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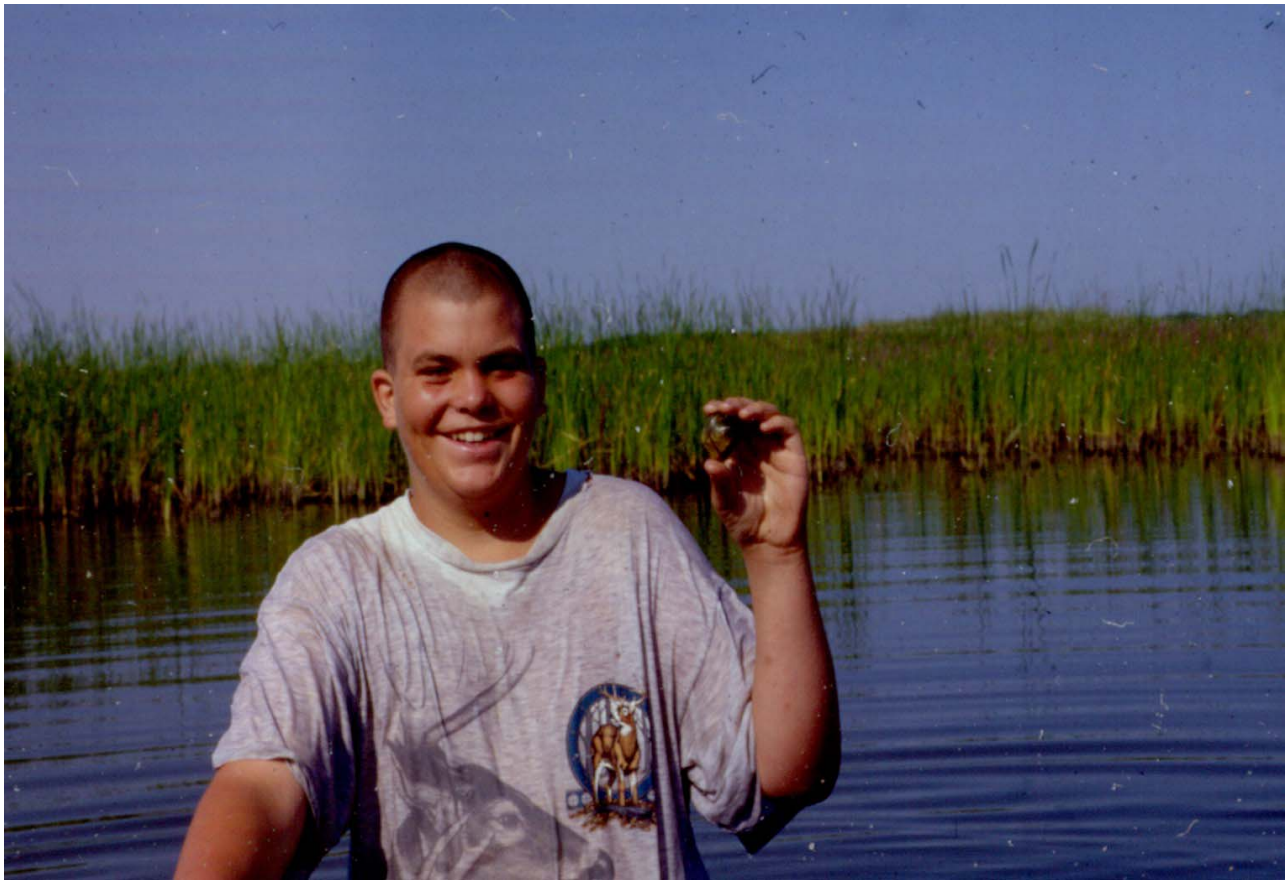

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COVER: Nick Backlund with one of two live *Quadrula quadrula* collected during this survey. This live was found in a backwater at RM 788.7

Contents

INTRODUCTION

In 1999 the U.S. Army Corps of Engineers contracted with the South Dakota Department of Game, Fish and Parks to conduct a presence/absence survey of the freshwater mussels of the Missouri National Recreational River below Gavins Point Dam, South Dakota and Nebraska. Subsequently, S.D. Department of Game, Fish and Parks contracted Keith Perkins III, a malacological expert at the University of Sioux Falls, to take charge of the inventory with the assistance of Doug Backlund, South Dakota Department of Game, Fish and Parks, Pierre, S.D.

BACKGROUND

The Missouri River has long been reported to be nearly devoid of freshwater mussels (Hayden, 1862; Coker and Southall, 1915; Over, 1915, 1942). These workers reported that the high silt load carried by the river made the river uninhabitable for freshwater mussels. The first published report of significant numbers of freshwater mussels in the Missouri River came in 1983 when Ellet Hoke reported the presence of thirteen species in the river along the Nebraska border (Hoke, 1983). Hoke also commented on the lack of historical reports of the unionid fauna in the Missouri River. Hoke indicated his belief that the lack of unionid records for the Missouri River was the result of "the apparent absence of extensive previous work in the Missouri River…" and not due to the habitat conditions present in the pre-impounded Missouri River. However, it is worth noting that all the previous workers did report that unionids were present, indeed often abundant, in the major tributaries entering the Missouri River from the north, the Big Sioux River, Vermillion River, and James River. Hayden (1862) reported that "recent shells are not abundant on the Missouri except in the streams that flow from the North." Coker and Southall (1915) reported that many tons of shells had been harvested from the James River in 1913 and that there were large beds of clams in the Vermillion River. Perkins (1975) completed a study of the mussels of the Vermillion River and found evidence of sixteen species; nine species were found live.

Mussel shells have been recovered from many archaeological sites along the Missouri River. Warren (1994) reported finding shells of five species at a site near Pierre and considered four of the species as probable natives to the area *(Pyganodon grandis, Lasmigona complanata, Ligumia subrostrata*, and *Lampsilis siliquoidea)*. More recent work in the Pierre area shows that two of the species reported by Warren are currently thriving in the upper portions of Lake Sharpe and three of the species are present in a small tributary, Medicine Knoll Creek, on the east side of the Missouri River (Backlund, 1996; Ecological Specialists, Inc., 1998). Twenty-five species of freshwater mussels are reported in collections from ninety-one archaeological sites along the Missouri River in Nebraska, South Dakota, and North Dakota (Warren and Oliver, 1998). Three species (*Pyganodon grandis, Lasmigona complanata*, and *Lampsilis siliquoidea*) made up 77% of the 3,188 identified valves from these archaeological sites. These three species are the same species reported in Medicine Knoll Creek near Pierre (Backlund, 1996). *Lampsilis siliquoidea* was once much more common in this creek as evidenced by the numbers of relict shells found. *Pyganodon grandis* and *Lasmigona complanata* are common in this creek and in mud flats at the mouth of

Medicine Knoll creek in the headwaters of Lake Sharpe. Other species present are *Potamilus ohiensis* and *Leptodea fragilis*, both are abundant.

