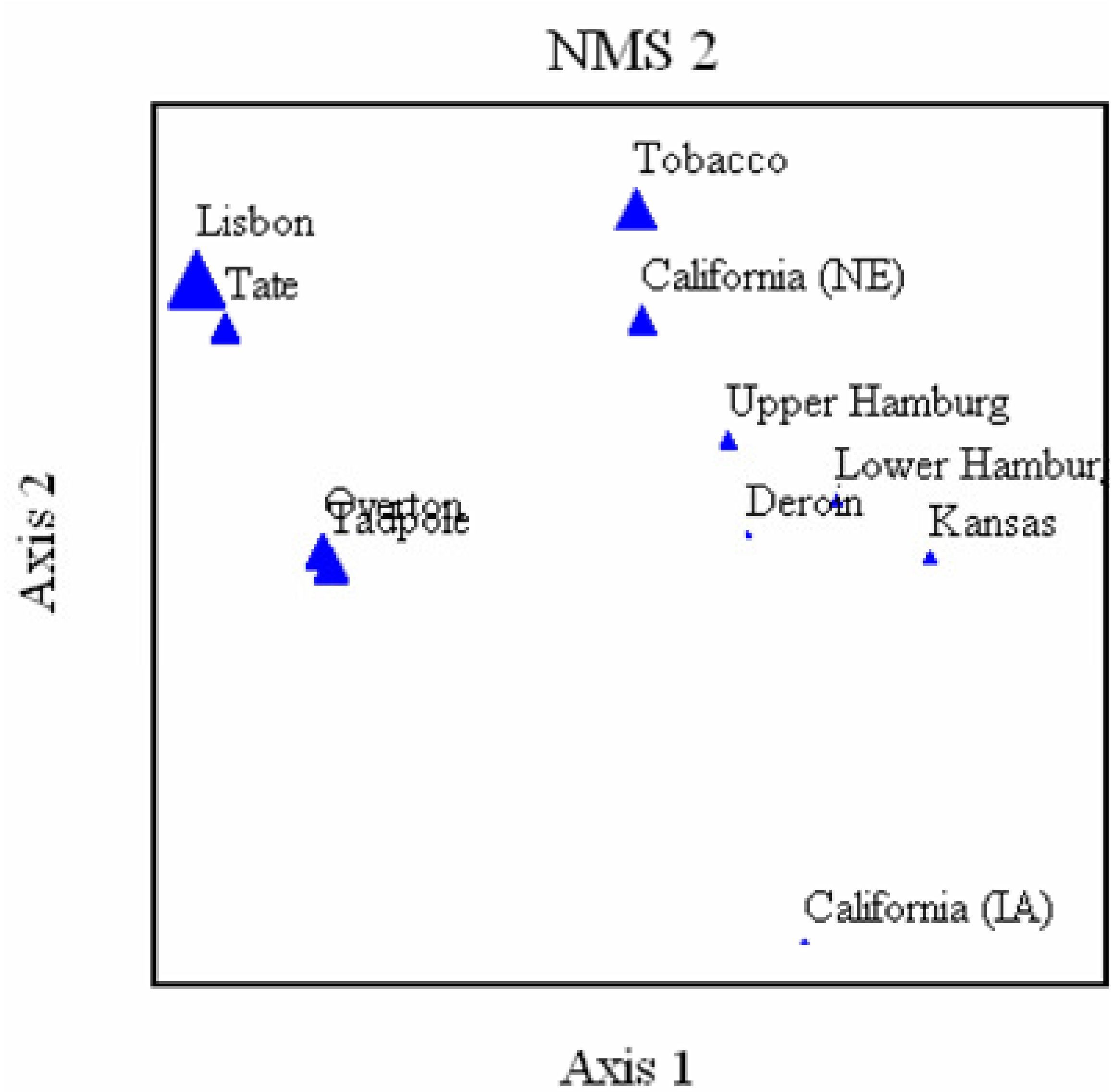


Figure IV.2.13. Red shiner affect on Non-parametric multidimensional scaling (NMS) plot of all chutes. Large triangles represent greater influence.

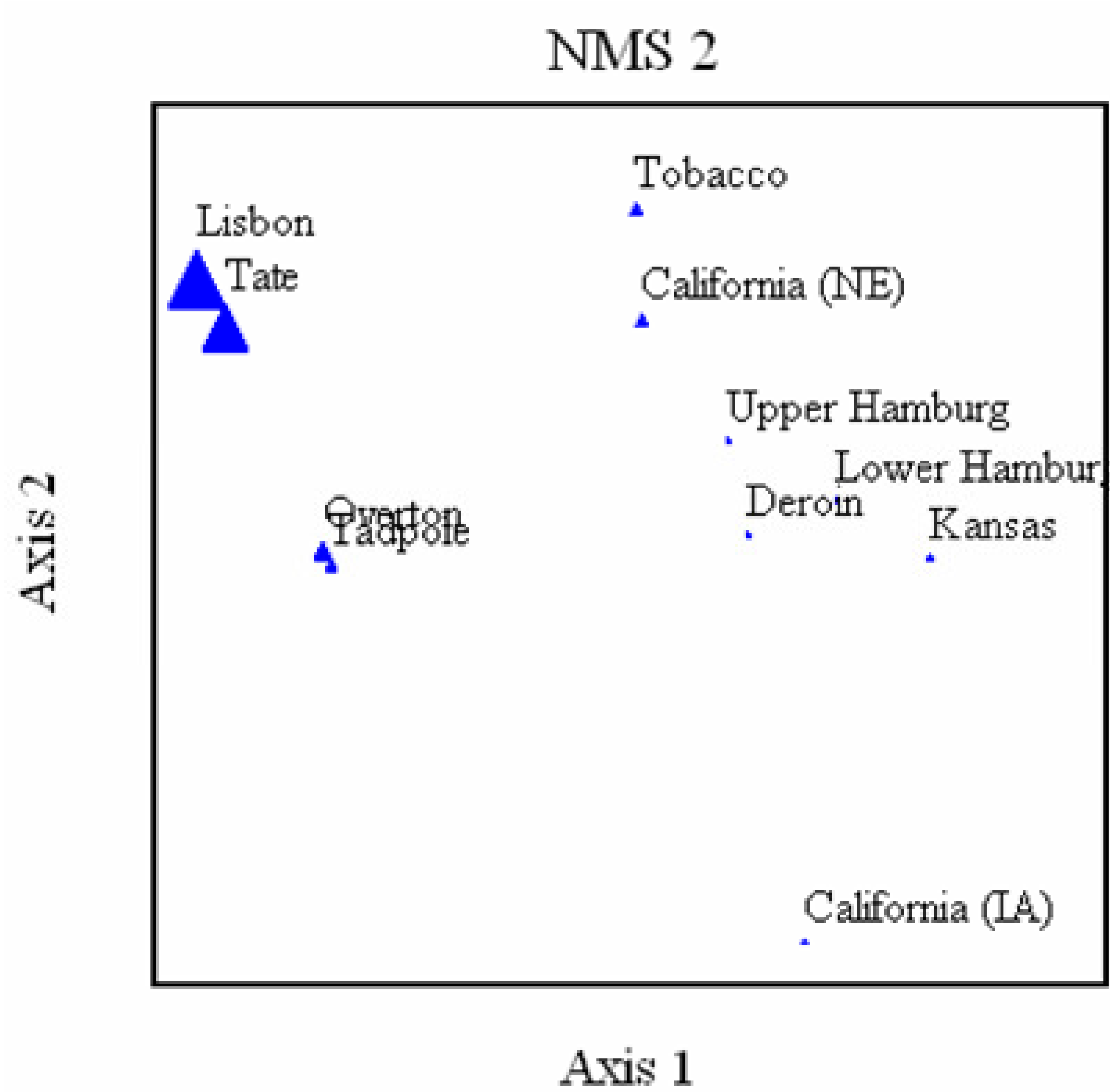


Figure IV.2.14. Bluntnose minnow affect on Non-parametric multidimensional scaling (NMS) plot of all chutes. Large triangles represent greater influence.

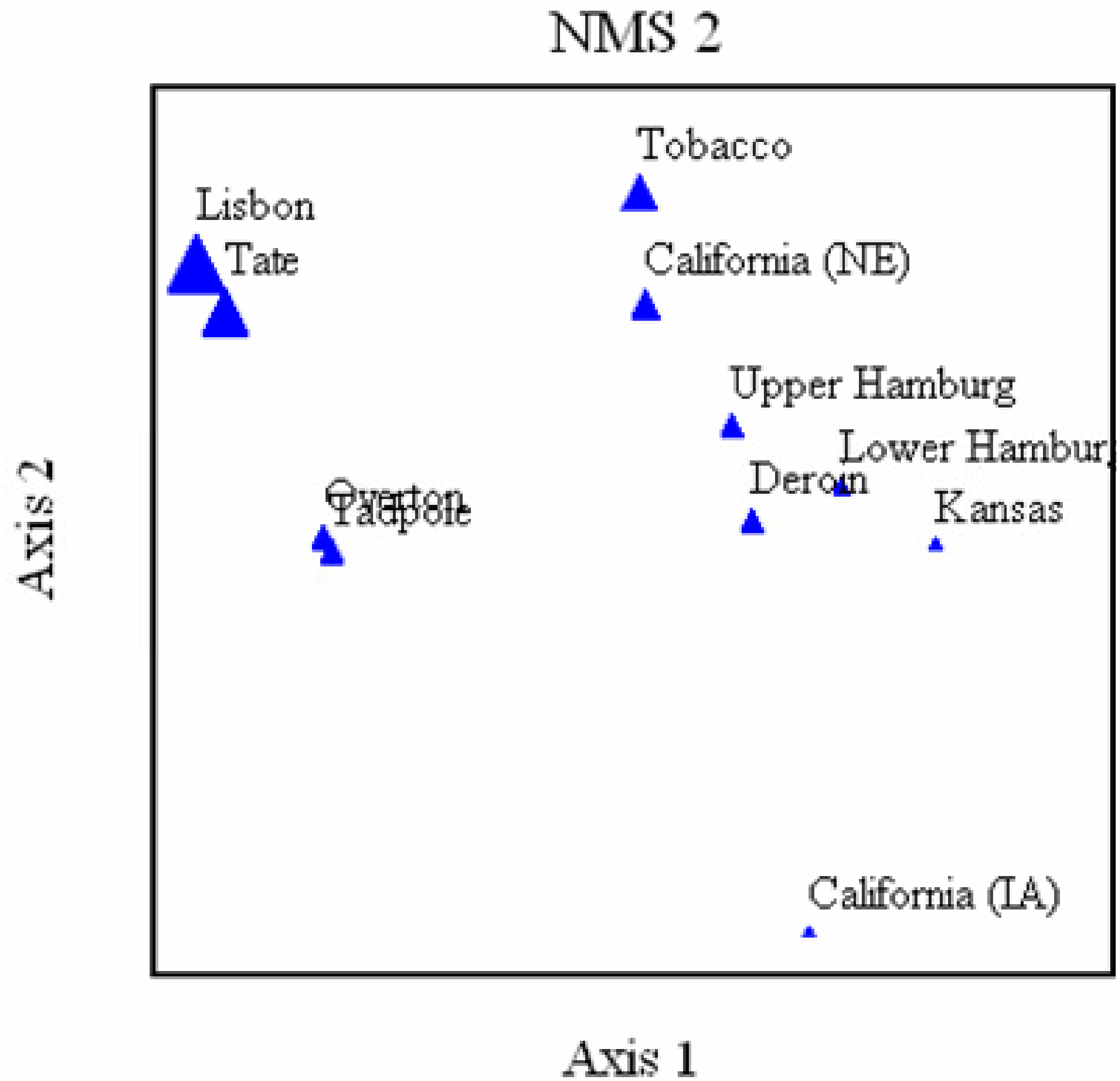


Figure IV.2.15. Freshwater drum affect on Non-parametric multidimensional scaling (NMS) plot of all chutes. Large triangles represent greater influence.

