2011 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

The 2011 Missouri River water year was historic in many ways, including the total amount of water that passed through the system and that the Fort Peck Dam Spillway ran for the first time since 1997. At its peak, the spillway ran at 52,500 cfs, which was accompanied by historically high flows from the Milk River (25,000 cfs) and higher than average flows out of the Fort Peck Dam powerhouse (~13,000). The 13,000 cfs that was being passed through the powerhouse was approximately twice as much discharge as segment 1 has typically had through the past five years of sampling. The large amount of water in the spillway and the Milk River, although downstream of segment 1, created a "backwater" effect that significantly increased the water elevation throughout segment 1. This "backwater" effect created an even higher river stage than would have been observed with just the increase in discharge through the powerhouse alone. Many side channel and shallow water habitats that traditionally occur in segment 1 were inundated with deep water and this likely impacted the efficiency of our gears, as well as the distribution of fishes.

Segment 1 was sampled during both the sturgeon and fish community seasons of the Pallid Sturgeon Population Assessment Program (Program) during 2011. This was the sixth year segment 1 has been sampled according to the Program's Standard Operating Procedures (Welker and Drobish 2011). Segment 1 is used as a reference river bend do to it being the most altered river segment from Fort Peck Dam, MT to the headwaters of Lake Sakakawea, ND. Comparisons made between segment 1 and other less altered segments should allow for inferences to how operations of Fort Peck Dam are affecting the Missouri River downstream.

Although pallid sturgeon *Scaphirynchus albus* have been stocked within 4.5 river miles of segment 1 for four out of the last six years, no pallid sturgeon have been found during sampling. Similarly, only one sturgeon chub *Macrhybopsis gelida* and no sicklefin chub *M. meeki*, two potential prey species for pallid sturgeon have been sampled in segment 1 during the past six years. On the other hand, shovelnose sturgeon *Scaphirynchus platorynchus* and blue suckers *Cycleptus elongates* two other target species have been collected in all six years of sampling segment 1. This was the first year that we did not collect any sand shiners *Notropis stramineus* in our sampling. Other native target species that have been collected in at least one of

the six years of sampling include sauger *Sander canadense* and western silvery minnows *Hybognathus argyritis*. Being the most altered segment in the upper basin, segment 1 hosts a variety of non-native fishes that range from rainbow trout *Oncorhynchus mykiss* to smallmouth bass *Micropterus dolomieu***.** While the cold clear water of the river reach just downstream of Fort Peck Dam is conducive to salmonid species, it is a detriment to native fishes such as pallid sturgeon.

Shovelnose sturgeon have been consistently collected in segment 1 over the past six years of sampling, with trammel nets being the most effective gear. However, trammel net CPUE has been variable, with a high of 4.5 fish/100m during the fish community season of 2009 to a low of 0.05 fish/100m during the sturgeon season of that same year. In 2011, sturgeon season CPUE was 0.26 fish/100m, while the fish community season CPUE was 0.40 fish/100m. Shovelnose sturgeon are relatively abundant in segment 1, however no fish smaller than 450 mm have been collected during the six years of sampling. The population is made up of larger old fish that have slow growth rates, likely due to the year round cold water temperatures.

The high river flows of 2011 likely contributed to the lack of fish that were sampled using mini fyke nets. Only six total fish were sampled with mini fyke nets during 2011, a significant decrease from previous years. In addition, fewer fish were collected using the otter trawl in 2011 than previous years. The lack of fish in these two gears was likely due to the increased flows and therefore reduced gear efficiencies, but could also be related to fishes using different habitats. Sampling in 2012 should give us a better understanding of how the 2011 water years influenced production and possibly the magnitude of entrained fish that came from Fort Peck Reservoir.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

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 (Welker and Drobish 2009). The 2000 Biological Opinion divides the Program area into river and reservoir segments and assigns high, moderate, or low priority management action areas to these segments for pallid sturgeon (Welker and Drobish 2009). 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 the Program sampling in the Missouri River from Fort Peck Dam downstream to its confluence with the Yellowstone River, 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 currents and therefore they are not used in any segment situated in Montana. Trammel nets and otter trawl are standard gears used in segments 1-3 during sturgeon season, and so far appear to be an effective way to sample pallid sturgeon. Trotlines are now a standard gear used in segment 1.

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.

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 canadensis*, 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. Thirdly, we wouldn't expect to see an immediate response in a long-lived species such as the 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 and their habitat are being affected.

Study Area

Segment 1 of the Missouri River begins at Fort Peck Dam and 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 (Welker and Drobish 2011). 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 dominated river. Fort Peck Reservoir has substantially reduced suspended sediment loads 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 (Welker and Drobish 2011), 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 Welker and Drobish (2011). 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. Segment 1 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 Recovery Priority Management Area (RPMA) 2 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.

During 2011 segment 1 was sampled on May 11th during the sturgeon season and October 25th and 31st during the fish community season. Four standard gears were used, trammel net, otter trawl, and trotlines were used during both the sturgeon and fish community seasons and mini-fyke nets during the fish community season.

River flows were substantially great during the spring and summer of 2011 when compared to the previous five sampling years (Figure 2). Record setting winter snowfall and spring rains in the upper basin of the Missouri River contributed to one of the largest runoff years in history. The flows out of the powerhouse during the summer of 2011 were in the 13,000 cfs range, which is about 6,000 cfs more than the previous years that sampling occurred.

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 habitats gears are utilized in and physical measurements taken in accordance with sampling the various gears described below please see Welker and Drobish (2011).

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 is 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.

Trotlines

Trotlines consisted of 32 m nylon rope attached to both upstream and downstream anchors. Octopus style circle hooks were attached to the ropes using 136 kg monofilament line and commercial fishing clips. Twenty 45.7 cm leaders were used on each trotline. Hooks consisted of 2/0 circle hooks. Each trotline used one hook size and each hook size was used at least once in each macrohabitat sampled. Trotlines were baited with night crawlers, and were set overnight then checked the following morning.

Data Collection and Analysis

A minimum of eight random subsamples with each gear were deployed in the reference bend in segment 1. At least two subsamples (when possible) were taken with 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.

All fish were measured to the nearest mm. Fork length (FL) was used for sturgeon species, while other species were measured to TL with one exception, paddlefish *Polyodon spathula*, which were measured from the eye to the fork 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 sets. 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.

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 nets.

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.

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 (2008). 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 Northeast Fishery Center Conservation Genetics Lab for analysis and archiving.

Analyses

The fundamental sampling unit for the Population Assessment Program is the river bend, where sample size is equal to the number of bends sampled. Since only one river bend in Segment 1 is sampled per year, only one true sample was taken. Therefore, all CPUE data for Segment 1 are the averages of all subsamples and no error is associated with these estimates.

