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 platorynchus* 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 *Oncorhnchus mykiss,* lake whitefish *Coregonus clupeaformisI,* and cisco *C. artedi* 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 platorynchus*, 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 nephelometeric 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 cm^2) 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.

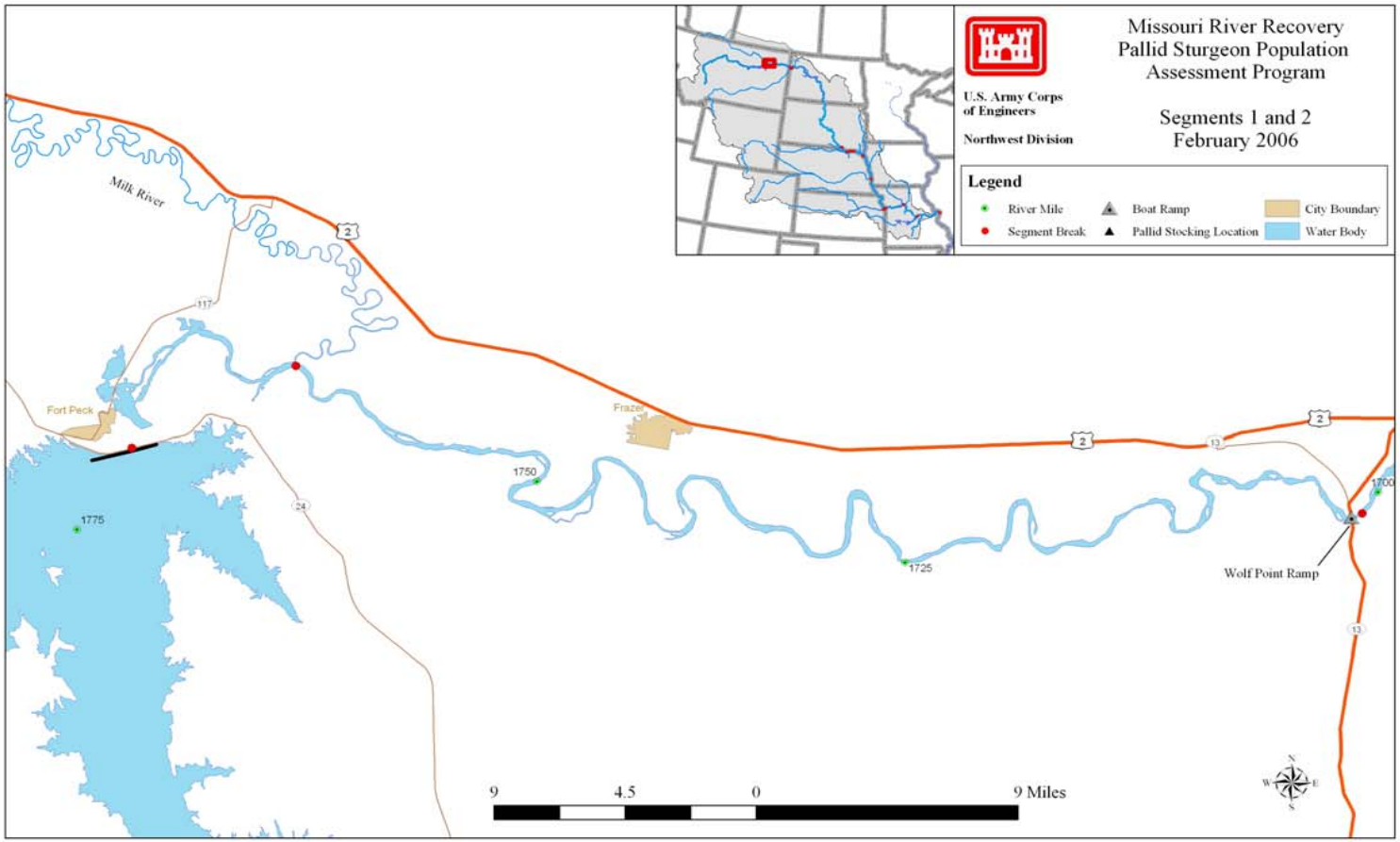

Figure 1a. Map of segment 1 of the Missouri River with major tributaries, common landmarks, and historic stocking locations for pallid sturgeon. Segment 1 encompasses the Missouri River from Fort Peck Dam (River Mile 1771.5) to the mouth of the Milk River (River Mile 1760.0).

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 m^2 (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.