It is apparent that unionids were present in the Missouri River and tributaries in pre-Columbian times. Although the Missouri River itself was probably, at best, marginal habitat for freshwater mussels, certain tributaries and oxbow lakes provided habitat that could be colonized by unionids. The Missouri River provided the corridor that allowed the host fish to disperse unionids into these habitats. The river system was certainly not a "faunal barrier" as described by Paul Bartsch (Bartsch, 1916). The Missouri River was instead a corridor of dispersal into suitable habitats.

The construction of large hydroelectric dams on the Missouri River has destroyed most of the former oxbow lake and backwater mussel habitats along the Missouri River but at the same time these dams have also created habitat that is suitable for freshwater mussels. Mussels from the tributaries have colonized this habitat becoming very abundant in some places.

The river immediately below Gavins Point Dam provides excellent habitat for several reasons. First, it is the lowest mainstem dam and is the highest point on the river that mussel host fish can ascend to. Concentrations of fish result in excellent conditions for colonization and reproduction. Second, Gavins Point Dam is a topwater discharge dam. During the summer months the warm phytoplankton rich waters are oxygenated during discharge from Gavins Point Dam. Third, the river substrate below the dam is firm and free of silt and shifting sand. The current provides a constant source of food for filter-feeding mussels. These are excellent conditions for certain species of freshwater mussels and some species have become very abundant.

Hoke (1983) was the first to publish on the existence of significant populations of freshwater mussels in the Missouri River. He found thirteen species in the Missouri River contiguous to Nebraska, including ten species at two sites on the Missouri National Recreational River segment extending from Gavins Point Dam downstream to Ponca, Nebraska. Nine of these species were found at one site, 1 kilometer east of Gavins Point Dam. Here, Hoke collected a fresh dead specimen of *Leptodea leptodon*, a rare mussel that is currently proposed for listing as endangered under the federal Endangered Species Act.

In 1996 the U.S. Fish and Wildlife Service contracted Arthur H. Clarke (ECOSEARCH, Inc.) to conduct a brail survey for *Leptodea leptodon* in the Missouri River below Gavins Point Dam. This project demonstrated that brailing is unsuitable for working this stretch of the Missouri River. Only four species and ten specimens were recovered (Clarke, 1996). No *Leptodea leptodon* were found.

In 1999 the U.S. Army Corps of Engineers contracted with the South Dakota Department of Game, Fish and Parks to conduct a presence or absence survey of the freshwater mussels of the Missouri National Recreational River below Gavins Point Dam, South Dakota and Nebraska. Subsequently, S.D. Department of Game, Fish and Parks contracted Keith Perkins III, a malacological expert at the University of Sioux Falls, to take charge of the inventory with the assistance of Doug Backlund, South Dakota Department of Game, Fish and Parks, Pierre, S.D.

STUDY AREA

The Missouri National Recreational River, Gavins Point Reach, extends from Gavins Point Dam near Yankton, South Dakota downstream to Ponca State Park, Nebraska, a

distance of approximately 58 river miles (see map in Appendix 3). The entire length of this river stretch forms the border between South Dakota and Nebraska.

In general, the South Dakota side of the study area is a broad, flat floodplain with remnant stands of cottonwood forest and late successional stands of eastern red cedar. In many sections, cropland now extends to the river edge. The Nebraska side is hilly and often heavily timbered with bur oak, hackberry, eastern red cedar, black walnut, green ash, American elm, and a variety of other tree species. Some sections of the Nebraska border are level and farmed.

Two major tributaries of the Missouri River enter from the north in this river segment. The James River enters at river mile (RM) 800.5 and the Vermillion River enters at RM 772.0. Controlled releases from Gavins Point Dam have eliminated periodic flooding from most of the river segment, but flooding from these major tributaries can have a flooding effect on the Missouri River, depositing sediment that creates new islands and sand bars in the Missouri River and maintaining some of the natural aggradation and degradation of floodplain habitats. These island and sandbar habitats are very important as nurseries for fish and turtles and also as nesting habitat for federally endangered Interior Least Terns and federally threatened Piping Plovers.

Prior to construction of the mainstem dams, chutes and backwater areas on the Missouri River were constantly forming and reforming. River bed degradation and lack of periodic flooding have resulted in the slow filling in of these chutes and backwaters. Currently, freshwater mussels inhabit the lower ends of the deeper chutes and backwaters.

This stretch of the Missouri River is inhabited by species of fish and aquatic turtles that are rare or extirpated from the impounded portions of the river. Blue sucker (*Cycleptus elongatus*), paddlefish (*Polyodon spathula*), blue catfish (*Ictalurus furcatus*), American eel (*Anguilla rostrata*), silver lamprey (*Ichthyomyzon unicuspis*), sauger (*Stizostedion canadense*), and longnose gar (*Lepisosteus osseus*) are among the fish species that can still be found in this river stretch. The federally endangered pallid sturgeon (*Scaphirhynchus albus*) occurs in the study area. Aquatic turtles typical of large rivers are common on the National Recreational River. Smooth softshell (*Trionyx mutica*) and false-map turtles (*Graptemys pseudogeographica*) are commonly seen and nest on the islands and sandbars. Federally endangered interior least terns (*Sterna antillarum athalassos*) and federally threatened piping plovers (*Charadrius melodus*) nest on islands in the study area.

METHODS

The entire Gavins Point National Recreational River segment was investigated by boat. Sandbars and islands were investigated and all unionid shells were collected to the practical limit. Many river stretches were nearly devoid of clam shells. With a few exceptions, these stretches were cruised by boat but not searched on foot.

Where large numbers of dead shells were found a search for live clams was initiated. Live clam searches consisted of searching the bottom by feeling for clams with our feet or by diving and searching by hand. Both methods of searching for live clams were very efficient. Use of SCUBA or snorkel gear was not needed. In addition to searching areas with large numbers of dead shells, the lower ends of tributaries, chutes and backwaters were also searched for live clams.

All dead shells were collected for later identification. Selected live clams were kept as voucher specimens. All other live clams were returned to the water. Specimens are currently

located at the University of Sioux Falls. Scientific and common names of unionid species are presented in Appendix 1. Numbers of each species (live and dead) collected by site and river mile are listed in Appendix 2.

