

2006 Annual Report

Pallid Sturgeon Population Assessment and Associated Fish Community Monitoring for the Missouri River: Segment 1



Prepared for the U.S. Army Corps of Engineers – Missouri River Recovery Program

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EXECUTIVE SUMMARY

Segment 1 of the Missouri River was sampled during the sturgeon and fish community seasons during 2006. Segment 1 consists of one non-random bend situated 5 miles downstream of Fort Peck Dam. Segment 1 is used as a reference bend to compare with segments 2 through 4. Due to its proximity to Fort Peck Dam, segment 1 is the most highly altered stretch of the Missouri River between Fort Peck Dam and the headwaters of Lake Sakakawea, North Dakota. Pallid sturgeon *Scaphirynchus albus* were not captured in segment 1 during 2006, even though approximately 1,657 yearling and 124 advanced fingerling hatchery reared pallid sturgeon were stocked just 5 miles downstream in the mouth of the Milk River in 2006 prior to sampling. Similarly, no sturgeon chubs *Macrhybopsis gelida* or sicklefin chubs *M. meeki* were sampled in segment 1.

Shovelnose sturgeon *Scaphirynchus platyrhynchus* were the most abundant target species collected in segment 1, with 47 specimens sampled. Trammel nets (N = 37) and otter trawls (N = 10) captured all shovelnose sturgeon sampled. Shovelnose sturgeon ranged in length from 441 to 777 mm FL, with an average length of 613.2 mm FL. Therefore, no shovelnose sturgeon younger than approximately age-8 were observed. Other target species sampled included, western silvery minnow *Hybognathus argyritis* (N = 2) blue suckers *Cycleptus elongatus* (N = 2), sauger *Sander canadense* (N = 1), and sand shiner *Notropis stramineus* (N = 1).

A total of 719 fish consisting of 16 species were sampled in segment 1 during 2006. A total of three macrohabitats were sampled during the sturgeon season and five macrohabitats were sampled during the fish community season. More fish were collected during the fish community season than during the sturgeon season. Similarly, more fish were collected with shallow water gears (mini fyke nets and bag seines) than in deep water gears (otter and beam trawls and trammel nets). Both water temperature and turbidity samples were on average lower in segment 1 than both segments 2 and 3 during 2006. The presence of nonnative rainbow trout *Oncorhynchus mykiss*, lake whitefish *Coregonus clupeaformis*, and cisco *C. artedii* further suggests significant differences in aquatic habitat directly downstream of Fort Peck Dam when compared to more downstream areas below Fort Peck Dam (segments 2 through 4).

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Introduction

The U.S. Fish and Wildlife Service (USFWS) listed the pallid sturgeon *Scaphirhynchus albus* as endangered in 1990. In response to the listing the USFWS issued a Biological Opinion to the U.S. Army Corps of Engineers (COE), the main water management entity responsible for the Missouri River mainstem from Fort Peck Dam and Reservoir to its confluence with the Mississippi River. Additionally, an amendment to the 2000 Biological Opinion was issued in 2003. The Amendment listed several Reasonable and Prudent Alternatives (RPA) to address the inability of pallid sturgeon to naturally reproduce and the need to be able to detect changes in their populations and ecosystem trends.

The Pallid Sturgeon Population Assessment Program (Program) is guided by the RPA's in the 2003 Amendment to the 2000 Biological Opinion. The Program is a comprehensive monitoring plan designed to assess survival, movement, distribution, habitat use, and physical characteristics of these habitats used by wild and hatchery reared juvenile pallid sturgeon (Drobish 2006). The 2000 Biological Opinion divides the Program area into river and reservoir segments and assigns high, moderate, or low priority management action to these segments for pallid sturgeon (Drobish 2006). The focus of the Program is on the high priority management action segments. The Missouri River from Fort Peck Dam downstream to the headwaters of Lake Sakakawea, ND is listed as a high priority action segment.

The Program has stratified the Missouri River from Fort Peck Dam to the headwaters of Lake Sakakawea into four study segments based on biological, hydrological and fluvial geomorphological characteristics. The COE has contracted Montana Fish, Wildlife & Parks (FWP) to conduct Program sampling from Fort Peck Dam downstream to the North Dakota border, which consists of study segments 1 through 3.

The objectives of this program are as follows:

1. Document annual results and long-term trends in pallid sturgeon population abundance and geographic distribution throughout the Missouri River System.
2. Document annual results and long-term trends of habitat use of wild pallid sturgeon and hatchery stocked pallid sturgeon by season and life stage.
3. Document population structure and dynamics of pallid sturgeon in the Missouri River System.

4. Evaluate annual results and long-term trends in native target species population abundance and geographic distribution throughout the Missouri River system.
5. Document annual results and long-term trends of habitat usage of the native target species by season and life stage.
6. Document annual results and long-term trends of all non-target species population abundance and geographic distribution throughout the Missouri River system, where sample size is greater than fifty individuals.

Sampling Season and Species

The Program has two discrete seasons (sturgeon and fish community), which are primarily based on water temperatures. However, the sturgeon season is designed to sample sturgeon with gears that are temperature dependent, such as gill nets. Due to the nature of the majority of habitats in segment 1 through 3, gill nets are not an efficient gear for collecting pallid sturgeon due to debris flows and swift current and therefore they are not used in any segment situated in Montana. Trammel nets and otter trawl are standard gears used in segments 1-4 during sturgeon season, and so far appear to be an effective way to sample pallid sturgeon.

The fish community season runs from the beginning of July till the end of October and is designed not only to monitor sturgeon, but also to monitor other native Missouri River fish populations. Both trammel nets and the otter trawl are still used, but to more effectively sample shallow water habitats < 1.2 m in depth mini fyke nets are also used as a standard gear. Additionally, during 2006 we used bag seines and beam trawls in segment 1. This was done to give us a data set we could compare to data collected by past researchers and especially data from the Benthic Fish Study.

In addition to pallid sturgeon, the Program is designed to monitor nine other native Missouri River species labeled “target” species. These include, shovelnose sturgeon *Scaphirhynchus platyrhynchus*, blue sucker *Cycleptus elongatus*, sauger *Sander canadense*, sturgeon chub *Macrhybopsis gelida*, sicklefin chub *M. meeki*, speckled chub *M. aestivalis*, plains minnow *Hybognathus placitus*, western silvery minnow *H. argyritis*, and sand shiner *Notropis stramineus*. This suite of species was selected for various reasons. First, some species may have similar habitat requirements as pallid sturgeon and therefore by monitoring their populations we may gain further insight into pallid sturgeon habitat and how anthropomorphic and natural changes to the Missouri River affect native fish assemblages.

Secondly, it is hypothesized that various chub species and other native fishes are an important component of pallid sturgeon diet, and thereby monitoring pallids sturgeon diet will allow us to better describe their habitat. Thirdly, we wouldn't expect to see an immediate response in a long-lived species like pallid sturgeon when environmental conditions change from either favorable or detrimental conditions. Thus, by monitoring short-lived native fishes we may be able to correlate environmental conditions to changes in fish populations on a much shorter time interval and make inferences on how pallid sturgeon populations are being affected.

Study Area

Segment 1 of the Missouri River begins at Fort Peck Dam runs downstream to its confluence with the Milk River. This segment constitutes only 6% (11.5 river miles) of the entire 189.5 river miles downstream of Fort Peck Dam to the headwaters of Lake Sakakawea in North Dakota (Drobish, 2006). This reach of the Missouri River is characterized by an unnatural hydrograph, thermograph, sediment dynamics, and fish community due to the influence of Fort Peck Dam, which was constructed in 1940 (Bramblett and White, 2001). Segment 1 includes the Fort Peck Dredge Cuts, a deepened and widened section of river immediately below the dam created by the dredging of earth used to construct the dam. Regulated hypolimnetic water releases from Fort Peck Reservoir have changed a once turbid sandy bottom stretch of river into a cold clear cobble bottomed river. Fort Peck Reservoir has substantially reduced turbidity in the river below Fort Peck Dam when compared to its natural state (Galat et al, 2005).

Peaks in the hydrograph are related to power production and barge traffic downstream, instead of spring runoff and precipitation events (Galat et al, 2005). Many species native to this stretch of river such as the pallid sturgeon, sicklefin chub and sturgeon chub find the cold clear water unsuitable and are now only found farther downstream where tributaries have warmed and muddied the waters of the Missouri (Gardner and Stewart, 1987). Fish much more suited for this cold clear water such as rainbow trout *Oncorhynchus mykiss*, brown trout *Salmo trutta* and Chinook salmon *Oncorhynchus tshawytscha* have been stocked on and off from 1950 to 1990. Other nonnative species such as largemouth bass *Micropterus salmoides*, northern pike *Esox lucius*, walleye *Sander vitreus*, and yellow perch *Perca flavescens* have been stocked in the dredge cuts to increase angling opportunities. It is believed that many of these sight-feeding piscivores have out competed the native fishes in this stretch of river (Galat et al, 2005). In summary, this unique stretch of river is now vastly different from the once braided and shifting channels of the “Big Muddy” before Fort Peck Dam (Galat et al, 2005).

Methods

Sampling methods for the Pallid Sturgeon Population Assessment Program were conducted in accordance with the Standard Operating Procedures (Drobish 2006), which was established by representatives from State and Federal agencies involved with pallid sturgeon recovery on the Missouri River. For a detailed description of methodologies please see Drobish (2006). A general description of those guidelines follows.

Sampling Site Selection and Description

Montana Fish Wildlife & Parks (FWP) was contracted to sample Segment 1 from Fort Peck Dam (RM 1771.5) to the mouth of the Milk River (RM 1761), Segment 2 from the mouth of the Milk River (RM 1761) to Wolf Point (RM 1701.5) and Segment 3 from Wolf Point (RM 1701.5) to the Montana/North Dakota border (RM 1586.5). Segment 1 consists of one non-random bend at river mile 1766. This bend was selected as a reference study bend to be sampled each year to facilitate comparisons of the most highly altered area of the Missouri River in RPMA 2 (segment 1) to downstream areas (segments 2 through 4). By comparing data from segment 1 with downstream segments, a better understanding of how Fort Peck Dam influences the fish communities of the Missouri River might be attained.

Two gears, trammel net and otter trawl were considered standard gears during both the sturgeon and fish community seasons. Beam trawls, mini fyke nets, and bag seines were utilized only during the fish community season.

The Population Assessment Team developed a standard set of habitat classifications for the Missouri River (Appendix B) which consists of three distinct macrohabitats found in every bend, a main channel crossover (CHXO), main channel outside bend (OSB), and main channel inside bend (ISB). Each sampling bend was comprised of these three main macrohabitats. Nine additional macrohabitats were identified that may or may not be present in every bend: large tributary mouths (TRML), small tributary mouths (TRMS), confluence areas (CONF), large and small secondary connected channels (SCCL& SCCS), deranged channels (DRNG), braided channels (BRAD), dendritic channels (DEND) and non-

connected secondary channel (SCN). For the reference bend in segment 1, five macrohabitats were sampled, CHXO, OSB, ISB, SCCL and SCCS.

Mesohabitats were established to further define macrohabitats. Mesohabitats include bars (BARS), pools (POOL), channel border (CHNB), thalweg (TLWG) and island tip (ITIP). Channel borders are situated in areas between the deepest portions of the river up to a depth of 1.2 m. Bars are considered shallow areas (< 1.2 m) where terrestrial and aquatic habitats merge. The thalweg is the deepest portion of the river between the two channel borders where the majority of the flow is directed. Pools are directly downstream of any feature that creates scour, thus creating a habitat of deep (> 1.2 m) slower moving water. Island tips are just downstream of bars or islands where two channels meet where the water is > 1.2 m in depth. Two mesohabitats were sampled in segment 1, CHNB and BARS.

For all analysis, the sampling unit was the river bend, where every river bend has a channel crossover, inside and outside bend. The downstream border of a river bend is the beginning of the next downstream bend's channel crossover.

