2008 Annual Report

Pallid Sturgeon Population Assessment and Fish Community Monitoring for the Missouri River: Segments 5 and 6.

Prepared for the U.S. Army Corps of Engineers – Missouri River Recovery Program
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April 2009

EXECUTIVE SUMMARY

Pallid sturgeon *Scaphirhynchus albus* and the Missouri River fish community were randomly sampled in the unchannelized Missouri River downstream of Fort Randall Dam to the headwaters of Lewis and Clark Lake (Recovery Priority Management Area 3; [RPMA 3]) with standardized gear and protocols from fall of 2007 to fall of 2008 (i.e., 2008 season). Ten randomly selected bends were sampled with a minimum of 8 deployments for each standard gear expended in each bend. The confluence of a major tributary, the Niobrara River, delineates segment 5 (upstream of the confluence) from segment 6 (the confluence to the headwaters of Lewis and Clark Lake); however, both segments were pooled for analysis. A total of 102 pallid sturgeon were captured in 2008; 79% were of known hatchery origin, with a 78% detection rate for passive integrated transponder (PIT) tags. Genetic analysis of 12 unmarked fish identified eight hatchery fish from the 2001 year class, one fish from the 2004 year class, one fish from the 2002 year class, and two fish as wild. Sixty-five percent of our unmarked genetically confirmed hatchery propagated fish were from a single stocking of the 2001 year class, demonstrating elevated PIT tag loss within this year class. The two wild pallid sturgeon (490 and 614 mm fork length [FL]), with unique genetic markers when compared to known hatchery broodstock, were of similar size to other hatchery propagated fish. Due to the lack of complete parental genetic history from the 1997 broodstock, we can not exclude the possibility of these fish being of hatchery or wild origin. Additionally, two fish from the 2006 year class had no PIT tag implanted at stocking and were identified by a visible implanted elastomer tags (VIE) and a removed scute.

Recaptured pallid sturgeon in 2008 represented all years classes stocked (1997 - 1999 and 2001 – 2007) as part of population supplementation efforts with the exception of the 1999 and 2006 year classes. However, pallid sturgeon from the 1999 year class have been recaptured in past years. For standardized gears, 20 pallid sturgeon were captured with gill nets, 36 with trammel nets, and 46 with otter trawls. In 2008, the relative abundance of hatchery produced pallid sturgeon captured in gill nets was similar to 2007 but 60% higher compared to the overall running average (2003-2007). For drifted trammel nets in 2008, pallid sturgeon relative abundance increased 423% during fall through spring (i.e. the sturgeon season) and decreased 51% during summer (i.e. fish community season) when compared to the overall running average. In contrast, relative abundance in the otter trawl decreased 41% during the sturgeon season and increased 109% during the fish community season. Spatially, pallid sturgeon were captured throughout most of the length of segments 5 and 6 (river mile 872 to 827) but 84% of recaptures were in the delta formed downstream of the confluence of the Niobrara and Missouri rivers. Forty percent of pallid sturgeon were caught in the same location where an active gear initially captured a pallid sturgeon (i.e., duplicate samples). At two separate locations within one mile of each other on 22-July-2008, 17 pallid sturgeon were captured with the otter trawl in the Niobrara River delta. These observed aggregations were comprised of multiple year classes based on the wide range of sizes: 522 – 880 mm FL and weights 535 – 2,900 g. Mean relative condition (K_n) of recaptured pallid sturgeon by year class ranged from 0.75 to 0.94, which was similar to previous years. The mean absolute growth rates of age-7 and older fish was < 0.09 mm/d, while growth rates for 1-6 year old fish were > 0.13 mm/d. Pallid sturgeon were recaptured in the channel border mesohabitat of braided channels (86%), channel crossovers (6%), inside bends

(4%), and outside bends (3%). A total of 249 shovelnose sturgeon *S. platorynchus* were captured in standard gears during 2008: 133 with gill nets, 94 with trammel nets, and 22 with otter trawls. All shovelnose sturgeon have been floy-tagged as part of a U.S. Geological Survey study of population size and survival. No young-of-year *Scaphirhynchus* spp. were captured and the ratio of pallid sturgeon to shovelnose sturgeon captured was 1:2.9.

In addition to sturgeon, eight native Missouri River species were targeted for assessment: speckled chub *Macrhybopsis aestivalis,* sturgeon chub *M. gelida*, sicklefin chub *M. meeki*, western silvery minnow *Hybognathus argyritis*, plains minnow *H. placitus*, sand shiner *Notropis stramineus*, blue sucker *Cycleptus elongatus*, and sauger *Sander canadense*. No sturgeon chubs, sicklefin chubs, or speckled chubs were captured in 2008, similar to previous years. A total of six *Hybognathus spp*. were captured in mini-fyke nets during the fish community season but were too small (< 33 mm) to accurately determine species. Sand shiners were captured with mini-fyke nets (n = 140) and otter trawls (n = 3) during summer. A total of seven blue suckers were captured with standard gears: five in gill nets and two in otter trawls. During 2008, a total of 186 saugers were caught in standard gears: 41 in trammel nets, 50 in otter trawls, and 78 in gill nets. Saugers were captured primarily during April and May (58%). A total of 46 fish species and one hybrid were caught in segments 5 and 6 of the Missouri River during 2008. None of the four exotic Asian carps, bighead carp *Hypophthalmichthys noblis*, silver carp *H. molitrix*, grass carp *Ctenopharyngodon idella*, and black carp *Mylopharyngodon piceus*, were captured, similar to past years.

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INTRODUCTION

A team of biologists representing State and Federal resource management agencies was assembled in 2002 to develop and implement a standardized long-term resource monitoring program for the Missouri River. This team is now known as the Pallid Sturgeon Population Assessment Team (Drobish 2007a). The primary goal of this monitoring program is to assess the status and recovery of endangered pallid sturgeon *Scaphirhynchus albus* (Dryer and Sandoval 1993). However, the monitoring program is also directed towards the native riverine fish community (Appendix A). This team developed standardized protocols for habitat classification (Appendix B), gear types and deployment methods (Appendix C), as well as data reporting (Drobish 2007b). The foundation for the design of this standardized long-term resource monitoring program was the "Benthic Fishes Study" conducted in the late 1990's by the U. S. Geological Survey Cooperative Fish and Wildlife Research Units located at universities throughout the Missouri River Basin (Berry and Young 2001).

Four high priority pallid sturgeon Recovery Priority Management Areas (RPMAs), were identified in the recovery plan (Dryer and Sandoval 1993), which encompass nearly 1,775 km (1,100 miles) of the Missouri River system. The Pallid Sturgeon Population Assessment Team selected 14 sampling segments within these RPMAs to implement the monitoring program. Each sampling segment was selected based on a variety of characteristics such as water temperature, turbidity, influence of tributaries, presence of degrading or aggrading stream beds, stream gradient, natural hydrograph, spillway releases and flow fluctuations (Drobish 2007a). Sampling within these segments allows biologists to monitor trends in pallid sturgeon and the native Missouri River fish abundance in relation to flow modification, mitigation efforts, and shallow water habitat restoration projects.

Standardized monitoring throughout the Missouri River Basin facilitates comparison of fish relative abundance and size structure in disparate habitats (e.g. Upper vs. Middle basins or unchannelized vs channelized river reaches).

Hatchery-reared pallid sturgeon have been stokced in the Missouri River downstream of Fort Randall Dam (also known as RPMA 3) in South Dakota and Nebraska (Figure 1a), since 2000 as part of recovery efforts (Appendices D - F). From 2000 to September of 2008, a total of 9,430 juvenile pallid sturgeon were released consisting of 11 year classes; 1997 - 1999, and 2001 - 2008. Additionally, nine adult fish, former broodstock or rehabilitated fish, were translocated from Lake Sharpe, South Dakota (Appendix E). During September of 2008 the first stocking of age-0 fingerlings occurred. There are four stocking locations in RPMA 3: the most upstream site was Sunshine Bottoms, the middle site was at the Verdel Boat Ramp, and the two downstream sites are the Running Water Boat Ramp on the South Dakota side and the Chief Standing Bear Bridge on the Nebraska side (Figure 2). This long-term monitoring program serves to assess the success of hatchery propagated fish and guide future stocking efforts.

Because current pallid sturgeon abundance is extremely low, data collection that solely targets pallid sturgeon likely would not provide adequate information to evaluate restoration projects and flow modifications to the Missouri River. An ecologically based long-term population assessment approach was adopted to address this concern and evaluate the entire warm water benthic fish community in the Missouri River as required by the U. S. Fish and Wildlife Service's (USFWS) 2000 Biological Opinion on operations of the main-stem Missouri River dams (USFWS 2000). Additionally, evaluating responses of other native, short-lived Missouri River fishes to changes in habitat or flow modifications may be a

more sensitive indicator of habitat change in the near term compared with the rare, long-lived pallid sturgeon. Information derived from this project will be vital for developing sound management recommendations for recovering the native Missouri River fish fauna. Because the pallid sturgeon is a known piscivore (Carlson et al. 1985; Gerrity et al. 2006; Wanner et al. 2007a; Grohs et al. in press), assessment of the native benthic Missouri River fish assemblage, which likely serves as pallid sturgeon prey, is also a critical component of the monitoring program. A representative group of nine native Missouri River fishes was selected as indicator species for detecting improvement in the warm water benthic fish community. The species selected were: shovelnose sturgeon *S. platorynchus*, western silvery minnow *Hybognathus argyritis*, plains minnow *H. placitus*, speckled chub *Macrhybopsis aestivalis*, sturgeon chub *M. gelida*, sicklefin chub *M. meeki*, sand shiner *Notropis stramineus*, blue sucker *Cycleptus elongatus,* and sauger *Sander canadense.* Counts and lengths of all fish collected during population assessment activities are recorded; however, detailed data (weight and age structures such as scales, otoliths, or pectoral fin rays) are only collected from pallid sturgeon and the representative group of nine native Missouri River species. However, no pectoral fin ray clips were taken on shovelnose sturgeon or blue suckers in RPMA 3 due to biologists' concerns regarding the risk of post-clip mortality as well as limited evidence of recruitment for these species in this reach.

Goals

Although the Pallid Sturgeon Population Assessment Program itself will not aid in direct recovery of pallid sturgeon, information derived from this program will be used to evaluate the progress of current and proposed management actions. Restoration of pallid

sturgeon in the Missouri River can be divided into three broad categories: population supplementation with hatchery-reared pallid sturgeon, habitat restoration, and changes in current operations of the main-stem dams (i.e., natural hydrograph or "spring rise"). These three actions are all directed towards the ultimate goal of recovery of pallid sturgeon and require monitoring to ascertain success within an adaptive management framework. Therefore, the specific overall goals of this population assessment program for the Missouri River are:

1. Provide needed information to detect change in pallid sturgeon and nine native targeted species populations and
2. Determine habitat preferences over time for pallid sturgeon and nine selected native species.

Objectives

Six objectives have been identified for the monitoring program. Detailed hypotheses for each objective can be found in Drobish (2007a).

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 (i.e., size structure, condition, growth, and survival).

4. Evaluate annual results and long-term trends in nine native targeted species population abundance and geographic distribution throughout the Missouri River system.
5. Document annual results and long-term trends of habitat usage of nine native targeted 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.

Success Criteria

Evaluation of success will be tied directly to the results of the Pallid Sturgeon Population Assessment Program and the resulting information that these assessments provide. The following four statements may be used to determine program success:

1. The program has the ability to detect population changes.
2. The program has the ability to measure survival of hatchery-reared and stocked pallid sturgeon in the river.
3. The program has the ability to detect reproduction of pallid sturgeon in the Missouri River.
4. The program has the ability to detect recruitment of wild pallid sturgeon in the Missouri River.

Study Area

Lewis and Clark Lake, the most downstream reservoir of the Missouri River, was formed by the closure of Gavins Point Dam in 1957 and is bounded upstream by Fort Randall Dam (Figure 1a). Both dams are operated by the U. S. Army Corps of Engineers (USACE). The primary function of Gavins Point Dam is to level out release fluctuations from upstream dams to serve downstream purposes such as navigation, flood control, and municipal water supply. The riverine section of Lewis and Clark Lake extends approximately 89 river kilometers (rkm) from Fort Randall Dam to Springfield, South Dakota (Figures 1a). Maximum depth of the riverine section of Lewis and Clark Lake is about 12 m and channel width ranges from 45 - 90 m. Downstream of Springfield, South Dakota, Lewis and Clark Lake becomes more like a reservoir. However, sediment from the Niobrara River has formed a large braided delta, which starts near rkm 1,351. This delta has progressively expanded downriver into the reservoir. The riverine section of Lewis and Clark Lake was selected in the Pallid Sturgeon Recovery Plan (Dryer and Sandoval 1993) as 1 of 4 RPMAs in the Missouri River for potential recovery of the species and was designated as RPMA 3.

The riverine section of Lewis and Clark Lake retains many natural characteristics such as sandbars, sandbar pools, side channels, backwater areas, islands, old growth riparian forest and year round flows. However historical temperatures, turbidity, and flows (i.e., the hydrograph) in the riverine section have been altered due to operation of Fort Randall Dam. Water levels substantially fluctuate daily and seasonally. Diel water levels are subjected to changes of almost 1 m. Lowest daily flows generally occur at 0600 hours with peak flows occurring between 1200 to 1900 hours in support of power generation demands (USACE 1994). The USACE Missouri River Main Stem Reservoirs 2000 - 2001 Annual Operating

Plan (http://www.nwd-mr.usace.army.mil/rcc/reports/aop.html) reported highest seasonal releases from Fort Randall Dam during August through November to support navigation on the Missouri River downstream of Sioux City, Iowa. Lowest releases were during December through April to prevent flooding due to ice jams.

Based on the presence of a major tributary, the Niobrara River, the riverine section of Lewis and Clark Lake (RPMA 3) was divided into two sampling segments by the Population Assessment Team. Segment 5 (rkm 1416 – 1358; river mile [rm] 880 – 844) encompassed the riverine section downstream of Fort Randall Dam to the Niobrara River confluence. In this segment, water temperatures are depressed by hypolimnetic discharges from Fort Randall Dam and turbidity is low. Segment 6 (rkm 1358 - 1331, rm 844 – 827) encompassed the riverine section downstream of the confluence of the Missouri and Niobrara rivers to the headwaters of Lewis and Clark Lake (Figure 1a). This segment has increased water temperatures and turbidity due to inflows from the Niobrara River and includes the large braided delta formed in the headwaters of Lewis and Clark Lake.

METHODS

Our sampling protocol followed the detailed guidelines identified in the "Pallid Sturgeon Population Assessment Project and the Missouri River Standard Operating Procedures for Fish Sampling and Data Collection" developed by the Pallid Sturgeon Population Assessment Team (Drobish 2007b). A general summary of those guidelines follows.

Habitat Classification

The basic habitat classification system used in the Benthic Fishes Study (Berry and Young 2001) was adopted by this program (Appendix B). This basic habitat classification system was further modified to address both broad and specific habitats using a hierarchical classification system (e.g., macrohabitat, mesohabitat, and microhabitat) to aid in consistent and comparable data collection across all segments of the Missouri River. Three continuous macrohabitats are present in every bend: outside bends, inside bends, and channel crossovers. An additional 10 discrete macrohabitats have been identified that may not be present in each bend: large tributary mouths, small tributary mouths, confluence areas, large and small secondary connected channels, non-connected secondary channels, deranged channels, braided channels, dendritic channels, and dam tailwaters. Mesohabitats and microhabitats have been defined to further describe fish habitat use. This hierarchal approach provides continuity with previous studies (e.g., Benthic Fish Study) while providing a more detailed and flexible habitat classification system for future work. All habitats were classified based on the conditions at the time of sampling.

The bend served as the basic hydrologic unit sampled within each river segment. A bend was comprised of three continuous macrohabitats: an outside bend (main channel), an inside bend (main channel) and a channel crossover (main channel). Bends were determined by the hydrologic nature of the river and extended from the upstream crossover to just upstream of the next downstream crossover and also encompassed any islands and secondary channels (i.e., discrete habitats) between these two crossovers. Typically, the river channel parallels the adjacent geographic landforms in the channelized river. However, in the unchannelized portions of the Missouri River, bends do not necessarily follow the general

form of the landscape; multiple meanders occur within what appears as one large bend based on the shape of the entire river channel. Also, in unchannelized sections, the location of bends and the number of bends within a segment may change over time. The habitat classification scheme allows for bend comparisons between the channelized and unchannelized river despite changes in scale.

Sampling effort

All bends within each segment were sequentially numbered, from upstream to downstream, and then ten bends (five per segment) were randomly selected for sampling (Appendix I). In past years (2003 and 2004) eight bends were randomly selected and two bends, one upstream and one downstream of the confluence of the Niobrara and Missouri rivers, were non-randomly selected. Following the 2004 sample season, no non-random bends were sampled (i.e., all five bends in each segment were randomly selected). Additional randomly selected bends were sampled to increase sample size as time allowed. Each mesohabitat within a macrohabitat was sampled using standard gears (Appendices B and C). A minimum of two sub-samples were required for each standard gear type for each habitat within that bend where a particular gear can effectively be deployed. Habitat data (velocity, substrate, turbidity) were collected at each pallid sturgeon capture site and in each bend for one of the two sub-samples from each mesohabitat sampled. Depth and temperature were collected at all sampling locations. Detailed habitat data collection methods are found in Drobish (2007b).

A minimum number of gear deployments for each standard gear was used, 10 for gill nets and eight for all other gears in each bend, to ensure sufficient sample size for

comparisons between segments (Tables 1 and 2). The standard gears were selected to sample specific habitats, fish species, and seasons. Some gears were selected to maximize capture of pallid sturgeon, while others targeted the fish community. However, all gears sampled multiple species despite targeting pallid sturgeon. All species captured were enumerated and measured (mm) to total length (TL) except for sturgeons were measured to fork length (FL) while paddlefish were measured from eye to FL. Wet weight (0.1 g) was only measured for pallid sturgeon and the nine targeted native Missouri River fishes.

The sampling year was divided into two seasons: sturgeon season and fish community season. The sturgeon season encompassed the fall through spring while the fish community season occurred during summer. The sturgeon season focused on the assessment of sturgeon species while collections in the fish community season continued to assess sturgeon but placed additional emphasis and effort towards description of the native fish community. Sampling during the fish community season targeted young-of-the-year (YOY) fishes to provide evidence of recruitment. Delineation between the sturgeon and fish community seasons is primarily based on water temperature. Based on the pallid sturgeon collection and handling protocols (USFWS 2005) pallid sturgeon can only be collected with gill nets at water temperatures < 12.5 °C (< 55 °F). Due to the diversity of habitats and longitudinal changes in climate along the Missouri River, a wide time frame was necessary to facilitate comparable sampling effort among the 14 segments. For example, gill netting downstream of Fork Peck Dam in Montana and North Dakota (segments 1 – 4) is typically not feasible throughout winter because of ice. However, lack of ice in the lower reaches of the Missouri River permit gill netting during most of the winter. Additional gears were deployed during the fish community season to assess the main channel and shallow water habitats (< 1.2 m)

and their associated fish communities. The fish community season ran between July 1 and October 30 and the intensive sturgeon sampling occurred when possible for the remainder of the year. Data in this report covers the time period from November 1, 2007 through October 30, 2008 and herein is referred to as the 2008 sampling season. Focused studies have been previously initiated in conjunction with the population assessments program to fulfill unique biological information gaps (e.g., food habits, sturgeon hormone studies, shovelnose sturgeon population estimates, gear evaluations, telemetry, and geographic information system (GIS) projects).

Sampling Gear

Multiple standard gears were deployed to sample deep and shallow habitats of the Missouri River (Appendix C). Gill nets, trammel nets, and otter trawls were fished in deep waters of the main channel, large secondary connected channels, and large tributaries during the sturgeon season. In the fish community season, trammel nets and otter trawls were again used with the addition of mini-fyke nets to sample shallow water habitats (i.e. bars). Multi-filament gill nets (1.8 m deep x 38 m length) consisted of five 8-m long panels with bar mesh sizes of 2.5 cm, 3.8 cm, 5.1 cm, 7.6 cm, and 10.2 cm. A standard gill net consisted of four panels (3.8 – 10.2 cm); the smallest mesh (1 inch: 2.5 cm) was coded as wild and not included in abundance calculations. Trammel nets were 1.8 m deep x 38 m long with outside wall panels of 15.2 cm bar mesh and an inside wall panel of 2.5 cm bar mesh. All gill and trammel nets were dyed green during 2003 - 2006 to reduce net avoidance in segments 5 and 6 due to extremely low turbidity levels (< 10 nephelometric turbidity units [ntu]). However, in a comparision study with white mesh nets found little difference in catch rates of sauger

and shovelnose sturgeon (Wanner et al. in review) and now only white nets are used. The otter trawl (0.5 m deep x 9.1 m wide) had an outer chafing mesh of 64 mm bar mesh, an inner bar mesh of 32 mm constructed of Sapphire®, and a 2-m long cod end. Mini-fyke nets consisted of a lead set at the bankline (4.5 m long x 0.6 m high) with two 1.2 m wide x 0.6 m high rectangular steel frames (cab) and two 0.6 m diameter circular hoops with 3 mm "ACE" type nylon mesh. Gill nets and mini-fyke nets were set overnight for a maximum of 18 h and catch per unit effort (CPUE) was calculated as the number of fish per net night. Trammel nets were drifted and otter trawls were pulled downstream on the river bottom for a minimum distance of 75 m and a maximum distance of 300 m. A global positioning system (GPS) was used to quantify distance sampled for trammel nets and otter trawls with CPUE measured as numbers of fish per 100 m of distance deployed. All gear deployments followed the detailed standard operating procedures (SOP) outlined in Drobish (2007b).

The stratified-random study design of the population assessment program shifts to targeted sampling whenever a pallid sturgeon is captured in the intial deployment of an active gear (i.e., otter trawls, drifted trammel net). Successive passes over the same location are done until two consecutive deployments fail to collect additional pallid sturgeon up to a maximum of nine deployments. These non-random deployments are excuded from CPUE calculations for annual relative abundance assessments but provide additional recaptures for determination of survival, growth, condition, and size structure. Capture of fish non-randomly with active gears are referred to as "duplicatate passes".

Calculations

The fundamental sampling unit (i.e., replicate) for the population assessment program was the bend. Therefore, our effective sample size was the number of bends sampled with each gear deployed in each season collectively for segments 5 and 6 (Tables 1 and 2). Data were pooled for segments 5 and 6 because of the short length (in river miles) and low number of bends sampled in each segment (n = 5). Mean CPUE was separately calculated for each species caught in each gear during each sampling season. First, the average CPUE for all sub-samples within a bend was calculated and then these "bend means" were averaged to calculate the overall mean CPUE. The overall CPUE was also calculated for each habitat effectively sampled by a particular gear in each season (Appendix H). Variability of CPUE was presented as two standard errors (2 SE) which approximates a 95% confidence interval around the mean.

Indices of fish condition (health) were calculated for pallid sturgeon and two native Missouri River species: shovelnose sturgeon (Quist et al. 1998) and sauger (Guy et al. 1990). Relative condition factor (K_n) was calculated to assess the condition of pallid sturgeon and used the weight-length relation in Keenlyne and Evanson (1993). Relative weight (W_r) calculations require a length-specific standard weight derived from an overall standard weight-length relation encompassing multiple populations across a species' range. Standard weight relations have been derived for shovelnose sturgeon (Quist et al. 1998) and sauger (Guy et al. 1990). Detailed equations for calculating K_n, and W_r are found in (Anderson and Newman 1996).

Incremental relative stock density (RSD) was calculated to describe the population size-structure of pallid sturgeon and shovelnose sturgeon using methods proposed by

Gablehouse (1984). Length categories proposed by Shuman et al. (2006) for pallid sturgeon, Quist et al. (1998) for shovelnose sturgeon, and Anderson and Newman (1996) for sauger were used to determine relative stock densities (RSD). For pallid sturgeon these fork length categories are: stock-quality (330 – 629 mm), quality-preferred (630 - 839 mm), preferred-memorable (840 - 1039 mm), memorable-trophy (1040 - 1269 mm), and trophy (≥ 1270 mm). Sturgeon were calculated as percents of < stock, stock, and > stock sized fish captured in each macrohabitat and mesohabitat type. The sub-stock size category was further divided into fish < 250 mm FL for pallid sturgeon and into fish < 150 mm FL for shovelnose sturgeon, to provide greater resolution of recruitment by YOY sturgeon.

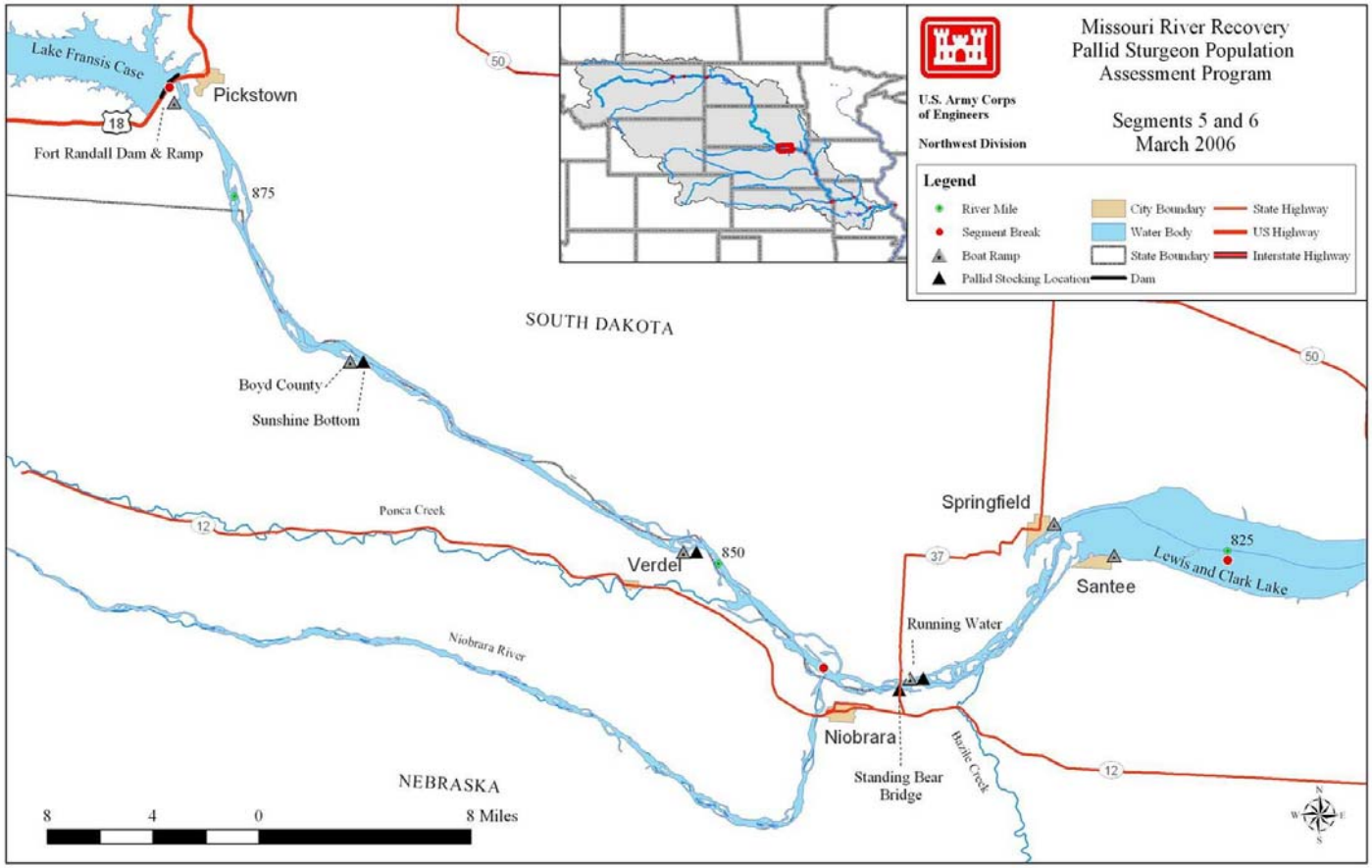

Figure 1a. Map of segments 5 and 6 of the Missouri River with major tributaries, common landmarks, and historic stocking locations for pallid sturgeon. Segments 5 and 6 encompass the Missouri River downstream of Ft. Randall Dam (River Mile 802) to the headwaters of Lewis and Clarke Lake (River Mile 827.5)

RESULTS

Pallid Sturgeon

Objective 1. Document annual results and long-term trends in pallid sturgeon population abundance and geographic distribution throughout the Missouri River System.

