

2004 Annual Report

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



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EXECUTIVE SUMMARY

Pallid sturgeon *Scaphirhynchus albus* and the associated fish community were randomly sampled in the unchannelized Missouri River below Fort Randall Dam to the headwaters of Lewis and Clark Lake (Recovery Priority Management Area #3; [RPMA]) with standardized gear and protocols from fall of 2003 to fall of 2004 (i.e., 2004 season). At least eight randomly selected bends were sampled with a minimum of 8 gear deployments 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 2004, all recaptured pallid sturgeons (n = 28) were of hatchery origin and readable passive integrated transponder (PIT) tags were found in 86% of the fish. Recaptured pallid sturgeon represented five of the six year classes that have been stocked (1997 - 1999 and 2001 - 2003) into RPMA #3 as part of population supplementation efforts. For standardized gears, 12 pallid sturgeon were captured with gillnets and 13 with trammel nets while three additional fish were captured with set lines baited with night crawlers, a non-standard gear. Relative condition of recaptured pallid sturgeons ranged from 0.7 to 0.9 with mean growth of 0.137 mm/d. Spatially, pallid sturgeons were captured throughout most of the length of segments 5 and 6 (river mile 868 to 831) with most fish captured in the channel border mesohabitat of inside bends, outside bends, and channel crossovers. A total of 91 shovelnose sturgeons *S. platyrhynchus* were captured in 2004: 43 with gillnets, 30 with trammel nets, 5 with beam trawls, 2 with hoopnets, and 11 with set lines. The ratio of pallid to shovelnose sturgeons was 1:3.25.

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 elongates*, bigmouth buffalo *Ictiobus cyprinellus*, and sauger *Sander canadense*. No plains minnows *Hybognathus spp.*, sturgeon chubs, sicklefin chubs, or speckled chubs were captured in 2004. Sand shiners were only captured with seines (n = 137) and mini-fyke nets (n = 33) during summer. A total of 18 blue suckers, 9 bigmouth buffalo, and 72 saugers were caught in 2004. Most blue suckers were captured in hoopnets, a nonstandard gear, during spring (n = 14). Saugers were captured with gillnets (n = 43) primarily during April to June. A total of 38 fish species and one hybrid were caught in segments 5 and 6 of the Missouri River during 2004. 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.

TABLE OF CONTENTS

	Page
Introduction	12
Goals	14
Objectives	14
Success criteria	15
Study Area	16
Methods	20
Habitat classification	20
Sampling effort and gear	21
Calculations	24
Results	30
Pallid sturgeon	30
Targeted native Missouri River species	44
Shovelnose sturgeon	44
Native cyprinids	52
Sturgeon chub	52
Sicklefin chub	52
Speckled chub	52
Plains minnow/Western silvery minnow	52
Sand Shiner	52
Native catostomids	58
Bigmouth buffalo	58
Blue sucker	64
Native percids	70
Sauger	70
Additional effort – wild gears	76
General Missouri River fish community	77
Discussion	87
References	92
Appendices	94

LIST OF TABLES

Table 1. Number of bends sampled, mean effort per bend (as deployments of each gear type), and total gear deployments by macrohabitat for segments 5 and 6 in the Missouri River during fall through spring (sturgeon season) and summer (fish community season) in 2004.

Table 2. Number of bends sampled, mean effort per bend (as deployments of each gear type), and total gear deployments by mesohabitat for segments 5 and 6 in the Missouri River during fall through spring (sturgeon season) and summer (fish community season) in 2004.

Table 3. Pallid sturgeon (PDSG) and hybrid sturgeon (SNPD) capture locations and habitat characteristics for segments 5 and 6 of the Missouri River during 2004.

Table 4. Pallid and hybrid sturgeon captured in segments 5 and 6 of the Missouri River during 2004.

Table 5. Mean fork length (+/- 2SE), weight (+/- 2SE), relative condition factor (K_n) and growth rates of juvenile hatchery-reared pallid sturgeon by year class at the time of stocking and recapture in 2004 for segments 5 and 6 of the Missouri River.

Table 6. Incremental relative stock density (RSD)^a by length category for wild and stocked pallid sturgeon in segments 5 and 6 of the Missouri River captured during 2004.

Table 7. Ratios of pallid sturgeon to shovelnose sturgeon, pallid sturgeon to hybrids (pallid X shovelnose), and stocked pallid sturgeon to wild pallid sturgeon captured in segments 5 and 6 of the Missouri River during 2004.

Table 8. Incremental relative stock density (RSD)^a by length category of shovelnose sturgeon in segments 5 and 6 of the Missouri River captured during 2004.

LIST OF FIGURES

Figure 1. Map of the mainstem Missouri River reservoirs in South Dakota and Nebraska with the Fort Randall to Gavins Point section enlarged.

Figure 2. Map of the riverine portion of Lewis and Clark Lake with common landmarks.

Figure 3. Mean annual catch-per-unit-effort (\pm 2SE) of wild (black bars) and stocked (white bars) pallid sturgeon in segments 5 and 6 of the Missouri River for: A) gill nets, and B) trammel nets, and C) beam trawls from fall through spring (sturgeon season) during 2003 - 2004.

Figure 4. Mean annual catch-per-unit-effort (\pm 2SE) of wild (black bars) and stocked (white bars) pallid sturgeon in segments 5 and 6 of the Missouri River for: A) trammel nets and B) beam trawls during summer (fish community season) during 2003 – 2004.

Figure 5. Effort expended (A) and pallid sturgeon catch in numbers (B) by river mile for segments 5 and 6 in the Missouri River during 2004.

Figure 6. Percent of total pallid sturgeon caught by macrohabitat type in segments 5 and 6 of the Missouri River during two seasons: Fall through Spring and Summer.

Figure 7. Percent of total pallid sturgeon caught by mesohabitat type in segments 5 and 6 of the Missouri River during two seasons: Fall through Spring and Summer.

Figure 8. Length frequency of pallid sturgeon during fall through spring (sturgeon season, black bars) and summer (fish community season, white bars) in segments 5 and 6 of the Missouri River during 2004.

Figure 9. Mean annual catch-per-unit-effort (\pm 2SE) of young-of-year (black bars) and $>$ age-1 (white bars) shovelnose sturgeon in segments 5 and 6 of the Missouri River for: A) gill nets, B) trammel nets, and C) beam trawls from fall through spring (sturgeon season) during 2004.

Figure 10. Mean annual catch-per-unit-effort (\pm 2SE) of young-of-year (black bars) and $>$ age-1 (white bars) shovelnose sturgeon in segments 5 and 6 of the Missouri River for: A) trammel nets and B) beam trawls in summer (fish community season) during 2004.

Figure 11. Percent of total shovelnose sturgeon caught by macrohabitat type in segments 5 and 6 of the Missouri River during two seasons: Fall through Spring and Summer.

Figure 12. Percent of total shovelnose sturgeon caught by mesohabitat type in segments 5 and 6 of the Missouri River during two seasons: Fall through Spring and Summer.

Figure 13. Length frequency of shovelnose sturgeon during fall through spring (sturgeon season, black bars) and summer (fish community season, white bars) in segments 5 and 6 of the Missouri River during 2004.

Figure 14. Mean annual catch-per-unit-effort (\pm 2SE) of sand shiners in segments 5 and 6 of the Missouri River for: A) bag seines and B) mini-fyke nets during summer (fish community season) during 2003 - 2004.

Figure 15. Percent of total sand shiners caught by macrohabitat type in segments 5 and 6 of the Missouri River during two seasons: Fall through Spring and Summer.

Figure 16. Percent of total sand shiners caught by mesohabitat type in segments 5 and 6 of the Missouri River during two seasons: Fall through Spring and Summer.

Figure 17. 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 2004.

Figure 18. Mean annual catch-per-unit-effort (\pm 2SE) of bigmouth buffalo in segments 5 and 6 of the Missouri River for: A) gill nets, B) trammel nets, and C) beam trawls from fall through spring (sturgeon season) during 2003 - 2004.

Figure 19. Mean annual catch-per-unit-effort (\pm 2SE) bigmouth buffalo in segments 5 and 6 of the Missouri River for: A) trammel nets and B) beam trawls in summer (fish community season) during 2003 - 2004.

Figure 20. Percent of total bigmouth buffalo caught by macrohabitat type in segments 5 and 6 of the Missouri River during two seasons: Fall through Spring and Summer.

Figure 21. Percent of total bigmouth buffalo caught by mesohabitat type in segments 5 and 6 of the Missouri River during two seasons: Fall through Spring and Summer. Habitat abbreviations presented in Appendix B.

Figure 22. Length frequency of bigmouth buffalo 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 2004.

Figure 23. Mean annual catch-per-unit-effort (\pm 2SE) of blue suckers in segments 5 and 6 of the Missouri River for: A) gill nets, B) trammel nets, and C) beam trawls from fall through spring (sturgeon season) during 2003 - 2004.

Figure 24. Mean annual catch-per-unit-effort (\pm 2SE) blue suckers in segments 5 and 6 of the Missouri River for: A) trammel nets and B) beam trawls in summer (fish community season) during 2004.

Figure 25. Percent of total blue suckers caught by macrohabitat type in segments 5 and 6 of the Missouri River during two seasons: Fall through Spring and Summer. Macrohabitat abbreviations presented in Appendix B.

Figure 26. Percent of total blue suckers caught by mesohabitat type in segments 5 and 6 of the Missouri River during two seasons: Fall through Spring and Summer.

Figure 27. 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 2004.

Figure 28. Mean annual catch-per-unit-effort (\pm 2SE) of saugers in segments 5 and 6 of the Missouri River for: A) gill nets, B) trammel nets, and C) beam trawls from fall through spring (sturgeon season) during 2003 – 2004.

Figure 29. Mean annual catch-per-unit-effort (\pm 2SE) saugers in segments 5 and 6 of the Missouri River for: A) trammel nets and B) beam trawls in summer (fish community season) during 2003 - 2004.

Figure 30. Percent of total saugers caught by macrohabitat type in segments 5 and 6 of the Missouri River during two seasons: Fall through Spring and Summer.

Figure 31. Percent of total saugers caught by mesohabitat type in segments 5 and 6 of the Missouri River during two seasons: Fall through Spring and Summer. Habitat abbreviations presented in Appendix B.

Figure 32. Length frequency of saugers during fall through spring (sturgeon season, black bars) and summer (fish community season, white bars) in segments 5 and 6 of the Missouri River during 2004.

Figure 33. Mean annual catch-per-unit-effort (\pm 2 SE) of stocked pallid sturgeon in segments 5 and 6 of the Missouri River for set lines fished during fall through spring (Sturgeon Season) of 2003 - 2004.

Figure 34. Mean annual catch-per-unit-effort (\pm 2 SE) of stocked pallid sturgeon in segments 5 and 6 of the Missouri River for set lines during summer (Fish Community Season) of 2003 - 2004.

Figure 35. Mean annual catch-per-unit-effort (\pm 2 SE) of wild shovelnose sturgeon in segments 5 and 6 of the Missouri River for wild gears: A) hoopnets and B) set lines fished during fall through spring (Sturgeon Season) of 2003 - 2004.

Figure 36. Mean annual catch-per-unit-effort (\pm 2 SE) of wild shovelnose sturgeon in segments 5 and 6 of the Missouri River for wild gears: A) hoopnets and B) set lines fished during the (Fish Community Season) of 2003 - 2004.

Figure 37. Mean annual catch-per-unit-effort (\pm 2 SE) of bigmouth buffalo in segments 5 and 6 of the Missouri River for hoopnets fished during fall through spring (Sturgeon Season) of 2003 - 2004.

Figure 38. Mean annual catch-per-unit-effort (± 2 SE) of bigmouth buffalo in segments 5 and 6 of the Missouri River for hoopnets fished during summer (Fish Community Season) of 2003 - 2004.

Figure 39. Mean annual catch-per-unit-effort (± 2 SE) of blue suckers in segment 5 and 6 of the Missouri River for hoopnets fished during fall through spring (Sturgeon Season) of 2003 - 2004.

Figure 40. Mean annual catch-per-unit-effort (± 2 SE) of blue suckers in segments 5 and 6 of the Missouri River for hoopnets fished during summer (Fish Community Season) of 2003 - 2004.

Figure 41. Mean annual catch-per-unit-effort (± 2 SE) of saugers in segments 5 and 6 of the Missouri River for hoopnets fished during summer (Fish Community Season) of 2003 - 2004.

LIST OF 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.

Appendix B. Definitions and codes used to classify standard Missouri River habitats in the long-term pallid sturgeon and associated fish community sampling program.

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

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

Appendix E. Juvenile and adult pallid sturgeon stocking summary for segments 5 and 6 of RPMA 3.

Appendix F. Total catch, overall mean catch per unit effort (± 2 SE), and mean CPUE (fish/net night) by mesohabitat within a macrohabitat for all species caught with gillnets from fall through spring (sturgeon season) for segments 5 and 6 of the unchannelized Missouri River during 2004.

Appendix G. 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 trammel nets from fall through spring (sturgeon season) for segments 5 and 6 of the unchannelized Missouri River during 2004.

Appendix H. 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 an beam-trawl from fall through spring (sturgeon season) for segments 5 and 6 of the unchannelized Missouri River during 2004

Appendix I. 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 trammel nets in summer (fish community season) for segments 5 and 6 of the unchannelized Missouri River during 2004.

Appendix J. 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 beam-trawl in summer (fish community season) for segments 5 and 6 of the unchannelized Missouri River during 2004.

Appendix K. Total catch, overall mean catch per unit effort (± 2 SE), and mean CPUE (fish/m²) by mesohabitat within a macrohabitat for all species caught with bag seines in summer (fish community season) for segments 5 and 6 of the unchannelized Missouri River during 2004.

Appendix L. Total catch, overall mean catch per unit effort (± 2 SE), and mean CPUE (fish/net night) by mesohabitat within a macrohabitat for all species caught with mini-fyke nets in summer (fish community season) for segments 5 and 6 of the unchannelized Missouri River during 2004.

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 and deployment methods (Appendix C), and data reporting (Drobish 2005b). . Four high priority pallid sturgeon recovery 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 1), have been supplemented through stocking since 2000 (Appendices D and E). During 2000, 2002, 2003 and 2004, a total of 2,373 juvenile pallid sturgeon were released consisting of six year classes (1997, 1998, 1999, 2001, 2002, and 2003) and 9 adult broodstock or rehabilitated fish that were also stocked (Appendix E). These fish were stocked at three locations: the most

upstream site was Sunshine Bottoms, the middle site was at the Verdel Boat Ramp, and lower most site was at the Running Water Boat Ramp (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 Missouri River fishes to changes in habitat or flow modifications may be a more sensitive indicator of habitat change. 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 10 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*, bigmouth buffalo *Ictiobus cyprinellus*, and sauger *Sander canadense*. All fish collected during population assessment activities are recorded; however, detailed data (weight and age structures such as scales and pectoral fin rays) are only being collected on pallid

sturgeon and the representative group of 10 native Missouri River species. No pectoral fin ray clips were taken on shovelnose sturgeon, blue suckers, and bigmouth buffalo 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 process 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 native target species population abundance and geographic distribution throughout the Missouri River system.
5. Evaluate annual results and long-term trends of habitat usage of the 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 detect 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 1). 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 1 and 2). 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, that 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 2). This segment has increased water temperatures and turbidity due to inflows from the Niobrara River.

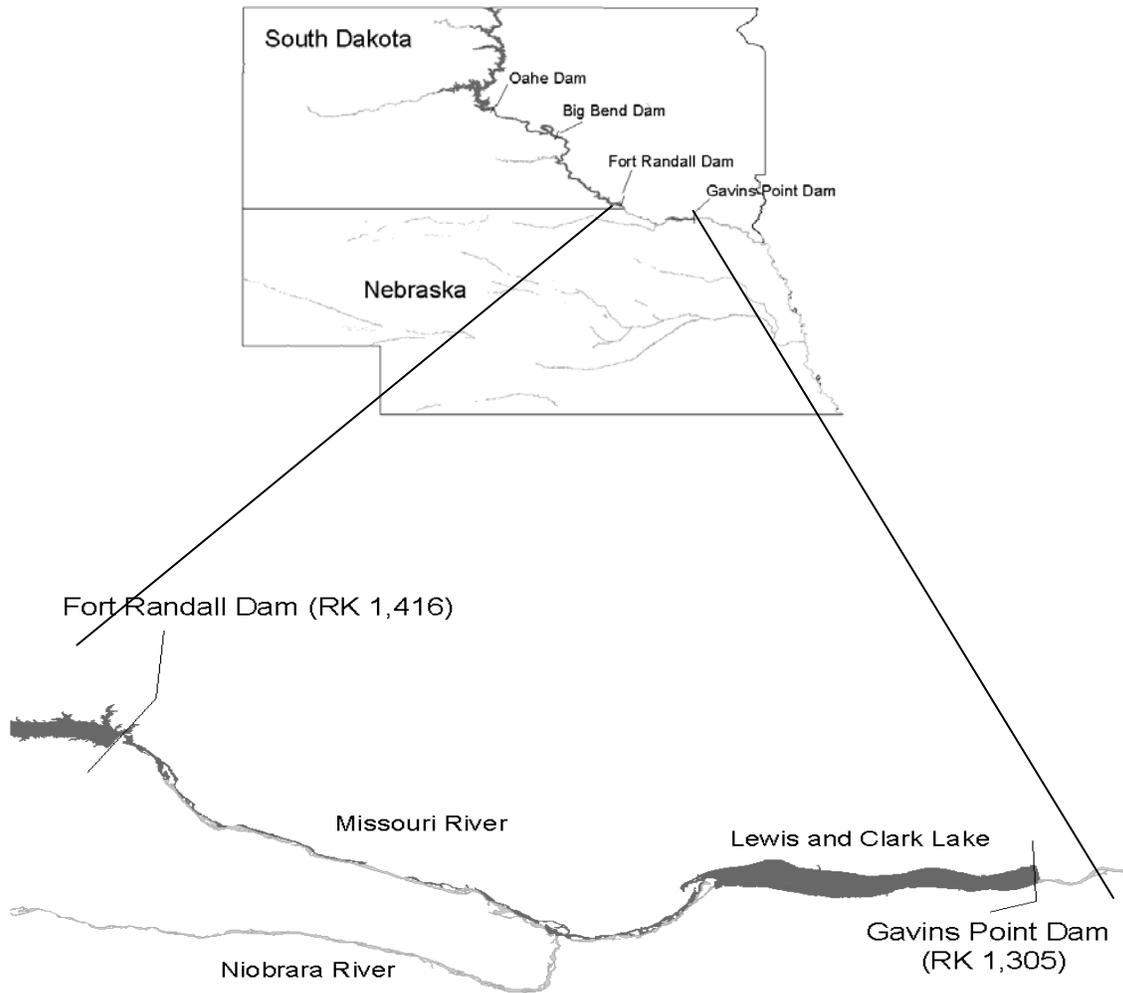


Figure 1. Map of the mainstem Missouri River reservoirs in South Dakota and Nebraska with the Fort Randall to Gavins Point section enlarged.

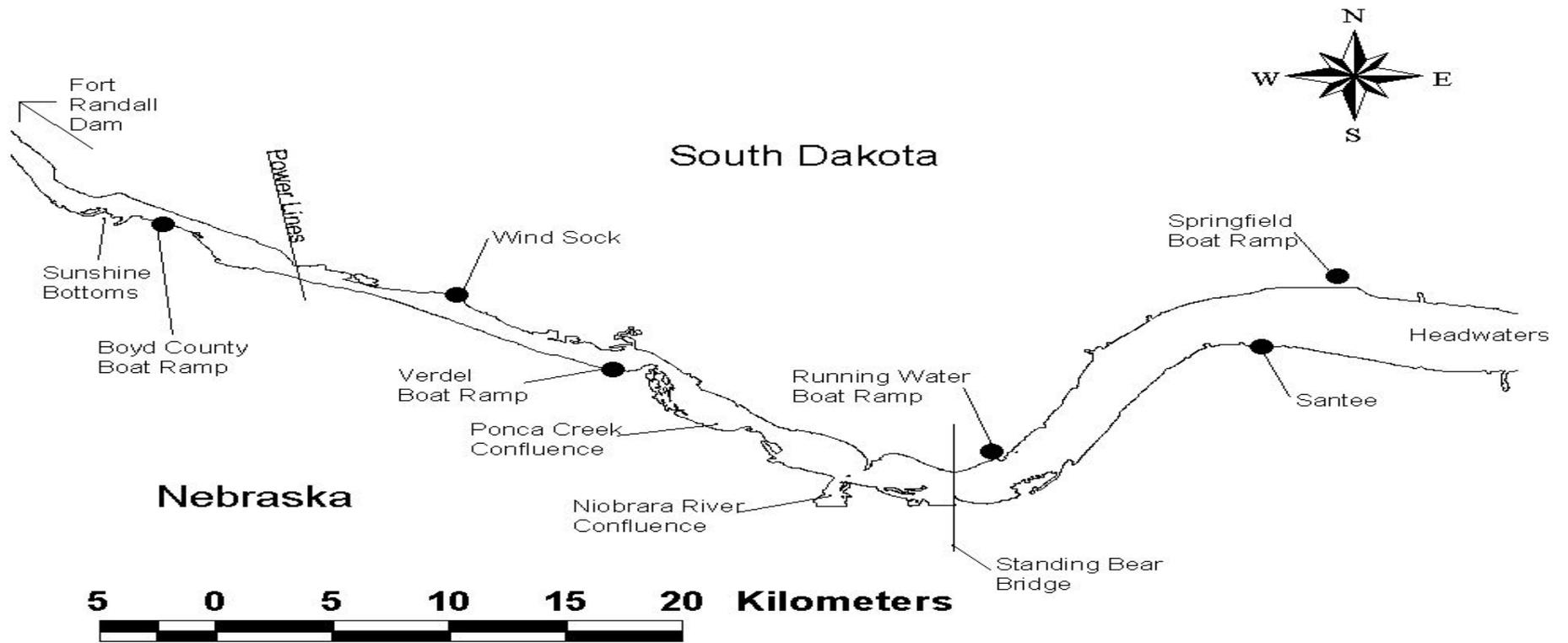


Figure 2. Map of the riverine portion of Lewis and Clark Lake with common landmarks. Segment 5 for the long term monitoring program encompassed the area between Fort Randall Dam to the Niobrara River Confluence. Segment 6 for the long term monitoring plan encompassed the area between the Niobrara River Confluence to the headwaters of Lewis and Clark Lake.

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 US Geological Survey Cooperative Fish and Wildlife Research Units located at universities throughout the Missouri River Basin states. 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 eight bends (four per segment) were randomly selected for sampling. An additional two bends, one in each segment, were non-randomly chosen. These non-random bends were the first bend upstream and downstream of the confluence of the Niobrara and Missouri rivers. Following the 2004 sample season, no non-random bends were sampled (i.e., all five bends in each segment were randomly selected. Additional 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) was 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) 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, gears sampled multiple species despite targeting the capture of pallid sturgeon or the fish community.

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 gillnets at water temperatures < 12 °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. 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). However, these specialized studies fall into the focused research category and are not reported here.

Multiple gears were deployed to sample deep and shallow habitats of the Missouri River. Gillnets, trammel nets, and beam trawls are 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 beam trawls were again used with the addition of mini-fyke nets and bag seines to sample shallow water habitats (i.e. bars). Multi-filament gillnets (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. The benthic beam trawl (0.5 m deep x 2 m width) had an outer chafing mesh of 0.64 cm bar mesh, inner bar mesh of 0.32 cm, 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. Bag seines were constructed of 6.4 mm “ACE” type mesh and were 9.1 m long, 1.8 m high, containing a 1.8 m x 1.8 m x 1.8 m bag. Gillnets and mini-fyke nets were set overnight for a maximum of 18 hour and CPUE was calculated as the number of fish per net night. Trammel nets were drifted and beam trawls were

pulled 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 beam trawls with CPUE measured as numbers of fish per 100 m of distance deployed. Deployment technique and seine width were used to quantify numbers of fish per m². All gear deployments followed the detailed standard operating procedures (SOP) outlined in Drobish (2005b).

In addition to the required standard gears, set lines and hoopnets, were used during both sampling seasons to target juvenile pallid sturgeon and shovelnose sturgeon. These additional gears are considered “wild” in the SOP (Drobish 2005b). Each set line contained two Mustad Tuna Circle hooks (sizes 10/0 and 12/0) and was held fast to the river bottom with a 1.8 kg collapsible anchor. Hooks were staged at 1m intervals from the anchor. Hoop nets were 4.8 m in length with 3.8 cm bar mesh and consisted of seven tapered 1.2 m diameter hoops. Hoop nets were used in areas where flow velocities were sufficient to maintain the net in a deployed position. Both setlines and hoop nets were marked with a float attached to a 40-ft line and set overnight for a maximum of 18 h. Hoop net and setline CPUE was calculated as the numbers of fish per net or hook night respectively. 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 (Appendices F to L). 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 three native target Missouri River species: shovelnose sturgeon, bigmouth buffalo, and sauger. 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), bigmouth buffalo (Bister et al. 2000), and sauger (Guy et al. 1989). 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, shovelnose sturgeon, bigmouth buffalo, and sauger using methods proposed by Gabelhouse (1984). For pallid sturgeon, length categories proposed by Shuman et al. (in review) were used to determine relative stock densities (RSD). These length categories are stock-quality (330 – 629 mm), quality-preferred (630 - 839 mm), preferred-memorable (840 - 1039 mm), memorable-trophy (1040 - 1269 mm), and trophy (≥ 1270 mm). Length categories exist in the literature for three target species of the population assessment program: shovelnose

sturgeon (Quist et al. 1998), bigmouth buffalo (Bister et al. 2000) and sauger (Gablehouse 1984). For these four species, we calculated the percents of < stock, stock, and > stock sized fish captured in each macrohabitat and mesohabitat type. Detailed calculations of RSD are found in Anderson and Newman (1996).

Table 1. Number of bends sampled, mean effort per bend (as deployments of each gear type), and total gear deployments by macrohabitat for segments 5 and 6 in the Missouri River during fall through spring (sturgeon season) and summer (fish community season) in 2004. Macrohabitat definitions and abbreviations are presented in Appendix B.

Gear	Number of bends	Mean effort/bend	Macrohabitat								
			OSB	ISB	CHXO	SCCL	SCCS	SCN	TRML	TRMS	CONF
Fall through Spring - Sturgeon Season											
Gillnet	10	20	69	73	25	23			4		
Trammel net	14	7.6	33	24	26	6					
Beam Trawl	10	8.1	20	19	19	6	2				
Hoop net	10	8	24	18	18	3	1				
Set lines	12	26.2	94	83	81	25	6				
Summer – Fish Community Season											
Bag seine	11	19.2	60	71	2	75			3		
Mini-fyke	10	10.5	30	36	2	35	1	1			
Trammel net	10	8.8	18	16	20	8					
Beam Trawl	10	8	16	15	15	8	2				
Hoop net	10	8.4	16	15	15	10					2
Set lines	10	24.9	60	52	55	26					

Table 1 (extended).

Gear	Number of bends	Mean effort/bend	Macrohabitat			Total deployments
			BRAD	DEND	DRNG	
Fall through Spring - Sturgeon Season						
Gillnet	10	20	6			200
Trammel net	14	7.6	15			106
Beam Trawl	10	8.1	15			81
Hoop net	10	8	16			80
Set lines	12	26.2	25			314
Summer – Fish Community Season						
Bag seine	11	19.2				211
Mini-fyke	10	10.5				105
Trammel net	10	8.8	26			88
Beam Trawl	10	8	24			80
Hoop net	10	8.4	26			84
Set lines	10	24.9	56			249

Table 2. Number of bends sampled, mean effort per bend (as deployments of each gear type), and total gear deployments by mesohabitat for segment 5 and 6 in the Missouri River during fall through spring (sturgeon season) and summer (fish community season) in 2004. Mesohabitat definitions and abbreviations are presented in Appendix B.

Gear	Number of bends	Mean effort/bend	Mesohabitat					Total deployments
			BAR	POOL	CHNB	TLWG	ITIP	
Fall through Spring - Sturgeon Season								
Gillnet	10	20		37	155		8	200
Trammel net	14	7.6		6	98			104
Beam Trawl	10	8.1		2	79			81
Hoop net	10	8		10	70			80
Set lines	12	26.2		39	275			314
Summer – Fish Community Season								
Bag seine	11	19.2	211					211
Mini-fyke	10	10.5	105					105
Trammel net	10	8.8		1	87			88
Beam Trawl	10	8			80			80
Hoop net	10	8.4		8	76			84
Set Lines	10	24.9		14	235			249

RESULTS

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 use 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 28 pallid sturgeons were captured during the 2004 season with 25 fish caught in standard gears: gillnets (n = 12) and trammel nets (n = 13). Catch per unit effort was greatest for gill nets (0.066 fish/net night) followed by trammel nets (Figures 3 and 4). The mean CPUE of pallid sturgeon with gillnets was essentially the same in 2003 and 2004; whereas, mean CPUE for trammel nets in 2004 was double that seen in 2003 during the sturgeon season (fall through spring). Trammel net mean CPUE during the fish community season (summer) was similar in both years. As expected, the variability in mean CPUE for all gears was high to due the high incidence of zero catches, 95% for gillnets and 97% for trammel nets. The majority of pallid sturgeons were captured during the sturgeon season (n = 21); only 7 fish were captured during the fish community season. No pallid sturgeons were captured with beam trawls during either the sturgeon or fish community seasons. Mini-fyke nets and seines also caught no pallid sturgeon during the fish community season.

