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AN EVALUATION OF SAMPLING TECHNIQUES AND LIFE HISTORY INFORMATION ON BIGHEAD CARP IN THE MISSOURI RIVER, BELOW GAVINS POINT DAM, SOUTH DAKOTA AND NEBRASKA

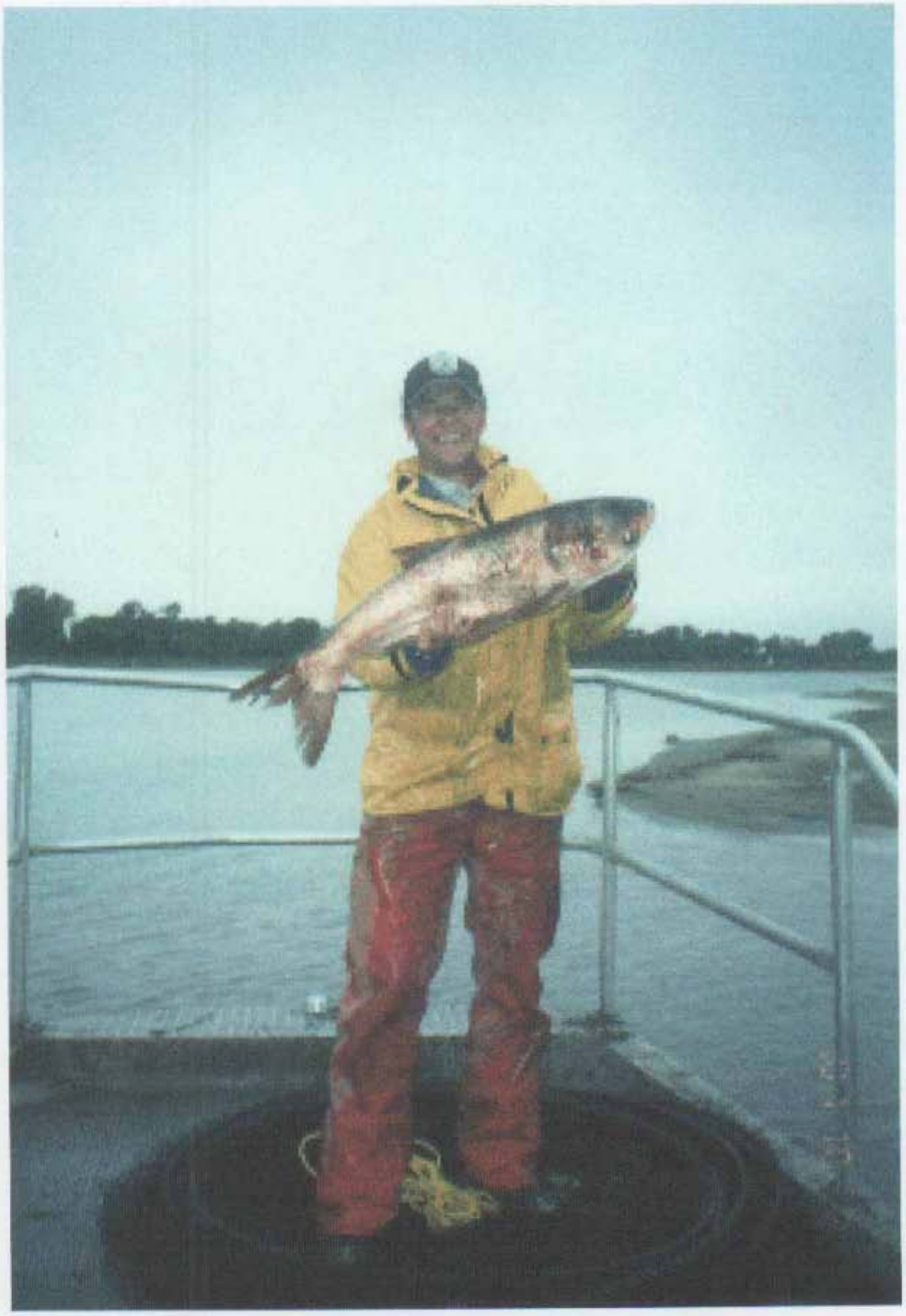
Prepared by the US Fish & Wildlife Service
Great Plains Fish and Wildlife Management Assistance Office
Pierre, SD