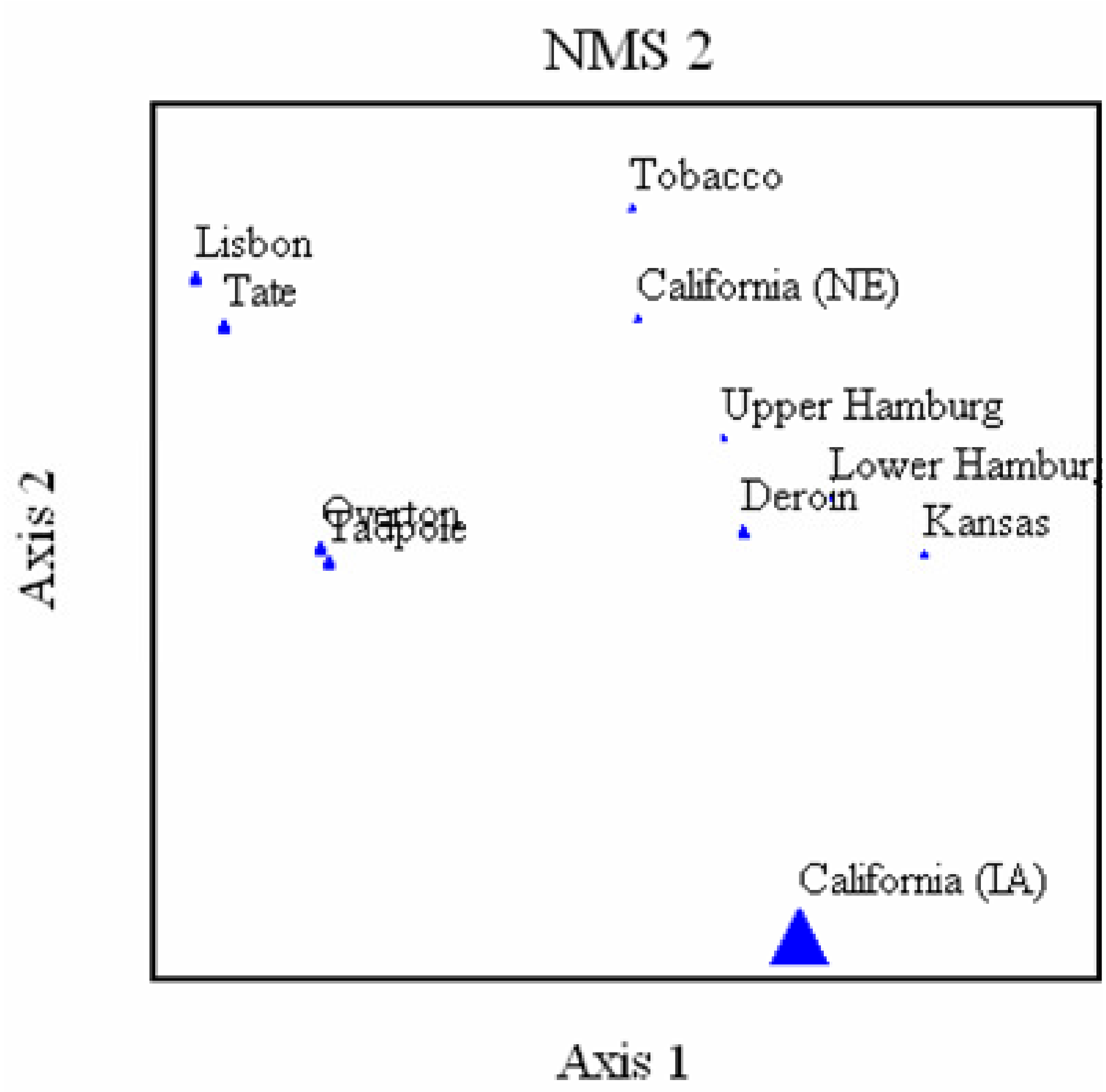


Figure IV.2.16. Bighead carp affect on Non-parametric multidimensional scaling (NMS) plot of all chutes. Large triangles represent greater influence.

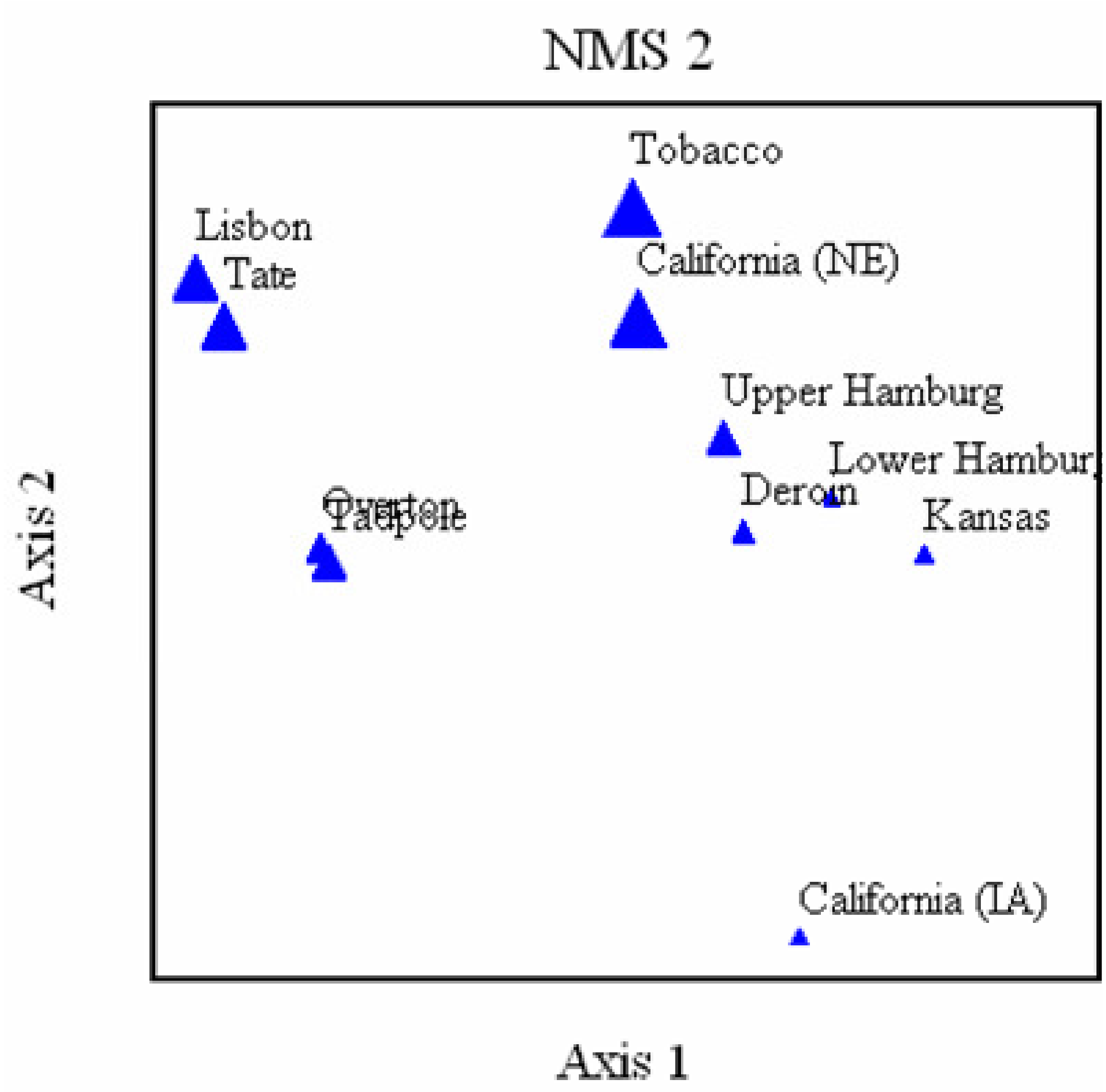


Figure IV.2.17. Channel catfish affect on Non-parametric multidimensional scaling (NMS) plot of all chutes. Large triangles represent greater influence.

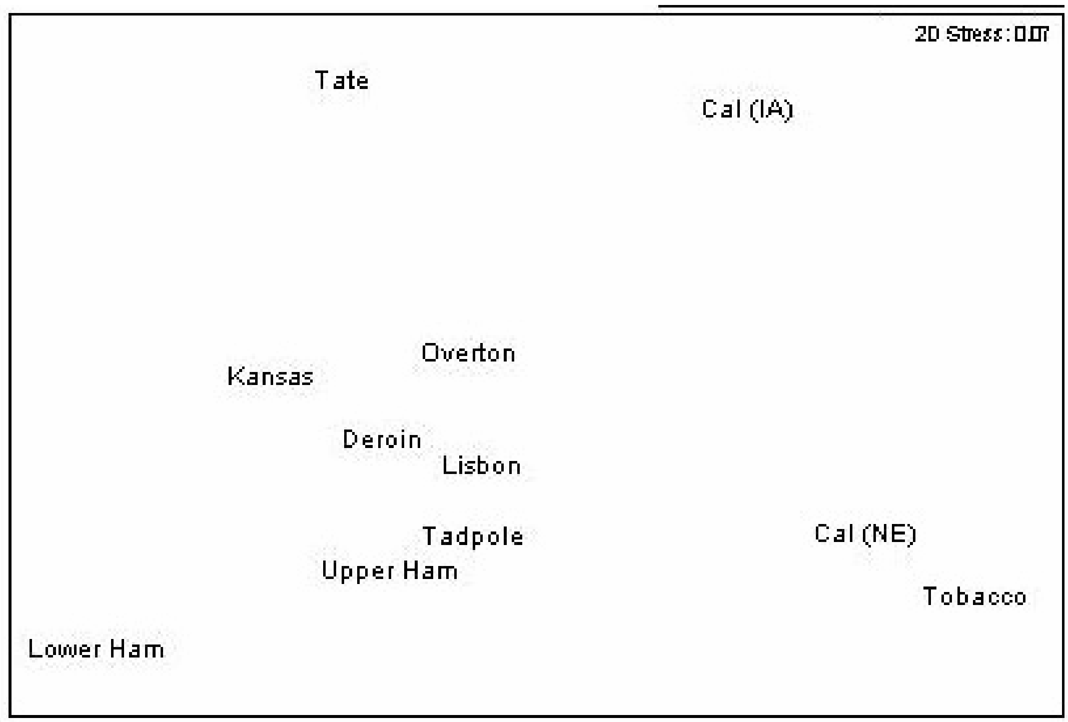


Figure IV.2.18. Multidimensional scaling (MDS) plot of chutes by proportions of juveniles in all chutes.