Pallid sturgeons were captured throughout segments 5 and 6 demonstrating no affinity towards a specific bend (Figure 5). Macrohabitats where pallid sturgeons were captured included outside bends, inside bends, channel crossovers, and large secondary connected channels (Figure 6). During the fish community season, pallid sturgeon were also captured in the braided macrohabitat. However, 2004 season was the first time the braided, deranged, and dendritic

macrohabitat categories were used. Channel borders were the mesohabitat where most pallid sturgeon were captured (Figure 7).

All pallid sturgeon captured were considered to be of hatchery origin. Recaptured pallid sturgeon either had detectable marks or were similar in size to stocked fish (Tables 3 and 4). Pit tag retention was 86%. Eight recaptured fish, most from the 1999 year class, lost weight while at liberty, while all fish added length (Table 5). The mean relative condition factor ranged from 0.66 to 0.91 for all year classes and declined since stocking.

Fork lengths (FL) of pallid sturgeon ranged from 310 – 750 mm in segments 5 and 6 during 2004 (Figure 8). There was no evidence of recruitment by wild pallid sturgeon. Most pallid sturgeon were of stock-quality length with only one fish smaller than stock size (Table 6). Incremental RSD for pallid sturgeon during the sturgeon season was generally similar to the fish community season. No hybrid *Scaphirhynchus* (pallid x shovelnose sturgeon) were captured and the ratio of pallid to shovelnose sturgeon was 1:3.25 (Table 7).

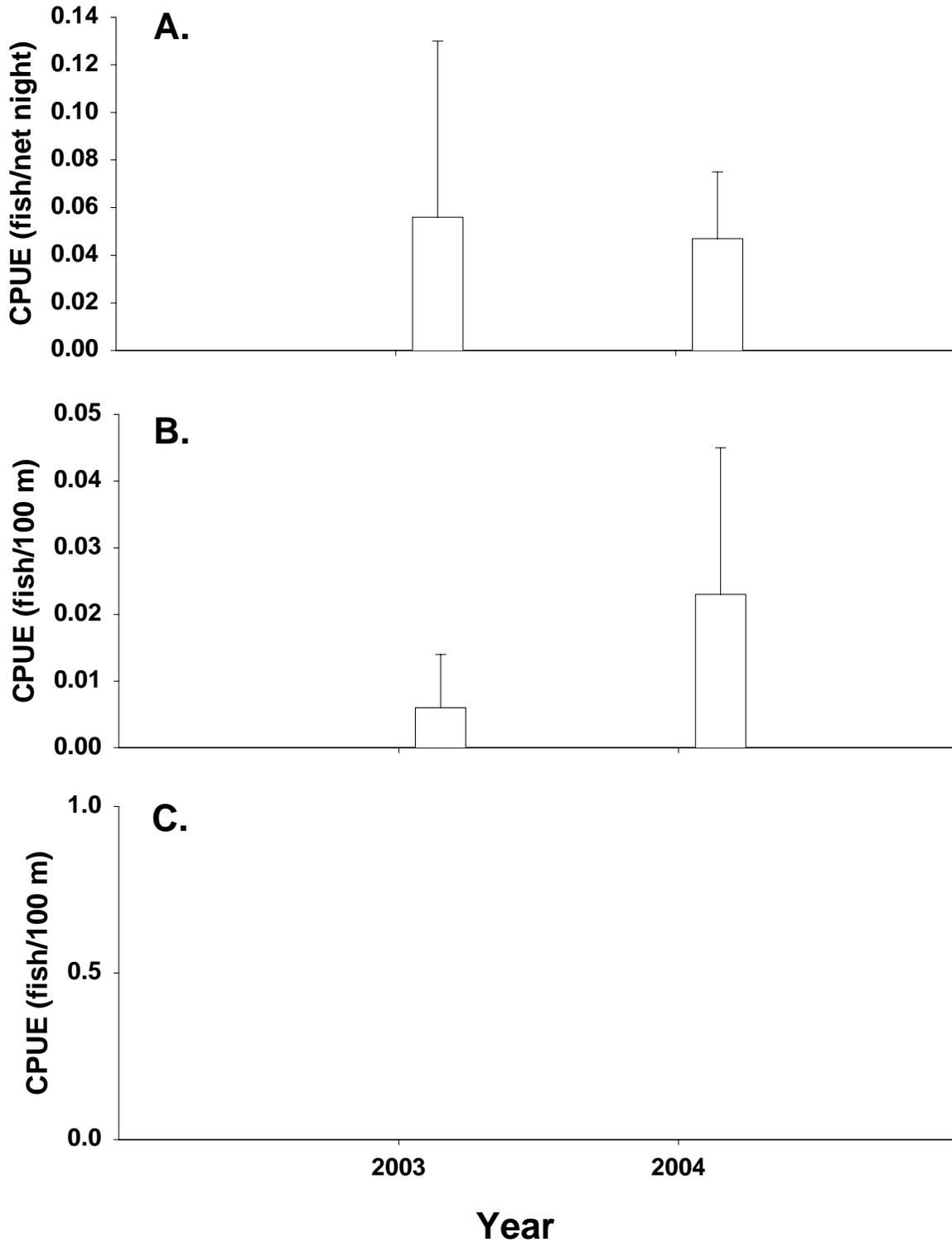


Figure 3. Mean annual catch-per-unit-effort (± 2 SE) of wild (black bars) and stocked (white bars) pallid sturgeon in segments 5 and 6 of the Missouri River for: A) gill nets, B) trammel nets, and C) beam trawls from fall through spring (Sturgeon season) during 2003 - 2004.

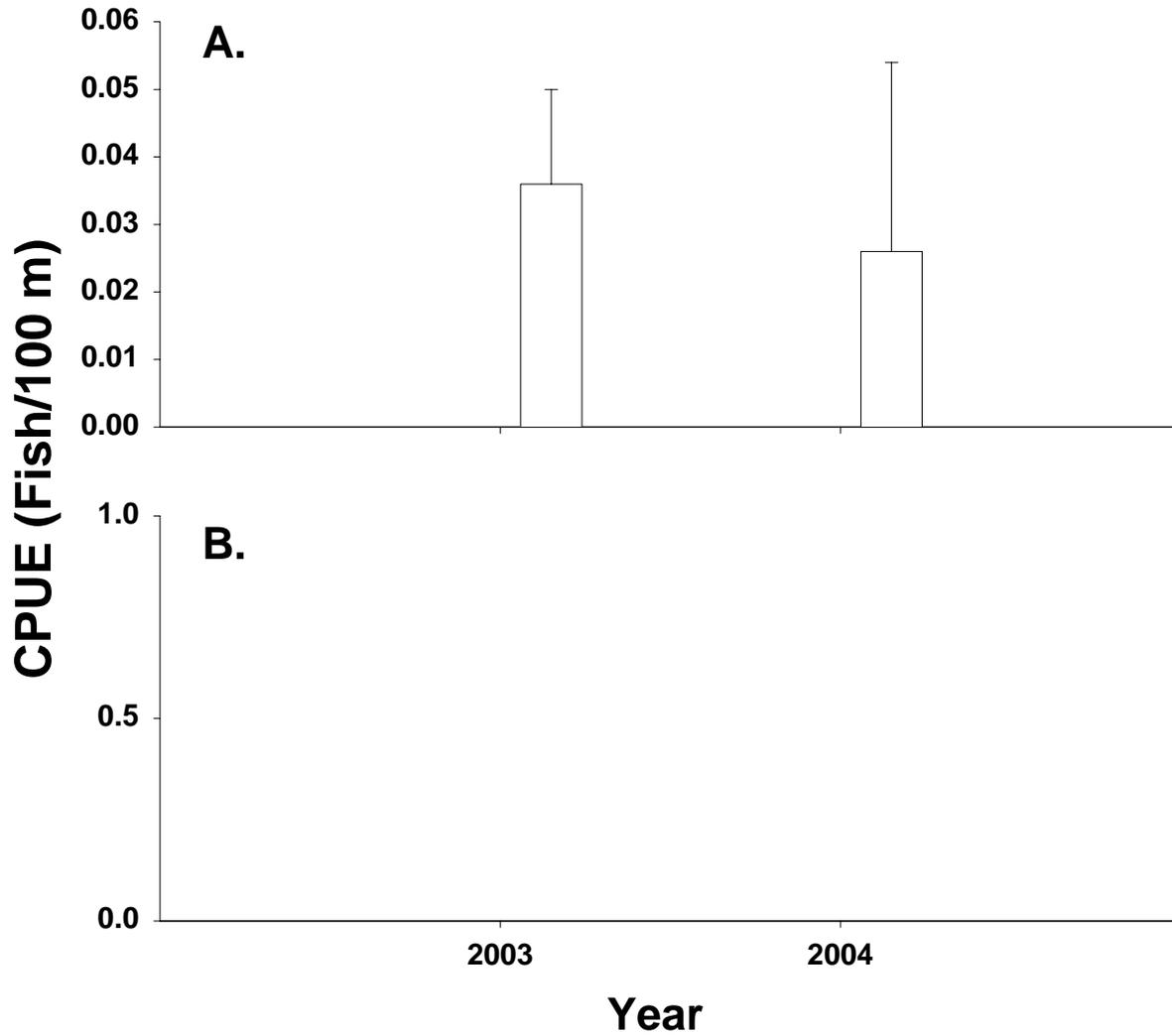


Figure 4. Mean annual catch-per-unit-effort (± 2 SE) of wild (black bars) and stocked (white bars) pallid sturgeon in segments 5 and 6 of the Missouri River for: A) trammel nets and B) beam trawls in summer (Fish Community Season) during 2003 -2004.

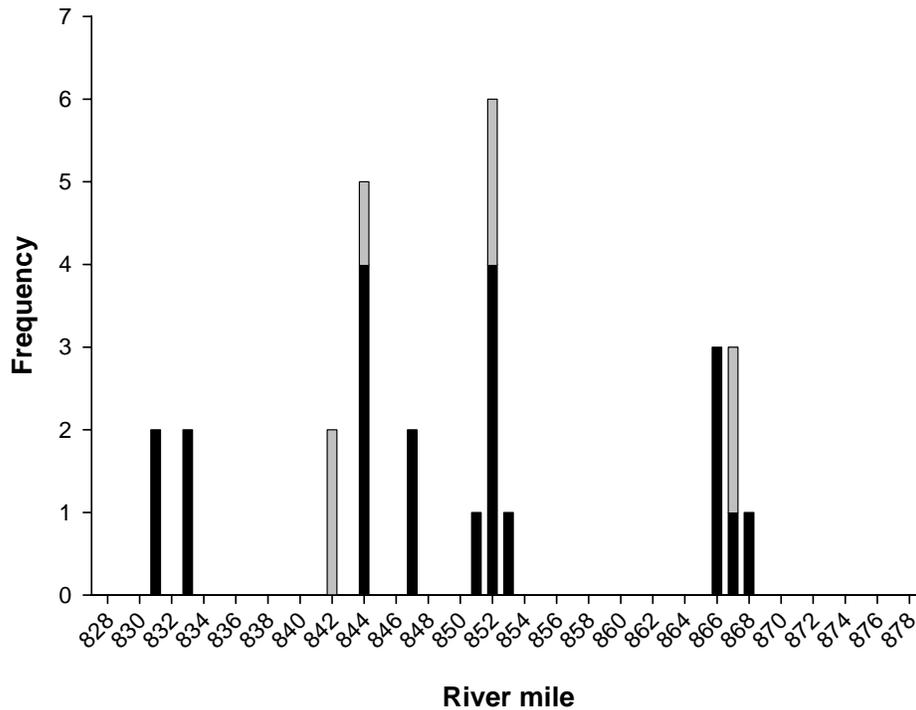
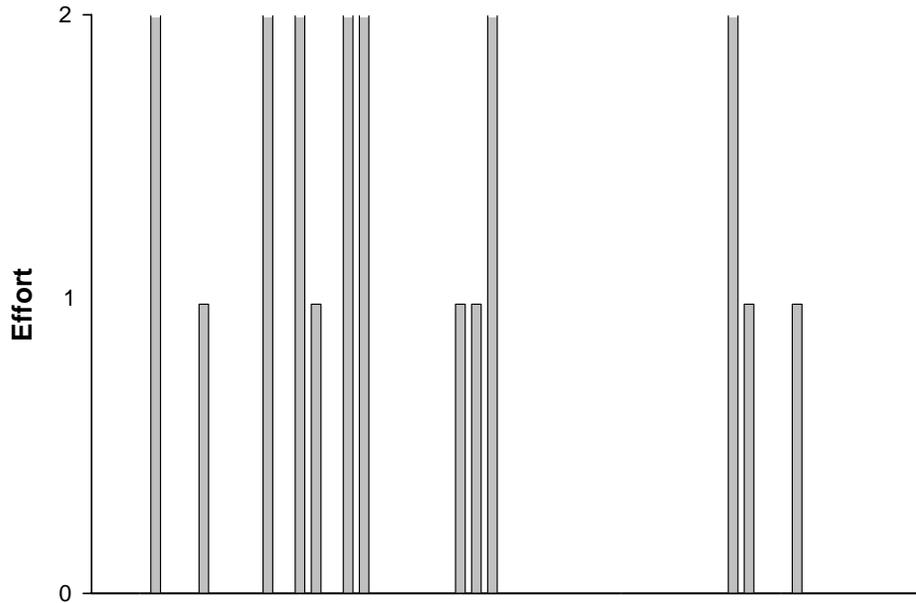
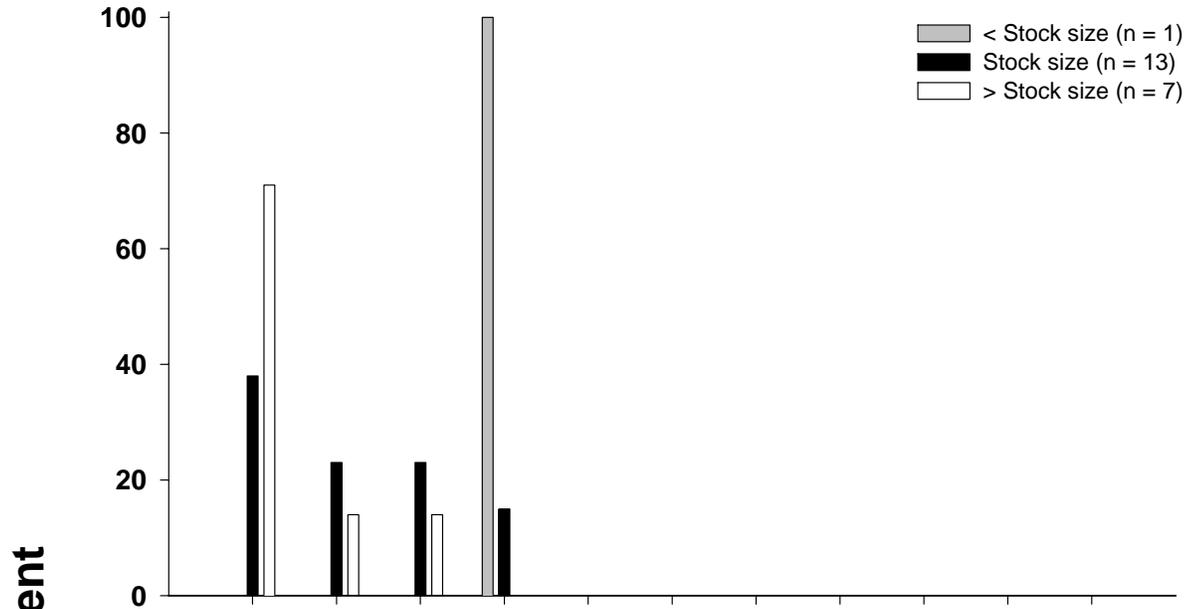


Figure 5. Distribution of: A) sampling effort and B) pallid sturgeon catch by river mile for segments 5 and 6 of the Missouri River during 2003 - 2004. Sampling effort of 2 indicates river miles sampled in both the fall to spring (Sturgeon season) and summer (Fish Community Season), Sampling effort of 1 indicates that river mile was only sampled in one season.

Fall to Spring (Sturgeon Season)



Summer (Fish Community Season)

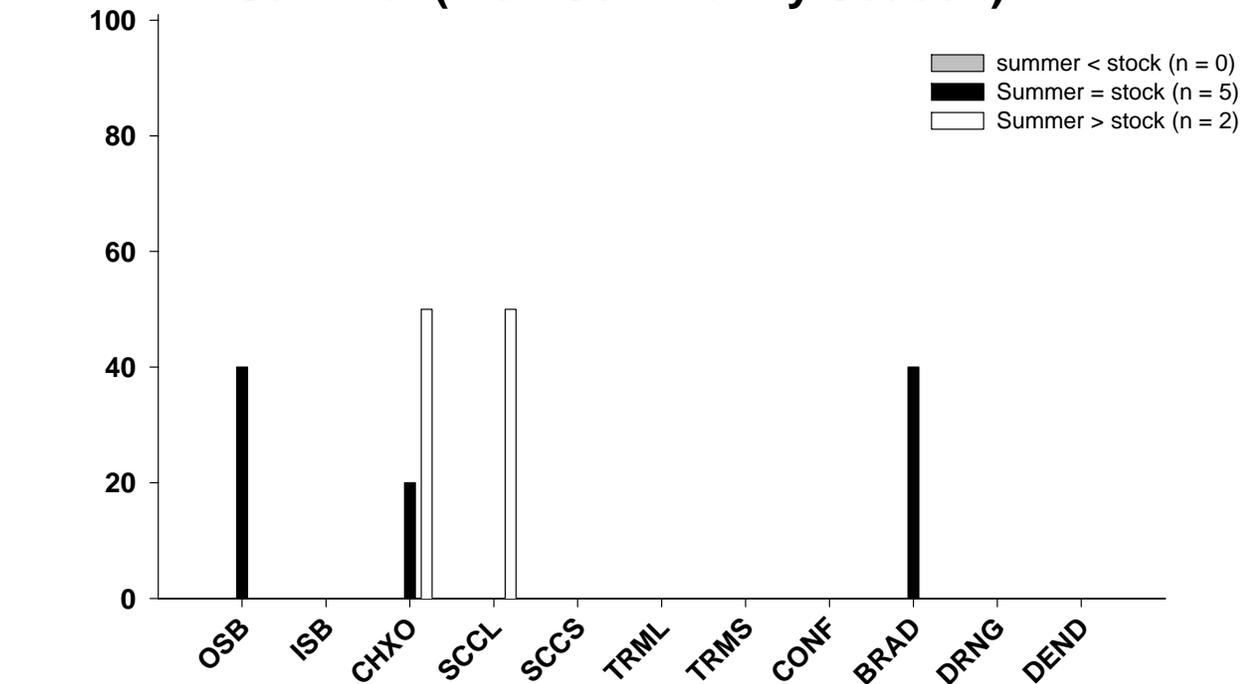
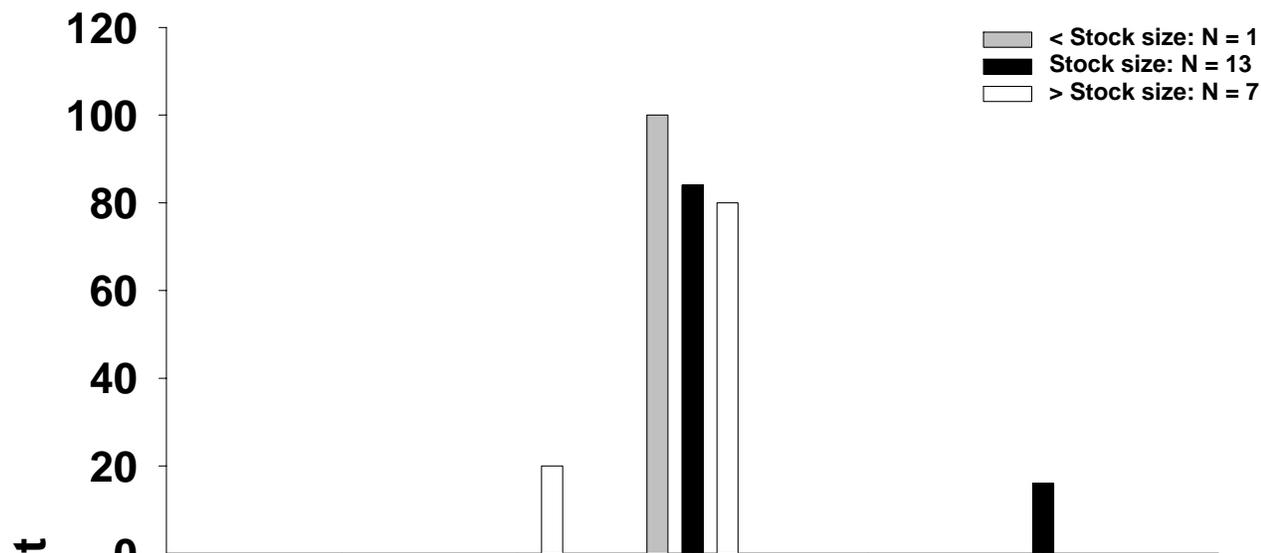


Figure 6. Percent of total pallid sturgeon for three size classes caught by macrohabitat type in segments 5 and 6 of the Missouri River during 2004 for two seasons: Fall through Spring and Summer. Size classes defined in the text and habitat abbreviations presented in Appendix B.

Fall to Spring (Sturgeon Season)



Summer (Fish Community Season)

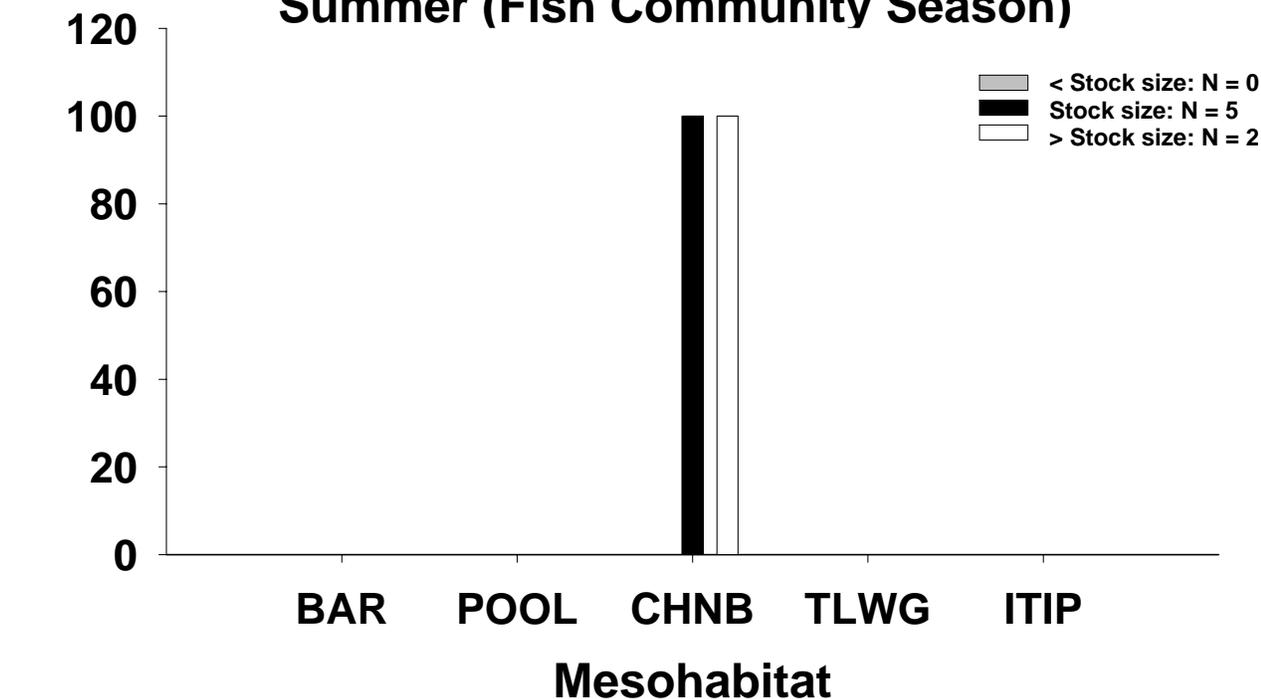


Figure 7. Percent of total pallid sturgeon for three size classes caught by mesohabitat type in segments 5 and 6 of the Missouri River during 2004 for two seasons: Fall through Spring and Summer. Size classes defined in the text and habitat abbreviations presented in Appendix B.

Table 3. Pallid sturgeon (PDSG) and hybrid sturgeon (SNPD) capture locations and habitat characteristics for segments 5 and 6 of the Missouri River during 2004. ID number links habitat information with individual fish length, weight, and tagging data in Table 4. Gear codes presented in Appendix C. Habitat definitions and codes presented in Appendices B.

Species	Date	Gear	Latitude (°)	Longitude (°)	River mile	Habitat			Water Temp (°C)	Turb ^a (NTU)	Depth ^b (m)	Bottom velocity (m/s)	Substrate ^c (silt/sand/ gravel)	ID#
						Macro-	Meso-	Micro-						
PDSG	10/23/2003	GN14	42.83709	-98.1705	853	OSB	CHNB	STPS	14	6	4.1	0.44	0/100/0	1
PDSG	10/26/2003	GN41	42.84314	-97.8435	831	OSB	CHNB	STPS	11	19	6.3	0.45	10/90/0	2
PDSG	11/18/2003	GN14	42.92811	-98.4334	868	ISB	CHNB	.	8	5	4.2	0.68	0/100/0	3
PDSG	11/18/2003	GN41	42.92754	-98.4184	866	OSB	CHNB	.	8	6	4.9	0.43	0/100/0	4
PDSG	11/18/2003	GN41	42.92754	-98.4184	866	OSB	CHNB	.	8	6	4.9	0.43	0/100/0	5
PDSG	11/18/2003	GN41	42.92754	-98.4184	866	OSB	CHNB	.	8	6	4.9	0.43	0/100/0	6
PDSG	11/19/2003	GN41	42.77507	-98.0481	844	CHXO	CHNB	.	8	.	4.8	.	.	7
PDSG	11/19/2003	GN41	42.77695	-98.05	844	ISB	ITIP	.	8	9	3.8	0.37	0/100/0	8
PDSG	11/19/2003	GN41	42.77695	-98.05	844	ISB	ITIP	.	8	9	3.8	0.37	0/100/0	9
PDSG	4/14/2004	GN41	42.84396	-97.8424	831	ISB	CHNB	.	9	14	2.4	0.45	90/10/0	10
PDSG	4/15/2004	GN41	42.83599	-98.1639	852	OSB	CHNB	.	6	2	2.6	0.3	30/60/10	11
PDSG	4/19/2004	SL	42.92591	-98.4249	867	OSB	CHNB	.	7	3	3.9	0.36	0/100/0	12
PDSG	4/22/2004	GN41	42.83449	-98.1391	851	CHXO	CHNB	.	8	2	3.5	0.1	0/100/0	13
PDSG	4/22/2004	TN	42.83788	-98.1645	852	SCCL	CHNB	.	7	3	2.5	0.37	0/100/0	14
PDSG	4/22/2004	TN	42.83788	-98.1645	852	SCCL	CHNB	.	8	3	2.5	0.37	0/100/0	15
PDSG	4/22/2004	TN	42.83788	-98.1645	852	SCCL	CHNB	.	8	3	2.5	0.37	0/100/0	16
PDSG	4/22/2004	TN	42.78352	-98.0663	846	CHXO	CHNB	.	8	3	6.4	0.27	0/100/0	17
PDSG	5/13/2004	TN	42.79987	-98.0863	847	OSB	POOL	.	13	6	9	0.55	0/90/10	18
PDSG	5/18/2004	SL	42.80446	-98.0964	847.5	CHXO	CHNB	.	15	3	3.5	0.44	10/90/0	19
PDSG	5/19/2004	TN	42.8437	-97.863	833	OSB	CHNB	.	16	12	3.2	0.78	0/95/5	20
PDSG	5/19/2004	TN	42.8437	-97.863	833	OSB	CHNB	.	16	12	3.2	0.78	0/95/5	21
PDSG	7/13/2004	TN	42.83067	-98.156	851.7	CHXO	CHNB	.	20	3	7.4	0.33	0/95/5	22
PDSG	7/13/2004	TN	42.83067	-98.156	851.7	CHXO	CHNB	.	20	3	7.4	0.33	0/95/5	23
PDSG	7/14/2004	SL	42.79046	-98.0533	844	SCCL	CHNB	.	21	9	2.6	0.46	0/100/0	24
PDSG	7/23/2004	TN	42.76494	-97.9999	841.8	BRAD	CHNB	.	21	12	1.9	0.51	0/100/0	25
PDSG	7/23/2004	TN	42.76494	-97.9999	841.8	BRAD	CHNB	.	21	12	1.9	0.51	0/100/0	26
PDSG	10/6/2004	TN	42.92361	-98.4192	867	OSB	CHNB	.	17	4	1.7	0.62	0/100/0	27
PDSG	10/7/2004	TN	42.92361	-98.4192	867	OSB	CHNB	.	17	4	1.7	0.62	0/100/0	28

^aTurb = turbidity.