Objective 2. Document annual results and long-term trends of habitat usage of wild pallid sturgeon and hatchery stocked pallid sturgeon by season and life stage.

Objective 3. Document population structure and dynamics of pallid sturgeon in the Missouri River System.

Spring 2008 tributary discharges into the Missouri River in the middle and lower basins required a reduction in discharge from mainstem dams to minimize flooding. This reduction in discharge from Fort Randall Dam, South Dakota during the 2008 sturgeon season limited trammel net effort (< 10%) in segment 5 (Table 1). The reduction in discharge above the Niobrara River confluence did not meet the requirements listed in the protocol for completion of a standard trammel net drift. On multiple sampling occasions we attempted to deploy trammel nets in segement 5 with no success (i.e., trammel nets would drift < 50 m in 15 min). Additionally, during the fish community season in 2008, twice the standard effort with the otter trawl was deployed because the push trawl was eliminated after evaluation and comparision with mini-fyke nets. Ten new bends were randomly selected during the fish community season for a complete second sampling effort with the otter trawl.

A total of 102 pallid sturgeon were captured during the 2008 season with 72 fish caught in standard gears: 16-ft otter trawl (n = 23), gill nets (n = 20), and drifted trammel nets (n = 18). A total of 108 duplicate passes were conducted for active gears. Duplicate passes with active gears caught 41 additional pallid sturgeon with trammel nets (n = 18) and 16-ft otter trawls (n = 23). Pallid sturgeon were primarily captured in the braided channel border habitat (n = 88) at depths ranging from of 1.2 – 9.4 m, bottom velocities ranging from

0.01 – 1.20 m/s, and turbidity ranging from 9.0 – 427 ntu (Table 3). Nearly 86% of the pallid sturgeon captured in the braided, channel border habitat of segment 6 were at a mean depth of 4.4 m, mean bottom velocity of 0.46 m/s, and mean turbidity of 61.7 ntu. The habitat pallid sturgeon were second most commonly collected (n = 6) was in the channel crossover, channel border habitat. In channel crossover channel border habitat fish were captured at a the mean depth of 4.9 m, mean bottom velocity of 0.42 m/s, and mean turbidity of 13.8 ntu.

The stocking of over 5,300 age-1 juvenile pallid sturgeon into segments 5 and 6 since 2002, was reflected in the increased CPUE (Figures 2, 3, and 5) for gill nets, trammel nets, and otter trawls during 2008. Passive integrated transponder (PIT) tag retention was 78%. In 2008, the 2007 year class were the smallest size class (minimum FL = 258 mm) present in RPMA 3 and only four fish were recaptured. All pallid sturgeon captured were the size of previously stocked fish and thus considered to be of hatchery origin, pending genetic verification, (Tables 6 and 7) with the exception of two large fish that were genetically identified as wild fish. However, we cannot exclude the possibility of natural recruitment. The two large pallid sturgeon identified as wild fish could be from the 1997 year class where complete genetic parentage of the broodstock is incomplete, thus creating uncertainty as to their true origin. All pallid sturgeon continued to increase in weight and length since stocking (Table 6). Mean weight gain was > 0.19 g/d for all year classes except the 2007 year class which on average lost weight. Age 1-6 pallid sturgeon grew at a rate greater than 0.13 mm/d. After age-7, increases in FL declined to < 0.09 mm/d. The mean relative condition factor ranged from 0.75 to 0.94 for all year classes and declined since stocking with the exception of the 1998 and 2006 year classes (Table 6).

Pallid sturgeon were captured throughout segments 5 and 6 with > 30 fish captured at two locations (Figure 1b). At 13 separate sampling locations five or more duplicate samples of active gear were deployed and on two occasions the maximum nine deployment passes was achieved providing strong evidence that pallid sturgeon cluster in certain habitats. Twelve duplicate passes in segment 5 occurred in channel crossover (n = 4), inside bend (n = 4), confluence (n = 2), and outside bend (n = 2) macrohabitats while the 96 duplicate passes in segment 6 were all within braided macrohabitats. Overall, macrohabitats where pallid sturgeon were captured included outside bends, inside bends, channel crossovers, confluence, and braided channels with all fish captured in the channel border mesohabitat (Tables 11-16).

During 2008 mean annual CPUE for pallid sturgeon in gill nets and the otter trawl during the fish community season was similar to 2007, while trammel net CPUE increased 45% during the sturgeon season and otter trawl CPUE decreased over three fold during the sturgeon season. Mean CPUE of stocked pallid sturgeon captured with gill nets was similar to 2007 but increased 60% compared to the running average from 2003 to 2007. Mean CPUE for drifted trammel nets in 2008 increased 423% during the sturgeon season (fall through spring) and decreased 51% during the fish community season compared to the 2003 to 2007 running average. In contrast to trammel nets, relative abundance in the otter trawl decreased 48% during the sturgeon season in 2008, but summer mean CPUE increased 43% when compared to the mean from 2005 – 2007. Collectively for all standard gears, nearly equal numbers of pallid sturgeon were captured during the sturgeon (n = 53) and fish community seasons (n = 49). No pallid sturgeons were captured with mini-fyke nets in 2008 which was similar to 2003-2007.

Fork lengths of pallid sturgeon ranged from 235 – 885 mm in segments 5 and 6 during 2008 (Figure 8). Most pallid sturgeon were of stock length (n = 72) with only four fish < stock size and 26 fish > stock size (Table 7). Similar to 2007, during the fish community season the proportion of fish within the quality length category was nearly double that of the sturgeon season (Table 7). Pallid sturgeon are continuing to grow and are progressively recruiting to larger length categories compared to previous years. The ratio of pallid sturgeon to shovelnose sturgeon captured in segements 5 and 6 was 1:2.9.

Table 1. Number of bends sampled, mean number of deployments, and total number of deployments by macrohabitat for segments 5 and 6 on the Missouri River during sturgeon season and fish community season in 2007-2008. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	Number of Bends	Mean deploy-ments	Macrohabitat[a]													
			BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCN	TRIB	TRML	TRMS	WILD
Fall through Spring - Sturgeon Season																
1 Inch Trammel Net	9	7.2	40	10	0	N-E	N-E	8	7	0	N-E	N-E	N-E	0	0	N-E
Gill Net	10	19.9	100	27	0	N-E	N-E	38	34	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	10	8.0	40	10	0	N-E	N-E	15	15	0	N-E	N-E	N-E	0	0	N-E
Summer – Fish Community Season																
1 Inch Trammel Net	10	8	40	13	0	N-E	N-E	15	12	0	N-E	N-E	N-E	0	0	N-E
Mini-Fyke Net	10	8	40	13	2	N-E	N-E	12	13	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	16	10	74	24	8	N-E	N-E	28	24	2	N-E	N-E	N-E	0	0	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

Table 2. Number of bends sampled, mean number of deployments, and total number of deployments by mesohabitat for segments 5 and 6 on the Missouri River during sturgeon season and fish community season in 2007-2008. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	Number of bends	Mean deploy-ments	Mesohabitat[a]					
			BARS	CHNB	DTWT	ITIP	POOL	TLWG
Fall through Spring – Sturgeon Season								
1 Inch Trammel Net	9	7.2	0	65	N-E	N-E	N-E	N-E
Gill Net	10	19.9	0	199	N-E	N-E	N-E	N-E
Otter Trawl	10	8.0	0	80	N-E	N-E	N-E	N-E
Summer – Fish Community Season								
1 Inch Trammel Net	10	8	1	79	N-E	N-E	N-E	N-E
Mini-Fyke Net	10	8	78	2	N-E	N-E	N-E	N-E
Otter Trawl	16	10	0	160	N-E	N-E	N-E	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

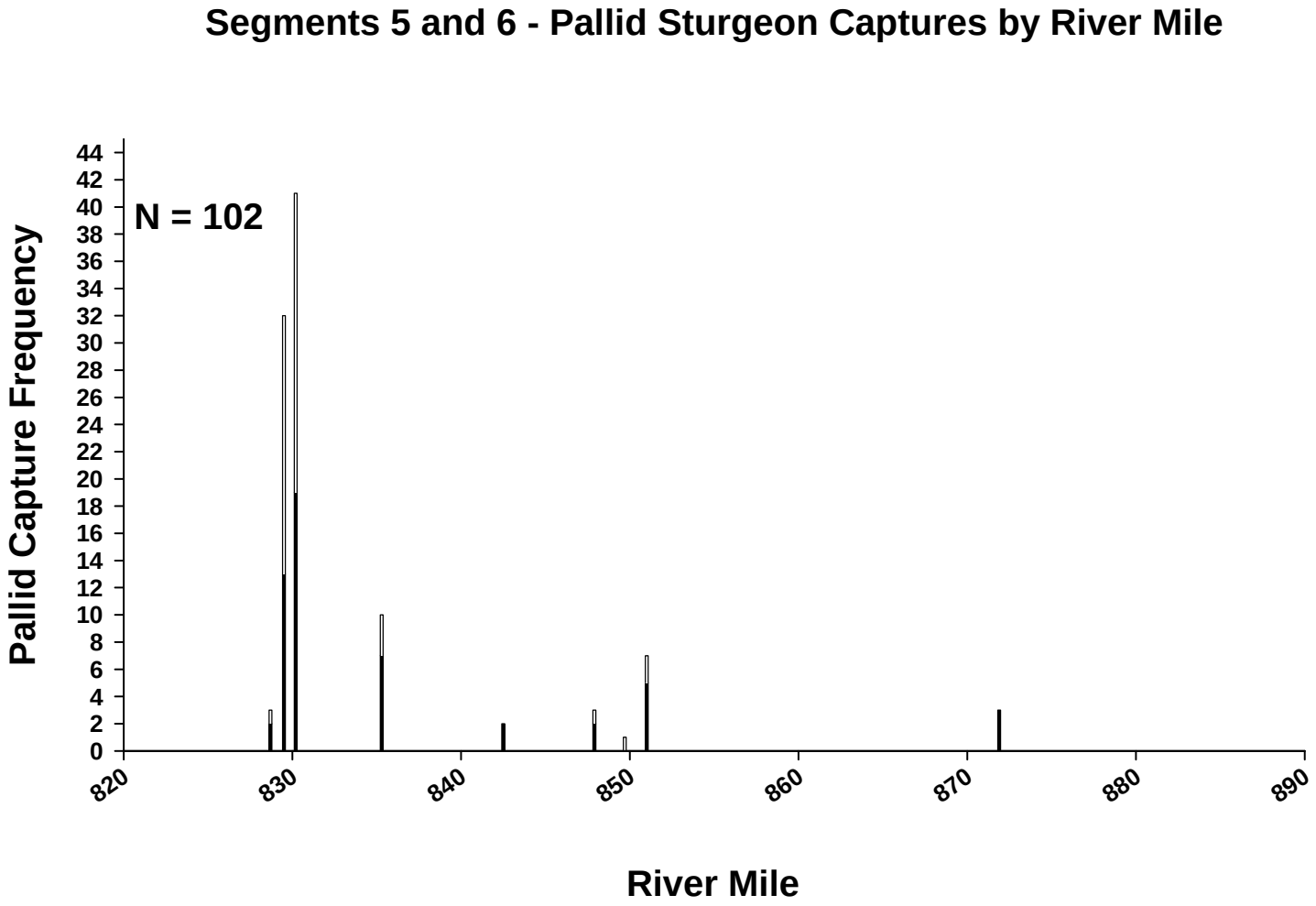

Figure 1b. Distribution of pallid sturgeon captures by river mile for segments 5 and 6 of the Missouri River during 2007-2008. Black bars represent pallid captures during the sturgeon season and white bars during the fish community season. Figure includes all pallid captures including non-random and wild samples.

Table 3. Pallid sturgeon capture summaries for all gears relative to habitat type and environmental variables on the Missouri River during 2007-2008. Means (minimum and maximum) are presented. Habitat definitions and codes presented in Appendix B. N-E indicates the habitat is non-existent in the segment.

Habitat		Depth		Bottom Velocity (m/s)		Temperature		Turbidity (ntu)		
Macro-	Meso-	Effort	Catch	Effort	Catch	Effort	Catch	Effort	Catch	Total pallids caught
BRAD	BARS	0.4 (0.2-0.7)		0.09 (0.00-0.15)		21.6 (20.5-22.8)		25.9 (12.0-42.0)		.
	CHNB	3.2 (1.2-9.4)	4.4 (1.6-9.4)	0.44 (0.01-1.20)	0.46 (0.10-1.20)	15.3 (3.7-25.0)	16.5 (4.8-23.2)	59.8 (9.0-427)	61.7 (17.0-363)	88
CHXO	BARS	0.5 (0.2-0.7)		0.08 (0.00-0.14)		19.9 (16.9-22.0)		6.3 (3.0-8.0)		.
	CHNB	3.3 (0.5-10.4)	4.9 (2.6-6.7)	0.45 (0.00-1.16)	0.42 (0.19-0.76)	13.5 (3.6-23.2)	8.9 (5.0-19.9)	11.9 (3.0-78.0)	13.8 (4.0-22.0)	6
CONF	BARS	0.4 (0.3-0.4)				22.6 (22.4-22.8)				.
	CHNB	3.9 (2.3-6.6)	2.5 (2.5-2.5)	0.68 (0.23-1.32)	0.23 (0.23-0.23)	21.1 (20.9-21.4)	21.2 (21.2-21.2)	70.0 (49.0-84.0)	77.0 (77.0-77.0)	1
ISB	BARS	0.9 (0.3-5.6)		0.07 (0.02-0.13)		20.0 (16.7-22.2)		9.0 (6.0-14.0)		.
	CHNB	2.9 (0.5-7.7)	3.6 (2.1-6.5)	0.35 (0.00-0.88)	0.25 (0.05-0.46)	13.0 (3.6-22.8)	12.7 (9.0-19.5)	11.9 (2.0-94.0)	8.5 (4.0-13.0)	4
OSB	BARS	0.5 (0.4-0.7)		0.06 (0.00-0.10)		19.7 (17.1-22.4)		9.5 (8.0-11.0)		.
	CHNB	4.5 (1.6-12.5)	6.4 (4.6-9.5)	0.38 (0.10-1.04)	0.36 (0.21-0.50)	13.2 (3.4-22.4)	12.6 (4.6-22.0)	11.2 (3.0-62.0)	12.0 (9.0-16.0)	3
SCCL	CHNB	3.3 (3.1-3.5)		0.23 (0.23-0.23)		21.0 (20.9-21.1)		18.0 (18.0-18.0)		.

Table 6. Mean fork length, weight, relative condition factor (Kn), and absolute growth rates for all hatchery-reared pallid sturgeon captures by year class at the time of stocking and recapture during 2008 from segments 5 and 6 of the Missouri River. Relative condition factor was calculated using the equation in Keenlyne and Evanson (1993). Standard error (+/- 2 SE) was calculated where N>1 and is represented on second line of each year.

Year class	N	Stock Data			Recapture Data			Growth Data	
		Length (mm)	Weight (g)	K_n	Length (mm)	Weight (g)	K_n	Length (mm/d)	Weight (g/d)
1997	12	534	610.3	0.993	792	1959.6	0.843	0.089	0.465
		(21)	(88.6)	(0.058)	(42)	(360.4)	(0.038)	(0.010)	(0.106)
1998	1	427	208.0	0.734	677	1000.0	0.751	0.087	0.277
		.	.	.	.	.	.	.	.
2001	18	194	.	.	617	811.9	0.827	0.184	.
		(12)			(25)	(83.0)	(0.038)	(0.018)	.
2002	20	248	62.7	1.334	541	529.8	0.815	0.161	0.253
		(11)	(8.3)	(0.063)	(22)	(82.3)	(0.041)	(0.013)	(0.044)
2003	10	318	110.2	0.993	523	452.5	0.806	0.161	0.268
		(30)	(32.0)	(0.058)	(20)	(55.5)	(0.057)	(0.015)	(0.031)
2004	12	322	139.1	1.234	480	342.8	0.798	0.150	0.195
		(18)	(26.4)	(0.057)	(24)	(57.7)	(0.036)	(0.025)	(0.055)
2005	10	314	142.4	1.401	444	257.5	0.781	0.215	0.191
		(21)	(25.0)	(0.130)	(23)	(51.4)	(0.100)	(0.063)	(0.096)
2007[a]	4	262	61.0	1.049	265	56.8	0.937	0.132	-.279
		(26)	(29.7)	(0.167)	(27)	(40.8)	(0.536)	(0.053)	(1.053)

[a]Mean length and weight at stocking derived from subsample (n = 80) of fish measured at tagging. All other year classes were PIT tagged and observed growth rates derived from individual fish.

Table 7. Incremental relative stock density (RSD)[a] and relative condition factor (Kn) for all pallid sturgeon captured with all gears divided by a length category during 2007-2008 in the Missouri River. Length categories[b] determined using the methods proposed by Shuman et al. (2006). Relative condition factor was calculated using the equation in Keenlyne and Evanson (1993).

Length Category	N	RSD	K_n (+/- 2 SE)
Fall through sSpring - Sturgeon Season			
Sub-stock (0-199 mm)	0	.	0
Sub-stock (200-329 mm)	4	.	0.937 (0.536)
Stock	42	86	0.809 (0.032)
Quality	6	12	0.826 (0.012)
Preferred	1	2	0.794
Memorable	0	.	0
Trophy	0	.	0
Overall K_n	.	.	0.821 (0.044)
Summer - Fish Community Season			
Sub-stock (0-199 mm)	0	.	0
Sub-stock (200-329 mm)	0	.	0
Stock	30	61	0.819 (0.029)
Quality	15	31	0.799 (0.033)
Preferred	4	8	0.877 (0.095)
Memorable	0	.	0
Trophy	0	.	0
Overall K_n	.	.	0.818 (0.022)

[a] RSD = (# of fish of a specified length class / # of fish ≥ minimum stock length fish) * 100.
[b] Length categories based on the percentage of the largest known pallid sturgeon: Sub-stock FL < 330 mm (20 %), Stock FL =330 - 629 mm (20 – 36 %), Quality FL = 630 – 839 mm (36 – 45 %), Preferred FL = 840 – 1039 mm (45 – 59 %), Memorable FL = 1040 – 1269 mm (59 – 74 %), Trophy FL > 1270 mm (>74 %).

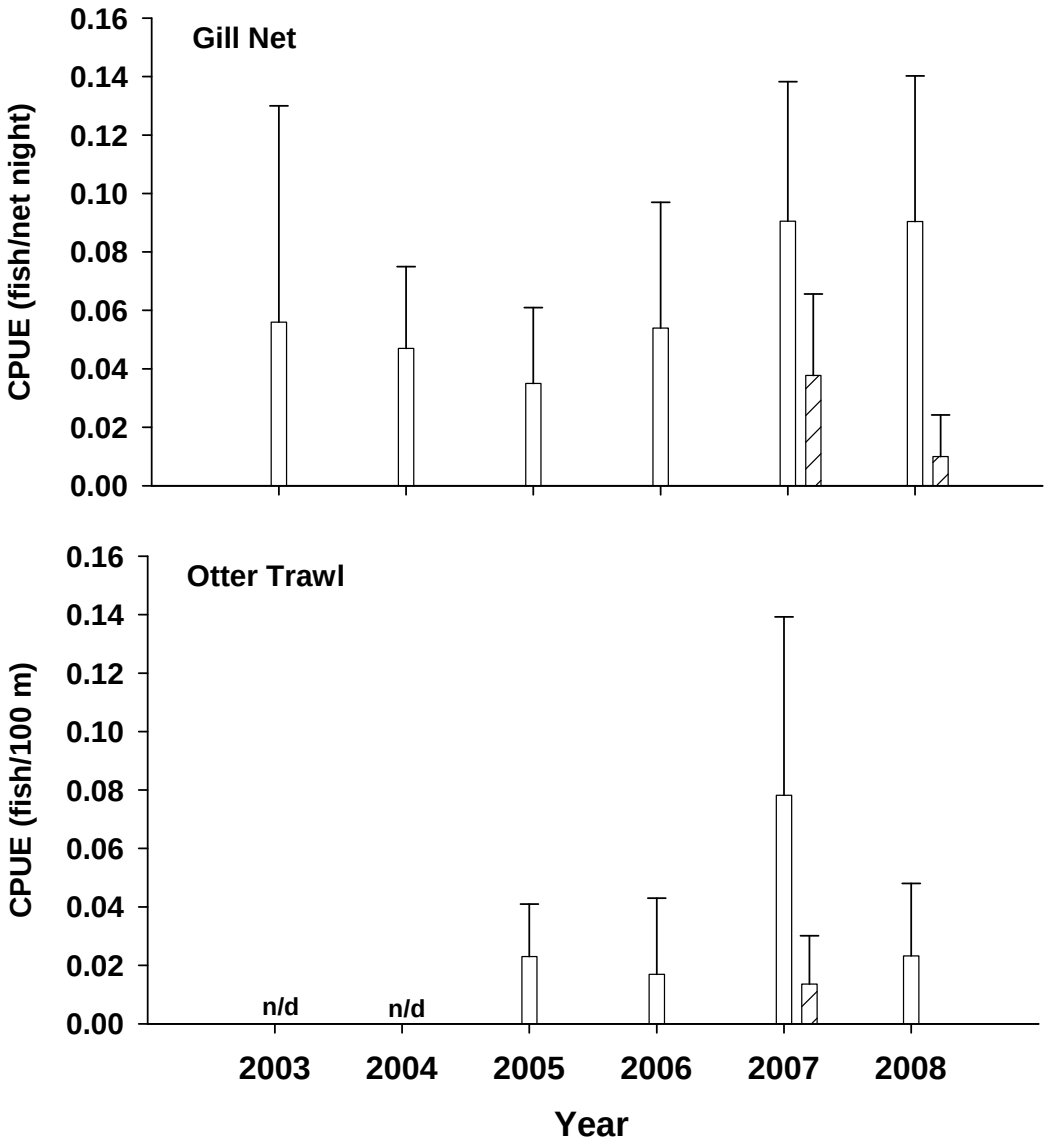

Figure 2. Mean annual catch per unit effort (+/- 2 SE) of wild (black bars), hatchery reared (white bars), and unknown origin (cross-hatched bars) pallid sturgeon using gill nets and otter trawls in segments 5 and 6 of the Missouri River during the sturgeon season 2003-2008. Pallid sturgeon of unknown origin are awaiting genetic verification.

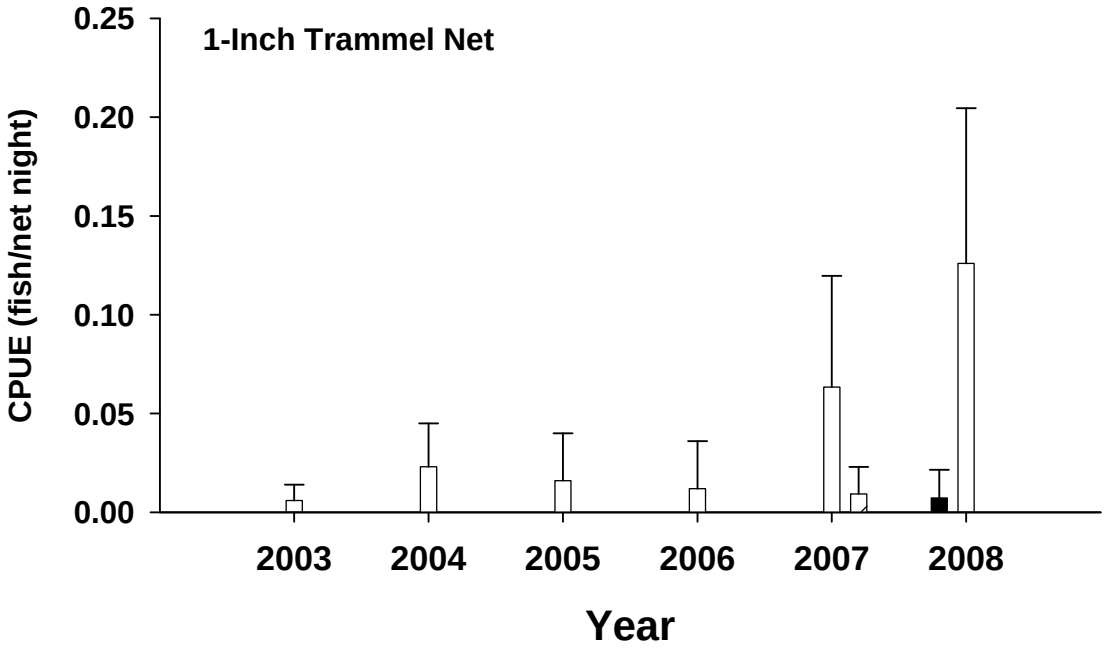

Figure 3. Mean annual catch per unit effort (+/- 2 SE) of wild (black bars), hatchery reared (white bars), and unknown origin (cross-hatched bars) pallid sturgeon using 1 inch trammel nets in segments 5 and 6 of the Missouri River during the sturgeon season 2003-2008. Pallid sturgeon of unknown origin are awaiting genetic verification.

