

2006 Annual Report

Pallid Sturgeon Population Assessment and Associated 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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EXECUTIVE SUMMARY

Pallid sturgeon *Scaphirhynchus albus* and the associated 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 2005 to fall of 2006 (i.e., 2006 season). Ten randomly selected bends were sampled with a minimum of 8 gear 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. In 2006, 72% of 50 recaptured pallid sturgeons possessed a readable passive integrated transponder (PIT) tag. Fourteen pallid sturgeon were captured without PIT tags but were of similar size to stocked fish and thus were considered to be of hatchery origin. However, we cannot exclude the possibility of natural reproduction. Recaptured pallid sturgeon represented the 1997 - 1999 and 2001 - 2004 years classes stocked into RPMA #3 as part of population supplementation efforts. No fish of the 1998 and 2005 year classes were recaptured during 2006. For standardized gears, 11 pallid sturgeon were captured with gillnets, 18 with trammel nets, and 17 with otter trawls. In 2006, the relative abundance of pallid sturgeon captured in gillnets was 15% higher compared to the overall running average (2003-2005). For drifted trammel nets in 2006, relative abundance decreased 16% during fall through spring (i.e. the sturgeon season) and decreased 52% during summer (i.e. fish community season) when compared to the overall running averages (2003-2005). Thirty-six percent of pallid sturgeons were caught in the same location where a gear initially captured a pallid sturgeon (i.e. duplicate samples). Relative condition (K_n) of recaptured pallid sturgeons ranged from 0.74 to 0.96, which was similar to previous years with an

incremental decline in K_n as fish attained great lengths. The mean growth rates of age-6 and older fish was < 0.09 mm/d, ages 3 and 4 was 0.22 mm/d, and the youngest year class (2004; age 2) grew an average of 0.33 mm/d. Spatially, pallid sturgeons were captured throughout most of the length of segments 5 and 6 (river mile 869 to 832) but 70 % of recaptures were in the delta formed below the Niobrara Confluence. Most habitats where pallid sturgeon were recaptured include the channel border mesohabitat of inside bends (8%), outside bends (14%), channel crossovers (8%) and braided channels (70%). A total of 264 shovelnose sturgeons *S. platyrhynchus* were captured in standard gears during 2006: 178 with gillnets, 46 with trammel nets, and 40 with otter trawls. No young-of-year *Scaphirhynchus* spp. were captured and the ratio of pallid to shovelnose sturgeons was 1:5.2.

In addition to sturgeon, nine 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, speckled chubs, or *Hybognathus* spp. were captured in 2006. Sand shiners were only captured with mini-fyke nets ($n = 42$) during summer. A total of eight blue suckers were captured with standard gears: 5 in gillnets, two in trammel nets, and one in an otter trawl. During 2006 a total of 89 saugers were caught in standard gears: 34 in trammel nets, 31 in otter trawls, and 24 in gillnets. Saugers were captured ($n = 47$) primarily during May to July. A total of 40 fish species and one hybrid were caught in segments 5 and 6 of the Missouri River during 2006. None of the four exotic Asian carps, bighead carp *Hypophthalmichthys nobilis*, silver carp *H. molitrix*, grass carp *Ctenopharyngodon idella*, and black carp *Mylopharyngodon piceus*, were captured.

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Introduction

A team of biologists representing State and Federal resource management agencies was assembled 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 2005a). The primary goal of this program is monitoring 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, deployment methods (Appendix C), and data reporting (Drobish 2005b). Four high priority pallid sturgeon recovery priority management areas (RPMAs), were identified in the recovery plan (Dryer and Sandoval 1993), which encompass nearly 1775 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 2005a). Sampling within these segments allows biologists to monitor trends of pallid sturgeon and the associated fish community as well as evaluate mitigation efforts and shallow water habitat restoration projects.

Pallid sturgeon within segments 5 and 6 of the Missouri River, also known as RPMA 3 (Figure 1a), have been supplemented through stocking since 2000 (Appendices D and E). From 2000 to 2006, a total of 4,245 juvenile pallid sturgeon were released consisting of

seven year classes (1997, 1998, 1999, 2001, and 2002 - 2005). Additionally, nine adult fish which were former broodstock or rehabilitated fish translocated from Lake Sharpe, SD have also been stocked (Appendix E). There are four stocking locations in RPMA 3 (or segments 5 and 6): the most upstream site was Sunshine Bottoms, the middle site was at the Verdel Boat Ramp, and the two lower most sites, at the Running Water Boat Ramp and Chief Standing Bear Bridge (Figure 2). The monitoring program will serve 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 & 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), 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.*

platyrhynchus, 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. No pectoral fin ray clips were taken on shovelnose sturgeon, blue suckers, and in segments 5 and 6 due to biologist's concerns regarding the risk of post-clip mortality.

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 main management actions are all directed towards the ultimate goal of recovery of pallid sturgeon and require monitoring to ascertain success. 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 native target species populations and

2. Determine habitat preferences over time for pallid sturgeon and select native species.

Objectives

Six objectives have been identified for the monitoring program. Detailed hypotheses for each objective can be found in Drobish (2005a).

1. Evaluate annual and long-term trends in pallid sturgeon population abundance and geographic distribution throughout the Missouri River System.
2. Evaluate annual long-term trends of habitat usage by wild and hatchery stocked pallid sturgeon by season and life stage.
3. Evaluate population structure and dynamics of pallid sturgeon in the Missouri River system.
4. Evaluate annual results and long-term trends in population abundance and geographic distribution for nine native target species throughout the Missouri River system.
5. Evaluate annual results and long-term trends of habitat usage for nine target native species by season and life stage.
6. Evaluate annual results and long-term trends in all remaining species (minimum of 50 fish collected/species) population abundance and geographic distribution throughout the Missouri River system.

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 1955. The head waters of Lewis and Clark Lake (river kilometer [rkm] 1327, river mile [rm] 825) defines the downstream end of segment 6. Lewis and Clark Lake extends to Fort Randall Dam (rkm 1416, rm 880) which also defines the upper end segment 5 (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 (i.e., navigation and water supply). The riverine section of Lewis and Clark Lake extends approximately 89 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, Lewis and Clark Lake becomes more like a reservoir. However, sedimentation from the Niobrara River has formed a large braided delta, which starts near rkm 1351. This delta is progressively expanding 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 Recovery Priority Management Areas (RPMAs) in the Missouri River for potential recovery of the species and was designated 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 the historical temperature and flow (i.e., the hydrograph) in the riverine section has been altered due to operation of Fort Randall Dam. Water levels substantially fluctuate daily and seasonally. Diel water levels are subject 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>) reports the highest seasonal releases from Ft. Randall Dam occurred from August through November to support navigation on the Missouri River below Sioux City, Iowa. The lowest releases were from 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 encompasses the riverine section below Fort Randall Dam to the confluence. In this segment, water temperatures are depressed by bottom discharges from Fort Randall Dam and turbidity is low. Segment 6 encompasses the riverine section from 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.

Methods

Our sampling protocol followed the detailed guidelines identified in the “Long Term Pallid Sturgeon and Associated Fish Community Assessment for the Missouri River Guidelines and Standardized Guidelines for Sampling and Data Collection” developed by the Pallid Sturgeon Population Assessment Team (Drobish 2005b). 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). The Benthic Fishes Study was 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. 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 macrohabitats. This 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 the next downstream crossover and 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 and gear

All bends within each segment were sequentially numbered, from upstream to downstream, and then ten bends (five per segment) were randomly selected for sampling. In the 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 to increase sample size were sampled 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. Depth and temperature were collected at all sampling locations. Detailed habitat data collection methods are found in Drobish (2005b).

A minimum number of gear deployments for each standard gear was used, (10 for gillnets 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 associated fish community. However, all gears sampled multiple species despite targeting pallid sturgeon.

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 descriptions of the native fish community. Delineation between the sturgeon and fish community seasons is primarily based on water temperature. Based on the pallid sturgeon collection and handling protocols (USFWS 2002) pallid sturgeon can only be collected with gill nets at water temperatures $< 12^{\circ}\text{C}$. Due to the diverse habitats in the river and the 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 in the Fork Peck reach of 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 October 1, 2005 through September 30, 2006 and herein referred to as the 2006 sampling season. Focused studies are initiated in conjunction with the fish population assessments program to fulfill unique biological information gaps (e.g., food habits and telemetry projects).

Sampling Gear

Multiple standard gears were deployed to sample deep and shallow habitats of the Missouri River. 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 2.54 cm, 3.81 cm, 5.08 cm, 7.62 cm, and 10.16 cm. Trammel nets were 1.8 m deep X 38 m with outside wall panels of 15.24 cm bar mesh and an inside wall panel of 2.54 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 (i.e. 10 ntu). The otter trawl (0.5 m

deep x 9.1 m wide) had an outer chafing mesh of 0.64 cm bar mesh, inner bar mesh of 0.32 cm 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 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 (2005b).

In addition to the required standard gears, multiple gears evaluations were conducted during 2006. In segments 5 and 6 an evaluation of green vs. white net twine in trammel and gill nets was conducted (Wanner, unpublished data). Also, a comparison of a new small mesh otter trawl to the standard OT16 was conducted to evaluate the effectiveness of these two gears (Steffensen, unpublished data) was evaluated. All target species captured with wild gears were used in calculating percents of the catch by habitat (macro- and meso-levels), length frequency histograms, and relative stock density (RSD) indices when applicable.

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 F). Variability of CPUE was presented as 2 standard errors (SE) which approximates a 95% confidence interval around the mean.

Indices of fish condition (health) were calculated for pallid sturgeon and two native target 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). 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). For pallid sturgeon, length categories proposed by Shuman et al. (2006) were used to determine relative stock densities (RSD). These fork length (FL) 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). Length

categories for shovelnose sturgeon were provided by Quist et al. (1998). We calculated the percents of < stock, stock, and > stock sized fish captured in each macrohabitat and mesohabitat type. Sub-stock was further divided < 250 mm (FL) for pallid sturgeon and < 150 mm (FL) for shovelnose sturgeon, to provide greater resolution of recruitment by young-of-year sturgeon. Detailed calculations of RSD are found in Anderson and Newman (1996).

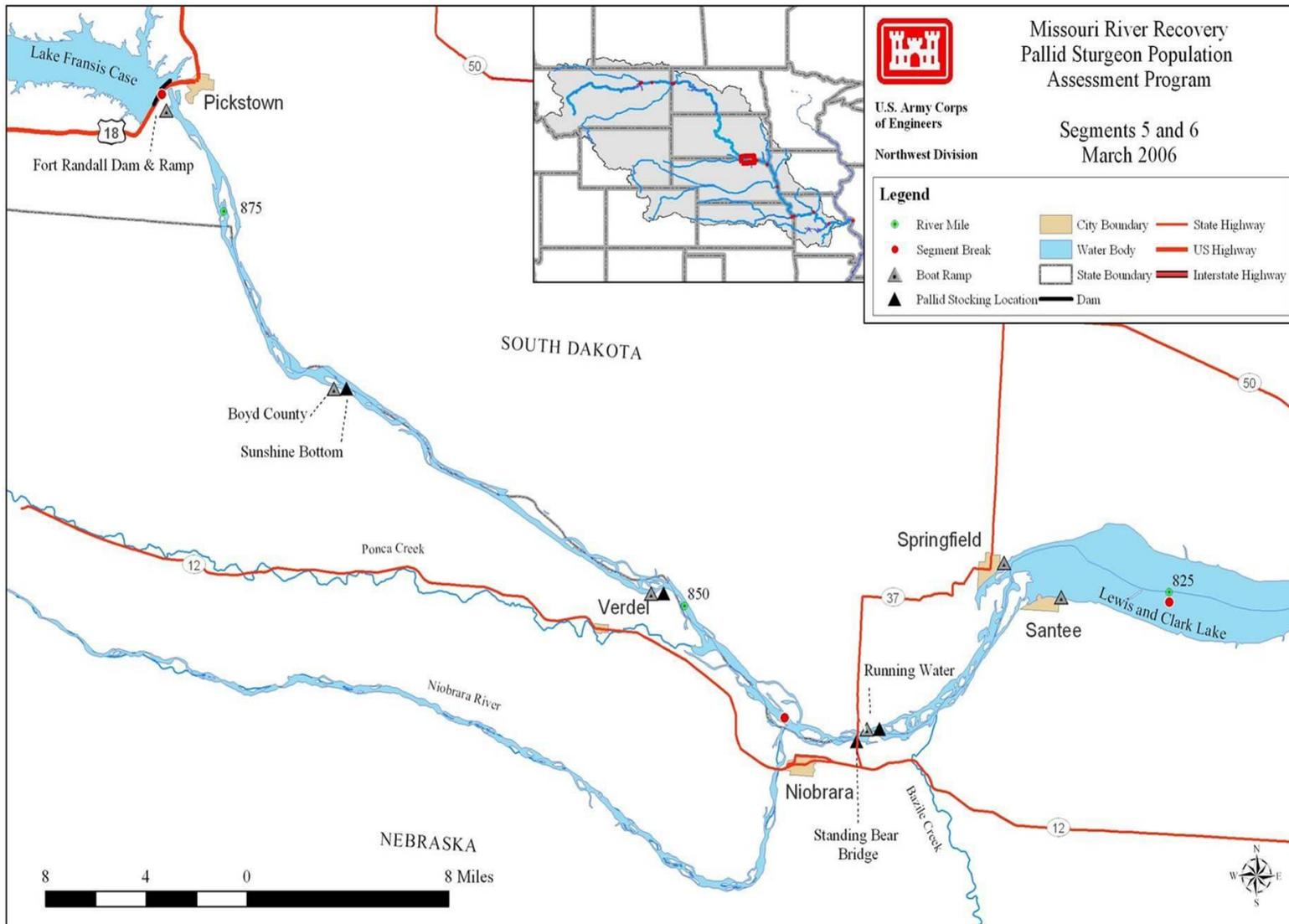


Figure 1a. Map of segments 5 and 6 of the Missouri River with major tributaries, common landmarks, and historic stocking locations for pallid sturgeon. Segments 5 and 6 encompasses the Missouri River from Fort Randall Dam to the headwaters of Lewis and Clark Lake.

Results

Errata for 2004 - Bag seine data reported (in caption) as fish/m² but actual values in the tables were fish/100 m².

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.

Pallid Sturgeon

A total of 50 pallid sturgeons were captured during the 2006 season with 46 fish caught in standard gears: gill nets (n = 11), drifted trammel nets (n = 18), and 16-ft otter trawl (n = 17). Table 3 identifies physical habitat types where pallid sturgeon were captured in segments 5 and 6 during 2006. Despite stocking over 2900 age-1 juvenile pallid sturgeon into segments 5 and 6, relative abundance has remained essentially constant (Fig. 2, 3, and 5) for gillnets, trammel nets, and otter trawls (fall through summer), the exception is the summer OT16 which declined 3.5 fold in CPUE during 2006 compared to 2005. All pallid sturgeon captured were the size of stocked fish and thus considered to be of hatchery origin (Tables 6 -7). However, we cannot exclude the possibility of natural recruitment. Passive integrated transponder (PIT) tag retention was 78%. All fish continued to increase in weight and length since stocking (Table 6). The mean relative condition factor ranged from 0.78 to 0.89 for all year classes and declined since stocking.

Pallid sturgeon were captured throughout segments 5 and 6 demonstrating no affinity towards a specific bend (Figure 1b). Macrohabitats where pallid sturgeon were captured

included outside bends, inside bends, channel crossovers, and braided channels with all fish captured in channel borders mesohabitat (Tables 11-16).

The mean CPUE of pallid sturgeon with gill nets was essentially the same in 2006 (4% greater) compared to the average from 2003 to 2005. Mean CPUE for trammel nets in 2006 was similar (20% lower) during the sturgeon season (fall through spring) compared to 2003 to 2005; whereas mean CPUE during the fish community season (summer) decreased over 2.5 times compared to the 2003 to 2005 running average. As expected, the variability in mean CPUE for all gears was high to due the high incidence of zero catches. The majority of pallid sturgeons were captured during the sturgeon season (n = 36); 14 fish were captured during the fish community season. No pallid sturgeons were captured with mini-fyke nets.

Fork lengths (FL) of pallid sturgeon ranged from 321 – 720 mm in segments 5 and 6 during 2005 (Figure 8). There was no evidence of recruitment by wild pallid sturgeon. Most pallid sturgeon were of stock length with only three fish smaller than stock size (Table 7). Incremental RSD for pallid sturgeon during the sturgeon season was generally similar to the fish community season (Table 7). No hybrid *Scaphirhynchus* (pallid x shovelnose sturgeon) were captured and the ratio of pallid to shovelnose sturgeon was 1:5.2.

Table 1. Number of bends sampled, mean effort per bend (mean number of deployments), and total effort by macrohabitat (total number of deployments) for segments 5 and 6 on the Missouri River during fall through spring (sturgeon season) and summer (fish community season) in 2005 – 2006. N-E indicates the habitat is non-existent in the segment.

Gear	Number of Bends	Mean Effort	Macrohabitat														
			BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD	
Fall through Spring - Sturgeon Season																	
1 Inch Trammel Net	10	8.4	34	13				14	20	3				N-E			
Gill Net	10	20.1	80	31				39	40	11							
Otter Trawl	10	7.9	32	13				19	12	3							
Summer – Fish Community Season																	
1 Inch Trammel Net	10	9.2	44	12	2			13	17	4	0			N-E			
Mini-Fyke Net	10	8	32	8	3			14	16	3	4						
Otter Trawl	10	8.4	35	14				18	15	2	0						

Table 2. Number of bends sampled, mean effort per bend (mean number of deployments), and total effort by mesohabitat (total number of deployments) for segments 5 and 6 on the Missouri River during fall through spring (sturgeon season) and summer (fish community season) in 2005 – 2006. N-E indicates the habitat is non-existent in the segment.

Gear	Number of bends	Mean Effort	Mesohabitat				
			BAR	CHNB	ITIP	POOL	TLWG
Fall through Spring – Sturgeon Season							
1 Inch Trammel Net	10	8.4		84			N-E
Gill Net	10	20.1	200			1	
Otter Trawl	10	7.9		79			
Summer – Fish Community Season							
1 Inch Trammel Net	10	9.2		92			N-E
Mini-Fyke Net	10	8	80				
Otter Trawl	10	8.4		84			

Segments 5 and 6 - Pallid Sturgeon Captures by River Mile

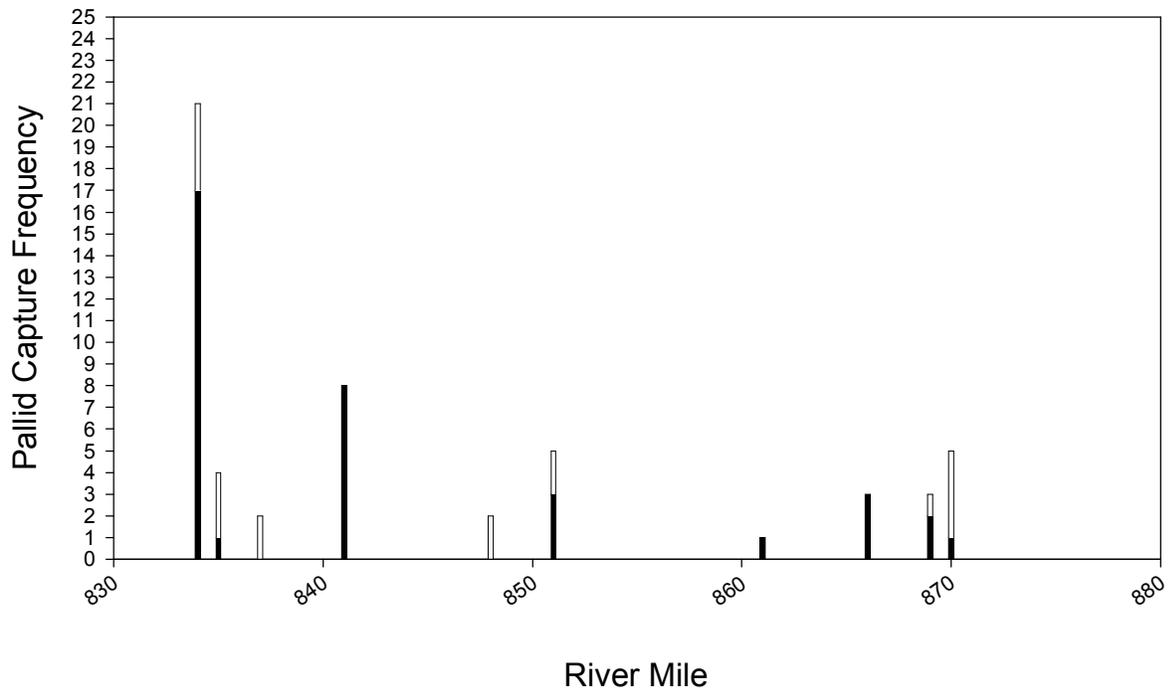


Figure 1b. Distribution of pallid sturgeon captures by river mile for segments 5 and 6 of the Missouri River during 2005-2006. Black bars represent pallid captures during Sturgeon Season and white bars during Fish Community Season. Figure included all pallid captures including non-random and wild samples.