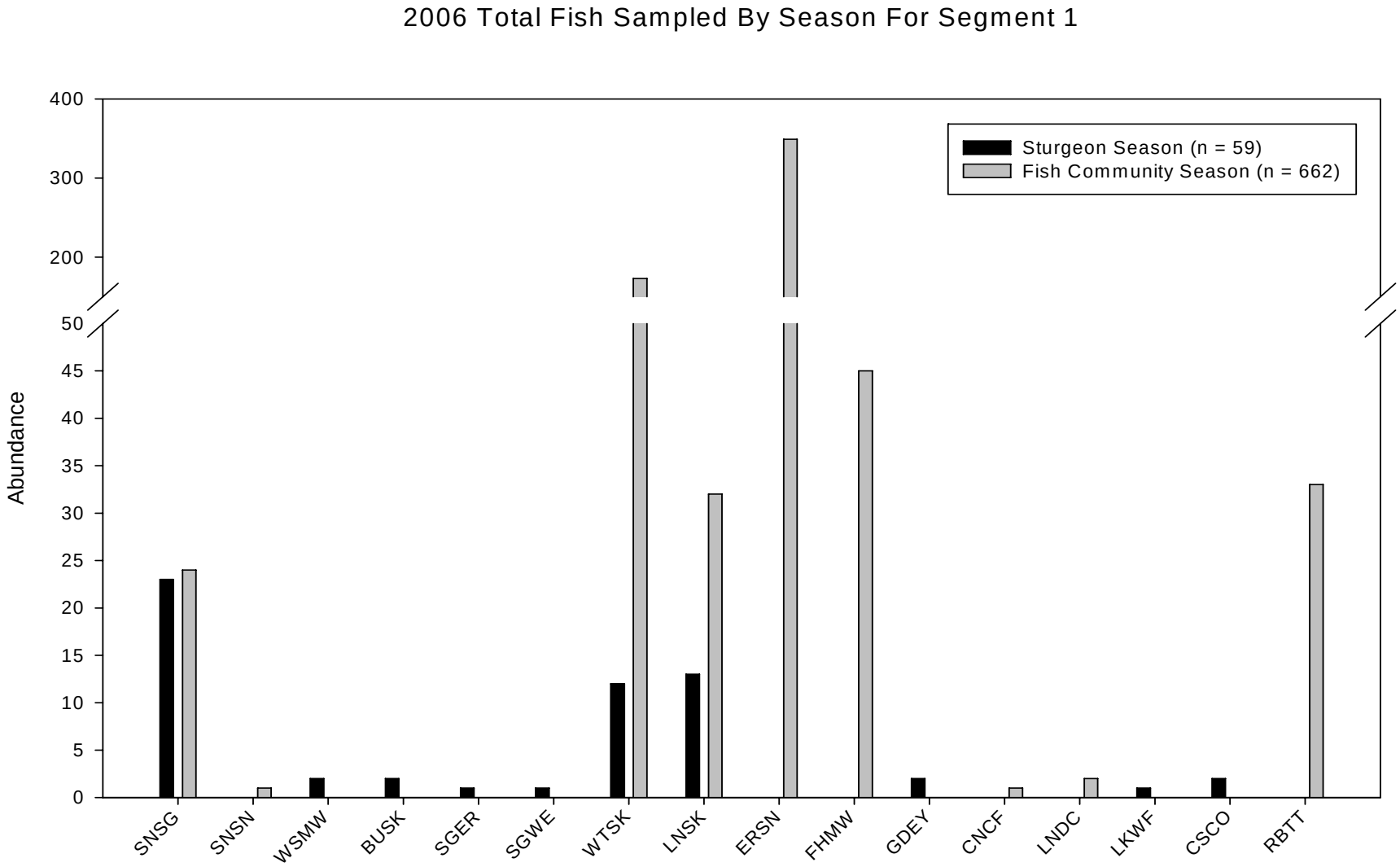

Figure 1b. Total number of fish sampled in segment 1 of the Missouri River during 2006. Note the break in the Y-axis and the difference in scale above and below the break.