Segments 5 and 6 - Pallid Sturgeon / Fish Community Season

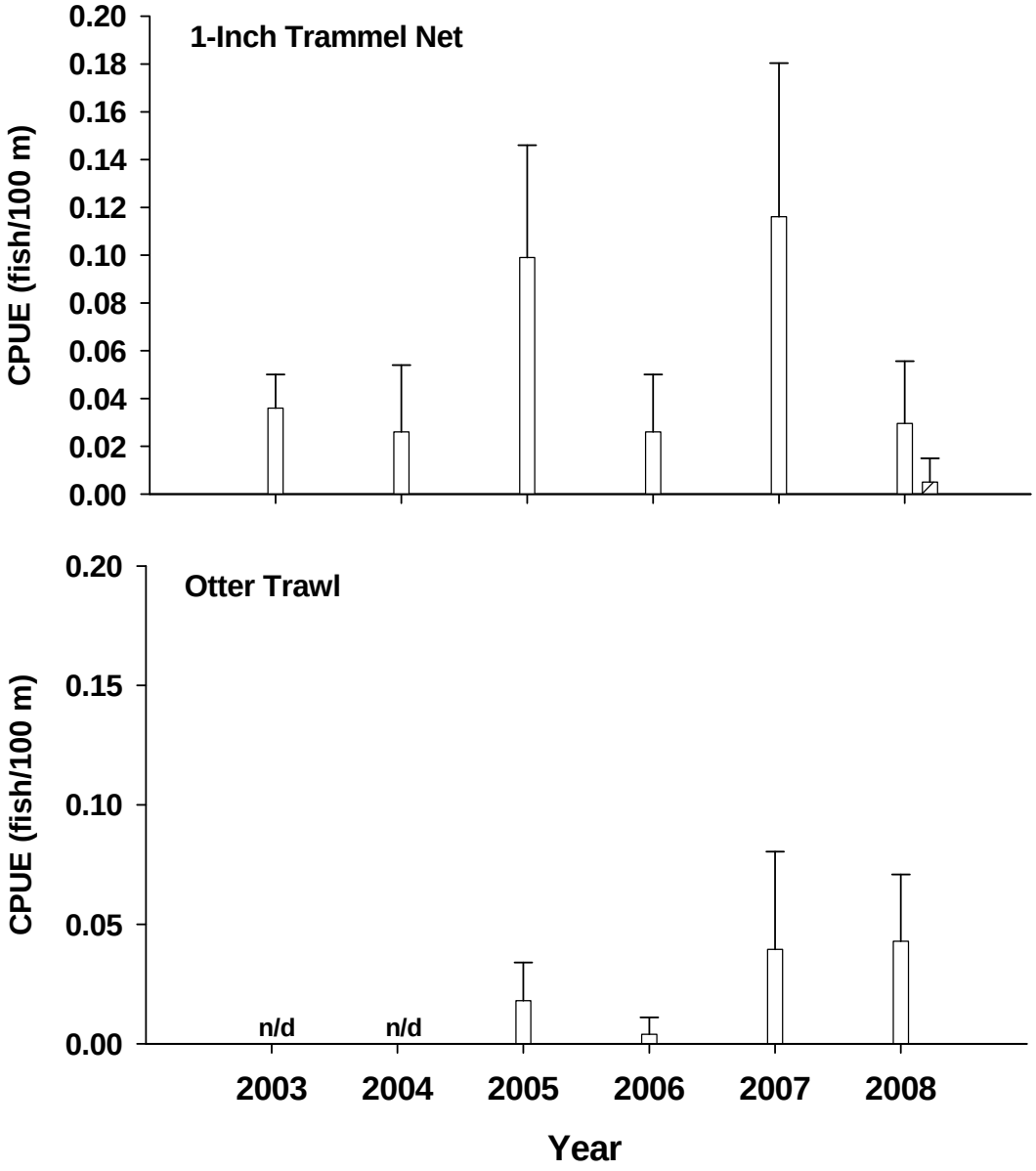

Figure 5. Mean annual catch per unit effort (+/- 2 SE) of wild (black bars), hatchery reared (white bars), and unknown origin (cross-hatched bars) pallid sturgeon using 1 inch trammel nets and otter trawls in segments 5 and 6 of the Missouri River during the fish community season 2003-2008. Pallid sturgeon of unknown origin are awaiting genetic verification. N/d indicates not deployed.

Table 11. Total number of sub-stock size (200-329 mm) pallid sturgeon captured for each gear during each season and the proportion caught within each macrohabitat type in segments 5 and 6 of the Missouri River during 2007-2008. The percent of total effort for each gear in each habitat is presented on the second line of each gear type. Size categories described in Table 7. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	N	Macrohabitat[a]													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCN	TRIB	TRML	TRMS	WILD
Fall through Spring - Sturgeon Season															
1 Inch Trammel Net	2	100	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(64)	(16)	0	N-E	N-E	(11)	(9)	0	N-E	N-E	N-E	0	0	N-E
Gill Net	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(50)	(14)	0	N-E	N-E	(19)	(17)	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(52)	(13)	0	N-E	N-E	(20)	(15)	0	N-E	N-E	N-E	0	0	N-E
Summer - Fish Community Season															
1 Inch Trammel Net	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(52)	(19)	0	N-E	N-E	(17)	(12)	0	N-E	N-E	N-E	0	0	N-E
Mini-Fyke Net	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(50)	(16)	(3)	N-E	N-E	(15)	(16)	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(49)	(15)	(5)	N-E	N-E	(17)	(13)	(1)	N-E	N-E	N-E	0	0	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

Table 12. Total number of sub-stock size (200-329 mm) pallid sturgeon captured for each gear during each season and the proportion caught within each mesohabitat type in segments 5 and 6 of the Missouri River during 2007-2008. The percent of total effort for each gear in each habitat is presented on the second line of each gear type. Size categories described in Table 7. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Fall through Spring - Sturgeon Season							
1 Inch Trammel Net	2	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Gill Net	0	0	0	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Otter Trawl	0	0	0	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Summer - Fish Community Season							
1 Inch Trammel Net	0	0	0	N-E	N-E	N-E	N-E
		(1)	(99)	N-E	N-E	N-E	N-E
Mini-Fyke Net	0	0	0	N-E	N-E	N-E	N-E
		(98)	(3)	N-E	N-E	N-E	N-E
Otter Trawl	0	0	0	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

Table 13. Total number of stock size (330-629 mm) pallid sturgeon captured for each gear during each season and the proportion caught within each macrohabitat type in segments 5 and 6 of the Missouri River during 2007-2008. The percent of total effort for each gear in each habitat is presented on the second line of each gear type. Size categories described in Table 7. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	N	Macrohabitat[a]													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCN	TRIB	TRML	TRMS	WILD
Fall through Spring - Sturgeon Season															
1 Inch Trammel Net	9	89	11	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(64)	(16)	0	N-E	N-E	(11)	(9)	0	N-E	N-E	N-E	0	0	N-E
Gill Net	16	56	25	0	N-E	N-E	6	13	0	N-E	N-E	N-E	0	0	N-E
		(50)	(14)	0	N-E	N-E	(19)	(17)	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	5	80	0	0	N-E	N-E	20	0	0	N-E	N-E	N-E	0	0	N-E
		(52)	(13)	0	N-E	N-E	(20)	(15)	0	N-E	N-E	N-E	0	0	N-E
Summer - Fish Community Season															
1 Inch Trammel Net	5	40	20	0	N-E	N-E	20	20	0	N-E	N-E	N-E	0	0	N-E
		(52)	(19)	0	N-E	N-E	(17)	(12)	0	N-E	N-E	N-E	0	0	N-E
Mini-Fyke Net	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(50)	(16)	(3)	N-E	N-E	(15)	(16)	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	11	91	0	9	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(49)	(15)	(5)	N-E	N-E	(17)	(13)	(1)	N-E	N-E	N-E	0	0	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

Table 14. Total number of stock size (330-629 mm) pallid sturgeon captured for each gear during each season and the proportion caught within each mesohabitat type in segments 5 and 6 of the Missouri River during 2007-2008. The percent of total effort for each gear in each habitat is presented on the second line of each gear type. Size categories described in Table 7. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	N	Mesohabitat[a]					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Fall through Spring - Sturgeon Season							
1 Inch Trammel Net	9	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Gill Net	16	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Otter Trawl	5	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Summer - Fish Community Season							
1 Inch Trammel Net	5	0	100	N-E	N-E	N-E	N-E
		(1)	(99)	N-E	N-E	N-E	N-E
Mini-Fyke Net	0	0	0	N-E	N-E	N-E	N-E
		(98)	(3)	N-E	N-E	N-E	N-E
Otter Trawl	11	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

Table 15. Total number of quality size and greater (≥630 mm) pallid sturgeon captured for each gear during each season and the proportion caught within each macrohabitat type in segments 5 and 6 of the Missouri River during 2007-2008. The percent of total effort for each gear in each habitat is presented on the second line of each gear type. Size categories described in Table 7. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	N	Macrohabitat[a]													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCN	TRIB	TRML	TRMS	WILD
Fall through Spring - Sturgeon Season															
1 Inch Trammel Net	1	100	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(64)	(16)	0	N-E	N-E	(11)	(9)	0	N-E	N-E	N-E	0	0	N-E
Gill Net	4	75	0	0	N-E	N-E	(25)	0	0	N-E	N-E	N-E	0	0	N-E
		(50)	(14)	0	N-E	N-E	(19)	(17)	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(52)	(13)	0	N-E	N-E	(20)	(15)	0	N-E	N-E	N-E	0	0	N-E
Summer - Fish Community Season															
1 Inch Trammel Net	1	100	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(52)	(19)	0	N-E	N-E	(17)	(12)	0	N-E	N-E	N-E	0	0	N-E
Mini-Fyke Net	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(50)	(16)	(3)	N-E	N-E	(15)	(16)	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	7	100	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(49)	(15)	(5)	N-E	N-E	(17)	(13)	(1)	N-E	N-E	N-E	0	0	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

Table 16. Total number of quality size and greater (≥630 mm) pallid sturgeon captured for each gear during each season and the proportion caught within each mesohabitat type in segments 5 and 6 of the Missouri River during 2007-2008. The percent of total effort for each gear in each habitat is presented on the second line of each gear type. Size categories described in Table 7. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	N	Mesohabitat[a]					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Fall through Spring - Sturgeon Season							
1 Inch Trammel Net	1	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Gill Net	4	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Otter Trawl	0	0	0	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Summer - Fish Community Season							
1 Inch Trammel Net	1	0	100	N-E	N-E	N-E	N-E
		(1)	(99)	N-E	N-E	N-E	N-E
Mini-Fyke Net	0	0	0	N-E	N-E	N-E	N-E
		(98)	(3)	N-E	N-E	N-E	N-E
Otter Trawl	7	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

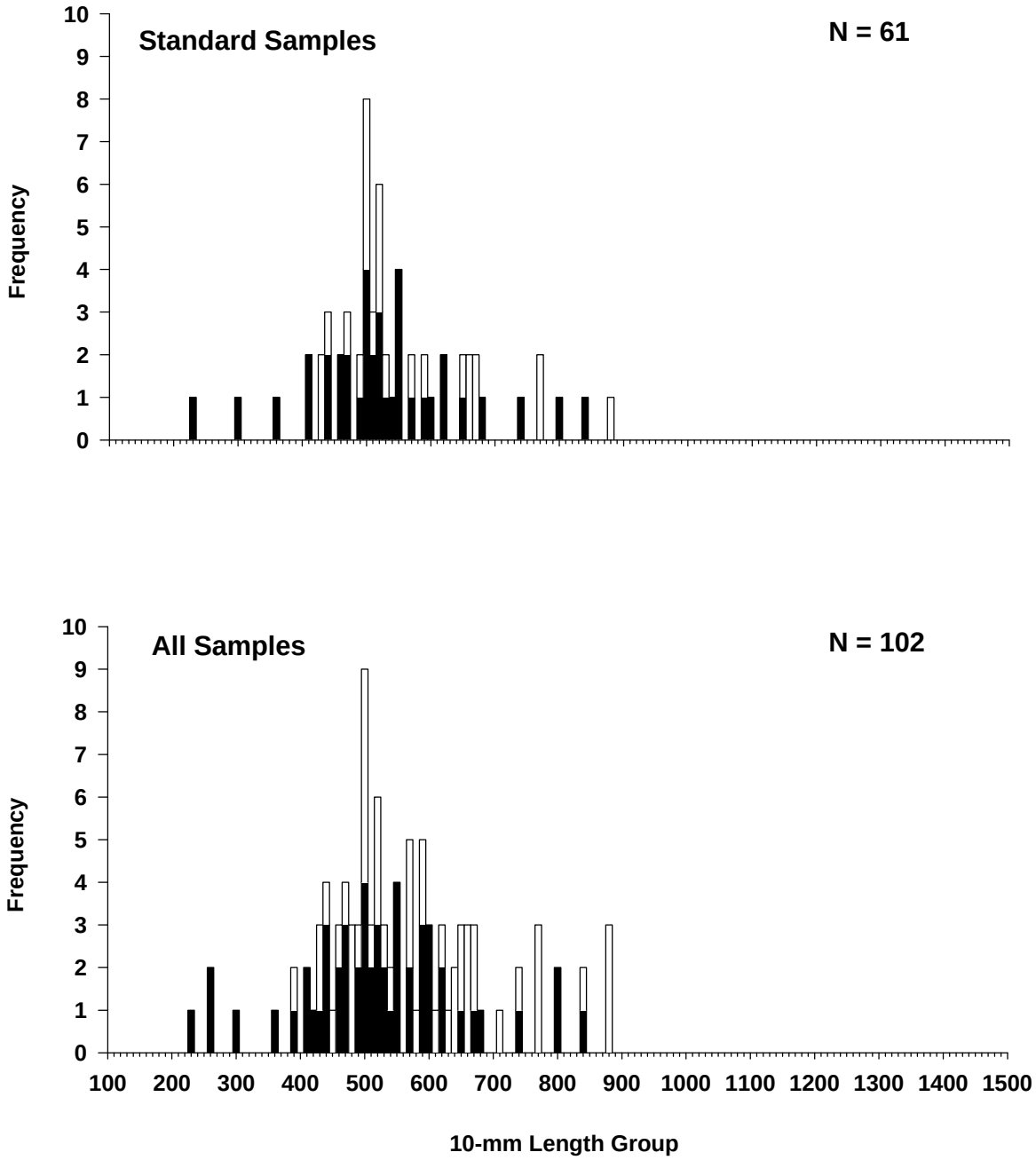

Figure 8. Length frequency of pallid sturgeon captured during fall through spring (sturgeon season; black bars) and summer (fish community season; white bars) in segments 5 and 6 of the Missouri River during 2007-2008. Standard samples include only standard gears, random bends, and random subsamples. All samples include all sampling conducted during 2007-2008.

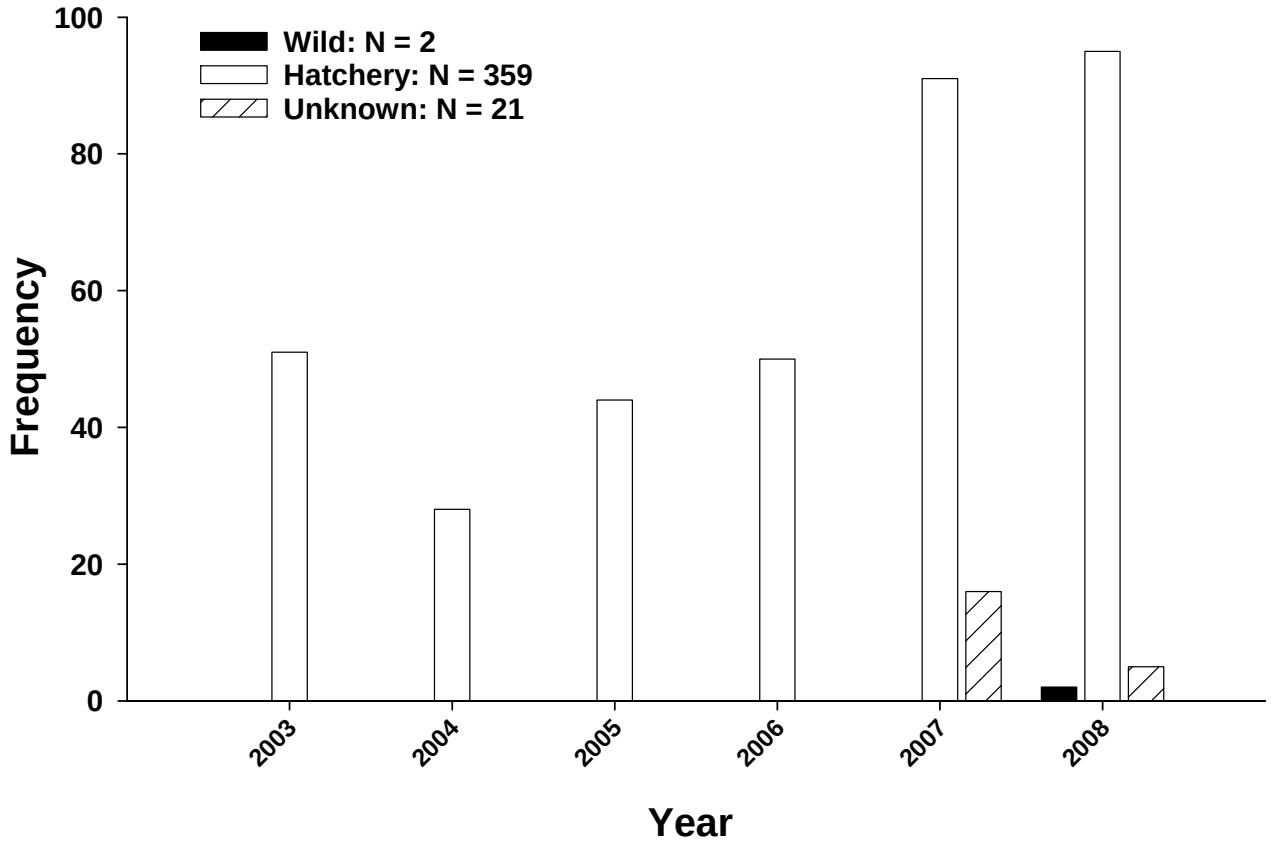

Figure 9. Annual capture history of wild (black bars), hatchery reared (white bars), and unknown origin (cross-hatched bars) pallid sturgeon collected in segments 5 and 6 of the Missouri River from 2003 to 2008. Figure is designed to compare overall pallid sturgeon captures from year to year and is biased by variable effort among years. Figure includes all pallid captures including non-random and wild samples.

Shovelnose X Pallid Sturgeon Hybrids

No shovelnose X pallid sturgeon hybrids were captured in segments 5 and 6 during 2008 or in previous years (2003 – 2007) since monitoring began.

Targeted Native River Species

Objective 4. Document annual results and long-term trends in native target species population abundance and geographic distribution throughout the Missouri River System.

Objective 5. Document annual results and long-term trends of habitat usage of the target native species by season.

Shovelnose Sturgeon

A total of 249 shovelnose sturgeon were sampled with standard effort and an additional 46 fish were captured in duplicate passes for active gears and non-random deployments. All shovelnose sturgeon were captured with gill nets (n = 133), trammel nets (n = 132), and otter trawls (n = 30). A total of 227 shovelnose sturgeons were captured during the sturgeon season while 68 were captured during the fish community season. Mean catch per unit effort of shovelnose sturgeon (Figures 11, 12, and 14) was 0.67 fish/net night in gill nets. The mean CPUE of shovelnose sturgeon in trammel nets during the sturgeon season was nearly twice that of the fish community season. Mean CPUE in gill nets during 2008 increased 17% from the running average for 2003 – 2007, but decreased over 33% from the previous two years (Figure 11). Trammel net mean CPUE during both seasons increased (34 and 68%) during 2008 compared to 2007, but has remained fairly consistent from 2003 – 2007 (Figures 12 and 14). Mean CPUE for the otter trawl in the sturgeon season was over 35% lower than the fish community season. In 2008, mean CPUE for otter trawls decreased 172% during the sturgeon season and 44% during the fish community season compared to the 2005 - 2007 running average. No shovelnose sturgeon were captured in the mini-fyke nets during 2008.

Shovelnose sturgeon were found in all macrohabitats sampled with the exception of large secondary connected channels (Table 23). For all gears pooled, shovelnose sturgeon were captured from braided channel (44%), outside bend (30%), channel crossover (18%), and inside bend (7%) macrohabitats during the sturgeon season. While during the fish community season, 57% of shovelnose sturgeon were captured in braided channels, 34% in inside bend, 7% in channel crossovers, and 1% in outside bend macrohabitats. For otter trawls, the proportion of total shovelnose sturgeon captured was greater than the proportion of effort expended in the braided macrohabitat. A greater proportion of shovelnose sturgeon were caught with trammel nets, gill nets, and otter trawls in the outside bend macrohabitat during the sturgeon season compared to the proportion of effort expended in those habitats. During the fish community season with otter trawls and trammel nets, the proportion of the total shovelnose sturgeon caught was greater than the proportion of effort expended in the braided and inside bend macrohabitats. The majority of shovelnose sturgeon were caught in the channel boarder mesohabitat (> 99%; Table 24), while 41% of shovelnose sturgeon were captured in the Niobrara River Delta of the Missouri River.

No shovelnose sturgeon smaller than the preferred size category (FL ≤ 510 mm) were captured downstream of Fort Randall Dam during 2008. Fork lengths of shovelnose sturgeon ranged from 520 - 770 mm, with 74% of the fish between 600 – 700 mm (Figure 17). Incremental RSD for shovelnose sturgeon in both seasons indicated an ageing population with no observed recruitment (Table 25). Shovelnose sturgeon captured during the sturgeon (n = 227) and fish community seasons (n = 68) exhibited a similar mean Wr of 92, which was lower than 2007 (Wr > 94).

Segments 5 and 6 - Shovelnose Sturgeon / Sturgeon Season

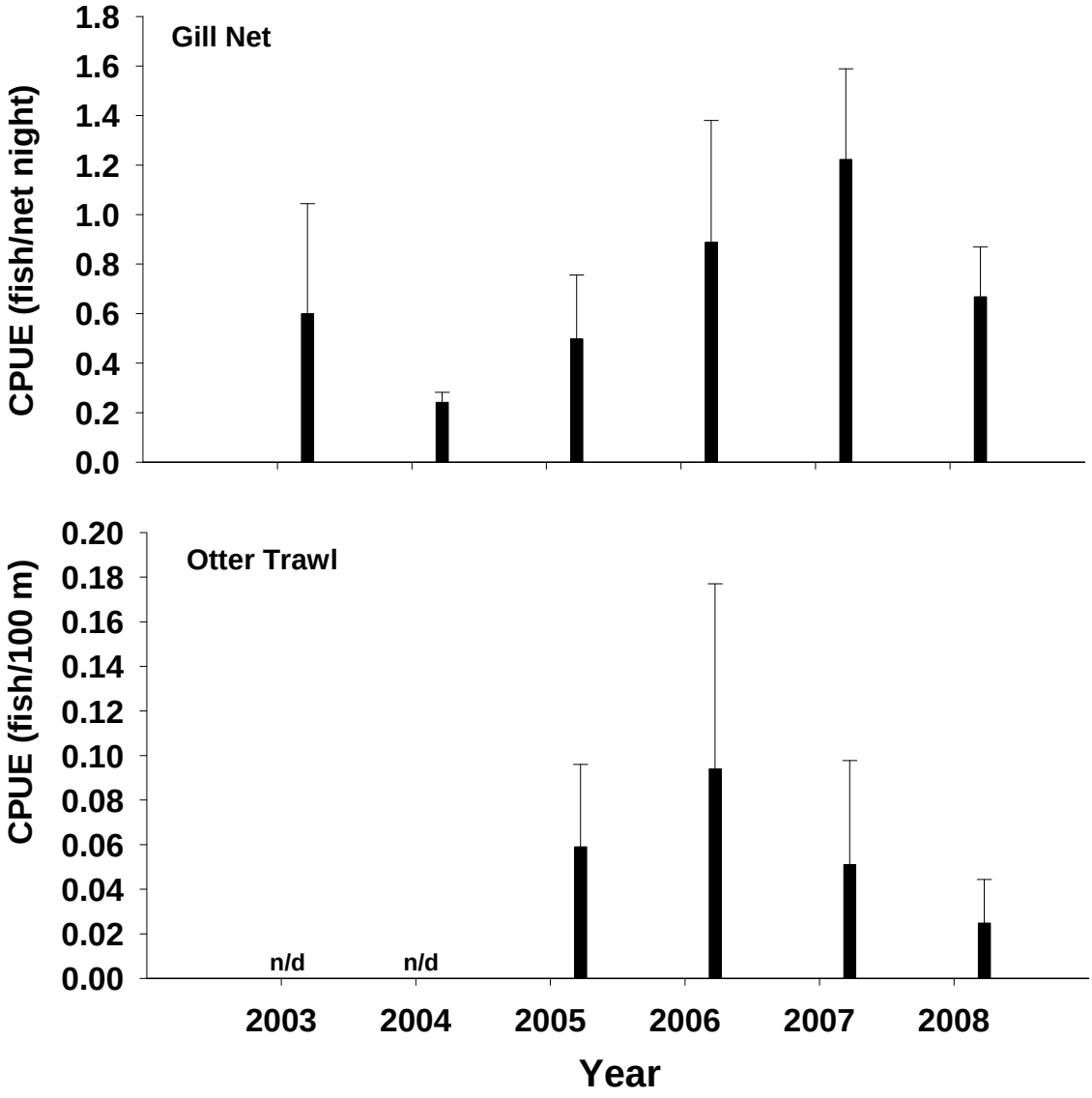

Figure 11. Mean annual catch per unit effort (+/- 2 SE) of sub-stock size (0-149 mm; white bars), sub-stock size (150-249 mm; cross-hatched), stock size (250-379 mm; gray bars), and quality and above size (> 380 mm; black bars) shovelnose sturgeon using gill nets and otter trawls in segments 5 and 6 of the Missouri River during the sturgeon season 2003-2008. N/d indicates not deployed.

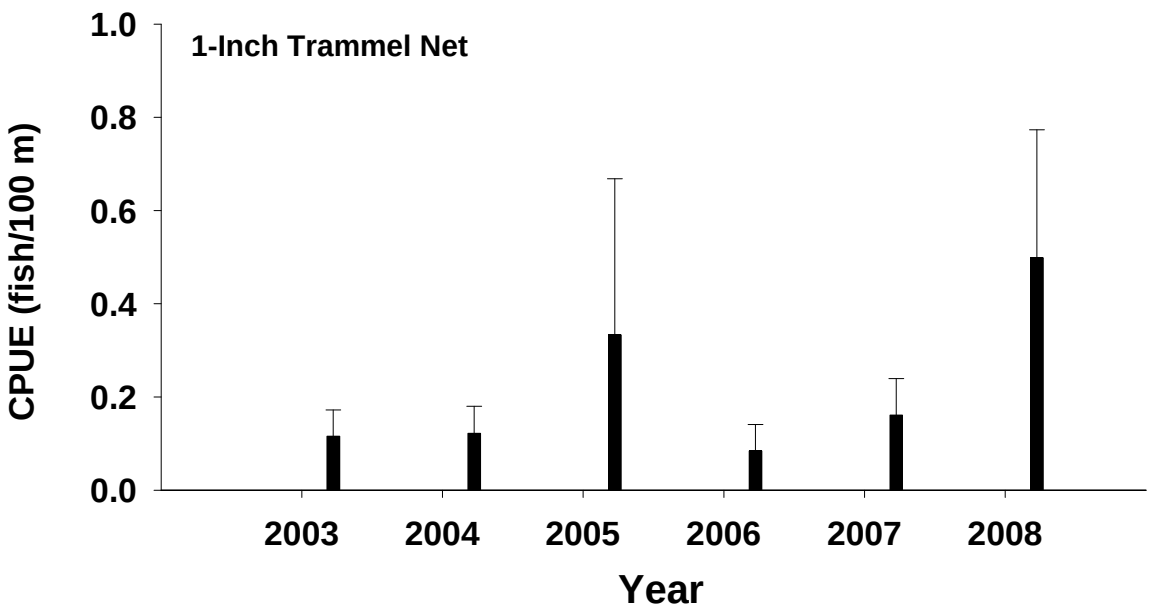

Figure 12. Mean annual catch per unit effort (+/- 2 SE) of sub-stock size (0-149 mm; white bars), sub-stock size (150-249 mm; cross-hatched), stock size (250-379 mm; gray bars), and quality and above size (> 380 mm; black bars) shovelnose sturgeon using 1 inch trammel nets in segments 5 and 6 of the Missouri River during the sturgeon season 2003-2008.