Table 3. Pallid sturgeon (PDSG) capture summaries for all gears relative to habitat type and environmental variables on the Missouri River during 2004-2005. Means (minimum and maximum) are presented. Habitat definitions and codes presented in Appendix B.

Macro-	Meso-	Depth (m) (Effort)	Depth (m) (Catch)	Bottom Velocity (m/s) (Effort)	Bottom Velocity (m/s) (Catch)	Temp. °C (Effort)	Temp. °C (Catch)	Turbidity (ntu) (Effort)	Turbidity (ntu) (Catch)	Total Pallids caught
BRAD	BAR	0.6 (0.03-0.09)		0.06 (0-0.14)		22.8 (21-24.4)		13 (4-26)		
	CHNB	2.9 (0.8-7)	4.1 (0.8-6.0)	0.55 (0.03-1.08)	0.56 (0.03-1.08)	15.9 (4.7-26.2)	18.9 (5.3-26.2)	23 (8-96)	24 (10-96)	35
CHXO	BAR	0.7 (0.4-1)		0.02 (0-0.05)		21.8 (21.2-22.8)		7 (3-13)		
	CHNB	2.9 (0.9-6.8)	4.5 (3.9-5)	0.41 (0.03-0.77)	0.22 (0.03-0.36)	14.5 (1.9-24)	15 (12-24)	5 (2-13)	5 (4-5)	4
CONF	BAR	0.4 (0.4-0.4)		0.16 (0.1-0.21)		22.6 (22.2-23.4)		37 (33-41)		
	CHNB	3.2 (2.8-3.6)		.062 (0.59-0.66)		21.5 (21.4-21.6)		24 (12-37)		
ISB	BAR	0.6 (0.4-1)		0.07 (0.02-0.15)		22.2 (21.4-23)		4 (3-4)		
	POOL	2.9 (2.9-2.9)		0.11 (0.11-0.11)		11.6 (11.6-11.6)		2 (2-2)		
	CHNB	2.5 (1-6.2)	1.9 (1.6-2.2)	0.41 (0.08-0.94)	0.24 (0.22-0.25)	14.3 (1.8-24)	9.5 (2.3-12)	6 (2-15)	5 (3-9)	4
OSB	BAR	0.6 (0.4-1.1)		0.01 (0-0.07)		21.3 (17.8-22.6)		9 (4-33)		
	CHNB	3.8 (1.3-11.4)	5.1 (2.4-8)	0.46 (0.13-0.78)	0.41 (0.27-0.59)	14.8 (1.9-24)	17.8 (2.4-22.3)	7 (3-35)	11 (5-27)	7
SCCL	BAR	0.7 (0.7-0.8)		0		21.4 (21.4-21.4)		9 (8-10)		
	CHNB	2.7 (1.2-4.1)		0.42 (0.21-0.68)		14.4 (5.4-21.6)		8 (6-10)		
SCCS	BAR	0.6 (0.4-0.8)		0.04 (0.04-0.04)		21.3 (20.9-21.4)		6 (6-6)		

Table 6. Mean fork length, weight, relative condition factor (Kn), growth rates, and water temperature for hatchery-reared pallid sturgeon captures by year class at the time of stocking and recapture during 2006 from segments 5 and 6 of the Missouri River. Relative condition factor was calculated using the equation in Keenlyne and Evanson (1993). Standard error (+/- 2SE) 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)	Kn	Length (mm)	Weight (g)	Kn	Length (mm/d)	Weight (g/d)
1997	7	498 (55)	533 (185.4)	1.04 (0.1)	688 (19)	1096 (112.8)	0.78 (0.4)	0.09	0.26 (0.09)
1998	0								
1999	1	393	200	0.93	606	710	0.77	0.01	0.3
2001	6	210 (15)			542 (28)	523 (69.2)	0.83 (0.6)	0.22 (0.03)	
2002	8	253 (20)	68 (13)	1.39 (0.2)	498 (34)	401 (72)	0.83 (0.6)	0.23 (0.03)	0.3 (0.05)
2003	4	308 (52)	121.5 (62)	1.20 (0.2)	413 (26)	215 (39)	0.84 (0.6)	0.18 (0.5)	0.13 (0.05)
2004	8	278 (16)	89 (16)	1.30 (0.8)	348 (19)	127 (18)	0.89 (0.7)	0.33 (0.15)	0.16 (0.08)
2005	0								

Table 7. Incremental relative stock density (RSD)^a and relative condition factor (Kn) for all pallid sturgeon captured with all gear by a length category during 2005-2006 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	Kn (+/- 2SE)
Sturgeon Season			
Sub-stock (0-199)			
Sub-stock (200-329)	3		0.96 (0.04)
Stock	28	85	0.81 (0.02)
Quality	5	15	0.75 (0.11)
Preferred			
Memorable			
Trophy			
Overall Kn	36		0.81 (0.03)
Fish Community Season			
Sub-stock (0-199)			
Sub-stock (200-329)			
Stock	11	79	0.87 (0.06)
Quality	3	21	0.74 (0.08)
Preferred			
Memorable			
Trophy			
Overall Kn	14		0.84 (0.06)

^aRSD = (# of fish of a specified length class / # of fish \geq minimum stock length fish) * 100.

^bLength 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 %).

Segments 5 and 6 - Pallid Sturgeon / Sturgeon Season

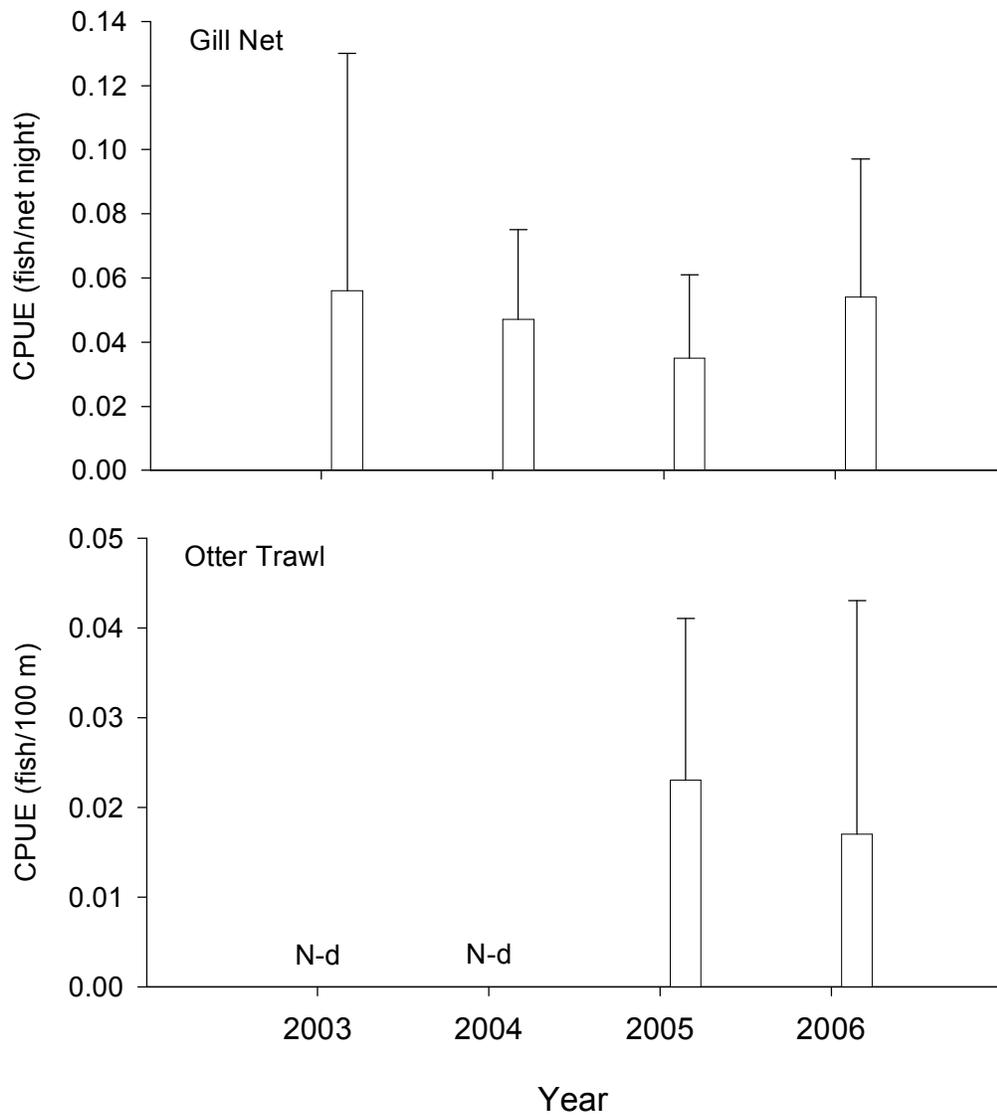


Figure 2. Mean annual catch-per-unit-effort (± 2 SE) of wild (black bars) and hatchery reared (white bars) pallid sturgeon using gill nets and otter trawls in segments 5 and 6 of the Missouri River during sturgeon season 2003-2006. N-d indicates not deployed

Segments 5 and 6 - Pallid Sturgeon / Sturgeon Season

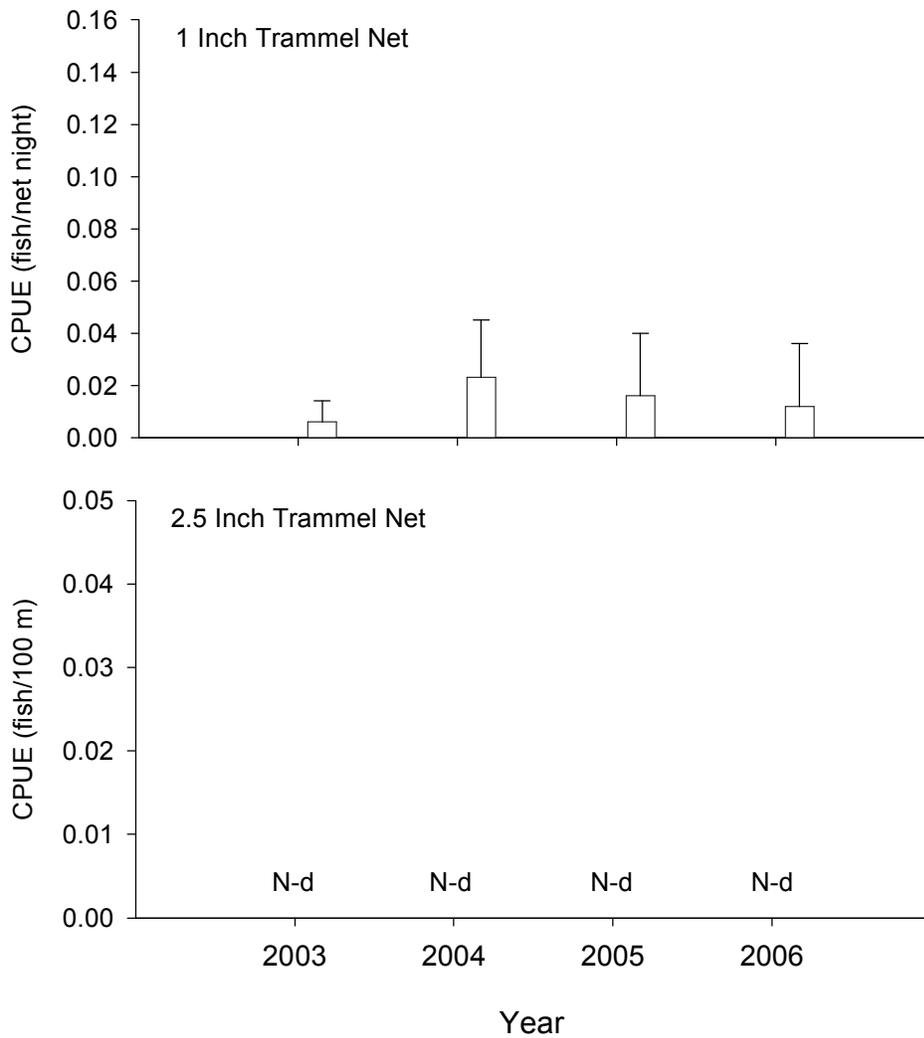


Figure 3. Mean annual catch-per-unit-effort (± 2 SE) of wild (black bars) and hatchery reared (white bars) pallid sturgeon using 1 and 2.5 inch trammel nets in segments 5 and 6 of the Missouri River during sturgeon season 2003-2006. N-d indicates not deployed.

Segments 5 and 6 - Pallid Sturgeon / Fish Community Season

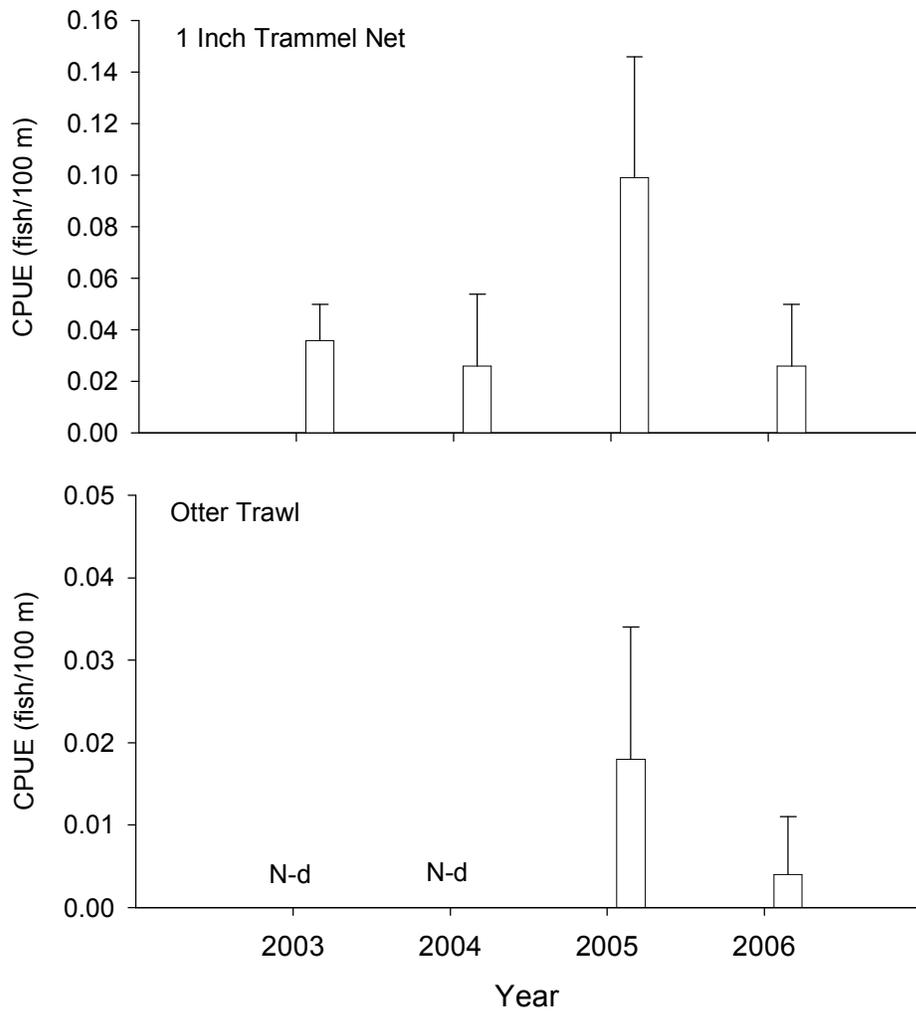


Figure 5. Mean annual catch-per-unit-effort (± 2 SE) of wild (black bars) and hatchery reared (white bars) pallid sturgeon using 1 inch trammel nets and otter trawls in segments 5 and 6 of the Missouri River during fish community season 2003-2006. N-d indicates not deployed.

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 2005 – 2006. 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 segment.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1 Inch Trammel Net	0												N-E		
Gill Net	2						50	50							
Otter Trawl	0														
Fish Community Season (Summer)															
1 Inch Trammel Net	0												N-E		
Mini-Fyke Net	0														
Otter Trawl	0														

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 2005 - 2006. 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 segment.

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

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 2005 – 2006. 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 segment.

Gear	N	Macrohabitat														
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD	
Sturgeon Season (Fall through Spring)																
1 Inch Trammel Net	7	100											N-E			
Gill Net	7	14	43				43									
Otter Trawl	13	85						15								
Fish Community Season (Summer)																
1 Inch Trammel Net	8	50						50					N-E			
Mini-Fyke Net	0															
Otter Trawl	1		100													

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 2005 – 2006. 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 segment.

Gear	N	Mesohabitat				
		BARS	CHNB	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)						
1 Inch Trammel Net	7					N-E
Gill Net	7					
Otter Trawl	13		100			
Fish Community Season (Summer)						
1 Inch Trammel Net	8					N-E
Mini-Fyke Net	0					
Otter Trawl	1		100			

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 2005 – 2006. 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 segment.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1 Inch Trammel Net	0												N-E		
Gill Net	2	100													
Otter Trawl	3	100													
Fish Community Season (Summer)															
1 Inch Trammel Net	3	100											N-E		
Mini-Fyke Net	0														
Otter Trawl	0														

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 2005 – 2006. 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 segment.