RESULTS

Forty-seven sites were examined for live or dead clams. A total of 1709 dead shells (a dead shell is considered a matching pair of valves or a single valve) and 355 live clams were found. Live specimens of eight species of freshwater mussels were collected. Sixteen species were identified in the 1709 dead specimens collected. Species diversity was highest at the mouth of the James River (Site 7) while total abundance was highest at sites 1, 2, and 3 in the stretch immediately below Gavins Point Dam (Figure 1, 2, 3, and 4 and Table 1. The high species diversity at the mouth of the James River was represented largely by old, dead shells that probably washed downstream from the James River. Highest species diversity of fresh dead shells and lives was in the river segment below Gavins Point Dam in the vicinity of collecting sites 1, 2 and 3.

FIGURE 1. Number of species of lives by site

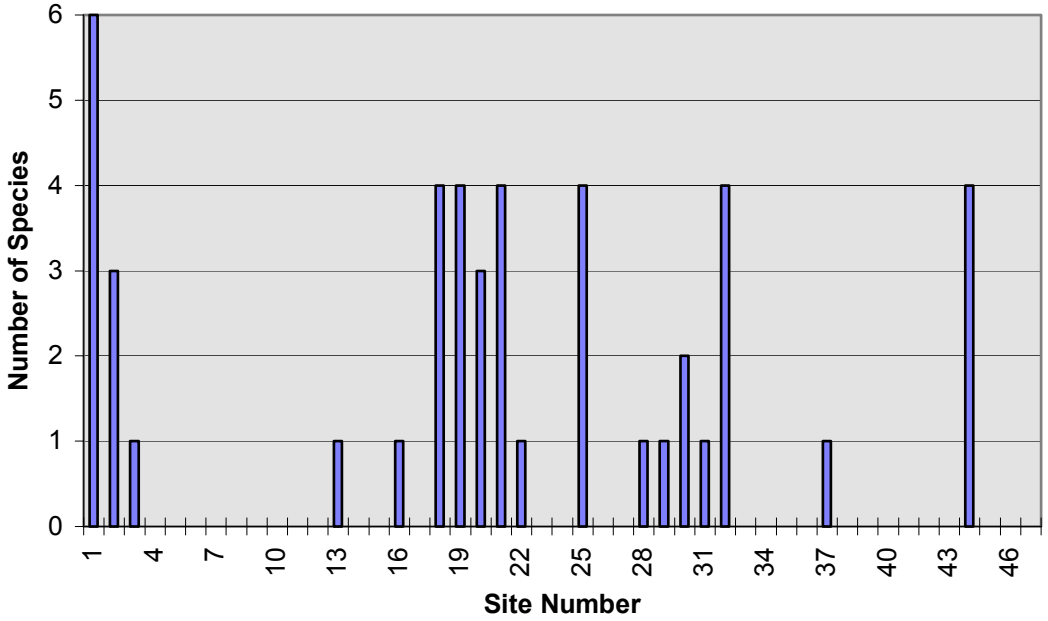

FIGURE 2. Number of species of deads by site

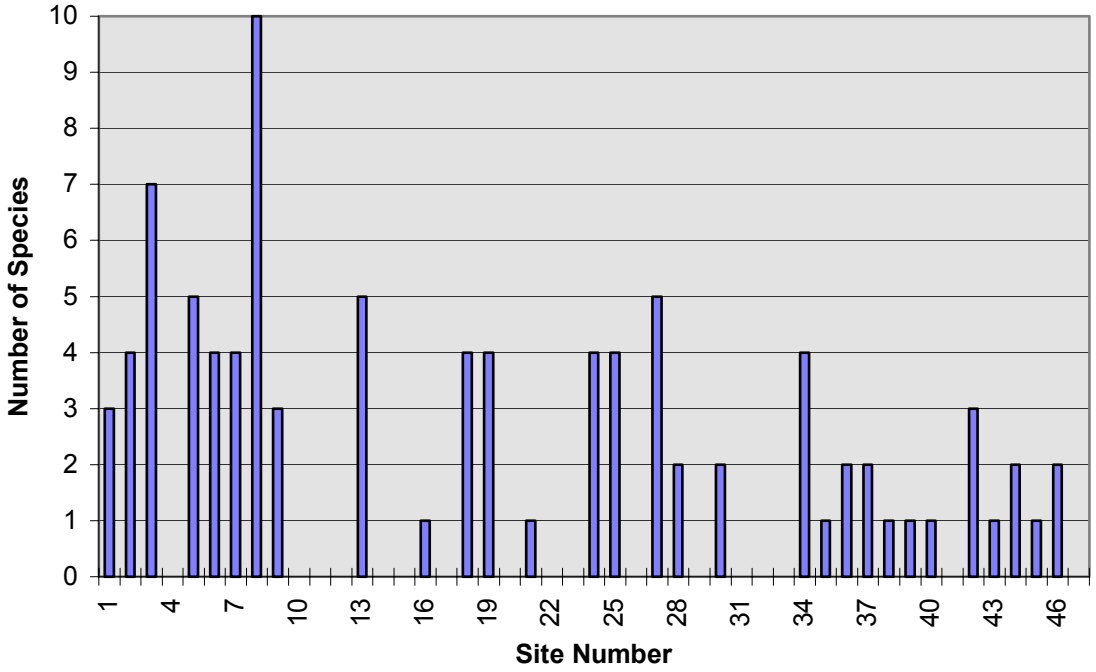

FIGURE 3. Total lives per site

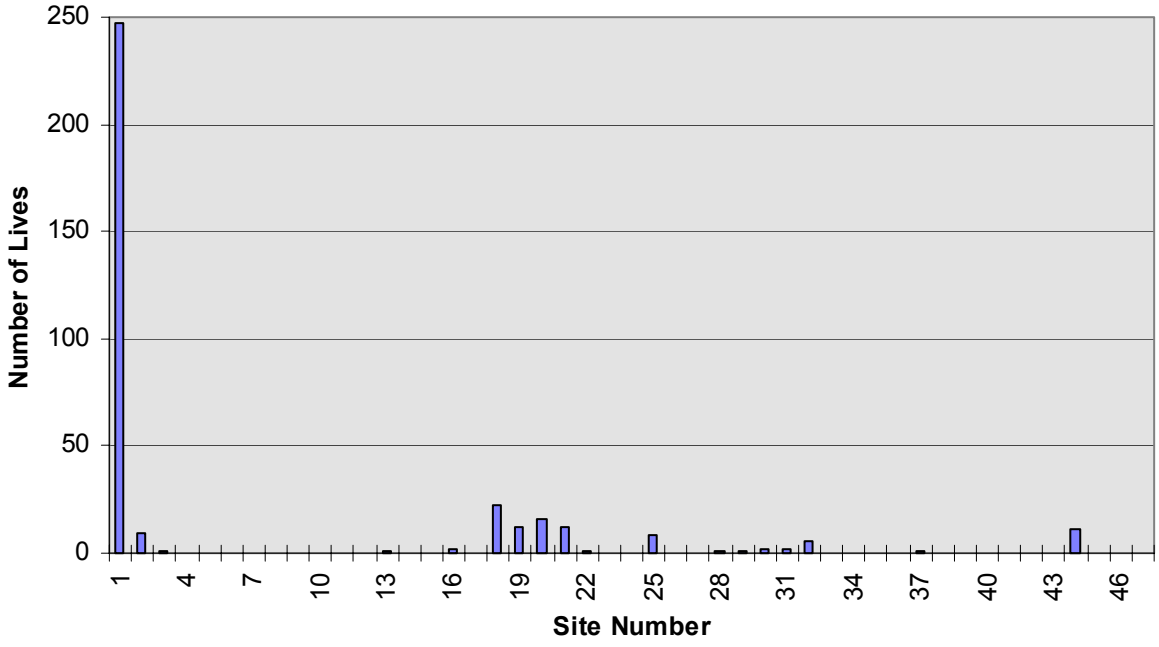

FIGURE 4. Total number of dead specimens per site

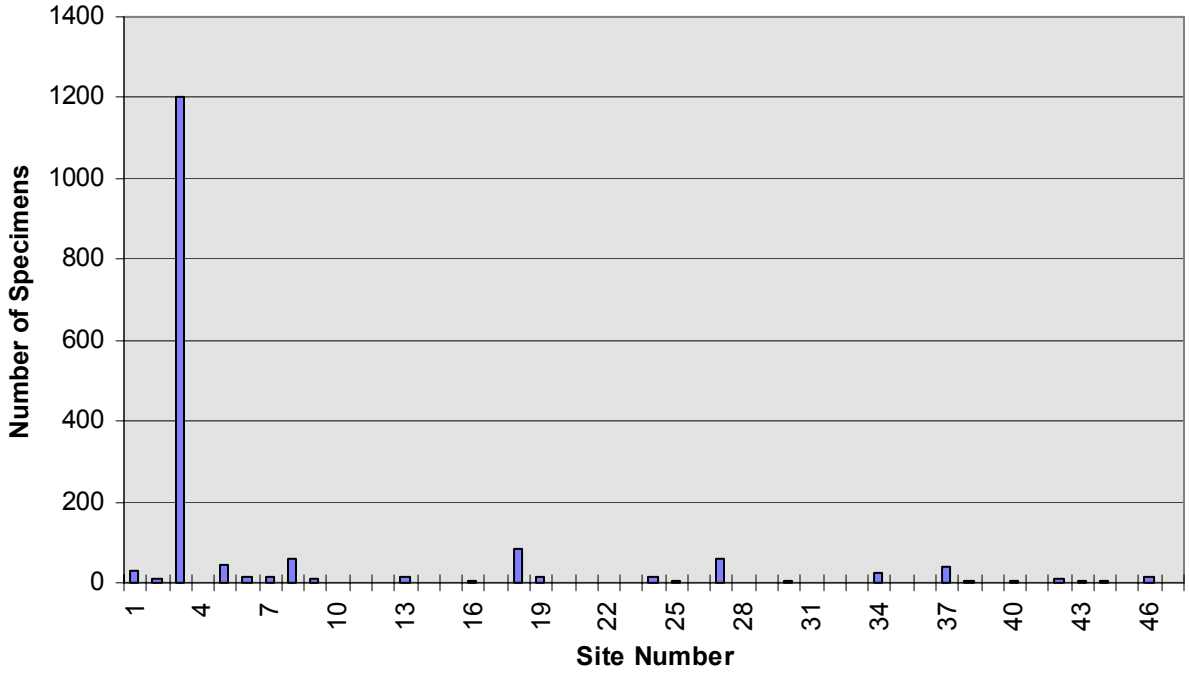

TABLE 1. Numbers of Specimens by Species.

SPECIES	LIVES	DEADS
Amblema plicata	0	1
Anodonta suborbiculata	2	0
Arcidens confragosus	0	2
Lampsilis siliquoidea	0	3
Lampsilis teres	0	4
Lasmigona complanata	33	11
Leptodea fragilis	96	1258
Potamilus alatus	40	72
Potamilus ohiensis	130	195
Pyganodon grandis	45	116
Pyganodon grandis corpulenta	0	1
Quadrula quadrula	2	4
Strophitus undulatus	0	3
Toxolasma parvus	0	1
Truncilla donaciformis	0	1
Truncilla truncata	7	37
TOTALS	355	1709

SPECIES ACCOUNTS FOR UNIONIDS IN THE MISSOURI NATIONAL RECREATION RIVER-GAVINS POINT DAM TO PONCA STATE PARK

Information on distribution, habitat, life history and host fish is taken from Parmalee and Bogan, 1998 and from Oesch, 1984.

Amblema plicata (Say, 1817) Threeridge