INTRODUCTION

Bighead carp *Hypopthmichtys nobilis* were introduced into the United States from south and central China (Robins et al. 1991) in 1972 (Henderson 1979). It is an efficient planktivore (Henderson 1978) that was imported into Arkansas by an aquaculturist to improve water quality in catfish ponds (Henderson 1976). In 1974, the Arkansas Game and Fish Commission began looking at potential impacts of bighead and other Asian carp as well as their beneficial effects on the environment. Regulations were also imposed to prevent these fish from entering public waters from private sources (Henderson 1975). In 1981, nevertheless, the first bighead carp was found by a commercial fisherman from the Ohio River below Smithland Dam at Mile Marker 919 (Freeze and Henderson 1982). Currently, Fuller et al. (1999) report that bighead carp are present in 19 states; however, specimens have been captured as far north as Gavins Point Dam on the Missouri River, South Dakota (Figure 1).

Life History. Bighead carp can weigh 18 - 23 kg (40 - 50 lbs) by their fourth year (Henderson 1978) (Figure 2) and have been documented as large as 40 kg (90 lbs) in their native range (Pflieger 1997). Henderson (1979) reported that sexual maturity is reached at three or four years, but Bardach et al. (1972) noted it can vary with climate and environmental conditions. Spawning is limited to free-flowing streams (Henderson 1979). Bighead carp migrate upstream to spawning grounds (Jennings 1988) which are characterized by rapid currents with a mixing of water, such as at a confluence of rivers or behind sandbars, stonebeds, or islands (Huet 1970).

Figure 1. Distribution of bighead carp *Hypopthalmichthys nobilis* in the United States. Adapted from Fuller et al. (1999) to include Nebraska and South Dakota.



Spawning naturally occurs in April - June with water temperatures ranging from 26 - 30 °C (Bardach et al. 1972) and is initiated by increasing water levels that occur after heavy rains (Pflieger 1997). Bardach et al. (1972) noted that all Chinese carps are annual spawners, while Pflieger (1997) indicated an extended spawning season may occur in the Missouri River. He found three inch young in August and fry less than one inch the following September 1989.

As fish mature, fecundity increases (Jennings 1988). Chang (1966) stated that a bighead carp from the Yangtze River, China with a body weight of 18.5 kg (42 lbs) and a gonad weight of 1.96 kg (4.4 lbs) produced 1,100,000 eggs. The eggs are semi-buoyant and are deposited in the river channel (Pflieger 1997). Eggs are either carried to feeding grounds (i.e., flood lakes, creeks, and quiet channels) or hatched in the current. If hatched in the current, larvae will actively seek feeding grounds (Nikolsky 1963).

Diet. The feeding behavior noted by Cremer and Smitherman (1980) suggested that bighead carp utilized all layers of the water column, including the substrate. Diet consisted primarily of zooplankton but also included phytoplankton and detritus. They found that gill raker size allowed for the wide range of food consumption while Henderson (1976) noted a mucous coating that allowed entrapment of particles smaller than gill raker width. Nikolsky (1963) stated food particle size decreased as fish size increased; larval bighead carp fed on planktonic crustaceans and adults fed on planktonic algae.

Feeding rhythm has been observed as most active at 2000 h and least active at 0500 h (Moskul 1977). Other studies have found that bighead carp fed for 18 h each day during July and August, with intensity peaking at 1200 and 2000 h, suggesting it may be a function of light intensity, dissolved oxygen, and temperature (Sifa et al. 1980).