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

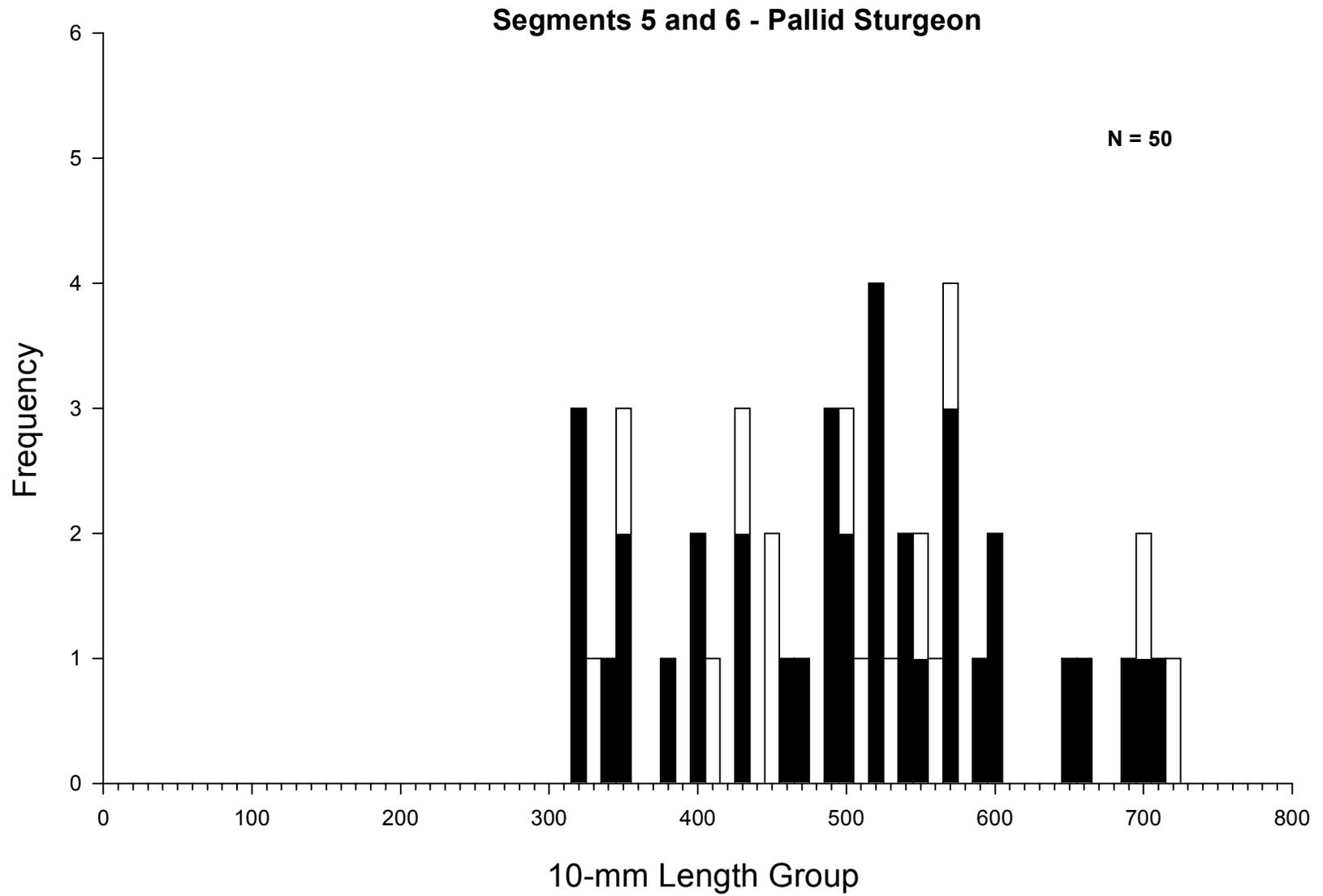


Figure 8. Length frequency of pallid sturgeon captured during fall through spring (sturgeon season, black bars) and summer (fish community season, white bars) in segments 5 and 6 of the Missouri River during 2005-2006 including non-random and wild samples.

Segments 5 and 6 - Annual Pallid Sturgeon Capture History

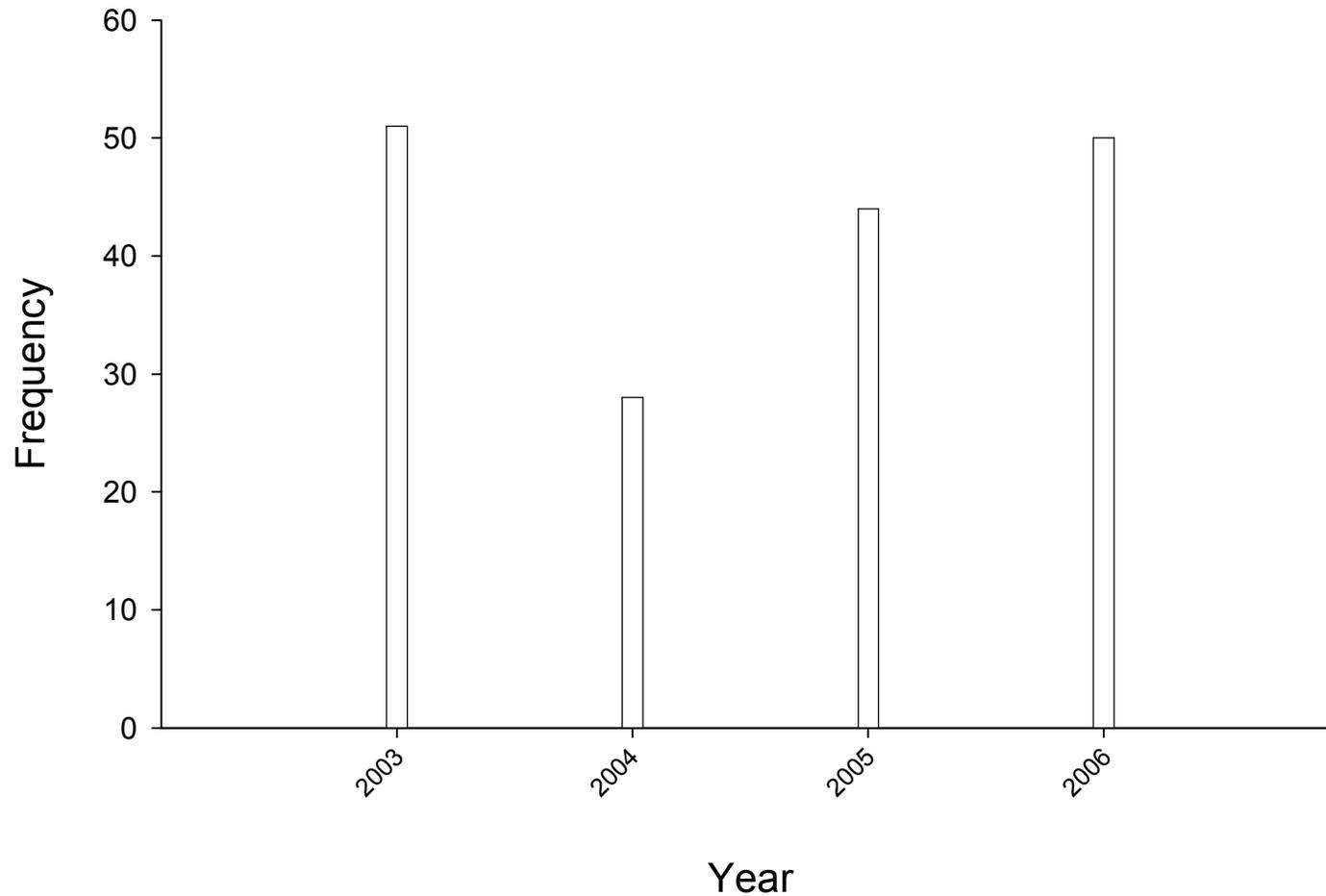


Figure 9. Annual capture history of wild (black bars) and hatchery reared (white bars) pallid sturgeon collected in segments 6 and 6 of the Missouri River from 2003 to 2006. Figure is designed to compare overall pallid sturgeon captures from year to year and may be biased by variable effort between years.

Shovelnose X Pallid Sturgeon Hybrids

No shovelnose X pallid sturgeon hybrids were captured in segments 5 and 6 during 2006 or in the previous 3 years 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 296 shovelnose sturgeon were sampled in 2006 with 264 captured in standard gears. Most shovelnose sturgeon were captured with gill nets ($n = 178$), trammel nets ($n = 46$), and otter trawls ($n = 40$). Catch per unit effort of shovelnose sturgeon (Figures 11, 12, and 14) was greatest in gill nets (0.888 fish/net night). The CPUE by trammel net in the sturgeon season (0.084 fish/100 m) was nearly the same as that of the fish community season CPUE (0.106 fish/100 m). Mean CPUE in gill nets increased nearly two fold from the running average (2003 – 2005; Figure 11). Mean CPUE during both seasons with trammel nets decreased from 2004 - 2006 (Figure 12 and 14). Mean CPUE for the OT16 was greater during the spring (0.094) than the fish community season (0.063). Two hundred-twenty shovelnose sturgeons were captured in standard gears during the fish sturgeon season while 44 were captured during the fish community season. No shovelnose sturgeon were captured in the mini-fyke nets.

Shovelnose sturgeon were found in all macrohabitats sampled with the exception of secondary channel connected small. Most fish were captured from braided channel (66%), outside bend (16%), channel crossover (8%), inside bend (6%), confluence (2%), and secondary channel connected larger (2%) macrohabitats during the sturgeon season (Table 25). During the

fish community season, 66% of shovelnose sturgeon were captured in braided channels (Table 23). All shovelnose sturgeon captured were caught in the channel boarder mesohabitat (Table 24). Fork lengths of shovelnose sturgeon ranged from 489 - 774 mm with 89% of the fish between the 580 – 719 mm (Figure 17). No shovelnose sturgeon of stock length and smaller were captured and only one fish of quality length was captured (during the sturgeon season). Incremental RSD for shovelnose sturgeon in both seasons indicated an ageing population with little recruitment (Table 25). Shovelnose sturgeon captured during the sturgeon (n =218) and fish community seasons (n = 44) exhibited a mean W_r of 96 and 93, respectively. Relative weights of shovelnose sturgeon had a more extended range during the sturgeon season (71 – 168) compared to the fish community season (54 – 112).

Segments 5 and 6 - Shovelnose Sturgeon / Sturgeon Season

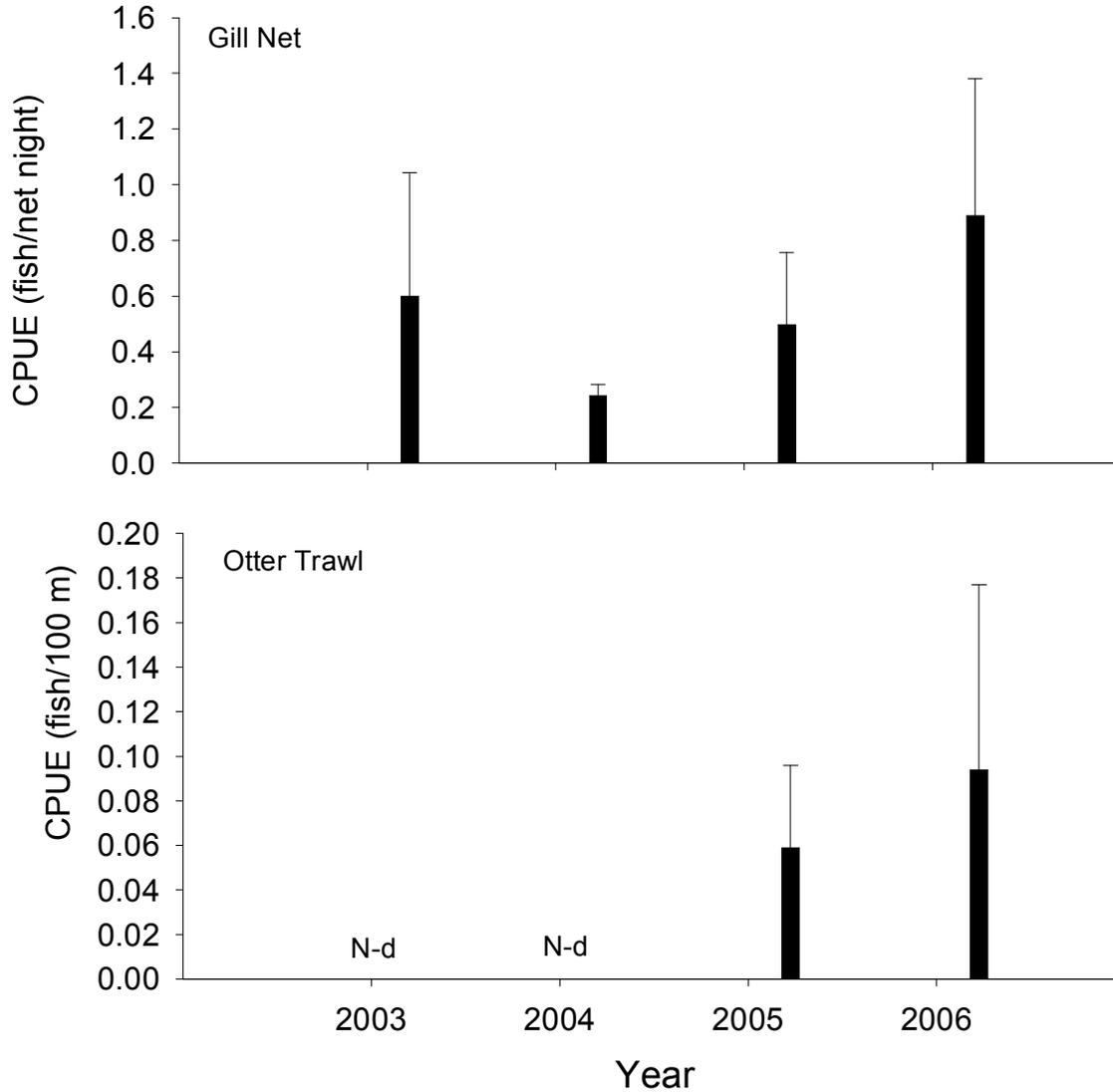


Figure 11. Mean annual catch-per-unit-effort (\pm 2SE) of sub-stock size (0-149 mm; white bars), sub-stock size (150-249; cross-hatched), stock size (250-379 mm; gray bars), and quality and above size ($>$ 380 mm; black bars) shovelnose sturgeon using gill nets and otter trawls in segments 5 and 6 of the Missouri River during sturgeon season 2003-2006. N-d indicates not deployed.

Segments 5 and 6 - Shovelnose Sturgeon / Sturgeon Season

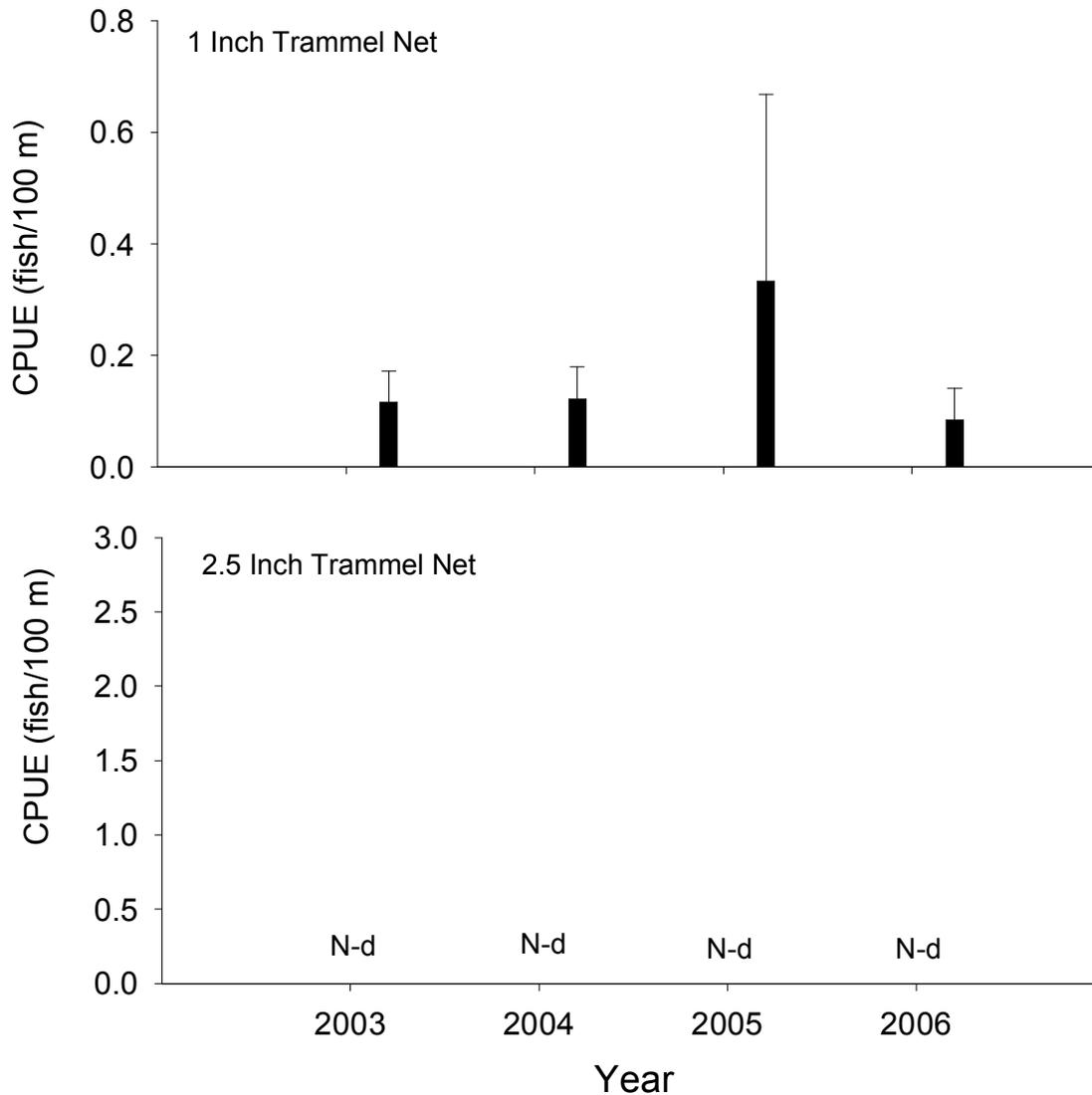


Figure 12. Mean annual catch-per-unit-effort (+/- 2SE) of sub-stock size (0-149 mm; white bars), sub-stock size (150-249; cross-hatched), stock size (250-379 mm; gray bars), and quality and above size (> 380 mm; black bars) shovelnose sturgeon using 1 and 2.5 inch trammel nets in segments 5 and 6 of the Missouri River during sturgeon season 2003-2006. N-d indicates not deployed.