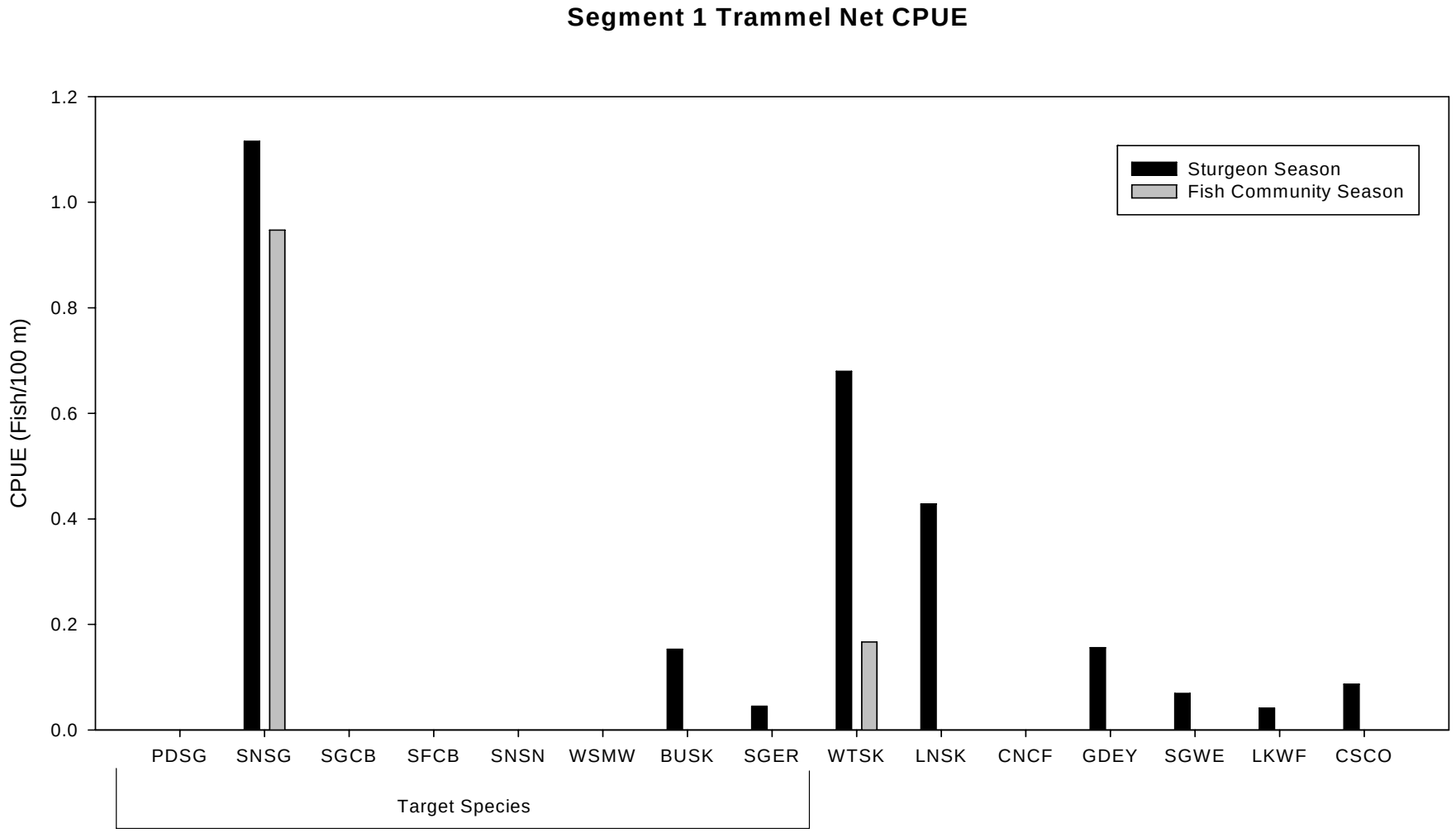

Figure 2. Trammel net CPUE by season for all target species and non-target species sampled in segment 1 of the Missouri River during 2006. Target species are indicated by the bracket below the X-axis.