^bDepths presented are the average of the starting, middle, and ending depths measured during gear deployment.

^cSubstrates are percents determined visually and by feel in the field.

Table 4. Pallid and hybrid sturgeon captured in segments 5 and 6 of the Missouri River during 2004. Recapture data includes: lengths (fork length [FL]), weights (wt), morphometric character index (CI) (Sheehan et al. 1999), status (H = hatchery, W = wild), tags found, elastomer tags (color, position, and orientation), and if tags were inserted in the field. Stocking history (if applicable) for each fish includes: year class, stocking length, weight, site, and hatchery source. The fish ID number links individual fish data with location and habitat data in Table 3.

ID #	FL (mm)	Wt (g)	CI	Status	Recapture data				Stocking data				
					Tags found ^a	Tag Number(s) ^{b,d}	Elastomer ^c	Marked in field? ^d	Year class	FL (mm)	Wt (g)	Site	Source
1	670	900		H	P,D	406E5F130F	Green	NO	1997	545	715	VER	GAV
2	680	1074		H	P,D	411A694D40	Blue	NO	1997	545	605	VER	GAV
3	581	612		H	P	424E680D67		NO	1999	519	697	SUN	GAV
4	555	522		H	P	423C127A3F		NO	1999	523	625	SUN	GAV
5	533	422		H	P	424F181402		NO	1999	463	523	SUN	GAV
6	593	584		H	P	4250041B1D		NO	1999	515	671	SUN	GAV
7	665	1000		H	.	.	.	NO	.	.	.	.	.
8	560	620		H	.	.	.	NO	.	.	.	.	.
9	578	607		H	.	.	.	NO	.	.	.	.	.
10	760	1253		H	.	.	.	NO	.	.	.	.	.
11	546	420		H	P,D	411B5A5E45		NO	1998	487	491	VER	GAV
12	538	458		H	P	424D2B1821		NO	1999	488	472	SUN	GAV
13	627	712		H	P	411B0F732C		NO	1997	530	635	VER	GAV
14	385	142		H	P	4323482363		NO	2001	220	.	VER	GAR
15	439	268		H	P	424B35301F		NO	1999	356	123	SUN	GAV
16	324	104.8		H	P	4442674279		NO	2002	210	33	SBB	GAV
17	617	435		H	P,D	411B724227		NO	1997	566	709	VER	GAV
18	664	881		H	P	411B4C467A		NO	1997	567	900	VER	GAV
19	571	532		H	P	435E347D73		YES					
20	648	908		H	P	41102D3C77	Orange	NO	1997	551	564	VER	GAV
21	706	1152		H	P	411B6C795B	Green	NO	1997	600	1000	VER	GAV
22	362	145		H	P	431C3B023A		NO	2001	210	.	VER	GAR
23	635	794		H	P	406E612022	Orange	NO	1997	528	512	VER	GAV
24	686	1010		H	P	424F0B6C5F		NO	1998	586	909	VER	GAV
25	494	391		H	P	435F15582E		YES					
26	458	326		H	P	431C7A291D		NO	2001	210	.	VER	GAR
27	368	160		H	P	42573D4C60		NO	2002	246	61	SBB	GAV

Table 4. (continued).

ID #	Recapture data								Stocking data				
	FL (mm)	Wt (g)	CI	Status	Tags found ^a	Tag Number(s) ^{b,d}	Elastomer ^c	Marked in field? ^d	Year class	FL (mm)	Wt (g)	Site	Source
28	359	134		H	P	4255792565		NO	2002	247	61	SUN	GAV

^aTag types include: coded wire tag (C), dangler tag (D), elastomer (E), floy (F), jaw tag (J), passive integrated transponder tag, i.e., PIT tag (P), and self piercing tag (S).

^bTag type in parentheses after number.

^cPositions and orientations listed after each color can include: fish's right (R), fish's left (L), center of rostrum (C), vertical (V), and horizontal (H).

^dIf fish marked in the field, tag number corresponds to new tag and the type is in parentheses next to the tag number.

^eStocking site codes found in Appendix yy.

^fHatchery sources: BOZ = Bozeman Fish Technology Center in MT, BPY = Blind Pony State Hatchery in MO, GAR = Garrison Dam National Fish Hatchery (NFH) in ND, GAV = Gavins Point Dam NFH in SD, MCY = Miles City State Fish Hatchery in MT, NAT = Natchitoches NFH in LA, NEO = Neosho NFH in MO and PEC = Fort Peck Dam State Fish Hatchery in MT.

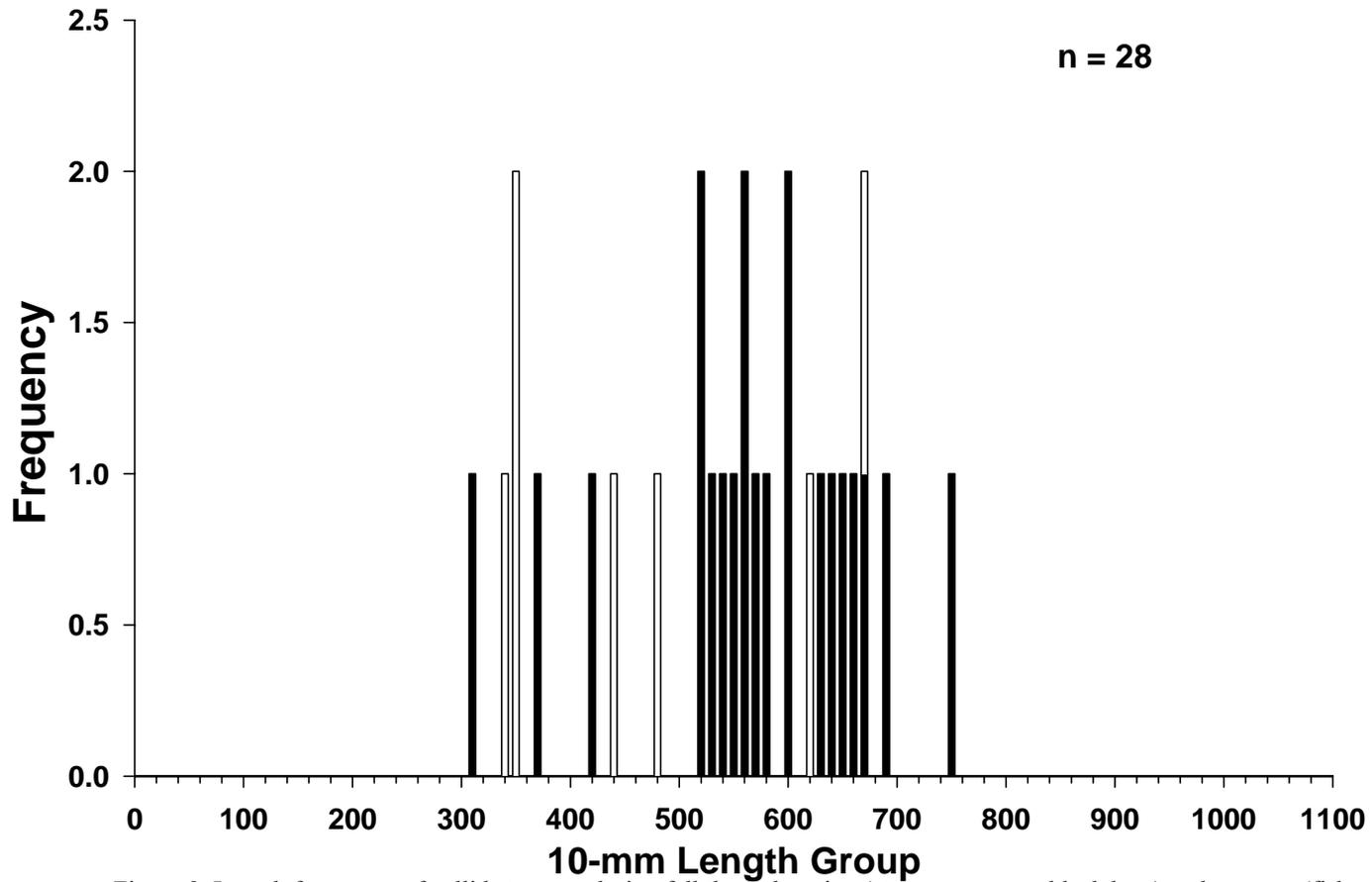


Figure 8. Length frequency of pallid sturgeon during fall through spring (sturgeon season, black bars) and summer (fish community season, white bars) in segments 5 and 6 of the Missouri River during 2004.

Table 5. Mean fork length (\pm 2 SE), weight (\pm 2 SE), mean relative condition factor (Kn) (\pm 2 SE) and growth rates of juvenile hatchery-reared pallid sturgeon by year class at the time of stocking and recapture in 2004 for segments 5 and 6 of the Missouri River. Relative condition factor was calculated using the equation in Keenlyne and Evanson (1993).

Year class	Stocking			Recapture					
	N	Length (mm)	Weight (g)	Kn	Length (mm)	Weight (g)	Kn	Growth (mm/d)	Growth (g/d)
1997	8	554 (17)	705 (119)	1.03 (0.09)	656 (21)	857 (156)	0.7 (1.41)	0.082 (0.020)	0.120 (0.120)
1998	2	537 (99)	700 (418)	1.11 (0.01)	616 (140)	715 (590)	0.69 (0.08)	0.057 (0.029)	0.010 (0.122)
1999	6	477 (52)	519 (173)	1.16 (0.17)	540 (45)	478 (102)	0.76 (0.05)	0.101 (0.026)	-0.079 (0.122)
2001	3	213 (7)	.	.	402 (58)	204 (122)	0.84 (0.13)	0.235 (0.116)	.
2002	3	234 (24)	52 (19)	1.33 (0.07)	350 (27)	133 (32)	0.91 (0.06)	0.309 (0.114)	0.213 (0.068)

Table 6. Incremental relative stock density (RSD)^a by length category for wild and stocked pallid sturgeon in segments 5 and 6 of the Missouri River captured during 2004. Length categories^b determined by Shuman et al. (in review) using the methods proposed by Gablehouse (1984).

Length Category	Wild		Stocked	
	N	RSD	N	RSD
Fall through Spring (Sturgeon Season)				
Sub stock ^c	0		1	
Stock -quality	0	0	13	64
Quality - preferred	0	0	8	36
Preferred - memorable	0	0	0	0
Memorable -trophy	0	0	0	0
Trophy	0	0	0	0
Summer (Fish Community Season)				
Sub stock ^c	0		0	
Stock -quality	0	0	5	71
Quality - preferred	0	0	2	29
Preferred - memorable	0	0	0	0
Memorable -trophy	0	0	0	0
Trophy	0	0	0	0

^aRSD = number of fish \geq specified length \div number of fish \geq minimum stock length x 100.

^bLength categories based on Shuman et al. (in review): sub-stock FL < 330 mm, Stock FL = 330 – 629 mm, Quality FL = 630 – 839 mm (36 - 45%), Preferred FL = 840 – 1039 mm, Memorable FL = 1040 – 1269 mm, Trophy FL \geq 1270 mm.

^cRSD not calculated for sub stock sized fish.

Table 7. Ratios of pallid sturgeon to shovelnose sturgeon, pallid sturgeon to hybrids (pallid x shovelnose), and stocked pallid sturgeon to wild pallid sturgeon captured in segments 5 and 6 of the Missouri River during 2004.

Pallid:Shovelnose	Pallid:Hybrid	Stocked:Wild
1:3.25	n/c	n/c

n/c = could not calculate ratio due to zero catches of hybrids and wild pallid sturgeon.

Missouri River Fish Community

I. Targeted Native Missouri 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 91 shovelnose sturgeons were sampled in 2004 with 78 captured in standard gears. Most shovelnose sturgeon were captured with gillnets ($n = 43$) and trammel nets ($n = 30$). Only 5 shovelnose sturgeons were captured in the beam trawl. Catch per unit effort of shovelnose sturgeon (Figures 9 and 10) was greatest in gillnets (0.24 fish/net night). The CPUE by trammel net in the sturgeon season (0.06 fish/100 m) was similar to the fish community season CPUE (0.05 fish/100 m). Mean CPUE in gillnets increased three fold in 2004 compared to 2003; whereas, mean CPUE with trammel nets was essentially the same in both years (Figure 9). No shovelnose sturgeon were captured in the beam trawl during 2003. Seventy-three shovelnose sturgeons were captured during the sturgeon season while 18 were captured during the fish community season. No shovelnose sturgeon were captured in the mini-fyke nets or bag seines.

Shovelnose sturgeon were found in all macrohabitats that were sampled. Most fish were captured from outside bend (34%), inside bend, (31%), and channel crossover (24%) macrohabitats during the sturgeon season. During the fish community season, 83% of shovelnose sturgeon were captured in braided (44%) and outside bend (39%) macrohabitats (Figure 11). Nearly all shovelnose sturgeon captured were caught in the channel boarder mesohabitat, with the exception of five fish collected from pools (Figure 12).

Fork lengths of shovelnose sturgeon ranged from 528– 725 mm with 70% of the fish between the 590 – 670 mm (Figure 13). No shovelnose sturgeon of quality length and smaller were captured. Incremental RSD for shovelnose sturgeon in both seasons indicated an ageing population with little recruitment. No fish smaller than the preferred size group were caught (Table 8). Shovelnose sturgeon during the sturgeon (n = 64) and fish community seasons (n = 18) exhibited a mean W_r of 97 and 91, respectively. Relative weights of shovelnose sturgeon had similar ranges during the sturgeon (72 – 126) and fish community (75 – 114).

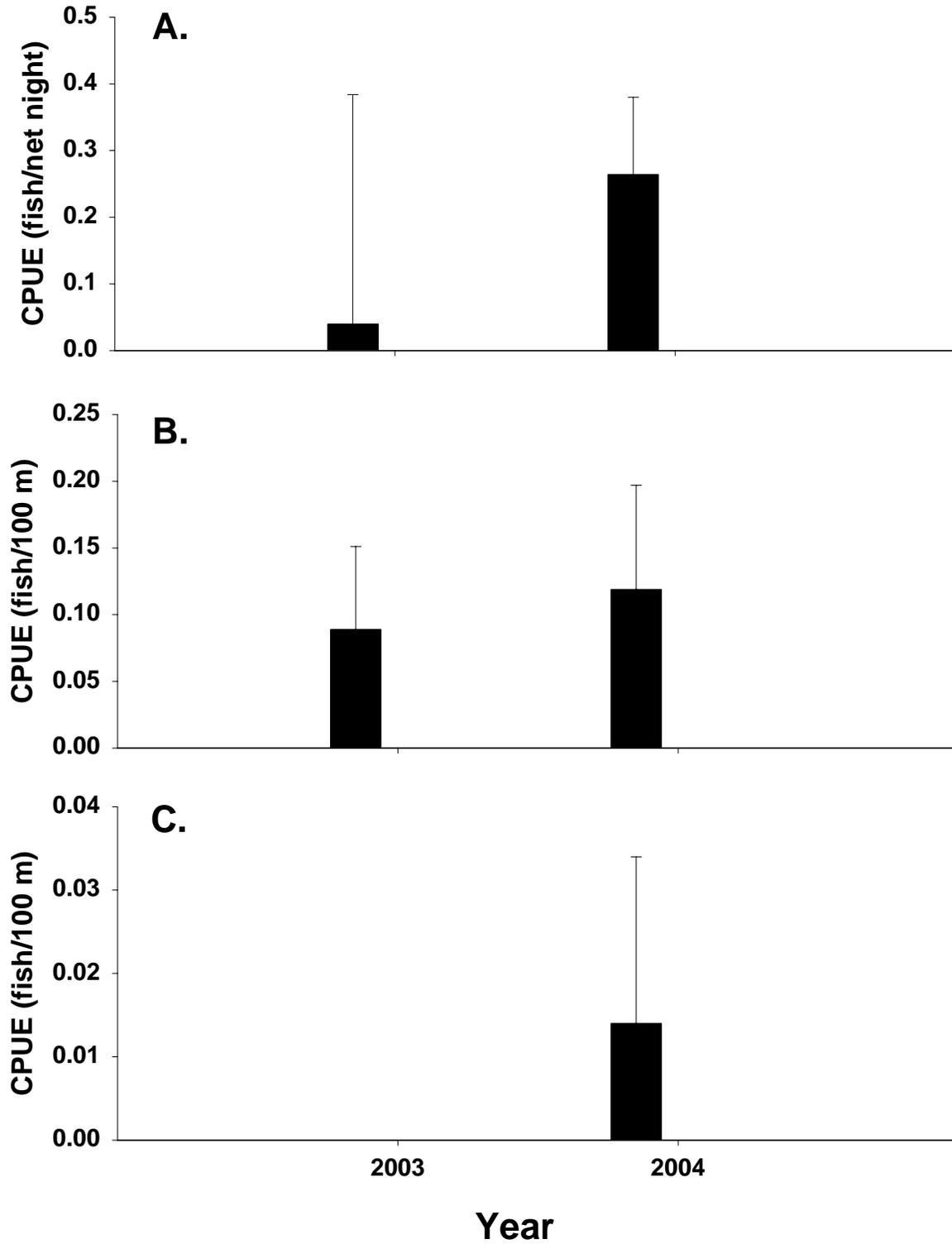


Figure 9. Mean annual catch-per-unit-effort (± 2 SE) of wild (black bars) and stocked (white bars) shovelnose sturgeon in segments 5 and 6 of the Missouri River for: A) gill nets, B) trammel nets, and C) beam trawls from fall through spring (Sturgeon season) during 2003- 2004

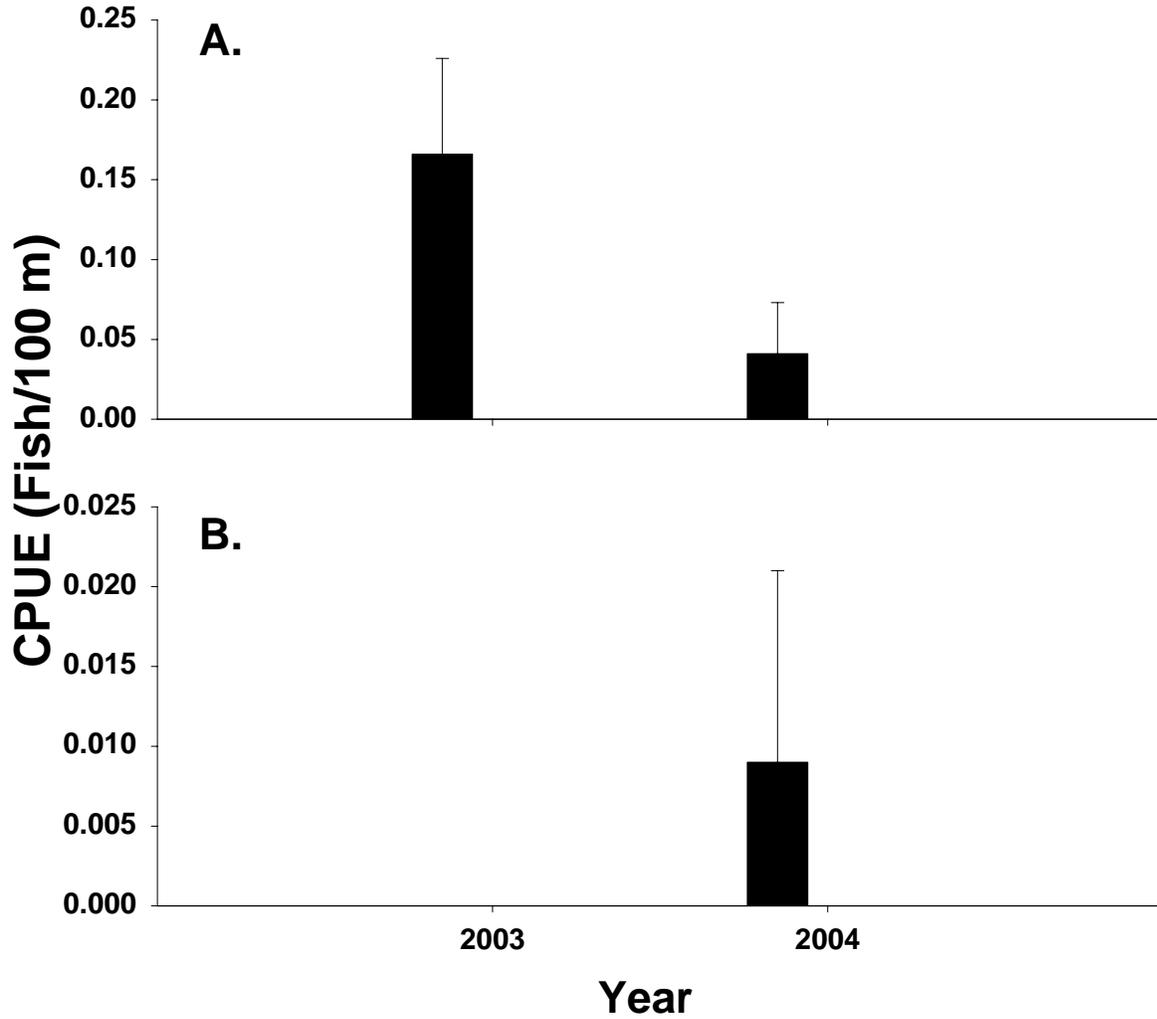
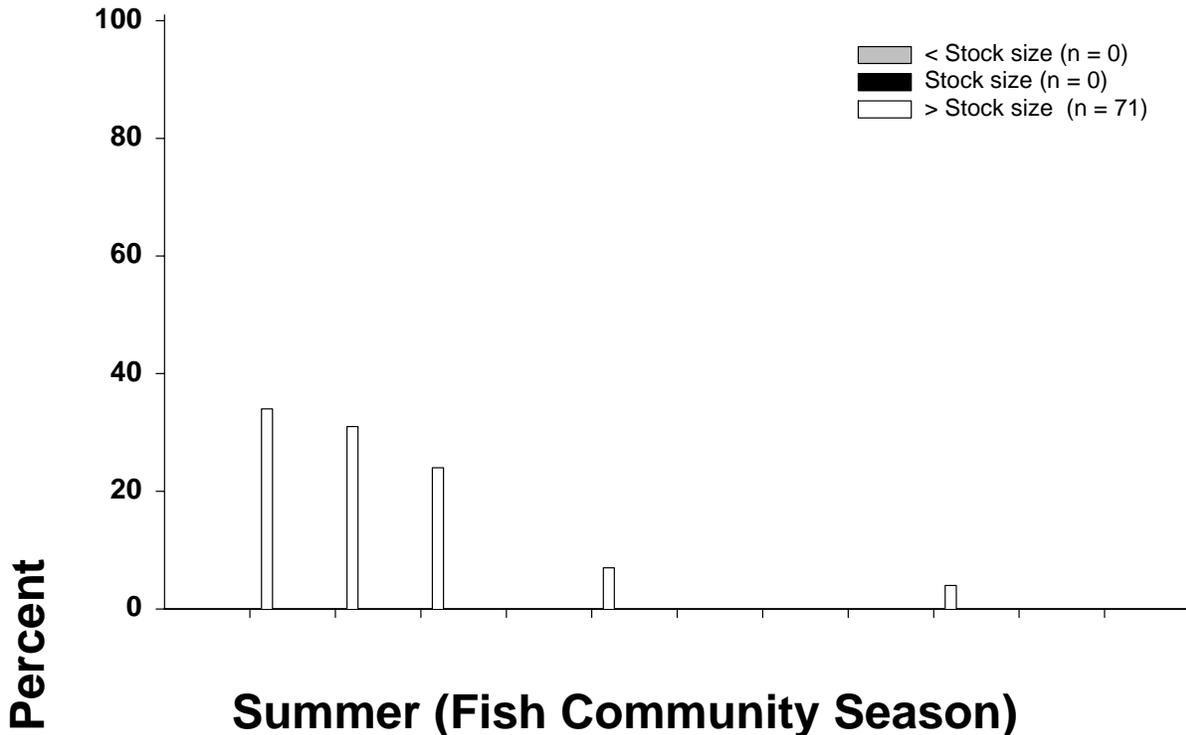


Figure 10. Mean annual catch-per-unit-effort (± 2 SE) of wild (black bars) and stocked (white bars) shovelnose sturgeon in segments 5 and 6 of the Missouri River for: A) trammel nets and B) beam trawls in summer (Fish Community Season) during 2003 - 2004.

Fall to Spring (Sturgeon Season)



Summer (Fish Community Season)

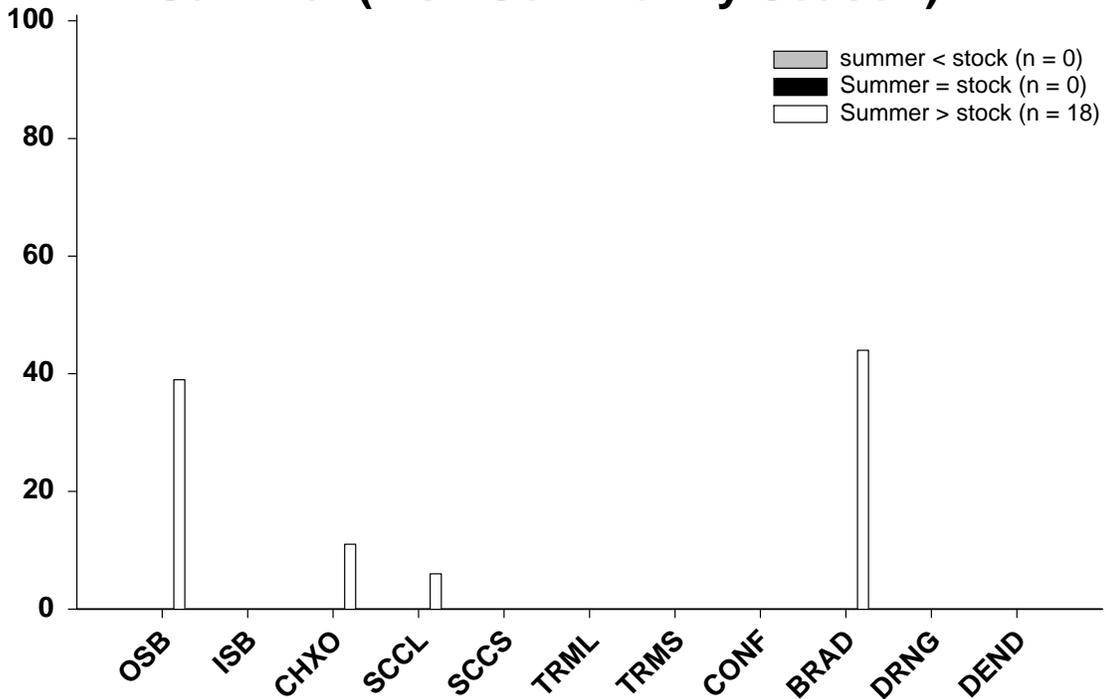
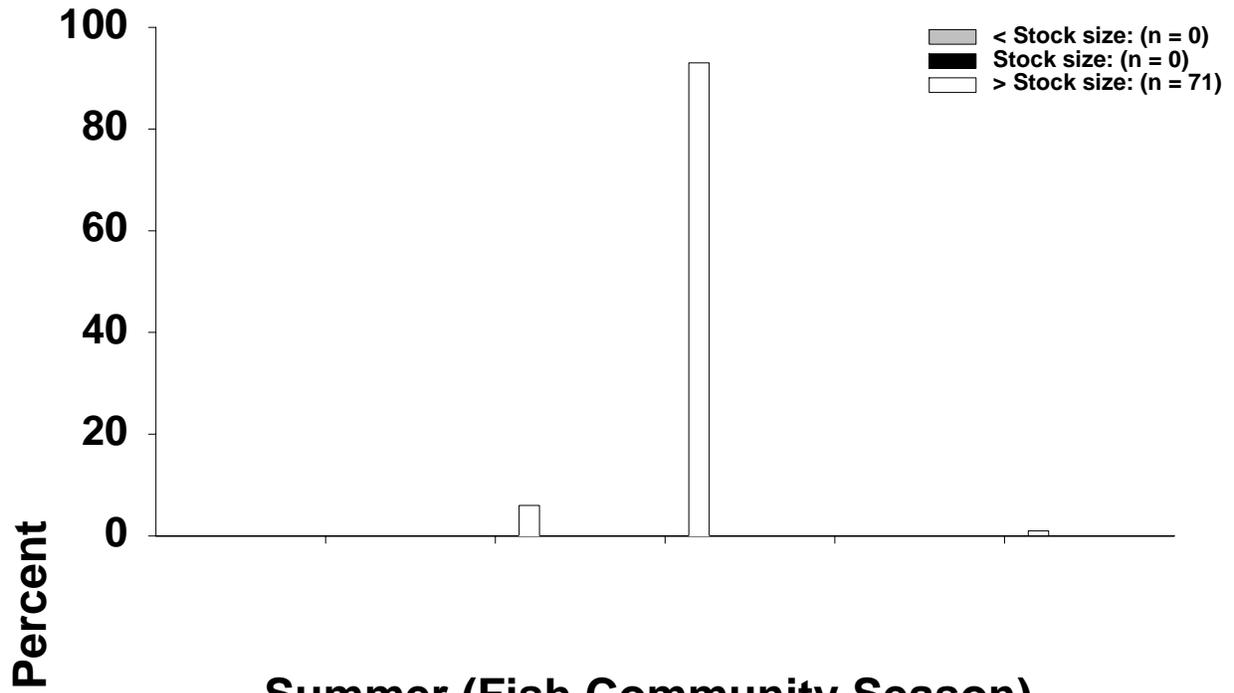


Figure 11. Percent of total shovelnose sturgeon for three size classes caught by macrohabitat type in segments 5 and 6 of the Missouri River during 2004 for two seasons: Fall through Spring and Summer. Size classes defined in the text and habitat abbreviations presented in Appendix B.