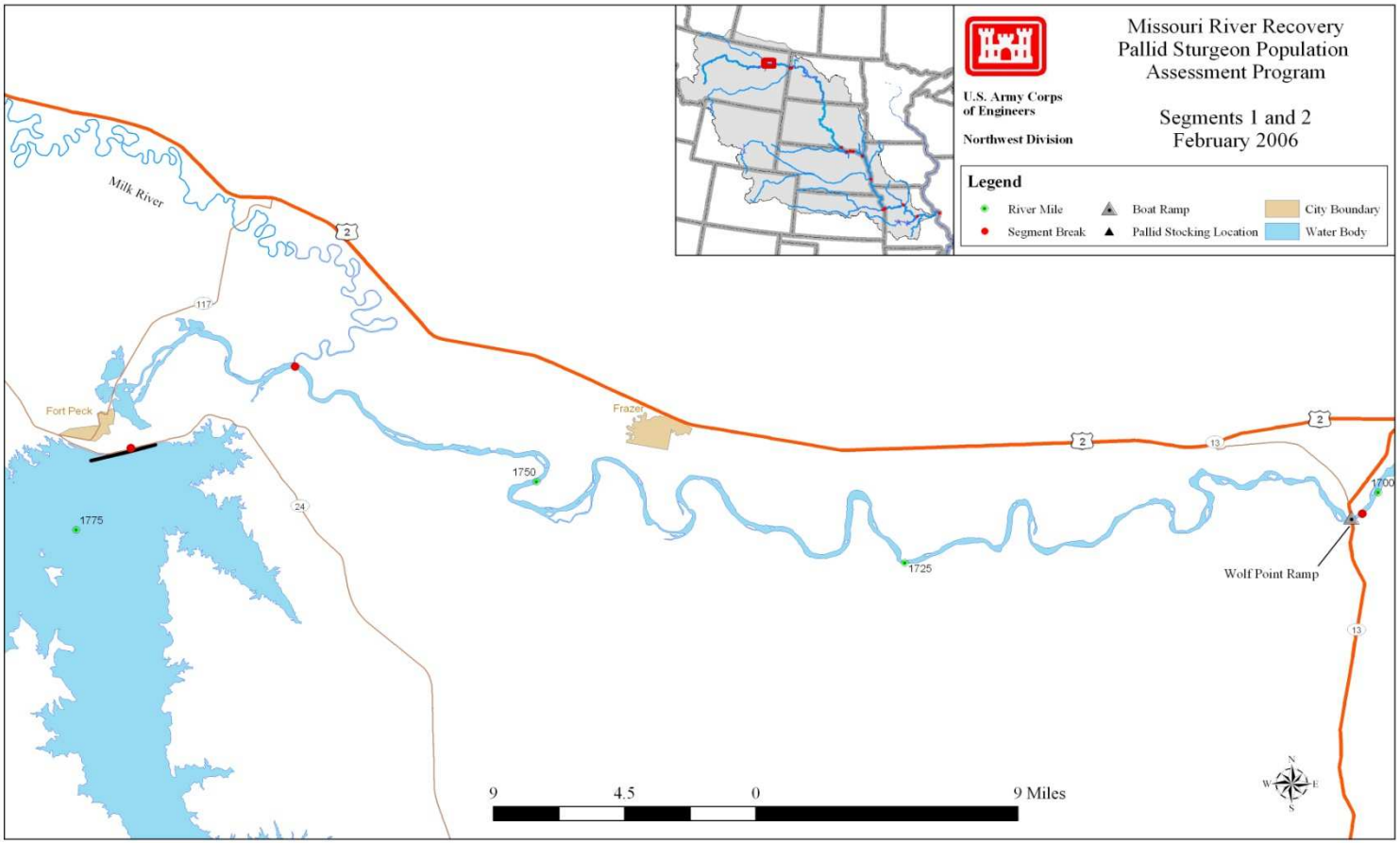

Figure 1. Map of segment 1 of the Missouri River with major tributaries, common landmarks, and historic stocking locations for pallid sturgeon. Segment 1 encompasses the Missouri River from Fort Peck Dam (River Mile 1771.5) to the mouth of the Milk River (River Mile 1760.0).

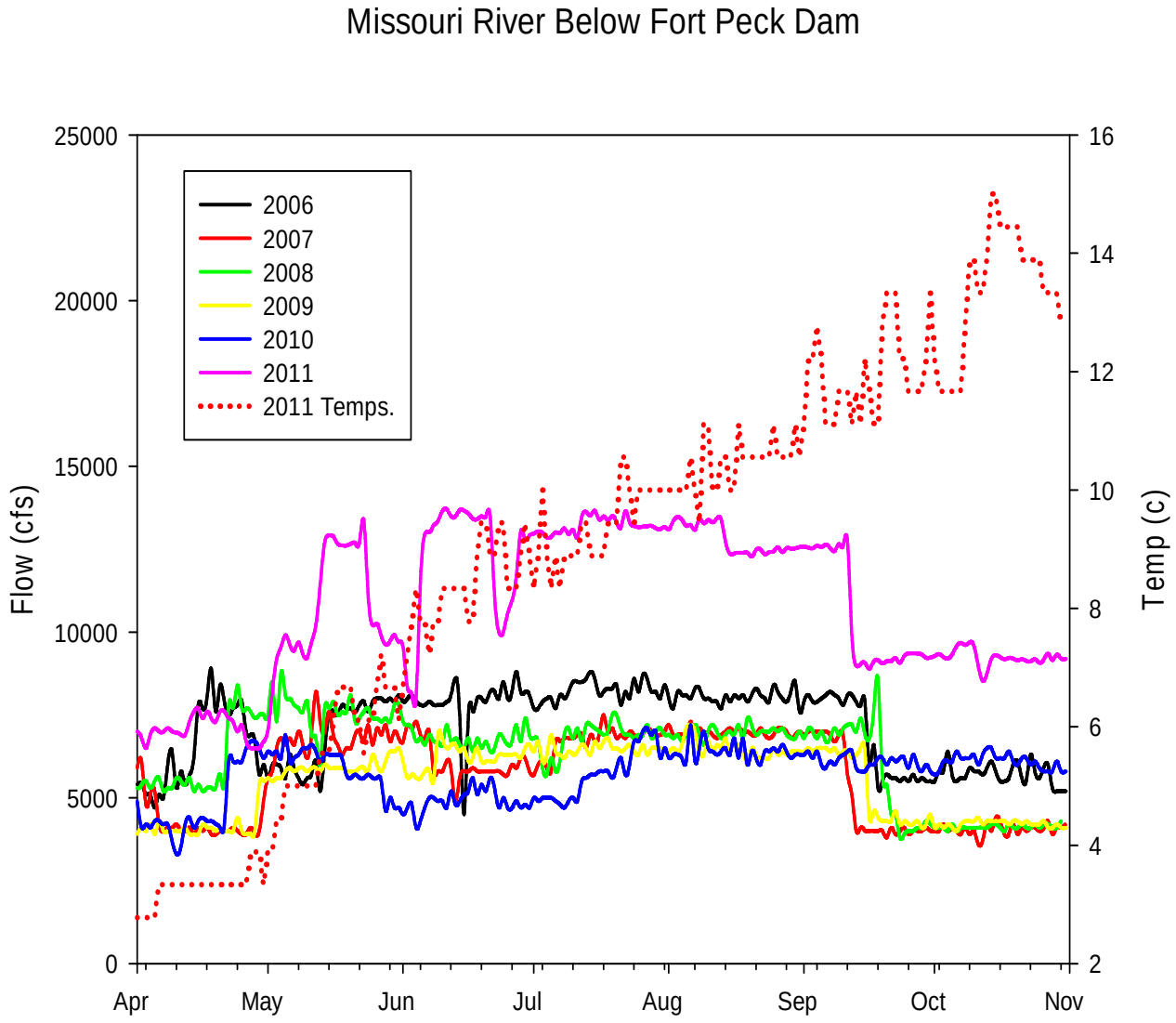

Figure 2. Discharge and temperature data for Segment 1 of the Missouri River from 2006 through 2011.

Results

Pallid Sturgeon

No pallid sturgeon or pallid sturgeon x shovelnose sturgeon hybrids were collected in segment 1 of the Missouri River during 2011. This was the sixth year of sampling where no pallid sturgeon were sampled.

Targeted Native River Species

Shovelnose Sturgeon

A total of 32 shovelnose sturgeon were sampled in segment 1 during 2011, 12 during the sturgeon and 20 during the fish community seasons. During the sturgeon season, 11 shovelnose sturgeon were sampled with trammel nets (Figure 3) while 1 was sampled with trotlines (Figure 4). Of the 20 shovelnose sturgeon sampled during the fish community season, trammel nets captured five, while otter trawls sampled one (Figure 6), and trotlines sampled 14.

Although trammel net CPUE for shovelnose sturgeon was lower in 2011 during the sturgeon season when compared to 2010, the differences were slight. Conversely, trammel net CPUE was slightly higher during the fish community season when compared to 2010, but again with minimal overall difference.

Shovelnose sturgeon have been the most abundant fish captured using trotlines during the sturgeon season for the past four years (Figure 4). However, shovelnose CPUE during the sturgeon season has decreased in every year since 2009. We have only sampled with trotlines during the fish community season the past two years and during both years CPUE was lower than that of the sturgeon season.

Few, shovelnose sturgeon have been captured in the otter trawl over the past six years (Figure 5). This is likely due to the fact that no shovelnose smaller than 450 mm have been captured in any gear (Figure 6).

The size structure of shovelnose sturgeon sampled in segment 1 during both seasons has not changed appreciably over the last six sampling seasons (Figure 6). Furthermore, no juvenile shovelnose sturgeon have been captured in any gear over the past six years of sampling. In addition to the size structure remaining very similar between years, the length to weight relationship of shovelnose sturgeon has also not changed significantly since 2006 (Figure 9).

Sturgeon Chub

No sturgeon chubs were collected in Segment 1 during sampling in 2011. Only one sturgeon chub has been collected to date in segment 1 through six years of sampling and that fish was collected in the otter trawl during 2010 (Figure 5).

Sicklefin Chub

No sicklefin chubs have been collected through six years of sampling Segment 1.

Sand Shiner

This was only the second year out of the six years of sampling that no sand shiners were sampled in segment 1, the other year being 2006 (Figure 8).