In the Missouri River. American Rivers listed the Missouri River as the most endangered river of 1997. The river has been substantially altered by actions such as federal dams, channelization, and channel stabilization. One-fifth of the species native to the river and its floodplain are listed as endangered, threatened, or of special concern by Federal and State agencies (American Rivers 1997). Although bighead carp do not directly compete with most commercial species (Henderson 1979), they could deplete zooplankton populations required for food by native mussels, larval fishes, and some adult fishes (Laird and Page 1996).

Bighead carp may compete directly with paddlefish *Polyodon spathula* and bigmouth buffalo *Ictiobus cyprinellus* for food (Pflieger 1997). Paddlefish were petitioned for listing as threatened under the Endangered Species Act in 1989 (Allardyce 1991) due to a decline in abundance and range from habitat alterations (Sparrowe 1986) and heavy commercial fishing (Carlson and Bonislawski 1981). The petition was denied due to insufficient data; however, competition with bighead carp could further affect already declining paddlefish populations.

USFWS. The Fish and Wildlife Service is committed to the prevention and control of invasive species on all Service-managed lands and waters and is working with private landowners and other partners to help control invasive species nationwide. These important directives and statutes have recently been joined by a new Executive Order from the President of the United

States. The new executive order directs all federal agencies to prevent and control introductions of invasive species in a cost-effective and environmentally sound manner. Executive Order 13112.

STUDY AREA

Gavins Point Dam is located in Yankton, South Dakota and is the most downstream mainstem dam on the Missouri River (Figure 3). The stretch of river below the dam resembles the natural Missouri River and contains sand bars, old growth riparian forest, side channels and year round flows.