Sampling Gear

For specific information pertaining to the specific habitats gears are utilized in and physical measurements taken in accordance with sampling the various gears described below, please see Drobish (2006).

Trammel Net

The standard trammel net has a length of 38.1 m, an inner mesh wall 2.4 m and two outer mesh walls 1.8 m deep. The inner mesh is made of #139 multifilament twine with a bar mesh size of 25.4 mm. The outer walls are constructed of #9 multifilament twine with a bar mesh size of 203.2 mm. The float line is a 12.7 mm diameter foam core with a lead line of 22.7 kg. Trammel nets were drifted from the bow of the boat and orientated perpendicular to the river flow for a minimum of 75 m and a maximum drift distance of 300 m.

Otter Trawl

The standard otter trawl has a length of 7.6 m, a width of 4.9 m and height of 0.9 m. The otter trawl has an inner mesh (6.35mm bar, #18 polyethylene twine) and outer mesh

(38mmbar, #9 polyethylene twine) and a cod end opening of 406.4 mm. The trawl doors were made from 19.1 mm marine plywood and measured 762 mm x 381 mm. The trawl doors are used to keep the mouth of the trawl open while deployed on the riverbed. The trawl also has a 7.9 m long tickler chain attached to the bottom of the mouth of the trawl, which aids in keeping it orientated on the riverbed and protecting the mouth when snags are encountered. The otter trawl was deployed from the bow of the boat parallel to the current with two 30.5 m ropes and towed downstream slightly faster than current speed for a minimum of 75 m and a maximum distance of 300 m.

Mini Fyke Nets

The standard mini-fyke net consists of two rectangular frames 1.2 m wide and 0.6 m high and two 0.6 m tempered steel hoops. A 4.5 m long and 0.6 m high lead is connected to the first frame. The fyke net was made of 3 mm “ace” style mesh. The lead has small floats attached to the top and lead weights on the bottom. Mini-fyke nets are set with a “T” stake on shore and extend into river as perpendicular to the shoreline as possible or angled slightly downstream where higher velocities existed. Mini-fyke nets were set overnight and checked the following morning.

Bag Seine

The bag seine is 9.1m long by 1.8m high with a bag of 1.8 m wide x 1.8 m high x 1.8m deep. The seine is made of 6.4 mm “ace” mesh and has a 29.5kg lead line attached to the bottom. A mud line was also attached to the bottom to facilitate seining silty or muddy bottoms. The bag seine was used in bar mesohabitats. Seines were pulled either in a downstream or upstream direction using a quarter arc, half arc, or rectangular method.

Beam Trawl

The standard beam trawl has a width of 2 m, a height of 0.5 m and a length of 5.5 m. The inner mesh size is 3.18 mm and outer mesh size of 38.1 mm and a cod end opening of 165.0 mm. The bottom of the mouth of the trawl has a 9.53 mm tickler chain attached. The beam trawl is attached to a steel frame with two steel skids to help in dragging the bottom. The beam trawl is deployed over the bow of the boat and was towed parallel to the current in downstream direction for a minimum of 75 m with a maximum distance of 300 m.

Data Collection and Analysis

A minimum of eight random subsamples were taken in macrohabitats were taken at the reference bend in segment 1. At least two subsamples (when possible) were taken using each gear in each macro habitat within the bend. More than two subsamples were taken in a macrohabitat for a gear when the number of discrete macrohabitats was less than four or less than four could be effectively sampled. If a pallid sturgeon was captured, we duplicated the sample in a non-random manner. No more than eight duplicates were taken and we would stop taking duplicates whenever two contiguous duplicate subsamples contain no pallid sturgeon. Although this non-random sampling, it gives us a better understanding of relative abundance and identifies habitats that pallid sturgeon may congregate in.

All fish were measured to the nearest mm. Fork length (FL) was used for pallid and shovelnose sturgeon, while other species were measured to TL, except for paddlefish *Polyodon spathula*, which were measured from the eye to the end of the caudal fin. The first 25 fish of each species in each subsample were measured, after 25 they were counted.

Time was recorded at the beginning of each sample with all gears and an end time was always recorded when pulling mini fyke net sets. A global positioning satellite (GPS) position was taken at the beginning and end of all otter and beam trawls and trammel net drifts. One GPS location was taken for mini fyke net and bag seine samples (middle of the seine). All GPS locations were taken using a Garmin GPS 76 unit with Wide Area Augmentation System (WAAS) capability.

Sample depth was determined at the beginning, middle and end of each trawl and drift using a Lowrance X136 sonar unit. One depth was taken for mini fyke nets at the

intersection of the frame and floatline using a wading rod. A wading rod was also used to take two depths for bag seine hauls (midpoint between shore and the outer width of the seine and one at full extended width of the haul at the midpoint of the seine haul length).

Water temperature taken near the surface was recorded at every sample using the Lowrance X136 unit for trawls and trammel net drifts and using a hand held thermometer for mini fyke net and bag seine samples.

Habitat samples were collected randomly for 25% of each mesohabitat within each macrohabitat sampled. Velocities (mps) were taken at three depths in the water column for habitats > 1.2 m in depth (bottom, 0.8 of bottom depth and 0.2 of the bottom depth) using either a Current AA Price Meter and sounding reel or a Marsh-McBirney Flo Mate 2000. Velocities for shallow water habitats (< 1.2 m) were taken at the bottom and 0.6 of the bottom depth using the March-McBirney Flo Mate 2000.

Substrate was determined for habitats > 1.2 m in depth using a Hesse style substrate sampler. For habitats < 1.2 m in depth, a random hand grab was made. Substrate samples were reported as the percentage of sand, silt, gravel in each sample. In addition, the amount of cobble and organic material was qualitatively determined.

Turbidity was recorded in nephelometric turbidity units (NTU) using a LaMotte 2020 turbidity meter. Turbidity was taken at the midpoint of all samples, except mini fyke sets, where it was taken at the convergence of the rectangular frame and float line.

In addition to 25% of all mesohabitats, habitat measurements were taken whenever a pallid sturgeon was captured.

Genetic Verification

Genetic verification for pallid sturgeon or potential hybrids followed the methods outlined in Drobish (2006). Two fin pectoral fin clips (~ 2 cm²) are taken from any pallid sturgeon of unknown origin. Fin samples are then preserved in 95% non-denatured alcohol for genetic analysis. All samples are sent to the U.S. Fish and Wildlife Service's Abernathy Fish Technology Center for analysis and archiving.

Analyses

The fundamental sampling unit for the Population Assessment Program is the river bend. Therefore, sample size was equal to the number of bends sampled. Accordingly, all catch-per-unit-effort (CPUE) estimates for each species by gear were made on a bend level and the mean bend CPUE's were averaged to obtain the segment CPUE. Since only one bend was sampled in segment 1, no estimates of variance were made for CPUE estimates.

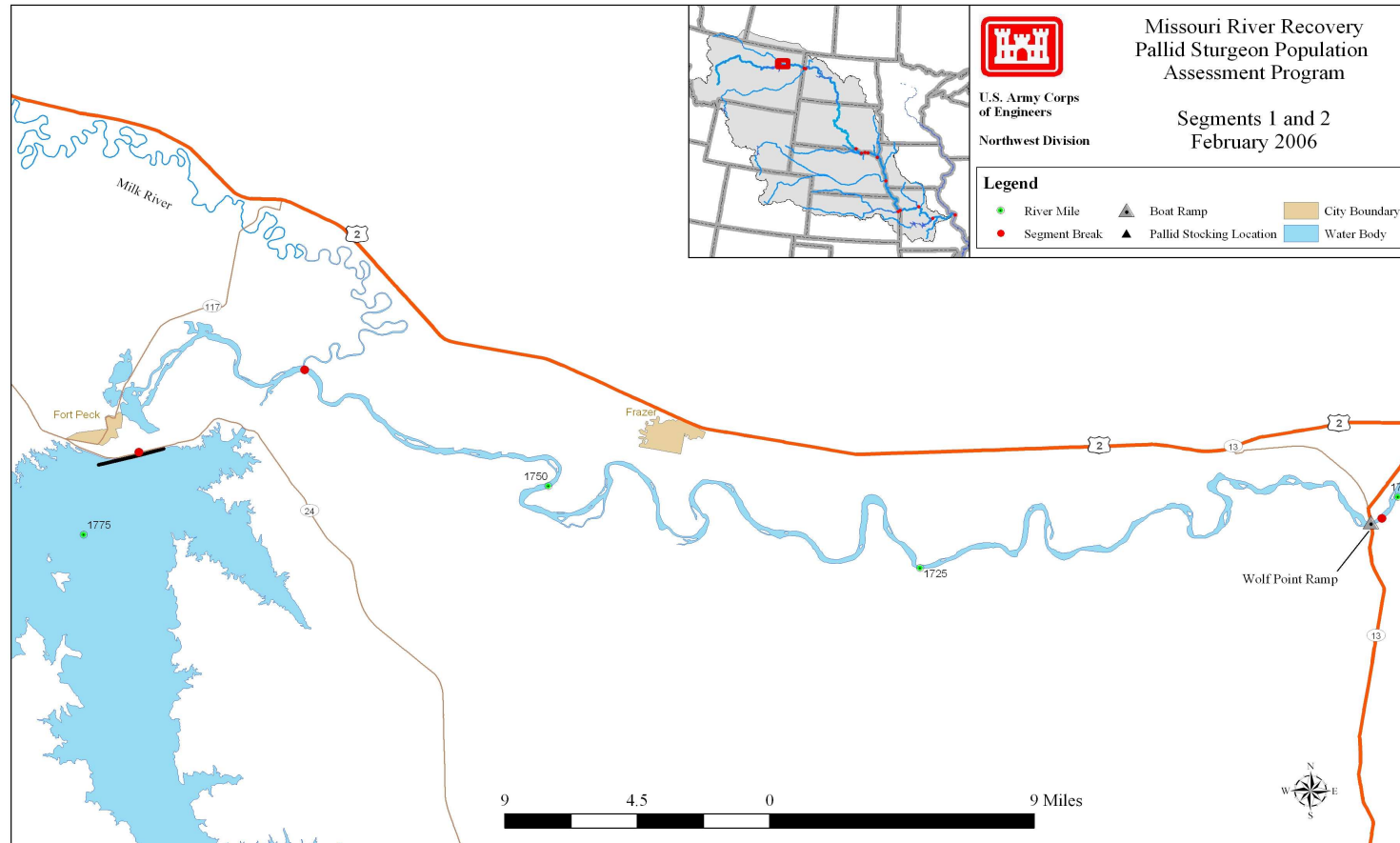


Figure 1a. Map of segment 1 of the Missouri River with major tributaries, common landmarks, and historic stocking locations for pallid sturgeon. Segment 1 encompasses the Missouri River from Fort Peck Dam (River Mile 1771.5) to the mouth of the Milk River (River Mile 1760.0).

Results

Pallid Sturgeon

No pallid sturgeon were collected in segment 1 of the Missouri River during 2006 (Figure 1b). Additionally, no pallid sturgeon x shovelnose sturgeon hybrids were sampled in segment 1.

Targeted Native River Species

Shovelnose Sturgeon

Forty-seven shovelnose sturgeon were collected in segment 1 during 2006. The number of shovelnose sturgeon captured was relatively equal between the sturgeon (N = 23) and fish community (N = 24) seasons. The majority (N = 37) were captured using trammel nets, while the remaining 10 were sampled in otter trawls. Shovelnose sturgeon were the most abundant species sampled during the sturgeon season and the sixth most abundant species during the fish community season (Figure 1b). Trammel net CPUE was higher during the sturgeon season (CPUE = 1.11 fish/ 100 m) when compared to the fish community season (CPUE = 0.95) (Figure 2). Conversely, otter trawl CPUE was lower during the sturgeon season (CPUE = 0.18 fish/ 100 m) than the fish community season (CPUE = 0.30 fish/ 100 m) (Figure 3), although both were substantially lower than trammel net CPUE. Shovelnose sturgeon were captured in the channel crossover (N = 19), inside bend (N = 18), and outside bend (N = 10) of segment 1. Shovelnose sturgeon were not captured in beam trawls (Figure 4), mini fyke nets (Figure 5), or bag seines (Figure 6) in segment 1 during 2006.