Western Silvery Minnow

No western silvery minnows were collected in 2011 in segment 1. Western silvery minnows have only been collected in two out of the six years of sampling, with over three fish per net night in 2008 and just over one per net night in 2010 (Figure 8).

Blue Sucker

Three adult blue suckers were sampled with trammel nets during the fish community season in 2011 (Figure 3). Blue suckers have been sampled every year in segment 1, although in very low numbers. Based on aging of blue suckers downstream of Gavins Point Dam, these fish are likely older than age 7 (Labay et al. 2008).

Sauger

No sauger were sampled in segment 1 during either the sturgeon or fish community seasons. Very few sauger have been sampled in segment 1 in the past five years (Figure 3).

Missouri River Fish Community

A total of 95 fishes consisting of 14 different species were collected in segment 1 during 2011 standard sampling. This was the lowest number of total fish and species captured in six years of sampling. Slightly more than half of the fish collected were sampled during the fish community season (n = 55) compared to the sturgeon season (n = 40). Of the fish collected in the sturgeon season, 34 were sampled on trammel nets, 5 with trotlines, and while 1 fish was sampled in the otter trawl. During the fish community season, the majority of fishes (n = 26) were sampled with trotlines, while 19 were sampled with trammel nets, 6 in mini fyke nets and 4 with otter trawls. White suckers *Catostomus commersoni* made up the largest proportion of the total catch of segment 1 during 2011 with 35 samples, the next most abundant species included shovelnose sturgeon *Scaphirhynchus platorynchus* (n = 32), longnose suckers *Catostomus catostomus* (n=9), and 11 other species making up the remaining 19 specimens. Lake trout *Salvelinus namaycush* and Cisco *Coregonus artedi* were sampled for the first time in six years during 2011.

Discussion

Segment 1 of the Missouri River is a highly altered segment due to the proximity of Fort Peck Dam. Fort Peck Dam, a hypolimnetic withdraw structure, is located approximately five river miles upstream of segment 1, which creates cold summer water temperatures and low suspended sediment loads. During the sturgeon season of 2011, water temperatures averaged 6.0 C^o and water turbidity averaged 3.0 NTU's. During the fish community season, temperature increased to an average of 10.5 C^o, while turbidity increased to 5.7 NTU's. In addition, the benthic substrate of segment 1 is noticeably different than the substrates of downstream segments. Segment 1 is primarily composed of gravel and cobble due to the degrading stream bed, which is at least in part due to the lack of suspended sediments in the water column. River discharge was at a six year high in segment 1 during 2011 (Figure 2), due to high releases at the Fort Peck Dam powerhouse. Flows of 13,000 cfs or greater were observed for the majority of the summer. Additionally, due to the Fort Peck spillway running and the large flows from the Milk River, a backwater effect occurred throughout segment 1 where water elevation was substantially higher than it has been in the past sampling years. These increased water elevations

and substantially different flows within the segment likely influence our gears capture efficiency, which makes CPUE comparisons more difficult.

No pallid sturgeon have been sampled in segment 1 from 2006 through 2011, despite continuous stocking from 2004 to 2008 in the confluence area of the Milk and Missouri Rivers. Data have indicated that at least some stocked pallid sturgeon from all other stockings sites in segments 2 and 3 do move upstream. This behavior has not been seen to date with the school trust or mouth of Milk River stocking locations. A recent telemetry study indicated lower survival rates from the upstream stocking sites in the Missouri River (Montana Fish, Wildlife & Parks, Unpublished Data). These lower survival rates could be one reason why no pallid sturgeon have been sampled in segment 1. However, during both 2011 and 2010 when the Milk River had increased flow, crews did capture juvenile pallid sturgeon in the lower sections of the Milk River, which is just downstream of segment 1.

Even with the highly altered conditions of segment 1, many native species are still occupying the habitats of this segment. However, during the past six years of sampling, a total of 10 non-native species have been found in segment 1 including, common carp *Cyprinus carpio*, rainbow trout *Onchorhyncus mykiss*, brown trout *Salmo trutta*, lake trout *Salvelinus namaycush*, lake whitefish *Coregonus clupeaformis*, ciscoe *C. artedi*, spottail shiner *Notropis hudsonius*, smallmouth bass *Micropterus dolomieu*, and yellow perch (Table 1).

The CPUE of shovelnose sturgeon in segment 1 continues to be variable (Figure 3 and 4). This was the lowest overall trammel net CPUE for shovelnose sturgeon observed in six years of sampling. In addition, trotline CPUE was at a four year low in 2011. Nevertheless, since only eight subsamples are taken during each season, catch is variable and little conclusions can be drawn from the CPUE data. More importantly is the consistency in the size distribution of shovelnose in segment 1. No shovelnose under 450 mm have been collected in six years of sampling, which indicates the population is made up of older fish and little to no juvenile rearing is occurring in the area. Past telemetry studies have also shown that the shovelnose sturgeon population in segment 1 is a resident population of fish that do not migrate far. These fish do not appear to be spawning since we don't collect any black egged females in the spring or early summer, as we do in the lower parts of segment 3. Tagging information has also shown that adult shovelnose in segment 1 either do not grow or grow at a very slow rate. Individuals that have been recaptured after 20 years at large often are the same size as they were when they were tagged.

Adult blue sucker have been captured in segment 1 during all six sampling years. Similar to shovelnose sturgeon, these have all been large adult fish. Again, CPUE has been variable, but since so few fish have been captured there does not appear to be any differences in their relative abundance over the sampling years.

Mini fyke nets were less effective in 2011 than the previous five years of sampling. A total of six fish, three white suckers *Catostomus commersoni*, two emerald shiners *Notropis atherinoides* and one spottail shiner were sampled. This was the only the second year that no sand shiners were collected in segment 1. Low catches of all species in the mini fyke nets was likely due to the change in the habitat from the increased flows and higher water elevation in segment 1, making shallow backwater type areas less abundant and therefore mini fyke nets less effective. However, it is possible that the higher flows were beneficial to many of the small bodied cyprinids production and sampling in 2012 under more normal hydrologic conditions will give us an understanding of 2011 production.

Similar to mini fyke nets, the 2011 otter trawl catch was substantially lower than many previous years, with a total of five fish being captured across both sturgeon and fish community seasons (Figure 5). Our sampling efficiency using the otter trawl as well as trammel nets may be very low in segment 1 when compared to portions of segment 2 and segment 3. The very low turbidity of segment 1 waters may reduce our catch rates due to possible net avoidance by some if not all fish species. Waters downstream becomes increasingly turbid where a fish would presumably have a harder time avoiding nets. Although this hasn't been studied for segments 1 through 3, it is likely affecting our CPUE and thus makes direct comparisons between the three areas problematic.

With the historic 2011 Missouri and Milk rivers water year, sampling in all four segments of the Missouri River downstream of Fort Peck Dam during 2012 should be very valuable in understanding how the fish assemblage was affected. Many of our gears were likely less effective during 2011 and with a more normalized water year we are hoping to gather data that will help explain the effects of a very rare water event.