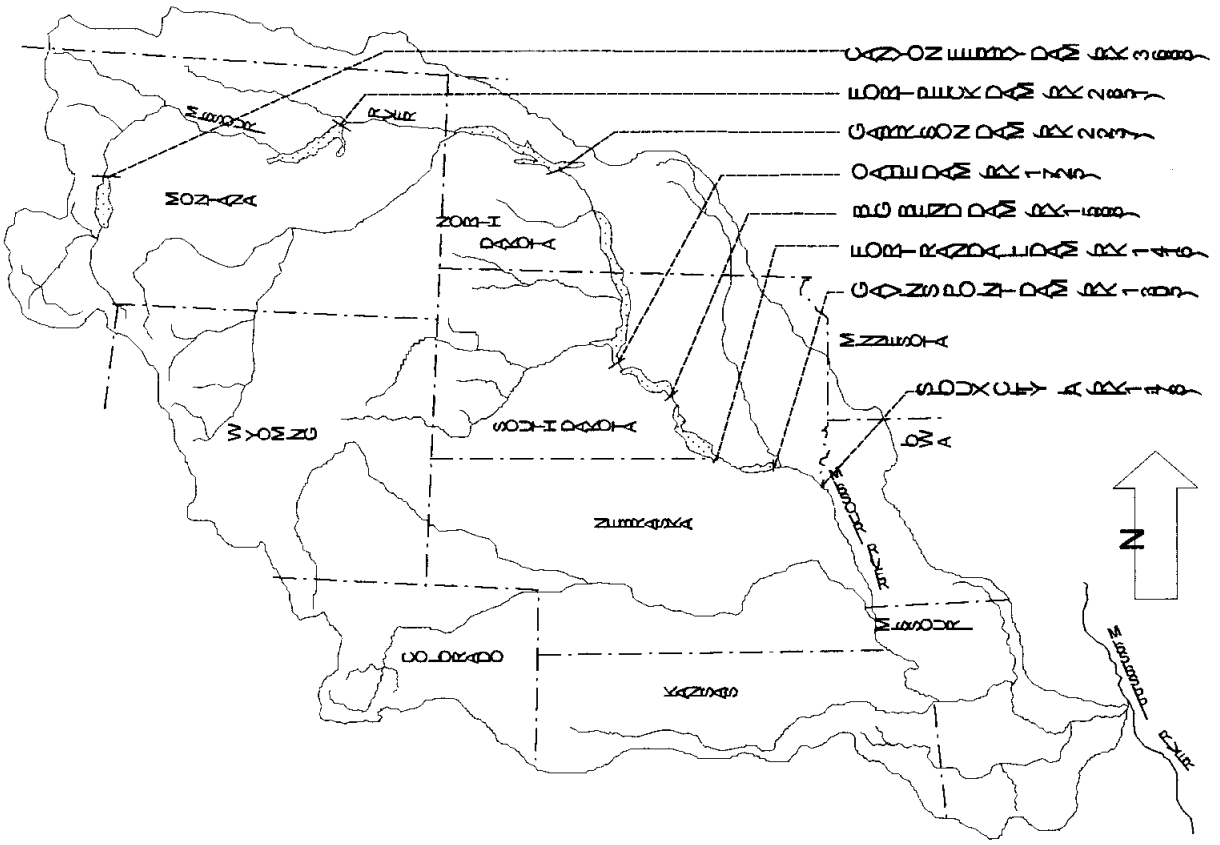


Figure 3. Missouri River with mainstem dams.

Our study area included the Missouri River from below Gavins Point Dam to 1 km below the Clay County boat ramp (figure 4). This stretch of river resembles the natural Missouri River and contains sand bars, old growth riparian forest, side channels and year round flows. Although the natural hydro graph has been greatly altered due to water releases from Gavins Point Dam, the fish assemblage more closely resembles that of the historical Missouri River and bighead carp have been reported by anglers to frequent this area.

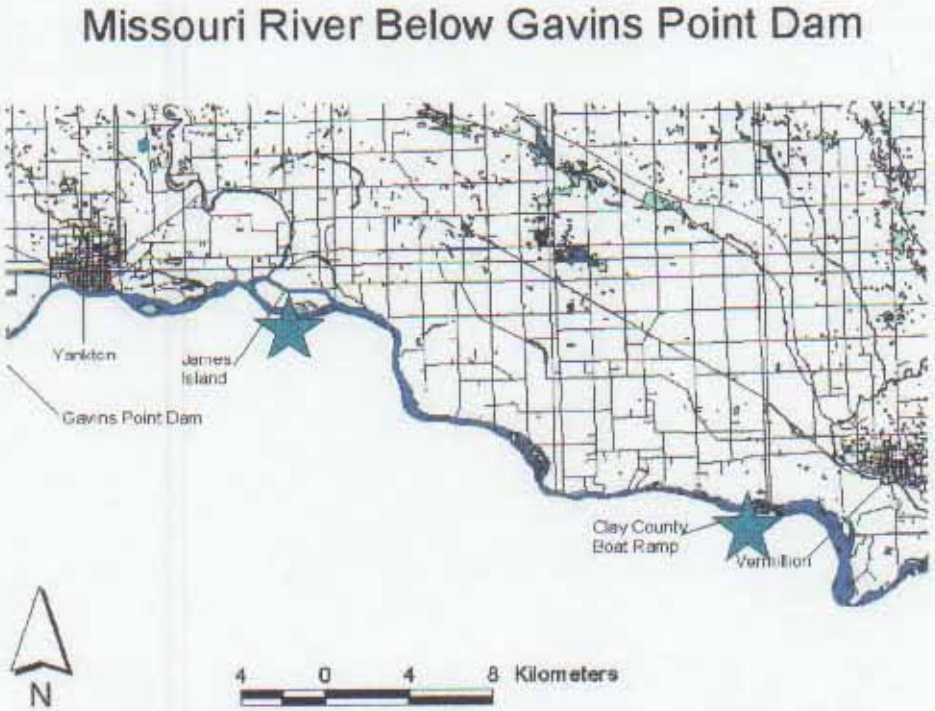


Figure 4. Study area for bighead carp study. Areas with stars represent approximate collection sites.