The threeridge was found only at the mouth of the James River where one long dead specimen was collected. Coker and Southall (1915) listed the threeridge as one of the most abundant species in the James River, reporting that 90% of the 20 tons of shells harvested at Riverside were of this species. The threeridge is tolerant of a wide range of habitats and is able to utilize many host fish species. Why this species has been unable to colonize the Missouri River is unknown.

Anodonta suborbiculata Say, 1831 Flat Floater

Previously unreported in South Dakota, a single live specimen was found in each of two separate backwaters. Hoke (1983) reported finding the flat floater at 3 sites in the Missouri River along the Iowa-Nebraska border. The flat floater prefers mud substrates in calm water or in slow current. Reported host fish that may occur in the study are: golden shiner (*Notemigonus crysoleucas*), white crappie (*Pomoxis annularis*), and largemouth bass (*Micropterus salmoides*).

Arcidens confragosus (Say, 1829) Rock Pocketbook

Only two dead shells of this species were found at widely separated collecting areas. This species is rare in South Dakota. Coker and Southall (1915) reported it present in the James River but did not report it as abundant. Although the study area seems to provide suitable habitat for this species the rock pocketbook has not become well established. The rock pocketbook was not reported in the study area by Hoke (1983). Reported host fish include: gizzard shad (*Dorosoma cepedianum*), rockbass (*Ambloplites rupestris*), white crappie, and freshwater drum (*Aplodinotus grunniens*).

Lampsilis siliquoidea (Barnes, 1823) Fatmucket

Three dead specimens of the fatmucket were collected, all between Gavins Point Dam and the mouth of the James River. This species is common in many rivers and streams in South Dakota. The fatmucket is a widespread species, occurring throughout the central United States, north to the Hudson Bay region and west to the Canadian Rockies. The preferred habitat for the fatmucket is quiet or slow moving water with a mud bottom, habitat present in the study area only in backwaters and the James River. Many species of fish are reported to be suitable host fish.