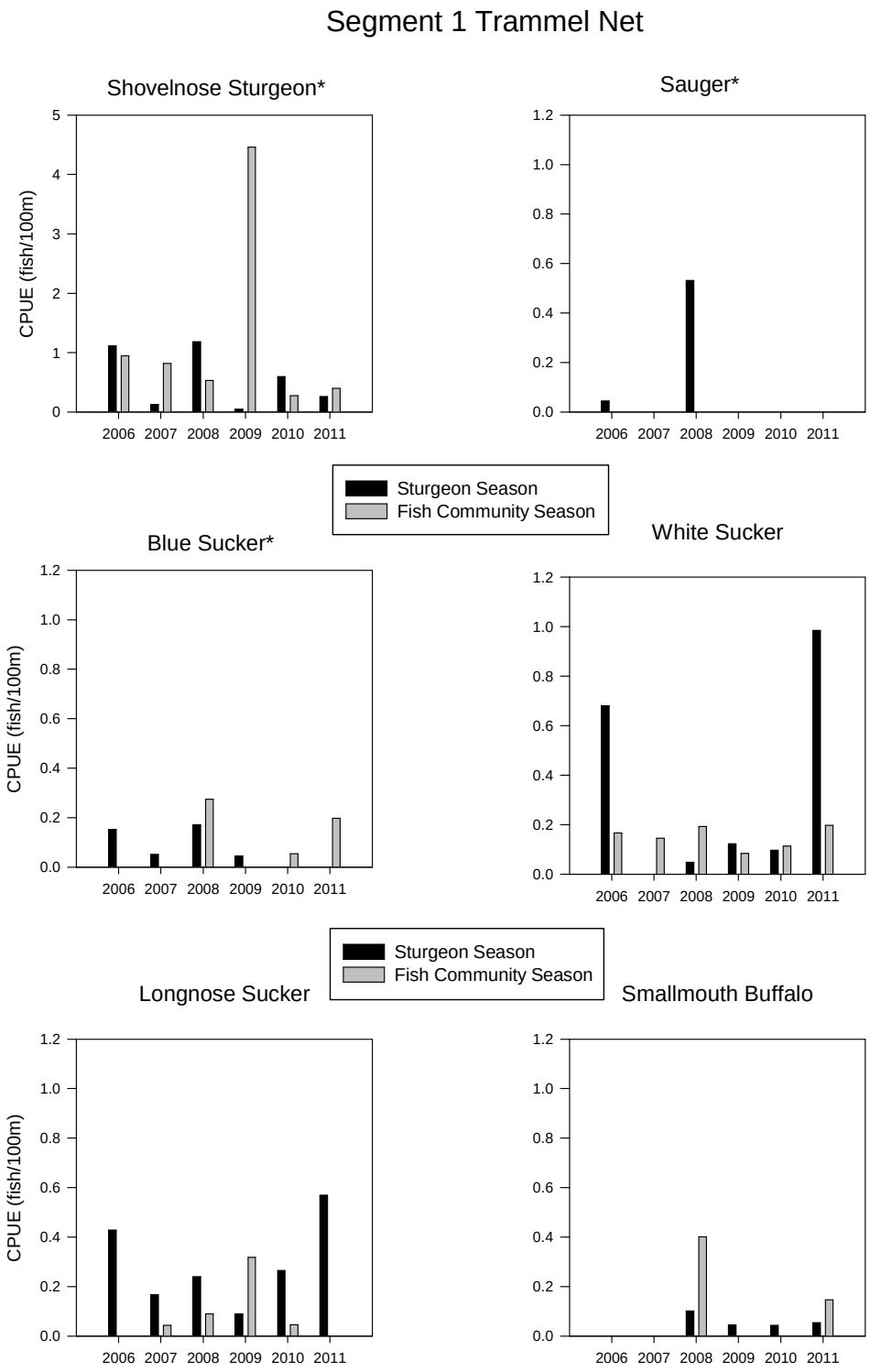

Figure 3. Trammel net CPUE by season for all target species and non-target species sampled in segment 1 of the Missouri River during sturgeon season (Top Panel) and fish community season (Bottom Panel) from 2006 through 2011. Target species are indicated by an asterisk. Note the difference in scale of the Y-axes.

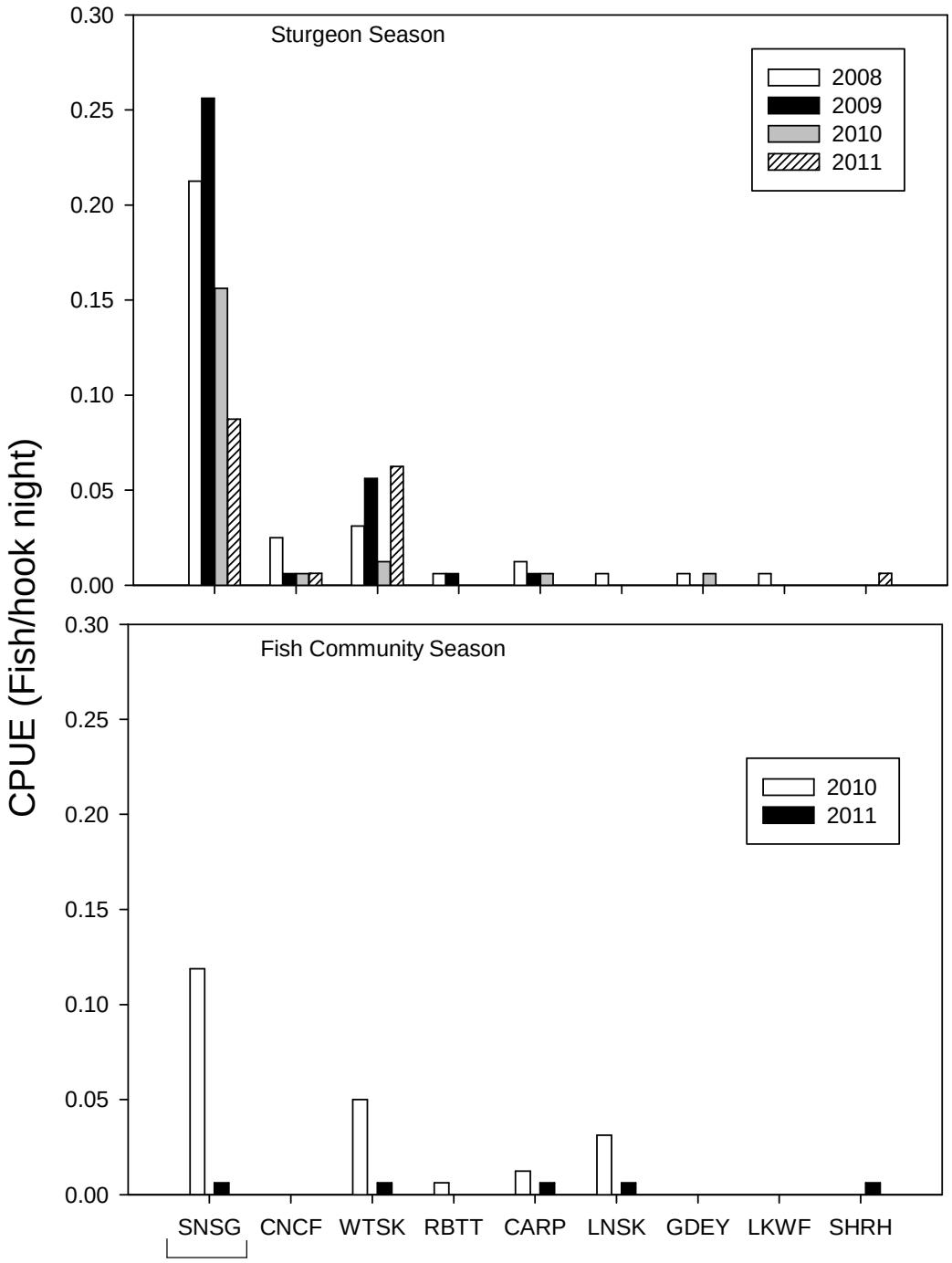

Figure 4. Trotline CPUE for all target and non-target species sampled in the sturgeon season (top panel) from 2008 through 2011, and the fish community season (bottom panel) from 2010 through 2011 in segment 1 of the Missouri River. Target species are indicated by bracket on X-axis.