METHODS

Bighead carp were collected at two areas (Figure 4) and in two sites within each area (Figures 5 & 6) between April and September 2001. Bighead carp were collected using 24-hr gill net sets, floating trammel nets, and hoop nets. The experimental gill nets were 38.1 x 1.8 m monofilament experimental nets consisting of five 8.3 m panels (19 mm, 25 mm, 38 mm, 51 mm, and 76 mm) mesh. The experimental floating trammel nets were 30.58 m long x 1.83 m high. Each net consisted of four 8.3 m long panels, each panel being randomly placed with a different wall size: bar mesh size (30.58 cm: 2.54 cm, 35.56 cm: 5.08 cm, 40.64 cm: 7.62 cm, and 45.72 cm: 10.16 cm). Trammel nets were floated through areas with flow: sandbars (channel side), plunge pools, and river channel. Areas too small for a 15 minute drift (e.g. plunge pools, sandbars) were floated repeatedly until the time requirement was met. If a net became filled with debris, the drift and timing was stopped until the materials were removed.

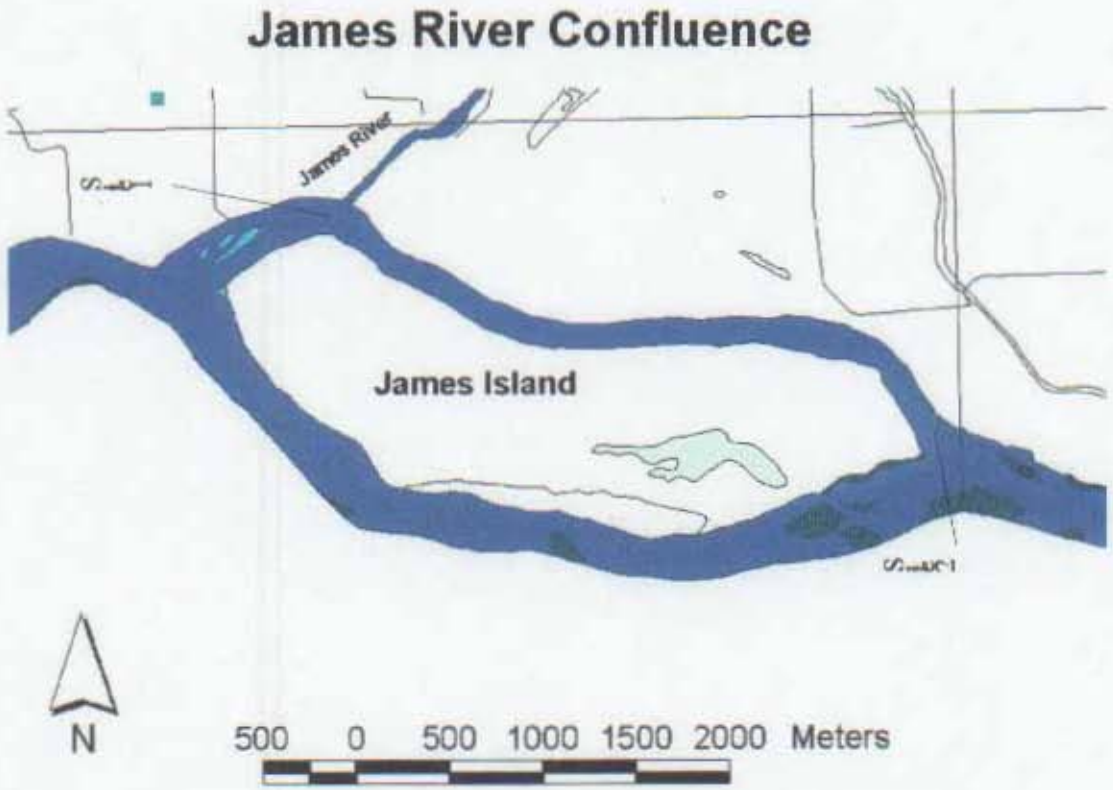


Figure 5. Bighead carp collection sites near the Missouri River-James River confluence.