Shovelnose sturgeon were on average larger during the sturgeon season (mean FL = 633 mm) than during the fish community season (mean FL = 594 mm). The length frequency histogram in Figure 7 indicates that no YOY or age-1 shovelnose sturgeon were collected in segment 1. Additionally, based on length at age data from Pierce et al. (2003), no shovelnose sturgeon younger than age-8 were collected in segment 1. The length-weight relationship for shovelnose sturgeon sampled in segment 1 is given in Figure 7.

Sturgeon Chub

No sturgeon chubs were collected in segment 1 of the Missouri River during 2006

Sicklefin Chub

No sicklefin chubs were collected in segment 1 of the Missouri River during 2006.

Sand Shiner

One sand shiner was sampled in segment 1 during 2006. The single sand shiner was 57 mm TL and was captured using a bag seine in a small-connected side channel. Bag seine CPUE for sand shiners was calculated at 0.05 fish/ 100 m² (Figure 6).

Western Silvery Minnow

Two western silvery minnows were sampled in segment 1 during 2006. One was captured in the channel crossover and the other in the inside bend. The two specimens were both captured in the otter trawl and measured 73 and 93 mm TL. Western silvery minnow CPUE was 0.11 fish /100 m for the otter trawl (Figure 3).

Blue Sucker

Two blue suckers were sampled in segment 1 during 2006, both being captured in trammel nets. The two fish measured 657 and 690 mm TL, which indicates both specimens were mature adults (Pierce et al. 2003). One blue sucker was captured in the channel crossover while the other was captured in the outside bend. Trammel net CPUE for blue suckers was 0.15 fish/ 100 m (Figure 2).

Sauger

One sauger was captured in segment 1 during 2006. The one specimen was captured in a trammel net in the inside bend and measured 376 mm TL. Trammel net CPUE for sauger was estimated at 0.05 fish/ 100 m (Figure 2). Based on length at age data from Pierce et al. (2003), this sauger was approximately four years of age.

2006 Total Fish Sampled By Season For Segment 1

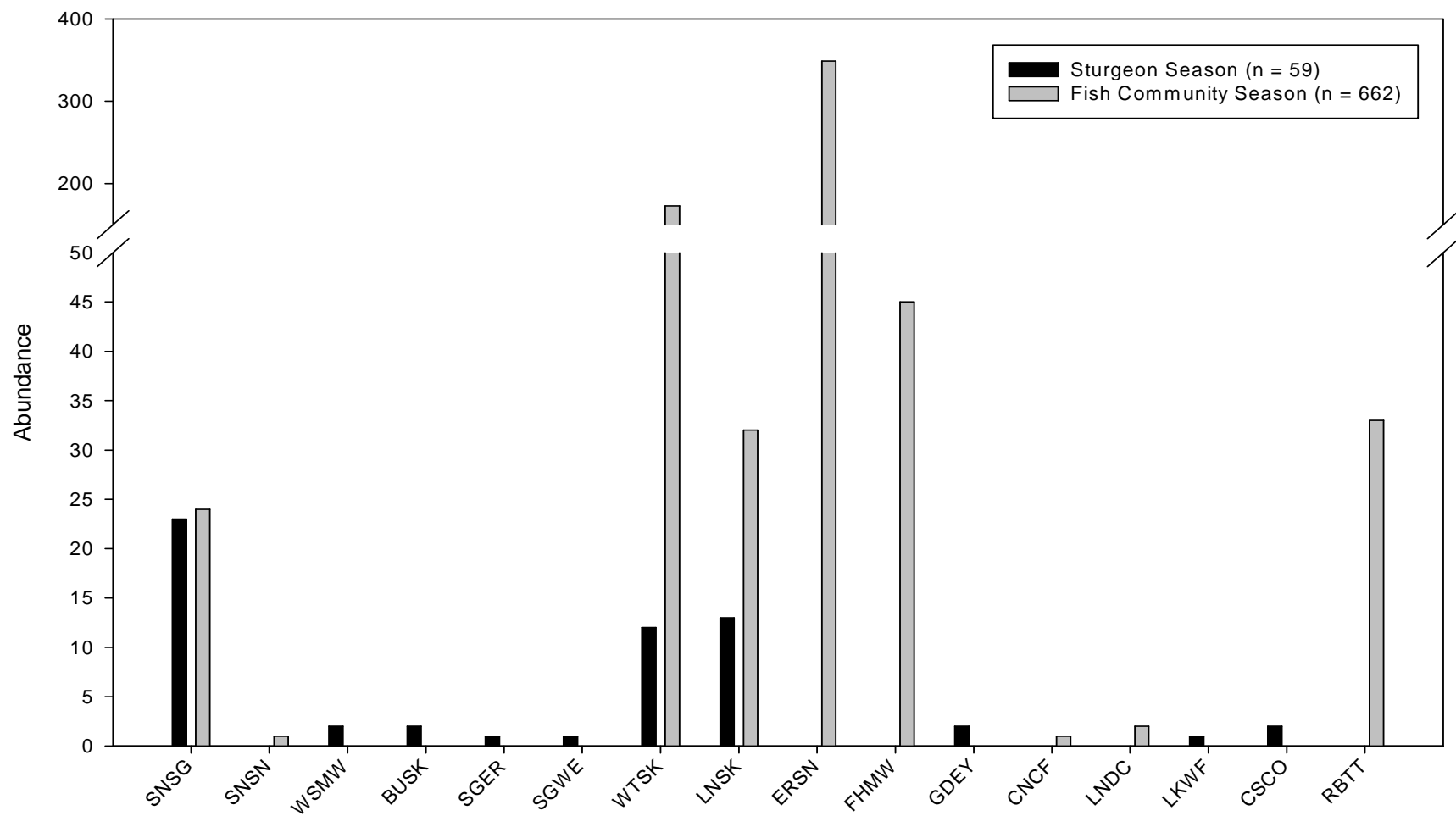


Figure 1b. Total number of fish sampled in segment 1 of the Missouri River during 2006. Note the break in the Y-axis and the difference in scale above and below the break.

Segment 1 Trammel Net CPUE

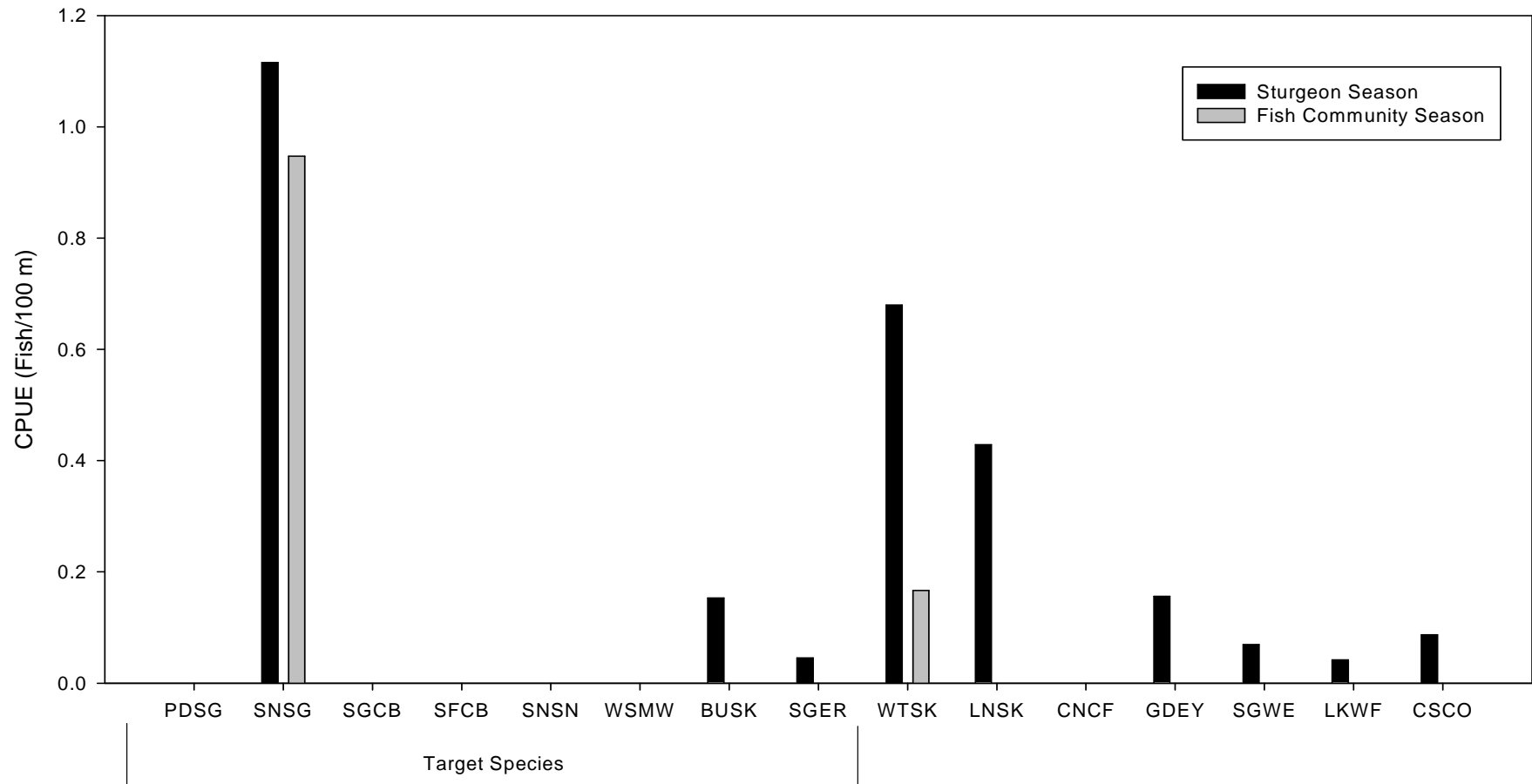


Figure 2. Trammel net CPUE by season for all target species and non-target species sampled in segment 1 of the Missouri River during 2006. Target species are indicated by the bracket below the X-axis.