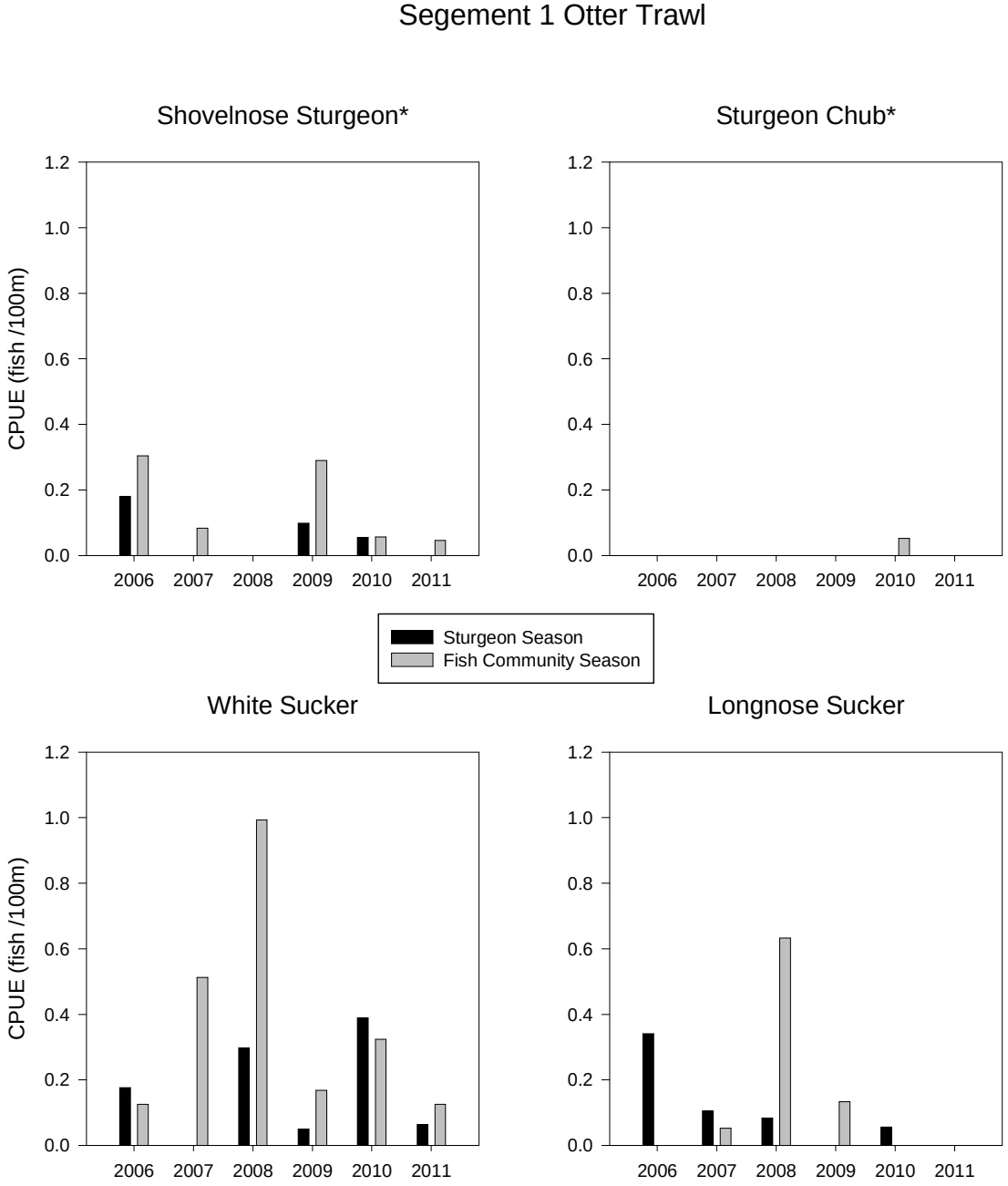

Figure 5. Otter trawl CPUE by season for all target species and non-target species sampled in segment 1 of the Missouri River during sturgeon (Top Panel) and fish community season (Bottom Panel) from 2006 through 2011. Target species are indicated by bracket on X-axis.

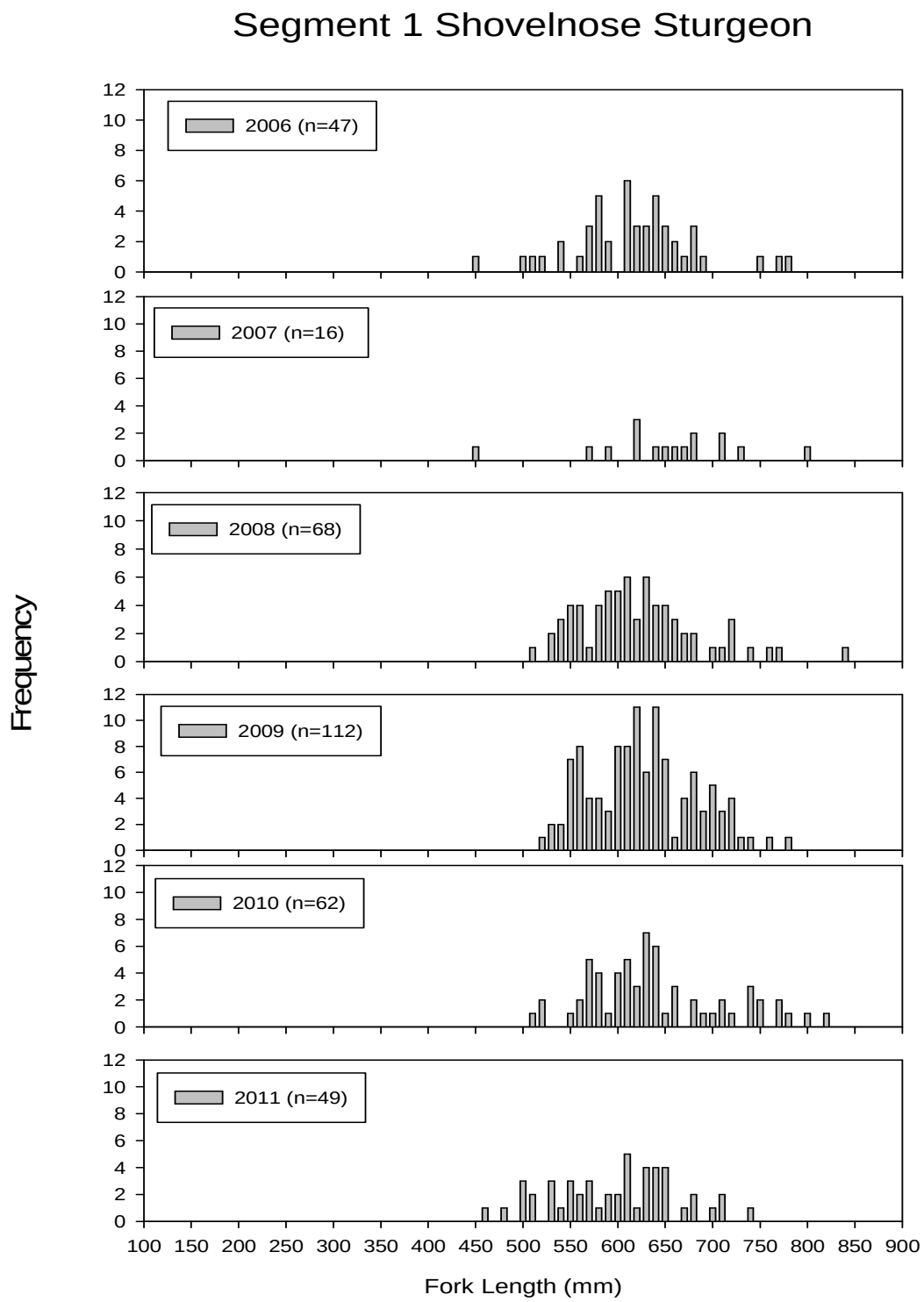

Figure 6. Length frequency histogram for all shovelnose sturgeon sampled in Segment 1 of the Missouri River from 2006 through 2011.