Lampsilis teres (Rafinesque, 1820) Yellow Sandshell

Four dead specimens of the yellow sandshell were collected. The specimens were collected at four separate sites. Three were found in the area from Gavins Point to the James River and one more collected at RM 782.6. This species is known to occur in a variety of habitats and is reported to have many host fish.

Lasmigona complanata (Barnes, 1823) White Heelsplitter

Like the fatmucket, the white heelsplitter is one of the most widespread species of freshwater mussels, occurring thoughout the central United States and northward across much of central Canada. In South Dakota, the species is usually not abundant anywhere but is present in nearly every stream or river capable of supporting freshwater mussels. In the study area, we found this species living primarily in backwater habitats. Surprisingly, more lives (33) were found than deads (11). The preferred habitat of this species is quiet water with a mud and fine sand substrate. Reported host fish that occur in the Missouri River include common carp (*Cyprinus carpio*), green sunfish (*Lepomis cyanellus*), orange-spotted sunfish (*L. humilus*), largemouth bass, white crappie, longnose gar (*Lepisosteus osseus*), gizzard shad, and sauger.

Leptodea fragilis (Rafinesque, 1820) Fragile Heelsplitter

Based on numbers of dead specimens, this is by far the most abundant species on the study area. The fragile heelsplitter was found throughout the study area but was most abundant in the upper river area below Gavins Point Dam. A total of 1258 dead specimens were collected. Number of lives was 96, second in abundance behind *Potamilus ohiensis* at 130 lives. A large bed of clams was found at site 1 and 88 lives of the fragile heelsplitter were found at this site. This species is also very abundant in the upper end of Lake Sharpe (Backlund, 1996; Ecological Specialists, Inc. 1998). Apparently the habitat present in the Missouri River system is very favorable for this species, which is reported to tolerate a wide range of habitat conditions. The only host fish reported for the fragile heelsplitter is the freshwater drum. Since this species closely resembles *Leptodea leptodon*, all live and dead specimens were closely examined.

Leptodea leptodon (Rafinesque, 1820) Scaleshell

The scaleshell has been proposed to be listed as an endangered species by the U.S. Fish and Wildlife Service. Although Hoke (1983) collected a single fresh dead specimen 1 km. east of Gavins Point Dam, we did not collect any specimens of this species. This species has apparently always been rare throughout its range. The species also tends to bury itself deeper than most species thus making it more difficult to locate. Habitat is reported to be restricted to clear, unpolluted waters in riffles with a good current. It has been reported from a variety of substrates. Although most sources report that the host fish is unknown, a recent report listed the freshwater drum as one host fish (Barnhart, et al., 1998). In this study twenty-four species of fish and one species of amphibian were tested as possible fish hosts but glochidia successfully transformed only on the freshwater drum. The fact that one fresh dead specimen has been collected indicates that there are probably other individuals of the scaleshell in the river system. The species is most likely to be found below Gavins Point Dam in the vicinities of our sites 1, 2 and 3.

Potamilus alatus (Say, 1817) Pink Heelsplitter

This species is fairly common in the river segment below Gavins Point Dam becoming much less common downstream. Thirty-two lives were found in the clam bed at site 1 and six lives in the chute at site 2. The pink heelsplitter is found in a variety of habitats from sandy to gravel substrates in lakes and rivers. The only reported host fish is the freshwater drum. Although reported to be stable in most its range, the pink heelsplitter is not common in South Dakota.

Potamilus ohiensis (Rafinesque, 1820) Pink Papershell

The pink papershell was the second most abundant species in the study area and one of the most widespread. One hundred ninety-five dead shells and 130 lives were collected. A total of 110 lives of this species were found in the clam bed at site 1. The pink papershell was found throughout the study area but was most abundant in the area below Gavins Point Dam. The pink papershell is also common in upper Lake Sharpe near Pierre (Backlund, 1996; Ecological Specialists, Inc. 1998). Habitat is described as quiet water or slow current in substrates of sand, gravel, or mud. We found this species in all of these habitats. Reported host fish are the freshwater drum and the white crappie.

Pyganodon grandis (Say, 1829) Giant Floater

The giant floater is a common clam in most rivers and streams and many lakes in South Dakota. This species prefers water that is still or with a slight current and favors a mud substrate. The giant floater was found throughout the study area but lives were most common in backwaters with a mud/sand substrate. We collected 45 lives and 116 dead shells. Many species of fish are suitable hosts for the glochidia of the giant floater.

Pyganodon grandis corpulenta (Cooper, 1834) Stout Floater

One specimen of the form *Pyganodon grandis corpulenta* was collected. The taxonomy of this form has been debated for many years. Various researchers consider this to be either a separate species (*Pyganodon corpulenta*), a subspecies, or an ecotype of *P. grandis*.

Quadrula quadrula (Rafinesque, 1820) Mapleleaf

The mapleleaf is relatively rare in the study area. Only two lives were found and 4 dead specimens. Although this species is reported to be adaptable it does not seem to be thriving in the study area. Preferred habitat is shallow lakes, rivers and streams with sand and fine gravel substrate. The species also has adapted to living in some reservoirs. Both of the lives we collected were found in backwater habitats. The only reported host fish is the flathead catfish (*Pylodictis olivaris*).

Strophitus undulatus (Say, 1817) Creeper

The creeper was found only as dead specimens in the vicinity of the mouth of the James River. The James River is the likely source of the few specimens found in the study area. Typically found in small rivers and streams in a fine sand or mud substrate, this species is probably not able to thrive in the study area. This is one of the few species of freshwater mussels in which the glochidia are not dependent on a host fish for development. Dispersal of the species into upstream habitats is still dependent on attachment to a host fish, however. Fish species found in the study area that are known host fish for the creeper are: fathead minnow (*Pimephales promelas*), black bullhead (*Ameiurus melas*), bluegill (*Lepomis macrochirus*), largemouth bass and walleye (*Stizostedion vitreum*).

Toxolasma parvus (Barnes, 1823) Lilliput

A single dead specimen was collected at the mouth of the James River. Like the creeper, this species is probably found in the James River and tributaries but is not thriving in the study area. The lilliput is typically found in the shallows of lakes, ponds, and reservoirs and in small to large rivers. Preferred substrates are mud, sand, or fine gravel. The fluctuating water levels in the Missouri River may not be conducive to species that typically are found in shallow water. Reported host fish include the bluegill, green sunfish, orangespotted sunfish, and white crappie.

Truncilla donaciformis (Lea, 1928) Fawnsfoot

A single dead specimen was collected from a sandbar at RM 787.8. Although the study area seemingly provides good habitat for this species, it apparently is just becoming established or is unable to thrive due to unknown circumstances. The freshwater drum is listed as the primary host fish. The sauger is also a potential host fish.