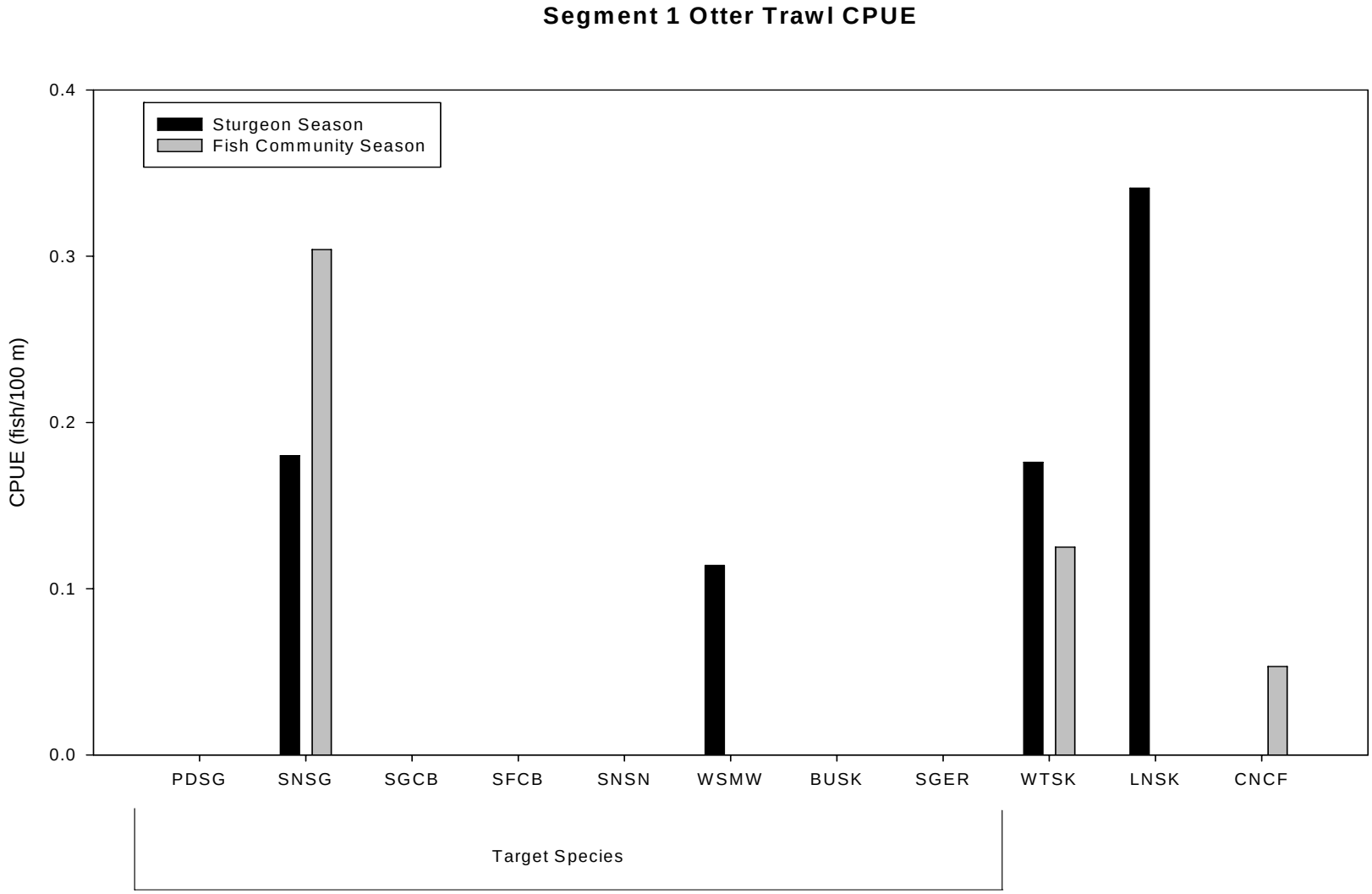

Figure 3. Otter trawl CPUE by season for all target species and non-target species sampled in segment 1 of the Missouri River during 2006. Target species are indicated by the bracket below the X-axis.