Trammel nets and gill nets were also set stationary in areas without flow: flats and backwater side of sandbars. Three nets were set for 24-hr each in both habitat types. A 100 m long x 4 m high seine with a 2.54 cm bar mesh was used as a secondary gear type in areas of low flow. Three seine hauls were performed in each habitat type, with each haul having the same area covered. For all sampling, habitat type, depth, temperature, and velocity were recorded. Each fish was measured to the nearest millimeter and weighed to the nearest gram. One pectoral spine, the dorsal spine, and scales were collected from each fish for age and growth analysis. Gonads were removed from both the male and females, weighed to the nearest gram and samples were preserved in 10% formalin for future fecundity analysis.

Habitat types were identified as either, main channel, main channel-outside bend, main channel-inside bend, side channel, sandbar pool, tributary river, or confluence area. The confluence area is that area where a tributary river meets the main river.

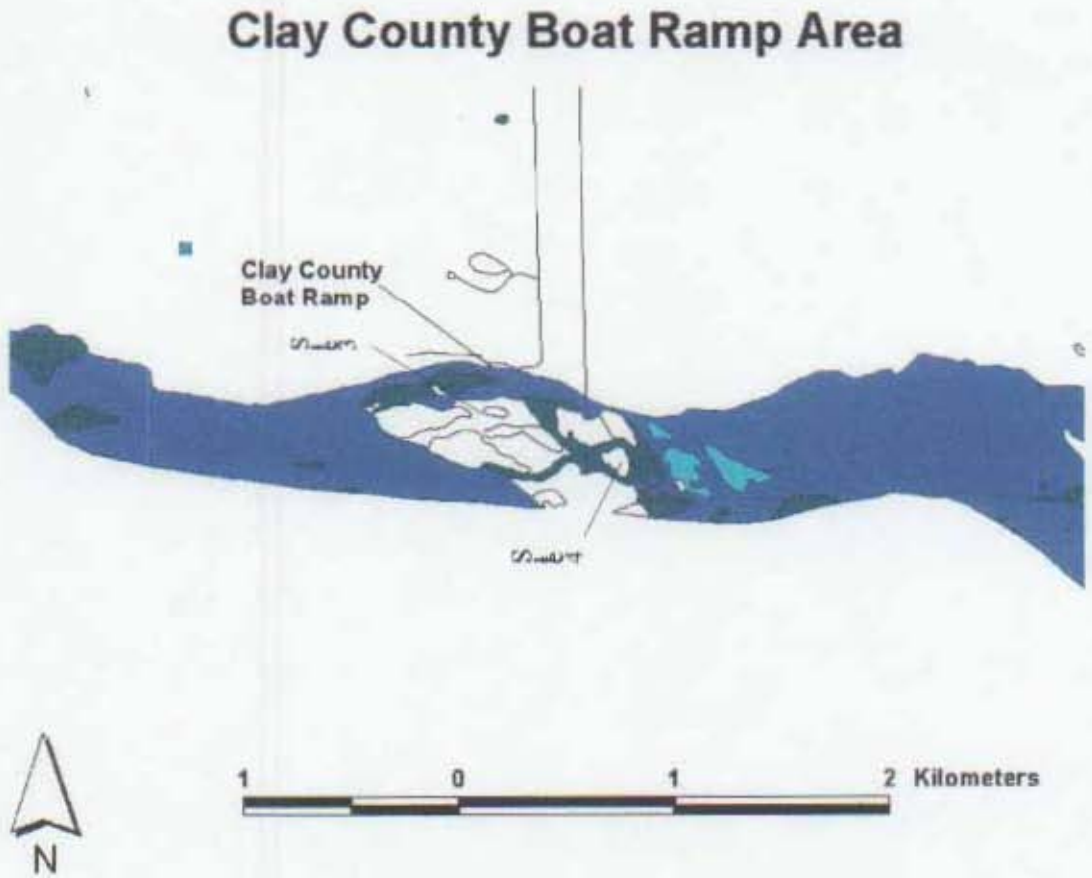


Figure 6. Bighead carp collection area near the Clay County Boat Ramp, South Dakota.