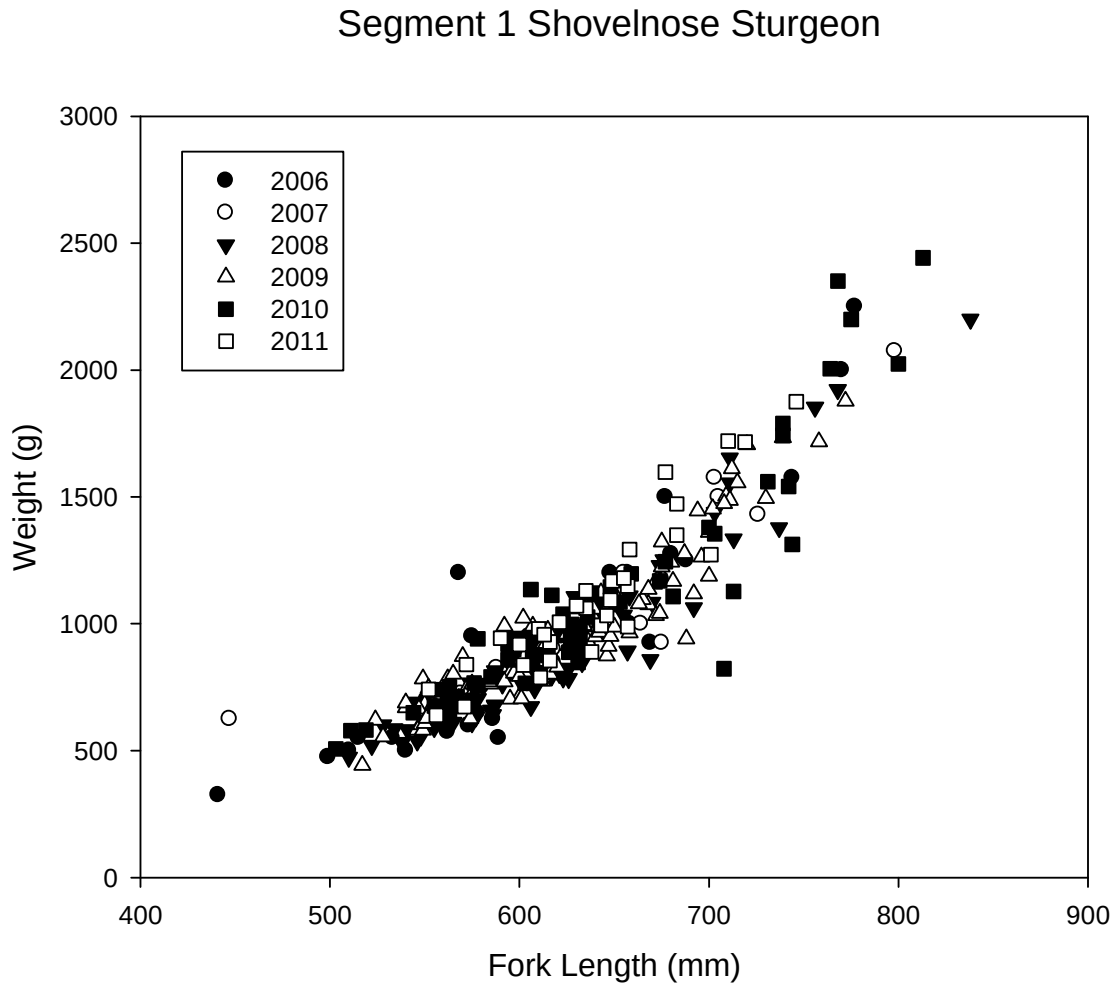

Figure 7. Weight-length relationship for all shovelnose sturgeon sampled in Segment 1 from 2006 through 2011.

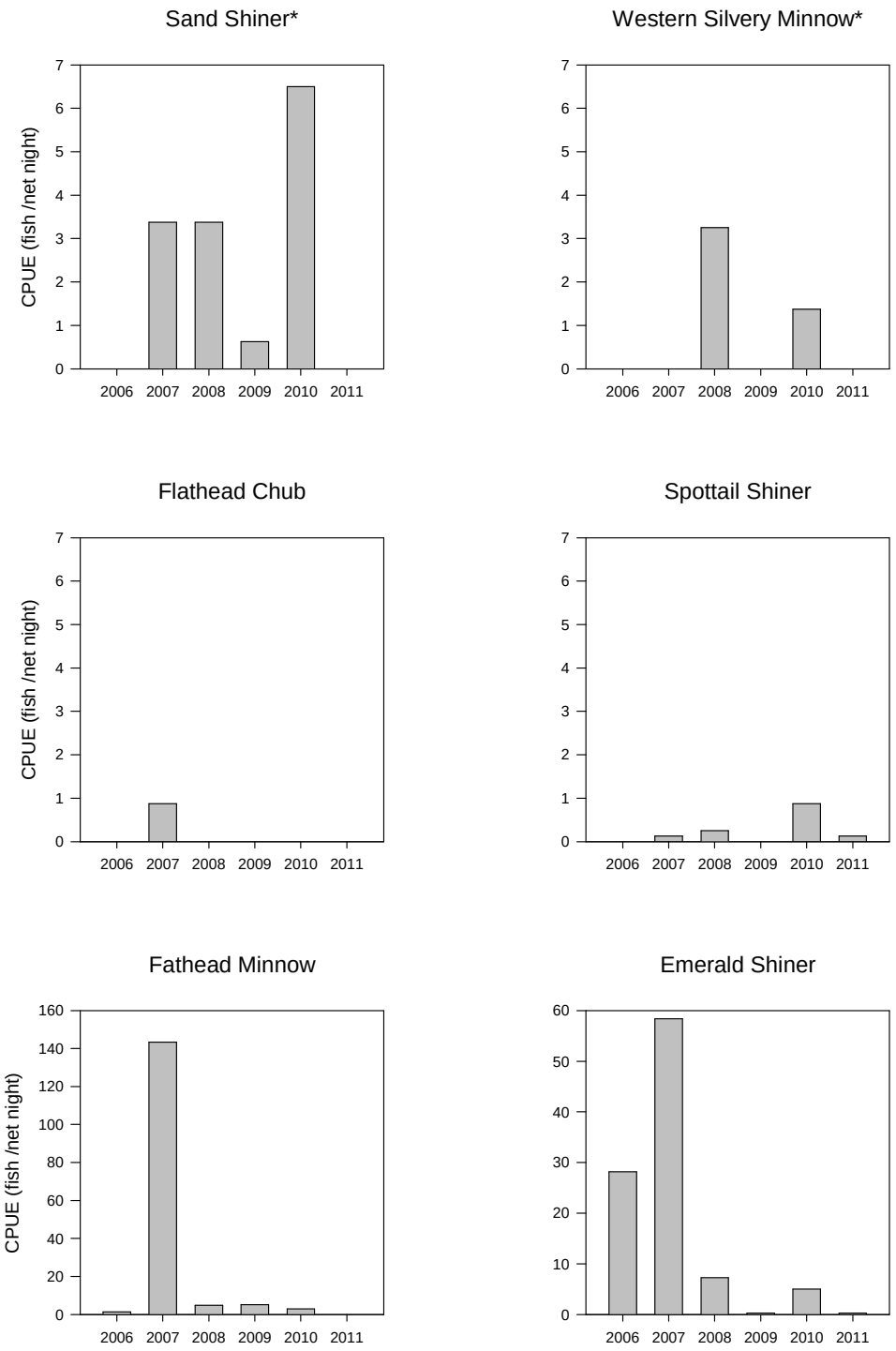

Figure 8. Mini-fyke net CPUE for target and non-target species sampled during the fish community season in segment 1 of the Missouri River from 2006 through 2011. Target species are indicated by asterisks. Note the differences in Y-axes.

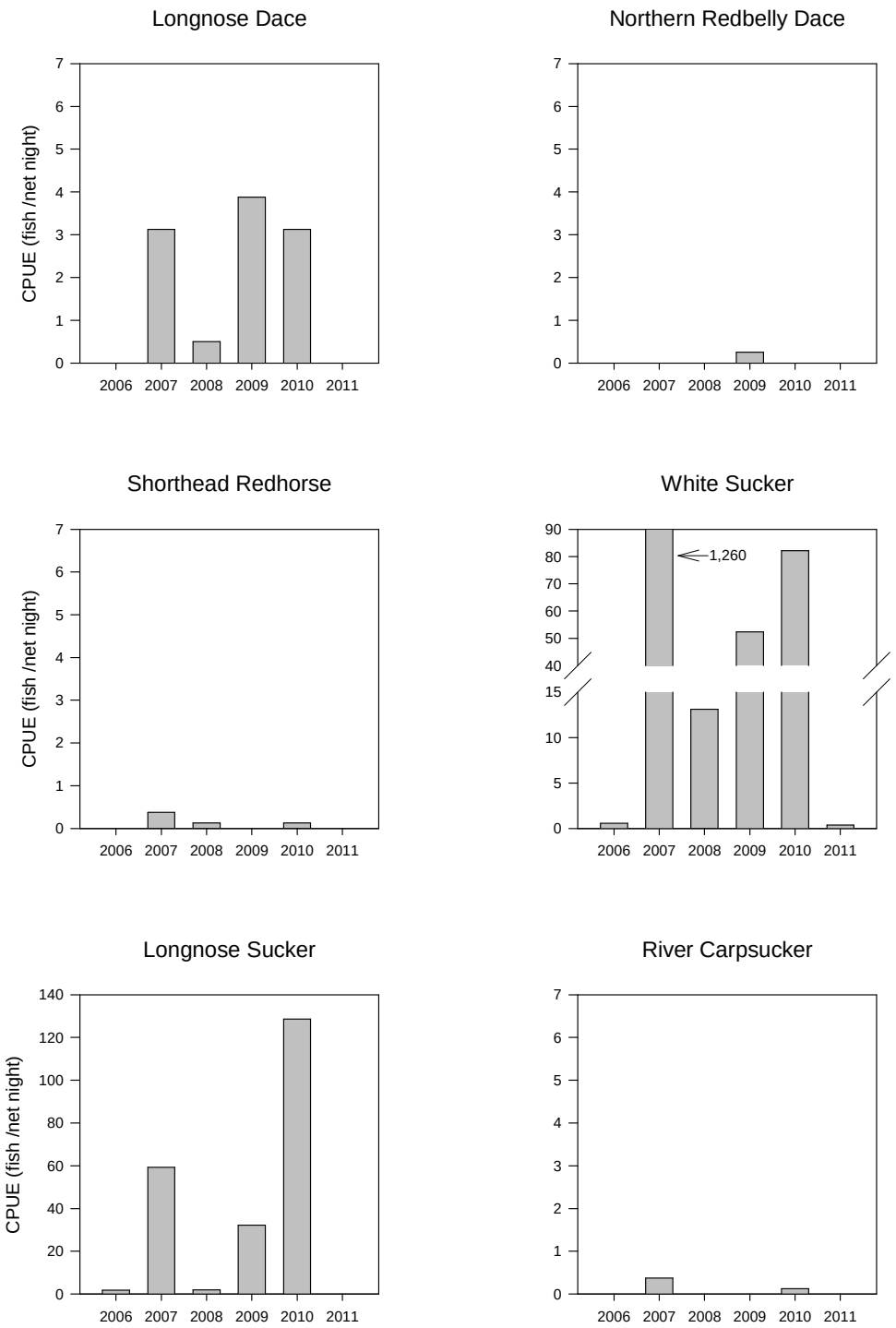

Figure 9. Mini-fyke net CPUE for non-target species sampled during the fish community season in segment 1 of the Missouri River from 2006 through 2011. Note the differences in Y-axes.