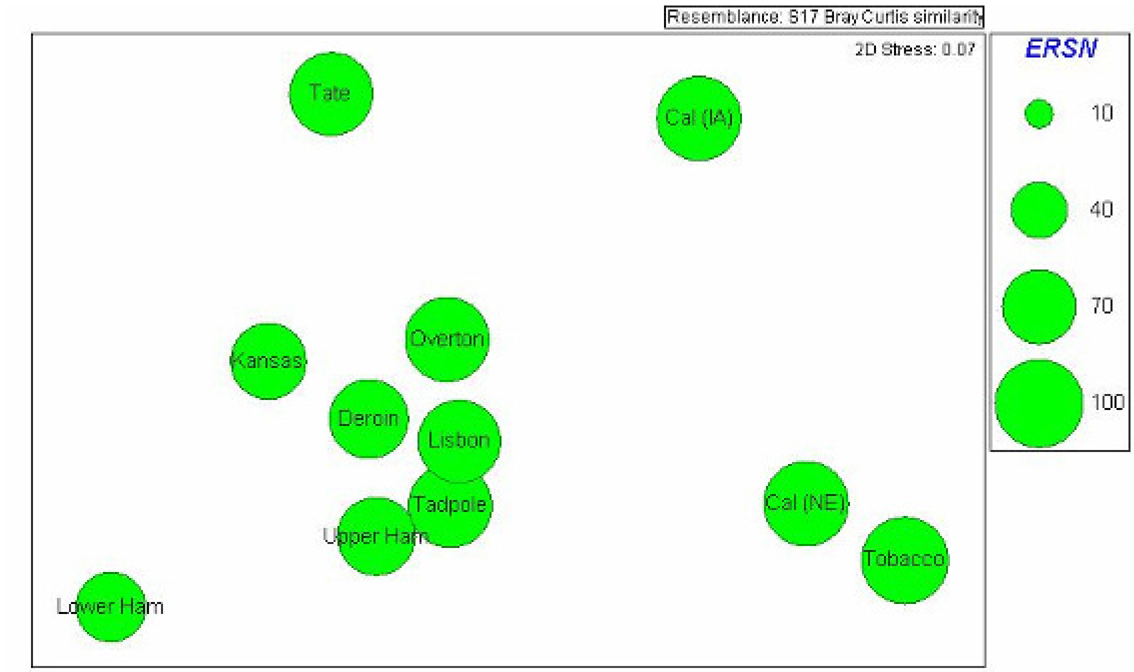


Figure IV.2.19. Multidimensial scaling (MDS) bubble plot of juvenile emerald shiner proportions for all chutes. Scale represents the mean percentage of juvenile emerald shiner in each chute.

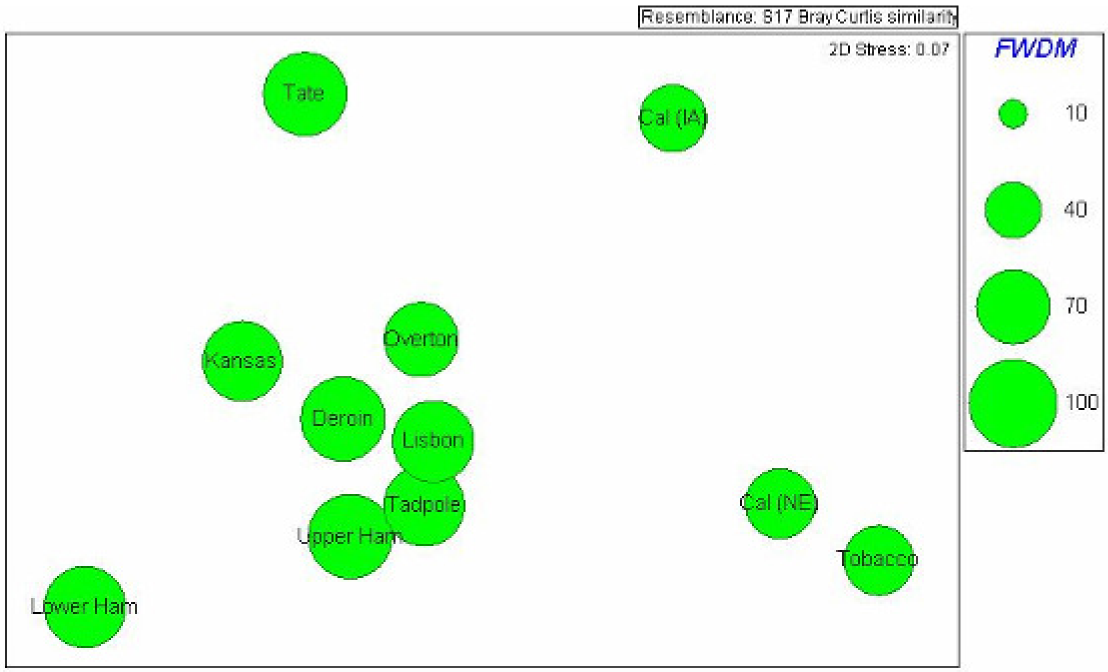


Figure IV.2.20. Multidimensial scaling (MDS) bubble plot of juvenile freshwater drum proportions for all chutes. Scale represents the mean percentage of juvenile freshwater drum in each chute.

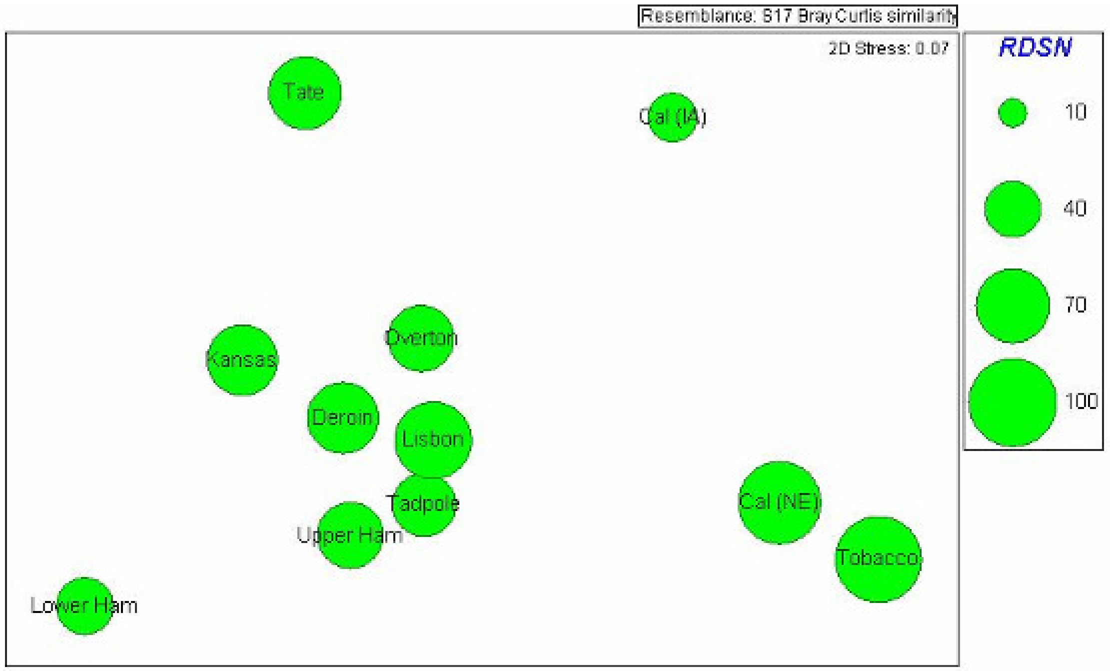


Figure IV.2.21. Multidimensial scaling (MDS) bubble plot of juvenile red shiner proportions for all chutes. Scale represents the mean percentage of juvenile red shiner in each chute.

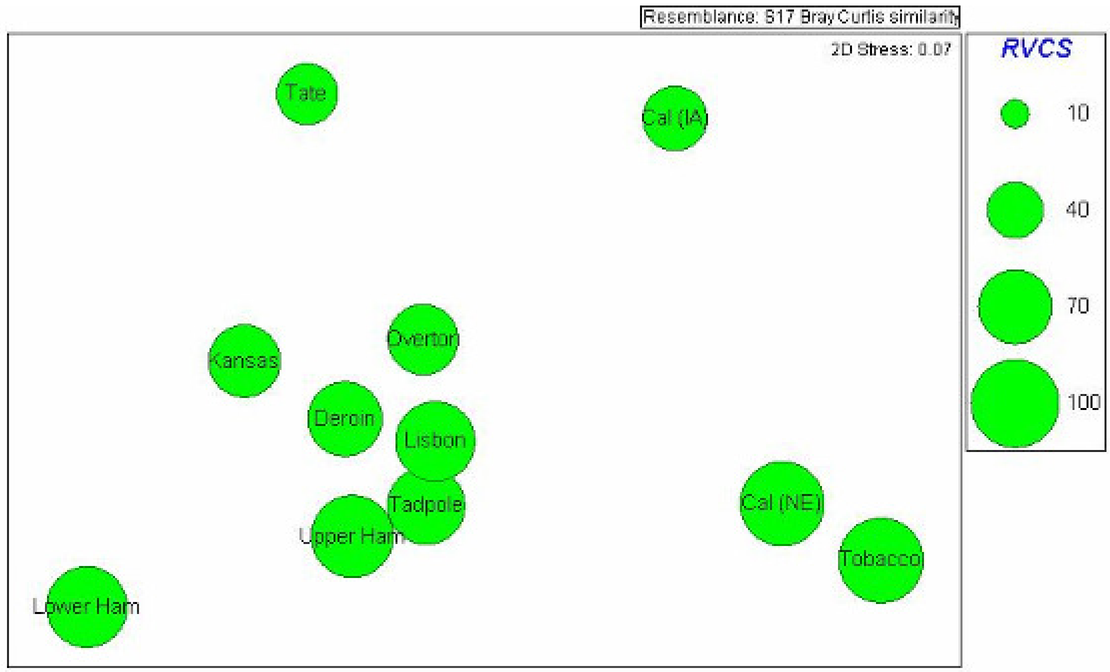


Figure IV.2.22. Multidimensial scaling (MDS) bubble plot of juvenile river carpsucker proportions for all chutes. Scale represents the mean percentage of juvenile river carpsucker in each chute.