Segment 1 Otter Trawl CPUE

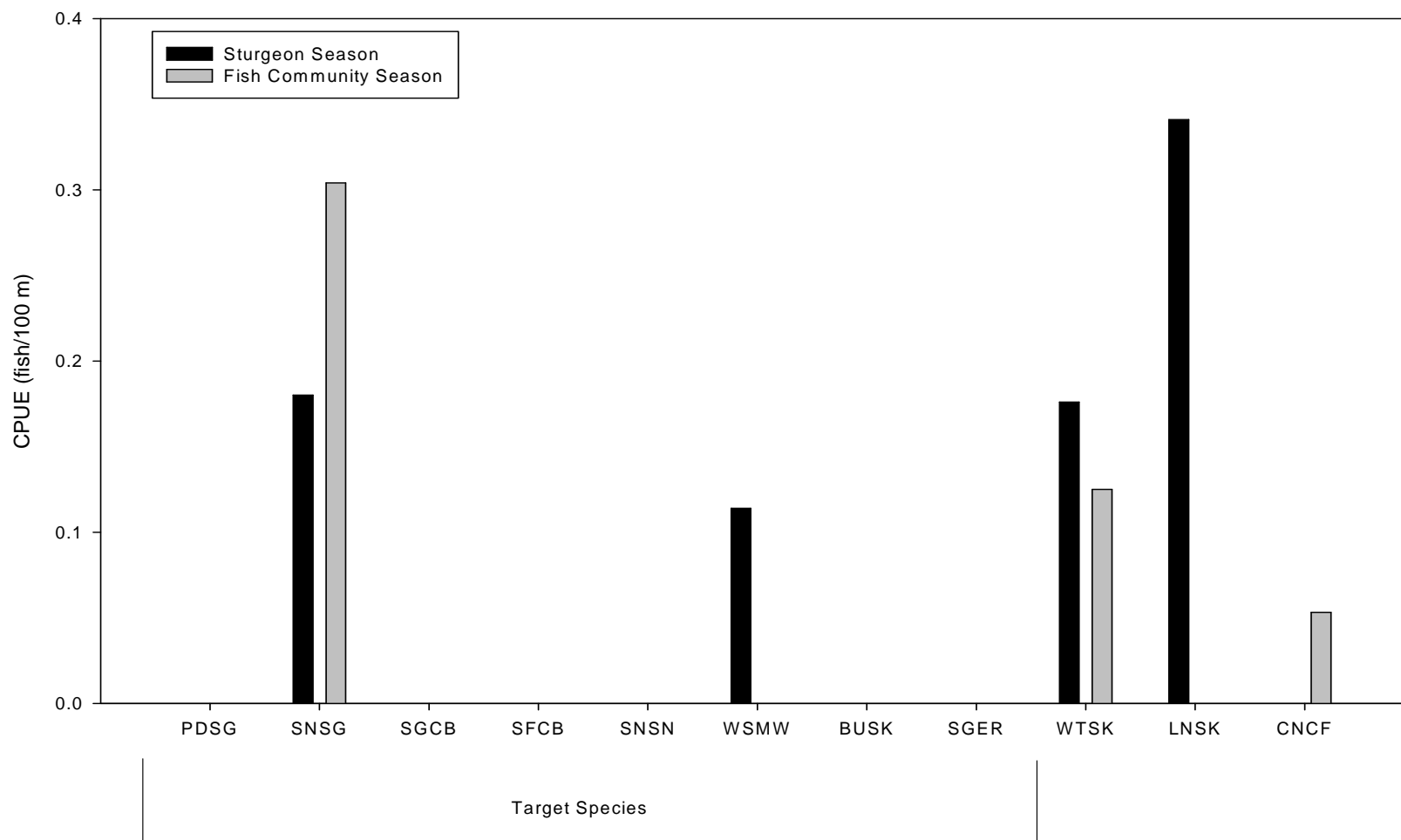


Figure 3. Otter trawl CPUE by season for all target species and non-target species sampled in segment 1 of the Missouri River during 2006. Target species are indicated by the bracket below the X-axis.

Segment 1 Beam Trawl CPUE

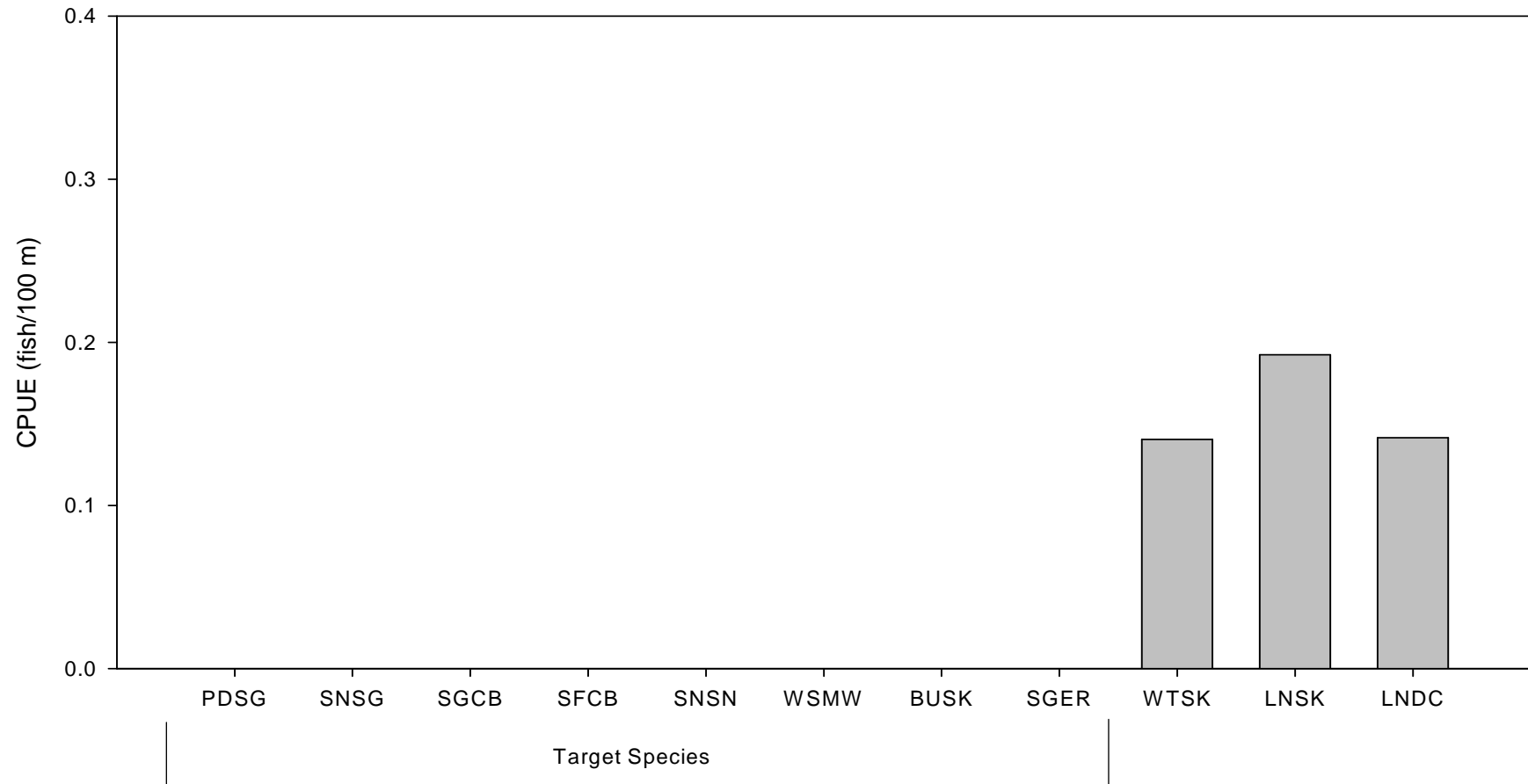


Figure 4. Beam trawl CPUE for all target species and non-target species sampled during the fish community season in segment 1 of the Missouri River during 2006. Target species are indicated by the bracket below the X-axis.

Segment 1 Mini Fyke Net CPUE

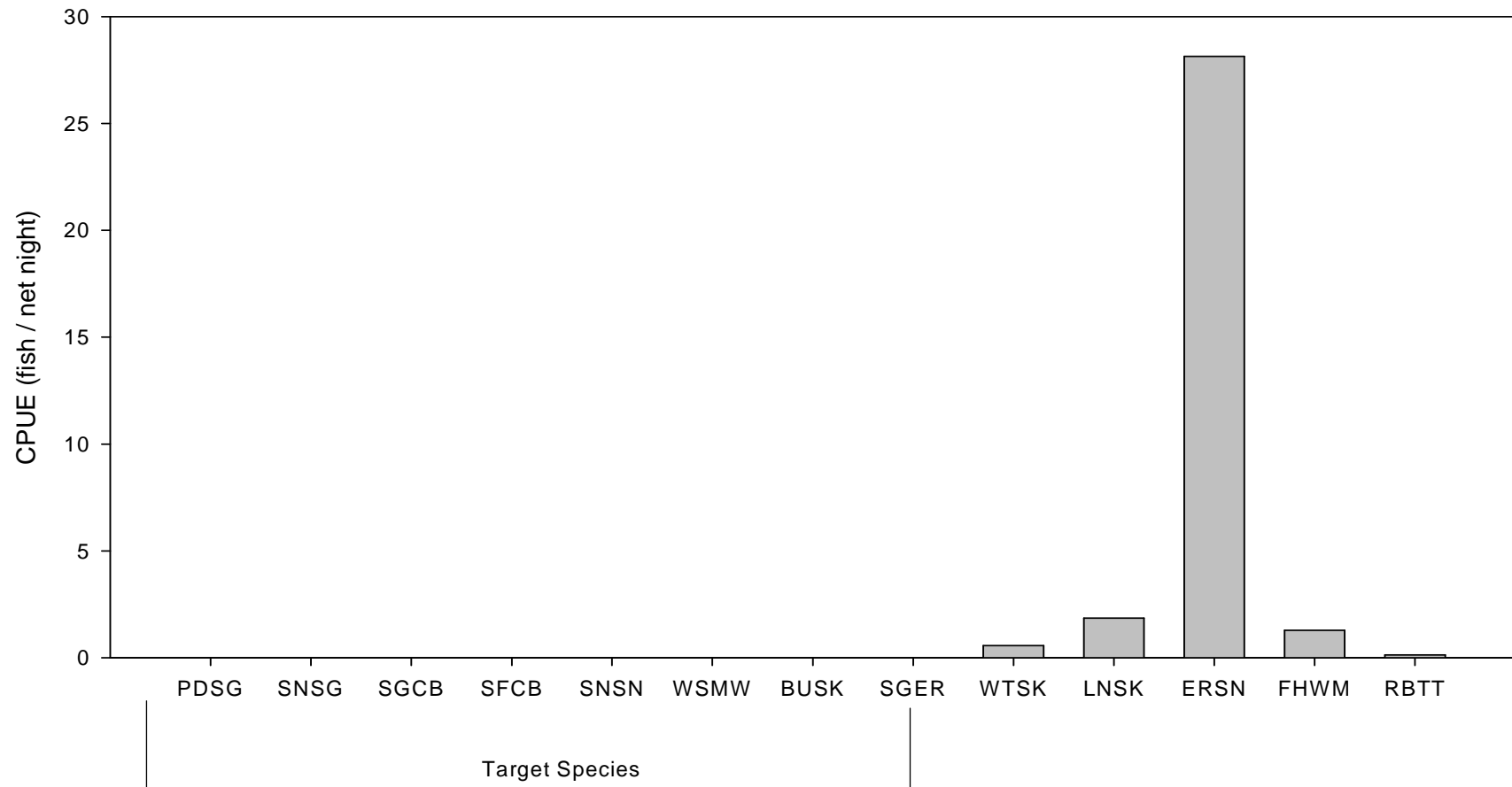


Figure 5. Mini fyke net CPUE for all target species and non-target species sampled during the fish community season in segment 1 of the Missouri River during 2006. Target species are indicated by the bracket below the X-axis.