Segments 5 and 6 - Shovelnose Sturgeon / Fish Community Season

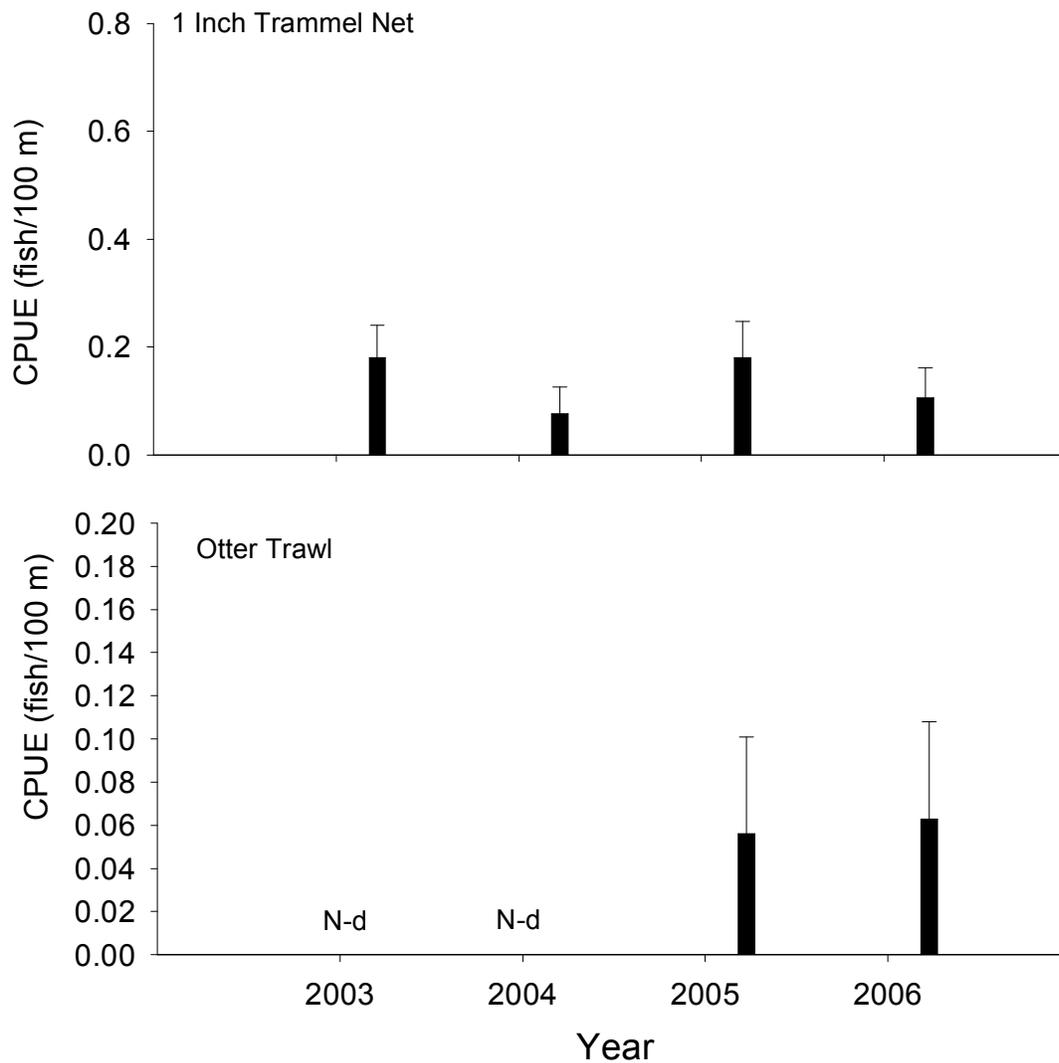


Figure 14. Mean annual catch-per-unit-effort (\pm 2SE) of sub-stock size (0-149 mm; white bars), sub-stock size (150-249; cross-hatched), stock size (250-379 mm; gray bars), and quality and above size ($>$ 380 mm; black bars) shovelnose sturgeon using 1 inch trammel nets and otter trawls in segments 5 and 6 of the Missouri River during fish community season 2003-2006. 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 2005 – 2006. 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 segment.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1 Inch Trammel Net	17	47					6	47					N-E		
Gill Net	178	70	7				7	14	2						
Otter Trawl	25	48	32					12	8						
Fish Community Season (Summer)															
1 Inch Trammel Net	29	66	3	14			10	7					N-E		
Mini-Fyke Net	0														
Otter Trawl	15	67					7	27							

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 2005 – 2006. 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 segment.

Gear	N	Mesohabitat				
		BARS	CHNB	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)						
1 Inch Trammel Net	17		100			N-E
Gill Net	178		100			
Otter Trawl	25		100			
Fish Community Season (Summer)						
1 Inch Trammel Net	29		100			N-E
Mini-Fyke Net	0					
Otter Trawl	15		100			

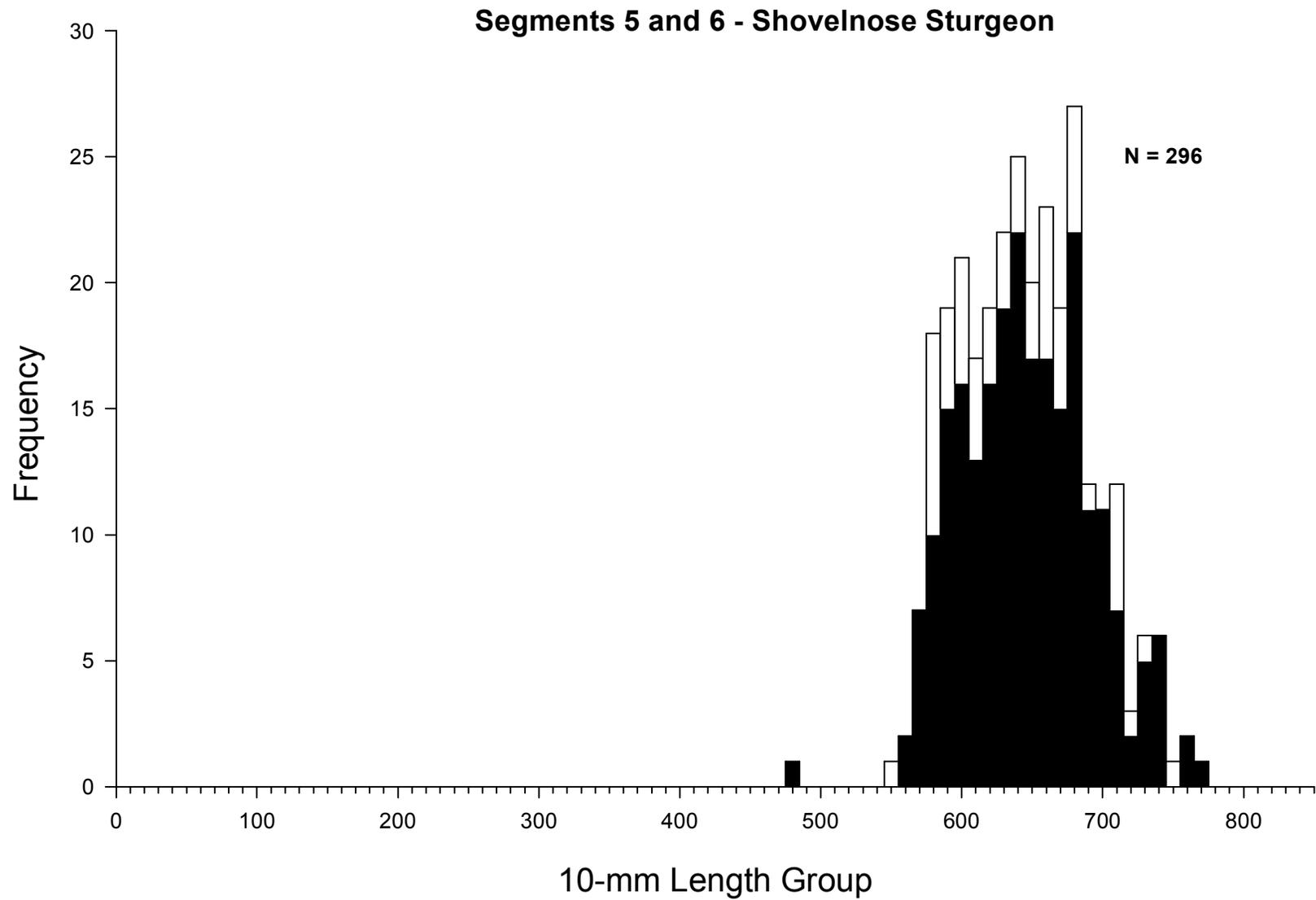


Figure 17. Length frequency of shovelnose sturgeon from fall through spring (sturgeon season, black bars) and summer (fish community season, white bars) in segments 5 and 6 of the Missouri River during 2005-2006 including non-random and wild samples.

Table 25. Incremental relative stock density (RSD)^a and mean relative weight (Wr) by a length category for shovelnose sturgeon in segments 5 and 6 of the Missouri River captured during 2005 – 2006. Length categories^b determined using methods proposed by Quist (1998).

Length category	N	RSD	Wr (+/- 2SE)
Sturgeon Season			
Sub-stock (0-149 mm)			
Sub-stock (150-249 mm)			
Stock			
Quality	1	< 1	168
Preferred	88	40	100 (2.8)
Memorable	129	59	91 (1.6)
Trophy			
Overall Wr	218		95 (1.7)
Fish Community Season			
Sub-stock (0-149 mm)			
Sub-stock (150-249 mm)			
Stock			
Quality			
Preferred	20	45	97 (4.3)
Memorable	24	55	86 (4.4)
Trophy			
Overall Wr	44		91 (3.4)

^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 2005 sampling season. This is the fourth year of zero captures for sturgeon chubs.

Sicklefin Chub

No sicklefin chubs were captured during the 2005 sampling season. This is the fourth year of zero captures for sicklefin chubs.

Speckled Chub

No speckled chubs were captured during the 2005 sampling season. This is the fourth year of zero captures for speckled chubs.

Sand Shiner

A total of 42 sand shiners were captured in mini-fyke nets during the 2006 sampling year with all fish captured in mini-fyke nets (Fig. 30 - 32). Annual catch per unit effort during 2006 for mini-fyke nets (Figure 32) was lower (0.525 fish/net night) than 2004 (1.65 fish/net night), but higher than 2005 (0.312). Over 52% of the fish captured in mini-fyke nets were collected in the braided macrohabitat with the remainder captured in the Niobrara River confluence (Table 32). Mini-fyke nets were only set in the bar mesohabitat (Table 33). Over 67% of the sand shiners captured were between 35 – 39 mm (Figure 33).

Segments 5 and 6 - Sand Shiner / Sturgeon Season

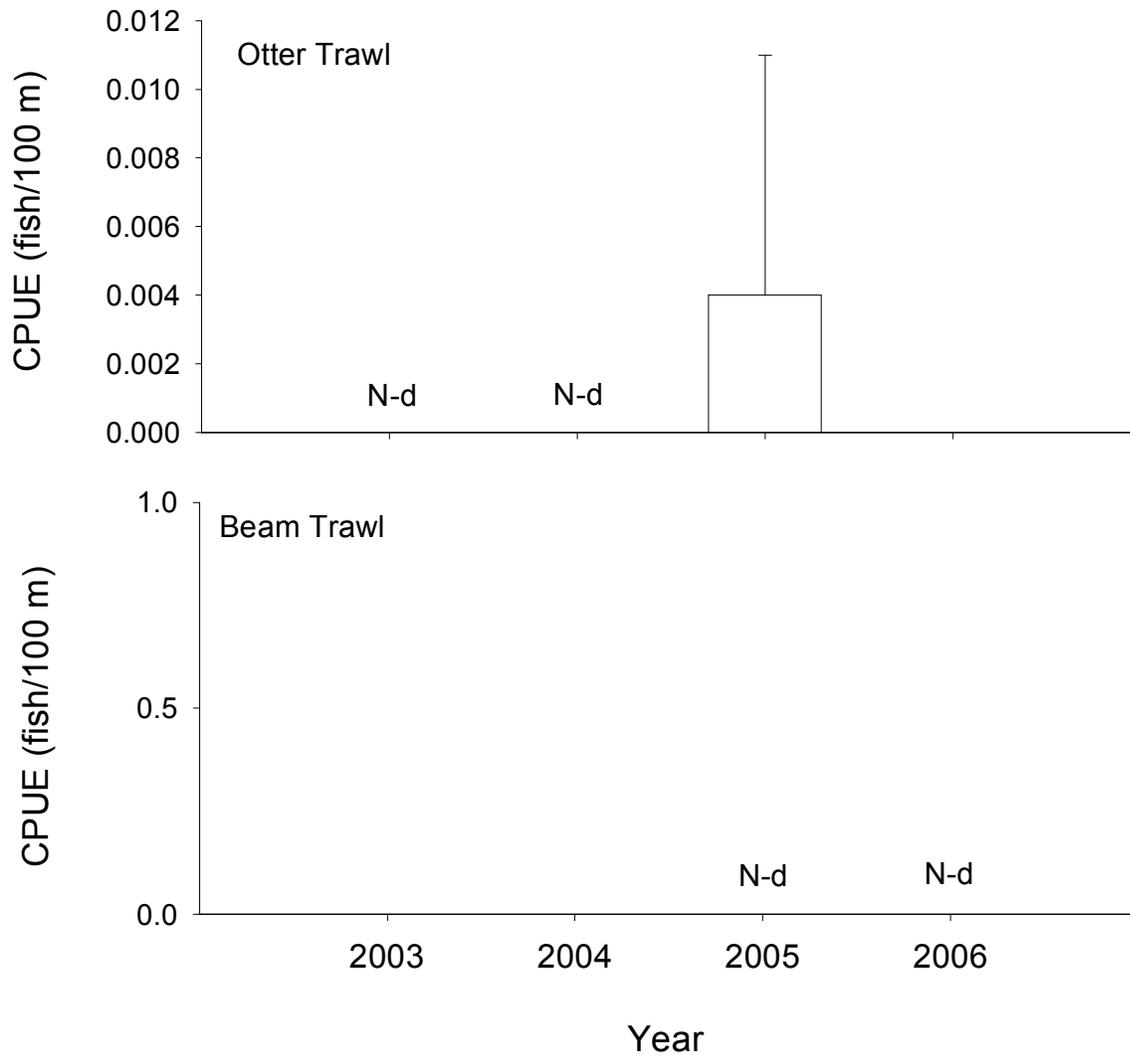


Figure 30. Mean annual catch-per-unit-effort ($\pm 2SE$) of sand shiner with otter trawls and beam trawls in segments 5 and 6 of the Missouri River during sturgeon season 2003-2006. N-d indicates not deployed.

Segments 5 and 6 - Sand Shiner / Fish Community Season

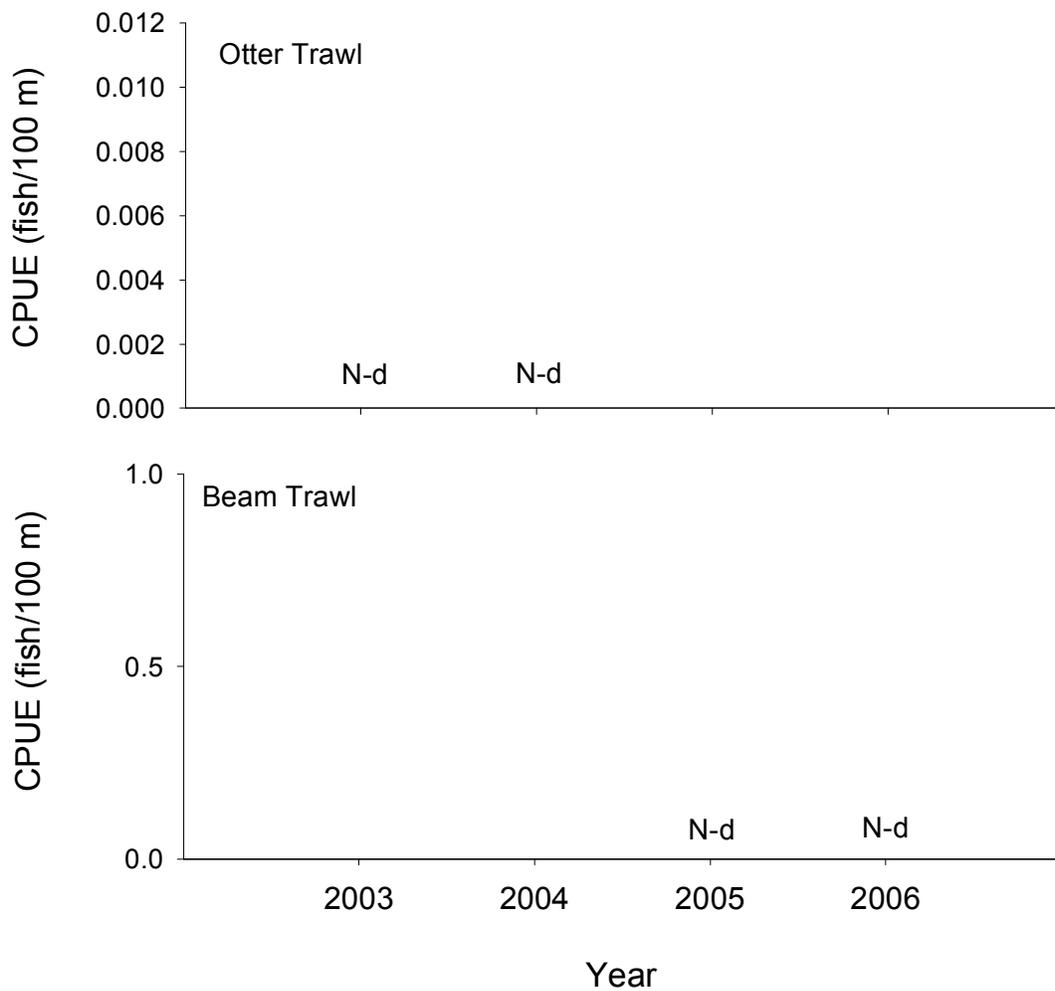


Figure 31. Mean annual catch-per-unit-effort (\pm 2SE) of sand shiner with otter trawls and beam trawls in segments 5 and 6 of the Missouri River during fish community season 2003-2006. N-d indicates not deployed.

Segments 5 and 6 - Sand Shiner / Fish Community Season

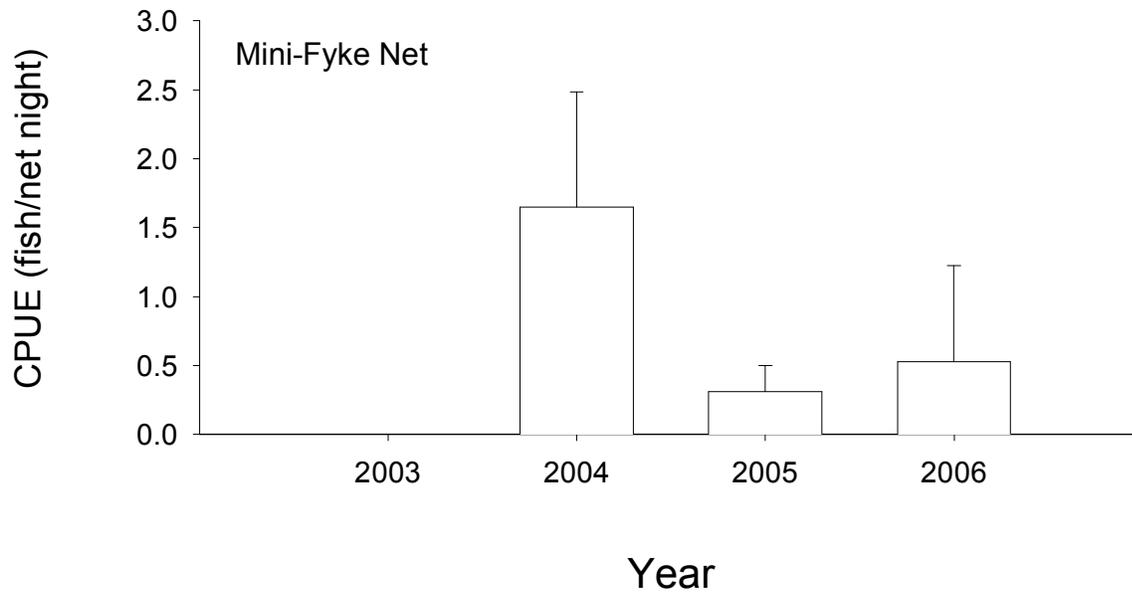


Figure 32. Mean annual catch-per-unit-effort ($\pm 2SE$) of sand shiner with mini-fyke nets in segments 5 and 6 of the Missouri River during fish community season 2003-2006.

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 2005 – 2006. 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 segment.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1 Inch Trammel Net	0												N-E		
Gill Net	0														
Otter Trawl	0														
Fish Community Season (Summer)															
1 Inch Trammel Net	0												N-E		
Mini-Fyke Net	42	52		48											
Otter Trawl	0														

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 2005 – 2006. 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 segment.