Truncilla truncata Rafinesque, 1820 Deertoe

Seven lives and 37 deads were collected. All lives and most of the deads were found in the upper portion of the study area; one dead specimen was found as far downriver as RM 787.8. This species is typical of larger rivers with a fine gravel substrate mixed with mud and sand, but it does occur in many type of habitats. The deertoe is known to be locally abundant in the James River north of Huron, but elsewhere is relatively rare in South Dakota. The reported host fish are the same as for the fawnsfoot.

DISCUSSION

The study area supports a thriving population of unionids. At least six species are thriving, *Lasmigona complanata, Leptodea fragilis, Potamilus alatus, Potamilus ohiensis, Pyganodon grandis* and *Truncilla truncata.* Another nine species and one subspecies (*Pyganodon grandis corpulenta*) are present. The greatest abundance of unionids was in the upper portion of the study area while the greatest diversity was near the James River. However, most of the specimens representing the higher diversity at the James River were

long dead and may have merely washed downstream from the James River. The greatest species diversity of both lives and fresh dead specimens was found in the area from Gavins Point Dam downstream to RM 807.4. A large clam bed was located at site 1, just downstream of the "bubble" or outlet of Lake Yankton on the South Dakota side. Hundreds of dead shells were collected at site 3, RM 807.7-807.8.

The results of our survey are in striking contrast to the survey for *Leptodea leptodon* conducted by Ecosearch Inc. in 1995. Brailing was the primary method used by Ecosearch, Inc. and resulted in the recovery of only ten specimens of four species in 18 days of field work. The four species recovered were *L. fragilis, P. alatus, L. complanata*, and *P. grandis*.

Our methods of searching for lives worked very well. By searching for clams with our feet or by diving and searching by hand we were able to locate lives of six species that represented the most common species in the study area and two that were not common (*Quadrula quadrula* and *Anodonta suborbiculata*).

Although we did not find any specimens of the rare scaleshell, *Leptodea leptodon*, this species was collected by Hoke in 1987 1 km. east of Gavins Point Dam. The fact that one fresh dead specimen has been collected indicates that there are probably other individuals of the scaleshell in the river system. The scaleshell is known to bury itself deep into the substrate making it difficult to detect. In addition, this species is reported to be rare wherever it is found. The species is most likely to be found below Gavins Point Dam in the vicinities of our sites 1, 2 and 3.

Figure 5. Diving and searching for live clams at Site 44, RM 754.1, a backwater upstream from Ponca State Park.

Probably the only limiting factor to mussel populations in the study area that the Corps of Engineers has control over is the fluctuating water levels. Sudden drops in water level,

especially in freezing temperatures or for long periods of time at any time of the year may severely impact mussels. These animals are not able to move quickly to deeper water. We found very few mussels in water less than 4-5 feet depth. This is probably due to the fluctuating water level that periodically eliminates most individuals at shallower depths. Although periodic low water levels may prevent mussels from colonizing and thriving in shallow waters, the mussels established at depths greater than the lowest water levels are probably not impacted by low water, except for a possible temporary increase in predation by terrestrial predators. However, drops in water level of six to seven feet or more can expose clams to freezing temperatures, dessication, and predation. Such severe water level drops should be avoided during periods of severe cold temperatures. Extremely low water levels for long periods of time at any time of year could be very damaging to mussel resources.

Figure 6. Shells collected from site 3.

TURTLES

Incidental to the mussel survey, we noted several important nesting areas of turtles and habitats that are important as nurseries for hatchling turtles. The two species of turtles we were able to identify were the false-map turtle (*Graptemys pseudogeographica*) and the smooth softshell turtle (*Trionyx mutica*). Timken (1968) reported that the false-map turtle was the most abundant turtle in the Missouri River followed by the smooth softshell. Timken also reported that the spiny softshell was present but we were unable to verify that any of the softshells we saw were that species. However, we saw many softshell turtles basking along the shorelines that were not identifiable to species.

Both the false-map turtle and the smooth softshell are species of concern in South Dakota. The false-map turtle is listed as a state threatened species. Specific concerns with these turtle populations are:

1. Reduced habitat and habitat fragmentation due to the impoundment of the Missouri River
2. Reduced nesting habitat due to shoreline erosion and bank stabilization
3. Increased predation of nests due to more concentrated nesting sites
4. Lack of knowledge on the population structure and reproductive success

Timken remarked on the lack of suitable nesting habitat for these species. Shoreline erosion combined with river bed degradation creates steep banks that turtles cannot climb to access suitable nesting areas. Lack of annual flooding has eliminated the process of natural creation of new nesting sites. Nesting habitat has become much more limited. The resulting concentration of nesting turtles attracts predators that may destroy a high percentage of nests. Timken reported several examples of this type of predation.

Many of the nests we found were located only because of predation, the nests having been dug out and the eggs destroyed. Even though it appeared that there was a high rate of predation, it is unknown how many nests survived. We found evidence of successful reproduction of both species.

The shallows around the edges of sandbars in the vicinity of nesting areas are important as nurseries for young of year (YOY) smooth softshells. Here the young turtles are protected from large fish and larger turtles. By burrowing into the sand the turtles are hidden from predatory birds and mammals. We found many YOY softshells on one sandbar near the James River (Figures 7 and 8).

Young of the year false-map turtles were found only at one site, an oxbow lake near the Elk Point sand dunes.

Turtle eggs can survive brief flooding, but if submerged over 24 hours survivorship decreases. Eggs submerged for four days have little chance of surviving (Ernst et al., 1994). Turtle nests in the study area were always found on relatively high ground in open sand. However, the thick vegetation that has developed on most of the larger sand bars has made many areas unsuitable for nesting often forcing turtles to use marginal nesting areas that are more prone to flooding.

Riprap and other bank stabilizations completely cut turtles off from nesting areas. Shoreline erosion, river be degradation, and a lack of annual flooding also creates steep banks that cannot be negotiated by turtles. Many otherwise suitable nesting areas in the study area are now inaccessable to turtles.

Keith Perkins made one other very important discovery while surveying for clams at Site 1. Here, a large number (>100) smooth softshell turtles were found in the clam bed on March 19. The turtles were densely packed together and were obviously hibernating communally in association with the clam bed. As far as we are aware such behavior has never been reported for smooth softshells. All of the turtles in this communal wintering site were large, older turtles. Such a number of large, sexually mature turtles may represent a significant portion of the breeding population in the study area. This communal site was discovered during low water but the turtles and the clam bed were still in water one foot or more in depth. This site should never be dewatered during winter months. A major turtle kill could result.