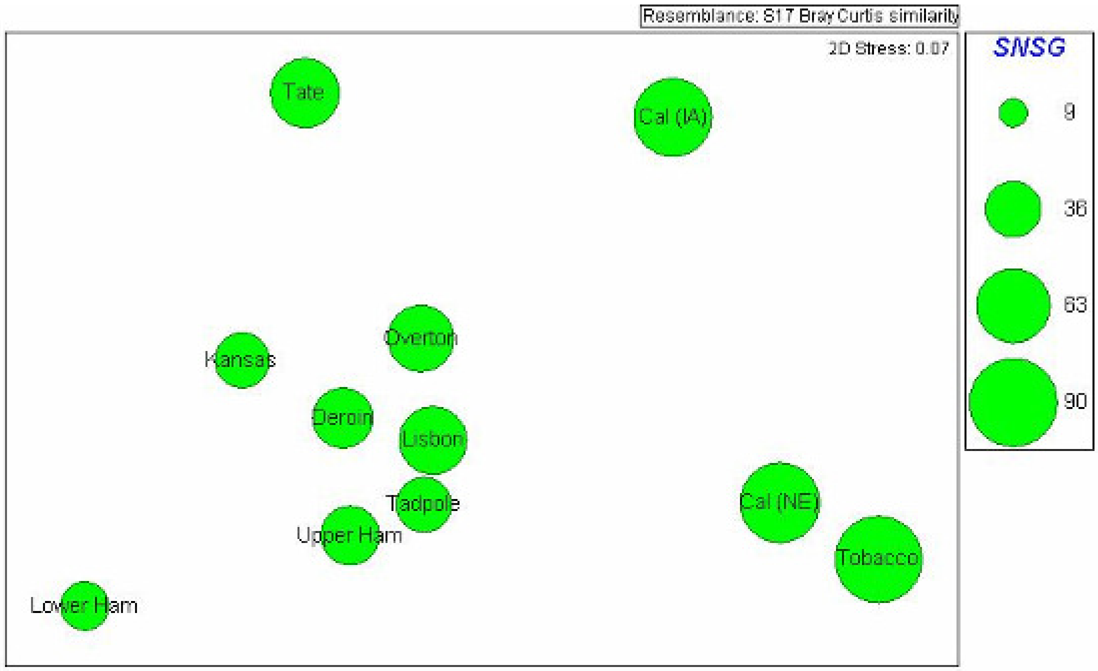


Figure IV.2.23. Multidimensial scaling (MDS) bubble plot of juvenile shovelnose sturgeon proportions for all chutes. Scale represents the mean percentage of juvenile shovelnose sturgeon in each chute.

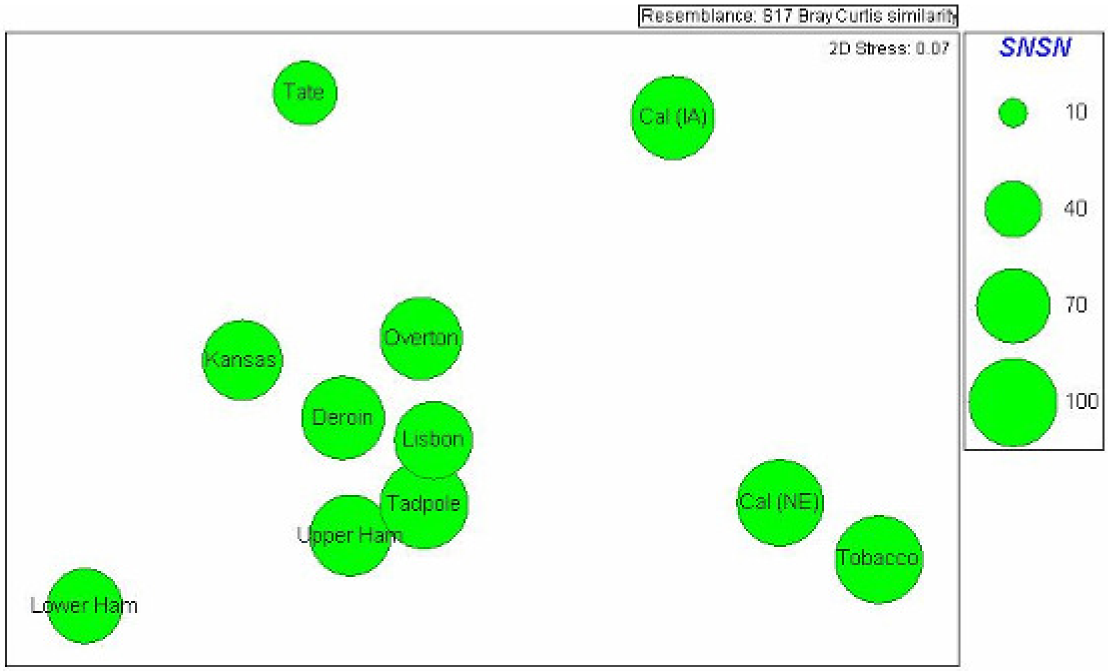


Figure IV.2.24. Multidimensial scaling (MDS) bubble plot of juvenile sand shiner proportions for all chutes. Scale represents the mean percentage of juvenile sand shiner in each chute.

FINAL REPORT

Missouri River Fish and Wildlife Mitigation Program

Fish Community Monitoring and Habitat Assessment of Off-channel Mitigation Sites

Section V Summary and Recommendations

Tieville-Decatur Bend[1], Louisville Bend[1], Tyson Island[1], California Cut-Off[1,2], Tobacco Island[2], Upper and Lower Hamburg Bend[2,3], Kansas Bend[2,3], Deroin Bend[2,3], Lisbon Bottom[4], North Overton Bottoms[4], Tadpole Island[4] and Tate Island[4]

Prepared for the U.S. Army Corps of Engineers

By:

[1]Van Sterner and Royce Bowman
[2]Brandon Eder, Sabrina Negus and Gerald Mestl
[3]Kasey Whiteman, Darrick Garner and Vince Travnichek
[4]Joshua Schloesser, Joseph McMullen and Tracy Hill

April 2009

[1]Van Sterner and Royce Bowman
Contract number –
Iowa Department of Natural Resources
607 10th St
Onawa, Iowa 51040

[2]Brandon Eder, Sabrina Negus and Gerald Mestl
Contract number – W9128F-05-P-0171
Nebraska Game and Parks Commission
Missouri River Program – Fisheries Division
2200 North 33rd Street
Lincoln, NE 68503

[3]Kasey Whiteman, Darrick Garner and Vince Travnichek
Contract number – W912DQ-07-D-0001
Missouri Department of Conservation
Nodaway Valley CA
21999 Hwy B
Maitland, MO 64466

[4]Joshua Schloesser, Joseph McMullen and Tracy Hill
Contract number - W59XQG83460940
U.S. Fish and Wildlife Service
Columbia National Fish & Wildlife Conservation Office
101 Park DeVille Drive, Suite A
Columbia, MO 65203-0057

Executive Summary

The Missouri River has been developed for flood control, commercial navigation, irrigation, fish and wildlife conservation, municipal water supply, water quality control and hydropower production through a series of congressional acts. However, prior to development, the lower Missouri River was characterized by a highly sinuous to braided channel with abundant log jams, sand bars, secondary channels and cut-off channels. Construction of the Bank Stabilization and Navigation Project (BSNP) converted the lower Missouri River into a narrow, self scouring channel. The active channel downstream of Sioux City, Iowa was as wide as 1.8 km before river modification, but is now confined to a 91.4 m channel. Total river and floodplain habitat altered or destroyed by the BSNP is estimated at 211,246 hectares.

The Missouri River Fish and Wildlife Mitigation Project (Mitigation Project) was established to restore fish and wildlife habitat lost by the construction, operation and maintenance of the BSNP. The Water Resources Development Act of 1986 authorized the United States Army Corps of Engineers (COE) to acquire and develop habitat on 12,100 hectares of non public lands and the development of 7,365 hectares of habitat on existing public lands to mitigate habitat losses. The Water Resources Development Act of 1999 authorized an additional 48,016 hectares to the program. The Final Supplemental Environmental Impact Statement (FSEIS) for the expanded Mitigation Project was issued in March of 2003, and it included a preferred alternative proposing the creation of additional shallow water habitat (defined as areas less than 1.5 m deep with a current velocity of less than 0.76 m/s). The preferred action in the FSEIS for the expanded

Mitigation Project included creation of 2,833 to 8,094 hectares of shallow water habitat (SWH).

In 2005, the Iowa Department of Natural Resources, Nebraska Game and Parks Commission (NGPC), Missouri Department of Conservation and U.S. Fish and Wildlife Service, Columbia Fisheries Resource Office (renamed to Columbia National Fish and Wildlife Conservation Office) were contracted by the COE to monitor and evaluate fish communities of select off-channel aquatic habitat sites that were constructed through the Mitigation Project. Additionally, the NGPC was contracted to collect physical habitat information from the secondary channels that were selected for biological monitoring in the upper channelized section above Kansas City. Sixteen sites selected for monitoring covered a range of aquatic habitats including backwaters and secondary channels with varying levels of engineering and development. Sites from upstream to downstream included Tieville-Decatur Bend (two backwaters), Louisville Bend (backwater), Tyson Island (backwater), California Bend (chute on the Nebraska bank and a chute with connected backwater on the Iowa bank), Tobacco Island (chute), Upper and Lower Hamburg Bends (one chute each), Kansas Bend (two small chutes, treated as one), Deroin Bend (chute), Lisbon Bottom (natural chute), North Overton Bottoms (chute), Tadpole Island (chute) and Tate Island (chute). The study was designed to include three field sampling seasons, but due to delays implementing contracts in 2005 another complete year of sampling was added. Thus, fish community monitoring and habitat assessment of off-channel mitigation sites began in April, 2006 and concluded in October, 2008. The objective of this project was to determine biological performance and functionality of chutes and backwaters and to compare chutes and backwaters in an effort to identify

designs most beneficial to native Missouri River fish species. Additionally, this project was designed to help determine if additional modifications are needed at existing mitigation sites, if existing designs are providing a range of habitats, if these habitats are of value to the biological diversity of the Missouri River and if these habitats are of specific value to species of concern or importance, such as pallid sturgeon.

Chutes and backwaters were sampled monthly from April thru October 2006 – 2008. Each chute was divided into 16 sampling segments, and eight segments were randomly chosen without replacement each month for each gear type used. The standard gears used for this project include; trammel nets, large and small otter trawls, push trawls, bag seines, electrofishing, large and small diameter hoop nets and mini-fyke nets. Additional gears used only in backwaters include experimental gill nets and large frame trap nets. Set lines and hook and line were used as wild gears (gears in addition to those required for standard sampling), these gears were used to target pallid sturgeon.

Chutes and backwaters provided habitat for different fish communities. Chutes were found to have more riverine species while these species were lacking in backwaters. Contiguous backwaters had greater species diversity and richness than those that were impounded. This connection to the river allowed species to access these areas that they otherwise could not have.

Chutes separated themselves out geographically. The available fish community in the main channel affected the fish community in the chutes. Chutes that were located farther up the Missouri River tended to benefit different species than those on the lower end of the river. Therefore, the benefit of a chute to the overall fish community probably depended on if the chute provided something different than what was already found in the

main channel. Also more diverse fish communities were found in the older constructed and natural chutes. This is probably due to the greater habitat diversity these chutes have developed compared to the younger chutes.

Overall, the fish communities in most sites were dominated by juveniles of most species. The habitat that has been developed via chutes and backwaters therefore are functioning as refuges for smaller fish. This is a valuable asset to the fish communities in the Missouri River. Currently little is known if these juveniles are spawned or drifted into the chutes and backwaters. It is also unknown if these juveniles are able to move out of the chutes and backwaters and into the main channel.