Table 1. Presence absence of all species (by common name) collected in segments 1 through 3 in the Missouri River during 2006 through 2011. Boxes marked with an X indicate at least one specimen was sampled. Species in bold are native target species.

	Segments				Segments		
	1	2	3		1	2	3
Ascipenseridae - sturgeons				***Esocidae - pikes***			
Pallid sturgeon		X	X	Northern Pike	X	X	
Shovelnose sturgeon	X	X	X	***Osmeridae - smelts***			
Polyodontidae - paddlefishes				Rainbow smelt			X
Paddlefish		X	X	***Ictaluridae - catfishes***			
Hiodontidae - mooneyes				Channel catfish	X	X	X
Goldeye	X	X	X	Black bullhead		X	X
Cyprinidae - carps and minnows				Yellow bullhead			X
Common Carp	X	X	X	Stonecat		X	X
Flathead chub	X	X	X	***Salmonidae - trouts***			
Emerald shiner	X	X	X	Rainbow trout	X	X	
Lake chub	X			Brown trout	X	X	
Longnose dace	X	X	X	Lake Trout	X		
Northern redbelly dace	X	X	X	Lake whitefish	X		X
Plains minnow		X	X	Cisco	X	X	X
Western silvery minnow	X	X	X	***Gadidae - cods***			
Brassy minnow		X		Burbot	X	X	X
Sicklefin chub		X	X	***Gasterosteidae - sticklebacks***			
Sturgeon chub	X	X	X	Brook stickleback		X	X
Sand shiner	X	X	X	***Centrarchidae - sunfishes***			
Spottail shiner	X	X	X	Green sunfish			X
Fathead minnow	X	X	X	Pumkinseed		X	X
Catostomidae-suckers				White crappie		X	X

	Segments				Segments		
	1	2	3		1	2	3
Bigmouth buffalo		X	X	Smallmouth bass	X		
Smallmouth buffalo	X	X	X	***Percidae - perches***			
Blue sucker	X	X	X	Iowa darter		X	
River carpsucker	X	X	X	Yellow perch	X	X	
White sucker	X	X	X	**Sauger**	X	X	X
Longnose sucker	X	X	X	Walleye	X	X	X
Shorthead redhorse	X	X	X	***Sciaenidae - drums***			
Moronidae-temperate bass				Freshwater drum		X	X
White bass			X	***Lepisosteidae - Gars***			
				Shortnose Gar			X

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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	
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
Carassus auratus	Goldfish	GDFH
Carassus auratus X Cyprinius carpio	Goldfish-Common carp hybrid	GFCC
Couesis 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 vigilas	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 platyrhyncus	Mountain sucker	MTSK
Catastomus spp.	Unidentified *Catastomus* spp.	UCA
Cycleptus elongates	**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
Ameiurusnebulosus	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 nocturnes	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	Bonniville 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 daphanus	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	
Culea 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 punctatus	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 caproides	Logperch	LGPH
Percina cymatotaenia	Bluestripe darter	BTDR
Percina evides	Gilt darter	GLDR
Percina maculate	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
Dendric	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
Dam Tailwaters	Meso	Area below dam	DTWT
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 1 for the long-term pallid sturgeon and associated fish community sampling program. Long-term monitoring began in 2006 for segment 1.

Gear	Code	Type	Season	Years	CPUE units
Gillnet – 4 meshes, small mesh set upstream	GN14	Wild	Sturgeon	NOT USED	fish/net night
Gillnet – 4 meshes, large mesh set upstream	GN41	Wild	Sturgeon	NOT USED	fish/net night
Gillnet – 8 meshes, small mesh set upstream	GN18	Wild	Sturgeon	NOT USED	fish/net night
Gillnet – 8 meshes, large mesh set upstream	GN81	Wild	Sturgeon	NOT USED	fish/net night
Mini-fyke net	MF	Standard	Fish Comm.	2006 - Present	fish/net night
Push Trawl – 8 ft 4mm x 4mm	POT02	Evaluation	Fish Comm.	2006 - 2008	fish/ 100 m trawled
Trammel net – 1 inch inner mesh	TN	Standard	All	2006 - Present	fish/100 m drift
Trot Line – Circle hooks**	TLC1	Experimental	Sturgeon	2007 - 2009	fish/hook night
Trot Line – Circle hooks**	TLC1	Standard	All	2010- present	fish/hook night
Trot Line – Octopus hooks**	TLO_	Wild	Sturgeon	NOT USED	fish/hook night
Trot Line – O'Shaughnessy hooks**	TLS_	Wild	Sturgeon	NOT USED	fish/hook night
Otter trawl – 16 ft head rope	OT16	Standard	All	2006 - Present	fish/100 m trawled
Otter trawl – 16 ft SKT 4mm x 4mm HB2 MOR	OT01	Wild	Fish Comm.	NOT USED	fish/100 m trawled

** Code ends with line length in feet (1 = 105 ft, 2 = 205 ft, 3 = 305 ft, 4 = 405 ft). Hooks are placed between 5 and 10 feet apart.

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

State(s)	RPMA	Site Name	Code	River	RM
MT	2	Forsyth	FOR	Yellowstone	253.2
MT	2	Cartersville	CAR	Yellowstone	235.3
MT	2	Miles City	MIC	Yellowstone	181.8
MT	2	Fallon	FAL	Yellowstone	124
MT	2	Intake	INT	Yellowstone	70
MT	2	Sidney	SID	Yellowstone	31
MT	2	Big Sky Bend	BSB	Yellowstone	17
ND	2	Fairview	FRV	Yellowstone	9
MT	2	Milk River	MLK	Milk	11.5
MT	2	Mouth of Milk	MOM	Missouri	1761.5
MT	2	Grand Champs	GRC	Missouri	1741
MT	2	Wolf Point	WFP	Missouri	1701.5
MT	2	Poplar	POP	Missouri	1649.5
MT	2	Brockton	BRK	Missouri	1678
MT	2	Culbertson	CBS	Missouri	1621
MT	2	Nohly Bridge	NOB	Missouri	1590
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
SD/NE	3	Standing Bear Bridge	STB	Missouri	845
SD/NE	3	Running Water	RNW	Missouri	840.1
SD/NE	4	St. Helena	STH	Missouri	799
SD/NE	4	Mullberry Bend	MUL	Missouri	775
NE/IA	4	Ponca State Park	PSP	Missouri	753
NE/IA	4	Sioux City	SIO	Missouri	732.6
NE/IA	4	Sloan	SLN	Missouri	709
NE/IA	4	Decatur	DCT	Missouri	691
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
KA/MO	4	Leavenworth	LVW	Missouri	397
MO	4	Parkville	PKV	Missouri	377.5
MO	4	Kansas City	KAC	Missouri	342

State(s)	RPMA	Site Name	Code	River	RM
MO	4	Miami	MIA	Missouri	262.8
MO	4	Grand River	GDR	Missouri	250
MO	4	Boonville	BOO	Missouri	195.1
MO	4	Overton	OVT	Missouri	185.1
MO	4	Hartsburg	HAR	Missouri	160
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 pallid sturgeon stocking summary for Segment 2 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

Year	Stocking Site	Number Stocked	Year Class	Stock Date	Age at Stocking[a]	Primary Mark	Secondary Mark
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		
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		
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 Fingerling		
2005	Wolf Point	1521	2005	10/13/2005	Advanced Fingerling	CWT	Elastomer
2005	Wolf Point	371	2005	10/13/2005	Advanced Fingerling		