Segments 5 and 6 - Shovelnose Sturgeon / Fish Community Season

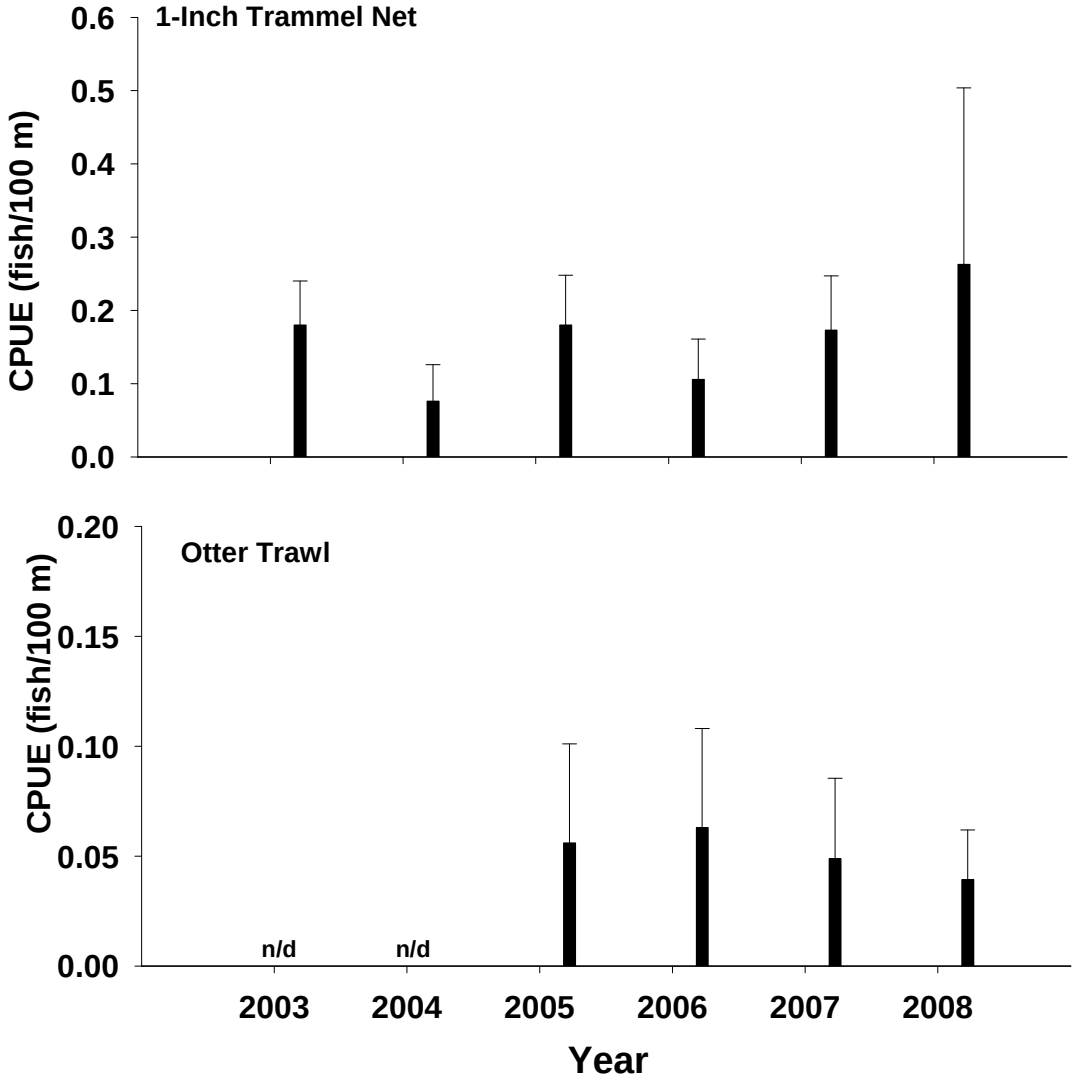

Figure 14. Mean annual catch per unit effort (+/- 2 SE) of sub-stock size (0-149 mm; white bars), sub-stock size (150-249 mm; cross-hatched), stock size (250-379 mm; gray bars), and quality and above size (> 380 mm; black bars) shovelnose sturgeon using 1 inch trammel nets and otter trawls in segments 5 and 6 of the Missouri River during the fish community season 2003-2008. N/d indicates not deployed.

Table 23. Total number of quality size and greater (≥380 mm) shovelnose sturgeon captured for each gear during each season and the proportion caught within each macrohabitat type in segments 5 and 6 of the Missouri River during 2007-2008. The percent of total effort for each gear in each habitat is presented on the second line of each gear type. Size categories described in Table 25. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	N	Macrohabitat[a]													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCN	TRIB	TRML	TRMS	WILD
Fall through Spring - Sturgeon Season															
1 Inch Trammel Net	54	52	30	0	N-E	N-E	2	17	0	N-E	N-E	N-E	0	0	N-E
		(64)	(16)	0	N-E	N-E	(11)	(9)	0	N-E	N-E	N-E	0	0	N-E
Gill Net	133	32	15	0	N-E	N-E	12	41	0	N-E	N-E	N-E	0	0	N-E
		(50)	(14)	0	N-E	N-E	(19)	(17)	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	6	67	0	0	N-E	N-E	0	33	0	N-E	N-E	N-E	0	0	N-E
		(52)	(13)	0	N-E	N-E	(20)	(15)	0	N-E	N-E	N-E	0	0	N-E
Summer - Fish Community Season															
1 Inch Trammel Net	40	33	10	0	N-E	N-E	58	0	0	N-E	N-E	N-E	0	0	N-E
		(52)	(19)	0	N-E	N-E	(17)	(12)	0	N-E	N-E	N-E	0	0	N-E
Mini-Fyke Net	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(50)	(16)	(3)	N-E	N-E	(15)	(16)	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	16	88	6	0	N-E	N-E	0	6	0	N-E	N-E	N-E	0	0	N-E
		(49)	(15)	(5)	N-E	N-E	(17)	(13)	(1)	N-E	N-E	N-E	0	0	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

Table 24. Total number of quality size and greater (≥380 mm) shovelnose sturgeon captured for each gear during each season and the proportion caught within each mesohabitat type in segments 5 and 6 of the Missouri River during 2007-2008. The percent of total effort for each gear in each habitat is presented on the second line of each gear type. Size categories described in Table 25. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	N	Mesohabitat[a]					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Fall through Spring - Sturgeon Season							
1 Inch Trammel Net	54	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Gill Net	133	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Otter Trawl	6	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Summer - Fish Community Season							
1 Inch Trammel Net	40	5	95	N-E	N-E	N-E	N-E
		(1)	(99)	N-E	N-E	N-E	N-E
Mini-Fyke Net	0	0	0	N-E	N-E	N-E	N-E
		(98)	(3)	N-E	N-E	N-E	N-E
Otter Trawl	16	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

Segments 5 and 6 - Shovelnose Sturgeon

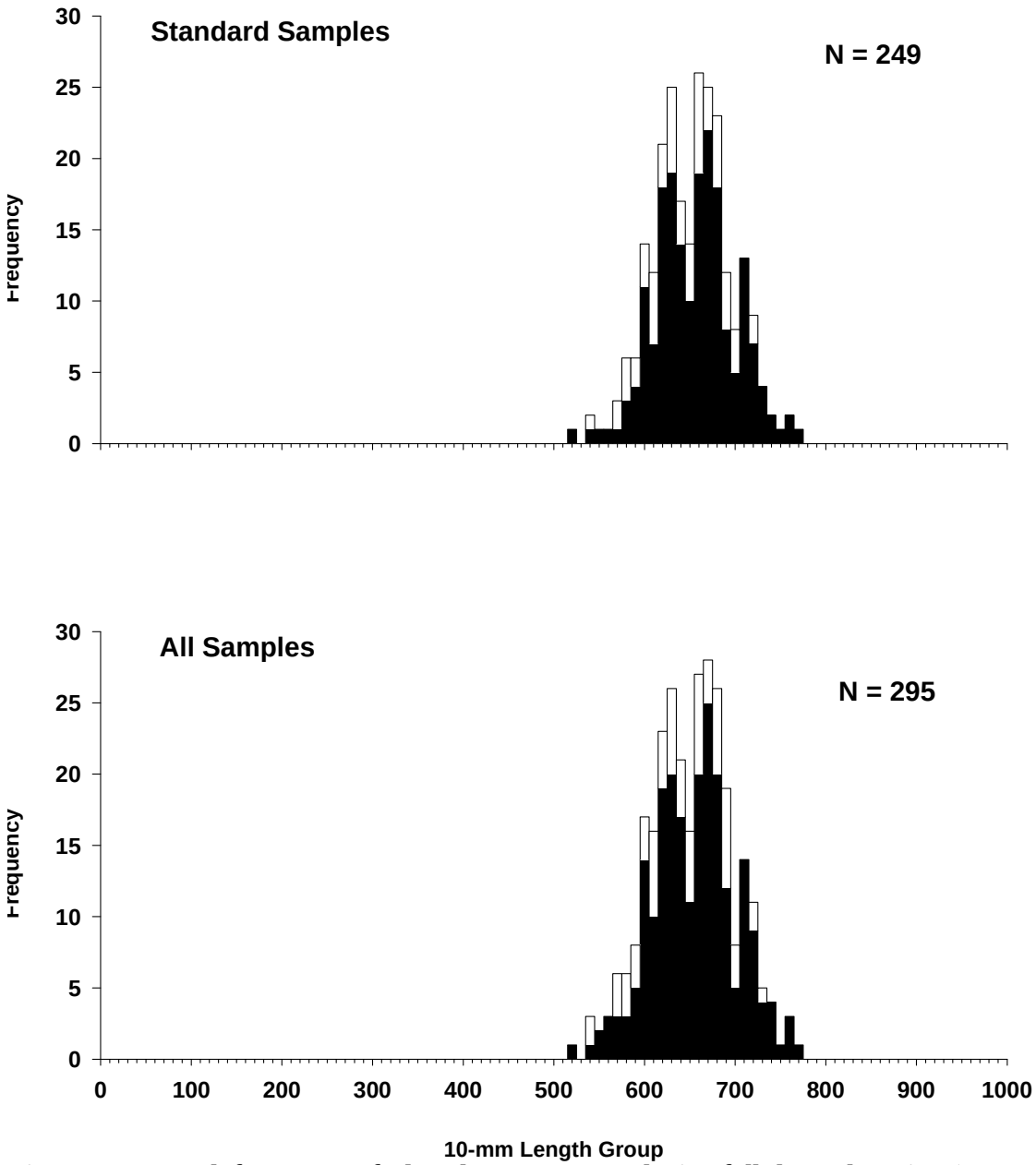

Figure 17. Length frequency of shovelnose sturgeon during fall through spring (sturgeon season; black bars) and summer (fish community season; white bars) in segments 5 and 6 of the Missouri River during 2007-2008. Standard samples include only standard gears, random bends, and random subsamples. All samples include all sampling conducted during 2007-2008.

Table 25. Incremental relative stock density (RSD)[a] and mean relative weight (Wr) by length category for shovelnose sturgeon in segments 5 and 6 of the Missouri River captured during 2007-2008. Length categories[b] determined using methods proposed by Quist (1998).

Length category	N	RSD	Wr (+/- 2 SE)
Fall through Spring - Sturgeon Season			
Sub-stock (0-149 mm)	0	.	0
Sub-stock (150-249 mm)	0	.	0
Stock	0	.	0
Quality	0	.	0
Preferred	67	35	97.98 (3.562)
Memorable	126	65	88.33 (1.579)
Trophy	0	.	0
Overall Wr	.	.	91.68 (1.736)
Summer - Fish Community Season			
Sub-stock (0-149 mm)	0	.	0
Sub-stock (150-249 mm)	0	.	0
Stock	0	.	0
Quality	0	.	0
Preferred	25	45	93.18 (4.428)
Memorable	31	55	90.21 (4.225)
Trophy	0	.	0
Overall Wr	.	.	91.53 (3.061)

[a] RSD = (# of fish of a specified length class / # of fish ≥ minimum stock length fish) * 100.
[b] Length categories based on the percentage of the largest known shovelnose sturgeon: Sub-stock FL < 250 mm (20 %), Stock FL =250-379 mm (20 – 36 %), Quality FL = 380 – 509 mm (36 – 45 %), Preferred FL = 510 - 639 mm (45 – 59 %), Memorable FL = 640 – 809 mm (59 – 74 %), Trophy FL > 810 mm (>74 %).

Sturgeon Chub

No sturgeon chubs were captured during the 2008 sampling season. This is the sixth year (2003 – 2008) of zero captures for sturgeon chubs.

Sicklefin Chub

No sicklefin chubs were captured during the 2008 sampling season. This is the sixth year (2003 – 2008) of zero captures for sicklefin chubs.

Speckled Chub

No speckled chubs were captured during the 2008 sampling season. This is the sixth year (2003 – 2008) of zero captures for speckled chubs.

Sand Shiner

A total of 143 sand shiners were captured during the fish community season in 2008 with all but four fish captured in mini-fyke nets (Figures 30 - 32). Annual catch per unit effort during 2008 for mini-fyke nets (Figure 32) was the highest observed (2.73 fish/net night)since monitoring began in 2003. Over 97% of the fish captured in mini-fyke nets were collected in the braided macrohabitat with the remainder captured in the outside bend (3%) macrohabitat (Table 32). Half of the sand shiners captured with the otter trawl were collected in the channel border of the braided (n = 2) and confluence (n = 2) macrohabitats. In 2006 and 2008 the majority of all sand shiners were captured downstream of the Niobrara River confluence with the exception of five fish in 2008; whereas, in 2007 nearly all sand shiners were captured upstream of the Niobrara River confluence. Mini-fyke nets were only set in the bar mesohabitat (Table 33). Over 73% of the sand shiners captured were between 35 – 39 mm (Figure 33).

Segments 5 and 6 - Sand Shiner / Sturgeon Season

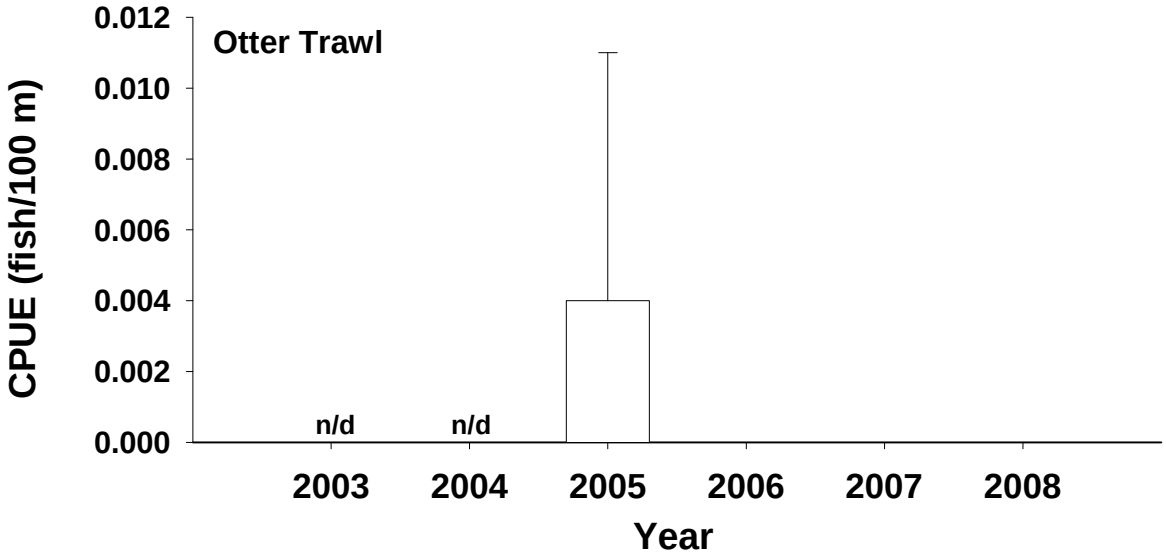

Figure 30. Mean annual catch per unit effort (+/- 2 SE) of sand shiners with otter trawls in segments 5 and 6 of the Missouri River during the sturgeon season 2003-2008. N/d indicates not deployed.

Segments 5 and 6 - Sand Shiner / Fish Community Season

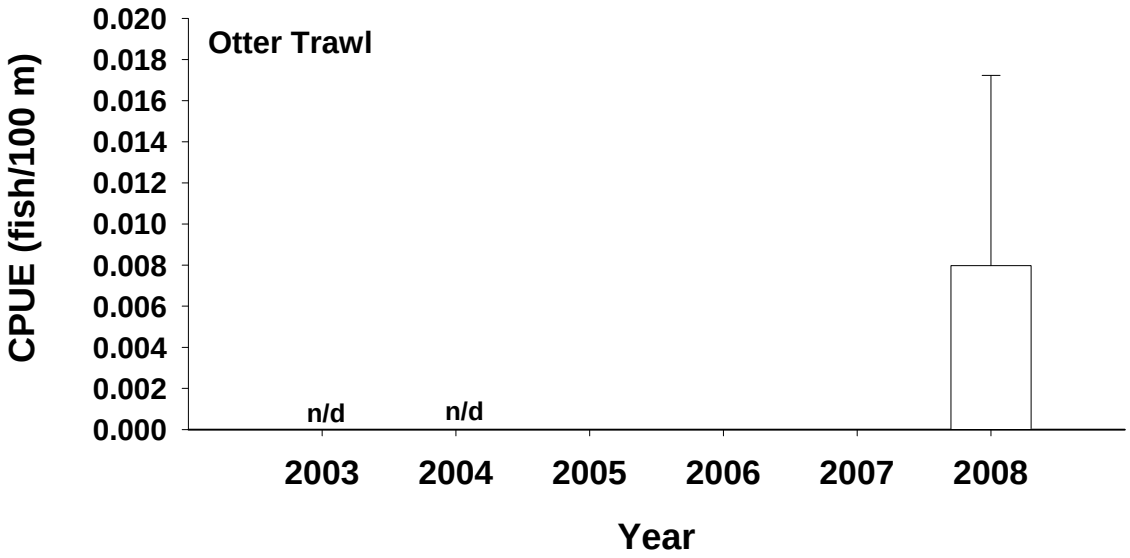

Figure 31. Mean annual catch per unit effort (+/- 2 SE) of sand shiners with otter trawls in segments 5 and 6 of the Missouri River during the fish community season 2003-2008. N/d indicates not deployed.

Segments 5 and 6 - Sand Shiner / Fish Community Season

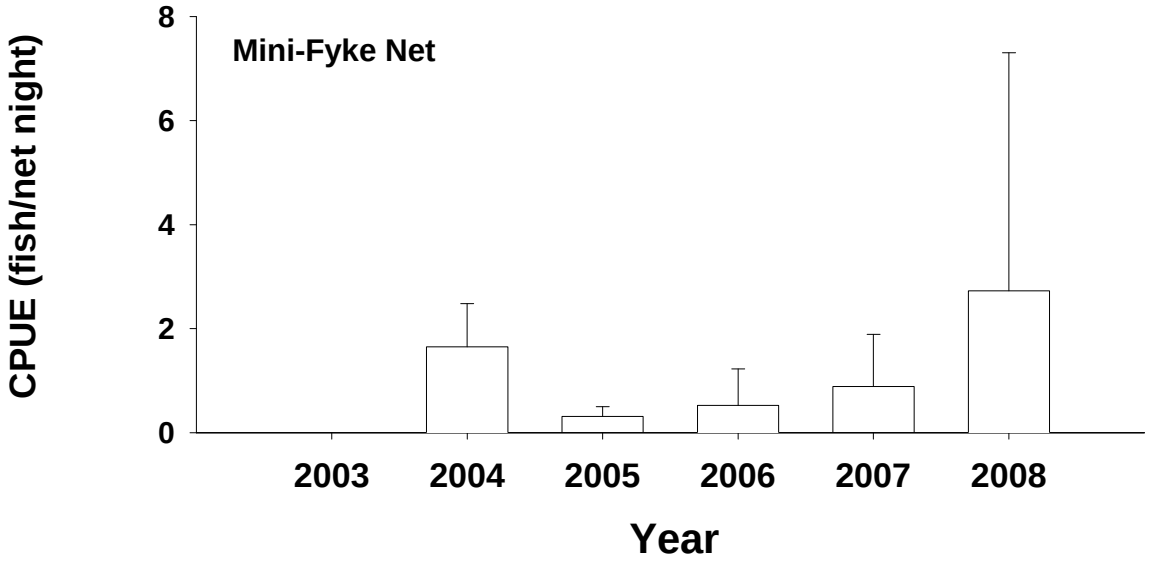

Figure 32. Mean annual catch per unit effort (+/- 2 SE) of sand shiners with mini-fyke nets in segments 5 and 6 of the Missouri River during the fish community season 2003-2008.

Table 32. Total number of sand shiners captured for each gear during each season and the proportion caught within each macrohabitat type in segments 5 and 6 of the Missouri River during 2007-2008. The percent of total effort for each gear in each habitat is presented on the second line of each gear type. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	N	Macrohabitat[a]													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCN	TRIB	TRML	TRMS	WILD
Fall through Spring - Sturgeon Season															
1 Inch Trammel Net	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(64)	(16)	0	N-E	N-E	(11)	(9)	0	N-E	N-E	N-E	0	0	N-E
Gill Net	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(50)	(14)	0	N-E	N-E	(19)	(17)	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(52)	(13)	0	N-E	N-E	(20)	(15)	0	N-E	N-E	N-E	0	0	N-E
Summer - Fish Community Season															
1 Inch Trammel Net	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(52)	(19)	0	N-E	N-E	(17)	(12)	0	N-E	N-E	N-E	0	0	N-E
Mini-Fyke Net	218	(98)	0	0	N-E	N-E	0	(2)	0	N-E	N-E	N-E	0	0	N-E
		(50)	(16)	(3)	N-E	N-E	(15)	(16)	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	3	67	0	33	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(49)	(15)	(5)	N-E	N-E	(17)	(13)	(1)	N-E	N-E	N-E	0	0	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

Table 33. Total number of sand shiners captured for each gear during each season and the proportion caught within each mesohabitat type in segments 5 and 6 of the Missouri River during 2007-2008. The percent of total effort for each gear in each habitat is presented on the second line of each gear type. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	N	Mesohabitat[a]					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Fall through Spring - Sturgeon Season							
1 Inch Trammel Net	0	0	0	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Gill Net	0	0	0	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Otter Trawl	0	0	0	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Summer - Fish Community Season							
1 Inch Trammel Net	0	0	0	N-E	N-E	N-E	N-E
		(1)	(99)	N-E	N-E	N-E	N-E
Mini-Fyke Net	218	100	0	N-E	N-E	N-E	N-E
		(98)	(3)	N-E	N-E	N-E	N-E
Otter Trawl	3	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

Segments 5 and 6 - Sand Shiner

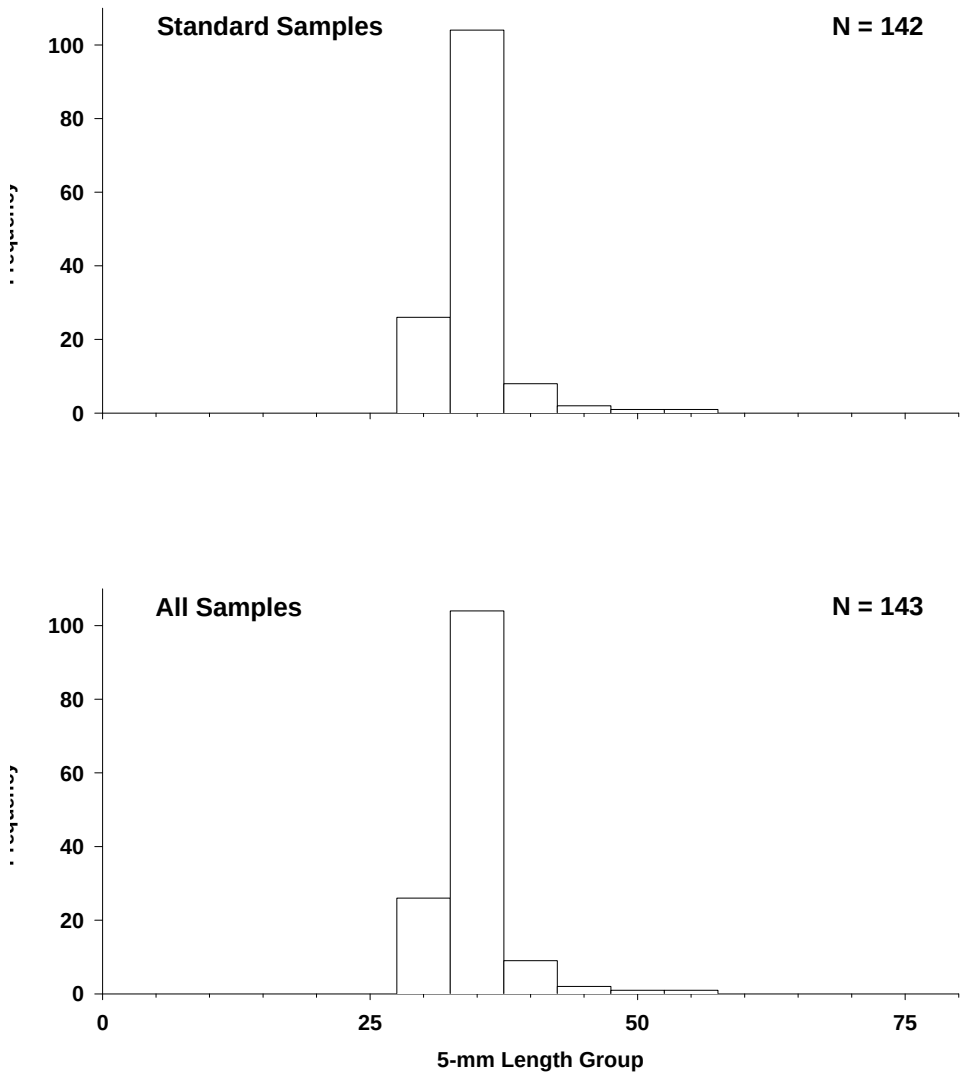

Figure 33. Length frequency of sand shiners during fall through spring (sturgeon season; black bars) and summer (fish community season; white bars) in segments 5 and 6 of the Missouri River during 2007-2008. Standard samples include only standard gears, random bends, and random subsamples. All samples include all sampling conducted during 2007-2008.

***Hybognathus* spp.**

A total of six unknown *Hybognathus spp*. were captured during the 2007 sampling season. All fish were captured in a single mini-fyke net during the fish community (summer) season on 29-June-2008, downstream of the Niobrara River confluence from a braided macrohabitat on bar mesohabitat. These six fish were too small (< 33 mm) to identify to species. During prior sampling from 2003 – 2007, one *Hybognathus* spp. was collected during 2005 and eight fish were collected during 2007 with mini-fyke nets. Additionally, during 2008, 37 brassy minnows *H. hankinsoni* were also captured in segment 5 with no captures occurring in segment 6. Over 95% of the brassy minnows captured were collected in four mini-fyke nets set immediately downstream of Fort Randall Dam in segment 5, bend 2.

Segments 5 and 6 - *Hybognathus* spp. / Sturgeon Season

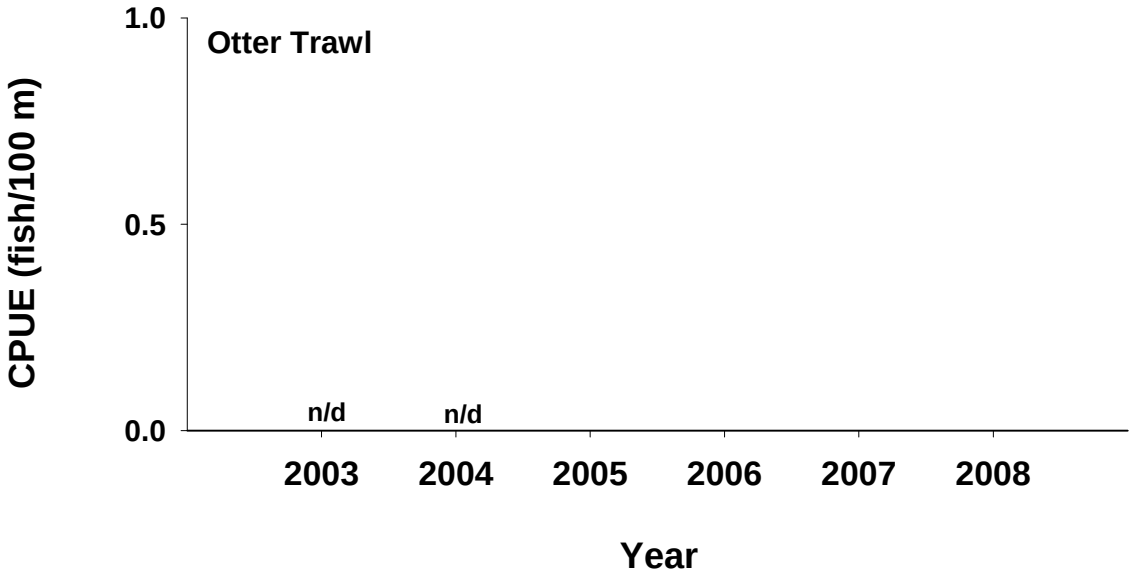

Figure 34. Mean annual catch per unit effort (+/- 2 SE) of *Hybognathus* spp. with otter trawls in segments 5 and 6 of the Missouri River during the sturgeon season 2003-2008. N/d indicates not deployed.