Predictive models indicated that chutes had different probabilities of presence for target species. In general, chutes that were relatively longer, wider, shallower and had greater sinuosity were more likely to have target species present. Conversely, chutes that were short, had low width to depth ratios and low sinuosity were less likely to have target species present.

Important predictor variables for species presence were year (85% of species models), water depth (80%), turbidity (65%), water temperature (60%), month (60%) and water velocity (50%). A year effect, likely related to river discharge, for many species supports the need for multiple year assessment programs. Water depth and, to some extent, water velocity were recognized as two variables that can be manipulated by river engineers and we found that the selected range of depths and velocities varied by species, which was expected with a diverse fish community. Many juvenile and small-bodied fishes utilized shallow water habitats (<1.0 m) over a broad range of water velocities (0.0-1.0 m/s), but large-bodied fishes tended to orient towards relatively deeper water. Therefore, creating

shallow water habitats with a range of velocities would likely benefit many juvenile native species.

Mitigation Project designs are providing a range of habitats. Backwater habitats are creating a habitat not currently available in most reaches of the Missouri River. Different backwater designs do not appear to be creating different habitats from each other; however, backwaters can only be used by riverine fish if they are connected to the river. All chutes are providing some habitat diversity, however, some chutes, including; California (NE), Upper Hamburg, Lisbon and Tate contain more habitat diversity, and therefore, are providing much needed habitat complexity to that reach of the river.

Backwater and chute habitats appear to be beneficial to the biodiversity of the Missouri River system; however, it is important to note that different reaches of the river have different needs. The highly modified middle Missouri River, from Sioux City, IA to Kansas City, MO has very little habitat diversity available within the main channel and many different habitats may be necessary to restore the healthy function of the river system. While the lower Missouri River has greater habitat diversity within the main channel, there are still habitats that may be limited, such as habitat diverse chutes (e.g., Lisbon or Tate) or backwaters that may be needed to restore a fully functioning river.

General Recommendations

- Promote natural side channel creation on suitable public lands. Allowing the river to naturally create side channel habitat may provide the most suitable habitat for riverine fish.
- We recommend constructing chutes that allow for floodplain connectivity, encourage natural river processes and maintain greater complexities of habitats (i.e. high width to depth ratios, diverse substrates, diverse depths, diverse velocities, shallow sandbars, woody debris and vegetated sandbars)
- Construction of longer chutes should receive higher priority than short chutes
- If a short chute must be built, build width, sinuosity and habitat diversity (deep scour holes, bar features and large woody debris).
- Promote channel movement through the use of structures or large woody debris.
- Soil type should be an important consideration in chute design, sites with clay or compacted soils need to be built to finished width or with wider pilot channels to hasten evolution.
- Slope banks when possible to allow large woody debris to accumulate in chutes rather than on high banks.
- Promote capture of large woody debris to increase habitat diversity and secondary productivity.
- Avoid designing chute entrances that may block upstream migration of fish (e.g., high sills or constricted entrances with high velocities and turbulence).
- Evaluate entrance structures to determine if certain life stages of some species (e.g., young of the year sturgeon) are being excluded from entering the chute.
- Avoid designs that promote sedimentation at chute entrances; keep entrances open so desired flows can be achieved.
- If a chute is intended to widen with increased main channel discharge, avoid designs where velocities decrease as main channel discharges increase such as at California (IA) and Kansas (upper).
- Use pilings, like those at Tate chute, instead of rip rap to create water control structures. Using pilings, as opposed to rock structures, may increase the permeability of water structures at varying levels of the water column, particularly the benthos.
- Include tie-channels and braids in chute designs to increase the amount of shallow, slow moving water at sites and provide more area that is in contact with the main channel.
- Design tie-channels, braids and connected backwaters to limit sedimentation.
- Tie channels can be used to direct flows to lower portions of the chute, allowing the upper portions to act more like backwater habitat.

- Create side channel habitat by building islands as opposed to digging channels, as was the case with Tate Island chute.
- Consider reopening existing, naturally formed side channels that are presently cut off from regular flows; there are at least 13 historic chutes that may be considered on the lower Missouri River.
- Contiguous dredged backwaters (such as Tyson Island and California (IA)) are recommended over impounded (disconnected) wetlands (such as Tieville, Louisville and Decatur). Contiguous sites provide connectivity that allows fish access to spawning and nursery habitat. Pumping did not provide accessible floodplain fish habitat.
- Backwaters should maintain a consistent, direct river connection. Open river connections are preferred over water control structures (culverts).
- Connectivity introduces sediment that will eventually fill backwaters. Siltation must be addressed by mechanical removal or improved backwater design.
- Backwaters of the upper channelized river become dewatered and isolated during winter discharges, backwaters should maintain adequate depth to prevent winter fish kills (approximately 3 m deep from December through February)
- Continued monitoring of chutes and backwaters would allow the determination of the rate at which the chute or backwater is evolving, the level of functionality that they can attain, value each chute has to different species, and how future manipulations affect the habitat and fish community.
- The variation in fish abundances seen among the three years of sampling indicates that a long term monitoring effort would be needed to detect population trends in chutes or backwaters. Furthermore, fish data from the chutes and backwaters should be compared to data from the main channel to determine how the chutes and backwaters are functioning with respect to main channel fish use.

TABLE OF CONTENTS

Summary

Introduction

Fish community monitoring and habitat assessment of off-channel mitigation sites began in April, 2006 and concluded in October, 2008. Although field work was projected to start in the spring of 2005, due to delays with contracts and startup, only a very limited amount of sampling was conducted late in 2005 and will not be included in this report. Sixteen mitigation sites, including backwaters and chutes, were sampled. Sites from upstream to downstream included Tieville-Decatur Bend (two backwaters), Louisville Bend (backwater), Tyson Island (backwater), California Bend (chute on the Nebraska bank and a chute with connected backwater on the Iowa bank), Tobacco Island (chute), Upper and Lower Hamburg Bends (one chute each), Kansas Bend (two small chutes, treated as one), Deroin Bend (chute), Lisbon Bottom (natural chute), North Overton Bottoms (chute), Tadpole Island (chute) and Tate Island (chute). This monitoring project was a joint effort between the Iowa Department of Natural Resources, Nebraska Game and Parks Commission, Missouri Department of Conservation and Columbia National Fish and Wildlife Conservation Office, U.S. Fish and Wildlife Service.

The objective of this project was to determine biological performance and functionality of chutes and backwaters and to compare chutes and backwaters in an effort to identify designs most beneficial to native Missouri River fish species. Additionally, this project was designed to help determine if additional modifications are needed at existing mitigation sites, if existing designs are providing a range of habitats, if these

habitats are of value to the biological diversity of the Missouri River and if these habitats are of specific value to species of concern or importance, such as pallid sturgeon.

Project Design

Chutes and backwaters were sampled monthly from April thru October 2006 – 2008. Each chute was divided into 16 sampling segments, and eight segments were randomly chosen without replacement each month for each gear type used. The standard gears used for this project include; trammel nets, 16 and 8 foot otter trawls, push trawls (added in 2007), bag seines (dropped after 2006 with the addition of push trawls), electrofishing, 2 and 4 foot diameter hoop nets and mini-fyke nets. Additional gears used only in backwaters include 200 foot experimental gill nets and 3'x 6' trap nets. Set lines and hook and line were used as wild gears (gears in addition to those required for standard sampling), these gears were used to target sturgeon and potentially pallid sturgeon. Standard operating procedures and methods used for deploying these gears can be found in Missouri River Standard Operating Procedures for Sampling and Data Collection, (Drobish, 2007). Every effort was made to keep sampling effort consistent month to month, and among years and chutes.

Physical and Biological Results and Recommendations for Backwaters

Tyson Island, California Cut-off, Tieville, Louisville and Decatur Bends

Our results conclude that richness, diversity and abundance of most target species were greater in contiguous dredged backwaters at Tyson Island and California Cut-off than the impounded wetlands at Tieville, Louisville and Decatur Bends. Tieville

performed poorly in comparison to the other impounded wetlands. The elevation of the Tieville Bend wetland with respect to the adjacent river channel and relatively low discharges during the study period prevented the river from back-filling through the control structure. Thus, there were few opportunities for fish from the river to access the site. Winter kill and fish imported through pumping (Gelwicks 1995) probably influenced the fish community more than passive connectivity. It is unknown whether the system of weirs constructed below Tieville allowed fish passage into the wetland. Operation of the pumps in 2006 and 2007, when functional, rarely discharged enough water through the outlet to allow fish immigration. The isolation of Tieville, coupled with frequent winter kills, limits both the fisheries potential and the benefits of floodplain connectivity. An upstream connection to Tieville would likely improve the fish community and reestablish an important link between the river and floodplain.

The design at Decatur and Louisville bends allows for a periodic, passive river connection. The fish communities were dominated by floodplain-using taxa like gizzard shad and centrarchids. The presence of channel spawning species that use floodplain water bodies as nursery or adult habitat indicates an exchange of fish with the main channel. The tie channel constructed from the river channel to Decatur provides a gravity flow connection but because of its long length (2.8 km) may have diminished use by riverine fishes. The outlet channel is much shorter (0.6 km) at Louisville Bend and connects to the river by back-filling. Young of the year channel catfish, sauger, paddlefish and goldeye were rare or absent at both these sites indicating that neither functioned as nursery areas for these species.

The backwaters at California Cut-off and Tyson Island provided continuously connected, zero velocity habitat adjacent to the main channel. Young of the year of all target species were sampled, except Asian carp and paddlefish, indicating these areas functioned as either spawning, refuge or nursery habitat for native fishes. The engineering challenge with constructed contiguous backwaters is to minimize sedimentation, which is gradually filling these sites. Deposition at the mouth of these sites has created a sill that is decreasing the range of discharges that provide an open connection and will eventually isolate the backwaters.

Recommendations for Modifications:

- Contiguous dredged backwaters (such as Tyson Island and California (IA)) are recommended over impounded (disconnected) wetlands (such as Tieville, Louisville and Decatur). Contiguous sites provide connectivity that allows fish access to spawning and nursery habitat. Pumping did not provide accessible floodplain fish habitat.
- Backwaters should maintain a consistent, direct river connection. Open river connections are preferred over water control structures (culverts).
- Connectivity introduces sediment that will eventually fill backwaters. Siltation must be addressed by mechanical removal or improved backwater design.
- Backwaters of the upper channelized river become dewatered and isolated during winter discharges, backwaters should maintain adequate depth to prevent winter fish kills (approximately 3 m deep from December through February)

- Increased shoreline length and gradually sloped shorelines would increase the area of shallow, near-shore habitat found to be important to larval fishes
- Large woody debris was an important habitat component of the historic Missouri River and should be evaluated in constructed off-channel sites.

Physical and Biological Results and Recommendations for Chutes

California IA

Physical Summary

California (IA) has experienced little geomorphic evolution despite being one of the oldest chutes in the study. Its single bend shape does not provide the necessary means for channel migration and bar formation. Some bank line movement has been noted but this movement has been minimal. If bank erosion continues the outside bend of the chute will eventually erode away the thin strip of land separating the chute from the backwater and the two will merge. The lack of evolution at this site raises concerns regarding future sites of this design.