RESULTS

Gear Efficiency

Eleven bighead carp ranging from 820 to 890 mm were sampled with various gear types and in a variety of habitats during May through October 2001. Bighead carp were sampled with 1457 hoop-net-hours in confluence areas, sandbar pools, side channels, and in the bends of the main channel. Static trammel nets were deployed for 1457 hours in confluence areas, side channel areas, and sandbar pools. Static gill nets were used in confluence areas, side channels, and sand bar pools for 194 hours of sampling. Floating gill and trammel nets were drifted in tributaries, main channel, and sandbar pools for 120 and 130 hours respectively. Seventeen seine hauls were completed in backwater areas. Our attempts to use static gill and trammel nets set parallel to the flow in the main channel areas or side channels with any significant flow proved ineffective because the nets would fill with debris or roll.

Bighead carp were often observed feeding on detritus drifting along the break lines of sand bars or current breaks. The carp were usually in schools of 10 - 60 fish and we could approach within 10 m if we shut the outboard motor off and drifted into them. But, if we approached them with the motor running, then the fish would submerge and stay submerged for varying lengths of time up to several hours based upon the degree of disturbance. On several occasions we observed bighead carp submerging when a boat approached with their outboard running at distances greater than 300 m.

We attempted to collect bighead carp using floating trammel and gill nets by drifting them along the surface perpendicular to the break lines where carp were observed feeding. But no bighead carp were collected with floating nets (Table 1). Based upon their susceptibility to disturbance, we suspect that our attempts to collect bighead carp with floating nets were unsuccessful because the fish would submerge due to our disturbance, the presence of the nets, or a combination of the two.

We also used floating trammel and gill nets in the James River tributary with no success. We suspected that bighead carp would be attracted to this area during the spring spawning season. We are unsure wether our lack of success with collecting carp in the James River was due to gear efficiency or timing as our first sampling period occurred during May.

Our attempts to collect bighead carp by floating nets along the bottom were also unsuccessful because of the large abundance of trees and similar objects that entangled the nets. Rarely were we able to drift for greater than 10 minutes before becoming entangled in trees or other objects and in most instances the net was destroyed while trying to untangle it. Bottom drifting as a sampling technique for bighead carp is not practical in the sections of river where we are working.

Bighead carp were collected with static gill and trammel nets in sandbar pools and side channels and to a limited extent with a shoreline seine in the backwater areas (Table 1). The static nets in

Table 1. Bighead carp Catch Per Unit Effort by gear type with sampling effort (n) in habitat types of the Missouri River below Gavins Point Dam during Spring through Fall of 2001.

Gear Type	Main Channel	Main Channel Outside Bend	Main Channel Inside Bend	Side Channel	Backwater	Sandbar Pool	Tributary Confluence	Tributary
Static Trammel	0 (15)	NA[1]	NA	0.21 (28)	NA	0.66 (51)	0.05 (22)	NA
Floating trammel	0 (12)	0 (17)	0 (33)	0 (2)	NA	0 (21)	NA	0 (14)
Floating gill net	0 (14)	0 (17)	0 (22)	0 (3)	NA	0 (22)	NA	0 (14)
Static gill net	0 (3)	0 (17)	0 (21)	0 (19)	NA	0.05 (18)	0 (16)	NA
Hoop net	0 (20)	0 (22)	0 (19)	0 (6)	NA	0.06 (33)	0 (19)	NA
Seine	NA	NA	NA	0 (2)	0.13 (8)	0 (7)	NA	NA

1) Gear type was not used because habitat conditions prohibited proper deployment.

the pools were our most successful collection method but there were also inherent problems with this gear type. We originally planned to set static nets with various mesh sizes and run them every two hours. Our decision to run the nets frequently was based upon the high frequency of paddlefish being entangled in the gill nets with mesh sizes larger than 7.5 cm and trammel nets with wall mesh sizes larger than 5 cm. Running the nets frequently proved to be counter productive for bighead carp sampling due their susceptibility to disturbance. In August, we starting using 24 hr static trammel nets sets but used inner wall meshes of 5 cm or less and outer wall diameters ranging from 25 cm to 40 cm and discontinued setting gill nets with mesh sizes larger than 5 cm.