Segment 1 Bag Seine CPUE

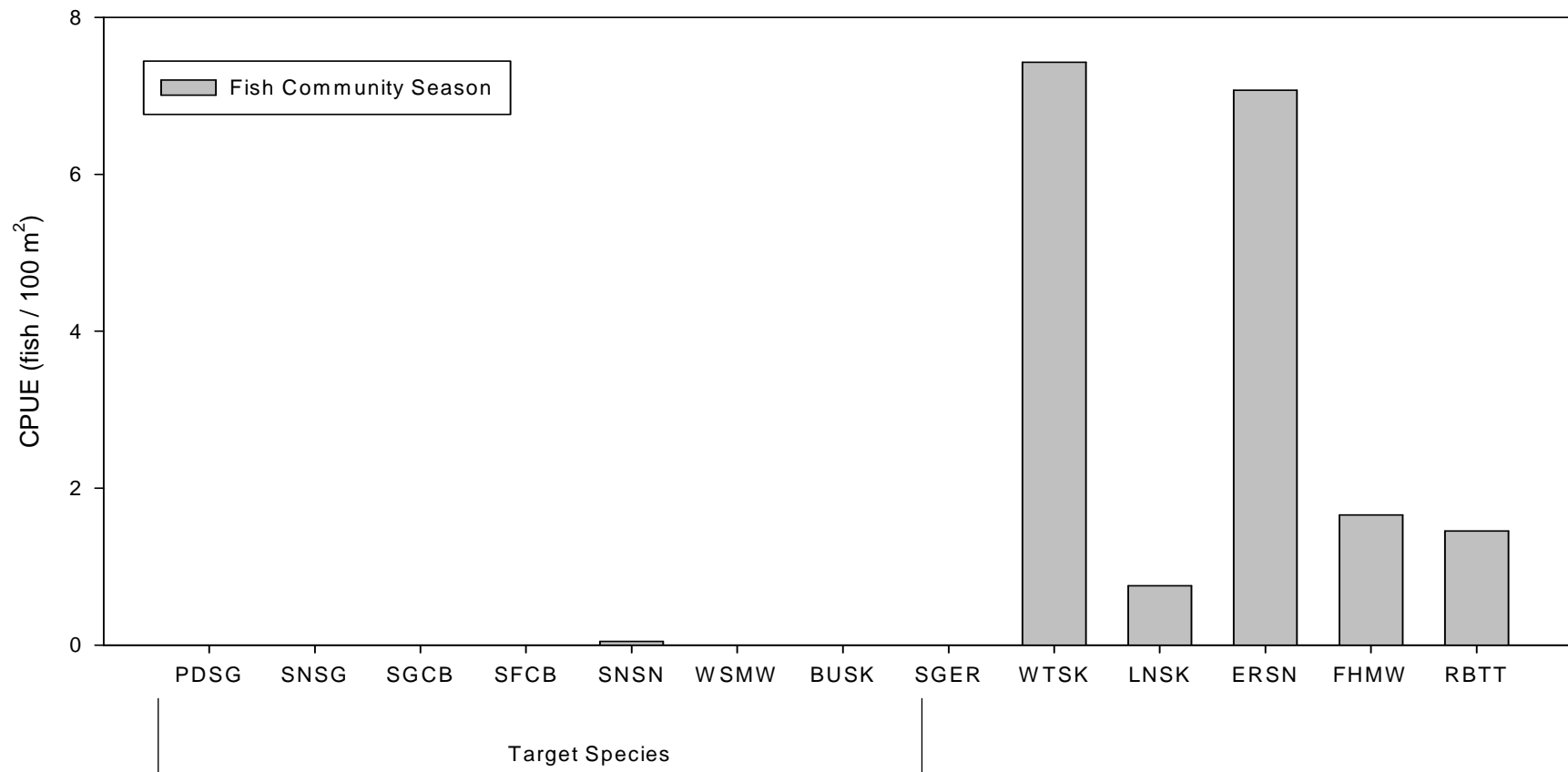


Figure 6. Bag seine CPUE for all target species and non-target species sampled during the fish community season in segment 1 of the Missouri River during 2006. Target species are indicated by the bracket below the X-axis.

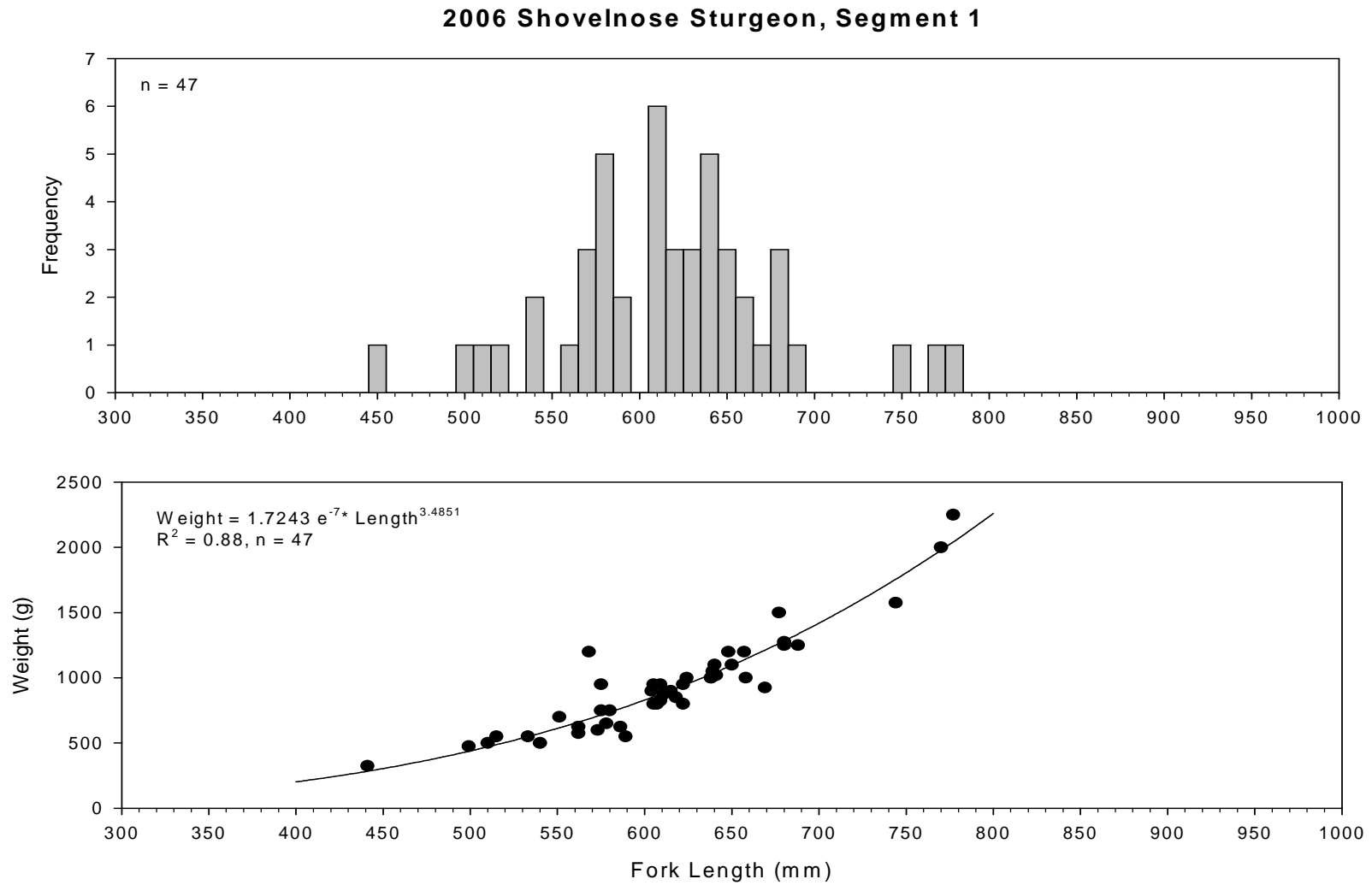


Figure 7. Top panel represents a length frequency histogram for all shovelnose sturgeon sampled in Segment 1 during 2006. Bottom panel represents the weight-length relationship for all shovelnose sturgeon sampled in Segment 1 during 2006. The two-parameter power function and sample sizes are given.

Table 1. Presence absence of all species collected in segments 1 through 3 in the Missouri River during 2006. Boxes shaded and marked with an X indicate at least one specimen was sampled. Species in bold are native target species (Source: Haddix et al. 2007a and. 2007b)

Species	Segment 1	Segment 2	Segment 3
BKBH		X	
BKSB		X	
BMBF		X	X
BNTT		X	
BRBT		X	X
BSMW		X	
BUSK	X	X	X
CARP		X	X
CNCF	X	X	X
CSCO	X		
ERSN	X	X	X
FHCB		X	X
FHMW	X	X	X
FWDM			X
GDEY	X	X	X
GNSF			X
LKCB		X	
LKWF	X		
LNDC	X	X	X
LNSK	X	X	X
NRBD		X	X
PDFH			X
PDSG		X	X
PNSD		X	X
RBTT	X	X	
RVCS		X	X
SFCB		X	X
SGCB		X	X
SGER	X	X	X
SGWE	X	X	
SHRH		X	X
SMBF		X	X
SNSG	X	X	X
SNSN	X	X	X
STCT		X	X
STSN		X	X
WLYE		X	X
WSMW	X	X	X
WTCP			X
WTSK	X	X	X
YWPH		X	

Missouri River Fish Community

A total of 719 fish consisting of 16 species were sampled in segment 1 during 2006. Emerald shiners *Notropis atherinoides* were the most abundant species with 349 sampled. The remaining species listed in order of abundance were, white suckers *Catostomus commersoni* (N = 185), shovelnose sturgeon (N = 47), fathead minnow *Pimephales promelas* (N = 45), longnose sucker *Catostomus catostomus* (N = 45), rainbow trout *Oncorhynchus mykiss* (N = 33), blue sucker (N = 2), western silvery minnow (N = 2), longnose dace *Rhinichthys cataractae* (N = 2), goldeye *Hiodon alosoides* (N = 2), sauger (N = 1), sand shiner (N = 1), lake whitefish *Coregonus clupeaformis* (N = 1), ciscoe *C. artedi* (N = 1), channel catfish *Ictalurus punctatus* (N = 1), and one suspected (based on phenotype) sauger x walleye *Sander vitreus* hybrid.

More fish were collected during the fish community season (N = 660) than during the sturgeon season (N = 59). While bag seines (N = 398) collected more fish than mini fyke nets (N=224), both gears captured considerably more fish than the trammel net (N = 65), otter trawl (N = 24), and beam trawl (N = 6). However, the bag seine and mini fyke nets only captured one target species each, while otter trawls captured three and trammel nets captured two. Beam trawls did not capture any target species. The species collected in segment 1 and those collected in segments 2 and 3 is shown in Table 1. Segment 1 had less diversity than both segments 2 and 3, although only one bend was sampled in segment 1. All three nonnative species collected in segment 1 were from the Salmonidae family, rainbow trout, lake whitefish, and cisco.

Discussion

Segment 1 of the Missouri River is highly altered due to the presence and operations of Fort Peck Dam. This altered state is evident in the fish species collected and not collected during 2006 from this section of the Missouri River. The cold clear waters are inhabited by cold water species such as rainbow trout, lake whitefish, and cisco. Some plausible causes for the presence of species like rainbow trout and the absence of other species like sturgeon and sicklefin chubs could be due to altered physical habitat. For instance, turbidity averaged 8.3 NTU's during sampling with a minimum of 6 and a maximum of 10 NTU's in segment 1. In comparison, turbidity averaged 44.7 and 46.1 NTU's for segments 2 and 3 during 2006 sampling efforts, respectively (Haddix et al. 2007a and 2007b). Similarly, temperature averaged 13.4 C° for samples in segment 1, while samples taken in both segments 2 and 3 were on average warmer at 16.5 and 16.9 C°, respectively. The benthic substrate in segment 1 is also different than those of most portions of segment 2 and all of segment 3. Gravel and cobble dominate segment 1 upstream of the Milk River, whereas areas of gravel and cobble are found to a lesser extent in segment 2 and are rarely found in segment 3.

Pallid sturgeon were not observed in segment 1 during 2006, even though the School Trust stocking site is located less than 2 miles downstream and the Milk River stocking is less than 5 miles downstream. During 2006 approximately 1,657 yearling and 134 advanced fingerling pallid sturgeon were stocked in the mouth of the Milk River before sampling began in segment 1 (Appendix E). While pallid sturgeon are either rare or nonexistent in segment 1, shovelnose sturgeon are quite common. Shovelnose sturgeon made up 6.54% of all fish sampled in segment 1. Whereas shovelnose sturgeon made up only 0.71% and 0.87% of all fish sampled in segments 2 and 3, respectively. However, all shovelnose sturgeon captured in segment 1 were older mature fish \geq age-8) and no signs of younger age classes as were observed as were found in segments 2 and 3.