Fall to Spring (Sturgeon Season)



Summer (Fish Community Season)

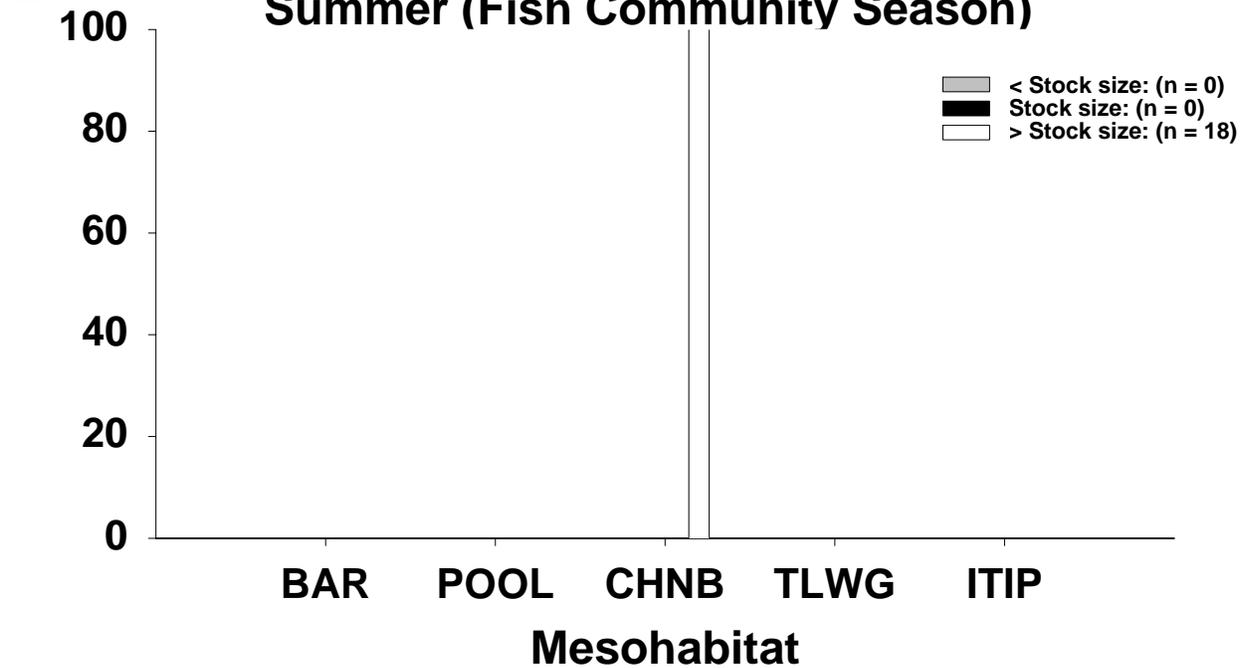


Figure 12. Percent of total shovelnose sturgeon for three size classes caught by mesohabitat type in segments 5 and 6 of the Missouri River during 2004 for two seasons: Fall through Spring and Summer. Size classes defined in the text and habitat abbreviations presented in Appendix B.

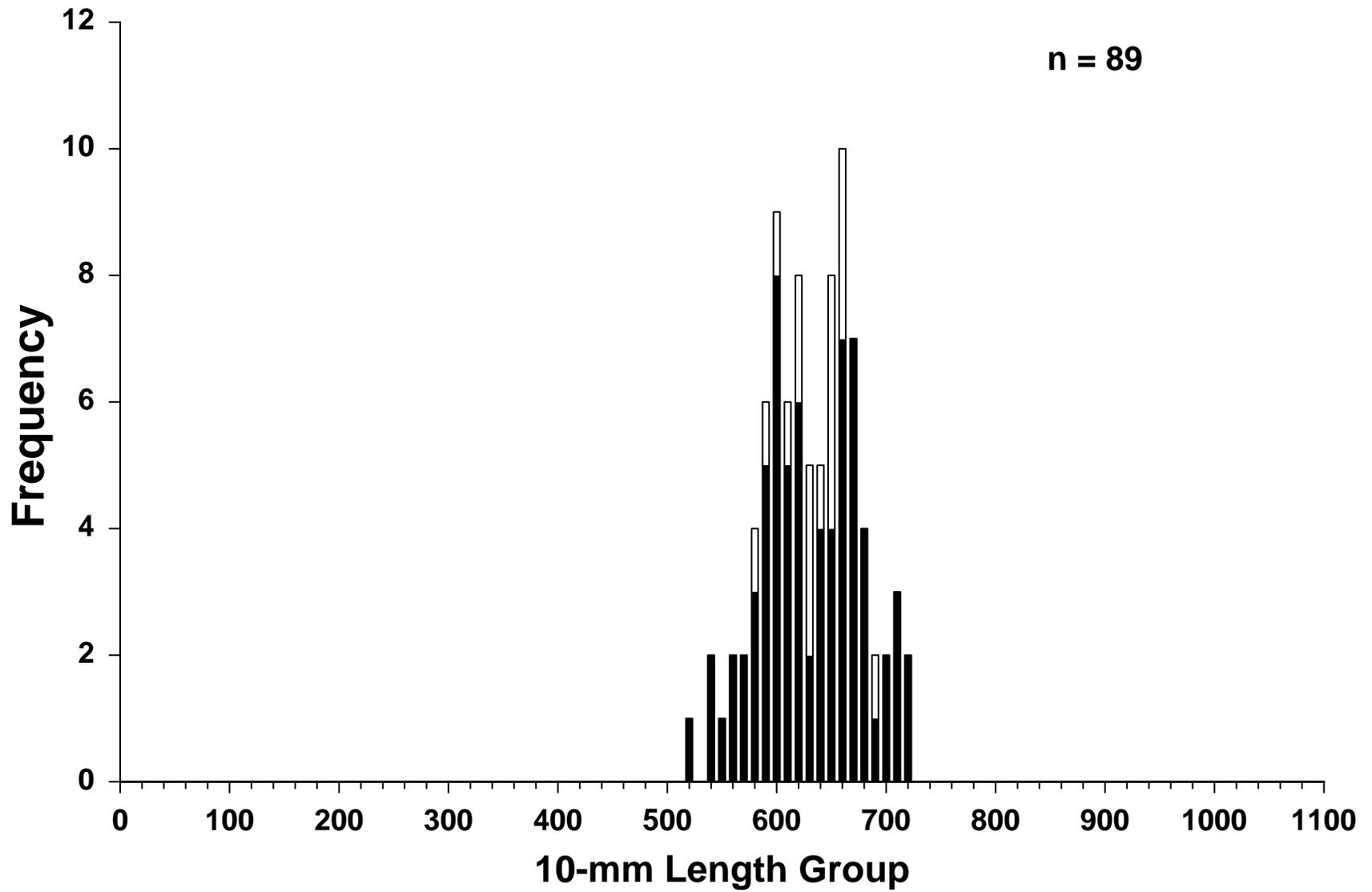


Figure 13. Length frequency of shovelnose sturgeon during fall through spring (sturgeon season, black bars) and summer (fish community season, white bars) in segments 5 and 6 of the Missouri River during 2004.

Table 8. Incremental relative stock density (RSD)^a by length category of shovelnose sturgeon in segments 5 and 6 of the Missouri River captured during 2004. Length categories^b based on the system proposed by Quist et al. (1998).

Length category	N	RSD
Fall through Spring (Sturgeon Season)		
Sub stock	0	
Stock -quality	0	0
Quality - preferred	0	0
Preferred - memorable	37	51
Memorable -trophy	34	47
Trophy	0	0
Summer (Fish Community Season)		
Sub stock	0	
Stock -quality	0	0
Quality - preferred	0	0
Preferred - memorable	9	50
Memorable -trophy	9	50
Trophy	0	0

^aRSD = number of fish \geq specified length \div number of fish \geq minimum stock length \times 100.

^bLength categories based on the percentage of the World Record 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 \geq 810 mm (> 74%).

II. Native cyprinids

Sturgeon chub

No sturgeon chubs were captured during the 2004 sampling season.

Sicklefin chub

No sicklefin chubs were captured during the 2004 sampling season.

Speckled chub

No speckled chubs were captured during the 2004 sampling season.

Hybognathus spp.

No plains or Western silvery minnows (*Hybognathus spp.*) were captured during the 2004 sampling season.

Sand shiner

A total of 206 sand shiners were captured in mini-fyke nets (n = 33) and bag seines (n = 173) during the 2004 sampling season. No sand shiners were captured during the sturgeon season or while beam trawling. Annual catch per unit effort (Figure 14) was greatest for mini-fyke nets (1.65 fish/net night) followed by bag seines (0.25 fish/m²). Over 60% of the fish were captured were from the inside and outside bends with the remainder captured in secondary channel connected channels (Figure 15). The bar mesohabitat was the only habitat were sand

shiners were collected (Figure 16). Over 70% of sand shiners were between the 50 – 69 mm total length (Figure 17).

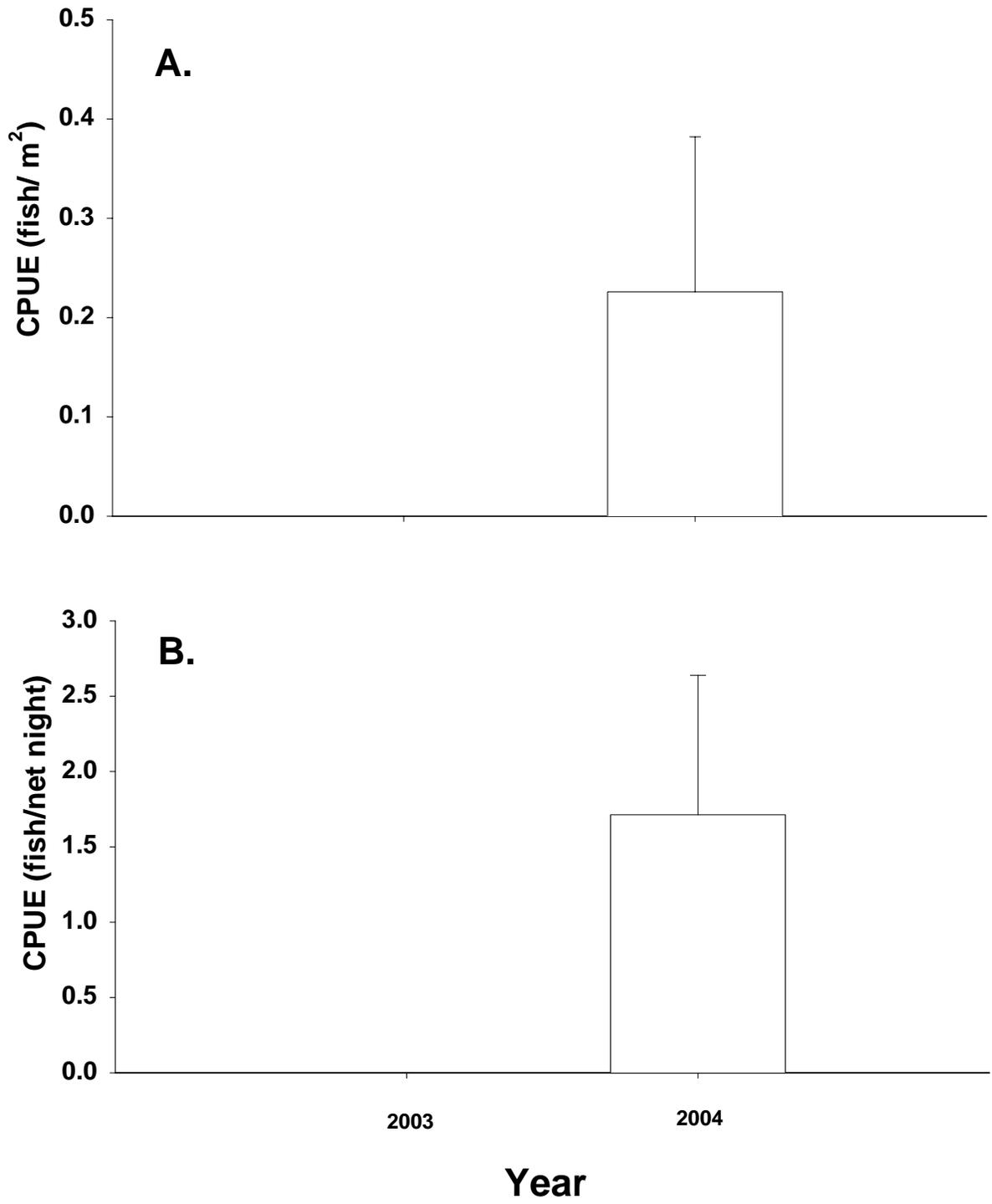
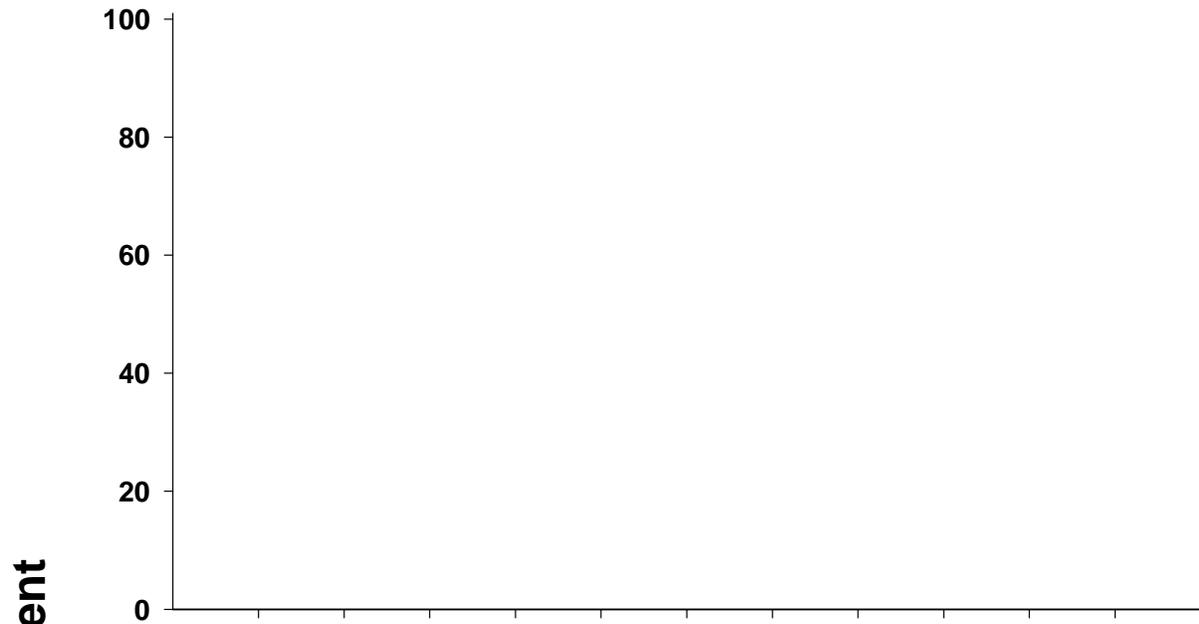


Figure 14. Mean annual catch-per-unit-effort (\pm 2SE) of sand shiners in segments 5 and 6 of the Missouri River for: A) beach seine, and B) mini-fyke from summer (fish community season) during 2004.

Fall to Spring (Sturgeon Season)



Summer (Fish Community Season)

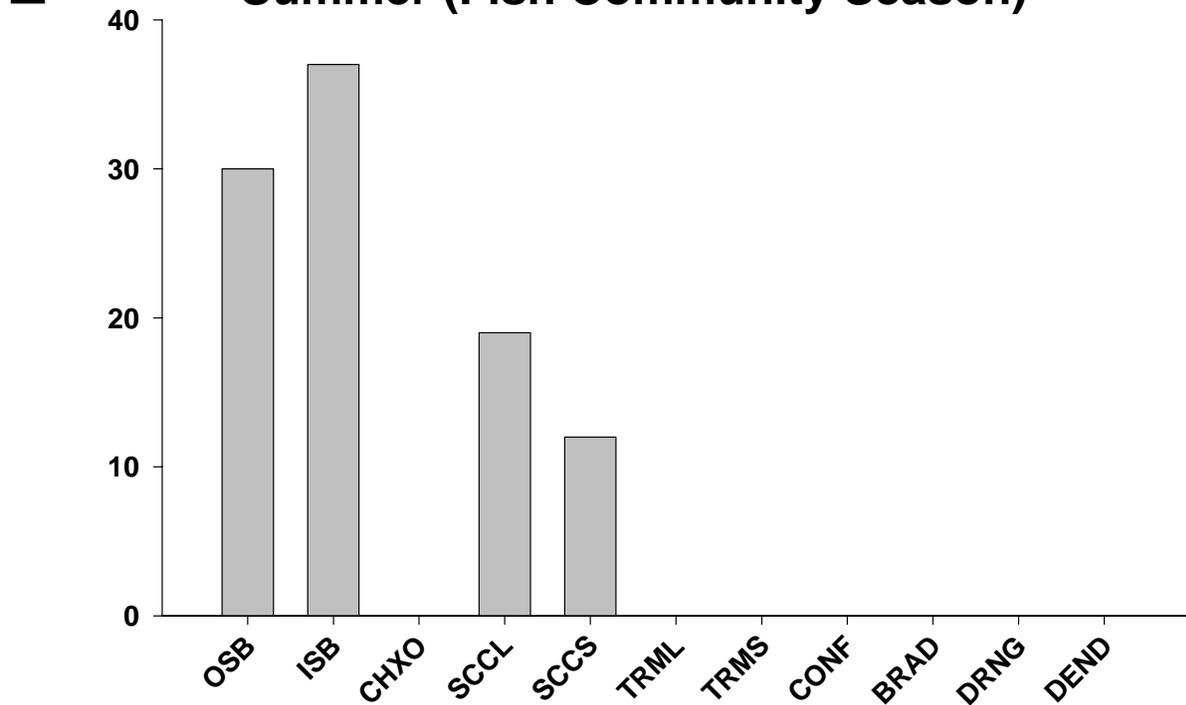
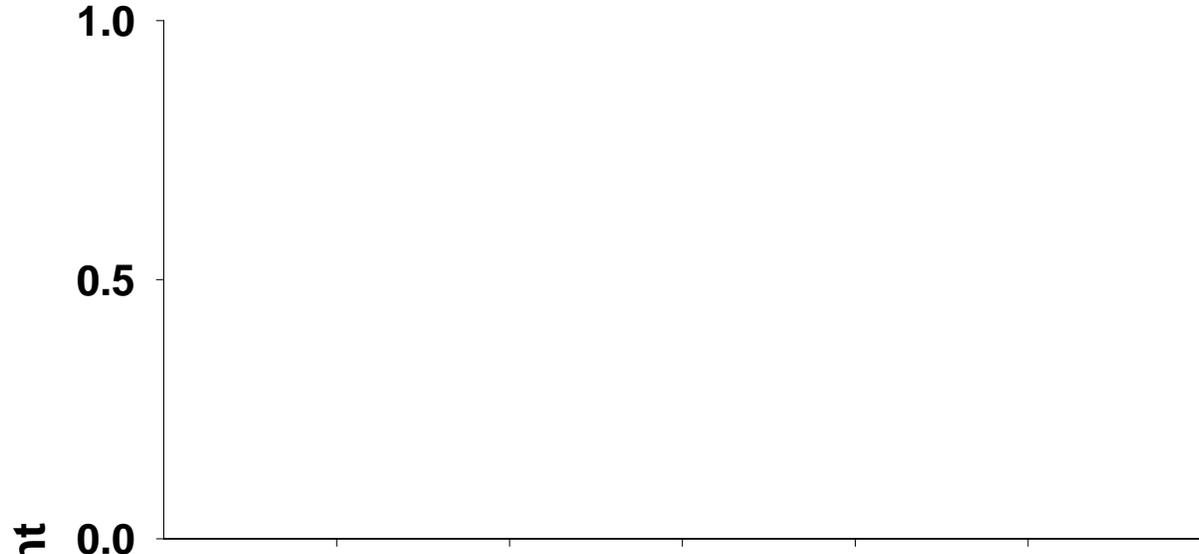


Figure 15. Percent of total sand shiners caught by macrohabitat type in segments 5 and 6 of the Missouri River during 2004 for two seasons: Fall through Spring and Summer.

Fall to Spring (Sturgeon Season)



Summer (Fish Community Season)

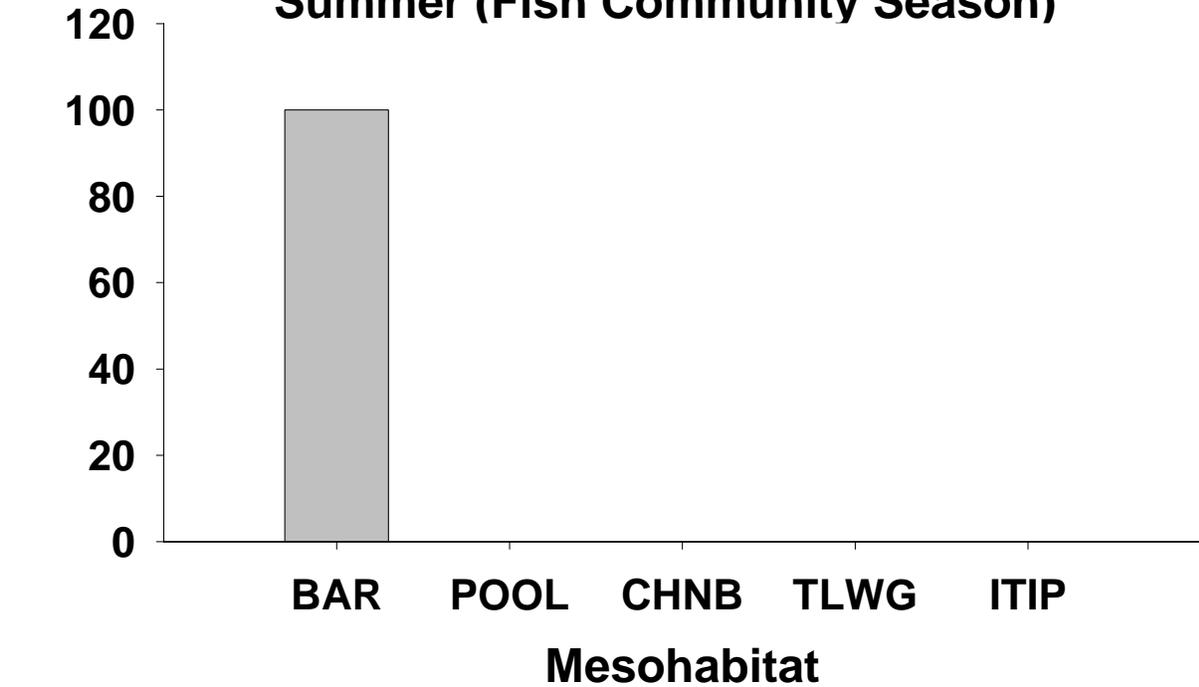


Figure 16. Percent of total sand shiners caught by mesohabitat type in segments 5 and 6 of the Missouri River during 2004 for two seasons: Fall through Spring and Summer.

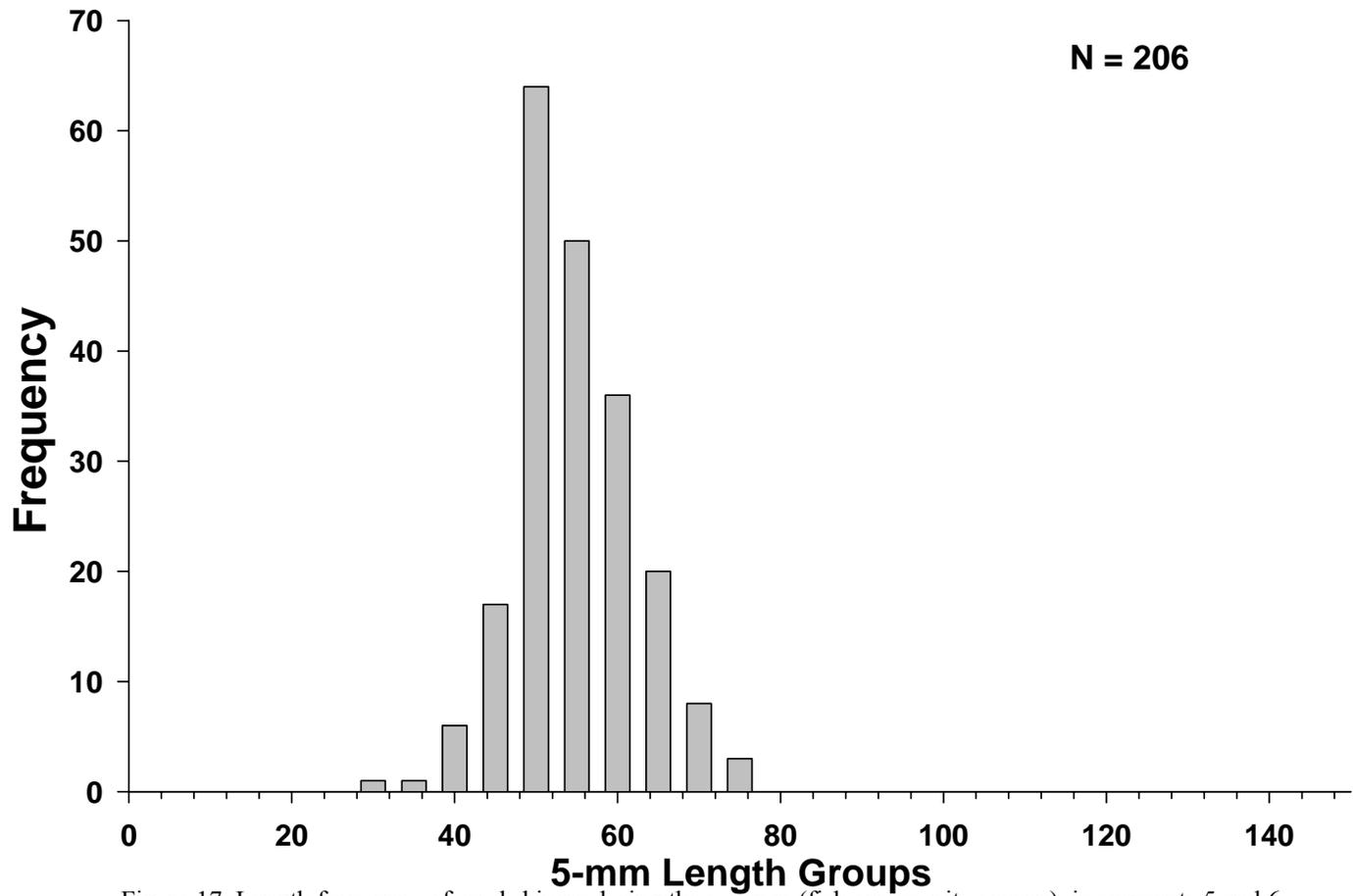


Figure 17. Length frequency of sand shiners during the summer (fish community season), in segments 5 and 6 of the Missouri River during 2004.

III. Native catostomids

Bigmouth buffalo

The total catch of bigmouth buffalo in 2004 was small, precluding analysis of habitat use and population size structure. A total of 9 bigmouth buffalo were caught with seven fish captured in standard gears: gillnets (n = 5) and mini-fyke nets (n = 2). No bigmouth buffalo were captured with trammel nets, the beam trawl, and bag seines. Seventy eight percent of our bigmouth buffalo were captured during the sturgeon season with gillnets and CPUE doubled from 2003 to 2004 (Figure 18). Gillnets and mini-fyke nets caught different size categories of bigmouth buffalo with larger fish captured in gillnets (Figures 18 and 19). Macrohabitat use may be segregated by life stage with adult bigmouth buffalo captured in inside and outside bends while small, likely juvenile fish, were captured only in small secondary connected channels (Figure 20). During the sturgeon season, most bigmouth buffalo were caught in the channel border and pool mesohabitats, while during the fish community season young fish were only caught on bars (Figure 21). The length frequency distribution identifies some reproduction in segments 5 and 6, but capture success or recruitment is low (Figure 22). Relative weights for bigmouth buffalo (n = 4) ranged from 76 – 87 with a mean of 82.