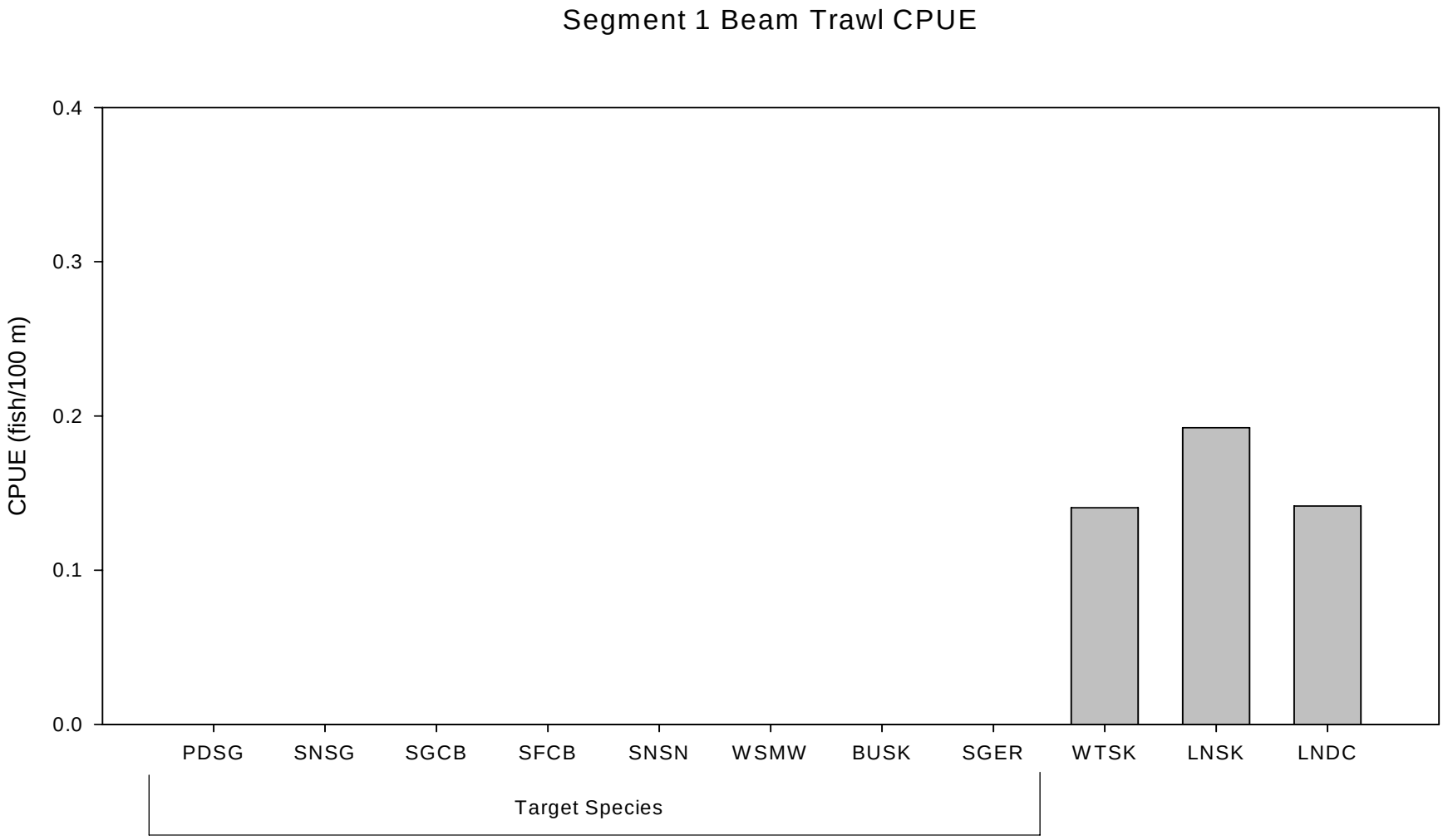

Figure 4. Beam trawl CPUE for all target species and non-target species sampled during the fish community season in segment 1 of the Missouri River during 2006. Target species are indicated by the bracket below the X-axis.

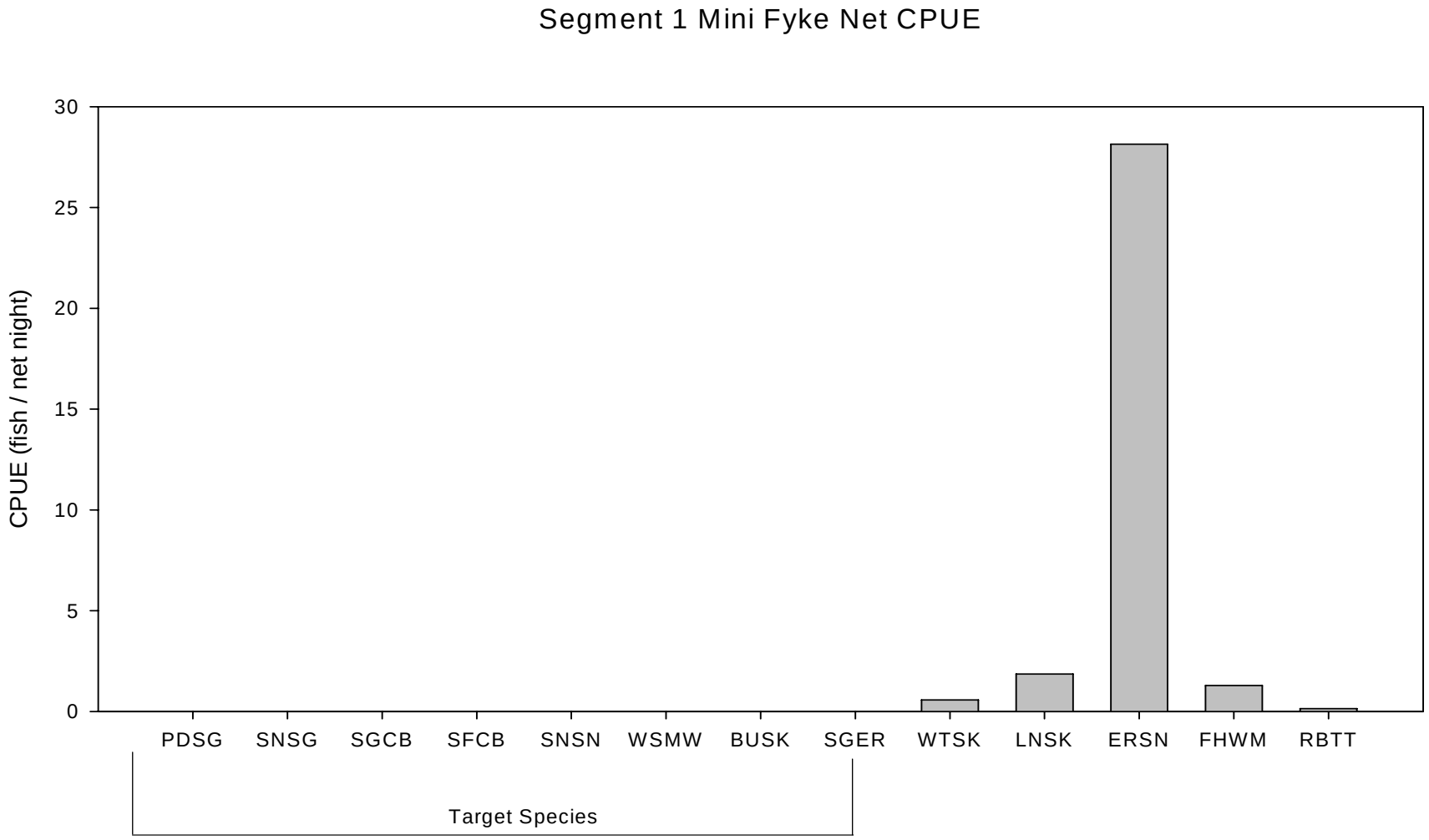

Figure 5. Mini fyke net CPUE for all target species and non-target species sampled during the fish community season in segment 1 of the Missouri River during 2006. Target species are indicated by the bracket below the X-axis.