Year	Stocking Site	Number Stocked	Year Class	Stock Date	Age at Stocking[a]	Primary Mark	Secondary Mark
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	
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	
2007	Culbertson	651	2006	4/5/2007	Yearling	PIT Tag	Scute Removed
2007	Fallon	491	2006	4/3/2007	Yearling	PIT Tag	Scute Removed
2007	Forsyth	492	2006	4/3/2007	Yearling	PIT Tag	Scute Removed
2007	Sidney	983	2006	4/3/2007	Yearling	PIT Tag	Scute Removed
2007	School Trust	639	2006	4/5/2007	Yearling	PIT Tag	Scute Removed

Year	Stocking Site	Number Stocked	Year Class	Stock Date	Age at Stocking[a]	Primary Mark	Secondary Mark
2007	Wolf Point	651	2006	4/5/2007	Yearling	PIT Tag	Scute Removed
2007	Wolf Point	428285	2007	7/9/2007	Fry		
2007	Grand Champs	5558	2007	7/13/2007	Fry		
2007	Miles City	13125	2007	7/18/2007	Fry		
2007	Intake	20763	2007	8/9/2007	Fry		
2007	Miles City	13675	2007	8/9/2007	Fry		
2007	Intake	336	2007	8/27/2007	Fingerling		
2007	Miles City	336	2007	8/27/2007	Fingerling		
2007	Wolf Point	672	2007	8/27/2007	Fingerling		
2007	Forsyth	690	2007	8/31/2007	Fingerling	CWT	
2007	Intake	615	2007	8/31/2007	Fingerling	CWT	
2007	School Trust	1160	2007	9/6/2007	Fingerling	CWT	
2007	Intake	293	2007	9/12/2007	Fingerling		
2007	Miles City	293	2007	9/12/2007	Fingerling		
2007	Wolf Point	586	2007	9/12/2007	Fingerling		
2007	Culbertson	6455	2007	9/14/2007	Fingerling	Elastomer	
2007	Fallon	4827	2007	9/14/2007	Fingerling	Elastomer	
2007	Forsyth	5370	2007	9/14/2007	Fingerling	Elastomer	
2007	Intake	7812	2007	9/14/2007	Fingerling	Elastomer	
2007	School Trust	6096	2007	9/14/2007	Fingerling	Elastomer	
2007	Sidney	1934	2007	9/14/2007	Fingerling	Elastomer	
2007	Wolf Point	6455	2007	9/14/2007	Fingerling	Elastomer	
2008	Culbertson	1384	2007	5/7/2008	Yearling	PIT Tag	Scute Removed
2008	Culbertson	643	2007	3/26/2008	Yearling	Elastomer	
2008	Fallon	1307	2007	5/7/2008	Yearling	PIT Tag	Scute Removed
2008	Forsyth	1384	2007	5/7/2008	Yearling	PIT Tag	Scute Removed
2008	Forsyth	106	2007	3/26/2008	Yearling	Elastomer	
2008	Intake	2395	2007	5/7/2008	Yearling	PIT Tag	Scute Removed
2008	Intake	103	2007	3/26/2008	Yearling	Elastomer	
2008	School Trust	1325	2007	5/7/2008	Yearling	PIT Tag	Scute Removed
2008	School Trust	654	2007	3/26/2008	Yearling	Elastomer	
2008	Sidney	149	2007	5/7/2008	Yearling	PIT Tag	Scute Removed

Year	Stocking Site	Number Stocked	Year Class	Stock Date	Age at Stocking[a]	Primary Mark	Secondary Mark
2008	Sidney	67	2007	3/26/2008	Yearling	Elastomer	
2008	Wolf Point	1328	2007	5/7/2008	Yearling	PIT Tag	Scute Removed
2008	Wolf Point	416	2007	3/26/2008	Yearling	Elastomer	
2008	Miles City	4797	2008	7/30/2008	Fry		
2008	Grand Champs	24395	2008	7/30/2008	Fry		
2008	Culbertson	15630	2008	9/24/2008	Fingerling	Elastomer	
2008	Fallon	7930	2008	9/29/2008	Fingerling	Elastomer	
2008	Forsyth	7723	2008	9/29/2008	Fingerling	Elastomer	
2008	Intake	12642	2008	9/29/2008	Fingerling	Elastomer	
2008	Sidney	3186	2008	9/29/2008	Fingerling	Elastomer	
2008	Wolf Point	11717	2008	9/24/2008	Fingerling	Elastomer	
2009	Culbertson	1387	2008	4/13/2009	Yearling	PIT Tag	Scute Removed
2009	Fallon	1155	2008	4/13/2009	Yearling	PIT Tag	Scute Removed
2009	Forsyth	1166	2008	4/13/2009	Yearling	PIT Tag	Scute Removed
2009	Intake	2181	2008	4/13/2009	Yearling	PIT Tag	Scute Removed
2009	Sidney	710	2008	4/13/2009	Yearling	PIT Tag	Scute Removed
2009	Wolf Point	2162	2008	4/13/2009	Yearling	PIT Tag	Scute Removed
2009	Miles City	46260	2009	7/31/2009	Fry		
2009	Wolf Point	26175	2009	7/22/2009	Fry		
2009	Culbertson	10238	2009	9/24/2009	Fingerling	Elastomer	
2009	Fallon	5133	2009	9/23/2009	Fingerling	Elastomer	
2009	Forsyth	5386	2009	9/23/2009	Fingerling	Elastomer	
2009	Intake	8374	2009	9/23/2009	Fingerling	Elastomer	
2009	Sidney	1865	2009	9/23/2009	Fingerling	Elastomer	
2009	Wolf Point	9946	2009	9/23/2009	Fingerling	Elastomer	
2009	Intake	8374	2009	9/23/2009	Fingerling	Elastomer	
2009	Sidney	1865	2009	9/23/2009	Fingerling	Elastomer	
2009	Wolf Point	9946	2009	9/23/2009	Fingerling	Elastomer	
2010	Fallon	721	2009	4/15/2010	Yearling	PIT Tag	Scute Removed
2010	Fallon	268	2009	8/3/2010	Yearling	PIT Tag	Scute Removed
2010	Fallon	1000	2010	10/7/2010	Fingerling	Elastomer	
2010	Forsyth	1402	2009	4/15/2010	Yearling	PIT Tag	Scute Removed

Year	Stocking Site	Number Stocked	Year Class	Stock Date	Age at Stocking[a]	Primary Mark	Secondary Mark
2010	Forsyth	268	2009	8/3/2010	Yearling	PIT Tag	Scute Removed
2010	Intake	1890	2009	4/15/2010	Yearling	PIT Tag	Scute Removed
2010	Intake	816	2009	6/4/2010	Yearling	Elastomer	
2010	Intake	541	2009	8/3/2010	Yearling	PIT Tag	Scute Removed
2010	Intake	1000	2010	10/7/2010	Fingerling	Elastomer	
2010	Sidney	331	2009	4/15/2010	Yearling	PIT Tag	Scute Removed
2010	Wolf Point	1309	2009	4/15/2010	Yearling	PIT Tag	Elastomer, Scute
2010	Wolf Point	858	2009	6/4/2010	Yearling	Elastomer	
2010	Wolf Point	425	2009	8/3/2010	Yearling	PIT Tag	Scute Removed
2010	Wolf Point	1000	2010	10/7/2010	Fingerling	Elastomer	
2010	Culbertson	65	2004	9/21/2010	6 Yr Old	PIT Tag	
2010	Culbertson	1337	2009	4/15/2010	Yearling	PIT Tag	Elastomer, Scute
2010	Culbertson	384	2009	6/4/2009	Yearling	PIT Tag	Scute Removed
2010	Culbertson	1000	2010	10/7/2010	Fingerling	Elastomer	
2010	School Trust	1766	2009	4/15/2010	Yearling	PIT Tag	Elastomer, Scute
2011	Culbertson	795	2010	5/5/2011	Yearling	PIT Tag	Scute
2011	Wolf Point	797	2010	5/5/2011	Yearling	PIT Tag	Scute
2011	Fallon	531	2010	5/5/2011	Yearling	PIT Tag	Scute
2011	Forsyth	545	2010	5/5/2011	Yearling	PIT Tag	Scute
2011	Intake	510	2010	5/5/2011	Yearling	PIT Tag	Scute
2011	Culbertson	262	2010	8/22/2011	Yearling	PIT Tag	Scute
2011	Fallon	131	2010	8/22/2011	Yearling	PIT Tag	Scute
2011	Forsyth	174	2010	8/22/2011	Yearling	PIT Tag	Scute
2011	Intake	132	2010	8/22/2011	Yearling	PIT Tag	Scute
2011	Wolf Point	262	2010	8/22/2011	Yearling	PIT Tag	Scute

[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