In summary, habitat loss for nesting turtles is similar to that of nesting interior least terns and piping plovers; ie. flooding of nest sites and increasing vegetation on sand bars. An additional problem with turtles is the increasing lack of access to nesting areas due to bank erosion, river bed degradation, and bank stabilization projects.

Since turtles are long-lived, late maturing animals with low reproductive capability, population declines may not be obvious until the population begins to die out due to reproductive failure. Table 2 lists the important sites that were found.

TABLE 2. Important turtle sites of the Gavins Point segment of the Missouri National Recreational River.

Location	Species	Date	Site Use by Turtles
Below Lake Yankton (outlet is locally known as the bubble), RM 810-809.72, SD side	Smooth softshell	3/19/99	Over 100 smooth softshells on bottom, in clam bed, wintering site
Upper end of sandbar at RM 807.1-807.4	Smooth softshell False-map turtle Possibly other species?	8/24/99	Many nests on island, one live smooth softshell and one live false-map turtle captured and released.
Large sandbar just upstream of the island at the mouth of the James River, RM 800.8	Smooth softshell	8/24/99	Nest site and nursery for smooth softshells; 24 YOY smooth softshells and one adult male captured and released.
1st sandbar in channel between Elk Island and mouth of James River, RM 800.4	Smooth softshell Possibly other species?	8/24/99	30-40 turtle nests, YOY smooth softshells found and much sign of smooth softshells
1st small sandbar between Elk Island and SD shore, RM 800.3	Smooth softshell	8/24/99	Much evidence of smooth softshells
north side of Goat Island, RM 783.0 to 783.2	Unknown, probably both smooth softshell and false-map turtle	8/12/99	Hundreds of nests on open sandy area, bank erosion is gradually making this site inaccessable to turtles
2 bars just below mouth of the Vermillion River, RM 770.8	Smooth softshell	8/4/99	Three nests
Oxbow in the Elk Point sand dunes area, RM 767	Smooth softshell False-map turtle	9/11/99	Two adult smooth softshells; 12 YOY false-map turtles, from 3.5 to 8 cm carapace length.

Figure 7. Hatchling smooth softshell turtles collected from shallow sandbars at RM 800.8. All were returned to the water.

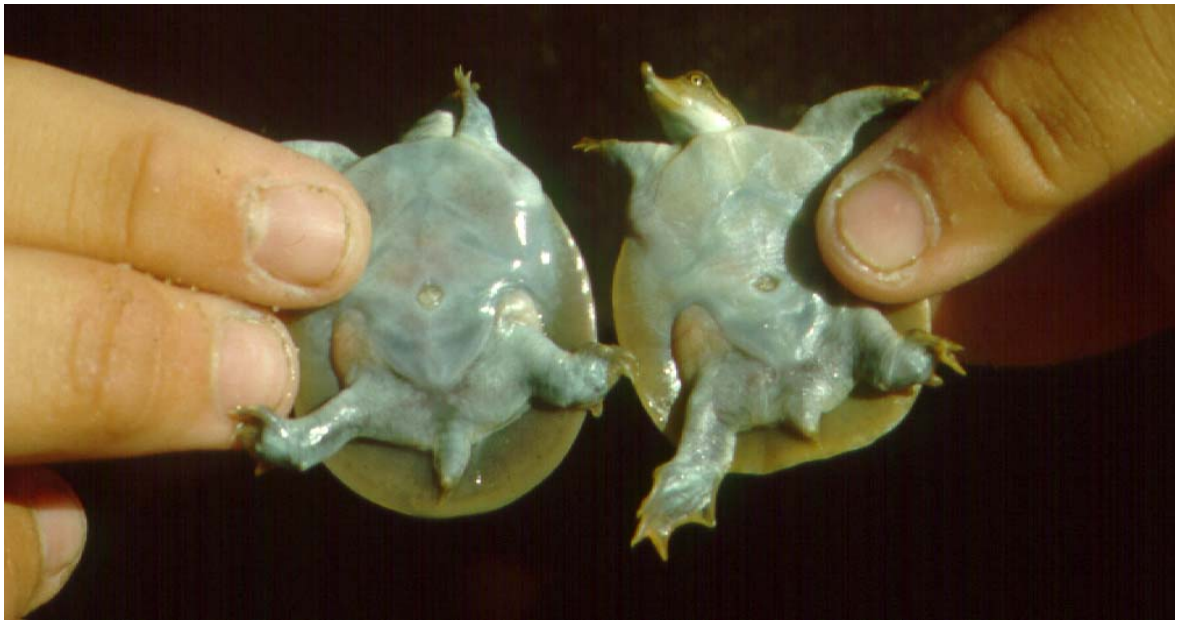

Figure 8. Hatchling smooth softshell turtles. Note yolk sac attachment scar.

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APPENDIX 1. SCIENTIFIC AND COMMON NAMES OF UNIONIDS USED IN THIS REPORT (taken from Parmalee and Bogan, 1998)

Amblema plicata (Say, 1817)	Threeridge
Anodonta suborbiculata Say, 1831	Flat Floater
Arcidens confragosus (Say, 1829)	Rock Pocketbook
Lampsilis siliquoidea (Barnes, 1823)	Fatmucket
Lampsilis teres (Rafinesque, 1820)	Yellow Sandshell
Lasmigona complanata (Barnes, 1823)	White Heelsplitter
Leptodea fragilis (Rafinesque, 1820)	Fragile Heelsplitter
Leptodea leptodon (Rafinesque, 1820)	Scaleshell
Potamilus alatus (Say, 1817)	Pink Heelsplitter
Potamilus ohiensis (Rafinesque, 1820)	Pink Papershell
Pyganodon grandis (Say, 1829)	Giant Floater
Pyganodon grandis corpulenta (Cooper, 1834)	Stout Floater (Oesch, 1984)
Quadrula quadrula (Rafinesque, 1820)	Mapleleaf
Strophitus undulatus (Say, 1817)	Creeper
Toxolasma parvus (Barnes, 1823)	Lilliput
Truncilla donaciformis (Lea, 1928)	Fawnsfoot
Truncilla truncata Rafinesque, 1820	Deertoe

APPENDIX 2-SITE LOCATIONS, DATES, AND SPECIES COLLECTED

Numbers are reported as L= lives; FD = Fresh dead; LD = Long dead and chalky
Deads are reported with a whole number for matching valves or valves found still connected and as X/2 where X represents numbers of single, non-matching valves.