Key Physical Characteristics:

- Decreasing velocities as main channel discharges increase
- Steep "U" shaped banks
- Short and shallow
- Sand is dominant substrate
- Banks are sand
- Some large woody debris (due mainly to beaver activity)

- Connected backwater – small strip of land separating backwater and chute may eventually erode joining chute and backwater

Key Biological Findings:

- Some native riverine species appear to be using this chute including: shovelnose and pallid sturgeon, chub species, blue sucker and catfish species.
- Many pool or backwater associated species were common in this chute, including: shortnose gar, goldeye, gizzard shad, common carp, bighead carp, river carpsucker, bigmouth buffalo, shorthead redhorse and freshwater drum.
- In 2007, 50 times more bighead carp were sampled in this chute than other years.
- Young-of-the-year bigmouth buffalo were sampled in 2007 and 2008.
- Flathead catfish were present in sizes targeted by sport fishermen, including some trophy-size fish.

Recommendations for Modification:

- Modify design so that velocities inside the chute increase as main channel discharges increase
- Remove strip of land separating chute and backwater
- Slope banks to encourage large woody debris to accumulate in chute
- Increase length

<u>California NE</u>

Physical Summary

Our surveys show that even during high water events California (NE) provides a refuge with slow moving water (at least 82% of velocities under 1.0 m/s). In the upper

half of the chute we found low velocities associated with shallow water, a combination that is missing in the main channel (Hesse and Mestl 1993).

The upper one-half of the chute is an area of very shallow, slow moving water. Some sand bar formation has occurred since the completion of our surveys. Little morphological evolution has occurred in the lower one-half of the chute. No bar formation has occurred and no defined channel has been established. A minimal amount of bank line erosion has occurred in the lower portions of the chute.

Sand is the dominant substrate throughout the chute. Areas of silt occur, but only in areas near the bank line where velocities are slowed. Areas that contained silt (tie-channels) have been filled in by sediment deposited during high water events. Rock occurs in areas where it has been placed to armor the bank line.

Key Physical Characteristics:

- Slow velocities
- Sandy substrate
- Banks are sand
- Little large woody debris
- Some rock substrate
- Two entrances and two exits
- Tie channels have little connectivity at navigation flows due to sedimentation
- Dug to finished width – little bankline movement

Key Biological Findings:

- Many native riverine species appear to be using this chute including: shovelnose and pallid sturgeon, chub species, blue sucker and catfish species.
- Many pool or backwater associated species were also common in this chute, including: goldeye, gizzard shad, common carp, river carpsucker, shorthead redhorse and freshwater drum.
- Young-of-the-year shovelnose sturgeon were caught in 2006 and 2008. Young-of-the-year sauger were caught in 2006. Young-of-the-year smallmouth buffalo were caught in 2007 and 2008. Young-of-the-year bigmouth buffalo were caught in 2008. Young-of-the-year buffalo were caught in large numbers.
- Blue sucker numbers significantly decreased over the three years of this study. More juvenile blue suckers were sampled in 2006 and 2007 than 2008.
- Almost twice as many silver chubs were caught in 2008 compared to 2006 and 2007.
- Channel and flathead catfish and sauger were present in sizes targeted by sport fisherman including several trophy-size flathead and channel catfish.

Recommendations for Modification:

- Remove sediment from tie-channels or redesign tie channels to promote flowing water to reduce sedimentation
- Introduce large woody debris

<u>Tobacco Island</u>

Physical Summary

Our surveys show that even during high flow events Tobacco Island chute exhibits low flow velocities. Velocities rarely exceed 1.0 m/s. During the two boat surveys over 10,000 data points were logged, of these only six exceeded 1.5 m/s. The majority of depths occurred over small ranges in both surveys. These results indicate a

chute with steep banks and little bar habitat or deep scour holes. We anticipate that more bar and scour hole habitats will develop as the chute ages. Anecdotal evidence points to some creation of bars on inside bends and scour holes at the entrance of the chute after high flow events in the spring and early summer of 2008. These high flow events were responsible for the erosion of bank-lines throughout the chute and especially at the entrance. Our 2009 survey shows bank-line movement of up to 12 m from 2006 to 2009. This indicates the potential for morphological evolution at the site.

Key Physical Characteristics:

- Narrow
- Slow velocities
- Shallow
- Compacted soils
- Sandy substrate
- Little bankline movement
- Little large woody debris
- Steep "U" shaped banks
- Some bar formation

Key Biological Findings

- Many native riverine species appear to be using this chute including: shovelnose and pallid sturgeon, chub species, blue sucker and catfish species.
- Many pool or backwater associated species were also common in this chute, including: shortnose gar, gizzard shad, common carp, river carpsucker, buffalo species, bluegill and freshwater drum.

- Young-of-the-year blue suckers were caught in flooded terrestrial vegetation in 2008.
- Young-of-the-year shovelnose sturgeon and smallmouth and bigmouth buffalo were caught in 2007 and 2008. Young-of-the-year buffalo were caught in large numbers.
- Silver and sturgeon chubs increased yearly, speckled chub catch was much lower in 2006 compared to 2007 and 2008.
- Shovelnose sturgeon numbers significantly increased over the three years of this study.
- Channel and flathead catfish were present in sizes targeted by sport fisherman including several trophy-size catfish.

Recommendations for Modification:

- Redesign entrance to reduce sedimentation
- Remove sediment from wide areas at grade control structures to return these areas to shallow sand bar habitat
- Increase width
- Introduce large woody debris
- Slope banks to allow large woody debris to accumulate in chute instead of on banks

<u>Upper Hamburg</u>

Physical Summary

Upper Hamburg chute has undergone the most morphological change of all the study sites. Bank-line movement of over 50 m is seen on some outside bends of the chute. The chute also contains a defined channel and most inside bends have large sand

bar areas associated with them. In addition, the chute contains multiple deep scour holes situated behind rock points or pile dike structures.

Depth data for the three surveys were not confined to a small range, unlike other study sites. This is indicative of a mature chute with deep outside bends and shallow inside bends, scour holes and sand bar formations. Likewise, velocity distributions are equal over their range indicating a chute that has evolved to include slow moving inside bends and faster moving outside bends.

Upper Hamburg is the oldest of the study sites and has been subjected to numerous high water events. The site most accurately reflects what a "mature" site would look like in the Nebraska reach of the Missouri River.

The entrance of the chute has been constricted to restrict flows entering the chute. This constriction has resulted in a 3-5 foot "waterfall" at the entrance of the chute. In addition, velocities inside the entrance are consistently greater than 2.0 m/s and may be higher as water is forced through the renovated entrance and turbulence at the entrance is significant. We feel these factors may prohibit fish, especially migrating pallid sturgeon, that from exiting at the top of the chute. If the chute is acting as a fish "trap" it may hinder the efforts of pallid sturgeon and other fishes that make long upstream spawning migrations.

Key Physical Characteristics:

- Significant drop in elevation at entrance of chute with extreme turbulence and high velocities – may block fish passage

- Diverse habitat with deep scour holes and shallow sand bars and areas of high velocities and low velocities
- Sand and gravel substrate
- Significant bankline movement
- Large woody debris present on eroded outside bends
- Deep scour holes – may contain deepest water in that reach of the river

Key Biological Findings:

- The majority of the fish community was juveniles (74%).
- Flathead catfish, shovelnose sturgeon and blue suckers collected were typically adults.
- Fish community, species richness, and species diversity were similar for all years.
- Eight species accounted for 75% of the fish community (blue catfish, channel catfish, emerald shiner, freshwater drum, river shiner, shovelnose sturgeon, sand shiner, and silver chub).
- For most species the percentage of juveniles increased year to year.
- Four pallid sturgeon were sampled with two being stocked fish from Bellevue, NE and two with unconfirmed stocking locations.

Recommendations for Modification:

- Redesign entrance to eliminate drop in elevation and promote fish passage
- Remove bankline revetment within chute to promote chute movement

Lower Hamburg

Physical Summary

The chute at Lower Hamburg has widened since its opening in 2004. The average width of the chute during the 2007 topographic survey was 31 m. Erosion is evident at the site and bank-line movement has taken place. The backwater at the site was connected to the chute in 2005 and 2006 but has been cut off by sediment deposition during high water events in 2007 and 2008.

The chute is characterized by high, steep banks and a uniform width. During the surveys the majority of depth data were confined to a small range indicating a generally "U" shaped chute. The channel is beginning to develop cross-overs; however channel width is not sufficient to allow point-bar development. Depth and velocity data from the three surveys may not be comparable due to modifications to in-channel navigation structures. These modifications were done in the summer of 2007, between our ADCP surveys in March 2007 and April 2008. Our surveys show that discharges in the chute were greater after the modifications (2,580 cfs on 3 March 2007 and 2,720 cfs on 14 April 2008) even though main channel discharges were less (50,000 cfs on 3 March 2007 and 41,100 cfs on 14 April 2008). These increased flows may have expedited bank-line erosion in the chute. In the summer of 2008 it was determined that too much water was being directed into the chute. In response to this, the entrance was partially filled with rock, limiting the amount of water that could enter the chute. No surveys were conducted after this work was done.

Key Physical Characteristics:

- Steep "U" shaped banks

- Little depth diversity
- Sandy substrate with some clays
- Repeated flow alterations due to modifications of in-channel navigation structures and chute entrance throughout study
- High rates of erosion during period when large amounts of water were forced through the chute by main channel modifications
- Increasing number large woody debris
- Little bar creation
- Backwater connected in 2006 but cut off from chute in 2007 by sedimentation

Key Biological Findings:

- Most fish were juveniles (61%).
- Eight species accounted for 65% of the fish assemblage (channel catfish, emerald shiner, freshwater drum, red shiner, river carpsucker, river shiner, shovelnose sturgeon and silver chub).
- The percentage of juveniles for most species increased each year except for flathead catfish, river carpsuckers and shovelnose sturgeon.
- Species of interest for Missouri River recovery (blue sucker, pallid sturgeon, *Hybognathus sp.*, sauger, speckled chub and sturgeon chub) were sampled in low numbers or not at all.

Recommendations for Modification:

- Remove control structure at the entrance of the chute to allow more flow and accelerate evolution
- Increase width in areas to increase shallow water and sand bar habitat
- Reconnect backwater and redesign the entrance to reduce sedimentation or add a connection to the chute at the top of the backwater to create a flow through environment with shallow water and slow water velocities
- Slope banks to allow large woody debris to accumulate in the water rather than on banks
- Add large woody debris or other hard structures to make the channel meander to add sinuosity.

Kansas Bend

Physical Summary – Upstream Chute

The upstream chute at the Kansas Bend site is characterized by deep, fast moving water. Banks at the site are steep and high, forming a uniform "U" shape channel for the entire length of the chute. Despite the high velocities exhibited in all surveys little erosion has taken place at the site. Bank-line movement is minimal and few sand bars are present except at the wide points of the entrance and exit of the chute. This may be due to the fact that as main channel discharges increase velocities in Kansas (upper) decrease. Even during low flow periods the site exhibits some of the fastest flowing water found at any of the study sites. Fast water is ubiquitous at the Kansas (upper) site, unlike other chutes where fast water is generally associated with constricted entrances or rock structures.