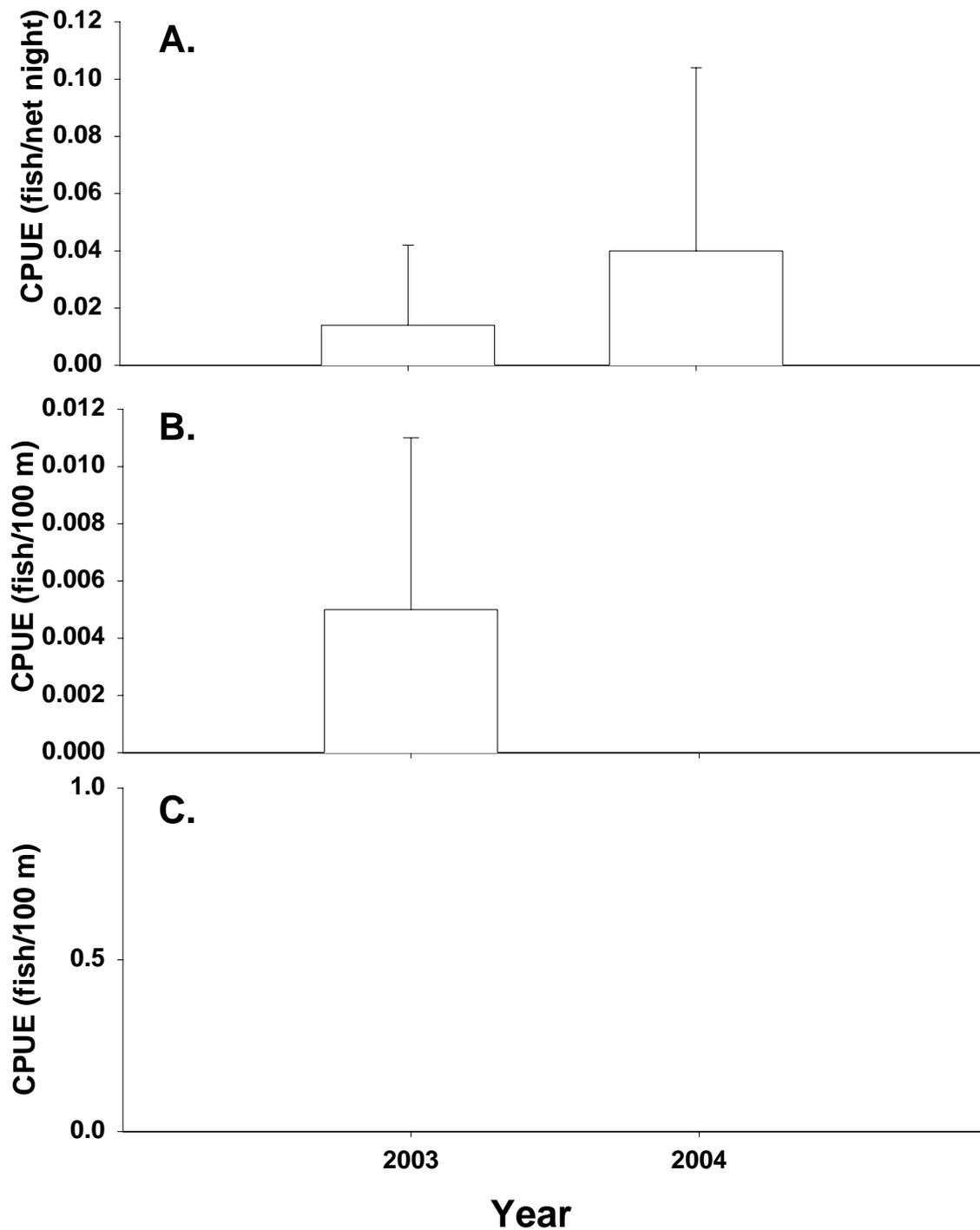


Figure 18. Mean annual catch-per-unit-effort (\pm 2SE) of bigmouth buffalo in segments 5 and 6 of the Missouri River for: A) gill nets, B) trammel nets, and C) beam trawls from fall through spring (Sturgeon season) during 2003 - 2004.

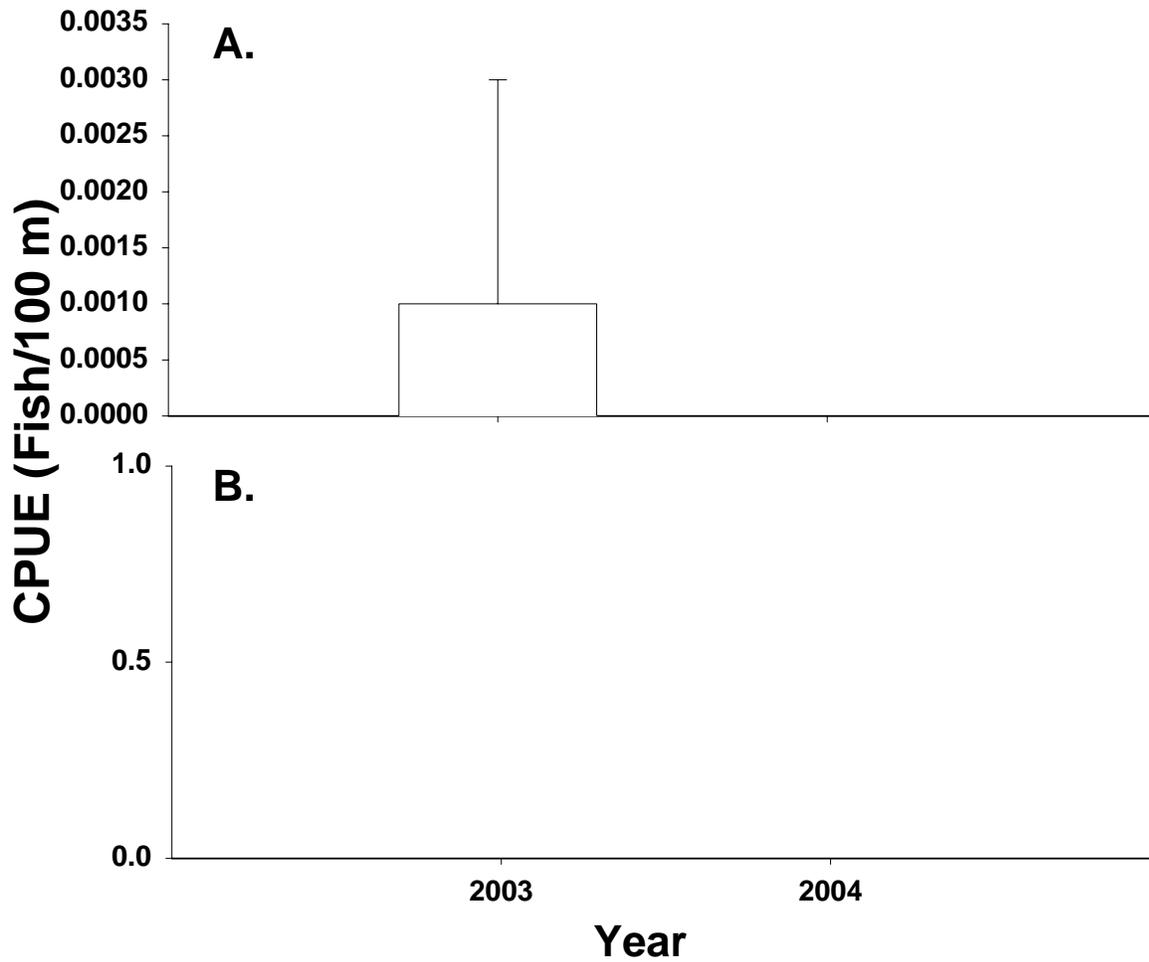
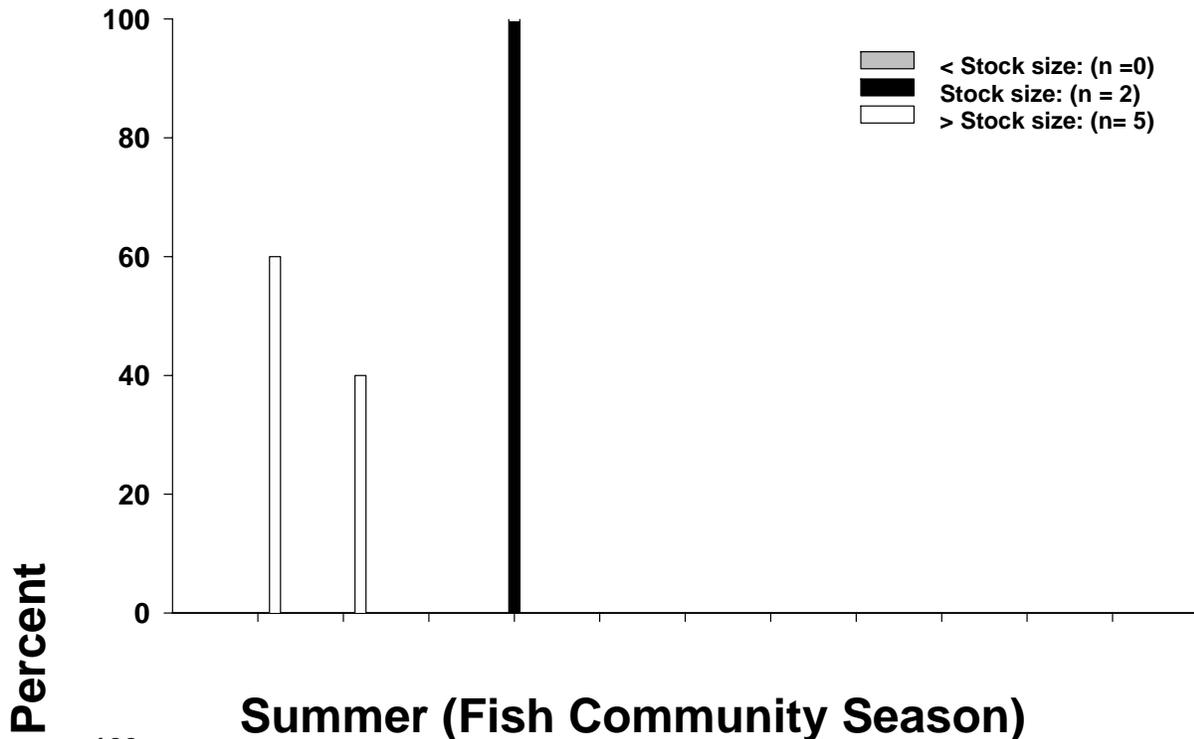


Figure 19. Mean annual catch-per-unit-effort ($\pm 2SE$) of big mouth buffalo in segments 5 and 6 of the Missouri River for: A) trammel nets and B) beam trawls in summer (Fish Community Season) during 2003 - 2004.

Fall to Spring (Sturgeon Season)



Summer (Fish Community Season)

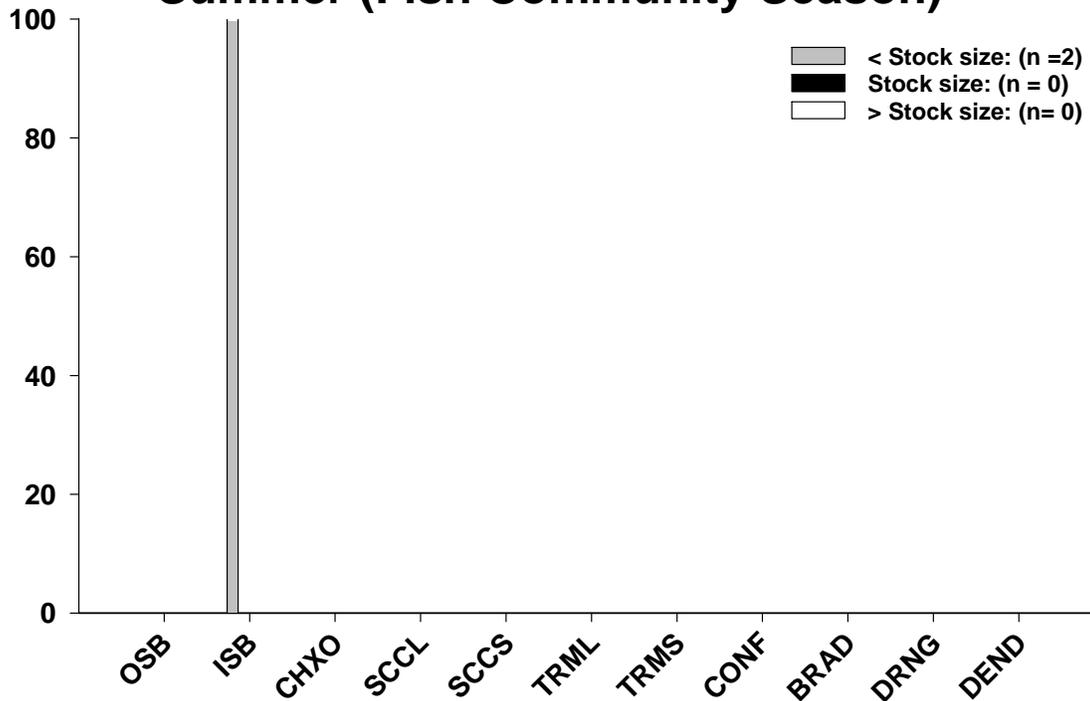
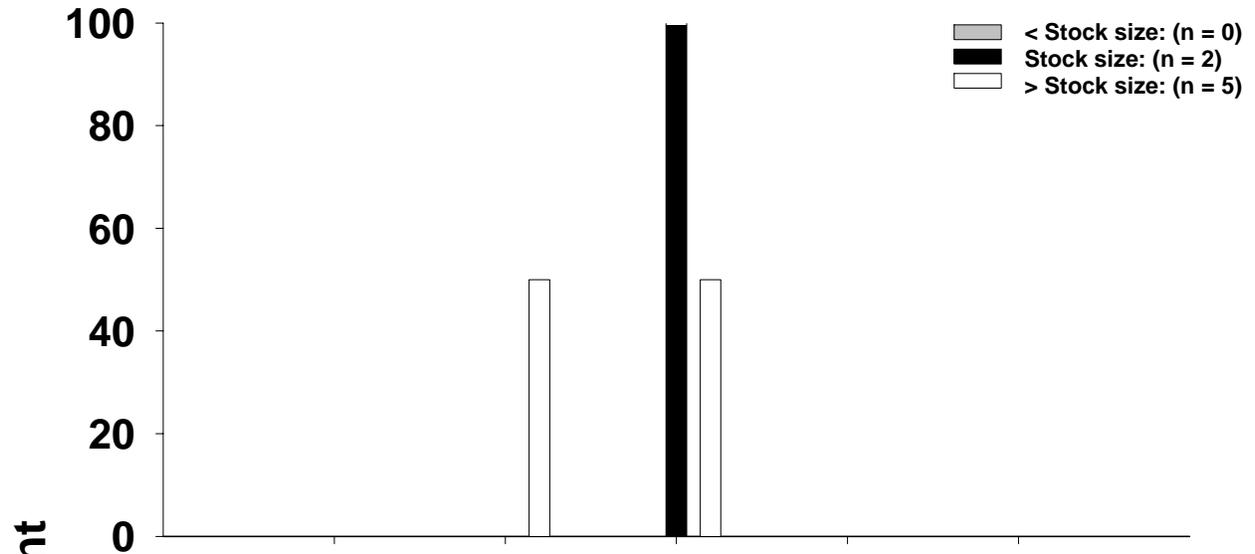


Figure 20. Percent of total bigmouth buffalo for three size classes caught by macrohabitat type in segments 5 and 6 of the Missouri River during 2004 for two seasons: Fall through Spring and Summer. Size classes defined in the text and habitat abbreviations presented in Appendix B.

Fall to Spring (Sturgeon Season)



Summer (Fish Community Season)

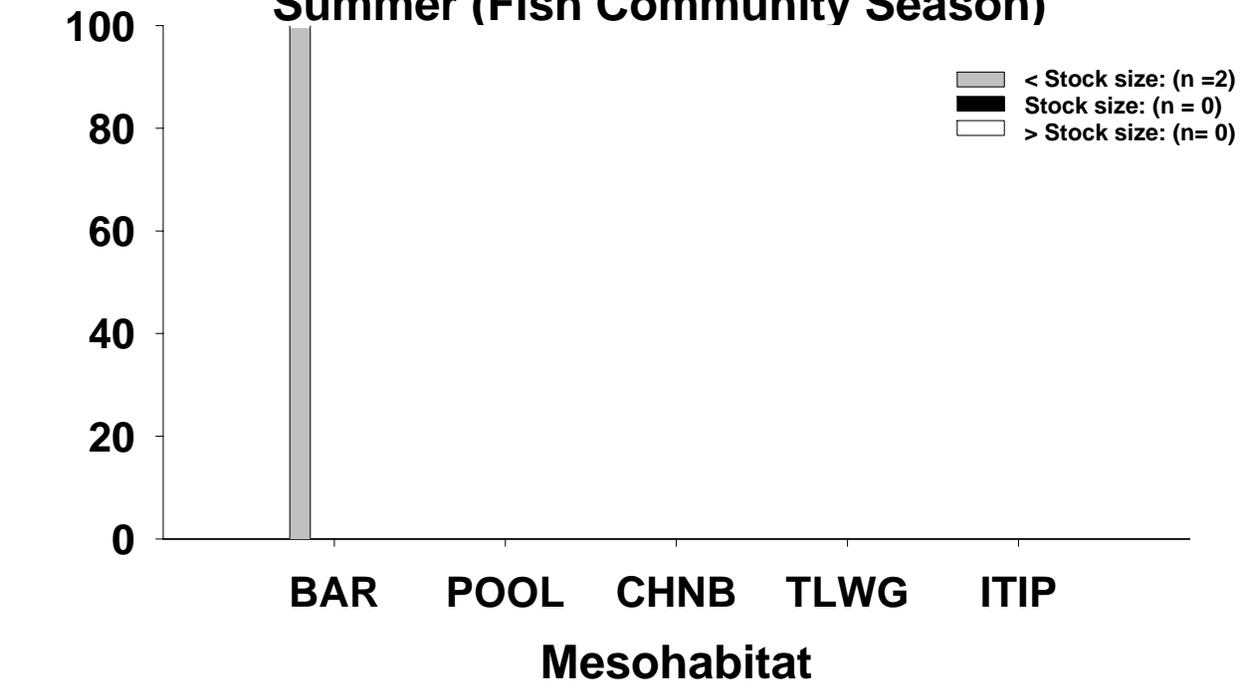


Figure 21. Percent of total bigmouth buffalo for three size classes caught by mesohabitat type in segments 5 and 6 of the Missouri River during 2004 for two seasons: Fall through Spring and Summer. Size classes defined in the text and habitat abbreviations presented in Appendix B.

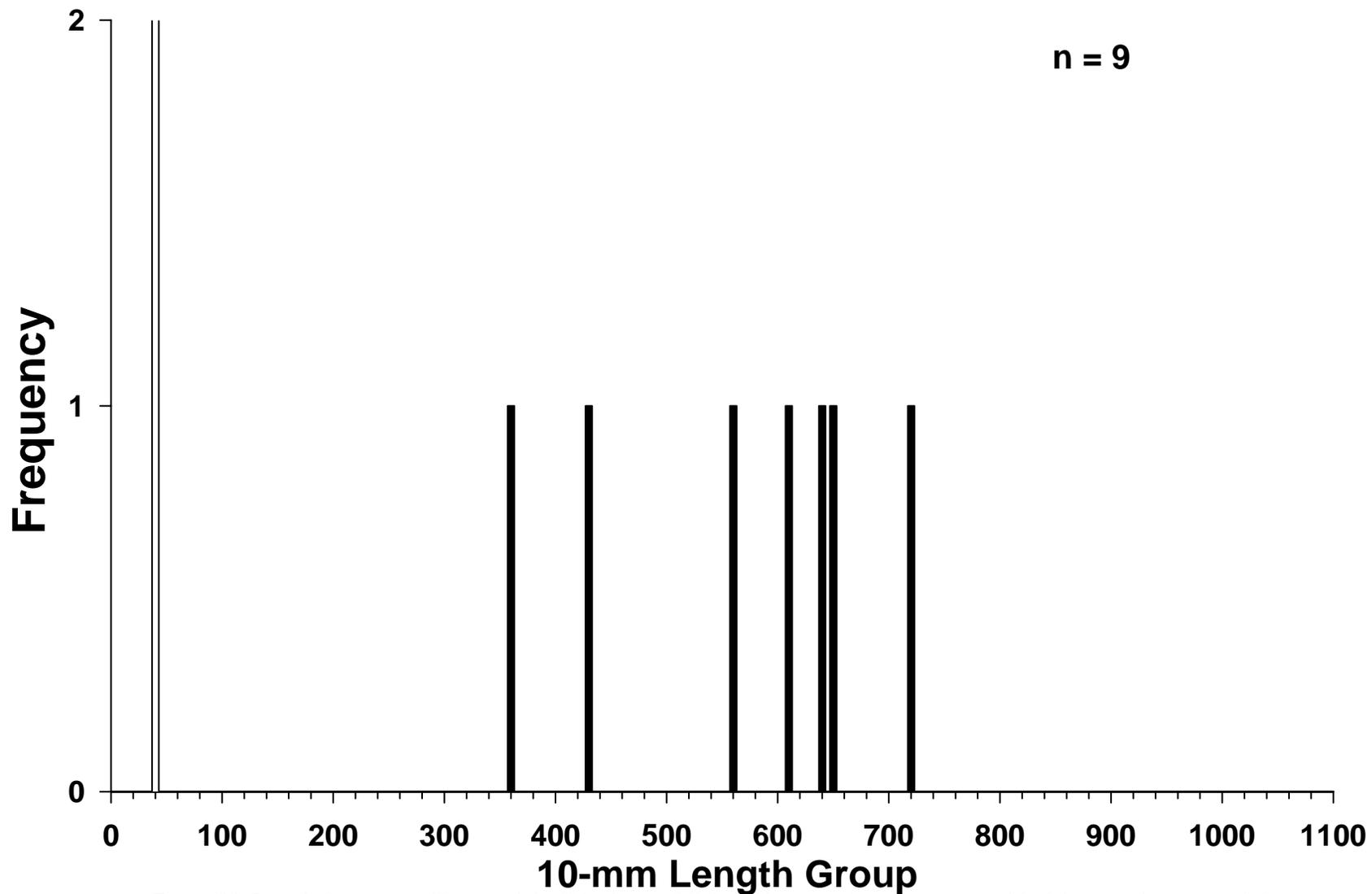


Figure 22. Length frequency of bigmouth buffalo during fall through spring (sturgeon season, black bars) and summer (fish community season, white bars) in segments 5 and 6 of the Missouri River during 2004.

Blue sucker

The total catch of blue suckers in 2004 was small, precluding analysis of habitat use and population size structure. A total of 18 blue suckers were sampled and only three fish were captured with a standard gear (gillnets). No blue suckers were captured with trammel nets, bag seines, mini-fyke nets, or beam trawls (Figures 23 and 24). Over 90% of blue suckers were captured from outside bends during the sturgeon season (Figure 25). The only fish captured during the fish community season was captured in a braided macrohabitat. Channel borders were the primary mesohabitat for the collection of blue suckers (Figure 26). Over 100% of the blue suckers captured were over 709 mm TL indicating a likely ageing population with no evidence of recruitment in segments 5 and 6 or poor sampling efficiency for small blue suckers (Figure 27).

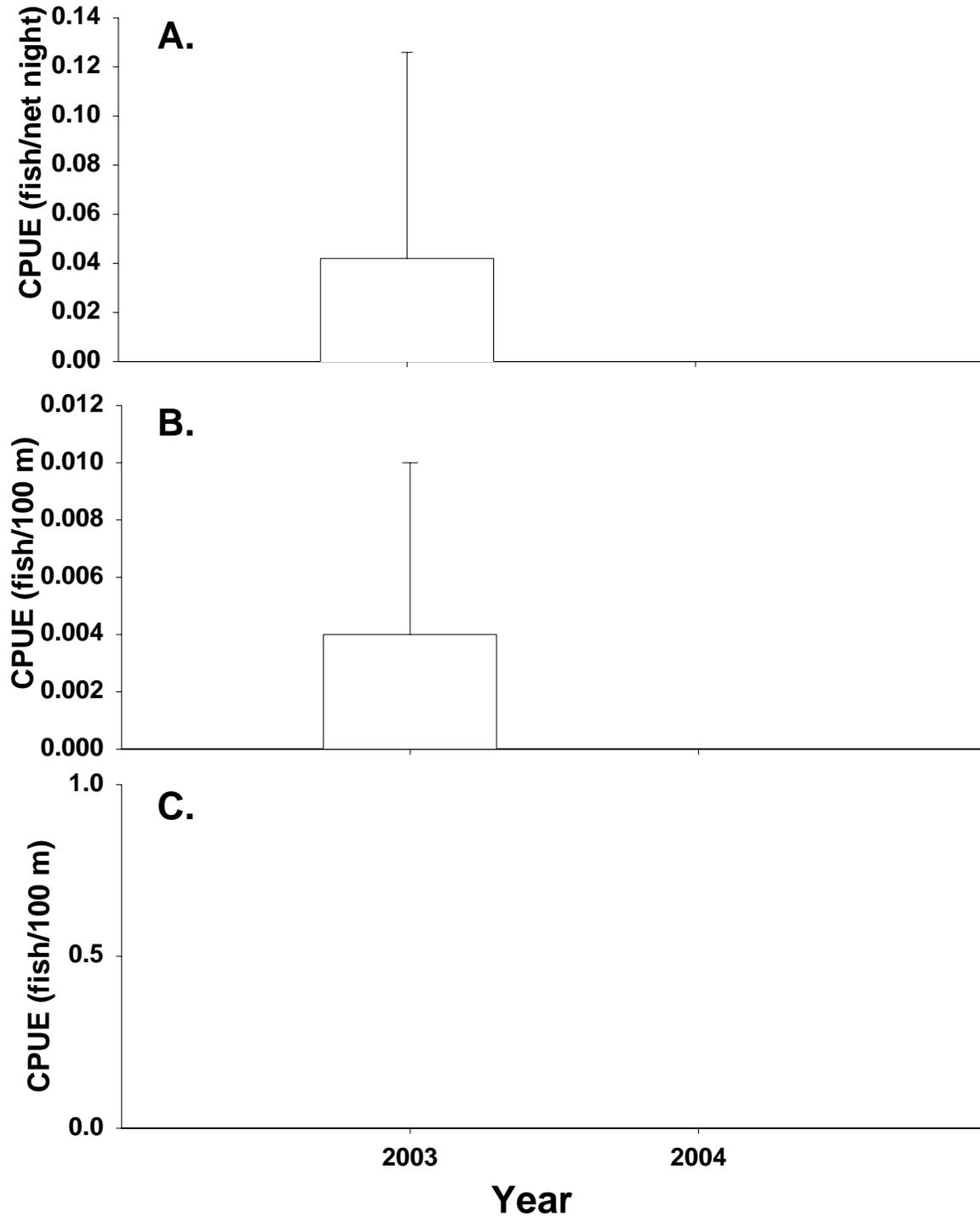


Figure 23. Mean annual catch-per-unit-effort ($\pm 2SE$) of blue suckers in segments 5 and 6 of the Missouri River for: A) gill nets, B) trammel nets, and C) beam trawls from fall through spring (Sturgeon season) during 2003 - 2004.