Gear	N	Mesohabitat				
		BARS	CHNB	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)						
1 Inch Trammel Net	0					N-E
Gill Net	0					
Otter Trawl	0					
Fish Community Season (Summer)						
1 Inch Trammel Net	0					N-E
Mini-Fyke Net	42	100				
Otter Trawl	0					

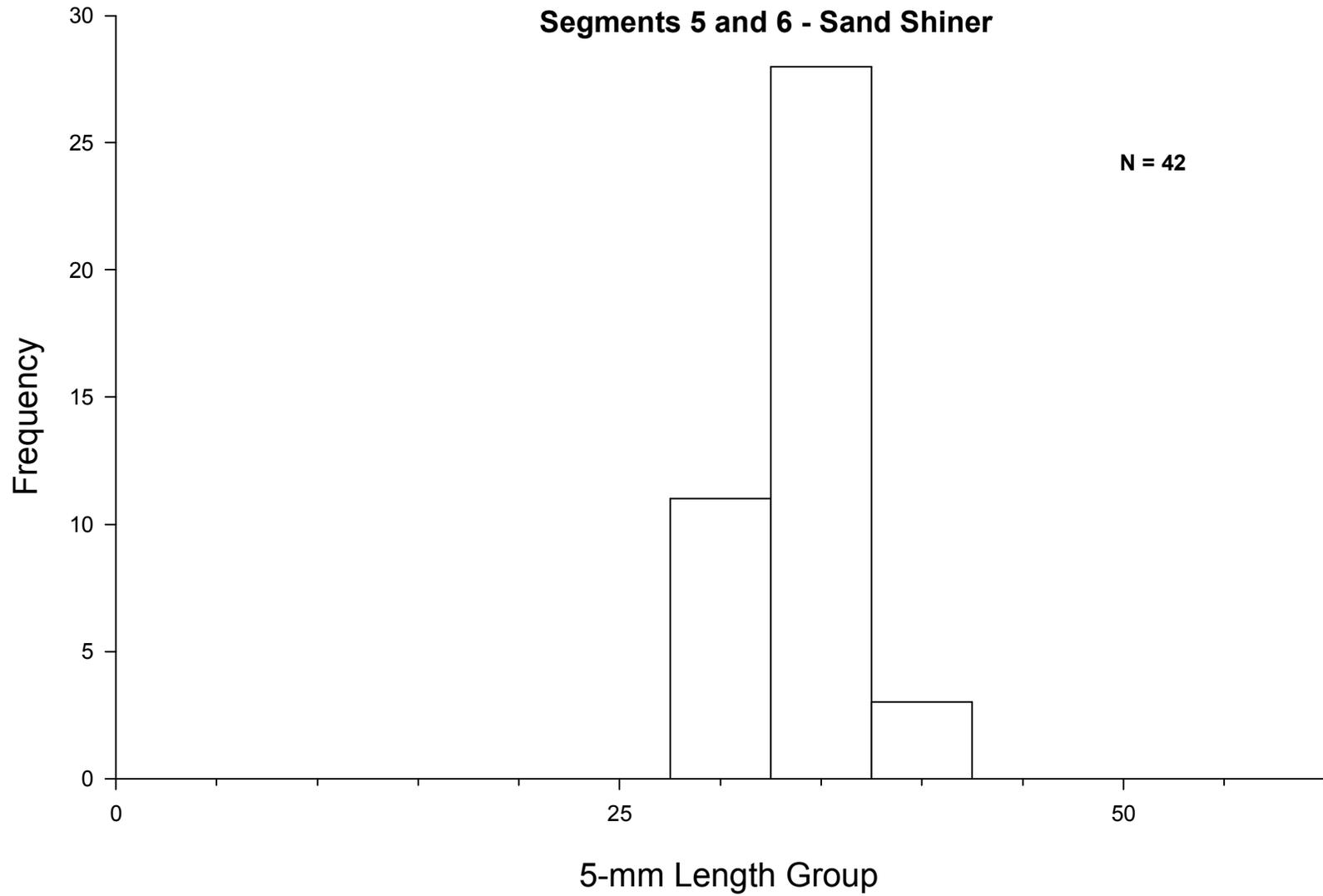


Figure 33. Length frequency of sand shiners during fall through spring (sturgeon season, black bars) and summer (fish community season, white bars) in segments 5 and 6 of the Missouri River during 2005-2006.

***Hybognathus* spp.**

No *Hybognathus* were captured during the 2006 sampling effort. Only one *Hybognathus* spp. has been captured during 2005 in a mini-fyke net set on a bar in an outside bend. This was the only *Hybognathus* spp. captured during the four years of monitoring.

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

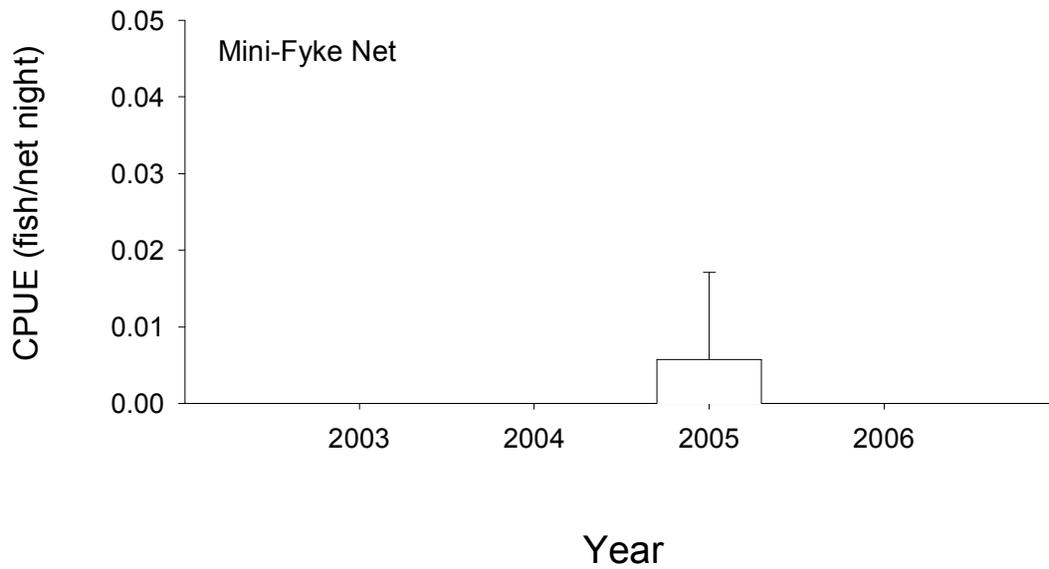


Figure 36. Mean annual catch-per-unit-effort ($\pm 2SE$) of *Hybognathus* spp. with mini-fyke nets in segments 5 and 6 of the Missouri River during fish community season 2003-2006.

Blue Sucker

The total catch of blue suckers in standard gears during 2006 was small ($n = 8$). One blue sucker was captured in a non-standard gear. Relative abundance of blue suckers captured with gillnets has remained relatively constant since 2003 (Fig. 38), whereas abundance measured with trammel nets, and the otter trawl were highly variable (Fig. 38-40). Since the inception of this effort, no blue suckers have been captured with mini-fyke nets (2003-2006). Of the eight blue suckers captured in the standard gears, five were captured in gill nets, two in trammel nets, and one was captured in the otter trawl. Macrohabitats where blue suckers were captured include outside bends ($n = 3$), braided channels ($n = 3$), channel crossover, and secondary channel connected large (Table 36). All blue suckers were captured in channel border mesohabitats (Table 37). All blue suckers captured in segments 5 and 6 were over 730 mm TL indicating an aging population with no evidence of recruitment or poor sampling efficiency for small blue suckers (Figure 44).

Segments 5 and 6 - Blue Sucker / Sturgeon Season

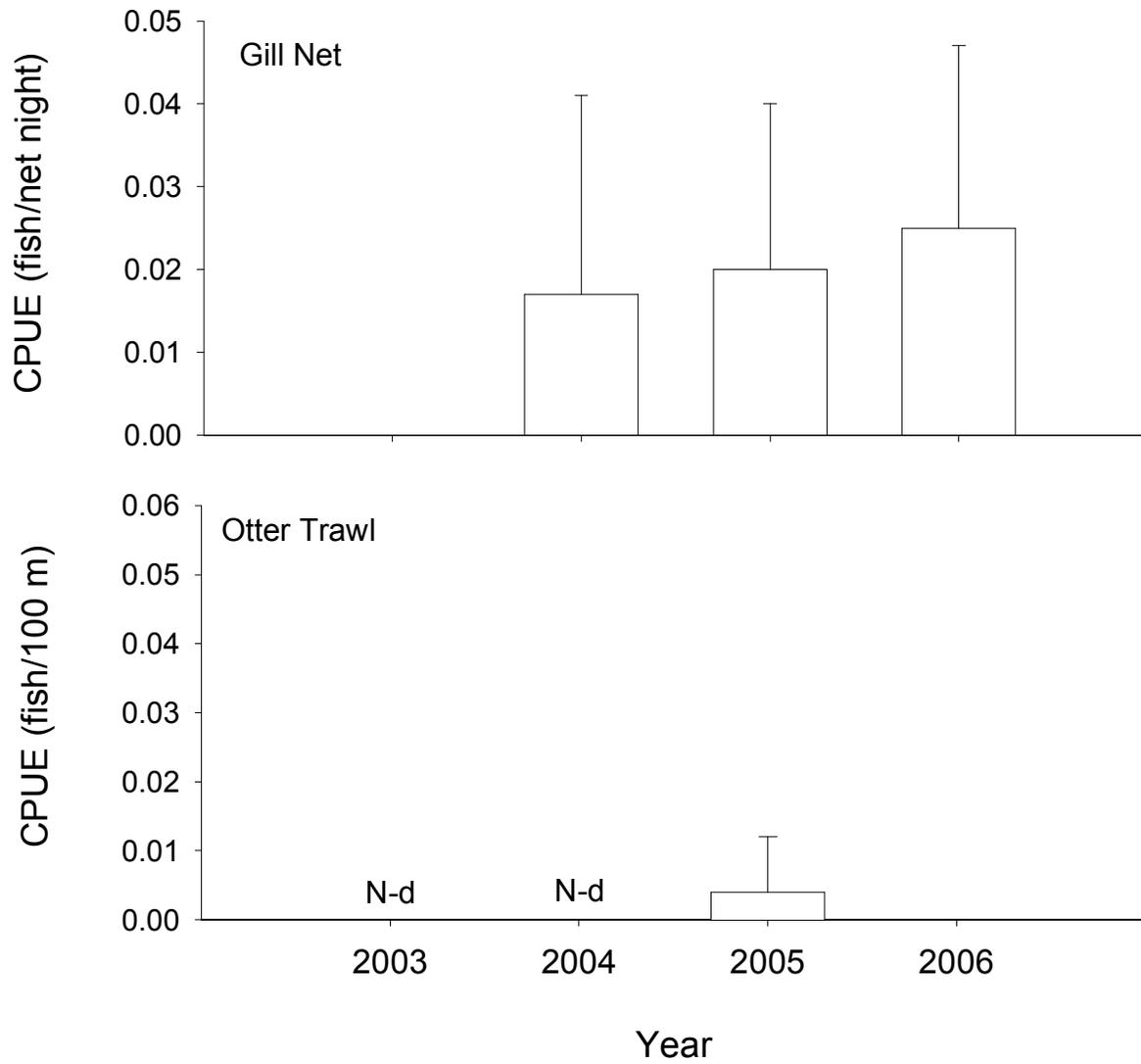


Figure 38. Mean annual catch-per-unit-effort (\pm 2SE) of blue sucker with gill nets and otter trawls in segments 5 and 6 of the Missouri River during sturgeon season 2003-2006. N-d indicates no deployed.

Segments 5 and 6 - Blue Sucker / Sturgeon Season

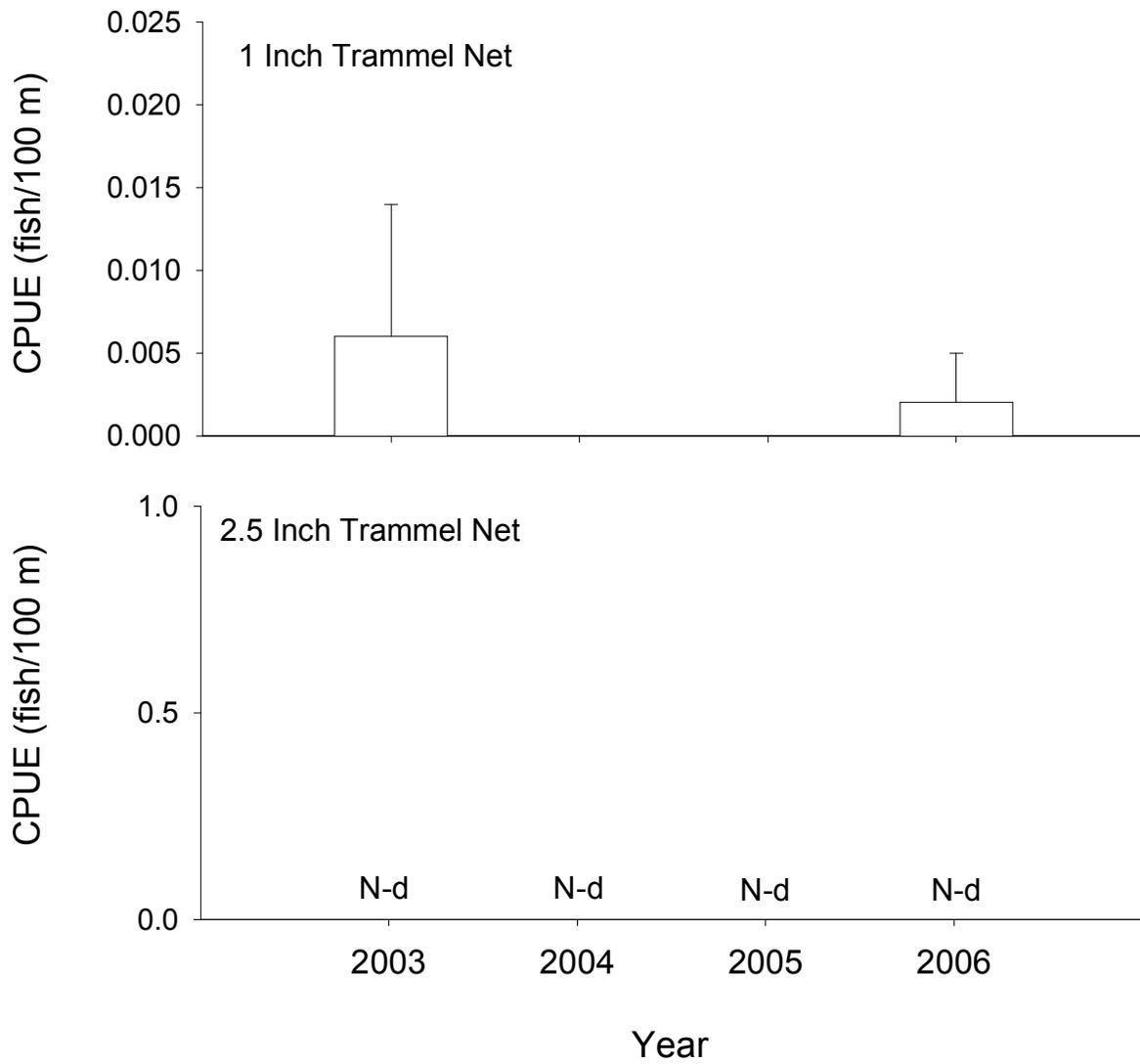


Figure 39. Mean annual catch-per-unit-effort (\pm 2SE) of blue sucker with 1 and 2.5 inch trammel nets in segments 5 and 6 of the Missouri River during sturgeon season 2003-2006. N-d indicates not deployed.

Segments 5 and 6 - Blue Sucker / Fish Community Season

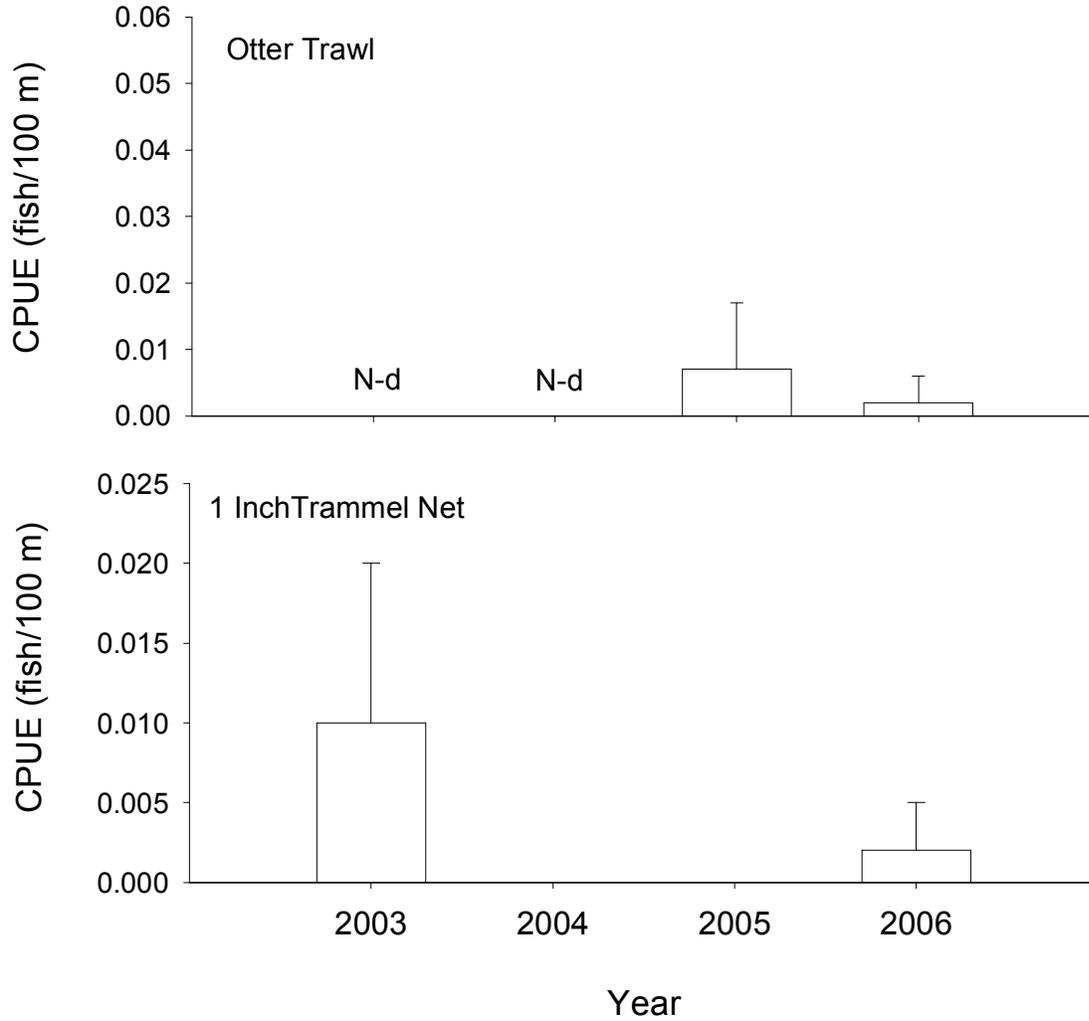


Figure 41. Mean annual catch-per-unit-effort ($\pm 2SE$) of blue sucker using otter trawls and 1 inch trammel nets in segments 5 and 6 of the Missouri River during fish community season 2003-2006. N-d indicates not deployed.

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 2005 – 2006. 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 segment.

Gear	N	Macrohabitat														
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD	
Sturgeon Season (Fall through Spring)																
1 Inch Trammel Net	1	100											N-E			
Gill Net	5		20					60	20							
Otter Trawl	0															
Fish Community Season (Summer)																
1 Inch Trammel Net	1	100											N-E			
Mini-Fyke Net	0															
Otter Trawl	1	100														

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 2005 – 2006. 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 segment.