The tall, steep banks and swift currents at the site mean little shallow water is found except at the entrance and exit of the site. Velocities at these shallow points are high, in keeping with the rest of the chute. The length of the chute and its relatively few bends do little to slow velocities and are not conducive to deposition of sediment. The potential for morphological evolution at the site may be limited.

Key Physical Characteristics:

- Velocities decrease as main channel discharges increase
- Short, narrow, deep and fast
- Sand and gravel substrate
- Clay or other highly compacted soils are hindering bankline movement
- Steep "U" shaped banks
- Little to no bar formation
- No large woody debris

Physical Summary – Downstream Chute

The chute at the Kansas (lower) Bend site has widened at a similar pace to the Kansas (upper) Bend chute but little habitat diversity has been created . The chute contains very little shallow water (between 1 and 6%) and the water velocity is relatively fast and remains fairly constant (between 0.76 and 0.80 m/s) at all flows. Some sand bar formation is present at the wide areas of the entrance and exit and where large woody debris has accumulated. However, the site is very short and there is little room for evolution due to its length and lack of sinuosity. In addition, the upper portion of the

chute contains rock structures designed to limit erosion on the right descending bank in order to protect a nearby levee. These factors suggest that there is limited potential for evolution at the site.

Key Physical Characteristics:

- Short, narrow, deep and fast
- Rock structures at top prohibiting bankline movement
- Sand and gravel substrate
- Clay or other highly compacted soils hindering bankline movement
- Steep banks
- Little large woody debris
- Little sand bar formation

Key Biological Findings (both upper and lower chutes):

- 64% of all fish sampled were juveniles.
- Four species accounted for 70% of all fish sampled (emerald shiner, river shiner, sand shiner, and shovelnose sturgeon).
- Missouri River recovery species of interest were found in low numbers or not at all (blue sucker, pallid sturgeon, *Hybognathus sp.*, speckled chub, sturgeon chub, and sauger).
- Flathead catfish and shovelnose sturgeon caught were primarily adults.

Recommendations for Modification:

- Widen the chute and slope the banks to create more shallow water habitat.
- Add woody debris or hard points to divert the channel and create slower velocities.
- Slope banks to allow large woody debris to accumulate in chute rather than on banks
- Increase length
- Connect upper and lower chutes

<u>Deroin Bend</u>

Physical Summary

Bank-line locations from our survey and aerial photography show some lateral bank-line movement at outside bend locations at the site. Significant movement has also taken place at the top of the chute where high water events eroded the bank behind rock structures and have formed large scallops. Some bar formation has been noted behind pile dike structures and grade control structures.

Deroin exhibits some of the fastest flowing water at the study sites. Pile dikes and rock structures constrict the channel at multiple points and are responsible for these high water velocities as well as deep scour holes and some bar formation. Deroin also contains some of the deepest water of the study sites, approaching 10 m in some scour holes. The sites length and sinuosity combined with the rock structures and pile dikes give the site a great deal of potential for evolution.

Key Physical Characteristics:

- High velocities
- Relatively deep with some deep scour holes
- Sand and gravel substrate
- Sand and clay banks
- Some large woody debris
- Some bar formation
- Flow through tie-channel/backwater area connected during periods of high water
- Tie-channel/backwater area contains large amounts of large woody debris
- Some bankline movement noted after sustained high water event in 2008

Key Biological Findings:

- 69% of all fish were juveniles.
- 2008 had the highest species richness.
- Five species accounted for 50% of the fish community (channel catfish, emerald shiner, freshwater drum, shovelnose sturgeon, and sand shiner).
- One pallid sturgeon was sampled in 2006 in the mouth of secondary channel off the chute.
- Missouri River recovery species of interest were sampled in low numbers or not at all (blue sucker, sauger, Hybognathus sp., speckled chub, sturgeon chub, and pallid sturgeon).
- Common carp, shovelnose sturgeon and flathead catfish sampled were predominantly adults.

Recommendations for Modification:

- Add large woody debris or hard structures to divert the channel to create sinuosity.
- Redesign secondary channel / backwater to promote flow and reduce sedimentation
- Continue to allow erosion behind rock structures at the top of the site
- Increase width in areas to create shallow sand bar habitat and decrease velocities
- Slope banks to allow large woody debris to accumulate in chute rather than on banks and provide more shallow water habitat

Lisbon Bottom

Physical Summary

Lisbon Chute was formed during a span of high water flows between 1993 and 2000 that resulted in a total of sixteen distinct floods (Jacobson et al. 2001; Jacobson et al. 2004). During the flood of 1993, and subsequent floods from 1993-1999, levees ruptured in the upper portion of the present day chute which resulted in a naturally formed side-channel scour that reconnected with the main channel approximately 3.3 km downstream. During this formation period, as much as 20% of the total flow of the Missouri River was diverted through the chute (Jacobson et al. 2004). To reduce flow through Lisbon, the U.S. Army Corps of Engineers, in consultation with the U.S. Fish and Wildlife Service, installed notched revetment at the top of the chute, a notched hydraulic control structure approximately 270 m downstream from the top, and a grade control structure near the bottom (Figure II.10.2). These structures were designed to restrict flow divergence from the main channel while at the same time allowing water to

flow through the structure 95% of the time (Jacobson et al. 2004). These structures have been modified over the past four years to create a deeper and wider notch at the top of the chute and the grade control structure has been reduced to allow more flow near the bottom. The current status of the control structures is accepted with no plans for further modification. The resulting chute maintains constant flow throughout most of the year with increasing flow as main stem discharge increases. Any additional "conditioning" of the chute will be the result of the natural rise and fall of the river. Lisbon has changed more than other Lower Missouri River chutes due to un-stabilized banks and fluctuating flows. This was observed during several flood events during 2008. Conditioning of the chute is expected to continue until the banks become stabilized by vegetation and timber growth.

Key Biological Findings:

- Sampling efforts at Lisbon chute produced a greater overall abundance of fish than at other chutes on the lower Missouri River (i.e. Overton, Tadpole and Tate).
- Lisbon also supported the largest number of juvenile fish on the lower river. Young of the year chubs, minnows, suckers and sunfish were all abundant in Lisbon chute.
- Large numbers of juvenile fish were collected in 2007 and in some instances during 2006. The opposite was true in 2008, when very few juveniles were collected.
- Large numbers of riverine species such as shovelnose sturgeon, speckled chubs, red shiners and channel catfish were collected in Lisbon chute.

- Shovelnose sturgeon, sicklefin chub and silver chub each had lower catch rates in 2006 than in subsequent years, suggesting habitat suitability for these species was different that year, perhaps in relation to different conditions in the main channel.
- Lisbon chute was the only lower Missouri River chute where pallid sturgeon were collected.
- Few young of the year sturgeon (*Scaphirhynchus spp.*) were captured in Lisbon chute despite the presence of large numbers of young of the year fish of other riverine species.
- Few *Hybognathus* species (Mississippi silvery minnow, plains minnow, and western silvery minnow) were found in Lisbon chute. However, *Hybognathus* species were captured in greater numbers at Lisbon chute than at other lower Missouri River chutes.
- Non-target species were abundant in Lisbon chute, including blue catfish, bluntnose minnow, bullhead minnow, freshwater drum and longnose gar.
- Lisbon supported high numbers of game species such as blue and flathead catfish, black and white crappie and sauger.

Recommendations for Modification:

- Lisbon chute's closing structure (at the head of the chute) should be evaluated to determine if certain life stages of some species (e.g., young of the year sturgeon) are being excluded from entering the chute.

<u>North Overton Bottoms</u>

Physical Summary

Overton has changed little since it's reconstruction in 2003. From 2000 through 2006, the Lower Missouri River has experienced a drought allowing little opportunity for the river to scour and widen Overton chute. During the spring of 2007, however, the Lower Missouri River experienced a 50 year flood event resulting in significant scouring of Overton chute. Recently constructed chutes, including Overton, were built with high steep banks to encourage undercutting and bank erosion. These processes are dependent on high water events and flood-pulses to initiate erosion and allow for the conditioning of the chute. In 2008, Overton chute experienced several high water events which caused an increase in bank erosion and undercutting.

Key Biological Findings:

- The overall catch at Overton chute was relatively low, as was species richness.
- Young of the year and other juvenile fish were detected in relatively low numbers in Overton chute, indicating that the present conditions at this chute are not providing nursery habitat comparable with that of older, more diverse chutes on the lower Missouri River (i.e., Lisbon and Tate chutes).
- The majority of juvenile fish that were collected in Overton chute were caught during 2006 and 2007.
- Riverine species such as shovelnose sturgeon, speckled chubs and channel catfish were found in Overton chute.
- No pallid sturgeon were captured in Overton chute.

- Overton chute produced the largest number of lake sturgeon among lower Missouri River chutes.
- Few *Hybognathus* species (i.e., Mississippi silvery minnow, plains minnow and western silvery minnow) were collected in Overton chute.
- A few game species were abundant in Overton chute including blue and flathead catfish. However, other species such as black and white crappie, paddlefish, sauger and white bass were captured in low numbers.

Recommendations for Modification:

- Promote shallow water habitat and slower velocities within Overton chute by sloping banks, increasing widths, creating back water areas and building tie channels.

<u>Tadpole Island</u>

Physical Summary

Since construction, this chute has undergone more conditioning from erosion than Overton chute because it has less vegetative encroachment on the banks and a higher sand content in the soil. During the high water events of 2008 Tadpole has undergone the most change out of all the chutes, with high water causing significant bank erosion, undercutting and widening of the chute.

Key Biological Findings:

- The overall catch at Tadpole chute was relatively low, as was species richness compared to other lower Missouri River chutes, such as, Lisbon and Tate.
- Species richness progressively increased over the course of the study suggesting that Tadpole's habitat may be evolving and becoming more diverse.
- Young of the year and other juvenile fish were detected in relatively low numbers in Tadpole chute. This may indicate that present chute conditions are not providing nursery habitat that older, more diverse chutes on the lower Missouri River (i.e., Lisbon and Tate chutes) do.
- The majority of juvenile fish that were collected in Tadpole chute were caught during 2006 and 2007.
- Riverine species such as shovelnose sturgeon and speckled chubs were found in Tadpole chute.
- No pallid sturgeon were captured in Tadpole chute.
- Two lake sturgeon were captured in Tadpole chute.
- Few *Hybognathus* species (i.e., Mississippi silvery minnow, plains minnow and western silvery minnow) were found in Tadpole chute.
- There were a few game species that were abundant in Tadpole chute including blue, channel and flathead catfish. Other species such as black and white crappie, paddlefish, sauger and white bass were captured in low numbers and infrequently.

Recommendations for Modification:

- Promote shallow water habitat and slower velocities within Tadpole chute by sloping banks, increasing widths, creating back water areas and building tie channels.

Tate Island

Physical Summary

Tate is a unique side-channel complex that formed more than 60 years ago and has stabilized over the past 50 years. The islands are made up of forested and moist shrub land dominated by mature cottonwoods and willow species (*Salix spp*.). Tate is unique in that it is the only chute being studied that has a tributary influence; Tavern and Little Tavern Creeks empty into the chute. This chute also contains unique backwater habitats and tie channels that are not typical to the other chutes in the study area (except, to some degree, Lisbon Chute). At present, the chute is stabilized with notched revetments. No additional modifications are currently planned.