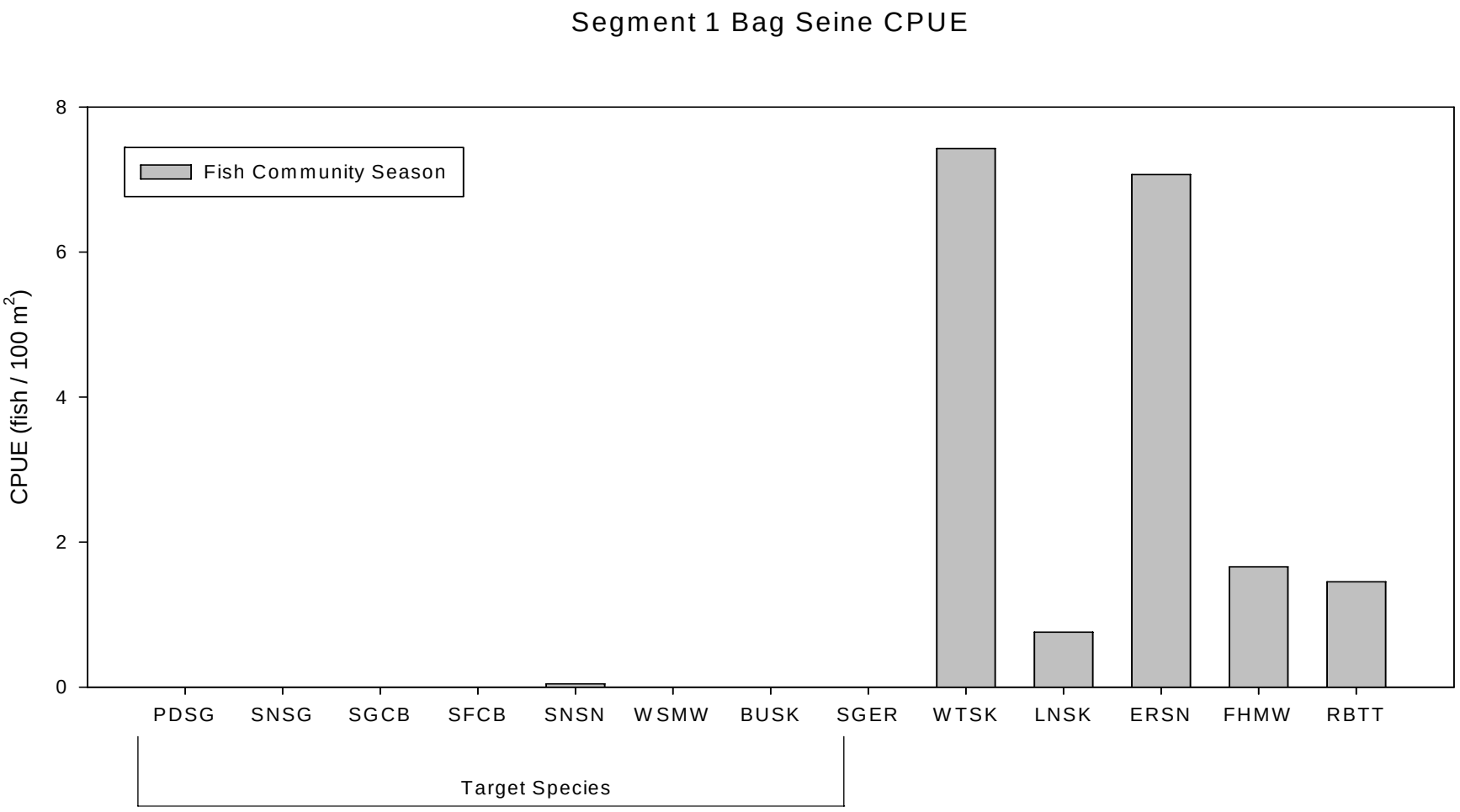

Figure 6. Bag seine CPUE for all target species and non-target species sampled during the fish community season in segment 1 of the Missouri River during 2006. Target species are indicated by the bracket below the X-axis.