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

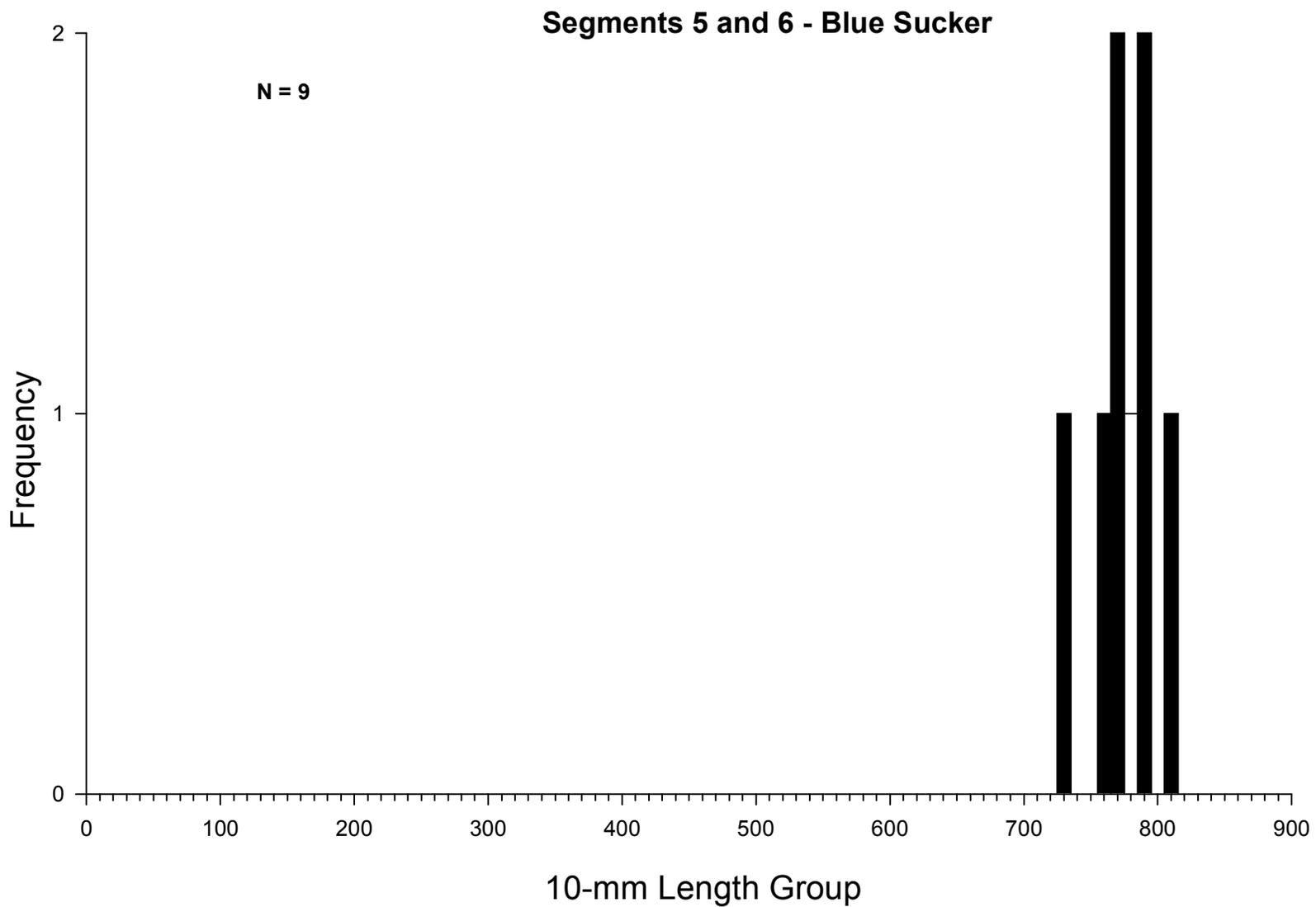


Figure 44. Length frequency of blue suckers during fall through spring (sturgeon season, black bars) and summer (fish community season, white bars) in segments 5 and 6 of the Missouri River during 2005-2006 including non-random and wild samples.

Sauger

A total of 117 sauger were sampled in segments 5 and 6 during 2006 with 89 fish captured in standard gears: gillnets (n = 24) trammel nets (n = 34), and otter trawls (n = 31). Gill net CPUE in 2006 was similar to the previous year, but was lower than the 3 year running average (Figure 45). Relative abundance overtime were generally similar with the CPUE in 2004 and 2006 being lower than 2003 and 2005 (Fig. 46-48). Relative abundance of saugers for the otter trawl was similar in 2006 to 2005. However, catches were approximately 2.5 times greater during the sturgeon season (fall through spring) compared to the fish community season (summer). No saugers were caught in mini-fyke nets during 2006 and catches in this gear have been low or zero since 2003 (Fig. 49). Over 86% of saugers captured were collected in the braided channel (77%) and outside bend (7%) macrohabitats during both seasons (Table 38). Saugers were only captured in the channel border mesohabitat (Table 39). Over 72% of saugers were between the 280 - 449 mm TL; however, catches of fish < 160 mm TL indicate some reproduction has occurred (Figure 51). Incremental relative stock density (RSD) was calculated for sauger captured in the standard gears (n = 89). The RSD values for each category during the sturgeon season were: stock = 14, quality = 16, preferred = 68, memorable = 2 and trophy = 0. While the RSD values shifted during the fish community season to: stock = 19, quality = 62, preferred = 15, memorable = 4, with no change in trophy. The mean relative weights during the sturgeon season was 79 (n = 57; $\pm 2SE = 3$), while during the fish community season the mean Wr was 74 (n = 30; $\pm 2SE = 3$).

Segments 5 and 6 - Sauger / Sturgeon Season

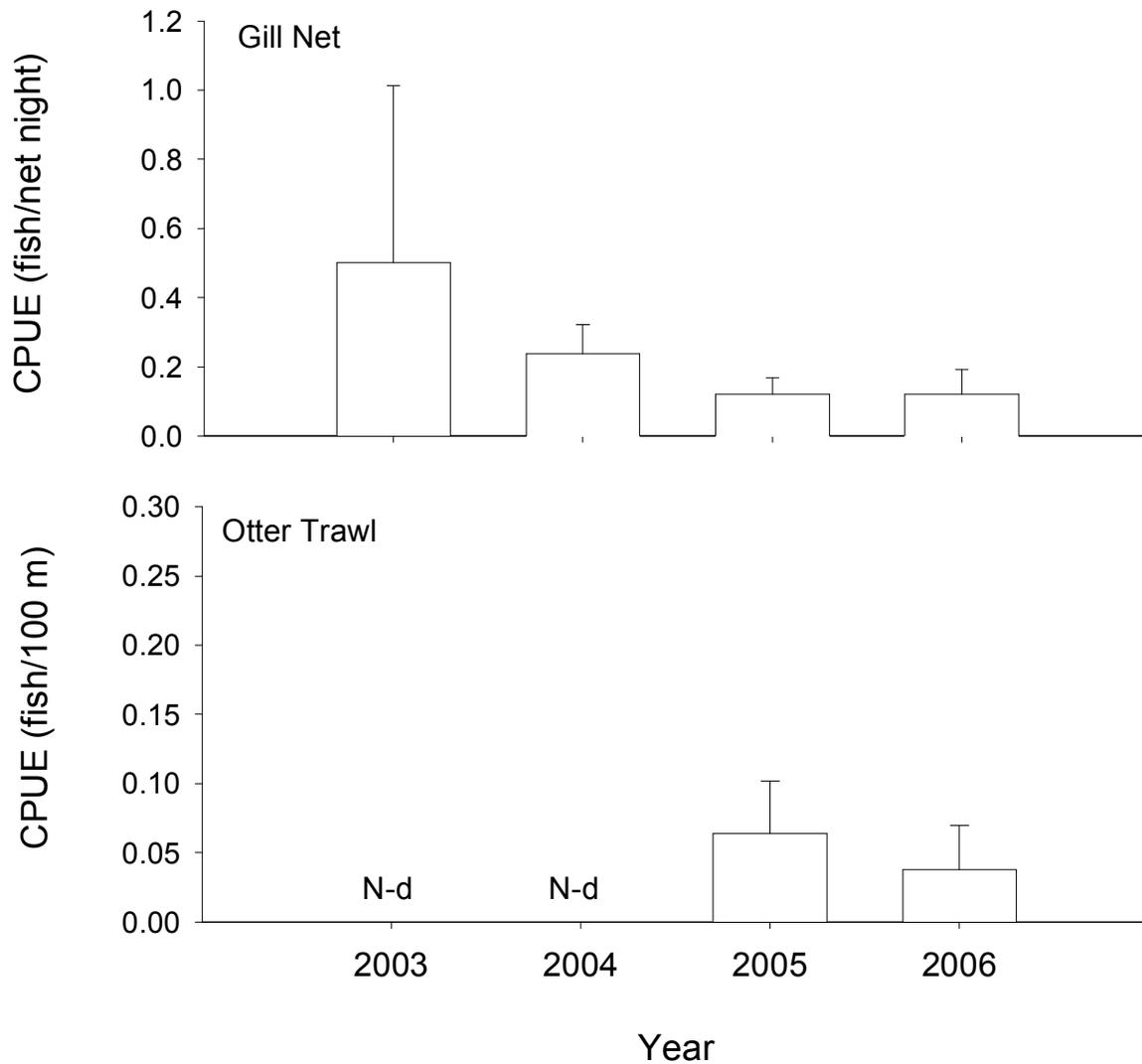


Figure 45. Mean annual catch-per-unit-effort ($\pm 2SE$) of sauger using gill nets and otter trawls in segments 5 and 6 of the Missouri River during sturgeon season 2003-2006. N-d indicates not deployed.

Segments 5 and 6 - Sauger / Sturgeon Season

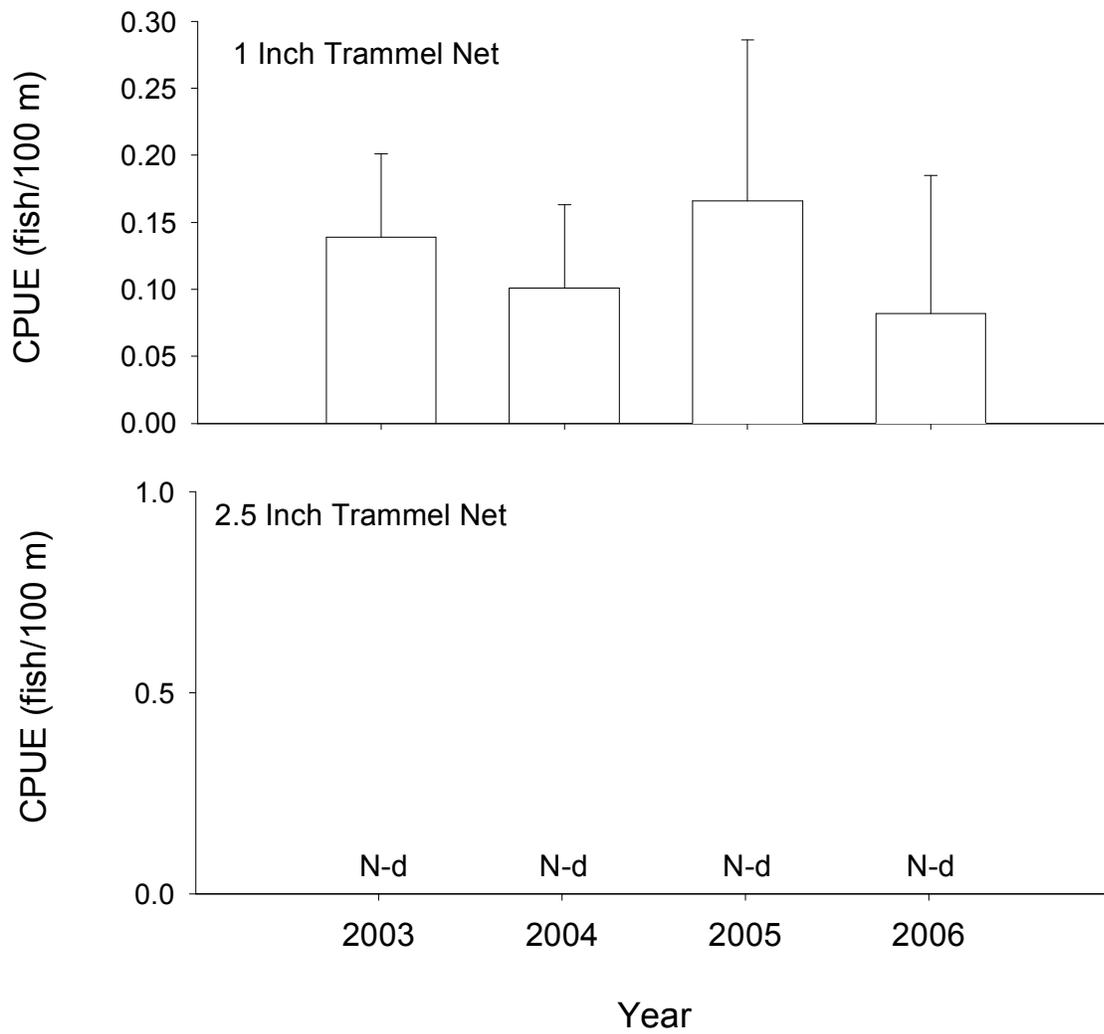


Figure 46. Mean annual catch-per-unit-effort ($\pm 2SE$) of sauger using 1 and 2.5 inch trammel nets in segments 5 and 6 of the Missouri River during sturgeon season 2003-2006. N-d indicates not deployed.

Segments 5 and 6 - Sauger / Fish Community Season

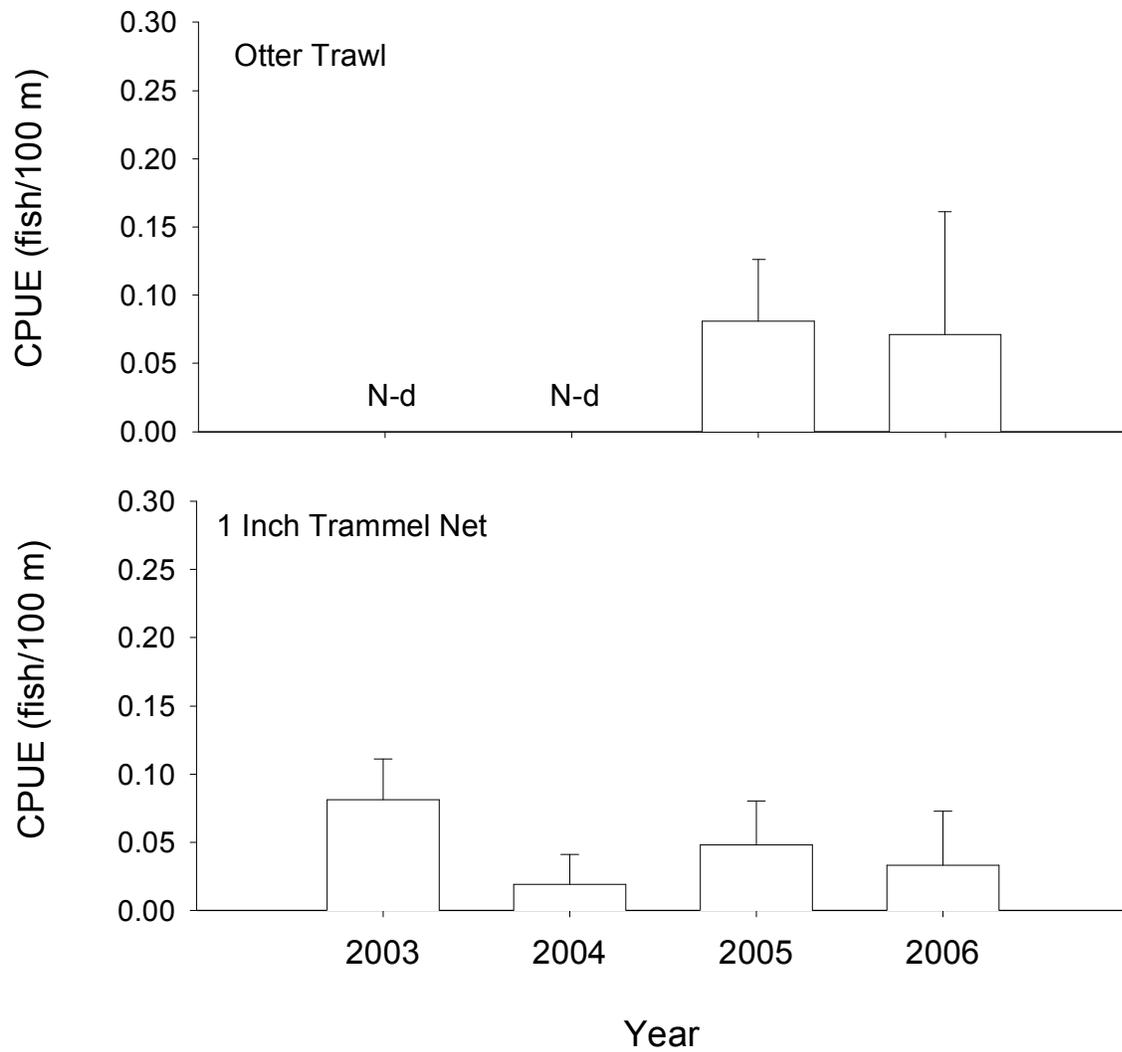


Figure 48. Mean annual catch-per-unit-effort ($\pm 2SE$) of sauger using otter trawls and 1 inch trammel nets in segments 5 and 6 of the Missouri River during fish community season 2003-2006. N-d indicates not deployed.

Segments 5 and 6 - Sauger / Fish Community Season

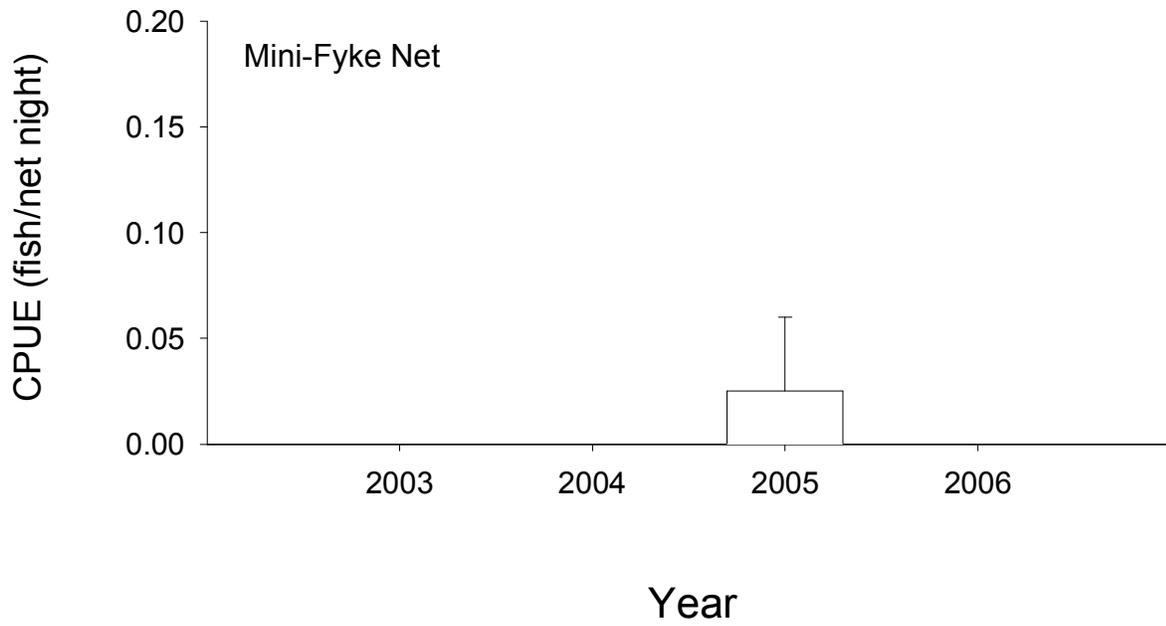


Figure 49. Mean annual catch-per-unit-effort ($\pm 2SE$) of sauger using mini-fyke nets in segments 5 and 6 of the Missouri River during fish community season 2003-2006.