Similar to shovelnose sturgeon, both blue suckers sampled in segment 1 were older individuals. However, no blue suckers < 635 mm TL were found in segments 1 through 3.

Besides shovelnose sturgeon, target species were at very low abundances in segment 1. Target species that were not collected in segment 1 that were collected in both segment 2 and 3 include sturgeon and sicklefin chubs.

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APPENDICES

Appendix A. Phylogenetic list of Missouri River fishes with corresponding letter codes used in the long-term pallid sturgeon and associated fish community sampling program. The phylogeny follows that used by the American Fisheries Society, Common and Scientific Names of Fishes from the United States and Canada, 5th edition. Asterisks and bold type denote targeted native Missouri River species.

Scientific name	Common name	Letter Code
CLASS CEPHALASPIDOMORPHI-LAMPREYS		
ORDER PETROMYZONTIFORMES		
Petromyzontidae – lampreys		
<i>Ichthyomyzon castaneus</i>	Chestnut lamprey	CNLP
<i>Ichthyomyzon fossor</i>	Northern brook lamprey	NBLP
<i>Ichthyomyzon unicuspis</i>	Silver lamprey	SVLP
<i>Ichthyomyzon gagei</i>	Southern brook lamprey	SBLR
Petromyzontidae	Unidentified lamprey	ULY
Petromyzontidae larvae	Unidentified larval lamprey	LVLP
CLASS OSTEICHTHYES – BONY FISHES		
ORDER ACIPENSERIFORMES		
Acipenseridae – sturgeons		
<i>Acipenser fulvescens</i>	Lake sturgeon	LKSG
<i>Scaphirhynchus</i> spp.	Unidentified Scaphirhynchus	USG
<i>Scaphirhynchus albus</i>	Pallid sturgeon	PDSG*
<i>Scaphirhynchus platyrhynchus</i>	Shovelnose sturgeon	SNSG*
<i>S. albus</i> X <i>S. platyrhynchus</i>	Pallid-shovelnose hybrid	SNPD
Polyodontidae – paddlefishes		
<i>Polyodon spathula</i>	Paddlefish	PDFH
ORDER LEPISTOSTEIFORMES		
Lepisosteidae – gars		
<i>Lepisosteus oculatus</i>	Spotted gar	STGR
<i>Lepisosteus osseus</i>	Longnose gar	LNGR
<i>Lepisosteus platostomus</i>	Shortnose gar	SNGR
ORDER AMMIFORMES		
Amiidae – bowfins		
<i>Amia calva</i>	Bowfin	BWFN
ORDER OSTEOGLOSSIFORMES		
Hiodontidae – mooneyes		
<i>Hiodon alosoides</i>	Goldeye	GDEY
<i>Hiodon tergisus</i>	Mooneye	MNEY
ORDER ANGUILLIFORMES		
Anguillidae – freshwater eels		
<i>Anguilla rostrata</i>	American eel	AMEL

Appendix A. (continued).

Scientific name	Common name	Letter Code
ORDER CLUPEIFORMES		
Clupeidae – herrings		
<i>Alosa alabame</i>	Alabama shad	ALSD
<i>Alosa chrysochloris</i>	Skipjack herring	SJHR
<i>Alosa pseudoharengus</i>	Alewife	ALWF
<i>Dorosoma cepedianum</i>	Gizzard shad	GZSD
<i>Dorosoma petenense</i>	Threadfin shad	TFSD
<i>D. cepedianum</i> X <i>D. petenense</i>	Gizzard-threadfin shad hybrid	GSTS
ORDER CYPRINIFORMES		
Cyprinidae – carps and minnows		
<i>Campostoma anomalum</i>	Central stoneroller	CLSR
<i>Campostoma oligolepis</i>	Largescale stoneroller	LSSR
<i>Carassius auratus</i>	Goldfish	GDFH
<i>Carassius auratus</i> X <i>Cyprinus carpio</i>	Goldfish-Common carp hybrid	GFCC
<i>Couesius plumbens</i>	Lake chub	LKCB
<i>Ctenopharyngodon idella</i>	Grass carp	GSCP
<i>Cyprinella lutrensis</i>	Red shiner	RDSN
<i>Cyprinella spiloptera</i>	Spotfin shiner	SFSN
<i>Cyprinus carpio</i>	Common carp	CARP
<i>Erimystax x-punctatus</i>	Gravel chub	GVCB
<i>Hybognathus argyritis</i>	Western silvery minnow	WSMN*
<i>Hybognathus hankinsoni</i>	Brassy minnow	BSMN
<i>Hybognathus nuchalis</i>	Mississippi silvery minnow	SVMW
<i>Hybognathus placitus</i>	Plains minnow	PNMW*
<i>Hybognathus</i> spp.	Unidentified <i>Hybognathus</i>	HBNS*
<i>Hypophthalmichthys molitrix</i>	Silver carp	SVCP
<i>Hypophthalmichthys nobilis</i>	Bighead carp	BHCP
<i>Luxilus chrysocephalus</i>	Striped shiner	SPSN
<i>Luxilus cornutus</i>	Common shiner	CMSN
<i>Luxilus zonatus</i>	Bleeding shiner	BDSN
<i>Lythrurus unbratilis</i>	Western redfin shiner	WRFS
<i>Macrhybopsis aestivalis</i>	Speckled chub	SKCB*
<i>Macrhybopsis gelida</i>	Sturgeon chub	SGCB*
<i>Macrhybopsis meeki</i>	Sicklefin chub	SFCB*
<i>Macrhybopsis storeriana</i>	Silver chub	SVCB
<i>M. aestivalis</i> X <i>M. gelida</i>	Speckled-Sturgeon chub hybrid	SPST
<i>M. gelida</i> X <i>M. meeki</i>	Sturgeon-Sicklefin chub hybrid	SCSC
<i>Macrhybopsis</i> spp.	Unidentified chub	UHY
<i>Margariscus margarita</i>	Pearl dace	PLDC
<i>Mylocheilus caurinus</i>	Peamouth	PEMT
<i>Nocomis biguttatus</i>	Hornyhead chub	HHCB
<i>Notemigonus crysoleucas</i>	Golden shiner	GDSN
<i>Notropis atherinoides</i>	Emerald shiner	ERSN
<i>Notropis blennioides</i>	River shiner	RVSN
<i>Notropis boops</i>	Bigeye shiner	BESN
<i>Notropis burchanani</i>	Ghost shiner	GTSN
<i>Notropis dorsalis</i>	Bigmouth shiner	BMSN
<i>Notropis greeniei</i>	Wedgespot shiner	WSSN

Appendix A. (continued).

Scientific name	Common name	Letter Code
Cyprinidae – carps and minnows		
<i>Notropis heterolepsis</i>	Blacknose shiner	BNSN
<i>Notropis hudsonius</i>	Spottail shiner	STSN
<i>Notropis nubilus</i>	Ozark minnow	OZMW
<i>Notropis rubellus</i>	Rosyface shiner	RYSN
<i>Notropis shumardi</i>	Silverband shiner	SBSN
<i>Notropis stilbius</i>	Silverstripe shiner	SSPS
<i>Notropis stramineus</i>	Sand shiner	SNSN*
<i>Notropis topeka</i>	Topeka shiner	TPSN
<i>Notropis volucellus</i>	Mimic shiner	MMSN
<i>Notropis wickliffi</i>	Channel shiner	CNSN
<i>Notropis</i> spp.	Unidentified shiner	UNO
<i>Opsopoeodus emiliae</i>	Pugnose minnow	PNMW
<i>Phenacobius mirabilis</i>	Suckermouth minnow	SMMW
<i>Phoxinus eos</i>	Northern redbelly dace	NRBD
<i>Phoxinus erythrogaster</i>	Southern redbelly dace	SRBD
<i>Phoxinus neogaeus</i>	Finescale dace	FSDC
<i>Pimephales notatus</i>	Bluntnose minnow	BNMW
<i>Pimephales promelas</i>	Fathead minnow	FHMW
<i>Pimephales vigilax</i>	Bullhead minnow	BHMW
<i>Platygobio gracilis</i>	Flathead chub	FHCB
<i>P. gracilis</i> X <i>M. meeki</i>	Flathead-sicklefin chub hybrid	FCSC
<i>Rhinichthys atratulus</i>	Blacknose dace	BNDC
<i>Rhinichthys cataractae</i>	Longnose dace	LNDC
<i>Richardsonius balteatus</i>	Redside shiner	RDSS
<i>Scardinius erythrophthalmus</i>	Rudd	RUDD
<i>Semotilus atromaculatus</i>	Creek chub	CKCB
	Unidentified Cyprinidae	UCY
	Unidentified Asian Carp	UAC
Catostomidae - suckers		
<i>Carpionodes carpio</i>	River carpsucker	RVCS
<i>Carpionodes cyprinus</i>	Quillback	QLBK
<i>Carpionodes velifer</i>	Highfin carpsucker	HFCS
<i>Carpionodes</i> spp.	Unidentified Carpiodes	UCS
<i>Catostomus catostomus</i>	Longnose sucker	LNSK
<i>Catostomus commersoni</i>	White sucker	WTSK
<i>Catostomus platyrhynchus</i>	Mountain sucker	MTSK
<i>Catostomus</i> spp.	Unidentified <i>Catostomus</i> spp.	UCA
<i>Cycleptus elongatus</i>	Blue sucker	BUSK*
<i>Hypentelium nigricans</i>	Northern hog sucker	NHSC
<i>Ictiobus bubalus</i>	Smallmouth buffalo	SMBF
<i>Ictiobus cyprinellus</i>	Bigmouth buffalo	BMBF
<i>Ictiobus niger</i>	Black buffalo	BKBF
<i>Ictiobus</i> spp.	Unidentified buffalo	UBF
<i>Minytrema melanops</i>	Spotted sucker	SPSK
<i>Moxostoma anisurum</i>	Silver redhorse	SVRH
<i>Moxostoma carinatum</i>	River redhorse	RVRH
<i>Moxostoma duquesnei</i>	Black redhorse	BKRH
<i>Moxostoma erythrurum</i>	Golden redhorse	GDRH
<i>Moxostoma macrolepidotum</i>	Shorthead redhorse	SHRH
<i>Moxostoma</i> spp.	Unidentified redhorse	URH

Appendix A. (continued).

Scientific name	Common name	Letter Code
Catostomidae - suckers	Unidentified Catostomidae	UCT
ORDER SILURIFORMES		
Ictaluridae – bullhead catfishes		
<i>Ameiurus melas</i>	Black bullhead	BKBH
<i>Ameiurus natalis</i>	Yellow bullhead	YLBH
<i>Ameiurus nebulosus</i>	Brown bullhead	BRBH
<i>Ameiurus</i> spp.	Unidentified bullhead	UBH
<i>Ictalurus furcatus</i>	Blue catfish	BLCF
<i>Ictalurus punctatus</i>	Channel catfish	CNCF
<i>I. furcatus</i> X <i>I. punctatus</i>	Blue-channel catfish hybrid	BCCC
<i>Ictalurus</i> spp.	Unidentified <i>Ictalurus</i> spp.	UCF
<i>Noturus exilis</i>	Slender madtom	SDMT
<i>Noturus flavus</i>	Stonecat	STCT
<i>Noturus gyrinus</i>	Tadpole madtom	TPMT
<i>Noturus nocturnus</i>	Freckled madtom	FKMT
<i>Pylodictis olivaris</i>	Flathead catfish	FHCF
ORDER SALMONIFORMES		
Esocidae - pikes		
<i>Esox americanus vermiculatus</i>	Grass pickerel	GSPK
<i>Esox lucius</i>	Northern pike	NTPK
<i>Esox masquinongy</i>	Muskellunge	MSKG
<i>E. lucius</i> X <i>E. masquinongy</i>	Tiger Muskellunge	TGMG
Umbridae - mudminnows		
<i>Umbra limi</i>	Central mudminnow	MDMN
Osmeridae - smelts		
<i>Osmerus mordax</i>	Rainbow smelt	RBST
Salmonidae - trouts		
<i>Coregonus artedii</i>	Lake herring or cisco	CSCO
<i>Coregonus clupeaformis</i>	Lake whitefish	LKWF
<i>Oncorhynchus aguabonita</i>	Golden trout	GDTT
<i>Oncorhynchus clarki</i>	Cutthroat trout	CTTT
<i>Oncorhynchus kisutch</i>	Coho salmon	CHSM
<i>Oncorhynchus mykiss</i>	Rainbow trout	RBTT
<i>Oncorhynchus nerka</i>	Sockeye salmon	SESM
<i>Oncorhynchus tshawytscha</i>	Chinook salmon	CNSM
<i>Prosopium cylindraceum</i>	Bonneville cisco	BVSC
<i>Prosopium williamsoni</i>	Mountain whitefish	MTWF
<i>Salmo trutta</i>	Brown trout	BNTT
<i>Salvelinus fontinalis</i>	Brook trout	BKTT
<i>Salvelinus namaycush</i>	Lake trout	LKTT
<i>Thymallus arcticus</i>	Arctic grayling	AMGL

Appendix A. (continued).