Hoop nets were the most versatile gear type we deployed as they could be used in all habitat types and under all flow conditions. But, only one bighead carp were collected in hoop nets even though we used them in all types of habitat types and were often stationed near trammel nets that were collecting bighead carp. We first attempted to use hoop nets in August and their lack of success may have been due to the season that we began deploying them as other species of fish, including common carp, are often collected using hoop nets. Baiting the nets with cheese or alfalfa cake may improve their efficiency.

The shoreline seine was successful in collecting bighead carp (Table 1) but its utility in the river is limited to specific habitat types such as backwater sites where the area was protected from the flows and also shallow enough to keep the lead lines on the bottom and the floats on the surface as we pulled the seine. Part of the problem with using the seine may also be related to the susceptibility of bighead carp to disturbance. We were most successful using the seine in areas where we could approach the area and push any fish in the area toward the end of a small cove or similar site. At this time we could stretch the seine across the mouth and seine towards the back of the cove which prohibited the fish from escaping. On several instances we attempted to seine small pools where we had seen bighead carp feeding as we approached. In each of these instances we were unsuccessful and we suspect that the fish left the area while we deployed the net. The seine can be used to sample bighead carp but its utility in the river is limited to specific areas and likely to specific seasons when the fish are utilizing these habitat types.

Habitat Use

We collected turbidity, bottom and surface flow data, water temperature, and noted habitat types at each site where sampling gear was deployed. This information will be useful in identifying preferred habitat types for bighead carp and improve our sampling efficiency. One problem with trying to use a multitude of gear types across habitat types to establish habitat preference for fish is the lack of standardization that occurs using this approach. For instance, if we collect more bighead carp in sandbar pools using static trammel nets than we do using hoop nets in outside bends of the main channel, then these differences could be greatly related to the greater efficiency of the trammel nets in the sandbar pools. Yet, we can't deploy static trammel nets in the main channel of the river because they fill with debris or roll shut. Based on the limited data that we collected during 2001, it appears that bighead carp in the size ranges that we collected, most often utilize sandbar pools with limited flow and low turbidity during the months of June through August. We still lack any information on the spawning behavior and over wintering sites for

bighead carp and the presence of juvenile fish needs to be established and information on their habitats and movements identified.

SUMMARY

Eleven bighead carp ranging from 820 to 890 mm were sampled with various gear types in a variety of habitats during May through October 2001. The absence of smaller bighead carp size classes in our sample maybe due to their absence from the sections of the river where we are working, juvenile selection for un-sampled habitats, or gear bias. Static trammel nets were the most efficient utilized gear at collecting bighead carp in protected areas such as sandbar pools with reduced flows but were inappropriate gear for areas such as the main channel where flows were significant.

We commonly saw bighead carp feeding along the break lines and bends of the main river channel but we had minimal success in collecting them in these habitat types. Although, hoop nets are commonly used in high flow areas, they also were unsuccessful in collecting bighead carp as deployed in our study. We need to further investigate hoop nets as a bighead carp sampling gear in high flow areas as suitable gear types in these habitats are limited.

Based on our literature review, we anticipated bighead carp to use the James River confluence area as a spring staging area and spawning site. One bighead carp was collected in the James River confluence area and this fish was collected well past the season when bighead carp have been reported to spawn. Whether their absence from our sampling in this areas is due to the timing of our sampling effort, gear bias, or their avoidance for this area is yet to be determined.

Bighead carp were often seen feeding along the break lines and sandbars of sandbar pools and were most often collected in this habitat type with the gear utilized in this study. Our sampling indicates sandbar pools are heavily utilized by bighead carp and are likely their preferred habitat from spring through fall. Sandbar pools were also heavily utilized by native riverine fish species including paddlefish. The presence of bighead carp in limited habitat types such as sandbar pools suggest habitat and dietary overlap with native fish and this situation may also result in interspecific competition.