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 2005 – 2006. 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 segment.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1 Inch Trammel Net	21	95						5					N-E		
Gill Net	24	54	13					17	17						
Otter Trawl	14	86	7				7								
Fish Community Season (Summer)															
1 Inch Trammel Net	13	92						8					N-E		
Mini-Fyke Net	0														
Otter Trawl	17	82					18								

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 2005 – 2006. 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 segment.

Gear	N	Mesohabitat				
		BARS	CHNB	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)						
1 Inch Trammel Net	21		100			N-E
Gill Net	24		100			
Otter Trawl	14		100			
Fish Community Season (Summer)						
1 Inch Trammel Net	13		100			N-E
Mini-Fyke Net	0					
Otter Trawl	17		100			

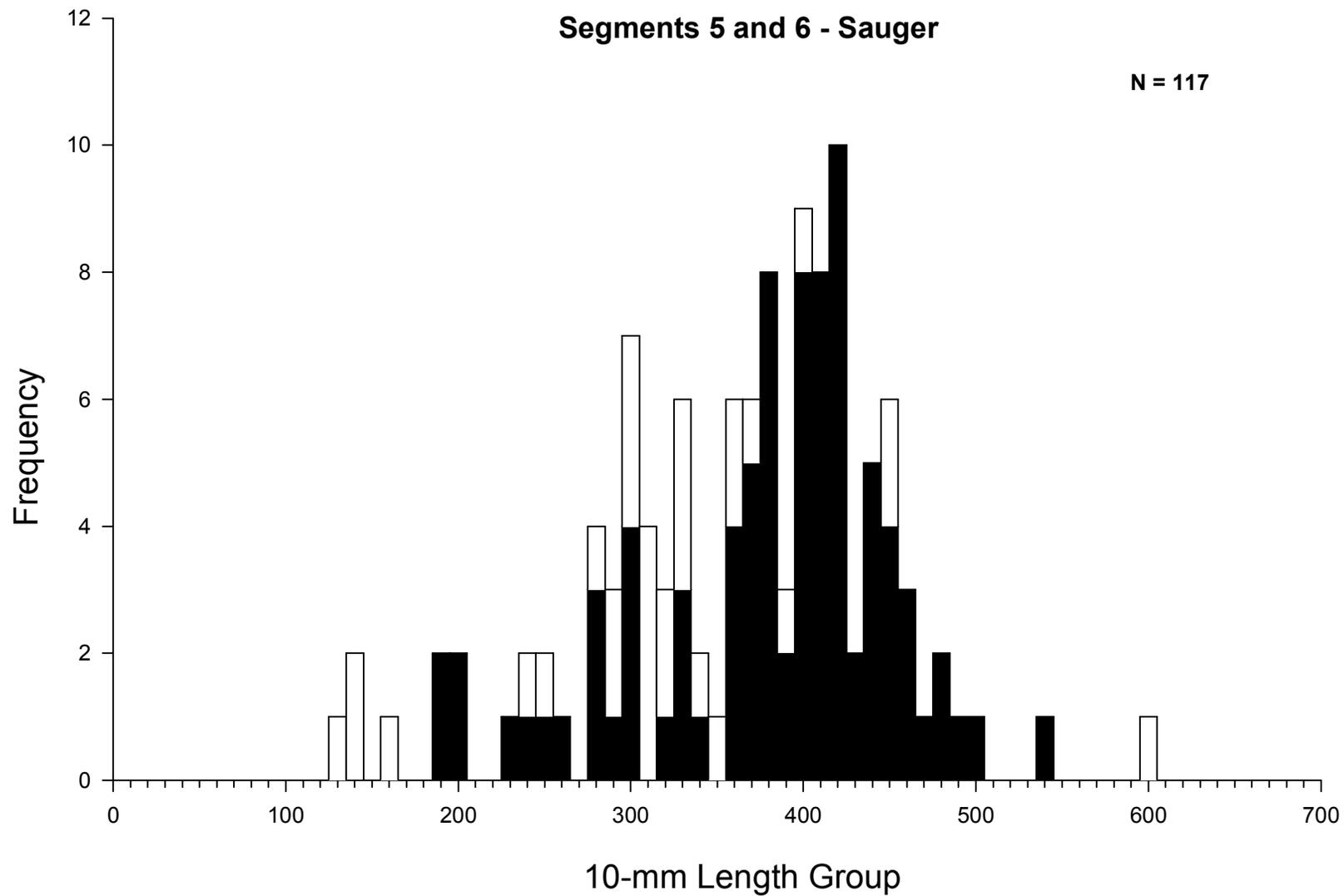


Figure 51. Length frequency of sauger during fall through spring (sturgeon season, black bars) and summer (fish community season, white bars) in segments 5 and 6 of the Missouri River during 2005-2006 including non-random and wild samples.

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.

VI. General Missouri River fish community

A total of 2,842 fish comprised of 40 species and one hybrid (sauger x walleye) were captured in standard and non-standard gears during the 2006 sampling season in segments 5 and 6 of the Missouri River (Appendix F). We captured one species during the 2006 season that was not seen in the previous season: black bullhead *Ameiurus melas* (n = 2). Two species captured in 2005 were not observed in 2006: grass pickerel *Esox americanus vermiculatus*, and *Hybognathus* spp. Greatest numbers of fishes were captured during the summer with mini-fyke nets (n = 2,005). These summer catches consisted mainly of small bodied and young-of-the-year (YOY) cyprinids. Gears with the greatest percentage of their catch comprised of pallid sturgeon and the nine targeted native fish species were gillnets (56%), trammel nets (46%) and the otter trawl (25%). Target species comprised 2% of the catch in mini-fyke nets. However, all sand shiners (100%) were captured with mini-fyke nets.

Collectively for all standard gears > 50 individuals were captured for the following 16 species: shovelnose sturgeon (n = 255), spotfin shiner *Cyprinella spiloptera* (n = 670), emerald shiner *N. atherinoides* (n = 126), silver chub *M. storeriana* (n = 65), river carpsucker *Carpionodes carpio* (n = 69), shorthead redhorse *Moxostoma macrolepidotum* (n = 101), channel catfish *Ictalurus punctatus* (n = 107), bluegill *Lepomis macrochirus* (n = 82), smallmouth bass *Micropterus dolomieu* (n = 237), white crappie *Pomoxis nigromaculatus* (n = 139), sauger (n = 78), and walleye *Sander vitreum* (n = 146). Six species were represented in the collective catches by only two or fewer specimens: paddlefish *Polydon spathula*, fathead minnow *Pimephales promelas*, quillback *C. cyprinus*, black bullhead, northern pike *E. lucius*, and yellow

perch *Perca flavescens*. Four species represented by 50 or more fish in 2005 season catches, bluntnose minnow *P. notatus*, white bass *Morone chrysops*, largemouth bass *M. salmoides*, and freshwater drum *Aplodinotus grunniens* were not represented by > 50 individuals in the cumulative 2006 season catches.

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. Only three species, shovelnose sturgeon, shorthead redhorse, and walleye had gillnet CPUE > 0.2 fish/net night during 2006 (Appendix H). In the sturgeon season, CPUE of channel catfish was the only species with a trammel net CPUE > 0.1 fish/100 m, followed closely by shovelnose sturgeon, sauger, and walleye, respectively (Appendix H). For trammel nets in the fish community season, only shovelnose sturgeon had a CPUE > 0.1 fish/100 m (Appendix H). There were two species with a CPUE ≥ 0.1 fish/100 m caught with the otter trawl: silver chub and channel catfish. Silver chubs were the most abundant species captured with the otter trawl during both seasons and their relative abundance was consistent between seasons.

The greatest numbers of fish species were captured in shallow water habitats with mini-fyke nets ($n = 30$). The four most abundant species captured in mini-fyke nets were spotfin shiner (8.38 fish/net night), smallmouth bass (2.88 fish/net night), emerald shiner (1.58 fish/net night), and white crappie (1.79 fish/net night). Additionally, the following 9 species had CPUE > 0.3 fish/net night with mini-fyke nets: shortnose gar *Lepiosteus osseus*, spottail shiner, sand shinner, bluntnose minnow *P. notatus*, Largemouth bass, bluegill, orangespotted sunfish *Lepomis humilis*, river carpsucker, and Johnny darter *Etheostoma nigrum*.

Six exotic species were captured in segments 5 and 6 during 2006 and four of these species are sport fishes that were intentionally introduced: northern pike, white bass, smallmouth bass and, largemouth bass (Bailey and Allum 1954). Additional exotic species encountered in 2006 were common carp *Cyprinus carpio* and rainbow smelt *Osmerus mordax*. Based on high

mean CPUE in mini-fyke nets (2.88 fish/net night), smallmouth bass were the most abundant exotic species seen in segments 5 and 6 during 2006 followed by largemouth bass (0.41 fish/net night) and common carp (0.16 fish/net night). 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 2006. Additionally, no zebra mussels *Dreissena polymorpha* were observed while working in segments 5 and 6 during 2006 despite the identification of larval zebra mussels (veligers) collected near the Verdel Boat Ramp in 2003 (L. Hesse, personal communication).

Discussion

Pallid sturgeon were captured in the all three continuous macrohabitats and in one discrete macrohabitat (braided channels) with the greatest number captured in braided channels. The braided macrohabitat was only first distinguished as a habitat type in 2004 and greater effort (4 bends) in the Niobrara River Delta of segment 6 was expended during the 2005-2006 season to assess use of this habitat by juvenile pallid sturgeon. All pallid sturgeon captured were within channel border mesohabitats. Habitats where pallid sturgeon were captured in 2006 corresponded with a telemetry study in segments 5 and 6 during 2000 – 2002 (Jordan et al. 2006) that found most sonic-tagged age-3 to age-5 pallid sturgeon were relocated in the main channel (91%) with few fish found in secondary connected channels (4%).

Gillnets were an effective gear for capturing pallid sturgeon and relative abundance mirrored the changes made in numbers of fish stocked into segments 5 and 6 the previous year. Stocking numbers declined 20% from 2002 – 2003 (Appendix E) and relative abundance declined 19% from 2003 – 2004 (Figure 2). From 2003 – 2004 stocking numbers again declined (17%) and gillnet CPUE also declined (26%) while during 2004 – 2005 stocking numbers increased 69% and relative abundance increased 54% from 2005 to 2006. The one year lag for changes in relative abundance in relation to stocking date may indicate that stocked yearling pallid sturgeon took one year to recruit to the gillnets. Stocking lengths of pallid sturgeon recaptured with gillnets in 2006 ranged from 200 - 567 mm while recapture lengths ranged from 321-720 mm. Variability (2 SE) in gillnet CPUE each year was high, often as large or larger than the mean, which likely precludes detecting statistically significant changes in pallid sturgeon abundance. However, the concomitant changes in relative abundance with the previous years stocking numbers provides a good indication that gillnets used in the current random

stratified sampling design can provide a useful index of population change for age-2 or greater juvenile pallid sturgeon.

Trammel nets and the 16-ft otter trawl are effective at capturing juvenile pallid sturgeon within the main channel but catch rates appear to vary seasonally. Summer trammel net CPUE ranged from 11 – 500% higher from 2003 - 2006 compared to fall through spring (sturgeon season). More specifically, Wanner (2006) found that pallid sturgeon trammel net CPUE from 2003 - 2005 was the highest and the coefficient of variation (CV) was the lowest during the month of August with most fish caught in OSB macrohabitats, at depths > 5 m, and over sandy substrate. In 2006, the preponderance of pallid sturgeon were captured with trammel nets in the main channel border of braided and outside bend macrohabitats at depths > 4 m (Table 3). In contrast to trammel nets, otter trawl CPUE differed seasonally with catches 28 - 325% greater during the fall through spring period compared to Fall and Spring. However, more years of data are required to be confident in these seasonal trends we observed in the otter trawl.

Although pallid sturgeon were captured in almost all bends sampled during 2006 there was evidence of fish clustering within specific river miles. During 2006, 25 pallid sturgeon were captured near river miles 834 to 835, eight fish near river miles 869 to 870, and an additional eight fish near river mile 841. Clusters of age-3 to age-5 pallid sturgeon were also seen in a telemetry study in segments 5 and 6 during 2000 to 2002 (Jordan et al. 2006). Clusters of > 2 sonic-tagged pallid sturgeon within a river kilometer were observed on 20 dates from 2000 to 2002 with most aggregations found at river mile 847 (rkm 1363) (Jordan et al. 2006). River mile 847 contains the deepest habitat (11 m) within segments 5 and 6 (known as the “deep pump hole”) and is located down river of the Ponca Creek confluence on the South Dakota side of the main channel. The bend containing the deep pump hole was randomly selected for sampling in 2005 and two pallid sturgeon were captured in a trammel net, thus giving more evidence of clustering.

For all year classes of stocked pallid sturgeon, the mean relative condition (K_n) declined since release; but mean length and weight has increased (Table 6). Condition of most fish was generally ≥ 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. The decrease in condition of hatchery-reared pallid sturgeon may also reflect a lack of sufficient prey resources or a stream-lined body form may be more advantageous in the natural lotic environment. Two macroinvertebrate studies initiated in 2005 (K. Berg, South Dakota State University (SDSU) unpublished data) and in 2006 (B. Spindler, SDSU unpublished data) will investigate prey types, availability, and spatial distribution in relationship to pallid sturgeon capture locations in segments 5 and 6.

Gill nets, trammel nets, and otter trawls were all effective at capturing shovelnose sturgeon. Gill net mean CPUE increased substantially (50%) in 2006 compared to previous years. Trammel net mean CPUE was the highest during the summer fish community season for shovelnose sturgeon, which corresponded with pallid sturgeon catch rates. While the mean CPUE of shovelnose sturgeon for otter trawls was greater during the sturgeon season compared to the fish community season, this seasonal pattern also corresponds with pallid sturgeon CPUE data.

The continued lack of shovelnose sturgeon within the stock length category indicates no recent recruitment has occurred within segments 5 and 6 of the Missouri River since 2003. Jordan and Willis (2001) also reported only capturing preferred length and larger shovelnose sturgeon in RPMA 3 from 1998 to 1999. During 2006 fish of the preferred and memorable length classes possessed a high relative condition, thus these fish should be physically capable of reproduction. An additional study to determine shovelnose sturgeon egg development also identified female shovelnose sturgeon in later stages of egg development (D. Shuman, personal communication). The standardized gears (gill nets, otter trawl, and trammel nets) have captured

smaller shovelnose sturgeon (i.e. < 200 mm FL) from the channelized Missouri River (Barada and Steffensen 2005; Kennedy et al. 2006; Steffensen and Barada 2005). These catches 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. During 2005, no shovelnose sturgeon sub-stock (< 249 mm) were captured in the unchannelized Missouri River below Fort Randall Dam (Shuman et al. 2006) or Gavins Point Dam (Stukel et al. 2006), but seven fish were captured in the unchannelized segment 4, downstream of the Yellowstone River (Wilson et al 2006). However, failure to effectively sample Y-O-Y shovelnose sturgeon with these standard gears in the unchannelized segments below Fort Randall and Gavins Point Dam a possibility. Our data support that Y-O-Y shovelnose sturgeon are truly in low abundance.

Failure to capture sturgeon chubs, sicklefin chubs, and speckled chubs with the otter trawl is likely due to lack of recruitment or extirpation in segments 5 and 6. The otter trawl did capture 64 silver chubs during 2006 and 255 silver chubs during 2005 in segments 5 and 6. This same trawl has captured sturgeon chub, sicklefin chub, and speckled chub in segments 7 - 14 (Barada and Steffensen 2005; Kennedy et al. 2006; Steffensen and Barada 2005; Stukel et al. 2006; Utrup et al. 2005a; Utrup et al. 2005b) and sicklefin and sturgeon chub in segment 4 (Wilson et al. 2006) of the Missouri River indicating that we should capture these species if present in segments 5 and 6.

No *Hybognathus* spp. were captured in segments 5 and 6 with a mini-fyke net in 2006. In 2005 the first and only *Hybognathus* spp. was captured since sampling began in 2003. This species is likely at a very low abundance in segments 5 and 6. *Hybognathus* spp. were captured in standard gears throughout the lower Missouri River during 2005 (Barada and Steffensen 2005; Kennedy et al. 2006; Steffensen and Barada 2005; Stukel et al. 2006; Utrup et al. 2005a; Utrup et al. 2005b).

No small blue suckers (< 700 mm TL) were captured in segments 5 and 6 during 2006 with few fish overall being captured with the standard gears (gill nets, trammel nets, otter trawls). At present, blue suckers do not appear to be successfully recruiting in segments 5 and 6. Few small (< 200 mm TL) blue suckers have also been captured in the lower segments of the Missouri River in Nebraska (Steffensen and Mestl 2005) with the exception of the segment 8 during the 2006 season below the Big Sioux River (Kirk Steffensen, personal communication). 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 conditions have not been appropriate for the last 4 years with the exception of the fish being captured below the Big Sioux River during 2006.

Gill nets, trammel nets, and otter trawls were effective at capturing sauger in segments 5 and 6. Gill net mean CPUE has been declining since 2003 for sauger but appears to have leveled off during 2005 and 2006. Trammel net mean CPUE has consistently been higher during the sturgeon season from 2003 to 2006. This seasonality in catch rates is likely due to sauger moving up into segments 5 and 6 from Lewis and Clark Lake as they stage for spawning in spring.

We captured 5 times fewer fish in 2006 (2,842) compared to 2005 (14,622) and just under 2 times fewer fish compared to 2004 (4,489). This decrease was mostly due to the discontinued use of the bag seine in 2006. Mini-fyke nets captured far fewer white bass ($n = 4$) and walleye ($n = 13$) in 2006 compared to 5,723 age-0 white bass and 555 age-0 walleye in 2005. We can not be certain that the decrease in fish captures represents a decrease in fish relative abundance in segments 5 and 6. The fish community season extends from July to October. Because different fish species may become more abundant during different times of the year due to YOY recruitment to the gear, sampling during the fish community season should be

systematically spread out through the four months or should be shortened into a more intense sampling period.

The pallid sturgeon population assessment program is adaptive, allowing for changes in standard gear types and experimentation with the effectiveness of non-standard gears (Appendix C). Hoop nets and setlines were used from 2003 to 2005 to evaluate the effectiveness of these gears and determine appropriate time frames when they are most effective at capturing sturgeon and other native species. Set lines were most effective from April to May and in October to capture pallid sturgeon and shovelnose sturgeon when water temperatures were lower (Wanner 2006). Hoop nets were most effective during the spring when native fish were likely making spawning runs (D. Shuman, unpublished data). Beam trawling was discontinued in 2005 as a standard gear due to extremely low catches for all fish species during 2003 and 2004. In 2005, a 16-ft. otter trawl replaced the beam trawl and appears to effectively sample channel border habitats. Mini-fyke nets capture more species and more numbers of fish compared to seines in 2005 (V. Travnichek, Missouri Department of Conservation, unpublished data). Therefore, seines were discontinued after the 2005 season and a small-mesh 16-ft otter trawl is now deployed to capture small-bodied benthic fishes. In 2006 comparisons of white and green mesh gill and trammel nets, bow vs. stern trawling, large and small mesh trammel nets, and large and small mesh otter trawls were evaluated to determine their effectiveness. Preliminary results from these studies suggest that net color (green vs. white) has no effect at elevated turbidity levels (i.e. ≥ 50 ntu), while at lower turbidity fishes, with acute eyesight may avoid the green nets (G. Wanner, unpublished data). Bow and stern trawling with the OT16 produced similar species composition, abundance, and length frequency distributions (K. Steffensen, unpublished data). The large mesh otter trawl (OT16) out fished the small mesh otter trawl (OT01) in total numbers of fish, while the small meshed trawl captured a greater number of chubs (K. Steffensen, unpublished data) and more chub species in the channelized Missouri River. However, within

segments 5 – 7, the remnant unchannelized Missouri River sections, the small mesh otter trawl caught much fewer numbers of fish compared to the large mesh trawl (D. Shuman, unpublished data, S. Stukel, unpublished data).