Segments 5 and 6 - *Hybognathus* spp. / Fish Community Season

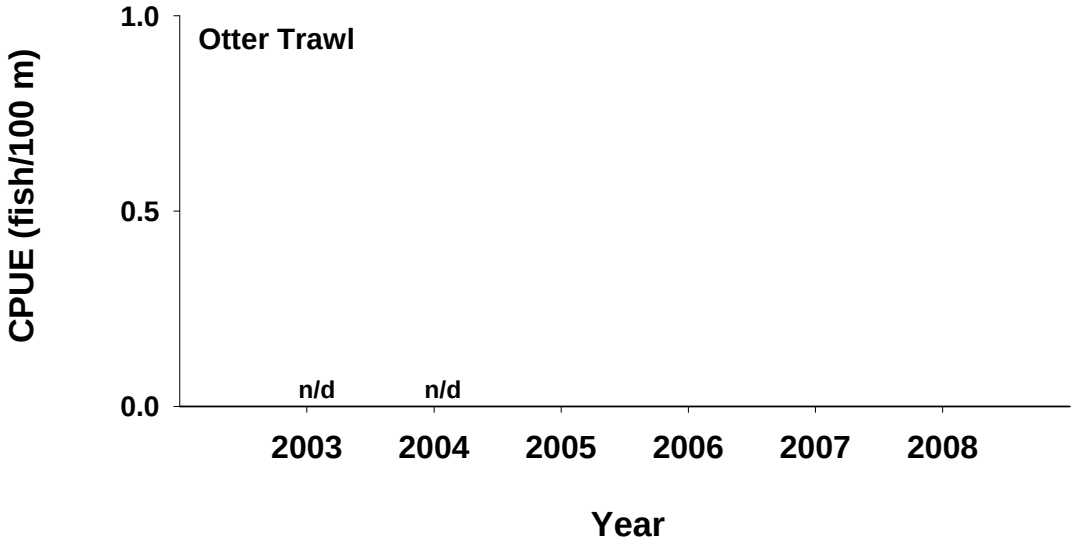

Figure 35. Mean annual catch per unit effort (+/- 2 SE) of *Hybognathus* spp. with otter trawls in segments 5 and 6 of the Missouri River during the fish community season 2003-2008. N/d indicates not deployed.

Segments 5 and 6 - *Hybognathus* spp. / Fish Community Season

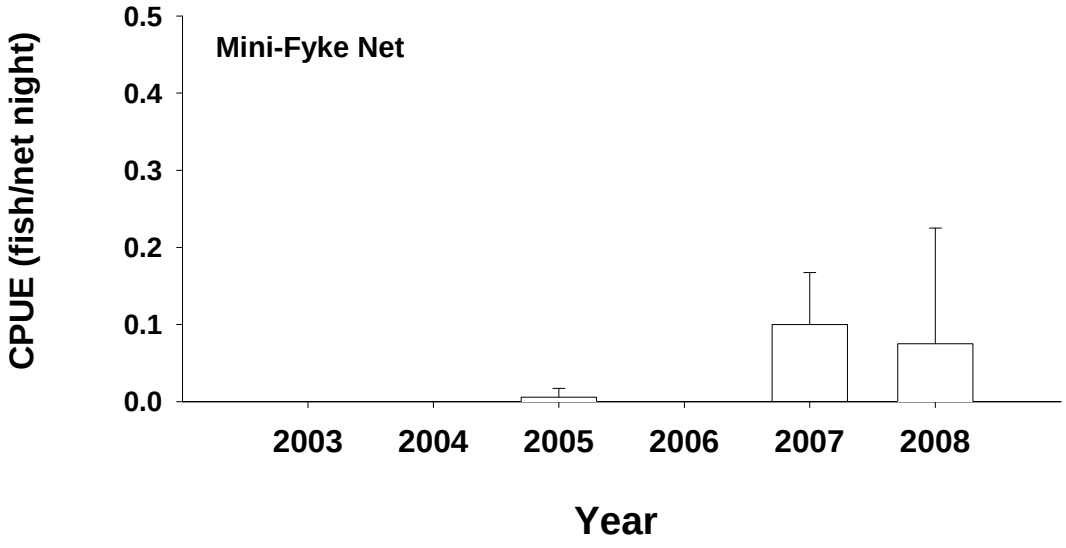

Figure 36. Mean annual catch per unit effort (+/- 2 SE) of *Hybognathus* spp. with mini-fyke nets in segments 5 and 6 of the Missouri River during the fish community season 2003-2008.

Table 34. Total number of *Hybognathus* spp. captured for each gear during each season and the proportion caught within each macrohabitat type in segments 5 and 6 of the Missouri River during 2007-2008. The percent of total effort for each gear in each habitat is presented on the second line of each gear type. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	N	Macrohabitat[a]													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCN	TRIB	TRML	TRMS	WILD
Fall through Spring - Sturgeon Season															
1 Inch Trammel Net	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(64)	(16)	0	N-E	N-E	(11)	(9)	0	N-E	N-E	N-E	0	0	N-E
Gill Net	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(50)	(14)	0	N-E	N-E	(19)	(17)	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(52)	(13)	0	N-E	N-E	(20)	(15)	0	N-E	N-E	N-E	0	0	N-E
Summer - Fish Community Season															
1 Inch Trammel Net	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(52)	(19)	0	N-E	N-E	(17)	(12)	0	N-E	N-E	N-E	0	0	N-E
Mini-Fyke Net	6	100	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(50)	(16)	(3)	N-E	N-E	(15)	(16)	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(49)	(15)	(5)	N-E	N-E	(17)	(13)	(1)	N-E	N-E	N-E	0	0	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

Table 35. Total number of *Hybognathus* spp. captured for each gear during each season and the proportion caught within each mesohabitat type in segments 5 and 6 of the Missouri River during 2007-2008. The percent of total effort for each gear in each habitat is presented on the second line of each gear type. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	N	Mesohabitat[a]					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Fall through Spring - Sturgeon Season							
1 Inch Trammel Net	0	0	0	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Gill Net	0	0	0	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Otter Trawl	0	0	0	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Summer - Fish Community Season							
1 Inch Trammel Net	0	0	0	N-E	N-E	N-E	N-E
		(1)	(99)	N-E	N-E	N-E	N-E
Mini-Fyke Net	6	100	0	N-E	N-E	N-E	N-E
		(98)	(3)	N-E	N-E	N-E	N-E
Otter Trawl	0	0	0	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

Segments 5 and 6 - *Hybognathus* spp.

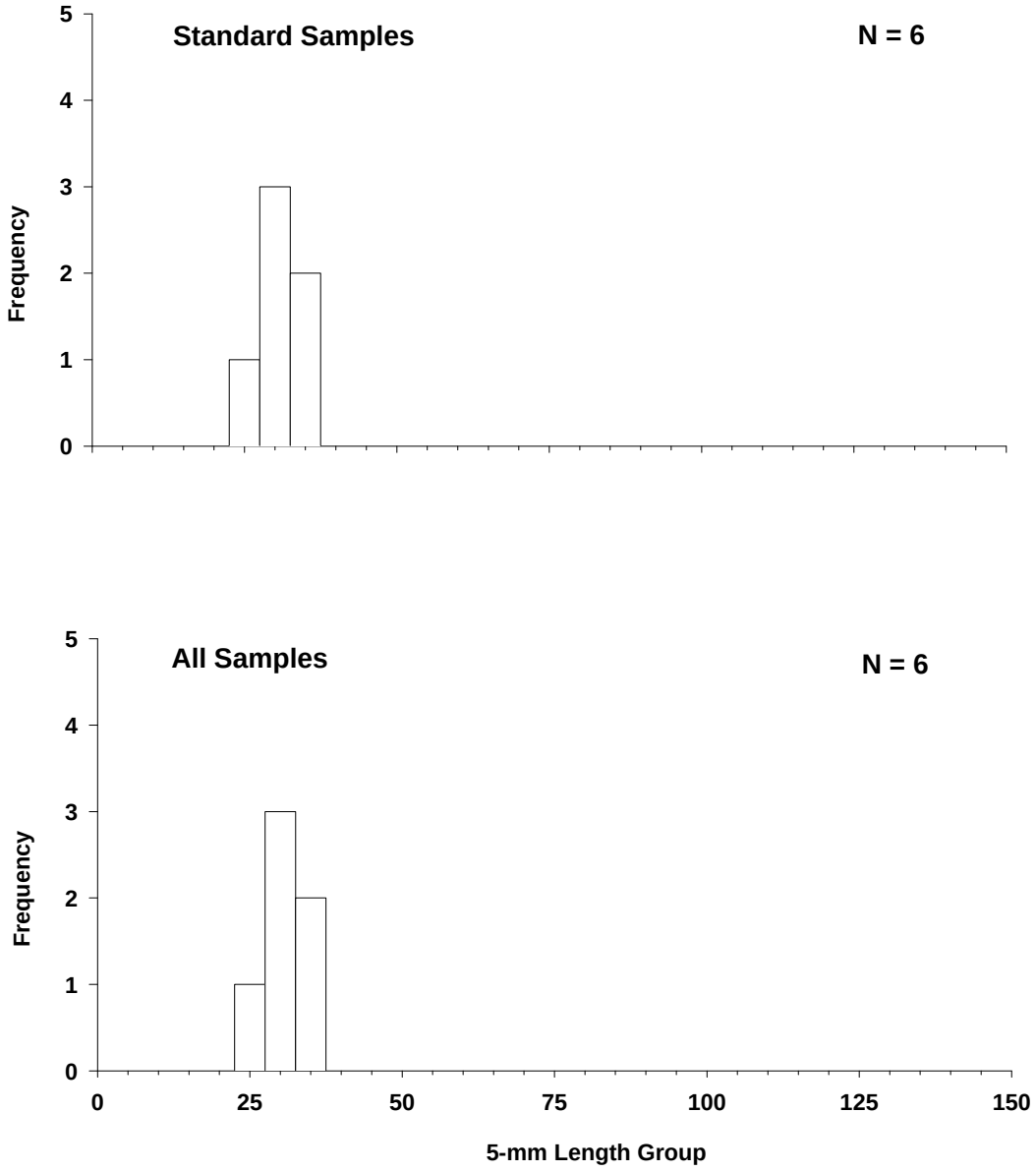

Figure 37. Length frequency of *Hybognathus* spp. caught during fall through spring (sturgeon season; black bars) and summer (fish community season; white bars) in segments 5 and 6 of the Missouri River during 2007-2008. Standard samples include only standard gears, random bends, and random subsamples. All samples include all sampling conducted during 2007-2008.

Blue Sucker

The total catch of blue suckers in standard gears during 2008 (n = 8) decreased 60% from 2007 (n = 20), but was similar to 2006 (n = 8). During 2008 the relative abundance of blue suckers captured with gill nets (0.025 fish/ net night) was similar to the 5 year average (0.024 fish/net night), but decreased 58% when compared 2007 (Figure 38). Abundance measured with trammel nets and the otter trawl ranged from 0 to < 0.01 fish/100m (Figure 38 – 41). Since the inception of this monitoring program, no blue suckers have been captured with mini-fyke nets (2003 - 2007). Of the 8 blue suckers captured in the standard gears, five were captured in gill nets, one in trammel nets, and two fish were captured in the otter trawl. Macrohabitats where blue suckers were captured (Table 36) included outside bends (n = 3), confluence (n = 1), channel crossovers (n = 2), and braided channels (n = 2). All blue suckers were captured in channel border mesohabitats (Table 37). In 2008, all blue suckers captured in segments 5 and 6 were over 735 mm TL indicating an ageing population (Figure 44). On June 5, 2007 a single 203 mm TL blue sucker was captured in the otter trawl, providing the first evidence of limited recruitment within segments 5 and 6 of the Missouri River.

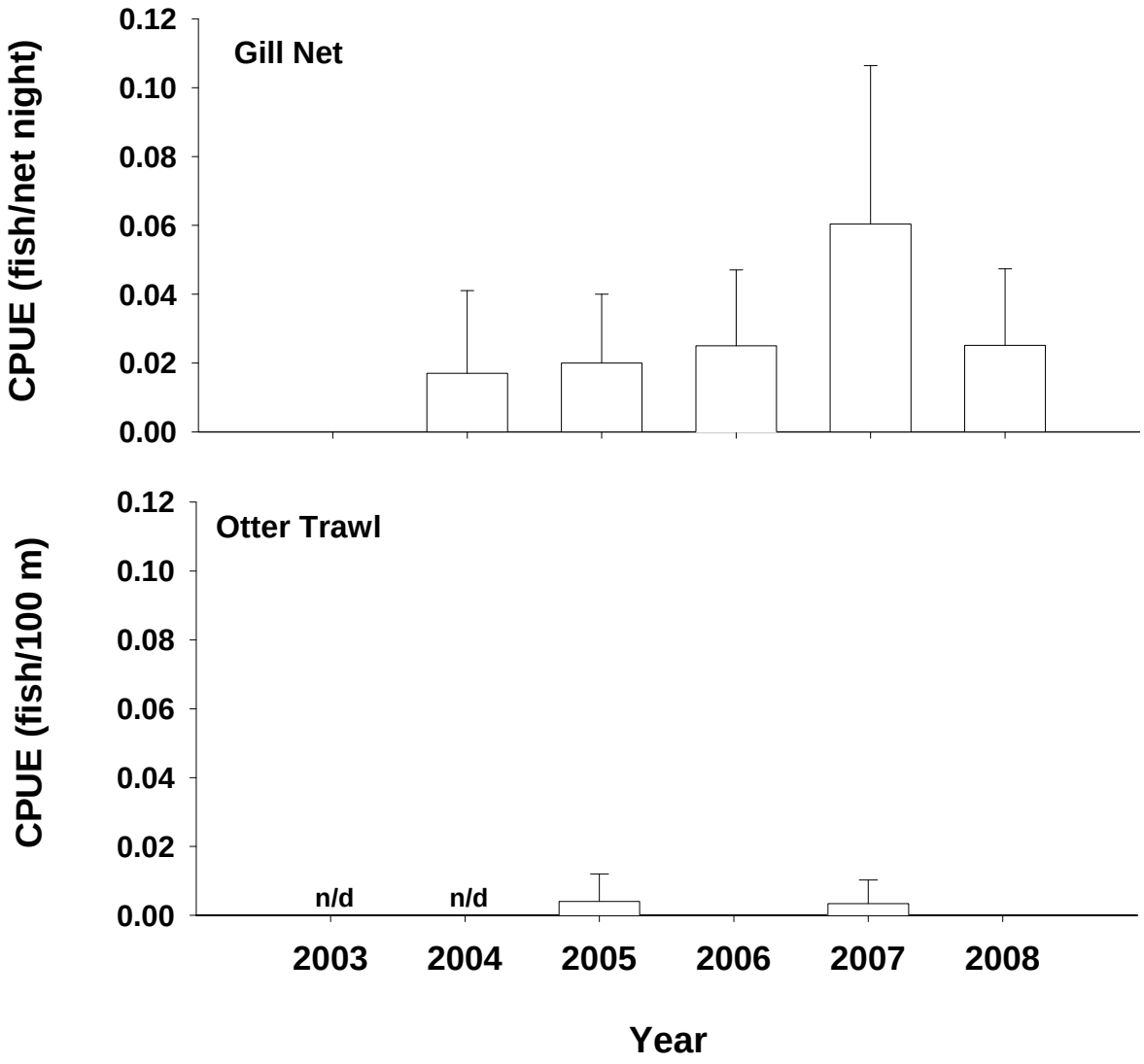

Figure 38. Mean annual catch per unit effort (+/- 2 SE) of blue suckers with gill nets and otter trawls in segments 5 and 6 of the Missouri River during the sturgeon season 2003-2008. N/d indicates not deployed.

Segments 5 and 6 - Blue Sucker / Sturgeon Season

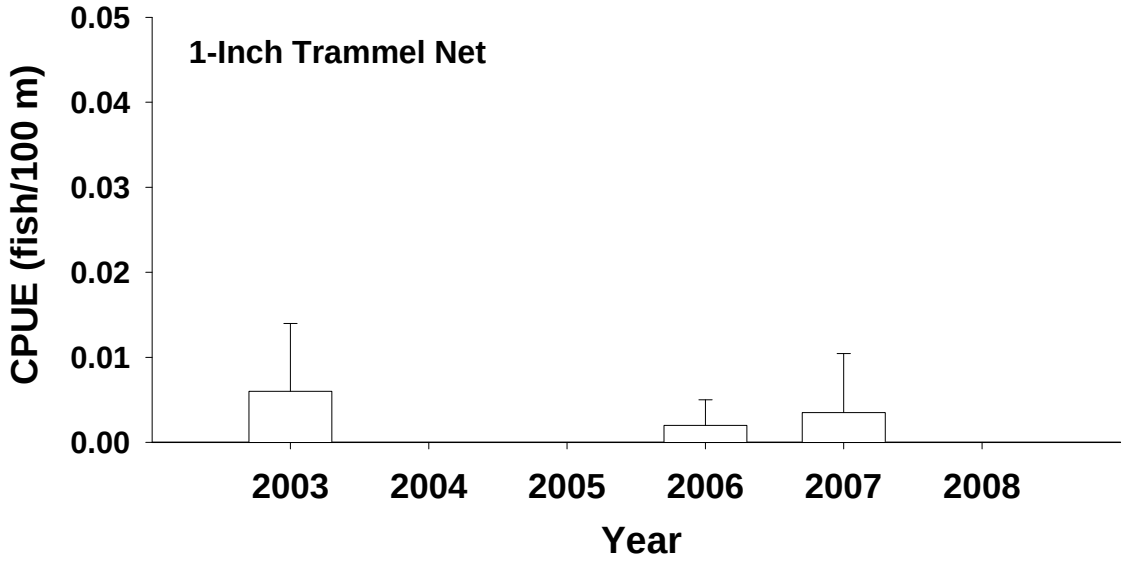

Figure 39. Mean annual catch per unit effort (+/- 2 SE) of blue suckers with 1 inch trammel nets in segments 5 and 6 of the Missouri River during the sturgeon season 2003-2008.

Segments 5 and 6 - Blue Sucker / Fish Community Season

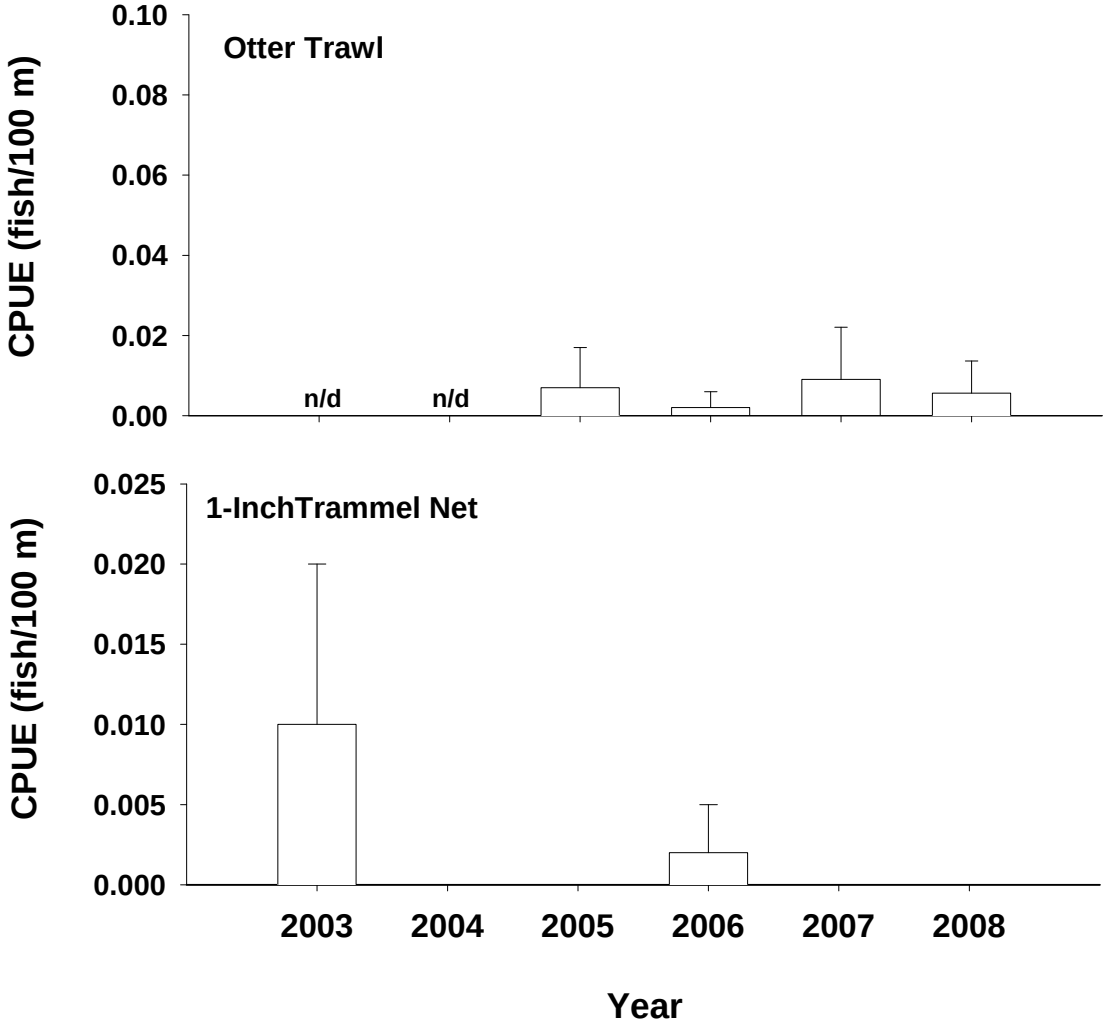

Figure 41. Mean annual catch per unit effort (+/- 2 SE) of blue suckers using otter trawls and 1 inch trammel nets in segments 5 and 6 of the Missouri River during the fish community season 2003-2008. N/d indicates not deployed.

Table 36. Total number of blue suckers captured for each gear during each season and the proportion caught within each macrohabitat type in segments 5 and 6 of the Missouri River during 2007-2008. The percent of total effort for each gear in each habitat is presented on the second line of each gear type. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	N	Macrohabitat[a]													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCN	TRIB	TRML	TRMS	WILD
Fall through Spring - Sturgeon Season															
1 Inch Trammel Net	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(64)	(16)	0	N-E	N-E	(11)	(9)	0	N-E	N-E	N-E	0	0	N-E
Gill Net	5	20	20	0	N-E	N-E	0	60	0	N-E	N-E	N-E	0	0	N-E
		(50)	(14)	0	N-E	N-E	(19)	(17)	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(52)	(13)	0	N-E	N-E	(20)	(15)	0	N-E	N-E	N-E	0	0	N-E
Summer - Fish Community Season															
1 Inch Trammel Net	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(52)	(19)	0	N-E	N-E	(17)	(12)	0	N-E	N-E	N-E	0	0	N-E
Mini-Fyke Net	0	0	0	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(50)	(16)	(3)	N-E	N-E	(15)	(16)	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	2	0	50	50	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(49)	(15)	(5)	N-E	N-E	(17)	(13)	(1)	N-E	N-E	N-E	0	0	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

Table 37. Total number of blue suckers captured for each gear during each season and the proportion caught within each mesohabitat type in segments 5 and 6 of the Missouri River during 2007-2008. The percent of total effort for each gear in each habitat is presented on the second line of each gear type. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	N	Mesohabitat[a]					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Fall through Spring - Sturgeon Season							
1 Inch Trammel Net	0	0	0	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Gill Net	5	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Otter Trawl	0	0	0	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Summer - Fish Community Season							
1 Inch Trammel Net	0	0	0	N-E	N-E	N-E	N-E
		(1)	(99)	N-E	N-E	N-E	N-E
Mini-Fyke Net	0	0	0	N-E	N-E	N-E	N-E
		(98)	(3)	N-E	N-E	N-E	N-E
Otter Trawl	2	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

Segments 5 and 6 - Blue Sucker

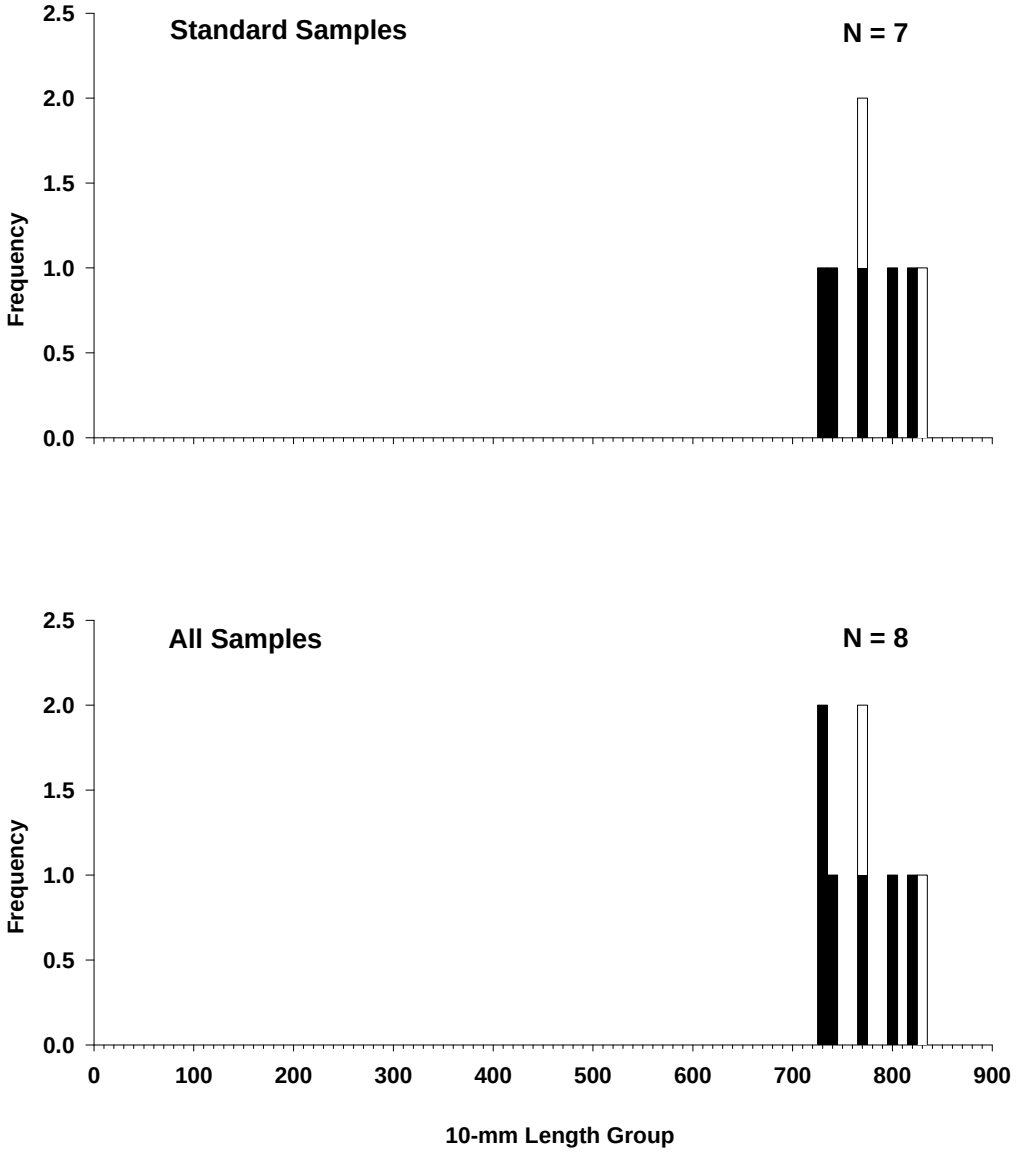

Figure 44. Length frequency of blue suckers during fall through spring (sturgeon season; black bars) and summer (fish community season; white bars) in segments 5 and 6 of the Missouri River during 2007-2008. Standard samples include only standard gears, random bends, and random subsamples. All samples include all sampling conducted during 2007-2008.