SPECIES CODES USED IN TABLE

Amblema plicata	AMPL
Anodonta suborbiculata	ANSU
Arcidens confragosus	ARCO
Lampsilis siliquoidea	LASI
Lampsilis teres	LATE
Lasmigona complanata	LACO
Leptodea fragilis	LEFR
Potamilus alatus	POAL
Potamilus ohiensis	POOH
Pyganodon grandis	PYGR
Pyganodon grandis corpulenta	PYGRC
Quadrula quadrula	QUQU
Strophitus undulatus	STUN
Toxolasma parvus	TOPA
Truncilla donaciformis	TRDO
Truncilla truncata	TRTR

SITE #	RM	DATE	SPECIES FOUND
1	**Below Lake Yankton, locally known as the Bubble 810-807.72**	**3/19/99**	**L=POOH 106; LACO 2; TRTR 5; PYGR 9; LEFR 81; POAL 23 FD=POOH 9 5/2; LEFR 5 10/2; TRTR 2/2**
2	**807.9**	**8/9/99**	**L=POAL 6; LEFR 1; TRTR 2 FD=PYGR 1 1/2; LEFR 1 7/2; POOH 1; POAL 1/2**
3	**807.7-807.8**	**8/24/99**	**L=POAL 1 FD (SOME CHALKY)=LEFR 49 943/2; PYGR 41/2; POOH 9 68/2; POAL 12 53/2; TRTR 9 15/2; LACO 1/2; LATE 1/2**
4	**805.8**	**8/9/99**	**NO UNIONIDS FOUND**
5	**800.8**	**8/24/99**	**FD=LACO 1 1/2, PYGR 4/2; LEFR 3 34/2; POAL 1/2; POOH 2**
6	**800.4**	**8/24/99**	**FD AND LD=POOH 1; LEFR 6 7/2; PYGR 1; LASI 1**
7	**800.3**	**8/24/99**	**FD AND LD=STUN 1/2; POOH 1 1/2; LEFR 13/2;**

			TRTR 1
8	**mouth of James River**	**7/30/99**	**LD=STUN 1/2; LASI 2/2; TOPA 1/2; AMPL 1/2; LATE 17/2, TRTR 9/2; LEFR 1 26/2; PYGR 14/2; QUQU 4/2; LACO 1/2**
9	**799.7**	**7/30/99**	**FD AND LD=LEFR 1 7/2; PYGR 1/2; ARCO 1/2**
10	**797.8**	**7/30/99**	**NO UNIONIDS FOUND**
11	**796.8**	**8/9/99**	**BACKWATER, NO UNIONIDS**
12	**796.4-796.6**	**8/9/99**	**BACKWATER, NO UNIONIDS FOUND**
13 & 17	**795.7**	**8/9/99** **8/28/99**	**L=PYGR 1** **FD AND LD=PYGR 4/2; TRTR 1 1/2; LATE 1/2; STUN 1/2** **FD AND LD=LEFL 5/2**
14	**795.3**	**8/9/99**	**NO UNIONIDS FOUND**
15	**793.2**	**8/9/99**	**NO UNIONIDS FOUND**
16	**789.9**	**8/9/99**	**NO UNIONIDS FOUND**
18	**789.2-789.4**	**8/10/99**	**L=LACO 3; POOH 2; ANSU 1; PYGR 12** **FD=PYGR 17 5/2; POOH 28 29/2; LACO 1; LEFR 2 3/2**
19	**788.7**	**8/10/99**	**BACKWATER ON SD SIDE ABOVE MYRON GROVE** **L=LACO 4; POOH 4; PYGR 3; QUQU 1** **FD AND LD=POOH 8; LACO 2; PYGR 2/2; LEFR 2 2/2**
19	**788.7**	**8/11/99**	**L=LACO 9; PYGR 5; POOH 2**
20	**788.6**	**8/8/99**	**BACKWATER** **L=LACO 8; PYGR 2; QUQU 1** **FD=POOH 1**
21	**788.6**	**8/8/99**	**NO UNIONIDS FOUND**
22	**788.2**	**6/10/90**	**L=LEFR 1**
23	**788.2**	**8/10/99**	**NO UNIONIDS FOUND**
24	**787.8**	**8/27/99**	**FD AND LD=TRTR 1; TRDO 1/2; PYGR 2/2; LEFR 13/2**
25A	**787.7-787.8**	**8/10/99**	**1ST SHOOT ABOVE BOW CREEK** **L=ANSU 1; POOH 2; PYGR 1; LACO 4** **FD=LACO 1; POOH 1; PYGR 3/2; PYGRC 1**
25B	**787.6**	**8/10/99**	**BOW CREEK, NO UNIONIDS FOUND**
26	**787.0-787.7 Highline**	**2/8/98**	**FD=POAL 3; POOH 6 9/2; LEFR 14 19/2; LACO 3; PYGR 1 2/2**
27	**786.05**	**6/22/91**	**L=POOH 1** **FD=LEFR 1; POOH 1**
28	**785.85**	**6/6/90**	**L=POOH 1**
29	**785.8**	**7/10/99**	**L=POOH 1**
30	**785.75**	**7/3/99**	**NO UNIONIDS FOUND**

31	**785.5**	**7/3/99** **8/10/99**	**L=PYGR 1** **FD AND LD=POOH 3/2; LEFR 1/2** **L=POOH 2**
32	**784.1**	**7/10/99**	**L=POAL 1; POOH 1; LEFR 3; PYGR 1**
33	**783.0-783.2**	**8/12/99**	**NO UNIONIDS FOUND**
34	**782.5**	**8/12/99**	**FD AND LD=POOH 1; LEFR 22/2; PYGR 1; ARCO 1/2**
35	**782.5**	**8/9/99**	**FD=LEFR 1/2**
36	**782.6**	**7/30/99**	**FD AND LD=POOH 1/2; LATE 1/2**
37	**780.4-781.1**	**8/12/99**	**L=POOH 1** **FD AND LD=PYGR 13/2; LEFR 27/2**
38	**779.2**	**8/5/99**	**FD=LEFR 5/2**
39	**773**	**8/5/99**	**FD=LEFR 1 1/2**
40	**770.8**	**8/4/99**	**FD=LEFR 3 2/2**
41	**759.5-Elk Point sand dunes**	**9/11/99**	**NO UNIONIDS FOUND**
42	**7578**	**8/25/99**	**FD=PYGR 2/2; LEFR 6/2; POOH 1/2**
43	**754.2**	**8/25/99**	**FD AND LD=LEFR 5/2**
44	**754.1**	**8/25/99**	**BACKWATER ABOVE PONCA STATE PARK ON NEB. SIDE** **L=LEFR 2; PYGR 3; LACO 3; POOH 3** **FD=POOH 4; PYGR 1**
45	**753.5**	**8/25/99**	**FD=LEFR 1/2**
46	**752-753**	**8/25/99**	**LD=POOH 3 2/2; LEFR 1 8/2**
47	**750.2-750.6**	**8/25/99**	**NO UNIONIDS FOUND**