Scientific name	Common name	Letter Code
ORDER PERCOPSIFORMES		
Percopsidae – trout-perches		
<i>Percopsis omiscomaycus</i>	Trout-perch	TTPH
ORDER GADIFORMES		
Gadidae - cods		
<i>Lota lota</i>	Burbot	BRBT
ORDER ATHERINIFORMES		
Cyprinodontidae - killifishes		
<i>Fundulus catenatus</i>	Northern studfish	NTSF
<i>Fundulus diaphanus</i>	Banded killifish	BDKF
<i>Fundulus notatus</i>	Blackstripe topminnow	BSTM
<i>Fundulus olivaceus</i>	Blackspotted topminnow	BPTM
<i>Fundulus sciadicus</i>	Plains topminnow	PTMW
<i>Fundulus zebrinus</i>	Plains killifish	PKLF
Poeciliidae - livebearers		
<i>Gambusia affinis</i>	Western mosquitofish	MQTF
Atherinidae - silversides		
<i>Labidesthes sicculus</i>	Brook silverside	BKSS
ORDER GASTEROSTEIFORMES		
Gasterosteidae - sticklebacks		
<i>Culaea inconstans</i>	Brook stickleback	BKSB
ORDER SCORPAENIFORMES		
Cottidae - sculpins		
<i>Cottus bairdi</i>	Mottled sculpin	MDSP
<i>Cottus carolinae</i>	Banded sculpin	BDSP
ORDER PERCIFORMES		
Percichthyidae – temperate basses		
<i>Morone Americana</i>	White perch	WTPH
<i>Morone chrysops</i>	White bass	WTBS
<i>Morone mississippiensis</i>	Yellow bass	YWBS
<i>Morone saxatilis</i>	Striped bass	SDBS
<i>M. saxatilis X M. chrysops</i>	Striped-white bass hybrid	SBWB
Centrarchidae - sunfishes		
<i>Ambloplites rupestris</i>	Rock bass	RKBS
<i>Archoplites interruptus</i>	Sacramento perch	SOPH
<i>Lepomis cyanellus</i>	Green sunfish	GNSF
<i>Lepomis gibbosus</i>	Pumpkinseed	PNSD
<i>Lepomis gulosus</i>	Warmouth	WRMH
<i>Lepomis humilis</i>	Orangespotted sunfish	OSSF
<i>Lepomis macrochirus</i>	Bluegill	BLGL
<i>Lepomis magalotis</i>	Longear sunfish	LESF
<i>Lepomis microlophus</i>	Redear sunfish	RESF
<i>L. cyanellus X L. macrochirus</i>	Green sunfish-bluegill hybrid	GSBG

Appendix A. (continued).

Scientific name	Common name	Letter Code
Centrarchidae - sunfishes		
<i>L. cyanellus</i> X <i>L. humilis</i>	Green-orangespotted sunfish hybrid	GSOS
<i>L. macrochirus</i> X <i>L. microlophus</i>	Bluegill-redear sunfish hybrid	BGRE
<i>Lepomis</i> spp.	Unidentified <i>Lepomis</i>	ULP
<i>Micropterus dolomieu</i>	Smallmouth bass	SMBS
<i>Micropterus punctulatus</i>	Spotted sunfish	STBS
<i>Micropterus salmoides</i>	Largemouth bass	LMBS
<i>Micropterus</i> spp.	Unidentified <i>Micropterus</i> spp.	UMC
<i>Pomoxis annularis</i>	White crappie	WTCP
<i>Pomoxis nigromaculatus</i>	Black crappie	BKCP
<i>Pomoxis</i> spp.	Unidentified crappie	UCP
<i>P. annularis</i> X <i>P. nigromaculatus</i>	White-black crappie hybrid	WCBC
Centrarchidae	Unidentified centrarchid	UCN
Percidae - perches		
<i>Ammocrypta asprella</i>	Crystal darter	CLDR
<i>Etheostoma blennioides</i>	Greenside darter	GS DR
<i>Etheostoma caeruleum</i>	Rainbow darter	RBDR
<i>Etheostoma exile</i>	Iowa darter	IODR
<i>Etheostoma flabellare</i>	Fantail darter	FTDR
<i>Etheostoma gracile</i>	Slough darter	SLDR
<i>Etheostoma microperca</i>	Least darter	LTDR
<i>Etheostoma nigrum</i>	Johnny darter	JYDR
<i>Etheostoma punctulatum</i>	Stippled darter	STPD
<i>Etheostoma spectabile</i>	Orangethroated darter	OTDR
<i>Etheostoma tetrazonum</i>	Missouri saddled darter	MSDR
<i>Etheostoma zonale</i>	Banded darter	BDDR
<i>Etheostoma</i> spp.	Unidentified <i>Etheostoma</i> spp.	UET
<i>Perca flavescens</i>	Yellow perch	YWPH
<i>Percina caprodes</i>	Logperch	LGPH
<i>Percina cymatotaenia</i>	Bluestripe darter	BTDR
<i>Percina evides</i>	Gilt darter	GLDR
<i>Percina maculata</i>	Blackside darter	BSDR
<i>Percina phoxocephala</i>	Slenderhead darter	SHDR
<i>Percina shumardi</i>	River darter	RRDR
<i>Percina</i> spp.	Unidentified <i>Percina</i> spp.	UPN
	Unidentified darter	UDR
<i>Sander canadense</i>	Sauger	SGER*
<i>Sander vitreus</i>	Walleye	WLEY
<i>S. canadense</i> X <i>S. vitreus</i>	Sauger-walley hybrid/Saugeye	SGWE
<i>Sander</i> spp.	Unidentified <i>Sander</i> (formerly <i>Stizostedion</i>) spp.	UST
	Unidentified Percidae	UPC
Sciaenidae - drums		
<i>Aplodinotus grunniens</i>	Freshwater drum	FWDM
NON-TAXONOMIC CATEGORIES		
	Age-0/Young-of-year fish	YOYF
	Lab fish for identification	LAB
	No fish caught	NFSH
	Unidentified larval fish	LVFS
	Unidentified	UNID
	Net Malfunction (Did Not Fish)	NDNF

Appendix B. Definitions and codes used to classify standard Missouri River habitats in the long-term pallid sturgeon and associated fish community sampling program. Three habitat scales were used in the hierarchical habitat classification system: Macrohabitats, Mesohabitats, and Microhabitats.

Habitat	Scale	Definition	Code
Braided channel	Macro	An area of the river that contains multiple smaller channels and is lacking a readily identifiable main channel (typically associated with unchannelized sections)	BRAD
Main channel cross over	Macro	The inflection point of the thalweg where the thalweg crosses from one concave side of the river to the other concave side of the river, (i.e., transition zone from one-bend to the next bend). The upstream CHXO for a respective bend is the one sampled.	CHXO
Tributary confluence	Macro	Area immediately downstream, extending up to one bend in length, from a junction of a large tributary and the main river where this tributary has influence on the physical features of the main river	CONF
Dendritic	Macro	An area of the river where the river transitions from meandering or braided channel to more of a treelike pattern with multiple channels (typically associated with unchannelized sections)	DEND
Deranged	Macro	An area of the river where the river transitions from a series of multiple channels into a meandering or braided channel (typically associated with unchannelized sections)	DRNG
Main channel inside bend	Macro	The convex side of a river bend	ISB
Main channel outside bend	Macro	The concave side of a river bend	OSB
Secondary channel-connected large	Macro	A side channel, open on upstream and downstream ends, with less flow than the main channel, large indicates this habitat can be sampled with trammel nets and trawls based on width and/or depths > 1.2 m	SCCL
Secondary channel-connected small	Macro	A side channel, open on upstream and downstream ends, with less flow than the main channel, small indicates this habitat cannot be sampled with trammel nets and trawls based on width and/or on depths < 1.2 m	SCCS
Secondary channel-non-connected	Macro	A side channel that is blocked at one end	SCCN
Tributary	Macro	Any river or stream flowing in the Missouri River	TRIB
Tributary large mouth	Macro	Mouth of entering tributary whose mean annual discharge is > 20 m ³ /s, and the sample area extends 300 m into the tributary	TRML
Tributary small mouth	Macro	Mouth of entering tributary whose mean annual discharge is < 20 m ³ /s, mouth width is > 6 m wide and the sample area extends 300 m into the tributary	TRMS
Wild	Macro	All habitats not covered in the previous habitat descriptions	WILD
Bars	Meso	Sandbar or shallow bank-line areas with depth < 1.2 m	BARS
Pools	Meso	Areas immediately downstream from sandbars, dikes, snags, or other obstructions with a formed scour hole > 1.2 m	POOL
Channel border	Meso	Area in the channelized river between the toe and the thalweg, area in the unchannelized river between the toe and the maximum depth	CHNB
Thalweg	Meso	Main channel between the channel borders conveying the majority of the flow	TLWG
Island tip	Meso	Area immediately downstream of a bar or island where two channels converge with water depths > 1.2 m	ITIP

Appendix C. List of standard and wild gears (type), their corresponding codes in the database, seasons deployed (Fall-Spring, Summer, or all), years used, and catch-per-unit-effort units for collection of Missouri River fishes in segment 2 for the long-term pallid sturgeon and associated fish community sampling program. Long-term monitoring began in 2006 for segment 2.

Gear	Code	Type	Season	Years	CPUE units
Trammel net – 1 inch inner mesh	TN	Standard	All	2006	fish/100 m drift
Otter trawl – 16 ft head rope	OT16	Standard	All	2006	fish/100 m trawled
Beam trawl	BT	Standard	Fish Comm.	2006	fish/100 m trawled
Bag Seine – quarter arc method pulled upstream	BSQU	Wild	Fish Comm.	2006	fish/100 m ²
Bag Seine – quarter arc method pulled downstream	BSQD	Wild	Fish Comm.	2006	fish/100 m ²
Bag Seine – half arc method pulled upstream	BSHU	Wild	Fish Comm.	2006	fish/100 m ²
Bag Seine – half arc method pulled downstream	BSHD	Wild	Fish Comm.	2006	fish/100 m ²
Bag seine – rectangular method pulled upstream	BSRU	Wild	Fish Comm.	2006	fish/100 m ²
Bag seine – rectangular method pulled upstream	BSRD	Wild	Fish Comm.	2006	fish/100 m ²
Mini-fyke net	MF	Standard	Fish Comm.	2006	fish/net night

Appendix D. Stocking locations and codes for pallid sturgeon by Recovery Priority Management Area (RPMA) in the Missouri River Basin.