Sauger

A total of 226 saugers were sampled in four standard gears in segments 5 and 6 during 2008: gill nets (n = 78), trammel nets (n = 78), otter trawls (n = 53), and mini-fyke nets (n = 17). Gill net mean CPUE in 2008 (0.39 fish/net night) more than doubled from 2007 (0.15 fish/net night), and increased 70% compared to the 5 year running average of 0.23 fish/net night (Figure 45). Gill net relative abundance in 2008 was lower than 2003, but has continued to increase since its low in 2005 (0.12 fish/net night; Figure 45). Relative abundance of saugers during the sturgeon season for the otter trawl is now at an all time high of 0.18 fish/100 m in 2008 after consistently decreasing from 0.06 fish/100 m in 2005 to 0.01 fish/100 m in 2007. However, sauger catches in otter trawls were approximately 8 times greater during the sturgeon season (fall through spring) of 2008 compared to the fish community season (summer). Higher sauger CPUE in otter trawls during the sturgeon season compared to the fish community season was opposite to the trend observed in the three previous years. Mean CPUE for saugers in trammel nets increased nearly 1.8x during the sturgeon season (0.24 fish/100 m) and 1.5x during fish community season (0.09 fish/100 m) from the long term running average of 0.13 fish/100m for the sturgeon and 0.06 fish/100 for the fish community seasons. Saugers CPUE in mini-fyke nets during 2008 (0.21 fish/net night) was the highest on record; all other years catches in this gear have been low or zero since 2003 (Figure 49).

Over 90% of saugers captured were collected in the braided channel (81%) and outside bend (9%) macrohabitats during both seasons (Table 38). The majority of saugers (92%) were only captured in the channel border mesohabitat (Table 39). A total of 184 saugers (81%) were captured in the delta downstream of Niobrara and Missouri river confluence. In segment 5, an additional 28 fish were captured within the three bends immediately upstream of the confluence. Only 14 saugers were captured upstream of the Verdel, Nebraska boat landing.

During 2008, the population structure and physical condition of sauger indicated successful spawning and recruitment occured in segments 5 and 6. Over 71% of saugers caught in segments 5 and 6 of Missouri River during 2007 were between the 300 - 500 mm TL; however, 8% of fish were < 160 mm TL (Figure 51). Multiple modes (> 5) in the length frequency histogram indicate suitable conditions for spawning and recruitment still exist in segments 5 and 6. Incremental relative size distribution (RSD) was calculated for sauger captured in the standard gears. The RSD values for each category during the sturgeon season were: stock – quality = 15, quality –preferred = 23, preferred –memorable = 58, memorable – trophy = 4, and trophy = 0. The RSD values shifted during the fish community season to: stock – quality = 35, quality –preferred = 22, preferred –memorable = 43, memorable –trophy = 0. The incremental RSD during the sturgeon season had greater numbers of quality –preferred, preferred –memorable, and memorable – trophy sized saugers compared to the fish community season, while an increase in the proportion of stock sized fish in the summer indicated some limited recruitment. The mean relative weights during the sturgeon season differed from that of the fish community season; the mean relative weights during the sturgeon season and the fish community season were 86 (n = 179; ± 2SE = 3.83) and 105 (n = 23; ± 2SE = 53.26), respectively.

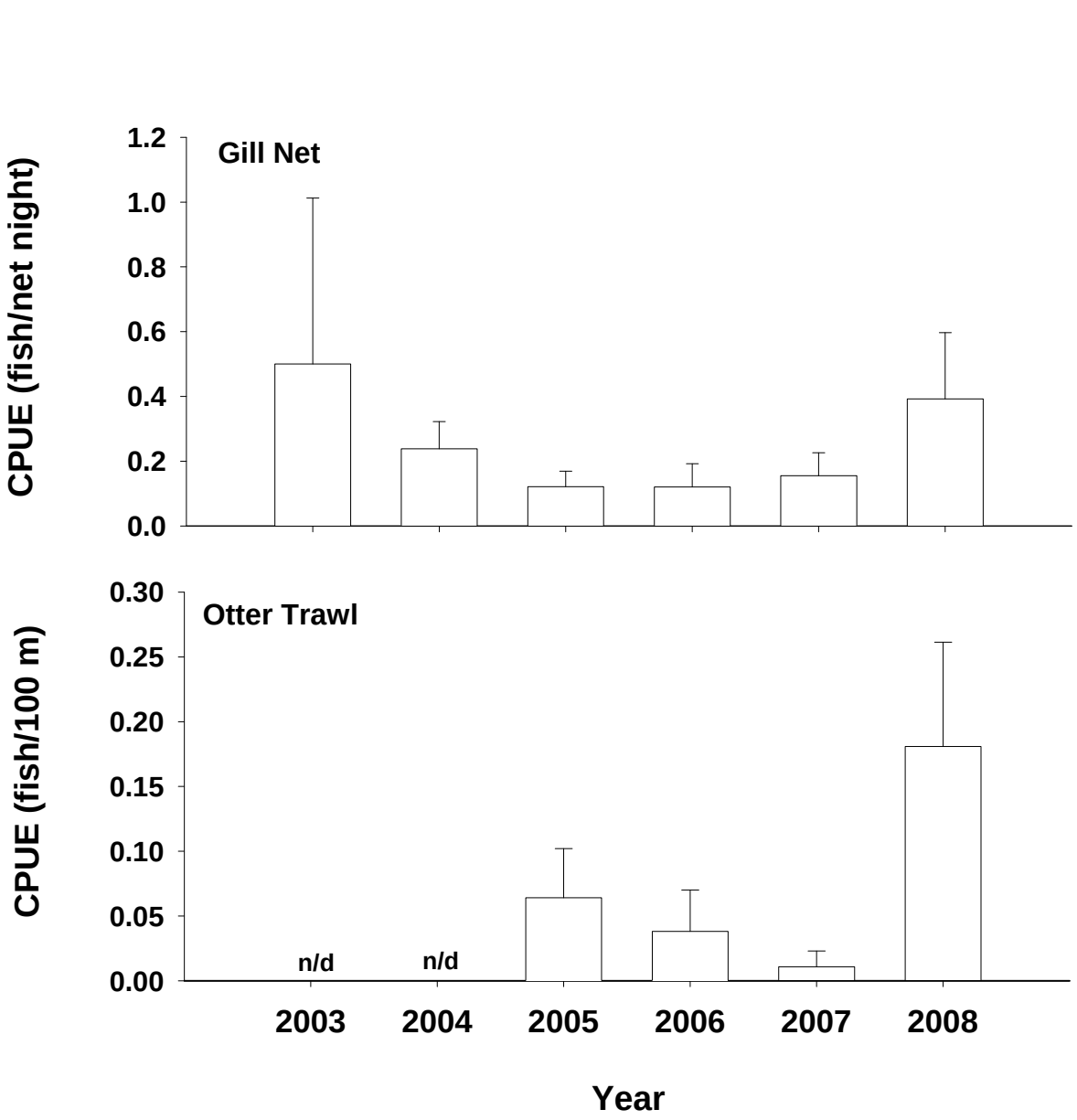

Figure 45. Mean annual catch per unit effort (+/- 2 SE) of saugers using gill nets and otter trawls in segments 5 and 6 of the Missouri River during the sturgeon season 2003-2008. N/d indicates not deployed.

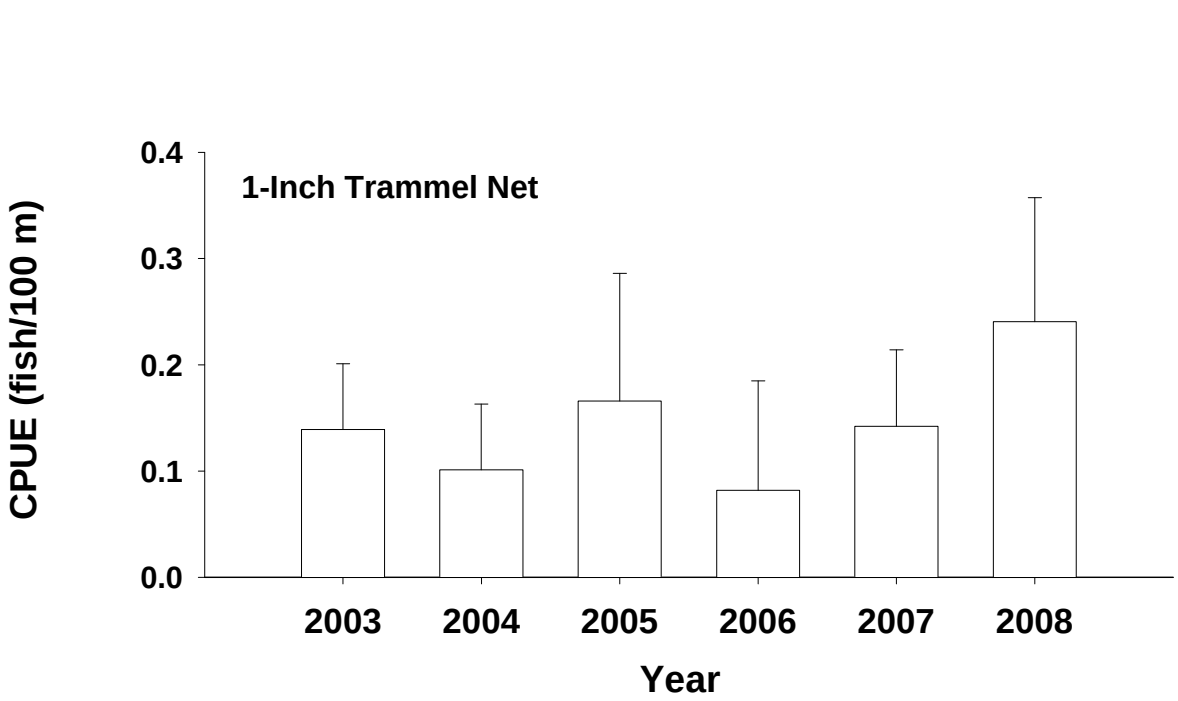

Figure 46. Mean annual catch per unit effort (+/- 2 SE) of saugers using 1 inch trammel nets in segments 5 and 6 of the Missouri River during the sturgeon season 2003-2008.

Segments 5 and 6 - Sauger / Fish Community Season

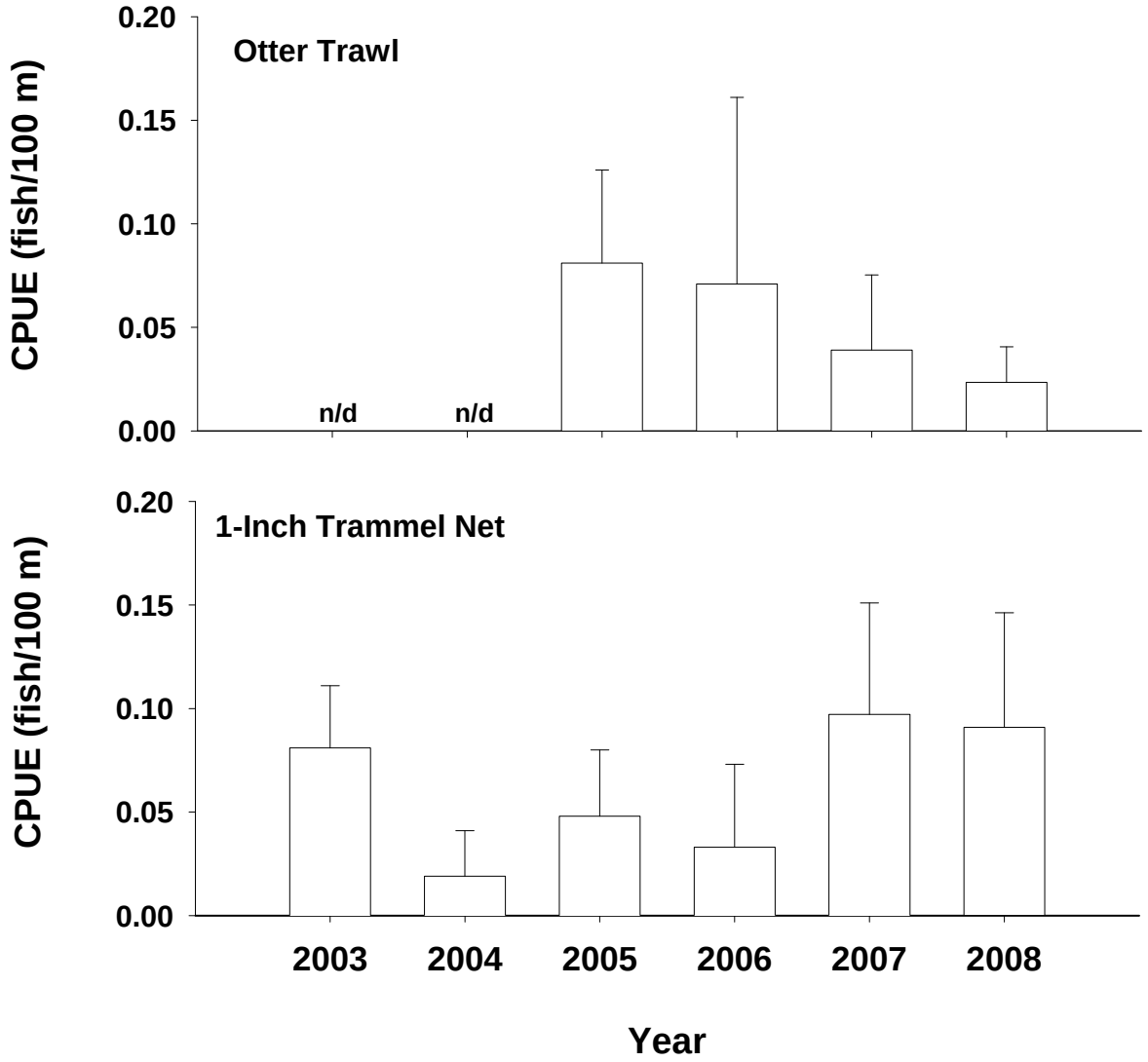

Figure 48. Mean annual catch per unit effort (+/- 2 SE) of saugers using otter trawls and 1 inch trammel nets in segments 5 and 6 of the Missouri River during the fish community season 2003-2008. N/d indicates not deployed.

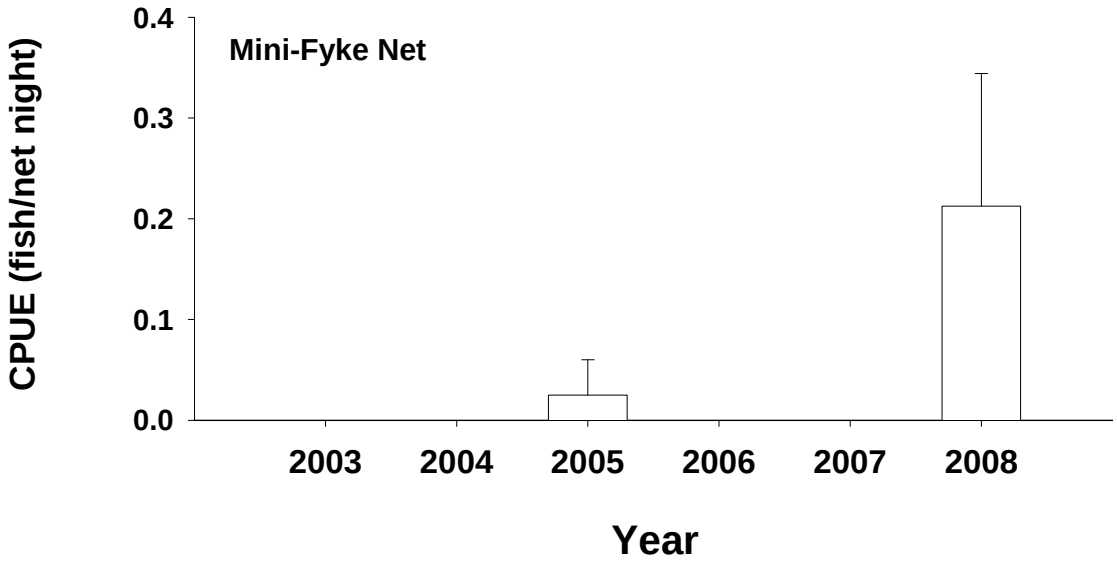

Figure 49. Mean annual catch per unit effort (+/- 2 SE) of saugers using mini-fyke nets in segments 5 and 6 of the Missouri River during the fish community season 2003-2008.

Table 38. Total number of saugers captured for each gear during each season and the proportion caught within each macrohabitat type in segments 5 and 6 of the Missouri River during 2007-2008. The percent of total effort for each gear in each habitat is presented on the second line of each gear type. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	N	Macrohabitat[a]													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCN	TRIB	TRML	TRMS	WILD
Fall through Spring - Sturgeon Season															
1 Inch Trammel Net	26	96	4	0	N-E	N-E	0	0	0	N-E	N-E	N-E	0	0	N-E
		(64)	(16)	0	N-E	N-E	(11)	(9)	0	N-E	N-E	N-E	0	0	N-E
Gill Net	78	74	5	0	N-E	N-E	9	12	0	N-E	N-E	N-E	0	0	N-E
		(50)	(14)	0	N-E	N-E	(19)	(17)	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	39	72	3	0	N-E	N-E	3	23	0	N-E	N-E	N-E	0	0	N-E
		(52)	(13)	0	N-E	N-E	(20)	(15)	0	N-E	N-E	N-E	0	0	N-E
Summer - Fish Community Season															
1 Inch Trammel Net	15	87	7	0	N-E	N-E	7	0	0	N-E	N-E	N-E	0	0	N-E
		(52)	(19)	0	N-E	N-E	(17)	(12)	0	N-E	N-E	N-E	0	0	N-E
Mini-Fyke Net	17	82	6	6	N-E	N-E	0	6	0	N-E	N-E	N-E	0	0	N-E
		(50)	(16)	(3)	N-E	N-E	(15)	(16)	0	N-E	N-E	N-E	0	0	N-E
Otter Trawl	11	64	18	0	N-E	N-E	9	0	9	N-E	N-E	N-E	0	0	N-E
		(49)	(15)	(5)	N-E	N-E	(17)	(13)	(1)	N-E	N-E	N-E	0	0	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

Table 39. Total number of saugers captured for each gear during each season and the proportion caught within each mesohabitat type in segments 5 and 6 of the Missouri River during 2007-2008. The percent of total effort for each gear in each habitat is presented on the second line of each gear type. N-E indicates the habitat is non-existent in the bends sampled within the segments.

Gear	N	Mesohabitat[a]					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Fall through Spring - Sturgeon Season							
1 Inch Trammel Net	26	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Gill Net	78	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Otter Trawl	39	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E
Summer - Fish Community Season							
1 Inch Trammel Net	15	7	93	N-E	N-E	N-E	N-E
		(1)	(99)	N-E	N-E	N-E	N-E
Mini-Fyke Net	17	100	0	N-E	N-E	N-E	N-E
		(98)	(3)	N-E	N-E	N-E	N-E
Otter Trawl	11	0	100	N-E	N-E	N-E	N-E
		0	(100)	N-E	N-E	N-E	N-E

[a]Habitat abbreviations and definitions presented in Appendix B.

Segments 5 and 6 - Sauger

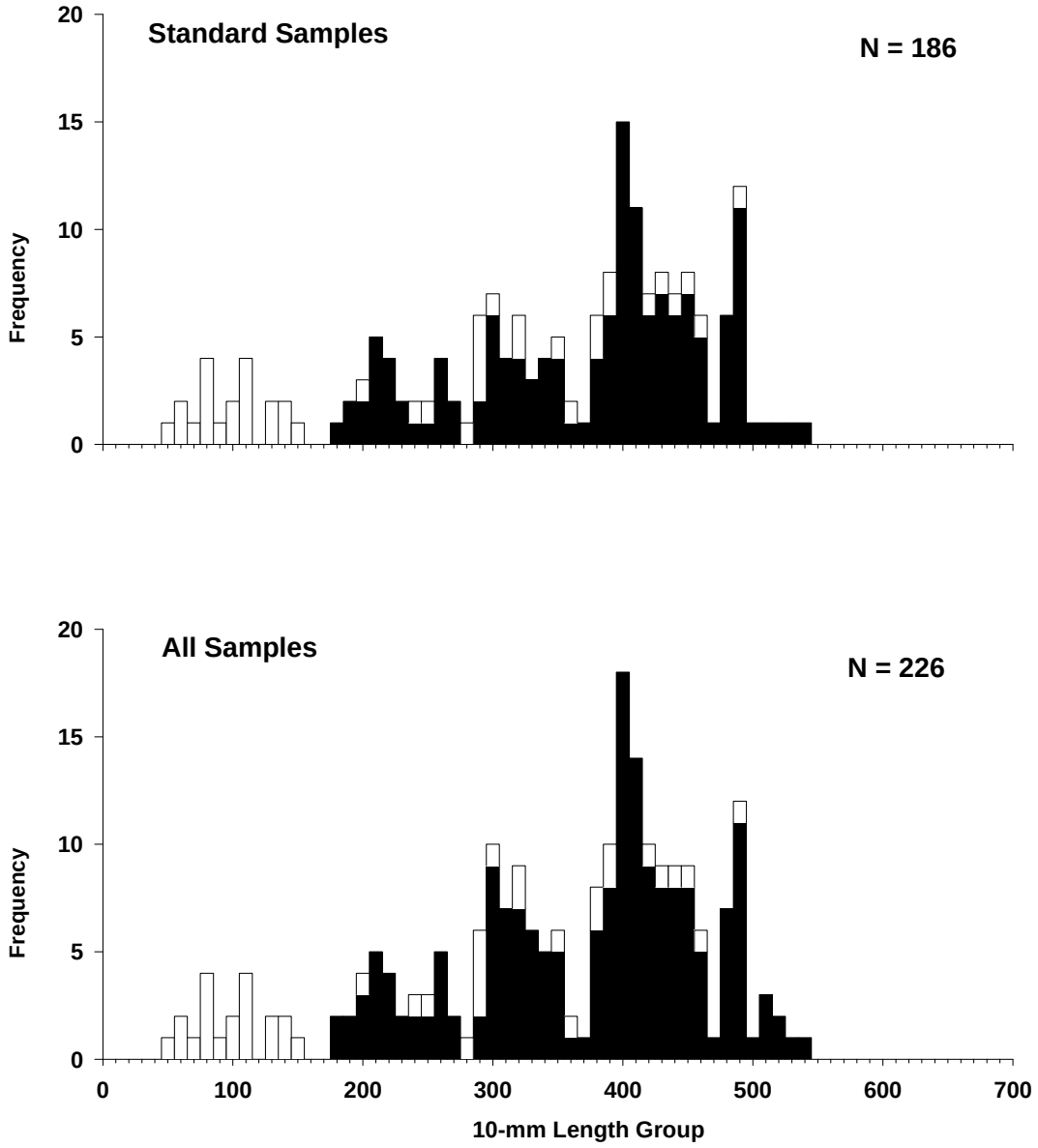

Figure 51. Length frequency of saugers during fall through spring (sturgeon season; black bars) and summer (fish community season; white bars) in segments 5 and 6 of the Missouri River during 2007-2008. Standard samples include only standard gears, random bends, and random subsamples. All samples include all sampling conducted during 2007-2008.

Missouri River Fish Community

Objective 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.

A total of 4,294 fish comprised of 46 species and one hybrid (sauger x walleye) were captured in standard gears during the 2008 sampling season in segments 5 and 6 of the Missouri River. A total of 211 gear deployments contained no fish: gill nets (n = 56: 28%), trammel nets (n = 57: 27%), otter trawls (n = 92: 31%), and mini-fyke (n = 6: 8%). We captured two species during the 2008 season that were not seen in the previous season: blacknose dace *Rhinichthys atratulus* (n = 1) and brassy minnow (n = 37). Five species captured in 2007 were not observed in 2008; river shiner *Notropis blennius*, western silvery minnow, plains minnow, rainbow trout *Oncorhynchus mykiss*, and yellow perch *Perca flavescens*. Greatest numbers of fishes were captured during the summer with mini-fyke nets (n = 1,814). These summer catches consisted mainly of small bodied cyprinids. Gears with the greatest percentage of their total catch comprised of pallid sturgeon and the nine targeted native fish species were trammel nets (43%), gill nets (18%), otter trawls (10%), and min-fyke nets (10%). Target species comprised 10% of the catch in mini-fyke nets in 2008; an increase of > 3x when compared to 2006 and 2007 (3%). However, nearly all sand shiners and *Hybognathus spp.* (97%) were captured with mini-fyke nets in 2008.

Of the 46 species and 1 hybrid captured, 37% had > 50 individuals collectively captured with standard gears. These species included: shovelnose sturgeon (n = 296), pallid sturgeon (n = 102), shortnose gar *Lepisosteus platostomus* (n = 69), spotfin shiner *Cyprinella spiloptera* (n = 394), sand shiner (n = 144), emerald shiner *N. atherinoides* (n = 276), bluntnose minnow *Pimephales notatus* (n = 50), common carp *Cyprinus carpio* (n = 62), silver chub *M. storeriana* (n = 93), shorthead redhorse *Moxostoma macrolepidotum* (n = 192), channel catfish *Ictalurus*

punctatus (n = 909), bluegill *Lepomis macrochirus* (n = 73), white crappie *Pomoxis nigromaculatus* (n = 105), freshwater drum *Aplodinotus grunniens* (n = 221), sauger (n = 226), and walleye *Sander vitreum* (n = 306). Nine species were represented in the collective catches by ≤ 2 specimens: black crappie *P. nigromaculatus*, grass pickerel *E. americanus vermiculatus*, longnose dace *R. cataractae*, blacknose dace, bigmouth buffalo *Ictiobus cyprinellus*, bigmouth shiner *N. dorsalis*, fathead minnow *Pimephales promelas*, goldeye *Hiodon alosoides*, and paddlefish *Polydon spathula*. All but five species represented by a cumulative catch of ≥ 50 fish in 2007 were represented by > 50 individuals in 2008, these species include; red shiner *C. lutrensis*, spottail shiner *N. hudsonius*, river carpsucker *Carpiodes carpio*, smallmouth buffalo I. *bubalus*, and Johnny darter *Etheostoma nigrum*.