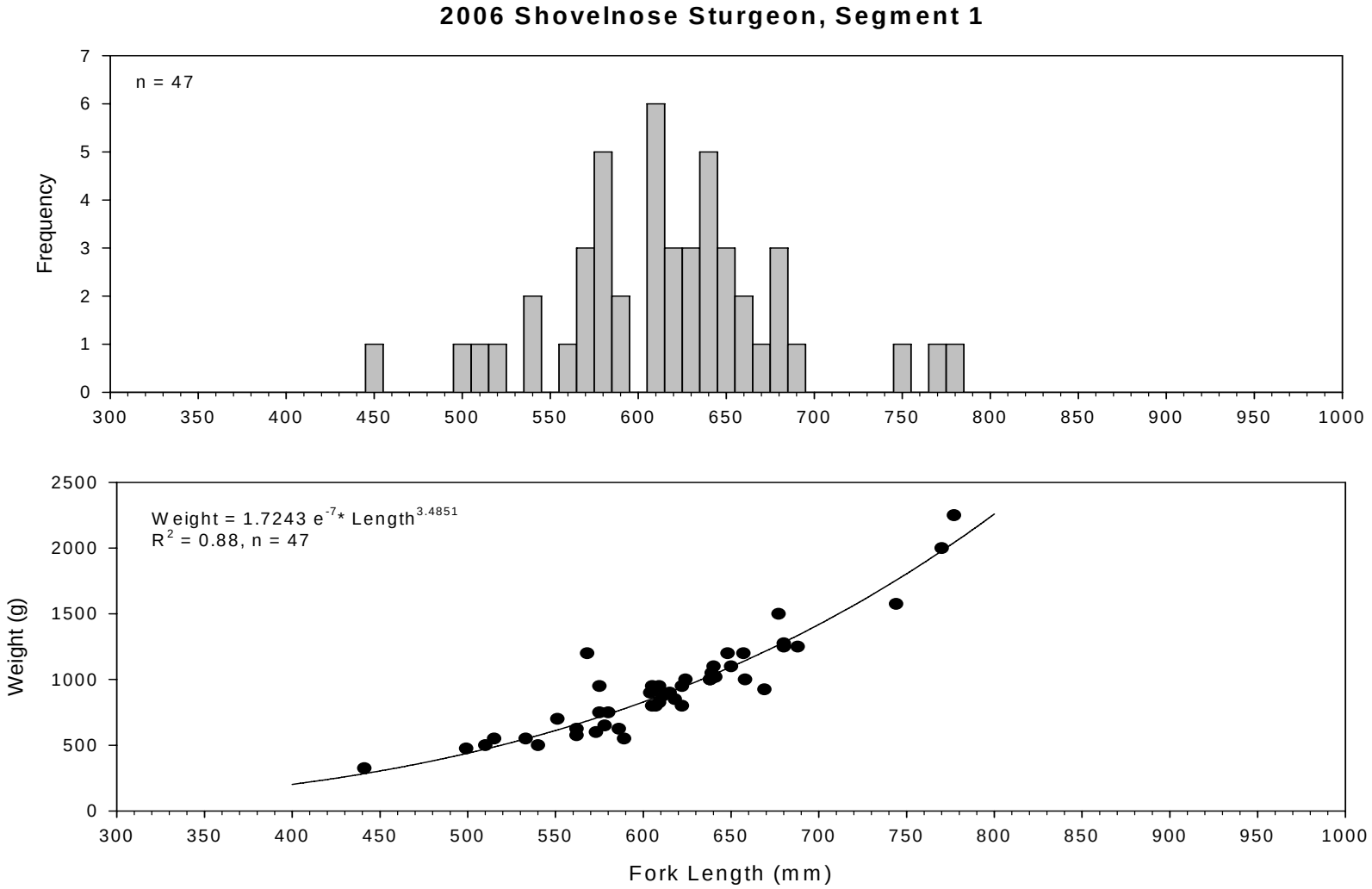

Figure 7. Top panel represents a length frequency histogram for all shovelnose sturgeon sampled in Segment 1 during 2006. Bottom panel represents the weight-length relationship for all shovelnose sturgeon sampled in Segment 1 during 2006. The two-parameter power function and sample sizes are given.

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 vitreas* 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^o 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^o, 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 ≥ 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 were < 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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References

Drobish, M.R. (editor), 2006. Missouri River Standard Operating Procedures and Data Collection, Volume 1.1. U.S. Army Corps of Engineers, Omaha District, Yankton, S.D.

Galat, D.L., C.R. Berry Jr., E.J. Peters and R.G. White. 2005. Missouri River. Pages 427-480 in A.C. Benke and C.E. Cushing (editors). Rivers of North America, Elesevier, Oxford.

Gardner, W.M. and P.A. Stewart. 1987. The Fishery of the Lower Missouri River. Federal Aid to Fish and Wildlife Restoration Project FW-2-R Job I-b. Montana Fish, Wildlife and Parks. Helena, Montana.