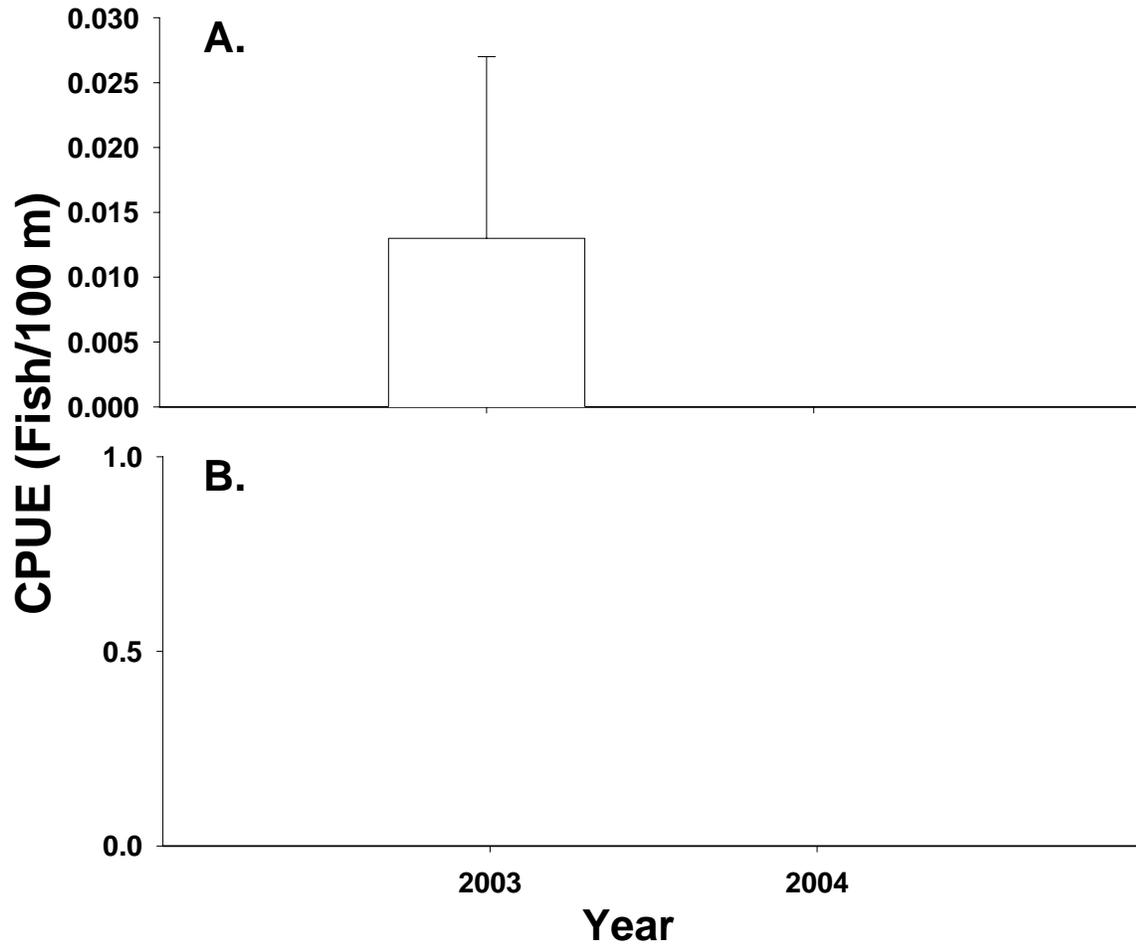
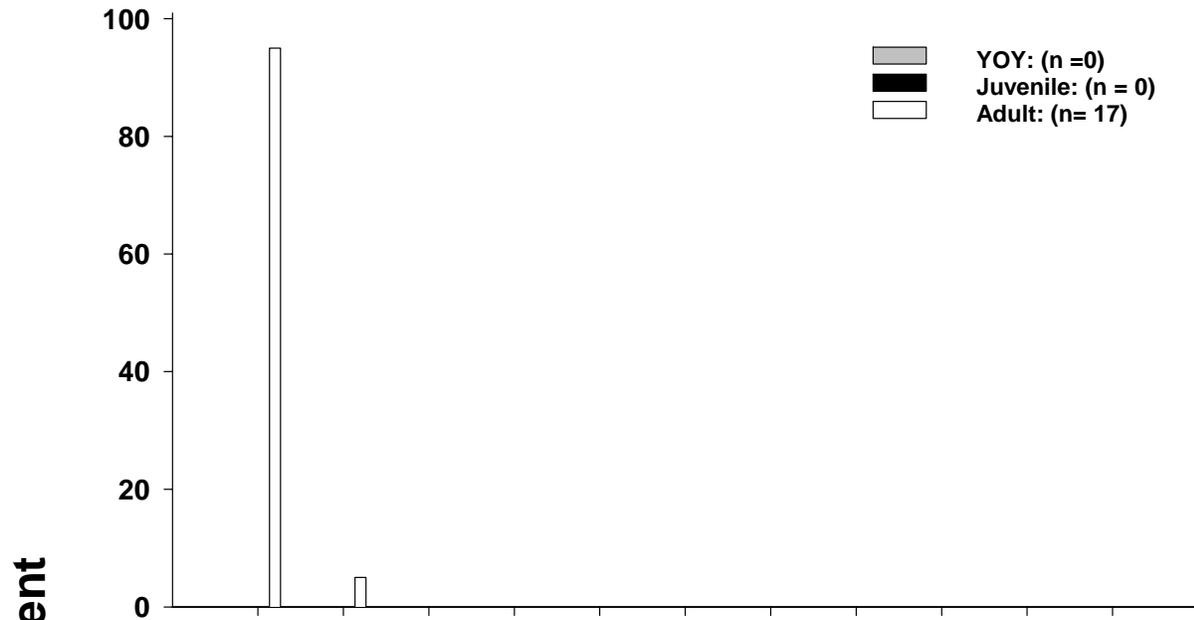


Figure 24. Mean annual catch-per-unit-effort ($\pm 2SE$) of blue suckers in segments 5 and 6 of the Missouri River for: A) trammel nets and B) beam trawls in summer (Fish Community Season) during 2003 - 2004.

Fall to Spring (Sturgeon Season)



Summer (Fish Community Season)

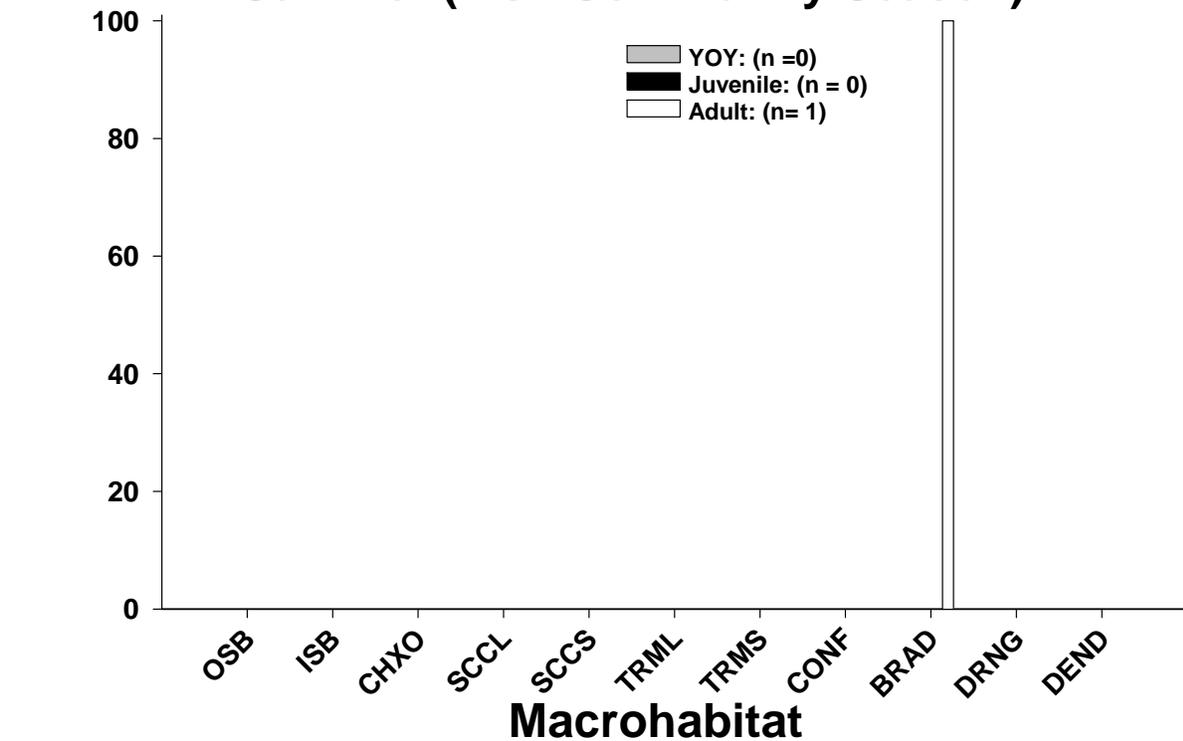
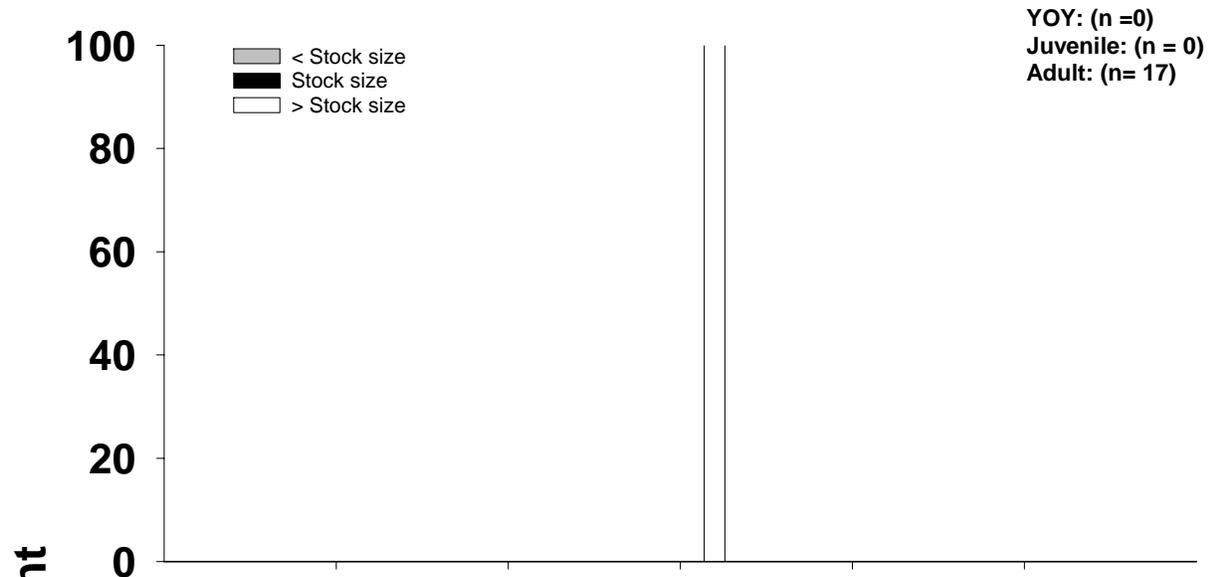


Figure 25. Percent of total blue suckers for three size classes caught by macrohabitat type in segments 5 and 6 of the Missouri River during 2004 for two seasons: Fall through Spring and Summer. Size classes defined in the text and habitat abbreviations presented in Appendix B.

Fall to Spring (Sturgeon Season)



Summer (Fish Community Season)

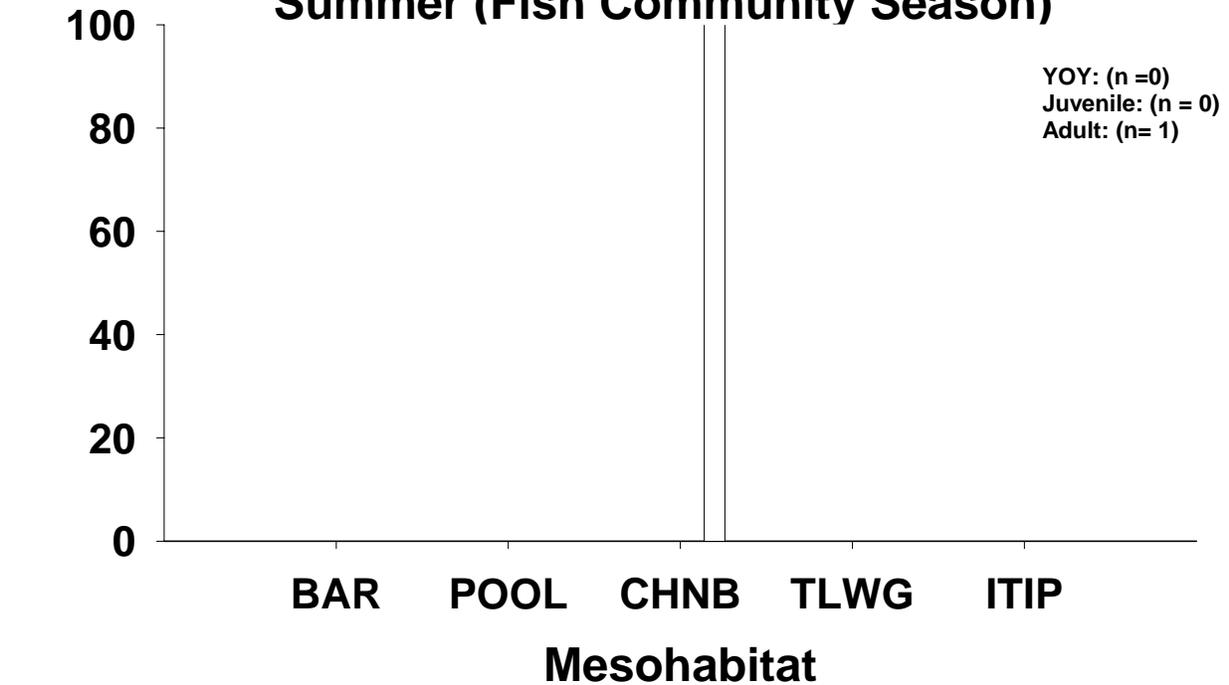


Figure 26. Percent of total blue suckers for three size classes caught by mesohabitat type in segments 5 and 6 of the Missouri River during 2004 for two seasons: Fall through Spring and Summer. Size classes defined in the text and habitat abbreviations presented in Appendix B.

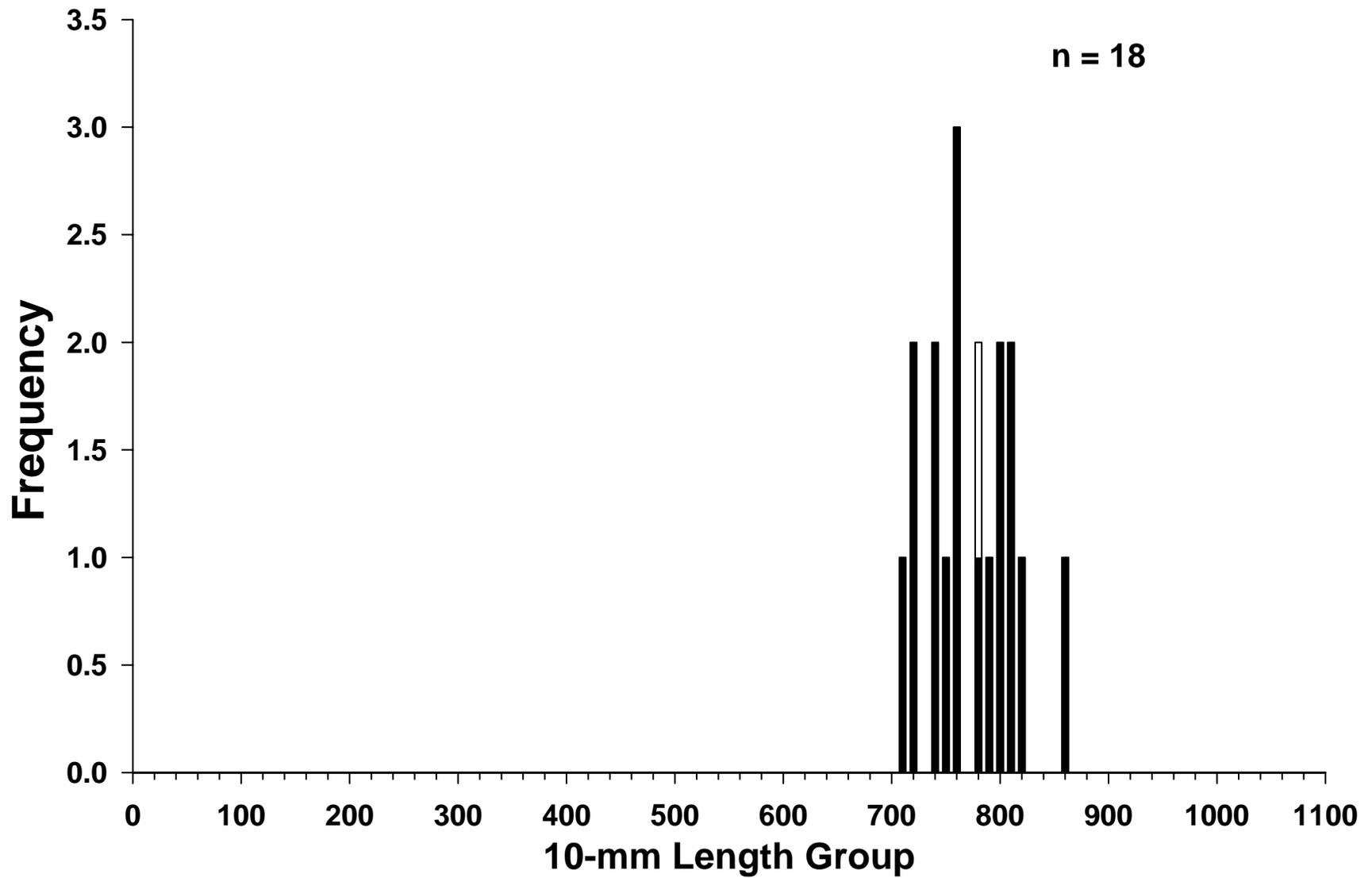


Figure 27. Length frequency of blue suckers during fall through spring (sturgeon season, black bars) and summer (fish community season, white bars) in segments 5 and 6 of the Missouri River during 2004.

IV. Native Percids

Sauger

A total of 72 saugers were sampled in segments 5 and 6 during 2004 with 71 fish captured in standard gears: gillnets (n = 43) trammel nets (n = 23), beam trawl (n = 1), mini-fyke nets (n = 2), and bag seines (n = 2). Gillnet CPUE declined from 2003 to 2004 (Figure 28). However, changes in trammel net CPUE from 2003 to 2004 were equivocal; CPUE was similar during the sturgeon season but declined from 2003 to 2004 during the fish community season (Figures 28 and 29). Trammel net catches of saugers were approximately 10 times greater during the sturgeon season (fall through spring) compared to the fish community season (summer). Most saugers during both seasons were caught in the outside and inside bend macrohabitats (Figure 30). Saugers were caught in four mesohabitats with most fish captured in channel borders (Figure 31). Over 65% of saugers were between the 320 - 409 mm TL; however, catches of fish < 160 mm TL indicate some reproduction occurred (Figure 32). Mean relative weights for saugers during the sturgeon and fish community seasons were 80 and 77, respectively. The range of relative weights was wider during the sturgeon season (58 - 96) compared to the fish community season (70 - 82) likely due to ripe and spent fish caught during the spawning season in spring.

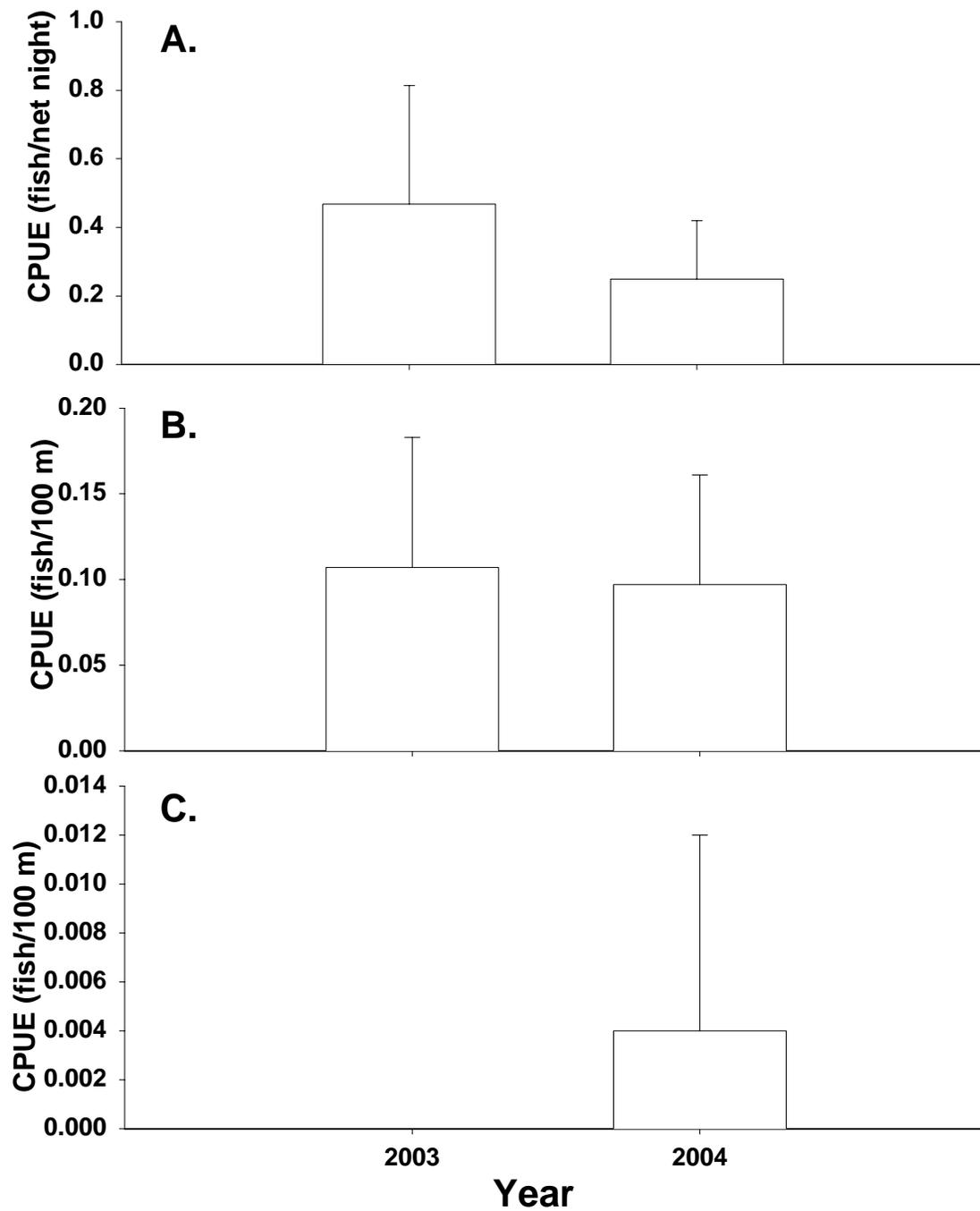


Figure 28. Mean annual catch-per-unit-effort (\pm 2SE) of saugers in segments 5 and 6 of the Missouri River for: A) gill nets, B) trammel nets, and C) beam trawls from fall through spring (Sturgeon season) during 2003 - 2004.

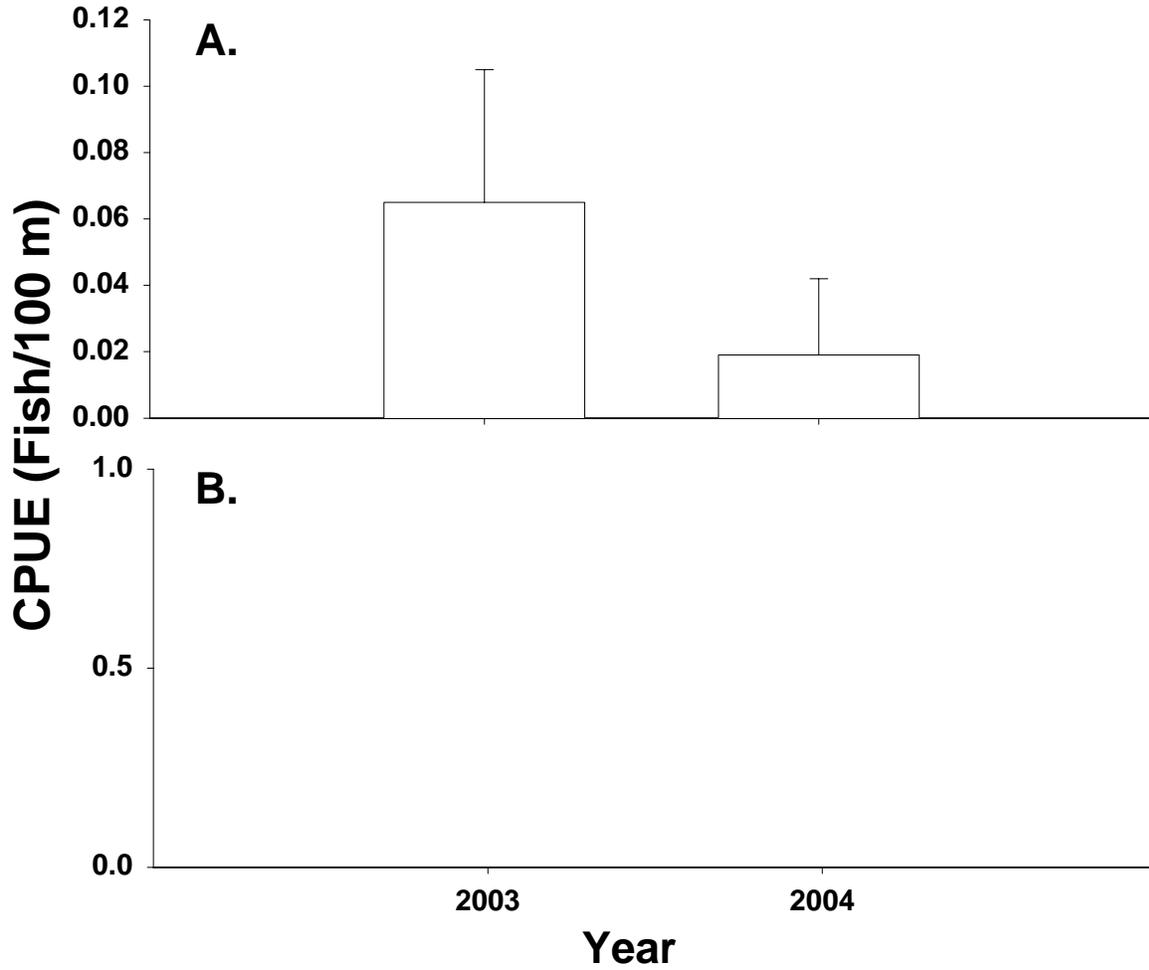
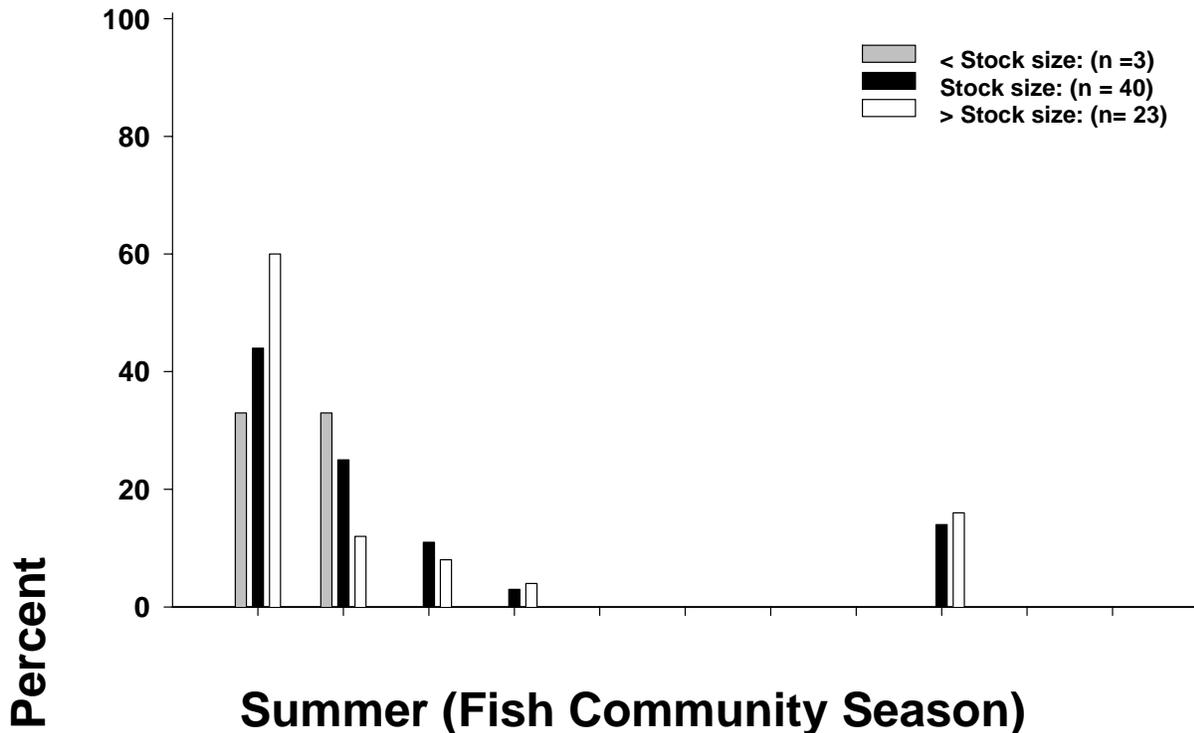


Figure 29. Mean annual catch-per-unit-effort (\pm 2SE) of saugers in segments 5 and 6 of the Missouri River for: A) trammel nets and B) beam trawls in summer (Fish Community Season) during 2003 - 2004.