For gears targeting large fish in deep water habitats (≥ 1.2 m), channel catfish, shorthead redhorse, and walleye were the three most common non-targeted species. Five species, shovelnose sturgeon, sauger, shorthead redhorse, channel catfish, and walleye had an overall gill net mean CPUE > 0.2 fish/net night during 2008 (Appendix H). During the 2008 sturgeon season, shovelnose sturgeon, walleye, channel catfish, and sauger had a trammel net mean CPUE > 0.2 fish/100 m, followed closely by pallid sturgeon (0.13 fish/100 m; Appendix H); whereas during 2004 - 2007 channel catfish (2004 - 2005, and 2007) and shovelnose sturgeon (2005) were the only species with a mean trammel net CPUE > 0.2 during the sturgeon season. For trammel nets in the fish community season, shovelnose sturgeon, channel catfish, and shorthead redhorse had a mean CPUE > 0.2 fish/100 m (Appendix H) followed by sauger with a CPUE of 0.09 fish/100 m. For the otter trawl during the sturgeon season, channel catfish, silver chub, sauger, and walleye were the only species with a mean CPUE ≥ 0.1 fish/100 m. Channel catfish and freshwater drum were the most abundant species captured with the otter trawl (mean CPUE ≥ 0.1 fish/100 m) during the fish community season of 2008.

The greatest numbers of fish species were captured in shallow water habitats with mini-fyke nets (n = 38). The five most abundant species captured in mini-fyke nets were spotfin shiners (6.0 fish/net night), emerald shiners (3.8 fish/net night), sand shiners (2.7 fish/net night), white bass (1.5 fish/net night), and white crappie (1.3 fish/net night). Additionally, the following 7 species had mean CPUE > 0.4 fish/net night with mini-fyke nets: bluegill, freshwater drum, bluntnose minnow, shortnose gar, common carp, gizzard shad *Dorosoma cepedianum*, spottail shiners, and brassy minnow.

Eight exotic species were captured in segments 5 and 6 during 2007 and five of these species are sport fishes that were intentionally introduced: black crappie, white crappie, bluegill, smallmouth bass, and largemouth bass (Berry and Young 2004). Additional exotic species encountered in 2008 were common carp *Cyprinus carpio,* spottail shiner *Notropis hudsonius,* and rainbow smelt *Osmerus mordax*. Based on high mean CPUE in mini-fyke nets (1.3 fish/net night), white crappie were the most abundant exotic species captured in segments 5 and 6 during 2008 followed by bluegill (0.9 fish/net night), carp (1.4 fish/net night), and spottail shiners (0.5 fish/net night). Ten turtles were captured in mini-fyke nets and otter trawls consisting of three species; Snapping turtle *Chelydra serpentina* (SNST, n = 1), spiny softshell *Apalone spinifera* (SPST, n = 1), and false map turtle *Graptemys pseudogeographica* (FSMT, n = 8, Appendix F). None of the four exotic Asian carps, bighead carp *Hypophthalmichthys noblis*, silver carp *H. molitrix*, grass carp *Ctenopharyngodon idella*, or black carp *Mylopharyngodon piceus,* were captured or seen within segments 5 and 6 during 2003 - 2008. Additionally, no zebra mussels *Dreissena polymorpha* were observed while working in segments 5 and 6 during 2003 - 2008 despite the identification of larval zebra mussels (veligers) collected near the Verdel Boat Ramp in 2003 (L. Hesse, River Eco System Inc., personal communication).

DISCUSSION

Pallid sturgeon were captured in all three continuous macrohabitats and in two discrete macrohabitats (braided channels and tributary confluence) with the greatest numbers captured in braided channels. Braided macrohabitats were first distinguished as a habitat type in 2004. Since the 2004 sampling season, nearly the entire Missouri River downstream of the Niobrara confluence was considered braided with the exception of a large secondary connected channel and confluence macrohabitats in segment 6, bend 1. Since 2005, 70% of all pallid sturgeon have been captured in the braided macrohabitat of the Niobrara River Delta in segment 6. All pallid sturgeon captured in 2008 were within channel border mesohabitats (depth > 1.2 m). A telemetry study in segments 5 and 6 during 2000 – 2002 relocated most sonic-tagged juvenile pallid sturgeon in the main channel (91%) with few fish found in secondary connected channels (Jordan et al. 2006). Synthesizing four years (2003 – 2006) of standardized monitoring in segments 5 and 6 using spatial scan statistics, Spindler et al. *in press* found three significant clusters of pallid sturgeon occurrence; two clusters were located in the braided delta. Grohs (2008) found macroinvertebrate abundance downstream of Fort Randall Dam was generally highest in the braided delta habitat in 2005 and 2006 and macroinvertebrates, especially Isonychiidae were important diet items for juvenile pallid sturgeon. Wanner et al. (2009) collected two hatchery-propagated pallid sturgeon in a single trammel net on July 29, 2008 in the lower two rkm of the Niobrara River; the first documentation of the species in this tributary.

Although pallid sturgeon were captured in almost all bends sampled as part of the standard monitoring effort during 2008 there was evidence of fish clustering within specific river kilometers. During 2008, 41 pallid sturgeon were captured between rkm 1,335 – 1, 336 (rm 829.5 – 830.4; segment 6, bend 9) just upstream of the Santee boat ramp, with 32 fish caught between rkm 1,333 – 1,334 (rm 828 – 829; segment 6, bend 10) one mile downstream of the

Santee boat ramp. An additional 10 pallid sturgeon in 2008 were captured between rkm 1,337 – 1,341 (rm 830.5 - 834.7; segment 6, bend 7). Synthesizing data for all gears deployed in the Missouri River downstream of Fort Randall Dam from 2003 – 2006 using spatial scan analysis, Spindler et al. *in press* found two of their significant clusters in two different channels in the braided habitat at rkm 1336. Clusters of > 2 age-3 to age-5 pallid sturgeon were also seen in a telemetry study in segments 5 and 6 on 20 dates from 2000 to 2002 with most aggregations found at rkm 1,363 (rm 847) (Jordan et al. 2006). River mile 847 in segment 5 contains one of the deepest habitats (11 m) in the Missouri River downstream of Fort Randall Dam (known as the "pump hole") and is located down river of the Ponca Creek confluence on the South Dakota side of the main channel. The pump hole, located in bend 16 of segment 5, was randomly selected for standardized sampling in 2008 and had multiple pallid sturgeon captured (n = 3). Multiple captures of pallid sturgeon from the pump hole were also seen in two past years: 2005 (n = 2) and 2007 (n = 3). However, habitat conditions within and near the pump hole are changing due to erosion of the hard point, shifting the main channel towards the Nebraska (South) side of the Missouri River. Spatial scan analysis found one significant cluster of pallid sturgeon presence at rkm 1,357 (rm 843) near the Ponca Creek confluence in segment 5 and two areas of significant absence at rkms 1,348 and 1,343 just downstream of the Niobrara River confluence (Spindler et al. *in press*).

The only substantial increase in relative abundance of hatchery propagated pallid sturgeon during 2008 was for trammel nets (99%) fished during the sturgeon season while otter trawl CPUE during the sturgeon season increased slightly (9%) compared to 2007. Gill net CPUE in 2008 was similar to 2007. Decreases in mean relative abundance (> 70%) were observed for otter trawls during the sturgeon season and trammel nets during the fish community season compared to 2007. Since April 17, 2008, 1,169 hatchery-reared pallid sturgeon from the 2007 year class were stocked into segments 5 and 6, an increase in total numbers stocked since

2000 of nearly 25% (Appendix E). Concomitant with the increases in total fish stocked since 2007, relative abundance of hatchery-propagated pallid sturgeon caught in trammel nets during the sturgeon season, and otter trawls during the fish community season increased. Gill netting occurred prior to the 2008 stocking events and newly stocked hatchery-fish may be too small (mean < 240 mm FL) to have fully recruited to capture by trammel nets during the summer of 2008. First year annual survival rates of pallid sturgeon stocked as yearlings was low (0.22 – 0.58) and highly variable but after two years at liberty, annual survival often exceeded 0.90 with increased precision in RPMA 3 (Hadley and Rotella 2009). The 2007 year class may have had low first year survival. Past trends in relative abundance for gill nets and trammel nets during the sturgeon season and otter trawls during the fish community season have generally mirrored changes in stocking numbers providing further evidence that our standard gears can effectively describe changes in relative abundance of the population.

Gill nets were an effective gear for capturing pallid sturgeon and relative abundance has generally mirrored the changes made in numbers of fish stocked into segments 5 and 6 the previous year. Stocking numbers declined 19% from 2002 – 2003 (Appendix E) and relative abundance declined 19% from 2003 – 2004 (Figure 2). From 2003 – 2004 stocking numbers again declined (14%) and gill net CPUE also declined (26%) while during 2004 – 2005 stocking numbers increased 69% and relative abundance increased 54% from 2005 to 2006. The number of fish stocked from 2005 - 2006 increased slightly (16%) followed by a (68%) increase in CPUE in 2006 – 2007. However, during 2008 this trend was not evident; a 40% decrease in the number of fish stocked from 2006 – 2007 coincided with no change (<1%) in relative abundance from 2007 – 2008. Stocking lengths of pallid sturgeon recaptured with gill nets in 2008 ranged from 180 - 566 mm FL while recaptured fish ranged from 235 - 885 mm. The one year lag for changes in relative abundance in relation to stocking period is due to gill net sampling effort occurring prior to stocking events. Mean length of stocked fish in May 2007 were also on the

low end of the size range recaptured by gill nets (189 mm FL). Variability (2 SE) in gill net CPUE each year was high, often as large or larger than the mean, which likely precludes detecting statistically significant changes in pallid sturgeon abundance within segments 5 and 6. However, the concomitant changes in relative abundance with most previous years stocking numbers provides a good indication that gill nets used in the current random stratified sampling design can provide a useful index of population change for age-2 and greater juvenile pallid sturgeon.

The trammel net was an effective gear capturing 18 pallid sturgeon in segments 5 and 6 during 2008 in standard drifts, while non-random duplicate passes captured an additional 18 fish. Seasonal differences were found in trammel net mean CPUE for pallid sturgeon with higher catch rates during the summer (fish community season) compared to the fall through spring (sturgeon season) in 2003 – 2007. Wanner et al. (2007b) also reported that from 2003 to 2005 trammel net mean CPUE for pallid sturgeon was the highest and the coefficient of variation (CV) was the lowest during the month of August. Schloesser (2008) found detection probabities with trammel nets for large-bodies fishes in the lower Missouri River were higher in summer compared to fall through spring. However, this trend did not hold in segments 5 and 6 during 2008 for pallid sturgeon. Sturgeon season (fall – spring) CPUE in segments 5 and 6 was three fold higher than during the summer fish community season. Lowered flows out of Fort Randall Dam in spring of 2008 may have caused pallid sturgeon to aggregate in deep waters and be more vulnerable to capture. Sexually maturing pallid sturgeon from older stocked year classes may have been more active in spring; however, the numbers of quality-sized fishes caught was similar in spring and summer (Table 16).

The 16-ft otter trawl was an effective active gear for capturing pallid sturgeon. A total of 23 pallid sturgeon were captured in standard tows with an additional 23 fish captured in duplicate passes. In past years, the trend in seasonal differences in otter trawl CPUE was

opposite that of the trammel net. Mean CPUE for pallid sturgeon in the otter trawl was higher during the fall through spring (sturgeon season) compared to the summer (fish community season). However, otter trawl CPUE in 2008 was highest during the summer and may have resulted from the doubling of effort. Wanner et al. (2007b) noted that during October otter trawls had the highest mean CPUE of pallid sturgeon and the lowest CV. From 2005 - 2007 our highest CPUE for otter trawls occurred during the sturgeon season (fall – spring).

The mean relative condition (K_n) of stocked pallid sturgeon declined after release for nearly all year classes (1997-1998 and 2001-2007). However, mean length increased for all year classes since of stocking (Table 6). Condition of most fish was > 1.0 at the time of stocking which may have provided excess energy reserves to better enable the transition from the hatchery to a natural environment, thereby increasing survival. Hadley and Rotella (2009) found first year annual survival estimates after stocking increased from 0.22 for spring yearlings to 0.74 for age-3 fish but variability around most estimates was high. Similar trends in K_n have been observed in the Missouri River in the states of Nebraska (Hamel and Steffensen 2007; Steffensen and Hamel 2007) and Missouri (Plauck et al 2007; Utrup et al. 2007). Mean relative condition of recaptured hatchery-reared pallid sturgeon in segments 5 and 6 during 2008 ranged from 0.75 to 0.94 which was similar to the ranges observed in Nebraska (0.62 – 0.93) and Missouri (0.83 – 1.1) during 2006 (Hamel and Steffensen 2007; Plauck et al 2007; Steffensen and Hamel 2007; Utrup et al. 2007). The decrease in condition of hatchery-reared pallid sturgeon may reflect a lack of sufficient prey resources or a stream-lined body form may be more advantageous in the natural lotic environment and hatchery-reared fish were unnaturally fat.

Average absolute growth rates for pallid sturgeon captured during 2007 in segments 2 (Haddix et al. 2008a), 3 (Haddix et al. 2008b), and 4 (Wilson et al. 2008) in Montana and North Dakota were lower for all yearclasses than growth rates in segments 5 and 6. Juvenile pallid sturgeon diets in Montana as percent wet weight were 90% fish (Gerrity et al. 2006), while

downstream of Fort Randall Dam diets were 68% fish and 23% ephemeropterans with diets switching at age-5 to a greater percentage of fish (Grohs et al. *in press*). Spindler (2008) found the abundance of ephemeropterans and dipterans in the drift were significantly higher (1.6 – 1.8 fold) in areas where juvenile pallid sturgeon were captured compared to areas where fish were not captured in segments 5 and 6 during 2006. These differences in growth rates demonstrate that immature pallid sturgeon can have positve growth in the absence of native chubs and also provides evidence that pallid sturgeon may be more opportunistic feeders than a strict piscivore.

Gill nets, trammel nets, and otter trawls were all effective at capturing shovelnose sturgeon. Gill net mean CPUE increased substantially in 2008 compared to 2003 – 2006, but remained similar to 2007. Relative abundance of shovelnose sturgeon substantially increased in trammel nets during the sturgeon season and slightly increased in otter trawls during the fish community season showing evidence of a stable population with low recruitment and high survival. Shovelnose sturgeon were individually marked with floy tags during 2006 (n = 161), 2007 (n = 411), and 2008 (n = 273). Numbers of recaptured shovelnose sturgeon increased in 2008 (n = 22) compared to 2007 (n = 12). Trammel net mean CPUE in 2008 was the highest during the sturgeon season for shovelnose sturgeon which corresponded with pallid sturgeon catch rates (Appendix H). The mean CPUE of shovelnose sturgeon in otter trawls was greater during the fish community season compared to the sturgeon season season in 2008; a similar seasonal trend as observed for pallid sturgeon (Appendix H).

The lack of shovelnose sturgeon within the stock and quality length categories indicates no recent recruitment has occurred within segments 5 and 6 of the Missouri River. Jordan and Willis (2001) during 1998 and 1999 and Pierce et al. (2003) also reported only capturing preferred length and larger shovelnose sturgeon in RPMA 3. Shovelnose sturgeon within the preferred and memorable length classes were in good condition (Wr > 0.88), thus these fish should be physically capable of reproduction. Personal observations also identified female

shovelnose sturgeon in later stages of egg development within segments 5 and 6. The standardized gears (gill nets, otter trawl, and trammel nets) have captured smaller shovelnose sturgeon (i.e. < 249 mm FL) from the channelized and unchannelized Missouri River (Caton et al. 2007; Hamel and Steffensen 2007; Plauck et al. 2007; Steffensen and Hamel 2007; Utrup et al. 2007; Wilson et al. 2007). In the lower Missouri River, trammel nets and otter trawls collected more small shovelnose sturgeon (< 150 mm FL) than gill nets but for sub-adult and adult fish gill nets had the greatest precision (Doyle et al. 2008). These catches in other segments further indicate that shovelnose sturgeon in segments 5 and 6 are failing to either spawn due lack of habitat or have poor larval and juvenile survival. Power analysis for sub-adult and adult shovelnose sturgeon CPUE in gill nets in the Missouri River from Fort Peck, Montana to St. Louis, Missouri found that > 500 deployments could detect a 25% change in relative abundance at $\beta = 0.90$ (Doyle et al. 2008). Currently, 200 gill net sets are deployed annually in segments 5 and 6.

No sturgeon chubs, sicklefin chubs, and speckled chubs were captured with the otter trawl in segments 5 and 6 in 2008. None of these three chub species have been captured in segments 5 and 6 since monitoring began in 2003 indicating these species could be extirpated. Berry and Young (2004) also did not capture these three *Macrhybopsis* spp. downstream of Fort Randall Dam during 1996 - 1998. In segments 5 and 6 the otter trawl captured 90 silver chubs during 2008 with > 64 captured each year from 2005 – 2007. This same trawl has captured sturgeon chub, sicklefin chub, and speckled chub in segments 7 - 10, and 13 - 14 (Caton et al. 2007; Hamel and Steffensen 2007; Plauck et al. 2007; Steffensen and Hamel 2007; Stukel et al. 2007; Utrup et al. 2007). Sicklefin and sturgeon chubs were also captured with the otter trawl in segments 2 (Haddix et al. 2008a), 3 (Haddix et al. 2008b), and 4 (Wilson et al. 2008) of the upper Missouri River in 2007. Capture of these three chubs in other segments of the Missouri River indicated that we should capture these species if present in segments 5 and 6.

Six *Hybognathus* spp. were captured in segment 6 with mini-fyke nets in 2008 but no *Hybognathus* spp. were captured in segment 5. Prior to 2008, only nine *Hybognathus* spp. have been captured since sampling began in 2003. This species is likely at very low abundance in segments 5 and 6. *Hybognathus* spp. were captured with mini-fyke and otter trawls throughout the Missouri River during 2006 (Hamel and Steffensen 2007; Plauck et al. 2007; Steffensen and Hamel 2007; Stukel et al. 2007; Utrup et al. 2007; Wilson et al. 2007). Additionally, 36 brassy minnows were captured less than 10 rkm (6 rm) downstream of Fort Randall Dam in 2008, the first documentation of this species since standardized monitoring monitoring began in 2003 but they have been reported previously (Berry and Young 2004). Age-0 *Hybognathus* spp. were captured in all zones of the Missouri River sampled in 1995 – 2000 during the Benthic Fishes Study (Berry and Young 2001) but no plains minnows or western silvery minnows were captured downstream of Fort Randall Dam from 1996 – 1998 (Berry and Young 2004). Small unidentifiable YOY *Hybognathus* spp. were captured in segment 5 and 6 during 2008 but low catches of adult fish indicates low recruitment of plains minnows and western silvery minnows.

The first record of blue sucker recruitment in segments 5 and 6 was documented in 2007 with the capture of a 203 mm TL fish. No small blue suckers < 600 mm TL were captured in segments 5 and 6 during 2003 – 2006 and 2008. At present, blue suckers appear to have difficulty recruiting in segments 5 and 6. Few small (< 250 mm TL) blue suckers have also been captured in the other segments of the Missouri River (Plauck et al. 2007; Steffensen and Hamel 2007; Stukel et al. 2007; Utrup et al. 2007; Wilson et al. 2007) with the exception of segment 8 during the 2006 season downstream the Big Sioux River (Hamel and Steffensen 2007). These low catch rates of small blue suckers in the channelized and unchannelized segments of the Missouri River highlight that habitats used by early life stages are poorly known or that spawning conditions have generally not been suitable over for the last 5 years, with the exception of high flows out of the Big Sioux River during 2006 and 2007. Wanner et al. (2009) captured

one adult bluesucker in the lower 2 rkm of the Niobrara River during 2008 that had been previously floy tagged in the Missouri River.

All standard gears (gill nets, trammel nets, otter trawls, and mini-fyke nets) were effective at capturing saugers in segments 5 and 6 during 2008. Multiple modes in the length frequency histogram (Figure 51) indicated suitable habitat conditions for spawning and recruitment of saugers still exists in segments 5 and 6. Graeb (2006) found that radio-tagged ripe saugers only spawned in the delta and not in the Missouri River upstream of the Niobrara River confluence. The mini-fyke net catch during summer 2008 of likely YOY and age-1 saugers was the highest recorded indicating 2007 and/or 2008 spawning conditions and larval survival was good in segments 5 and 6. Niobrara River discharge exceeded 10,000 ft^3/s (CFS) in early June of 2008 (Wanner et al. 2009) potentially increasing productivity of downstream delta habitats in the Missouri River. However, Graeb (2006) found a negative relation to discharge and flow for sauger recruitment in the downstream reservoir, Lewis and Clark Lake. Although saugers can spawn and recruit in segments 5 and 6, the population's long term viability could still be at risk due to hybridization with walleye. Hybridization rates of sauger with walleye in Lewis and Clark Lake were 21%; hybrids were comprised of multiple year classes indicating hybridization occurred regularly (Graeb 2006).

We captured approximately 1000 fewer fish in 2008 (4,294) compared to 2007 (5,337), nearly twice as many in 2006 (2,842), but only one-third the fish of 2005 (14,622). We can not be certain that the fluctuations in total fish captures represent a decrease in overall fish relative abundance in segments 5 and 6 during 2008. The fish community season extended from July 1st to October 30th. Because different fish species may become more abundant during different times of the year (increase in YOY), sampling during the fish community season should be systematically spread throughout the four month period. Sampling monthly from July – August,

Klumb (2007) noted little variation in mean relative abundance of overall fish catches in mini-fyke nets within segments 5 and 6, but peaks for individual species were observed.

We captured 46 fish species and one hybrid (saugeye) downstream of Fort Randall Dam during 2008. During 1996 – 1998, Berry and Young (2004) captured 45 fish species and one hybrid (saugeye). We captured five species not observed by Berry and Young (2004): pallid sturgeon, grass pickerel, bigmouth shiner, creek chub *Semotilus atromaculatus*, longnose dace, and orange-spotted sunfish *Lepomis humilis*. Species encountered by Berry and young (2004) but not observed during standardized monitoring in segments 5 and 6 during 2008 included: burbot *Lota lota*, white sucker *Catastomus commersonii,* golden shiner *Notemegonus crysoleucas*, river shiner, mimic shiner *Notropis volucellus*, flathead chub *Platygobio gracilis*, white crappie *Pomoxis annularis*, and yellow perch. Flathead chubs, yellow perch, and white crappies have been captured in past years of monitoring in segments 5 and 6 but since 2003 no burbots, white suckers, golden shiners, and mimic shiners have been observed. Flathead chubs were commonly collected by Wanner et al. (2009) within the Niobrara River.

The pallid sturgeon population assessment program is adaptive, allowing for changes in standard gear types and experimentation with the effectiveness of new gears (Appendex C). Since the monitoring program began in 2003 the beam trawl, small mesh otter trawl, hoop net, setline, bag seine, and push trawl have been evaluated and are no longer used as standard gears due to low catch rates in comparison to current standard gears. In 2006 and 2007 a comparison of white and green mesh gill nets and trammel nets were evaluated. Wanner et al. (in review) reported no significant differences in catch rates between colors for gill nets with significance only noted for 5 of 25 species in trammel nets. Therefore, green and white mesh gill nets and trammel nets can be pooled for future analyses. For the 2008 – 2009 sampling season, trotlines will be evaluated during the second half of the sturgeon season (i.e. spring).

ACKNOWLEDGEMENTS

We thank Daniel Dembkoski, Jordan Hull, Alexis Maple, Kevin Perry, (USFWS) and Mark Drobish (ACOE) for field assistance. We thank Shelley Erickson (USFWS) and the ACOE personnel at the Gavins Point Dam Project for coordinating our float plans to ensure our safety while working on the Missouri River. Cover photo credit of the Niobrara River Delta goes to Steve Krentz USFWS, Missouri River Fish and Wildlife Conservation Office.

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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 (AFS), Common and Scientific Names of Fishes from the United States and Canada, 5th edition (AFS 1991). 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	SCN
Tributary	Macro	Any river or stream flowing into the Missouri River	TRIB
Tributary mouth large	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

Appendix B. (continued).

Habitat	Scale	Definition	Code
Tributary mouth small	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	Immediate area downstream of a 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 (STD) and wild gears (type), their corresponding codes in the database, seasons deployed (sturgeon season [ST], fish community season [FC], or both), years used, and catch-per-unit-effort units for collection of Missouri River fishes in segments 5 and 6 for the Long-term Pallid Sturgeon and Associated Fish Community Sampling Program. Long-term monitoring began in 2003 for segments 5 and 6. New gears go through an evaluation period before adoption as a standard gear.

Gear	Code	Type	Season	Years	CPUE units
Trammel net – 1 inch inner mesh	TN	STD	Both	2003 - present	fish/100 m
Gill net – 4 meshes, small mesh set upstream	GN14	STD	ST	2003 - present	fish/net night
Gill net – 4 meshes, large mesh set upstream	GN41	STD	ST	2003 - present	fish/net night
Otter trawl – 16 ft head rope	OT16	STD	Both	2003 - present	fish/100 m
Otter trawl – 16 ft SKT 4mm x 4mm HB2 MOR	OT01	WILD	FC	2006 - 2007	fish/100 m
Beam trawl	BT	STD[a]	Both	2003-2004 STD	fish/100 m
Push Trawl – 8 ft 4mm x 4mm	POT02	Evaluation	FC	2006 - 2007	fish/ m
Mini-fyke net	MF	WILD	FC	2003 - present	fish/net night
Bag Seine – quarter arc method pulled upstream	BSQU	WILD[b]	FC	2003 – 2005 STD	fish/100 m^2
Bag Seine – quarter arc method pulled downstream	BSQD	WILD[b]	FC	2003 – 2005 STD	fish/100 m^2
Bag Seine – half arc method pulled upstream	BSHU	WILD[b]	FC	2003 – 2005 STD	fish/100 m^2
Bag Seine – half arc method pulled downstream	BSHD	WILD[b]	FC	2003 – 2005 STD	fish/100 m^2
Bag seine – rectangular method pulled upstream	BSRU	WILD[b]	FC	2003 – 2005 STD	fish/100 m^2
Bag seine – rectangular method pulled downstream	BSRD	WILD[b]	FC	2003 – 2005 STD	fish/100 m^2
Hoopnets	HN	STD/WILD[c]	Both	2003 - 2004 STD 2005 WILD	fish/ net night
Setlines	SL	WILD	Both	2003 – 2005 WILD	fish/ hook night

[a]Beam trawls were a standard gear from 2003 - 2004 and dropped as a standard gear in 2005.
[b]Bag seines were a standard gear from 2003 – 2005 and dropped as a standard gear in 2006.
[c]Hoop nets were a standard gear from 2003 – 2004 and dropped as a standard gear in 2005.

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	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
KS/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 segments 5 and 6 of the Missouri River (RPMA 3). Fish < 230mm fork length tagged with passive integrated transponders (PIT) tags.