Haddix, T., L. Holte and C. Sampson. 2007(a). Pallid sturgeon population assessment and associated fish monitoring for the Missouri River: Segment 2. Prepared for the U.S. Army Corps of Engineers by Montana Fish, Wildlife & Parks. Fort Peck, MT.

Haddix, T., L. Holte and C. Sampson. 2007(b). Pallid sturgeon population assessment and associated fish monitoring for the Missouri River: Segment 3. Prepared for the U.S. Army Corps of Engineers by Montana Fish, Wildlife & Parks. Fort Peck, MT.

Pierce, C. L., C. S. Guy, P. J. Braaten, and M.A. Pegg. 2004. Fish growth, mortality, recruitment, condition, and size structure. Volume 4. Population structure and habitat use of benthic fishes along the Missouri and lower Yellowstone Rivers. U.S. Geological Survey, Cooperative Research Units, Iowa State University, Ames Iowa.

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

Appendix A. (continued).

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

Appendix A. (continued).

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

Appendix A. (continued).

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

Appendix A. (continued).

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

Appendix A. (continued).

Scientific name	Common name	Letter Code
	Centrarchidae - sunfishes	
L. cyanellus X L. humilis	Green-orangespotted sunfish hybrid	GSOS
L. macrochirus X L. microlophus	Bluegill-redear sunfish hybrid	BGRE
Lepomis spp.	Unidentified *Lepomis*	ULP
Micropterus dolomieu	Smallmouth bass	SMBS
Micropterus punctulatus	Spotted sunfish	STBS
Micropterus salmoides	Largemouth bass	LMBS
Micropterus spp.	Unidentified *Micropterus* spp.	UMC
Pomoxis annularis	White crappie	WTCP
Pomoxis nigromaculatus	Black crappie	BKCP
Pomoxis spp.	Unidentified crappie	UCP
P. annularis X P. nigromaculatus	White-black crappie hybrid	WCBC
Centrarchidae	Unidentified centrarchid	UCN
	Percidae - perches	
Ammocrypta asprella	Crystal darter	CLDR
Etheostoma blennioides	Greenside darter	GSDR
Etheostoma caeruleum	Rainbow darter	RBDR
Etheostoma exile	Iowa darter	IODR
Etheostoma flabellare	Fantail darter	FTDR
Etheostoma gracile	Slough darter	SLDR
Etheostoma microperca	Least darter	LTDR
Etheostoma nigrum	Johnny darter	JYDR
Etheostoma punctulatum	Stippled darter	STPD
Etheostoma spectabile	Orangethroated darter	OTDR
Etheostoma tetrazonum	Missouri saddled darter	MSDR
Etheostoma zonale	Banded darter	BDDR
Etheostoma spp.	Unidentified Etheostoma spp.	UET
Perca flavescens	Yellow perch	YWPH
Percina caprodes	Logperch	LGPH
Percina cymatotaenia	Bluestripe darter	BTDR
Percina evides	Gilt darter	GLDR
Percina maculata	Blackside darter	BSDR
Percina phoxocephala	Slenderhead darter	SHDR
Percina shumardi	River darter	RRDR
Percina spp.	Unidentified Percina spp.	UPN
	Unidentified darter	UDR
Sander canadense	**Sauger**	**SGER***
Sander vitreus	Walleye	WLEY
S. canadense X S. vitreus	Sauger-walley hybrid/Saugeye	SGWE
Sander spp.	Unidentified *Sander* (formerly *Stizostedion*) spp.	UST
	Unidentified Percidae	UPC
	Sciaenidae - drums	
Aplodinotus grunniens	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	Elasomer
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
2004	Mouth of Milk	3482	2004	10/15/2004	Advanced Fingerling	CWT	Elastomer
2004	Intake	2477	2004	11/18/2004	Advanced 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
2005	Brockton	229	2005	10/5/2005	Advanced Fingerling	CWT	Elastomer
2005	Culbertson	226	2005	10/5/2005	Advanced Fingerling	CWT	Elastomer
2005	Intake	456	2005	10/5/2005	Advanced Fingerling	CWT	Elastomer
2005	Milk River	232	2005	10/5/2005	Advanced Fingerling	CWT	Elastomer
2005	Sidney	122	2005	10/5/2005	Advanced Fingerling	CWT	Elastomer
2005	Wolf Point	611	2005	10/12/2005	Advanced Fingerling	CWT	Elastomer
2005	Brockton	371	2005	10/13/2005	Advanced fingerling		
2005	Culbertson	1736	2005	10/13/2005	Advanced Fingerling	CWT	Elastomer
2005	Culbertson	182	2005	10/13/2005	Advanced Fingerling		
2005	Intake	313	2005	10/13/2005	Advanced Fingerling		
2005	Milk River	845	2005	10/13/2005	Advanced Fingerling	CWT	Elastomer
2005	Mouth of Milk	371	2005	10/13/2005	Advanced 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	

[a]Age 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