Fall to Spring (Sturgeon Season)



Summer (Fish Community Season)

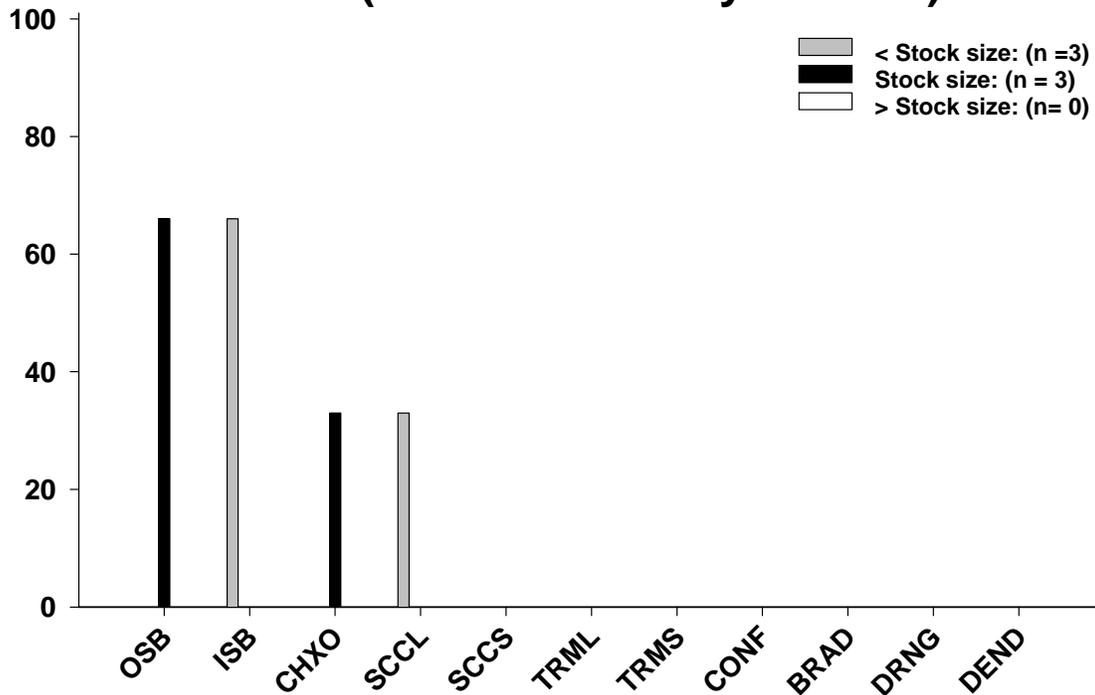
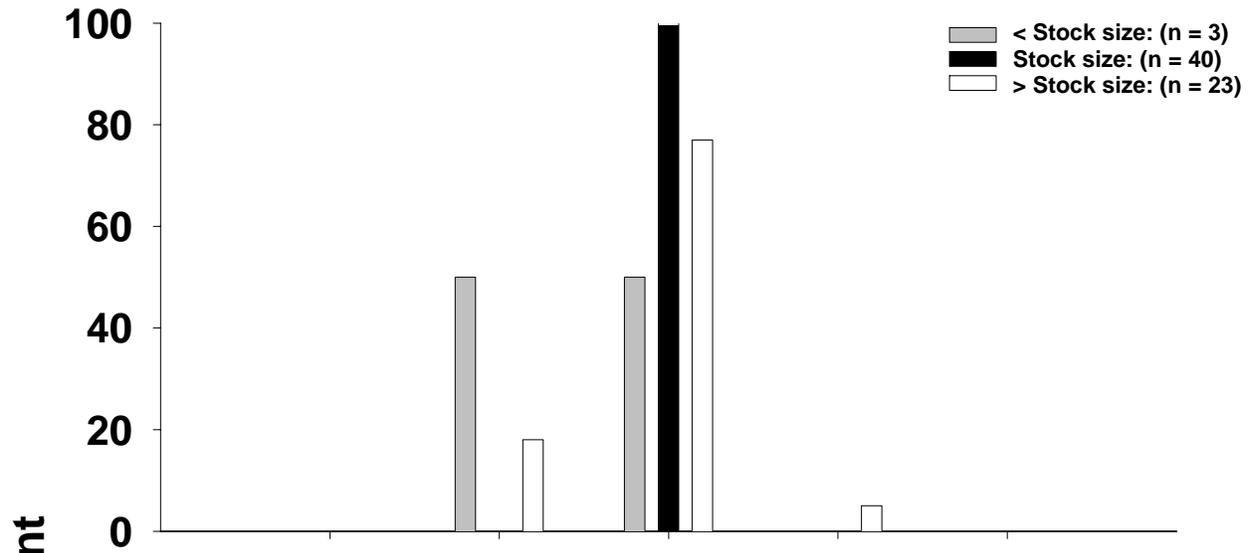


Figure 30. Percent of total saugers for three size classes caught by macrohabitat type in segments 5 and 6 of the Missouri River during 2004 for two seasons: Fall through Spring and Summer. Size classes defined in the text and habitat abbreviations presented in Appendix B.

Fall to Spring (Sturgeon Season)



Summer (Fish Community Season)

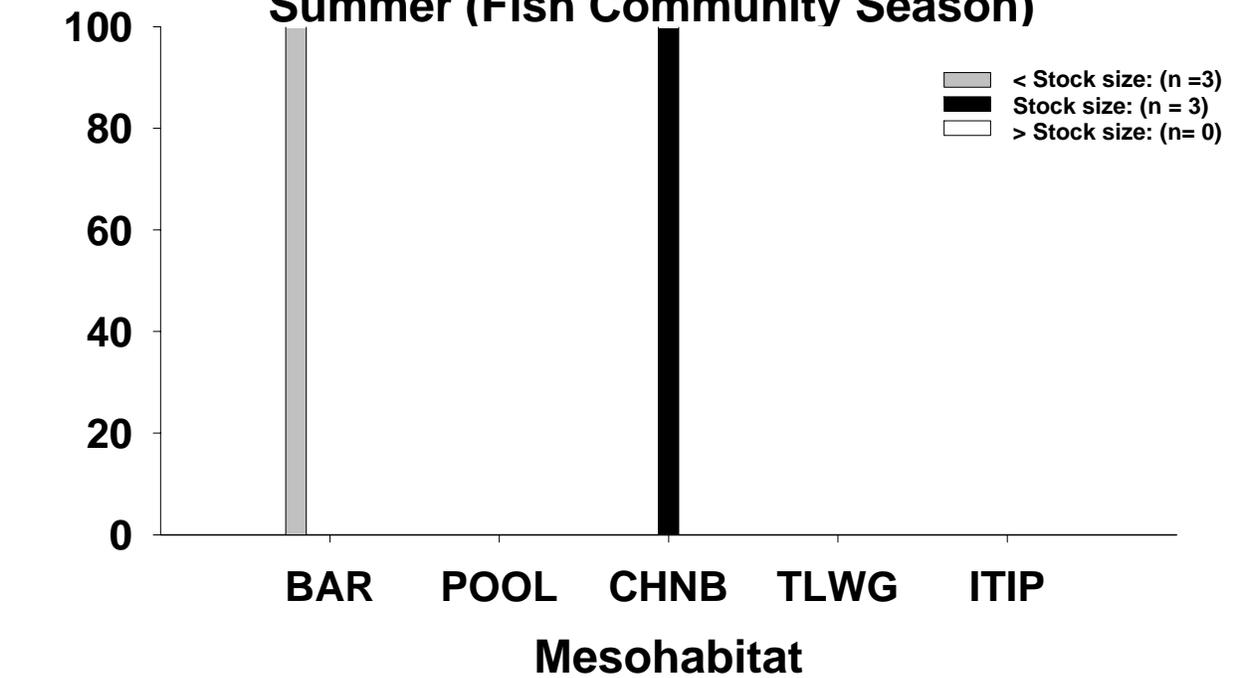


Figure 31. Percent of total saugers for three size classes caught by mesohabitat type in segments 5 and 6 of the Missouri River during 2004 for two seasons: Fall through Spring and Summer. Size classes defined in the text and habitat abbreviations presented in Appendix B.

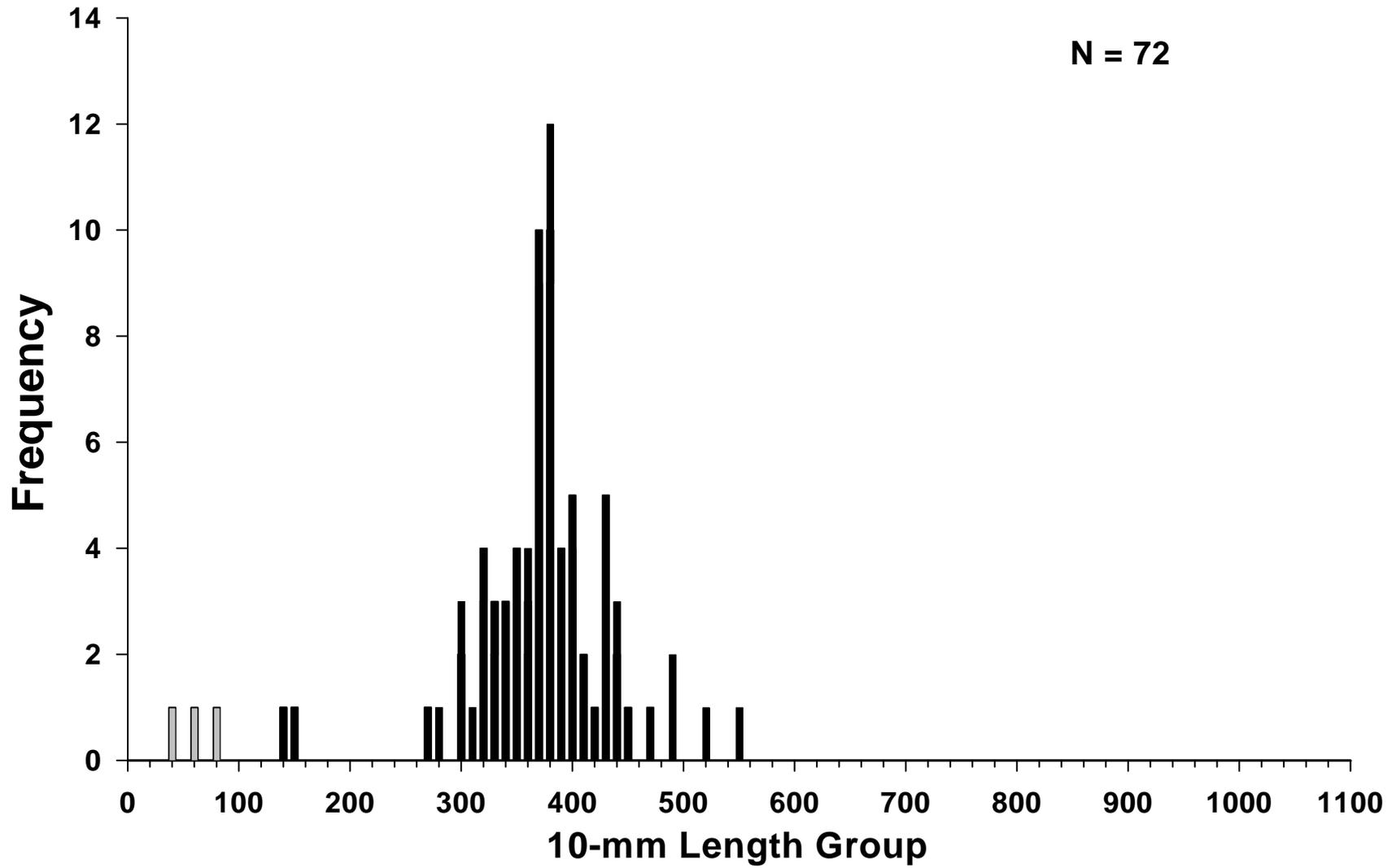


Figure 32. Length frequency of saugers during fall through spring (sturgeon season, black bars) and summer (fish community season, white bars) in segments 5 and 6 of the Missouri River during 2004.

V. Additional Effort – wild gears

Wild gears (i.e., non-standard) used in 2003 -2004 consisted of hoopnets and setlines during the sturgeon and fish community seasons. Hoop nets in the past were considered a standard gear but since completion of the 2003 season were not required. Therefore, hoop net catches are included in this section. During the sturgeon season an average of 26 setlines/bend were deployed in 12 bends, while an average of 25 deployments/bend were set in 10 bends during the fish community season (Tables 2 and 3). An average of 8 hoop nets/bend was deployed in 10 bends during both seasons (Tables 2 and 3).

Pallid and shovelnose sturgeon catches with set lines and hoop nets were low during 2004. Three pallid sturgeon were caught with setlines and mean annual CPUE was 0.006 fish/hook night and 0.004 fish/hook night for the sturgeon season and fish community seasons respectively (Figures 33 and 34). Set line CPUE for pallid sturgeon with set lines was generally similar in 2003 and 2004 with large variances due to the prevalence of zero catches. No pallid sturgeon were caught with hoop nets during 2004. Eleven shovelnose sturgeons were caught on set lines during 2004 and CPUE was 0.035 fish/hook night during the sturgeon season. No set lines caught shovelnose sturgeon during the fish community season (summer). Few shovelnose sturgeon ($n = 2$) were caught in hoop nets with a CPUE of 0.01 fish/net night in both seasons (Figures 35 and 36).

Hoop nets had varied success in capturing targeted native Missouri River fishes; whereas, set lines failed to capture any target species other than shovelnose sturgeon. Few bigmouth buffalo ($n = 2$), and saugers ($n = 1$) were captured in hoop nets. Mean annual CPUE of big mouth buffalo declined from 2003 to 2004 (Figure 37). Hoop nets caught more blue suckers ($n =$

15) than any other target species and relative abundance remained unchanged from 2003 to 2004 (Figures x). However, eleven of 18 blue suckers were captured in a single hoop net on 06 May 2004.

VI. General Missouri River fish community

A total of 4,489 fish comprised of 38 species and one hybrid (Sauger x walleye) were captured during the 2004 sampling season in segments 5 and 6 of the Missouri River. Greatest numbers of fishes were captured during the summer with seines (n = 1,664) and mini-fyke nets (n = 2,281). These summer catches consisted mainly of small bodied cyprinids and young-of-the-year (YOY) catostomids, centrarchids, and percids. Gears with the greatest percentage of their catch comprised of pallid sturgeon and the ten targeted native fish species were gillnets (39%), trammel nets during the sturgeon season (33%), and trammel nets during the fish community season (43%). The beam trawl captured low percentages of sturgeon and the targeted native species in spring through fall (8%) and summer (0%). Sand shiners were the only target species captured with seines (2%) and mini-fyke nets (5%). Collectively for all standard gears > 50 individuals were captured for the following 14 species: shovelnose sturgeon (n = 91), gizzard shad *Dorosoma cepedianum* (n = 77), spotfin shiner *Cyprinella spiloptera* (n = 993), emerald shiner *Notropis atherinoides* (n = 1,172), spottail shiner *Notropis hudsonius* (n = 51), sand shiner (n = 206), shorthead redhorse *Moxostoma macrolepidotum* (n = 73), channel catfish *Ictalurus punctatus* (n = 167), smallmouth bass *Micropterus dolomieu* (n = 814), largemouth bass *M. salmoides* (n = 55), Johnny darter *Etheostoma nigrum* (n = 106), yellow perch *Perca flavescens* (n = 101), sauger (n = 72), and walleye *Sander vitreum* (n = 64). Only 33 positively identified river carpsuckers *Carpiodes carpio* were captured; however, 45 YOY unidentified

carpsuckers (*Carpiodes* spp.) were caught with seines. Most gizzard shad, largemouth bass, smallmouth bass, and yellow perch were YOY collected with mini-fyke nets and bag seines. Five species were represented in the collective catches by only one specimen: longnose gar *Lepisosteus osseus*, goldeye *Hiodon alosoides*, quillback *Carpiodes cyprinus*, white perch *Morone Americana*, and orange spotted sunfish *Lepomis humilis*.

For gears targeting large fish in deep water habitats, channel catfish, shorthead redhorse, and walleye were the three most common non-targeted species. Only five species, shovelnose sturgeon, shorthead redhorse, channel catfish, sauger, and walleye had gillnet CPUE > 0.2 fish/net night during 2004 (Appendix F). In the sturgeon season, CPUE of shovelnose sturgeon, channel catfish and sauger were the only species with a trammel net CPUE > 0.1 fish/100 m with the relative abundance of catfish three times greater than that of shovelnose sturgeon and sauger (Appendix G). For trammel nets in the fish community season, only channel catfish had a CPUE > 0.1 fish/100 m (Appendix I). Channel catfish were the most abundant species captured with the beam trawl during both seasons (Appendices H and J).

The greatest numbers of fish species were captured in shallow water habitats with bag seines (n = 25) and mini-fyke nets (n = 31). Only two species captured with bag seines had densities > 1 fish/m², spotfin shiner (3.7 fish/m²) and emerald shiner (5.4 fish/m²) during 2004 (Appendix K). The most abundant species captured in mini-fyke nets were smallmouth bass (6.8 fish/net night) and spotfin shiner (4.7 fish/net night). Only two other species had CPUE > 1 fish/net night with mini-fyke nets: emerald shiner (4.3 fish/net night) and sand shiner (1.6 fish/net night).

Seven exotic species were captured in segments 5 and 6 during 2004 and five of these species are sport fishes that were intentionally introduced: northern pike *Esox lucius*, white bass

Morone chrysops, smallmouth bass, largemouth bass (Bailey and Allum 1954). Additional exotic species encountered in 2004 were common carp *Cyprinus carpio*, white perch *M. americana* and rainbow smelt *Osmerus mordax*. Based on high CPUE in mini-fyke nets, smallmouth bass were the most abundant exotic species seen in segments 5 and 6 during 2004. 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 2004. Additionally, no zebra mussels *Dreissena polymorpha* were observed while working in segments 5 and 6 during 2004 despite the identification of larval zebra mussels (veligers) from samples at the Verdell Boat Ramp in 2003.

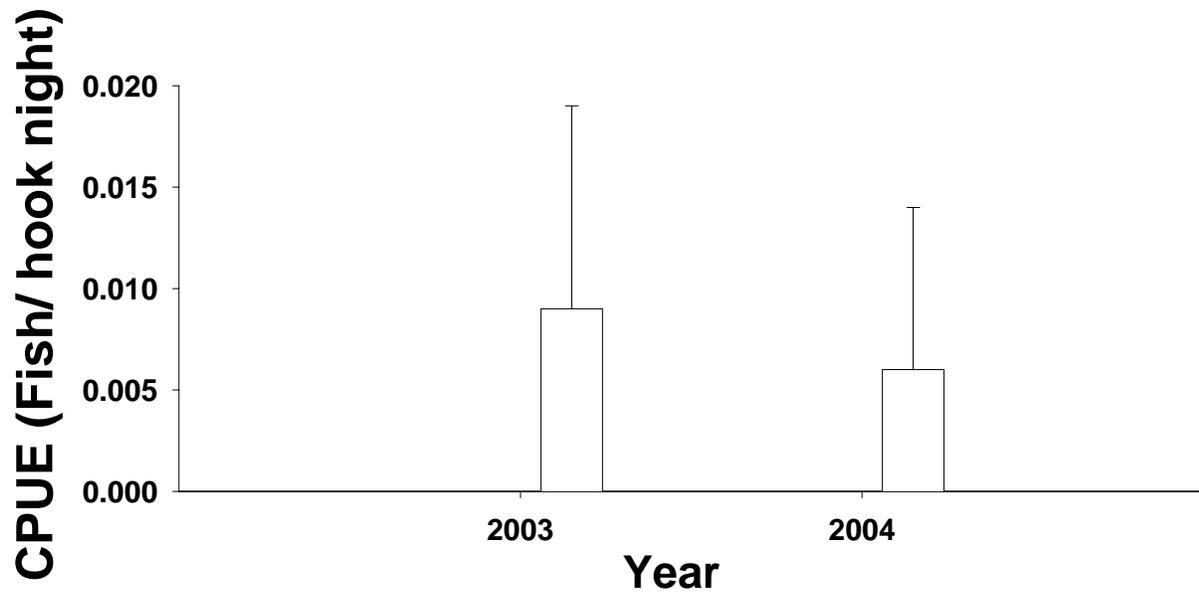


Figure 33. Mean annual catch-per-unit-effort (± 2 SE) of stocked pallid sturgeon in segments 5 and 6 of the Missouri River for set lines fished during fall through spring (Sturgeon Season) during 2003 - 2004.

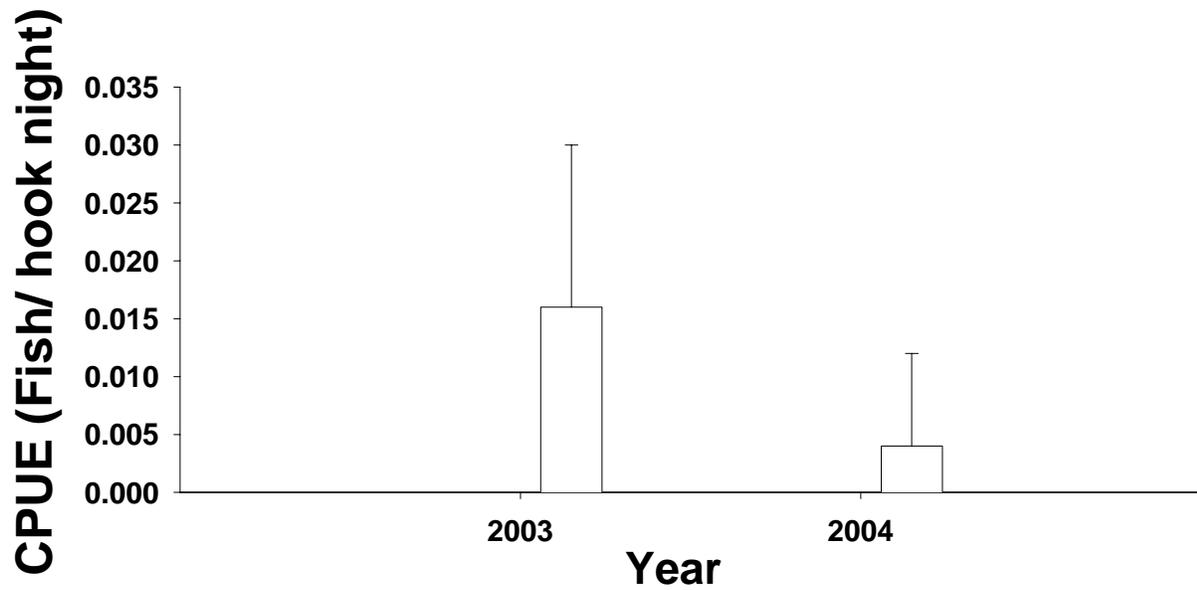


Figure 34. Mean annual catch-per-unit-effort (± 2 SE) of stocked pallid sturgeon in segments 5 and 6 of the Missouri River for set lines during summer (Fish Community Season) during 2003 - 2004.

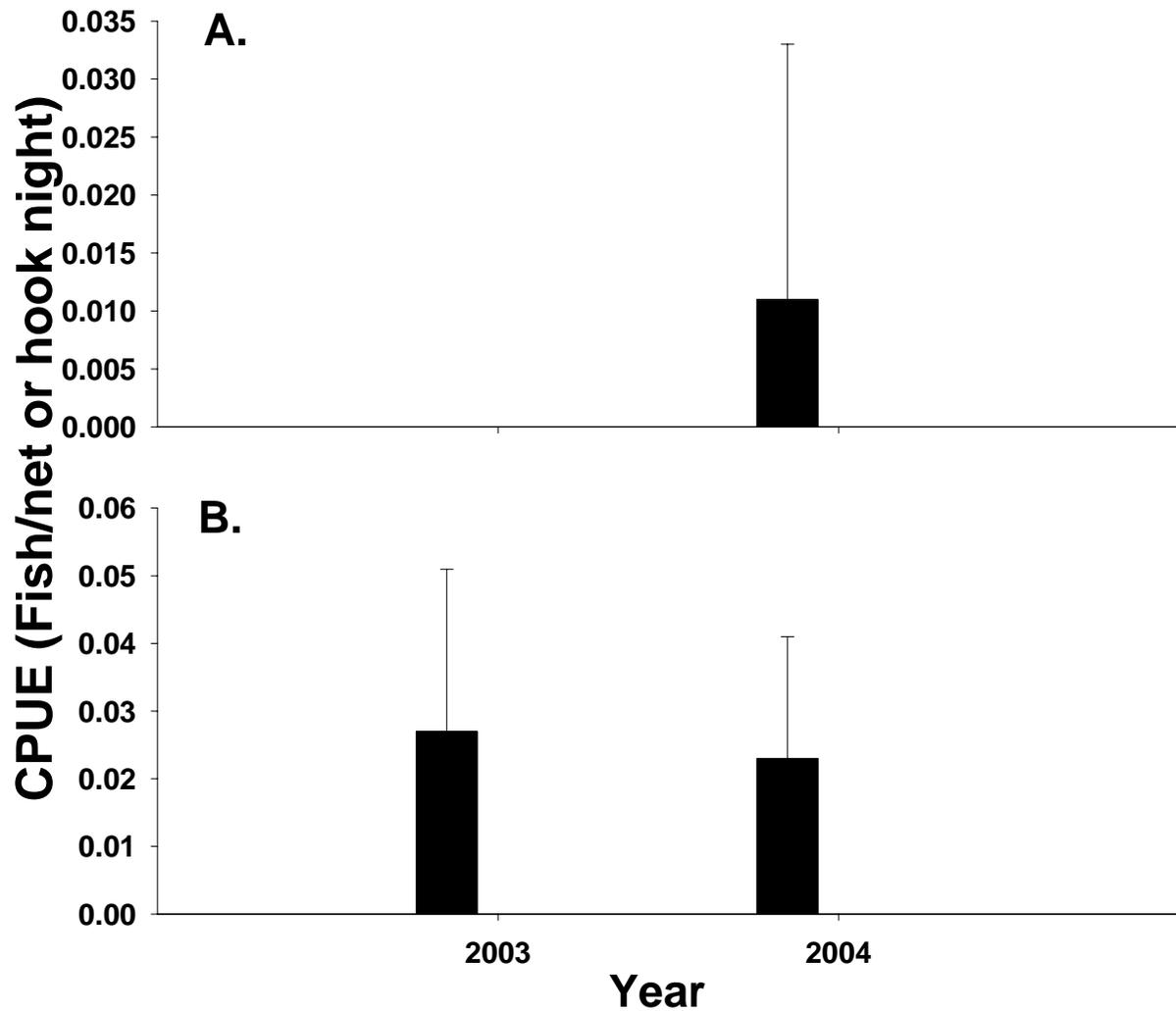


Figure 35. Mean annual catch-per-unit-effort (± 2 SE) of shovelnose sturgeon in segments 5 and 6 of the Missouri River for wild gears: A: hoop nets and B: set lines fished during fall through spring (Sturgeon Season) during 2003 - 2004.

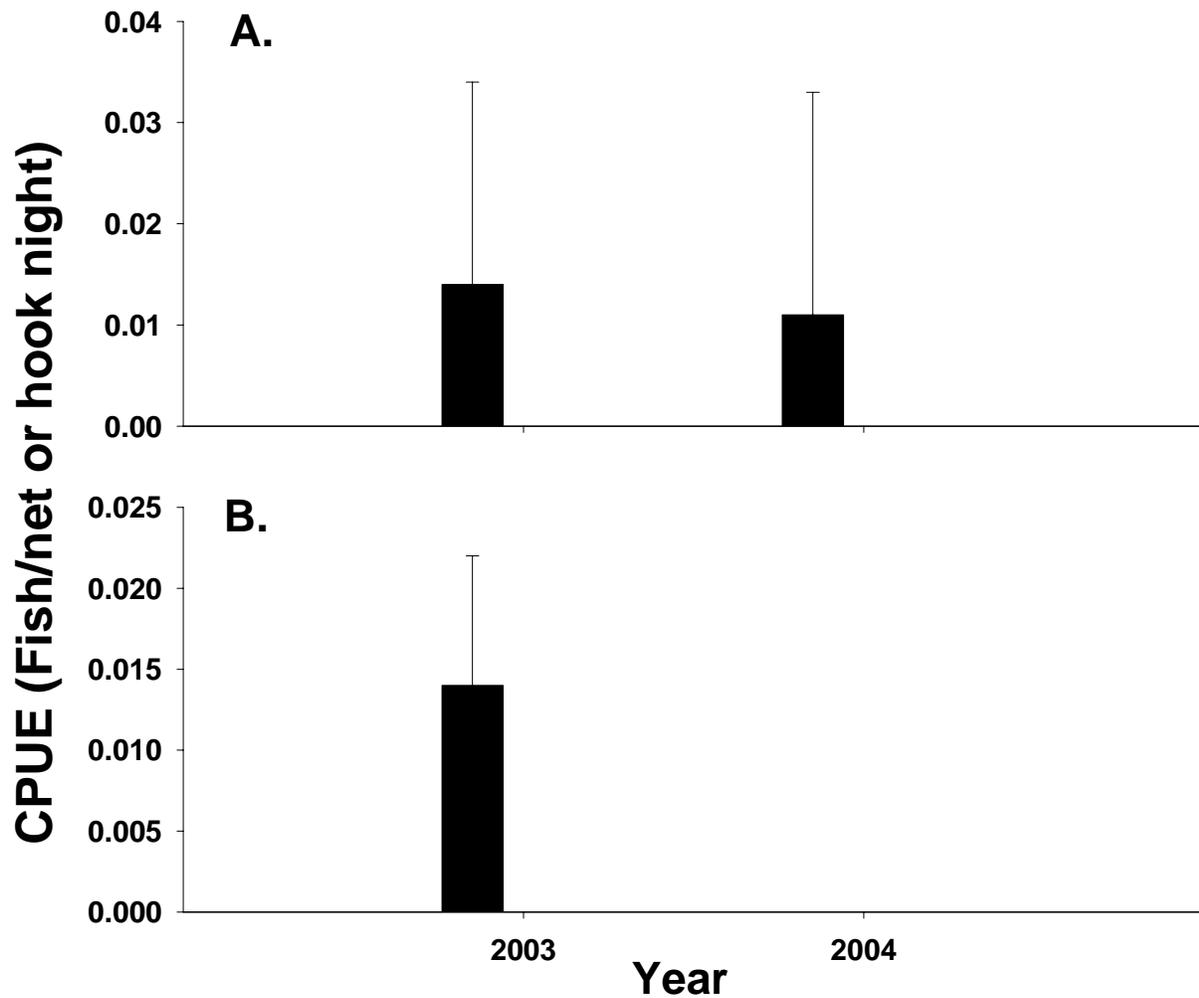


Figure 36. Mean annual catch-per-unit-effort (± 2 SE) of shovelnose sturgeon in segments 5 and 6 of the Missouri River for wild gears: A: hoop nets and B: set lines fished during summer (Fish Community Season) during 2003 - 2004.