Year	Stocking Site[a]	Number Stocked	Year Class	Stock Date	Age at Stocking	Primary Mark	Secondary Mark
2000	VER	416	1997	6/6/2000	Age - 3	PIT	Elastomer / Dangler
2000	VER	98	1998	9/20/2000	Age - 2	PIT	
2000	VER	4	Adults[b]	7/6/00	Unknown - Adult	PIT	Sonic
2000	VER	3	Adults[b]	9/20/00	Unknown - Adult	PIT	2 w/ sonic
2000	RNW	2	Adults[b]	7/6/00	Unknown - Adult	PIT	
2002	VER	558	2001	4/21/2002	Age - 1	PIT	Elastomer
2002	SUN	181	1999	4/27/2002	Age - 3	PIT	Elastomer
2003	STB	300	2002	7/26/2003	Age - 1	PIT	Elastomer
2003	SUN	301	2002	7/26/2003	Age - 1	PIT	Elastomer
2004	SUN	244	2003	10/7/2004	Age - 1	PIT	Elastomer
2004	STB	271	2003	10/7/2004	Age - 1	PIT	Elastomer
2005	RNW	868	2004	8/30/2005	Age - 1	PIT	Elastomer
2006	STB	1,005	2005	8/25/2006	Age - 1	PIT	Elastomer
2007	STB	600	2006	5/9/2007	Age - 1	3rd right scute	Elastomer
2008	STB	600	2007	4/17/2008	Age - 1	PIT	4th left scute
2008	SUN	569	2007	5/8/2008	Age - 1	PIT	3rd and 4th left scute[c]
2008	STB	3,410	2008	9/14/2008	Age - 0	2x Elastomer[d]	

[a] Stocking site abbreviation presented in Appendix D.
[b] Translocated fish from Lake Sharpe.
[C] Only about 100 fish had wrong scute removed (3rd left) removed and had correct scute (4th left) also removed.
[d] 2008 year class approximately 300 fish (<10%) were incorrectly tagged with purple on left and yellow on right. Yellow last used as year class designation in 2005.

Appendix F

Total catch, overall mean catch per unit effort [± 2 SE], and mean CPUE (fish/100 m) by Mesohabitat within a Macrohabitat for all species caught with each gear type during the sturgeon season and the fish community season for segment 5 and 6 of the Missouri River during 2007-2008. Overall CPUE was calculated from bend averages and not total fish captured. Species captured are listed alphabetically and their codes are presented in Appendix A. Asterisks with bold type indicate targeted native Missouri River species and habitat abbreviations are presented in Appendix B. Standard Error was not calculated when N < 2.

Appendix F1. Gill Net: overall season and segment summary. Lists CPUE (fish/net night) and 2 standard errors in brackets.

Species	Total Catch	Overall CPUE	Macrohabitat/Mesohabitat										
			CHXO		CONF		ISB		OSB		SCCL		BRAD
			CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	ITIP	CHNB
BUSK*	**5**	**0.025**	**0.037**				**0**		**0.088**				**0.01**
		[0.022]	**[0.074]**				**[0]**		**[0.099]**				**[0.02]**
CARP	3	0.015	0				0		0				0.03
		[0.022]	[0]				[0]		[0]				[0.045]
CNCF	49	0.246	0.259				0.342		0.618				0.08
		[0.126]	[0.202]				[0.253]		[0.609]				[0.079]
FHCF	1	0.005	0				0		0				0.01
		[0.01]	[0]				[0]		[0]				[0.02]
GZSD	1	0.005	0				0.026		0				0
		[0.01]	[0]				[0.053]		[0]				[0]
NTPK	3	0.015	0.037				0		0				0.02
		[0.017]	[0.074]				[0]		[0]				0.028
PDSG*	**20**	**0.101**	**0.148**				**0.053**		**0.059**				**0.12**
		[0.051]	**[0.176]**				**[0.073]**		**[0.082]**				**[0.082]**
QLBK	2	0.01	0				0		0				0.02
		[0.014]	[0]				[0]		[0]				[0.028]
RKBS	1	0.005	0				0		0				0.01
		[0.01]	[0]				[0]		[0]				[0.02]
RVCS	2	0.01	0				0.026		0				0.01
		[0.014]	[0]				[0.053]		[0]				[0.02]
SGER*	**78**	**0.392**	**0.148**				**0.184**		**0.265**				**0.58**
		[0.204]	**[0.139]**				**[0.166]**		**[0.195]**				**[0.392]**
SGWE	4	0.02	0.037				0		0				0.03
		[0.025]	[0.074]				[0]		[0]				[0.045]
SHRH	60	0.302	0.185				0.474		0.618				0.16
		[0.106]	[0.186]				[0.269]		[0.422]				[0.093]
SMBS	7	0.035	0				0.053		0.147				0
		[0.033]	[0]				[0.105]		[0.149]				[0]
SNGR	17	0.085	0.037				0.316		0.118				0
		[0.078]	[0.074]				[0.378]		[0.14]				[0]
SNSG*	**133**	**0.668**	**0.741**				**0.421**		**1.618**				**0.42**
		[0.202]	**[0.55]**				**[0.317]**		**[0.869]**				**[0.156]**
WLYE	176	0.884	1.741				1.605		0.794				0.41
		[0.525]	[2.038]				[1.947]		[0.8]				[0.408]
WTCP	1	0.005	0				0		0				0.01
		[0.01]	[0]				[0]		[0]				[0.02]

Appendix F2. 1 Inch Trammel Net: overall season and segment summary. Lists CPUE (fish/100 m) and 2 standard errors in brackets.

Species	Total Catch	Overall CPUE	Macrohabitat/Mesohabitat											
			CHXO		CONF		ISB		OSB		SCCL		BRAD	
			CHNB	POOL	CHNB	POOL	CHNB	BARS	CHNB	POOL	CHNB	ITIP	CHNB	
BKBH	1	0.004 [0.008]	0 [0]				0 [0]	0	0 [0]				0.007 [0.014]	
CARP	8	0.035 [0.027]	0 [0]				0 [0]	0	0 [0]				0.063 [0.047]	
CNCF	65	0.232 [0.081]	0.467 [0.277]				0.252 [0.265]	0	0.107 [0.117]				0.192 [0.093]	
FHCF	2	0.01 [0.015]	0 [0]				0 [0]	0	0 [0]				0.019 [0.027]	
FWDM	2	0.009 [0.012]	0 [0]				0 [0]	0	0 [0]				0.016 [0.022]	
GDEY	1	0.003 [0.006]	0 [0]				0 [0]	0	0 [0]				0.005 [0.01]	
PDFH	1	0.005 [0.009]	0 [0]				0 [0]	0	0 [0]				0.008 [0.017]	
PDSG*	**18**	**0.079 [0.039]**	**0.045 [0.062]**				**0.023 [0.045]**	**0**	**0.019 [0.038]**				**0.119 [0.066]**	
QLBK	3	0.015 [0.022]	0 [0]				0 [0]	0	0 [0]				0.027 [0.039]	
RKBS	3	0.014 [0.017]	0 [0]				0 [0]	0	0 [0]				0.026 [0.03]	
RVCS	10	0.041 [0.026]	0.047 [0.066]				0.021 [0.041]	0	0 [0]				0.055 [0.042]	
SGER*	**41**	**0.158 [0.062]**	**0.038 [0.053]**				**0 [0]**	**0.526**	**0 [0]**				**0.269 [0.104]**	
SGWE	6	0.019 [0.015]	0 [0]				0 [0]	0	0 [0]				0.035 [0.027]	
SHRH	120	0.364 [0.426]	1.949 [2.629]				0.061 [0.068]	0	0.097 [0.139]				0.059 [0.039]	
SMBF	11	0.042 [0.039]	0.023 [0.046]				0 [0]	0	0 [0]				0.07 [0.069]	
SNSG*	**94**	**0.369 [0.181]**	**0.45 [0.298]**				**0.619 [0.855]**	**1.053**	**0.395 [0.702]**				**0.262 [0.14]**	
SVCB	1	0.003 [0.006]	0.019 [0.037]				0 [0]	0	0 [0]				0 [0]	
WLYE	43	0.16 [0.104]	0.034 [0.068]				0 [0]	0	0 [0]				0.28 [0.184]	
WTBS	6	0.021 [0.028]	0 [0]				0 [0]	0	0 [0]				0.039 [0.051]	

Appendix F4. Otter Trawl: overall season and segment summary. Lists CPUE (fish/100 m) and 2 standard errors in brackets.

Species	Total Catch	Overall CPUE	Macrohabitat/Mesohabitat											
			CHXO		CONF		ISB		OSB		SCCL		BRAD	
			CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	ITIP	CHNB	
BKBH	1	0.002 [0.004]	0 [0]		0 [0]		0 [0]		0.013 [0.025]		0 [0]		0 [0]	
BKCP	1	0.002 [0.004]	0 [0]		0 [0]		0 [0]		0 [0]		0 [0]		0.004 [0.008]	
BLGL	1	0.001 [0.003]	0 [0]		0 [0]		0 [0]		0 [0]		0 [0]		0.003 [0.006]	
BMSN	1	0.002 [0.003]	0 [0]		0 [0]		0 [0]		0 [0]		0 [0]		0.004 [0.007]	
BUSK*	**2**	**0.004 [0.005]**	**0.012 [0.024]**		**0.063 [0.125]**		**0 [0]**		**0 [0]**		**0 [0]**		**0 [0]**	
CARP	3	0.005 [0.005]	0 [0]		0.042 [0.083]		0 [0]		0 [0]		0 [0]		0.007 [0.01]	
CNCF	453	0.74 [0.255]	0.031 [0.045]		2.04 [3.329]		0.016 [0.022]		0.086 [0.08]		0 [0]		1.37 [0.453]	
ERSN	7	0.011 [0.009]	0 [0]		0.063 [0.125]		0.008 [0.016]		0 [0]		0 [0]		0.016 [0.015]	
FHCF	2	0.004 [0.006]	0 [0]		0 [0]		0 [0]		0 [0]		0 [0]		0.009 [0.013]	
FSMT	3	0.004 [0.008]	0 [0]		0 [0]		0.023 [0.046]		0 [0]		0 [0]		0 [0]	
FWDM	72	0.15 [0.142]	0 [0]		0 [0]		0 [0]		0 [0]		0 [0]		0.315 [0.298]	
GZSD	7	0.011 [0.013]	0 [0]		0.083 [0.167]		0.016 [0.031]		0 [0]		0 [0]		0.011 [0.021]	
JYDR	2	0.003 [0.004]	0.01 [0.02]		0 [0]		0.008 [0.016]		0 [0]		0 [0]		0 [0]	
OSSF	1	0.001 [0.003]	0 [0]		0 [0]		0.008 [0.016]		0 [0]		0 [0]		0 [0]	
PDSG*	**23**	**0.036 [0.02]**	**0 [0]**		**0.042 [0.083]**		**0.008 [0.016]**		**0 [0]**		**0 [0]**		**0.071 [0.041]**	
RBST	5	0.01 [0.01]	0.012 [0.024]		0 [0]		0.044 [0.052]		0 [0]		0 [0]		0 [0]	
RVCS	15	0.022 [0.012]	0.039 [0.047]		0 [0]		0.025 [0.028]		0.009 [0.017]		0 [0]		0.022 [0.018]	

Appendix F 4. (continued).

Species	Total Catch	Overall CPUE	Macrohabitat/Mesohabitat CHXO CHNB	CHXO POOL	CONF CHNB	CONF POOL	ISB CHNB	ISB POOL	OSB CHNB	OSB POOL	SCCL CHNB	SCCL ITIP	BRAD CHNB
SGER*	**50**	**0.076**	**0.029**		**0**		**0.016**		**0.097**		**0.167**		**0.109**
		[0.031]	**[0.033]**		**[0]**		**[0.022]**		**[0.115]**		**[0.333]**		**[0.048]**
SGWE	7	0.011	0		0.125		0.008		0		0		0.012
		[0.012]	[0]		[0.25]		[0.016]		[0]		[0]		[0.018]
SHRH	25	0.046	0.115		0		0.085		0.051		0.333		0.007
		[0.029]	[0.16]		[0]		[0.064]		[0.076]		[0]		[0.01]
SMBF	2	0.003	0		0		0		0		0		0.006
		[0.004]	[0]		[0]		[0]		[0]		[0]		[0.009]
SMBS	2	0.003	0.012		0		0		0		0		0.003
		[0.004]	[0.024]		[0]		[0]		[0]		[0]		[0.006]
SNGR	2	0.005	0		0		0		0.022		0		0.004
		[0.008]	[0]		[0]		[0]		[0.045]		[0]		[0.007]
SNSG*	**22**	**0.034**	**0.011**		**0**		**0**		**0.03**		**0**		**0.059**
		[0.016]	**[0.021]**		**[0]**		**[0]**		**[0.034]**		**[0]**		**[0.031]**
SNSN*	**3**	**0.005**	**0**		**0.057**		**0**		**0**		**0**		**0.007**
		[0.006]	**[0]**		**[0.114]**		**[0]**		**[0]**		**[0]**		**[0.01]**
SNST	1	0.001	0.01		0		0		0		0		0
		[0.003]	[0.02]		[0]		[0]		[0]		[0]		[0]
SPST	1	0.001	0		0.042		0		0		0		0
		[0.003]	[0]		[0.083]		[0]		[0]		[0]		[0]
STCT	2	0.004	0		0		0		0		0		0.008
		[0.005]	[0]		[0]		[0]		[0]		[0]		[0.011]
SVCB	76	0.12	0.042		0		0.093		0.07		0.5		0.172
		[0.039]	[0.04]		[0]		[0.087]		[0.051]		[0.333]		[0.071]
UCS	11	0.019	0		0		0		0		0		0.04
		[0.016]	[0]		[0]		[0]		[0]		[0]		[0.032]
WLYE	36	0.059	0.015		0		0.019		0.077		0		0.086
		[0.027]	[0.03]		[0]		[0.037]		[0.108]		[0]		[0.04]
WTBS	4	0.006	0		0		0		0		0		0.012
		[0.006]	[0]		[0]		[0]		[0]		[0]		[0.012]
WTCP	2	0.003	0		0		0.016		0		0		0
		[0.006]	[0]		[0]		[0.031]		[0]		[0]		[0]

Appendix F6. Mini-fyke Net: overall season and segment summary. Lists CPUE (fish/net night) and 2 standard errors in brackets.

Species	Total Catch	Overall CPUE	Macrohabitat/Mesohabitat										
			CHXO		CONF		ISB		OSB		SCCL		BRAD
			CHNB	BARS	CHNB	BARS	CHNB	BARS	CHNB	BARS	CHNB	ITIP	BARS
BKBH	5	0.063 [0.103]	0	0.417 [0.672]		0 [0]	0	0 [0]		0 [0]			0 [0]
BLGL	72	0.9 [0.528]	0	2.083 [2.443]		5.5 [9]	7	0.182 [0.244]		0.923 [1.097]			0.375 [0.326]
BMBF	2	0.025 [0.035]	0	0 [0]		0 [0]	0	0 [0]		0 [0]			0.05 [0.07]
BMSN	1	0.013 [0.025]	0	0 [0]		0 [0]	0	0 [0]		0 [0]			0.025 [0.05]
BNDC	1	0.013 [0.025]	0	0 [0]		0 [0]	0	0 [0]		0 [0]			0.025 [0.05]
BNMW	50	0.625 [0.38]	0	0.25 [0.359]		0 [0]	0	0.636 [0.905]		0.385 [0.622]			0.875 [0.68]
BSMW	37	0.463 [0.573]	0	0 [0]		0.5 [1]	2	0 [0]		2.615 [3.363]			0 [0]
CARP	42	0.525 [0.261]	0	0.083 [0.167]		1 [2]	0	0.091 [0.182]		0 [0]			0.95 [0.475]
CKCB	5	0.063 [0.09]	0	0 [0]		2.5 [1]	0	0 [0]		0 [0]			0 [0]
CNCF	4	0.05 [0.049]	0	0 [0]		0.5 [1]	0	0 [0]		0.077 [0.154]			0.05 [0.07]
ERSN	301	3.763 [1.741]	0	2.833 [2.816]		10.5 [21]	1	1.818 [1.591]		1.692 [1.886]			5.075 [3.126]
FHCF	1	0.013 [0.025]	0	0 [0]		0 [0]	0	0.091 [0.182]		0 [0]			0 [0]
FHMW	2	0.025 [0.035]	0	0 [0]		0 [0]	0	0 [0]		0 [0]			0.05 [0.07]
FSMT	5	0.063 [0.074]	0	0 [0]		0 [0]	0	0.182 [0.364]		0.077 [0.154]			0.05 [0.1]
FWDM	60	0.75 [0.425]	0	0 [0]		0 [0]	0	0 [0]		0 [0]			1.5 [0.784]
GNSF	8	0.1 [0.136]	0	0 [0]		0 [0]	0	0 [0]		0 [0]			0.2 [0.27]
GSPK	1	0.013 [0.025]	0	0 [0]		0 [0]	0	0 [0]		0 [0]			0.025 [0.05]
GZSD	38	0.475 [0.302]	0	0 [0]		0 [0]	0	0 [0]		0 [0]			0.95 [0.568]

Appendix F6. (continued).

Species	Total Catch	Overall CPUE	Macrohabitat/Mesohabitat										
			CHXO		CONF		ISB		OSB		SCCL		BRAD
			CHNB	BARS	CHNB	BARS	CHNB	BARS	CHNB	BARS	CHNB	ITIP	BARS
HBNS*	**6**	**0.075**	**0**	**0**		**0**	**0**	**0**		**0**			**0.15**
		[0.15]		**[0]**		**[0]**		**[0]**		**[0]**			**[0.3]**
JYDR	9	0.113	0	0		0	0	0		0.154			0.175
		[0.08]		[0]		[0]		[0]		[0.208]			[0.141]
LMBS	19	0.238	0	0		0.5	0	0		0			0.45
		[0.208]		[0]		[1]		[0]		[0]			[0.405]
LNDC	1	0.013	0	0		0	0	0		0.077			0
		[0.025]		[0]		[0]		[0]		[0.154]			[0]
OSSF	2	0.025	0	0		0	1	0		0.077			0
		[0.035]		[0]		[0]		[0]		[0.154]			[0]
RBST	1	0.013	0	0		0	0	0.091		0			0
		[0.025]		[0]		[0]		[0.182]		[0]			[0]
RDSN	16	0.2	0	0.25		0.5	0	0		0.769			0.05
		[0.199]		[0.5]		[1]		[0]		[1.09]			[0.07]
RKBS	3	0.038	0	0		0	0	0		0.077			0.05
		[0.043]		[0]		[0]		[0]		[0.154]			[0.07]
RVCS	6	0.075	0	0		0.5	0	0.091		0			0.1
		[0.059]		[0]		[1]		[0.182]		[0]			[0.096]
SFSN	480	6	0	3.333		4.5	8	1		7.769			7.775
		[2.188]		[2.562]		[5]		[0.853]		[7.467]			[3.422]
SGER*	**17**	**0.213**	**0**	**0.083**		**0.5**	**0**	**0**		**0.077**			**0.35**
		[0.132]		**[0.167]**		**[1]**		**[0]**		**[0.154]**			**[0.243]**
SHRH	6	0.075	0	0		0	0	0		0.154			0.1
		[0.069]		[0]		[0]		[0]		[0.208]			[0.12]
SMBF	5	0.063	0	0		0	0	0		0			0.125
		[0.054]		[0]		[0]		[0]		[0]			[0.106]
SMBS	11	0.138	0	0.083		0.5	0	0.273		0.308			0.05
		[0.085]		[0.167]		[1]		[0.39]		[0.266]			[0.07]
SNGR	49	0.613	0	0.25		0	0	0.273		0.154			1.025
		[0.258]		[0.359]		[0]		[0.545]		[0.308]			[0.438]
SNSN*	**218**	**2.725**	**0**	**0**		**0**	**0**	**0**		**0.308**			**5.35**
		[4.581]		**[0]**		**[0]**		**[0]**		**[0.474]**			**[9.141]**

Appendix F6. (continued).

Species	Total Catch	Overall CPUE	Macrohabitat/Mesohabitat										
			CHXO		CONF		ISB		OSB		SCCL		BRAD
			CHNB	BARS	CHNB	BARS	CHNB	BARS	CHNB	BARS	CHNB	ITIP	BARS
STSN	38	0.475	0	0.583		2	0	0		0.846			0.4
		[0.332]		[0.999]		[4]		[0]		[1.533]			0.285
SVCB	2	0.025	0	0		0	0	0		0			0.05
		[0.035]		[0]		[0]		[0]		[0]			[0.07]
UCS	37	0.463	0	0		0	0	0		0			0.925
		[0.371]		[0]		[0]		[0]		[0]			[0.718]
UCY	1	0.013	0	0		0	0	0		0			0.025
		[0.025]		[0]		[0]		[0]		[0]			[0.05]
UPP	4	0.05	0	0		0	0	0.364		0			0
		[0.079]		[0]		[0]		[0.557]		[0]			[0]
WLYE	23	0.288	0	0		1	0	0		0.154			0.475
		[0.182]		[0]		[2]		[0]		[0.308]			[0.328]
WTBS	123	1.538	0	0		0	0	0		0.077			3.05
		[1.241]		[0]		[0]		[0]		[0.154]			[2.402]
WTCP	107	1.338	0	0		0	0	0.091		0			2.65

Appendix G. Hatchery names, locations, and abbreviations.

Hatchery	State	Abbreviation
Blind Pony State Fish Hatchery	MO	BLP
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

Appendix H. Alphabetic list of Missouri River fishes with total catch per unit effort by gear type for the sturgeon season (fall through spring) and the fish community season (summer) during 2007-2008 for segments 5 and 6 of the Missouri River. Species codes are located in Appendix A. Asterisks and bold type denote targeted native Missouri River species.

Species Code	Fall through Spring - Sturgeon Season			Summer - Fish Community Season			
	Gill Net	Otter Trawl	1 Inch Trammel Net	Otter Trawl	Push Trawl	1 Inch Trammel Net	Mini-Fyke Net
BKBH	0.000	0.006	0.008	0.000		0.000	0.063
BKCP	0.000	0.006	0.000	0.000		0.000	0.000
BLGL	0.000	0.000	0.000	0.002		0.000	0.900
BMBF	0.000	0.000	0.000	0.000		0.000	0.025
BMSN	0.000	0.000	0.000	0.003		0.000	0.013
BNDC	0.000	0.000	0.000	0.000		0.000	0.013
BNMW	0.000	0.000	0.000	0.000		0.000	0.625
BSMW	0.000	0.000	0.000	0.000		0.000	0.463
BUSK*	**0.025**	**0.000**	**0.000**	**0.006**		**0.000**	**0.000**
CARP	0.015	0.010	0.041	0.002		0.030	0.525
CKCB	0.000	0.000	0.000	0.000		0.000	0.063
CNCF	0.246	0.426	0.251	0.897		0.216	0.050
ERSN	0.000	0.000	0.000	0.017		0.000	3.763
FHCF	0.005	0.000	0.023	0.006		0.000	0.013
FHMW	0.000	0.000	0.000	0.000		0.000	0.025
FSMT	0.000	0.012	0.000	0.000		0.000	0.063
FWDM	0.000	0.005	0.010	0.222		0.007	0.750
GDEY	0.000	0.000	0.006	0.000		0.000	0.000
GNSF	0.000	0.000	0.000	0.000		0.000	0.100
GSPK	0.000	0.000	0.000	0.000		0.000	0.013
GZSD	0.005	0.000	0.000	0.016		0.000	0.475
HBNS*	**0.000**	**0.000**	**0.000**	**0.000**		**0.000**	**0.075**
JYDR	0.000	0.008	0.000	0.000		0.000	0.113
LMBS	0.000	0.000	0.000	0.000		0.000	0.238
LNDC	0.000	0.000	0.000	0.000		0.000	0.013
NTPK	0.015	0.000	0.000	0.000		0.000	0.000
OSSF	0.000	0.000	0.000	0.002		0.000	0.025
PDFH	0.000	0.000	0.010	0.000		0.000	0.000
PDSG*	**0.101**	**0.023**	**0.133**	**0.043**		**0.035**	**0.000**
QLBK	0.010	0.000	0.033	0.000		0.000	0.000

Appendix H. (continued).

Species Code	Fall through Spring - Sturgeon Season			Summer - Fish Community Season			
	Gill Net	Otter Trawl	1 Inch Trammel Net	Otter Trawl	Push Trawl	1 Inch Trammel Net	Mini-Fyke Net
RBST	0.000	0.017	0.000	0.006		0.000	0.013
RDSN	0.000	0.000	0.000	0.000		0.000	0.200
RKBS	0.005	0.000	0.032	0.000		0.000	0.038
RVCS	0.010	0.039	0.054	0.013		0.030	0.075
SFSN	0.000	0.000	0.000	0.000		0.000	6.000
SGER*	**0.392**	**0.181**	**0.241**	**0.023**		**0.091**	**0.213**
SGWE	0.020	0.004	0.021	0.015		0.018	0.000
SHRH	0.302	0.050	0.503	0.044		0.251	0.075
SMBF	0.000	0.000	0.086	0.004		0.007	0.063
SMBS	0.035	0.004	0.000	0.003		0.000	0.138
SNGR	0.085	0.016	0.000	0.000		0.000	0.613
SNSG*	**0.668**	**0.025**	**0.499**	**0.039**		**0.263**	**0.000**
SNSN*	**0.000**	**0.000**	**0.000**	**0.008**		**0.000**	**2.725**
SNST	0.000	0.004	0.000	0.000		0.000	0.000
SPST	0.000	0.000	0.000	0.002		0.000	0.000
STCT	0.000	0.011	0.000	0.000		0.000	0.000
STSN	0.000	0.000	0.000	0.000		0.000	0.475
SVCB	0.000	0.236	0.000	0.062		0.005	0.025
UCS	0.000	0.005	0.000	0.026		0.000	0.463
UCY	0.000	0.000	0.000	0.000		0.000	0.013
UPP	0.000	0.000	0.000	0.000		0.000	0.050
WLYE	0.884	0.126	0.307	0.025		0.040	0.288
WTBS	0.000	0.005	0.048	0.006		0.000	1.538
WTCP	0.005	0.000	0.000	0.004		0.000	1.338

Appendix I. Comprehensive list of bend numbers and locations for segments 5 and 6 of the Missouri River comparing bend selection for both sturgeon season (ST) and fish community season (FC) between years from 2003 – 2007. (W) indicates a non-random bend sampled.

Segment -Bend Number	Bend River Mile	Year					
		2003	2004	2005	2006	2007	2008
5 - 1	880						
5 - 2	878.9						ST, FC
5 - 3	875.5			FC			
5 - 4	873.5		ST				ST, FC
5 - 5	871.9		ST			ST	ST, FC
5 - 6	870.3	ST, FC	FC		ST, FC	ST, FC	
5 - 7	868.5	ST, FC	ST, FC	ST, FC	ST, FC	ST, FC	
5 - 8	866				ST, FC		
5 - 9	864.4						
5 - 10	863.4	ST, FC	ST	ST		ST, FC	
5 - 11	861.1	ST (W)		FC	ST, FC	ST, FC	
5 - 12	853.2		ST, FC	ST,FC			
5 - 13	851.7	ST (W)	FC				
5 - 14	851				ST, FC		ST, FC
5 - 15	849.1	ST, FC	ST	ST			
5 - 16	847.5	ST (W)	ST	FC	(W)	ST, FC	ST, FC
5 - 17	846	ST, FC	FC	ST			
6 - 1	844		ST, FC	ST	ST,FC	ST, FC	
6 - 2	843.2	ST, FC	ST	ST		ST	
6 - 3	842.1	ST (W)	FC				ST, FC
6 - 4	841.4	ST, FC	ST,FC	ST, FC	ST, FC		
6 - 5	840	ST, FC	ST,FC	ST			
6 - 6	836.9	ST, FC	ST		ST, FC	ST, FC	
6 - 7	835.3	ST (W)	ST	ST, FC	ST, FC	ST, FC	ST, FC
6 - 8	834.1	ST, FC		FC	ST, FC	ST, FC	
6 - 9	832	ST (W)	ST,FC	FC			ST, FC
6 - 10	831	ST (W)		FC			ST, FC
6 - 11	829.5	ST (W)				ST, FC	ST, FC

*Bend river mile represents the upper most point of the bend (i.e., the top of the bend going upstream).