Key Biological Findings:

- Large numbers of riverine species such as shovelnose sturgeon, speckled chubs and red shiners were found in Tate chute.
- Tate supported large numbers of chub and minnow species, particularly young of the year and other juveniles.
- Tate chute was unique among side channel chutes on the lower portions of the Missouri River, in that many young of the year sturgeon (*Scaphirhynchus spp.*) were captured there.

- No pallid sturgeon were caught in Tate chute but two hybrid sturgeon (shovelnose x pallid sturgeon) were found.
- Many pool and backwater associated species such as silver and bighead carp, shortnose gar and gizzard shad were collected in Tate chute. Large numbers of juvenile backwater species were also documented.
- Large numbers of game species were found in Tate chute including blue, channel and flathead catfish, largemouth bass, white bass, white crappie and bluegill.
- Species richness was higher at Tate chute than at other chutes on the lower Missouri River (Lisbon, Overton and Tadpole).
- Tributaries entering the chute likely influenced the species richness at Tate chute, as many species normally associated with tributaries were found in the chute, such as smallmouth bass, johnny and blackside darters.
- Many non-target species were abundant in Tate chute including bluntnose minnow, bullhead minnow, freshwater drum, longnose gar and smallmouth buffalo.
- Within and downstream of the tie channels shallow water habitat is created, while habitats upstream of the tie channels often function more like a backwater because of reduced flows.
- Tate Island's form is such that both shallow water habitat and backwater habitat are sometimes present adjacent to one another. This feature may be a driving factor in the species richness found in Tate chute.

Recommendations for Modification:

- No modifications are recommended at this time

Combined Physical and Biological Summary

Chutes and backwaters provided habitat for different fish communities. Chutes were found to have more riverine species while these species were lacking in backwaters. Contiguous backwaters had greater species diversity and richness than those that were impounded. This connection to the river allowed species to access these areas that they otherwise could not have.

Chutes separated themselves out geographically. The available fish community in the main channel affected the fish community in the chutes. Chutes that were located farther up the Missouri River tended to benefit different species than those on the lower end of the river. Therefore, the benefit of a chute to the overall fish community probably depended on if the chute provided something different than what was already found in the main channel. Also more diverse fish communities were found in the older constructed and natural chutes. This is probably due to the greater habitat diversity these chutes have developed compared to the younger chutes.

Overall, the fish communities in most sites were dominated by juveniles of most species. The habitat that has been developed via chutes and backwaters therefore are functioning as refuges for smaller fish. This is a valuable asset to the fish communities in the Missouri River. Currently little is known if these juveniles are spawned or drifted into the chutes and backwaters. It is also unknown if these juveniles are able to move out of the chutes and backwaters and into the main channel.

Predictive models indicated that chutes had different probabilities of presence for target species. In general, chutes that were relatively longer, wider, shallower and had greater sinuosity were more likely to have target species present. Conversely, chutes that were short, had low width to depth ratios and low sinuosity were less likely to have target species present.

Important predictor variables for species presence were year (85% of species models), water depth (80%), turbidity (65%), water temperature (60%), month (60%) and water velocity (50%). A year effect, likely related to river discharge, for many species supports the need for multiple year assessment programs. Water depth and to some extent water velocity, were recognized as two variables that can be most easily manipulated by river engineers and we found that the selected range of depths and velocities varied by species, which was expected with a diverse fish community. Many juvenile and small-bodied fishes utilized shallow water habitats (<1.0 m) over a broad range of water velocities (0.0-1.0 m/s), but large-bodied fishes tended to orient towards relatively deeper water. Therefore, creating shallow water habitats with a range of velocities would likely benefit many juvenile native species.

We suggest that length and width are two of the most important variables to consider during the design process. Longer chutes inherently have more capacity to evolve habitats that are considered important for many fish species. Longer chutes generally have higher sinuosity (more bends and crossovers) than shorter chutes. This increased sinuosity allows for the formation of areas of shallow water that may not exist in a short chute such as inside bend sand bar formations. The increased sinuosity of longer chutes also means that they may have greater capacity to slow water that may be

entering the chute at high velocities. Wider chutes also posses the ability to slow water better than narrow "U" shaped chutes which can constrict and accelerate flows. Increased length and width increase the chances of habitat diversity within the chute. Both are more likely to result in deep scour holes and shallow bars as well as deposition of large woody debris or contain areas where high water can flood terrestrial vegetation. After the high water events of 2007 and 2008 large amounts of large woody debris were observed on the banks of most chutes however, very little large woody debris was observed in the chutes. Alternative bank designs (sloping etc.) could facilitate large woody debris being deposited in the chutes rather than on the banks. Habitat diversity has been described as missing in the main channel of the Missouri River (Hesse and Mestl 1993) and should be an important part of chute design.

Discussion

Many sites were found to need additional modifications to achieve optimal functionality and maximize biodiversity. Managed wetlands (disconnected backwaters) functioned poorly as habitat for native fish species; this could be rectified with river connectivity. Contiguous (connected) backwaters functioned well but were subject to siltation, these backwaters need design improvements to decrease flood deposition and resulting siltation. Chutes were found to function differently. In California (IA) water velocities decrease in the chute with an increase in main channel discharge, thus creating a flow refuge. The upper portion of Kansas chute functioned in a similar manner. California (NE) chute no longer has functioning tie-channels. These tie-channels, like connected backwaters, proved susceptible to siltation by high flood flows. For these tie-channels to remain viable, they would need to be re-designed. Tobacco chute had high

species richness and appears to function well as a shallow water habitat, however, because of highly cohesive clay soils, Tobacco, which was dug as a pilot channel and expected to widen by natural processes, has changed little since its initial excavation. Upper Hamburg had high species diversity and functions well with high habitat complexity, however, modifications to the entrance of Upper Hamburg chute may be acting as a fish passage barrier. Gravid pallid sturgeon have been documented to use chutes in their upstream spawning migrations (Personal communication, Aaron Delonay, USGS), therefore further modification to the entrance of this chute to allow for fish passage should be considered. Lower Hamburg was constructed with a connected backwater, which became disconnected as the result of large deposits of sand and silt during high water events in 2007 and 2008. A flow-through tie-channel/backwater complex at Deroin suffered the same fate and no longer functions as designed. We suggest that re-opening of these silted in areas would be beneficial but their design should be evaluated. The functionality of the Kansas chutes was poor overall; these chutes are probably too short to develop the habitat complexities desired to support a diverse native fauna, especially when combined with the high velocities that these chutes experience. Lisbon chute had high species diversity and very high habitat complexity; however improvements to the closing structure at the entrance of this chute could facilitate juvenile fish movement into the chute. Overton chute is another chute with highly cohesive soils that are not allowing for natural widening. This chute may need to be modified to promote widening to produce more habitat complexity and biological diversity. Tadpole chute is a very young chute (constructed in 2006) and will need more time before modification recommendations can be made. Tate chute had high habitat

diversity and supported high species diversity and therefore no recommendations are being made at this time

Mitigation project designs are providing a range of habitats. Backwater habitats are creating habitat not currently available in most reaches of the Missouri River. Different backwater designs do not appear to be creating different habitats from each other; however, backwaters can only be used by riverine fish if they are connected to the river. All chutes are providing some habitat diversity, however, some chutes, including; California (NE), Upper Hamburg, Lisbon and Tate contain more habitat diversity, and therefore, they are providing much needed habitat complexity to that reach of the river.

Backwater and chute habitats appear to be beneficial to the biodiversity of the Missouri River system; however, it is important to note that different reaches of the river have different needs. The highly modified middle Missouri River, from Sioux City, IA to Kansas City, MO has very little habitat diversity available within the main channel and many different habitats may be necessary to restore the healthy function of the river system. While the lower Missouri River has greater habitat diversity within the main channel, there are still habitats that may be limited, such as habitat diverse chutes (i.e. Lisbon or Tate) or backwaters that may be needed to restore a fully functioning river.

General Recommendations

- Promote natural side channel creation on suitable public lands. Allowing the river to naturally create side channel habitat may provide the most suitable habitat for riverine fish.

- We recommend constructing chutes that allow for floodplain connectivity, encourage natural river processes and maintain greater complexities of habitats (i.e. high width to depth ratios, diverse substrates, diverse depths, diverse velocities, shallow sandbars, woody debris and vegetated sandbars)
- Construction of longer chutes should receive higher priority than short chutes
- If a short chute must be built, build width, sinuosity and habitat diversity (deep scour holes, bar features and large woody debris).
- Promote channel movement through the use of structures or large woody debris.
- Soil type should be an important consideration in chute design, sites with clay or compacted soils need to be built to finished width or with wider pilot channels to hasten evolution.
- Slope banks when possible to allow large woody debris to accumulate in chutes rather than on high banks.
- Promote capture of large woody debris to increase habitat diversity and secondary productivity.
- Avoid designing chute entrances that may block upstream migration of fish (high sills, constricted entrances with high velocities and turbulence).
- Evaluate entrance structures to determine if certain life stages of some species (e.g., young of the year sturgeon) are being excluded from entering the chute.
- Avoid designs that promote sedimentation at chute entrances; keep entrances open so desired flows can be achieved.

- If a chute is intended to widen with increased main channel discharge, avoid designs where velocities decrease as main channel discharges increase such as at California (IA) and Kansas (upper).
- Use pilings, like those at Tate chute, instead of rip rap to create water control structures. Using pilings, as opposed to rock structures, may increase the permeability of water structures at varying levels of the water column, particularly the benthos.
- Include tie-channels and braids in chute designs to increase the amount of shallow, slow moving water at sites and provide more area that is in contact with the main channel.
- Design tie-channels, braids and connected backwaters to limit sedimentation.
- Tie channels could be used to direct flows to lower portions of the chute, allowing the upper portions to act more like backwater habitat.
- Create side channel habitat by building islands as opposed to digging channels, as was the case with Tate Island chute.
- Consider reopening existing, naturally formed side channels that are presently cut off from regular flows; there are at least 13 historic chutes that might be considered on the lower Missouri River.
- Contiguous dredged backwaters (such as Tyson Island and California (IA)) are recommended over impounded (disconnected) wetlands (such as Tieville, Louisville and Decatur). Contiguous sites provide connectivity that allows fish access to spawning and nursery habitat. Pumping did not provide accessible floodplain fish habitat.

- Backwaters should maintain a consistent, direct river connection. Open river connections are preferred over water control structures (culverts).
- Connectivity introduces sediment that will eventually fill backwaters. Siltation must be addressed by mechanical removal or improved backwater design.
- Backwaters of the upper channelized river become dewatered and isolated during winter discharges, backwaters should maintain adequate depth to prevent winter fish kills (approximately 3 m deep from December through February)
- Continued monitoring of chutes and backwaters would allow the determination of the rate at which the chute or backwater is evolving, the level of functionality that they can attain, value each chute has to different species, and how future manipulations affect the habitat and fish community.
- The variation in fish abundances seen among the three years of sampling indicates that a long term monitoring effort would be needed to detect population trends in chutes or backwaters. Furthermore, fish data from the chutes and backwaters should be compared to data from the main channel to determine how the chutes and backwaters are functioning with respect to main channel fish use.