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APPENDICES

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

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

Appendix A. (continued).

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

Appendix A. (continued).

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

Appendix A. (continued).

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

Appendix A. (continued).

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

Appendix A. (continued).

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

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

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

Appendix C. List of standard and wild gears (type), their corresponding codes in the database, seasons deployed (Fall-Spring, Summer, or all), years used, and catch-per-unit-effort units for collection of Missouri River fishes in 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.

Gear	Code	Type	Season	Years	CPUE units
Trammel net – 1 inch inner mesh	TN	STD	All	2003 - Present	fish/100 m drift
Gillnet – 4 meshes, small mesh set upstream	GN14	STD	Spring-Fall	2003 - Present	fish/net night
Gillnet – 4 meshes, large mesh set upstream	GN41	STD	Spring-Fall	2003 - Present	fish/net night
Otter trawl – 16 ft head rope	OT16	STD	All	2003 - Present	fish/100 m trawled
Otter trawl – 16 ft SKT 4mm x 4mm HB2 MOR	OT01	WILD	Summer	2006	fish/100 m trawled
Push Trawl – 8 ft 4mm x 4mm	POT02	WILD	Summer	2007 - Present	fish/ m trawled
Beam trawl	BT	STD*	All	2003 - 2004	fish/100 m trawled
Bag Seine – quarter arc method pulled upstream	BSQU	WILD	Summer	2003 - 2005	fish/100 m ²
Bag Seine – quarter arc method pulled downstream	BSQD	WILD	Summer	2003 - 2005	fish/100 m ²
Bag Seine – half arc method pulled upstream	BSHU	WILD	Summer	2003 - 2005	fish/100 m ²
Bag Seine – half arc method pulled downstream	BSHD	WILD	Summer	2003 - 2005	fish/100 m ²
Bag seine – rectangular method pulled upstream	BSRU	WILD	Summer	2003 - 2005	fish/100 m ²
Bag seine – rectangular method pulled upstream	BSRD	WILD	Summer	2003 - 2005	fish/100 m ²
Mini-fyke net	MF	STD	Summer	2003 - Present	fish/net night
Hoopnets	HN	STD/WILD	All	2003-2004 STD 2005 WILD	fish/hook night
Setlines	SL	WILD	All	2003-2005	Fish/net night

* Standard only in upper Missouri River segments

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

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

Appendix E. Juvenile and adult pallid sturgeon stocking summary for segments 5 and 6 of the Missouri River (RPMA 3)

Year	Stocking Site	Number Stocked	Year Class	Stock Date	Age at Stocking ^a	Primary Mark	Secondary Mark
2000	VER	416	1997	6/6/00	Juvenile	PIT	Elastomer / Dangler
	VER	98	1998	9/20/00	Juvenile	PIT	
	VER	4	Adults	7/6/00	Adults	PIT	Sonic
	VER	3	Adults	9/20/00	Adults	PIT	2 w/ sonic
	RNW	2	Adults	7/6/00	Adults	PIT	
2002	VER	561	2001	4/20/02	Yearling	PIT	Elastomer
	SUN	181	1999	4/25/02	Juvenile	PIT	Elastomer
2003	RUN	300	2002	7/24/03	Yearling	PIT	Elastomer
	SUN	301	2002	7/24/03	Yearling	PIT	Elastomer
2004	SUN	244	2003	8/7/04	Yearling	PIT	Elastomer
	RUN	271	2003	8/7/04	Yearling	PIT	Elastomer
2005	RUN	868	2004	8/3/05	Yearling	PIT	Elastomer
2006	RUN	1005	2005	8/25/05	Yearling	PIT	Elastomer

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

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 sturgeon season (Fall through Spring) and fish community season (Summer) for segments 5 and 6 of the Missouri River during 2005-2006. 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	CHXO		CONF		ISB		OSB		SCCL		SCCS	BRAD
			CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	ITIP	ITIP	CHNB
BUSK*	5	0.0283 (0.0288)	0.0286 (0.0571)						0.0685 (0.0960)		0.0625 (0.1250)			
CARP	2	0.0042 (0.0058)												0.0250 (0.0289)
CNCF	6	0.0292 (0.0235)	0.0536 (0.0659)						0.0556 (0.0703)					0.0250 (0.0289)
FHCF	1	0.0021 (0.0042)												0.0125 (0.0250)
NTPK	1	0.0052 (0.0104)	0.0250 (0.0500)											
PDSG	11	0.0526 (0.0488)	0.0750 (0.1500)				0.0992 (0.1425)		0.0238 (0.0476)					0.0375 (0.0750)
QLBK	1	0.0062 (0.0119)					0.0238 (0.0476)							
RKBS	2	0.0139 (0.0278)							0.0556 (0.1111)					
RVCS	1	0.0021 (0.0042)												0.0125 (0.0250)
SGER	24	0.0911 (0.0565)	0.0786 (0.1020)						0.1071 (0.1098)		0.2500 (0.5000)			0.1625 (0.1181)
SHRH	52	0.2616 (0.0915)	0.1655 (0.1203)				0.3016 (0.2659)		0.3681 (0.2107)		0.2917 (0.0833)			0.2125 (0.0629)
SMBS	7	0.0432 (0.0416)	0.0500 (0.1000)				0.0833 (0.1139)		0.0476 (0.0952)					
SNSG	178	0.6240 (0.2622)	0.4250 (0.4285)				0.3135 (0.1749)		0.5992 (0.3947)		0.5625 (0.8750)			1.5625 (0.8350)
WLYE	99	0.4166 (0.2475)	0.3143 (0.4081)				0.2183 (0.2542)		0.6944 (0.6407)		0.2500 (0.5000)			0.6125 (0.9656)

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	CHXO		CONF		ISB		OSB		SCCL		SCCS	BRAD
			CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	ITIP	ITIP	CHNB
BUSK*	2	0.0011 (0.0036)												0.0029 (0.0057)
CARP	4	0.0038 (0.0054)												0.0216 (0.0269)
CNCF	39	0.1114 (0.0536)	0.1231 (0.0878)				0.0790 (0.0621)		0.2041 (0.1625)			0.0649		0.0458 (0.0522)
FWDM	1	0.0005 (0.0011)												0.0031 (0.0062)
PDFH	2	0.0036 (0.0057)							0.0106 (0.0213)					0.0049 (0.0098)
PDSG	11	0.0107 (0.0091)							0.0099 (0.0198)					0.0464 (0.0179)
RVCS	7	0.0227 (0.0251)	0.0111 (0.0222)				0.0683 (0.0876)		0.0093 (0.0185)					
SGER	28	0.0278 (0.0310)							0.0111 (0.0222)					0.1434 (0.1328)
SHRH	23	0.0660 (0.0405)	0.0400 (0.0489)				0.0526 (0.0504)		0.0966 (0.1337)			0.1587		0.0245 (0.0489)
SMBF	2	0.0017 (0.0026)												0.0098 (0.0131)
SNSG	41	0.1027 (0.0624)	0.0533 (0.1067)				0.0582 (0.0607)		0.1001 (0.0581)					0.1199 (0.0967)
WLYE	18	0.0220 (0.0177)					0.0110 (0.0220)		0.0203 (0.0275)					0.0793 (0.0664)

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	CHXO		CONF		ISB		OSB		SCCL		SCCS	BRAD
			CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	ITIP	ITIP	CHNB
BUSK*	1	0.0009 (0.0018)												0.0050 (0.0018)
BLGL	1	0.0009 (0.0018)												0.0050 (0.0018)
CARP	7	0.0119 (0.0096)					0.0093 (0.0185)		0.0111 (0.0222)		0.0645 (0.129)			0.0190 (0.0144)
CNCF	46	0.1147 (0.0680)	0.1389 (0.1571)				0.0463 (0.0727)		0.2104 (0.1864)					0.0722 (0.0349)
FWDM	4	0.0098 (0.0124)	0.0167 (0.0333)				0.0185 (0.0370)							0.0052 (0.0104)
PDSG*	5	0.0079 (0.0088)	0.0111 (0.0222)						0.0111 (0.0222)					0.0132 (0.0263)
RBST	8	0.0186 (0.0184)	0.0444 (0.0416)				0.0278 (0.0556)							0.0052 (0.0104)
RVCS	3	0.0045 (0.0062)					0.0093 (0.0185)							0.0106 (0.0213)
SGER	26	0.0323 (0.0338)	0.0111 (0.0222)				0.0370 (0.0741)							0.1081 (0.1362)
SGWE	8	0.0092 (0.0109)					0.0093 (0.0185)							0.0365 (0.0490)
SHRH	23	0.0627 (0.0727)	0.0222 (0.0272)				0.0362 (0.0458)		0.1717 (0.2556)					0.0050 (0.0101)
SMBS	12	0.0386 (0.0399)	0.0667 (0.1333)				0.0185 (0.0370)		0.0667 (0.1333)					
SNSG	36	0.0762 (0.0514)	0.1022 (0.1509)				0.0093 (0.0185)		0.0992 (0.1214)		0.1290 (0.2580)			0.0965 (0.1157)
STCT	4	0.0083 (0.0147)							0.0269 (0.0538)					0.0052 (0.0104)
STSN	1	0.0024 (0.0049)							0.0090 (0.0179)					
SVCB	64	0.0785 (0.0730)	0.0278 (0.0351)				0.0463 (0.0603)		0.0248 (0.0317)		0.0645 (0.1290)			0.0463 (0.0603)
WLYE	16	0.0232 (0.0131)	0.0111 (0.0222)				0.0185 (0.0234)		0.0109 (0.0219)		0.0678 (0.1366)			0.0527 (0.0279)
WTBS	4	0.0049 (0.0068)					0.0093 (0.0185)							0.0132 (0.0263)

Appendix F4 (continued).

Species	Total Catch	Overall CPUE	CHXO		CONF		ISB		OSB		SCCL		SCCS	BRAD
			CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	ITIP	ITIP	CHNB
YWPH	2	0.0047 (0.0077)	0.0167 (0.0333)											0.0052 (0.0104)

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	CHXO	CONF	ISB	OSB	SCCL	SCCS	BRAD
			BARS						
BKBH	2	0.025 (0.050)							0.0625 (0.1250)
BKCP	8	0.100 (0.174)					2.3333 (4.6667)		0.0313 (0.0625)
BLGL	81	1.013 (0.751)	2.2500 (1.9365)		0.3333 (0.5164)	0.7778 (0.7027)			1.3750 (1.5910)
BMBF	18	0.225 (0.225)							0.5625 (1.1250)
BNMW	25	0.3135 (0.251)	0.2500 (0.5000)	1.3333 (2.6667)	0.0667 (0.1333)	0.0833 (0.1667)			0.5313 (0.5340)
CARP	13	0.163 (0.167)		0.6667 (0.6667)		0.0556 (0.1111)			0.3125 (0.3750)
CNCF	16	0.200 (0.294)		3.6667 (1.7654)	0.0667 (0.1333)		0.3333 (0.6667)		0.0938 (0.1197)
ERSN	126	1.575 (0.921)	1.0000 (2.0000)		0.3333 (0.5164)	1.4444 (1.8751)		1.5000 (1.2911)	2.5313 (1.2348)
FHCF	7	0.088 (0.118)		1 (1.1545)					0.1250 (0.2500)
FHMW	1	0.013 (0.250)							0.0313 (0.0625)
FWDM	9	0.113 (0.069)		0.3333 (0.6667)	0.1333 (0.1633)	0.0556 (0.1111)			0.1563 (0.1197)
GNSF	18	0.225 (0.291)	0.2500 (0.2887)			0.1667 (0.2277)			0.4063 (0.7315)
GZSD	6	0.075 (0.067)		0.6667 (0.6667)		0.0556 (0.1111)			0.0938 (0.1197)
JYDR	39	0.488 (0.680)			0.1167 (0.1453)	0.2222 (0.2049)	1.5000		0.9688 (1.6967)
LMBS	33	0.413 (0.427)	0.1250 (0.2500)			0.1111 (0.2222)		1.5000 (1.0000)	0.7500 (0.9186)
OSSF	38	0.475 (0.923)				0.0556 (0.1111)			1.1563 (2.3125)
RDSN	9	0.113 (0.102)	0.1250 (0.2500)	1.0000	0.0667 (0.1333)	0.0556 (0.1111)	0.3333 (0.6666)		0.0625 (0.1250)
RKBS	13	0.163 (0.140)	0.5000 (0.7071)		0.3833 (0.3317)		0.3333 (0.6666)		0.0625 (0.0722)

Appendix F6 (continued).

Species	Total Catch	Overall CPUE	CHXO	CONF	ISB	OSB	SCCL	SCCS	BRAD
			BARS	BARS	BARS	BARS	BARS	BARS	BARS
RVCS	58	0.725 (0.422)		0.3333 (0.6667)					1.7813 (3.5625)
SFSN	670	8.375 (6.602)	6.3750 (8.1688)	5.6667	6.9667 (12.3344)	2.7222 (2.5043)	12.0000		10.5938 (15.4226)
SHRH	3	0.0375 (0.038)			0.0500 (0.1000)				0.0625 (0.0722)
SMBF	5	0.063 (0.100)							0.1563 (0.2366)
SMBS	230	2.875 (2.297)	2.1250 (2.2867)	1.0000	2.2167 (1.4941)	2.5278 (2.3920)	3.667	1.000	3.8750 (5.7753)
SNGR	31	0.388 (0.188)	0.3750 (0.4787)	2.3333	0.2500 (0.2472)	0.4444 (0.3182)		0.2500	0.2813 (0.2772)
SNSN	42	0.525 (0.701)		6.6667					0.6875 (1.3750)
STSN	31	0.388 (0.287)	0.2500 (0.5000)	1.3333		0.1111 (0.1405)	0.6667	0.7500	0.5625 (0.6333)
SVCB	1	0.013 (0.025)				0.0833 (0.1667)			
UCS	16	0.200 (0.269)							0.5000 (0.5863)
UCY	300	3.750 (7.090)		4.0000		0.1667 (0.3333)			8.9063 (17.8125)
WLYE	13	0.163 (0.158)				0.0556 (0.1111)			0.3750 (0.2887)
WTBS	4	0.050 (0.067)	0.2500 (0.5000)				0.6667		
WTCP	139	1.738 (1.632)	0.6250 (1.2500)	4.0000	0.2000 (0.4000)	0.7222 (1.4444)	1.0000		3.2188 (3.5727)

Appendix G. Hatchery names, locations, and abbreviations.

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

Appendix H. Alphabetic list of Missouri River fishes with total catch-per-unit-effort by gear type for sturgeon season (fall through spring) and fish community season (summer) during 2005 – 2006 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	Sturgeon Season (Fall through Spring)			Fish Community Season (Summer)		
	1 Inch Trammel Net	Gill Net	Otter Trawl	1 Inch Trammel Net	Mini-Fyke Net	Otter Trawl
BKBH					0.025 (0.050)	
BKCP					0.100 (0.174)	
BLGL			0.004 (0.008)		1.013 (0.751)	
BMBF					0.225 (0.450)	
BNMW					0.313 (0.251)	
BUSK*	0.002 (0.003)	0.025 (0.022)		0.002 (0.003)		0.002 (0.004)
CARP	0.010 (0.020)	0.010 (0.013)	0.008 (0.011)	0.011 (0.022)	0.163 (0.167)	0.019 (0.020)
CNCF	0.146 (0.093)	0.030 (0.022)	0.115 (0.099)	0.054 (0.032)	0.200 (0.294)	0.078 (0.032)
ERSN					1.575 (0.921)	
FHCF		0.005 (0.010)			0.088 (0.118)	
FHMW					0.013 (0.250)	
FWDM				0.002 (0.004)	0.113 (0.069)	0.016 (0.017)
GNSF					0.225 (0.291)	
GZSD					0.075 (0.067)	
JYDR					0.488 (0.680)	
LMBS					0.413 (0.427)	
NTPK		0.005 (0.010)				
OSSF					0.475 (0.923)	
PDFH	0.009 (0.012)					
PDSG*	0.012 (0.024)	0.054 (0.043)	0.017 (0.026)	0.026 (0.024)		0.004 (0.007)
QLBK		0.005 (0.010)				
RBST			0.033 (0.041)			
RDSN					0.113 (0.102)	
RKBS	0.010 (0.020)				0.163 (0.140)	
RVCS	0.019 (0.022)	0.005 (0.010)	0.004 (0.009)	0.012 (0.023)	0.725 (0.422)	0.008 (0.011)
SFSN					8.375 (6.602)	
SGER*	0.082 (0.103)	0.120 (0.072)	0.038 (0.032)	0.033 (0.039)		0.071 (0.090)
SGWE						0.033 (0.043)
SHRH	0.062 (0.062)	0.258 (0.054)	0.027 (0.025)	0.061 (0.044)	0.0375 (0.038)	0.072 (0.115)
SMBF				0.007 (0.011)	0.063 (0.100)	

Appendix H. (continued).

Species Code	Sturgeon Season (Fall through Spring)			Fish Community Season (Summer)		
	1 Inch Trammel Net	Gill Net	Otter Trawl	1 Inch Trammel Net	Mini-Fyke Net	Otter Trawl
SMBS		0.035 (0.042)			2.875 (2.297)	0.051 (0.074)
SNGR					0.388 (0.188)	
SNSG*	0.084 (0.057)	0.888 (0.492)	0.094 (0.083)	0.106 (0.055)		0.063 (0.045)
SNSN*					0.525 (0.701)	
STCT						0.016 (0.025)
STSN					0.388 (0.287)	0.004 (0.008)
SVCB			0.135 (0.165)		0.013 (0.025)	0.127 (0.150)
UCS					0.200 (0.269)	
UCY					3.750 (7.090)	
WLEY	0.0712 (0.066)	0.495 (0.410)	0.033 (0.032)	0.012 (0.014)	0.163 (0.158)	0.032 (0.027)
WTBS					0.050 (0.067)	0.013 (0.019)
WTCP					1.738 (1.632)	
YWPH						0.008 (0.011)

Appendix I. Comprehensive list of bend numbers and bend river miles for segments 5 and 6 of the Missouri River comparing bend selection for both sturgeon season (ST) and fish community season (FCS) between years from 2003 – 2006. A bend that also had a non-random or wild sampling effort is indicated by a (w).

Segment - Bend Number	Bend River Mile	2003	2004	2005	2006
5 - 1	880				
5 - 2	878.9				
5 - 3	875.5			FC	
5 - 4	873.5		ST		
5 - 5	871.9		ST		
5 - 6	870.3	ST, FC	FC		ST, FC
5 - 7	868.5	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	
5 - 11	861.1	ST (w)		FC	ST, FC
5 - 12	853.2		ST, FC	ST, FC	
5 - 13	851.7	ST (w)	FC		
5 - 14	851				ST, FC
5 - 15	849.1	ST, FC	ST	ST	
5 - 16	847.5	ST (w)	ST	FC	(w)
5 - 17	846	ST, FC	FC	ST	
6 - 1	844		ST, FC	ST	ST, FC
6 - 2	843.2	ST, FC	ST	ST	
6 - 3	842.1	ST (w)	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
6 - 7	835.3	ST (w)	ST	ST, FC	ST, FC
6 - 8	834.1	ST, FC		FC	ST, FC
6 - 9	832	ST (w)	ST, FC	FC	
6 - 10	831	ST (w)		FC	
6-11	829	ST (w)			