State(s)	RPMA	Site Name	Code	River	RM
MT	2	Above Intake	AIN	Yellowstone	70 +
MT	2	Intake	INT	Yellowstone	70.0
MT	2	Sidney	SID	Yellowstone	31.0
MT	2	Big Sky Bend	BSB	Yellowstone	17.0
ND	2	Fairview	FRV	Yellowstone	9.0
MT	2	Milk River	MLK	Milk	11.5
MT	2	Mouth of Milk	MOM	Missouri	1761.5
MT	2	Wolf Point	WFP	Missouri	1701.5
MT	2	Poplar	POP	Missouri	1649.5
MT	2	Brockton	BRK	Missouri	1678.0
MT	2	Culbertson	CBS	Missouri	1621.0
MT	2	Nohly Bridge	NOB	Missouri	1590.0
ND	2	Confluence	CON	Missouri	1581.5
SD/NE	3	Sunshine Bottom	SUN	Missouri	866.2
SD/NE	3	Verdel Boat Ramp	VER	Missouri	855.0
SD/NE	3	Standing Bear Bridge	STB	Missouri	845.0
SD/NE	3	Running Water	RNW	Missouri	840.1
SD/NE	4	St. Helena	STH	Missouri	799.0
SD/NE	4	Mullberry Bend	MUL	Missouri	775.0
NE/IA	4	Ponca State Park	PSP	Missouri	753.0
NE/IA	4	Sioux City	SIO	Missouri	732.6
NE/IA	4	Decatur	DCT	Missouri	691.0
NE/IA	4	Boyer Chute	BYC	Missouri	637.4
NE/IA	4	Bellevue	BEL	Missouri	601.4
NE/IA	4	Rulo	RLO	Missouri	497.9
NE/MO/KS	4	Kansas River	KSR	Missouri	367.5
NE	4	Platte River	PLR	Platte	5.0
KA/MO	4	Leavenworth	LVW	Missouri	397.0
MO	4	Parkville	PKV	Missouri	377.5
MO	4	Kansas City	KAC	Missouri	342.0
MO	4	Miami	MIA	Missouri	262.8
MO	4	Grand River	GDR	Missouri	250.0
MO	4	Boonville	BOO	Missouri	195.1
MO	4	Overton	OVT	Missouri	185.1
MO	4	Hartsburg	HAR	Missouri	160.0
MO	4	Jefferson City	JEF	Missouri	143.9
MO	4	Mokane	MOK	Missouri	124.7
MO	4	Hermann	HER	Missouri	97.6
MO	4	Washington	WAS	Missouri	68.5
MO	4	St. Charles	STC	Missouri	28.5

Appendix E. Juvenile and adult pallid sturgeon stocking summary for segment 4 of the Missouri River (RPMA 2)

Year	Stocking Site	Number Stocked	Year Class	Stock Date	Age at Stocking ^a	Primary Mark	Secondary Mark
1998	Big Sky Bend	255	1997	8/11/1998	Yearling	PIT Tag	Elastomer
1998	Confluence	40	1997	8/11/1998	Yearling	PIT Tag	Elastomer
1998	Nohly Bridge	255	1997	8/11/1998	Yearling	PIT Tag	Elastomer
1998	Sidney	230	1997	8/11/1998	Yearling	PIT Tag	Elastomer
2000	Culbertson	34	1998	10/11/2000	2 yr Old	PIT Tag	
2000	Fairview	66	1998	10/11/2000	2 yr Old	PIT Tag	
2000	Sidney	66	1998	10/11/2000	2 yr Old	PIT Tag	
2000	Wolf Point	34	1998	10/11/2000	2 yr Old	PIT Tag	
2000	Culbertson	89	1999	10/17/2000	Yearling	PIT Tag	
2000	Fairview	150	1999	10/17/2000	Yearling	PIT Tag	
2000	Sidney	149	1999	10/17/2000	Yearling	PIT Tag	
2000	Wolf Point	90	1999	10/17/2000	Yearling	PIT Tag	
2002	Culbertson	270	2001	7/18/2002	Yearling	CWT	Elastomer
2002	Fairview	270	2001	7/18/2002	Yearling	CWT	Elastomer
2002	Intake	199	2001	7/18/2002	Yearling	CWT	Elastomer
2002	Sidney	271	2001	7/18/2002	Yearling	CWT	Elastomer
2002	Wolf Point	269	2001	7/18/2002	Yearling	CWT	Elastomer
2002	Culbertson	317	2001	7/26/2002	Yearling	PIT Tag	
2002	Fairview	360	2001	7/26/2002	Yearling	PIT Tag	
2002	Intake	97	2001	7/26/2002	Yearling	PIT Tag	
2002	Sidney	427	2001	7/26/2002	Yearling	PIT Tag	
2002	Wolf Point	425	2001	7/26/2002	Yearling	PIT Tag	
2002	Intake	155	2001	9/18/2002	Yearling	PIT Tag	
2003	Culbertson	1033	2002	8/7/2003	Yearling	PIT Tag	Elastomer
2003	Fairview	887	2002	8/7/2003	Yearling	PIT Tag	Elastomer
2003	Intake	1040	2002	8/7/2003	Yearling	PIT Tag	Elastomer
2003	Wolf Point	926	2002	8/7/2003	Yearling	PIT Tag	Elastomer
2004	Milk River	821	2003	4/13/2004	Yearling	Elastomer	
2004	Culbertson	523	2003	8/9/2004	Yearling	PIT Tag	Elastomer
2004	Intake	347	2003	8/9/2004	Yearling	PIT Tag	Elastomer
2004	Sidney	397	2003	8/9/2004	Yearling	PIT Tag	Elastomer
2004	Wolf Point	379	2003	8/9/2004	Yearling	PIT Tag	Elastomer
2004	Larval Drift	30000	2004	7/2/2004	Fry		

Year	Stocking Site	Number Stocked	Year Class	Stock Date	Age at Stocking ^a	Primary Mark	Secondary Mark
2004	Larval Drift	50000	2004	7/8/2004	Fry		
2004	Larval Drift	25000	2004	7/20/2004	Fry		
2004	Larval Drift	25000	2004	7/23/2004	Fry		
2004	Larval Drift	25000	2004	7/27/2004	Fry		
2004	Culbertson	3819	2004	9/10/2004	Fingerling	CWT	Elastomer
2004	Sidney	2991	2004	9/10/2004	Fingerling	CWT	Elastomer
2004	Wolf Point	4040	2004	9/10/2004	Fingerling	CWT	Elastomer
					Advanced		
2004	Mouth of Milk	3482	2004	10/15/2004	Fingerling	CWT	Elastomer
					Advanced		
2004	Intake	2477	2004	11/18/2004	Fingerling	CWT	Elastomer
2005	Culbertson	288	2004	4/12/2005	Yearling	CWT	Elastomer
2005	Intake	309	2004	4/12/2005	Yearling	CWT	Elastomer
2005	Wolf Point	271	2004	4/12/2005	Yearling	CWT	Elastomer
2005	Intake	175	2004	8/19/2005	Yearling	PIT Tag	Elastomer
					Advanced		
2005	Brockton	229	2005	10/5/2005	Fingerling	CWT	Elastomer
					Advanced		
2005	Culbertson	226	2005	10/5/2005	Fingerling	CWT	Elastomer
					Advanced		
2005	Intake	456	2005	10/5/2005	Fingerling	CWT	Elastomer
					Advanced		
2005	Milk River	232	2005	10/5/2005	Fingerling	CWT	Elastomer
					Advanced		
2005	Sidney	122	2005	10/5/2005	Fingerling	CWT	Elastomer
					Advanced		
2005	Wolf Point	611	2005	10/12/2005	Fingerling	CWT	Elastomer
					Advanced		
2005	Brockton	371	2005	10/13/2005	fingerling		
					Advanced		
2005	Culbertson	1736	2005	10/13/2005	Fingerling	CWT	Elastomer
					Advanced		
2005	Culbertson	182	2005	10/13/2005	Fingerling		
					Advanced		
2005	Intake	313	2005	10/13/2005	Fingerling		
					Advanced		
2005	Milk River	845	2005	10/13/2005	Fingerling	CWT	Elastomer
					Advanced		
2005	Mouth of Milk	371	2005	10/13/2005	Fingerling		
2005	Sidney	105	2005	10/13/2005	Advanced		

Year	Stocking Site	Number Stocked	Year Class	Stock Date	Age at Stocking ^a	Primary Mark	Secondary Mark
					Fingerling		
2005	Wolf Point	1521	2005	10/13/2005	Advanced Fingerling	CWT	Elastomer
2005	Wolf Point	371	2005	10/13/2005	Advanced Fingerling		
2005	Culbertson	651	2005	10/19/2005	Advanced Fingerling	CWT	Elastomer
2005	Intake	2120	2005	10/19/2005	Advanced Fingerling	CWT	Elastomer
2005	Milk River	485	2005	10/19/2005	Advanced Fingerling	CWT	Elastomer
2005	Sidney	882	2005	10/19/2005	Advanced Fingerling	CWT	Elastomer
2005	Wolf Point	650	2005	10/19/2005	Advanced Fingerling	CWT	Elastomer
2006	Culbertson	235	2005	3/28/2006	Advanced Fingerling	Elastomer	
2006	Intake	327	2005	3/28/2006	Advanced Fingerling	Elastomer	
2006	Mouth of Milk	134	2005	3/28/2006	Advanced fingerling	Elastomer	
2006	Sidney	113	2005	3/28/2006	Advanced Fingerling	Elastomer	
2006	Wolf Point	232	2005	3/28/2006	Advanced Fingerling	Elastomer	
2006	Intake	970	2005	4/3/2006	Yearling	PIT Tag	Elastomer
2006	Sidney	314	2005	4/3/2006	Yearling	PIT Tag	Elastomer
2006	Culbertson	844	2005	4/5/2006	Yearling	PIT Tag	Elastomer
2006	Mouth of Milk	1007	2005	4/5/2006	Yearling	PIT Tag	Elastomer
2006	Wolf Point	866	2005	4/5/2006	Yearling	PIT Tag	Elastomer
2006	Culbertson	669	2005	5/1/2006	Yearling	PIT Tag	Scute Removed
2006	Intake	765	2005	5/1/2006	Yearling	PIT Tag	Scute Removed
2006	Mouth of Milk	650	2005	5/1/2006	Yearling	PIT Tag	Scute Removed
2006	Sidney	228	2005	5/1/2006	Yearling	PIT Tag	Scute Removed
2006	Wolf Point	653	2005	5/1/2006	Yearling	PIT Tag	Scute Removed
2006		1355	2005	5/1/2006	Yearling	PIT Tag	Scute Removed
2006	Culbertson	1544	2006	10/24/2006	Advanced Fingerling	Elastomer	
2006	Intake	1680	2006	10/24/2006	Advanced Fingerling	Elastomer	

Year	Stocking Site	Number Stocked	Year Class	Stock Date	Age at Stocking ^a	Primary Mark	Secondary Mark
2006	Mouth Milk	1117	2006	10/24/2006	Advanced Fingerling	Elastomer	
2006	Sidney	586	2006	10/24/2006	Advanced Fingerling	Elastomer	
2006	Wolf Point	1553	2006	10/24/2006	Advanced Fingerling	Elastomer	
2006	School Trust	436	2006	11/8/2006	Advanced Fingerling	Elastomer	

^aAge of fish when stocked: Fry, Fingerling, Yearling, 1yo, 2yo, 3yo, etc...

Appendix G. Hatchery names, locations, and abbreviations.

Hatchery	State	Abbreviation
Blind Pony State Fish Hatchery	MO	BYP
Neosho National Fish Hatchery	MO	NEO
Gavins Point National Fish Hatchery	SD	GAV
Garrison Dam National Fish Hatchery	ND	GAR
Miles City State Fish Hatchery	MT	MCH
Blue Water State Fish Hatchery	MT	BLU
Bozeman Fish Technology Center	MT	BFT
Fort Peck State Fish Hatchery	MT	FPH