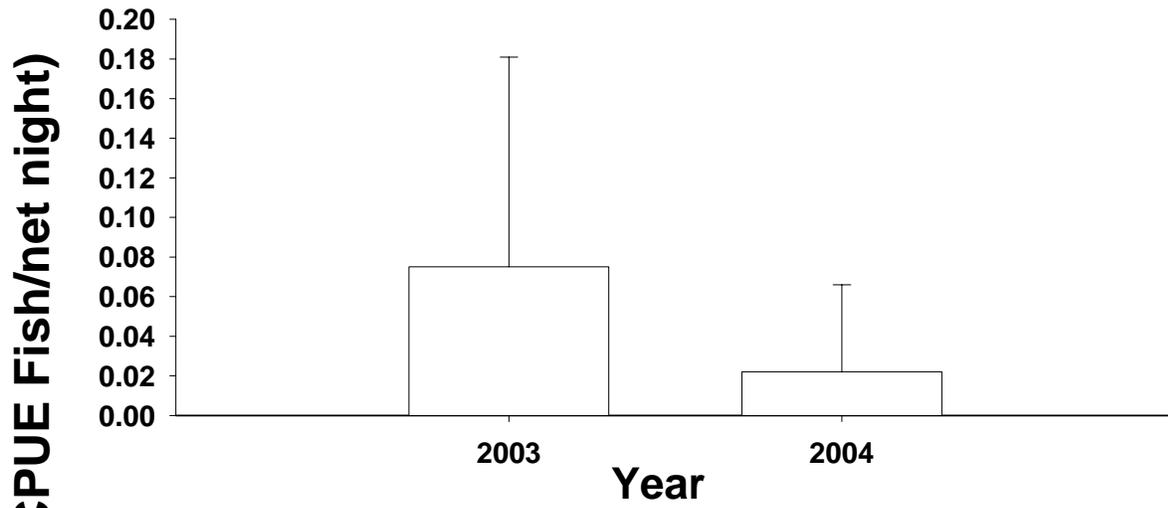


Figure 37. Mean annual catch-per-unit-effort (\pm 2 SE) of bigmouth buffalo in segments 5 and 6 of the Missouri River for hoop nets fished during fall through spring (Sturgeon Season) during 2003 - 2004.

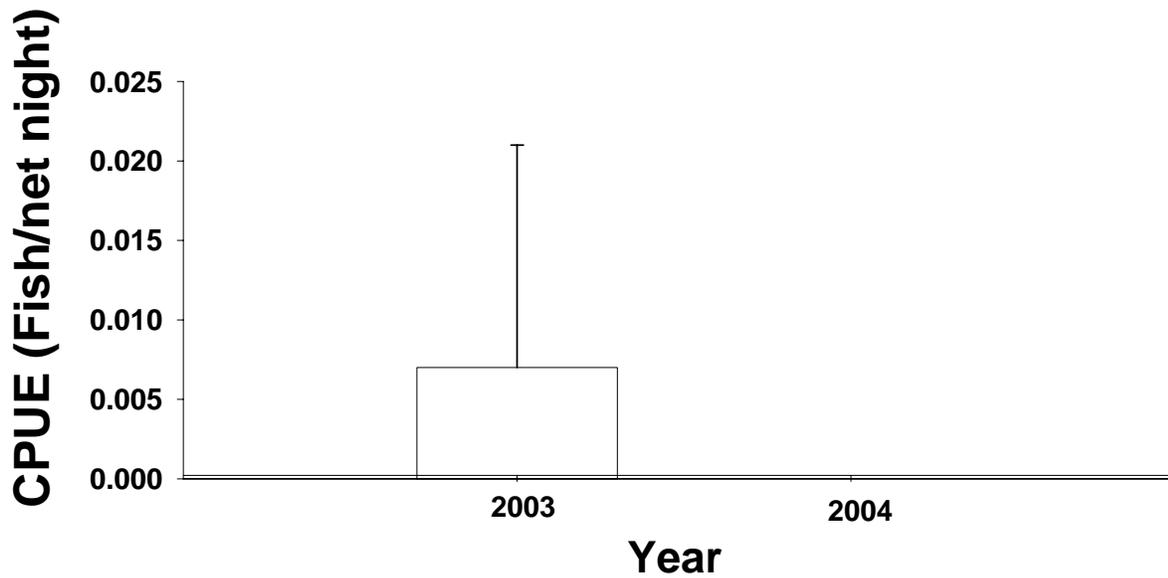


Figure 38. Mean annual catch-per-unit-effort (\pm 2 SE) of bigmouth buffalo in segments 5 and 6 of the Missouri River for hoop nets fished during summer (Fish Community Season) during 2003 - 2004.

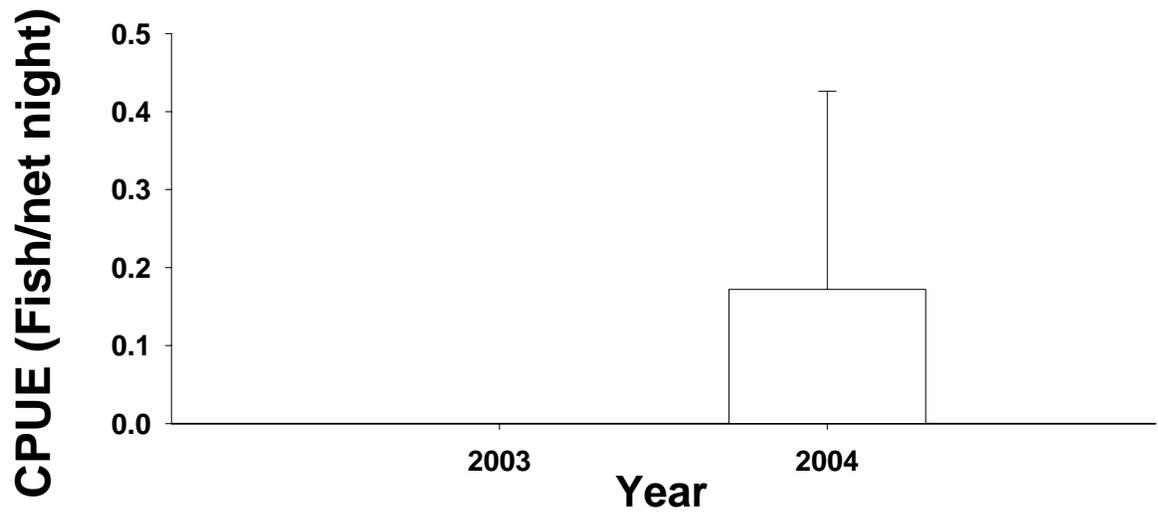


Figure 39. Mean annual catch-per-unit-effort (± 2 SE) of blue suckers in segment 5 and 6 of the Missouri River for hoop nets fished during fall through spring (Sturgeon Season) during 2003 - 2004.

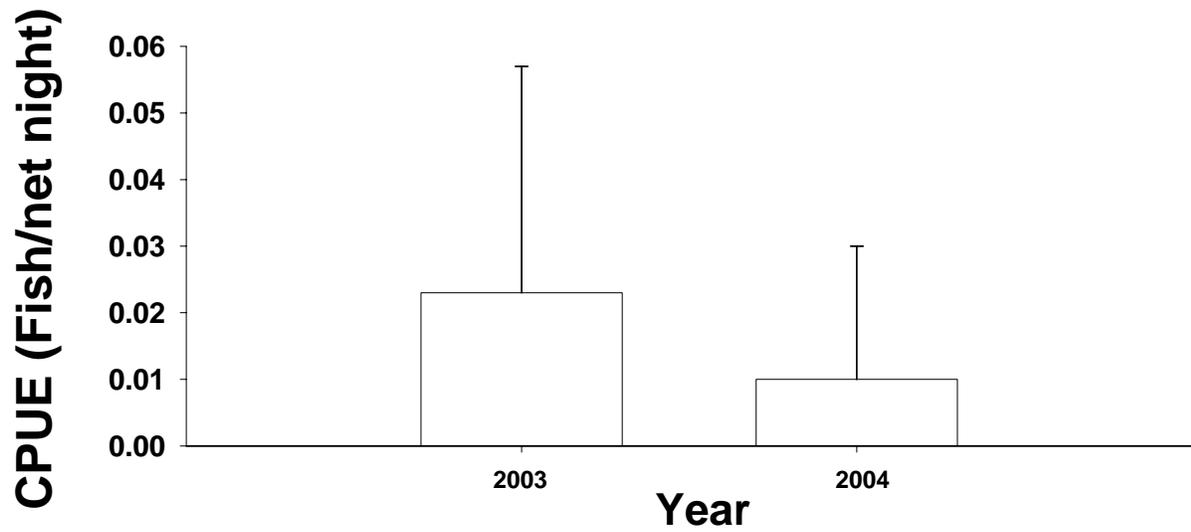


Figure 40. Mean annual catch-per-unit-effort (± 2 SE) of blue suckers in segments 5 and 6 of the Missouri River for hoop nets fished during summer (Fish Community Season) during 2003 - 2004.

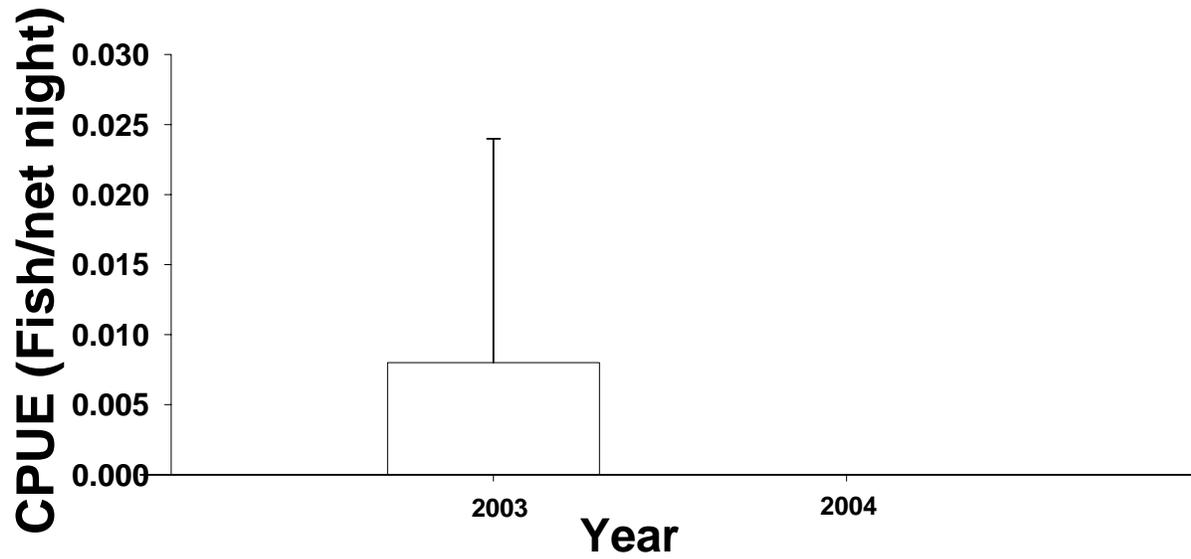


Figure 41. Mean annual catch-per-unit-effort (± 2 SE) of sauger in segments 5 and 6 of the Missouri River for hoop nets fished during summer (Fish Community Season) during 2003 - 2004.

DISCUSSION

Pallid sturgeons were captured in all three continuous macrohabitats with the greatest number captured from outside bends with all fish captured within channel border mesohabitats (Figures 6 and 7). Stock and sub-stock length pallid sturgeon were also captured in the discrete macrohabitats, secondary channel connected large and braided channels. However, braided macrohabitats were only first distinguished as a habitat type in 2004 and greater effort (4 bends) in the Niobrara Delta region of segment 6 will be expended during the 2005 season to assess use of this habitat by juvenile pallid sturgeon. Habitats where pallid sturgeon were caught in 2004 corresponded with habitats where fish were relocated during a telemetry study in segments 5 and 6 during 2000 – 2002 (Jordan et al. in review). Most sonic-tagged age-3 pallid sturgeon were relocated in the main channel (91%) with few fish found in secondary connected channels (4%).

Gill nets and trammel nets were the most effective gears for catching pallid and shovelnose sturgeon in segments 5 and 6 of the Missouri River during 2004. There does not appear to be major seasonal differences in effectiveness of trammel nets to capture sturgeon with similar CPUE in the fall through spring and summer of 2004 (Figures 3, 4, 9 and 10). Initial samples with a new 16-ft otter trawl have captured both sturgeon species in the early part of the 2005 season. The beam trawl, hoop nets, and set lines caught few to zero sturgeon. However, set lines are easy to deploy and may be an effective method to increase samples for diet, age assessment, growth, contaminant, and stable isotope studies that require larger numbers of fish. Detailed analyses of monthly sampling effort in 2003 are ongoing and may indicate specific times where set lines are most effective at capturing sturgeon (Greg Wanner, unpublished data).

Although pallid sturgeons were captured in almost all bends sampled during 2004 there was evidence of fish aggregating within specific river miles (Figure 5). During 2004, seven

pallid sturgeon were captured within river miles 842 to 844 and five fish were captured with rkm 851 to 852. Evidence of aggregations by age-3 pallid sturgeon was also seen in a telemetry study in segments 5 and 6 during 2000 to 2002 (Jordan et al. in review). Aggregations 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. in review). 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 so further study of potential aggregations of pallid sturgeon in this area will be possible.

The mean relative condition of all stocked pallid sturgeon year classes declined since release (Table 5). Condition of most fish was > 1.0 at the time of release 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 sturgeons may also reflect a lack of sufficient prey resources. For the 1999 year class, 5 of 6 fish lost weight; however, all 6 fish gained in length (Table 5). For the oldest cohort, the 1997 year class, 6 of 8 recaptured fish had positive growth rates in terms of weight and all fish increased in length. A macroinvertebrate study was initiated in 2005 to compare prey availability in segments 5 and 6 at Sunshine Bottoms, Verdel Boat Ramp, and in the Niobrara Delta at Santee, Nebraska and Springfield, South Dakota (Figure 2).

The lack of shovelnose sturgeon within the stock and quality length categories indicated no recent recruitment has occurred within segments 5 and 6 of the Missouri River (Table 8). Fish within the preferred and memorable length classes were in good relative condition ($Wr = 97$), thus these fish should be physically capable of reproduction. Personal observations also

identified exceptionally rotund shovelnose sturgeon, most likely females in later stages of egg development. 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 in the states of Nebraska (segments 8, NGPC 2004) and Missouri (segments 13 and 14, Doyle and Starostka 2004). 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. However, failure to effectively sample YOY shovelnose sturgeon with these standard gears in the unchannelized Missouri River remains a possibility. Initiation of sampling in the unchannelized Missouri River below Gavins Point Dam (segment 7) by the South Dakota Department of Game, Fish and Parks in 2005 should further assist in determining effectiveness of standard gears to sample young shovelnose sturgeon in the unchannelized river.

Failure to capture sturgeon, sicklefin, and speckled chubs could also be due to lack of recruitment, but more likely is due to ineffective sampling efficiency of benthic fishes in the main channel of the Missouri River. However, the beam trawl did capture a few silver chubs in the sturgeon (n = 11) and fish community (n = 1) seasons during 2004. The beam trawl caught low numbers (n ≤ 4) of all targeted chub species in segment 9 in Nebraska with greater numbers (n = 6 – 52) captured with the otter trawl (NGPC 2004). All three chub species were captured with the otter trawl (n = 4 – 166) in segments 13 and 14 of the Missouri River in 2003 and sicklefin and speckled chubs were also captured with bag seines and mini-fyke nets (Doyle and Starostka 2004). Initial use of a new 16-ft otter trawl in segments 5 and 6 will hopefully help to identify the presence of the three chub species in segments 5 and 6.

No *Hybognathus* spp. were captured in segments 5 and 6 of the Missouri River in 2004 indicating possible extirpation of these species or ineffective sampling with the chosen standard

gears. However, *Hybognathus* spp. were captured in the lower Missouri River during 2003 with bag seines and mini-fyke nets in Nebraska (NGPC 2004) and Missouri (Doyle and Starostka 2004).

No small blue suckers (< 700 mm TL) were captured in segments 5 and 6 during 2004 with few fish overall being captured with the standard gears (gill nets, trammel nets, beam trawl). At present, blue suckers appear to not be successfully reproducing or survival of early life stages is low 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 (NGPC 2004). These de 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. Therefore, ineffective sampling with either inefficient gears or in habitats not inhabited by the early life stages of blue suckers may also explain the lack of evidence of recruitment. Hoop nets in spring caught the majority of blue suckers in segments 5 and 6 with most caught in a single net set in May. Efficiency of capturing blue suckers with gill nets and trammel nets in the unchannelized Missouri River may be lower than in the channelized segments. Use of hoop nets was continued in 2005 to further address sampling issues for this species.

The population assessment program is adaptive, allowing for changes in standard gear types and experimentation with the effectiveness of non-standard gears. Hoop nets and setlines will continue to be used during the 2005 season to evaluate the effectiveness of these gears and determine appropriate time frames when they are most effective at capturing sturgeon and other native species. 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 will be tested in the sturgeon and fish community seasons as a new standard gear for deep water, benthic habitats.

This new otter trawl shows great promise. During the early 2005 sampling season, the otter trawl has captured pallid and shovelnose sturgeons.

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APPENDICES

Appendix A. Phylogenetic list of Missouri River fishes with corresponding letter and numeric 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 (AFS 1991). Asterisks and bold type denote targeted native Missouri River species.

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

Appendix A. (continued).

Scientific name	Common name	Letter Code
ORDER CLUPEIFORMES		
Clupeidae – herrings		
<i>Alosa alabame</i>	Alabama shad	ALSD
<i>Alosa chrysochloris</i>	Skipjack herring	SJHR
<i>Alosa pseudoharengus</i>	Alewife	ALWF
<i>Dorosoma cepedianum</i>	Gizzard shad	GZSD
<i>Dorosoma petenense</i>	Threadfin shad	TFSD
<i>D. cepedianum 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>Carassus auratus</i>	Goldfish	GDFH
<i>Carassus 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 buchmanii</i>	Ghost shiner	GTSN

Appendix A. (continued).

Scientific name	Common name	Letter Code
Cyprinidae – carps and minnows		
<i>Notropis dorsalis</i>	Bigmouth shiner	BMSN
<i>Notropis greenei</i>	Wedgespot shiner	WSSN
<i>Notropis heterolepsis</i>	Blacknose shiner	BNSN
<i>Notropis hudsonius</i>	Spottail shiner	STSN
<i>Notropis nubilus</i>	Ozark minnow	OZMW
<i>Notropis rubellus</i>	Rosyface shiner	RYSN
<i>Notropis shumardi</i>	Silverband shiner	SBSN
<i>Notropis stilbius</i>	Silverstripe shiner	SSPS
<i>Notropis stramineus</i>	Sand shiner	SNSN*
<i>Notropis topeka</i>	Topeka shiner	TPSN
<i>Notropis volucellus</i>	Mimic shiner	MMSN
<i>Notropis wickliffi</i>	Channel shiner	CNSN
<i>Notropis</i> spp.	Unidentified shiner	UNO
<i>Opsopoeodus emiliae</i>	Pugnose minnow	PNMW
<i>Phenacobius mirabilis</i>	Suckermouth minnow	SMMW
<i>Phoxinus eos</i>	Northern redbelly dace	NRBD
<i>Phoxinus erythrogaster</i>	Southern redbelly dace	SRBD
<i>Phoxinus neogaeus</i>	Finescale dace	FSDC
<i>Pimephales notatus</i>	Bluntnose minnow	BNMW
<i>Pimephales promelas</i>	Fathead minnow	FHMW
<i>Pimephales vigilas</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
Catostomidae - suckers		
<i>Carpionodes carpio</i>	River carpsucker	RVCP
<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 platyrhincus</i>	Mountain sucker	MTSK
<i>Catostomus</i> spp.	Unidentified <i>Catostomus</i> spp.	
<i>Cycleptus elongates</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

Appendix A. (continued).

Scientific name	Common name	Letter Code
Catostomidae - suckers		
<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
	Unidentified Catostomidae	UCT
ORDER SILURIFORMES		
Ictaluridae – bullhead catfishes		
<i>Ameiurus melas</i>	Black bullhead	BKBH
<i>Ameiurus natalis</i>	Yellow bullhead	YLBH
<i>Ameiurusnebulosus</i>	Brown bullhead	
<i>Ameiurus</i> spp.	Unidentified bullhead	
<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.	
<i>Noturus exilis</i>	Slender madtom	SDMT
<i>Noturus flavus</i>	Stonecat	STCT
<i>Noturus gyrinus</i>	Tadpole madtom	TPMT
<i>Noturus nocturnes</i>	Freckled madtom	FKMT
<i>Pylodictis olivaris</i>	Flathead catfish	FHCF
	Unidentified – not <i>Ictalurus</i>	UCF
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	
Umbridae - mudminnows		
<i>Umbra limi</i>	Central mudminnow	
Osmeridae - smelts		
<i>Osmerus mordax</i>	Rainbow smelt	RBST
Salmonidae - trouts		
<i>Coregonus artedi</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>	Bonville cisco	BVSC
<i>Prosopium williamsoni</i>	Mountain whitefish	MTWF

Appendix A. (continued).

Scientific name	Common name	Letter Code
Salmonidae - trouts		
<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
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 daphanus</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>Culea 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

Appendix A. (continued).

Scientific name	Common name	Letter Code
Percichthyidae – temperate basses		
<i>Morone saxatilis</i>	Striped bass	SDBS
<i>M. saxatilis</i> X <i>M. chrysops</i>	Striped-white bass hybrid	
Centrarchidae - sunfishes		
<i>Ambloplites rupestris</i>	Rock bass	RKBS
<i>Archoplites interruptus</i>	Sacramento perch	
<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	
<i>L. cyanellus</i> X <i>L. macrochirus</i>	Green sunfish-bluegill hybrid	GSBG
<i>L. cyanellus</i> X <i>L. spp?</i>	Unknown Green sunfish hybrid	GN*?
<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	
<i>Lepomis</i> spp.	Unidentified <i>Lepomis</i>	ULP
<i>Micropterus dolomieu</i>	Smallmouth bass	SMBS
<i>Micropterus punctatus</i>	Spotted sunfish	STBS
<i>Micropterus salmoides</i>	Largemouth bass	LMBS
<i>Micropterus</i> spp.	Unidentified <i>Micropterus</i> spp.	
<i>Pomoxis annularis</i>	White crappie	WTCP
<i>Pomoxis nigromaculatus</i>	Black crappie	BKCP
<i>Pomoxis</i> spp.	Unidentified crappie	
<i>P. annularis</i> X <i>P. nigromaculatus</i>	White-black crappie hybrid	
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 caproides</i>	Logperch	LGPH
<i>Percina cymatotaenia</i>	Bluestripe darter	BTDR
<i>Percina evides</i>	Gilt darter	GLDR
<i>Percina maculate</i>	Blackside darter	BSDR

Appendix A. (continued).

Scientific name	Common name	Letter Code
Percidae - perches		
<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 vitreum</i>	Walleye	WLEY
<i>S. canadense</i> X <i>S. vitreum</i>	Sauger-walleye hybrid/Saugeye	SGWE
<i>Sander</i> spp.	Unidentified <i>Zander</i> (formerly <i>Stizostedion</i>) spp.	UST
Percidae	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

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
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
Main channel outside bend	Macro	The concave side of a river bend	OSB
Main channel inside bend	Macro	The convex side of a river bend	ISB
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
Non-connected secondary channels	Macro	A side channel, open on the upstream or downstream end, with minimal flow.	SCN
Tributary small mouth	Macro	Mouth of entering tributary whose mean annual discharge is < 20 m ³ /s, mouth width is > 6 m wide and the sample area extends 300 m into the tributary	TRMS
Tributary large mouth	Macro	Mouth of entering tributary whose mean annual discharge is > 20 m ³ /s, and the sample area extends 300 m into the tributary	TRML
Tributary 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
Braided channel	Macro	Riverine area with multiple channels separated by sand bar complexes, no well-defined main channel exists	BRAD
Deranged channel	Macro	Where a braided channel coalesces into a single well-defined main channel	DRNG
Dendritic channel	Macro	Where a single well-defined main channel separates into a braided channel, opposite of deranged channel	DEND

Appendix B. (continued).

Habitat	Scale	Definition	Code
Dam tailwaters	Macro	Area immediately downstream of a dam	DTWT
Bars	Meso	Sandbar or shallow bank-line areas with depth < 1.2 m	BAR
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
Steep	Micro	Area where water depth increases by 1.2 m or more within a 3 m distance. Does not necessarily have to be associated with a bank-line or bar	ST

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 deployed	CPUE units
Trammel net	TN	standard	all	2003 - present	fish/100 m drift
Gillnet – 4 meshes, small mesh set upstream	GN14	standard	fall - spring	2003 - present	fish/net night
Gillnet – 4 meshes, large mesh set upstream	GN41	standard	fall - spring	2003 - present	fish/net night
Otter trawl – 16 ft head rope	OT16	standard	all	2005	fish/100 m trawled
Beam trawl	BT	standard	all	2003 - 2004	fish/100 m trawled
Hoop net	HN	wild	all	2003 - 2005	fish/net night
Set line	SL	wild	all	2003 - 2005	fish/hook night
Bag Seine – quarter arc method pulled upstream	BSQU	standard	summer	2003 - present	fish/m ²
Bag Seine – quarter arc method pulled downstream	BSQD	standard	summer	2003 - present	fish/m ²
Bag Seine – half arc method pulled upstream	BSHU	standard	summer	2003 - present	fish/m ²
Bag Seine – half arc method pulled downstream	BSHD	standard	summer	2003 - present	fish/m ²
Bag seine – rectangular method pulled upstream	BSRU	standard	summer	2003 - present	fish/m ²
Bag seine – rectangular method pulled upstream	BSRD	standard	summer	2003 - present	fish/m ²
Mini-fyke net	MF	standard	summer	2003 - present	fish/net night

Gillnets in 2003 - 2005 had a fifth experimental panel of 1 inch (2.54 cm) bar mesh.

Hoopnets were considered a standard gear during 2003 and 2004 but changed to a wild gear in 2005 due to low catch rates of sturgeon.

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
MT	2	Wolf Point	WFP
MT	2	Culbertson	CBS
MT	2	Milk	MLK
MT	2	Brockton	BRK
MT	2	Poplar	POP
MT	2	Intake – Yellowstone River	INT
MT	2	Sidney – Yellowstone River	SID
MT	2	Fairview – Yellowstone River	FRV
MT	2	Above Intake – Yellowstone River	AIN
SD/NE	3	Sunshine Bottoms	SUN
SD/NE	3	Verdel Boat Ramp	VER
SD/NE	3	Standing Bear Bridge/Running Water Boat Ramp	SBB
SD/NE	4	Mulberry Bend	MUL
NE/IA	4	Sioux City	SIO
NE/IA	4	Bellevue – Platte River Confluence	BEL
NE/IA	4	Rulo	RLO
NE/MO/KS	4	Kansas River	KSR
MO	4	Grand River	GDR
MO	4	Boonville	BOO
MO	4	Jefferson City	JEF
MO	4	Mokane	MOK
MO	4	Herman	HER

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	Avg. Length (mm)	Primary mark	Secondary Mark
2000	Verdel	416	1997	6/6/2000	516	PIT Tag	Elastomer
	Verdel	98	1998	9/20/2000	473	PIT Tag	
	Verdel	4	*	7/6/2000		PIT Tag	Sonic Tag
	Verdel	3	*	9/20/200		PIT Tag	2 w/ sonic
	Running Water	2	*	7/6/2000		PIT Tag	
2002	Verdel	561	2001			PIT Tag	Elastomer
	Sunshine Bottoms	182	1999			PIT Tag	Elastomer
2003	Running Water	300	2002			PIT Tag	Elastomer
	Sunshine Bottoms	301	2002			PIT Tag	Elastomer
2004	Sunshine Bottoms	244	2003			PIT Tag	Elastomer
	Running Water	271	2003			PIT Tag	Elastomer

* indicates broodstock and rehabilitated fish (originally captured from Lake Sharpe) stocked due to iridovirus issues.

Appendix F. Total catch, overall mean catch per unit effort (± 2 SE), and mean CPUE (fish/net night) by mesohabitat within a macrohabitat for all species caught with gillnets from fall through spring (sturgeon season) for segments 5 and 6 of the unchannelized Missouri River during 2004. Species captured are listed phylogenetically 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. Double asterisks indicate sample size < 5 (i.e. < 5 bends with that particular habitat) and SE was not calculated.

Species	Total catch	Overall CPUE	OSB		ISB		CHXO		CONF	
			CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	POOL
Ascipenseridae - sturgeons										
PDSG*	12	0.077 (0.056)	0.081 (0.096)		0.034 (0.048)			0.058 (0.078)		
SNSG*	43	0.250 (0.086)	0.321 (0.204)		0.233 (0.156)	0.333 (0.334)		0.300 (0.204)	1.0 (**)	
Lepisosteidae – gars										
SNGR	2	0.013 (0.018)								
Hiodontidae – mooneyes										
GDEY	1	0.006 (0.012)	0.026 (0.052)							
Clupeidae – herrings										
GZSD	1	0.006 (0.012)				0.083 (0.167)				
Cyprinidae – carps and minnows										
CARP	6	0.032 (0.028)	0.026 (0.051)			0.167 (0.333)				
Catostomidae – suckers										
RVCS	14	0.083 (0.052)	0.108 (0.160)		0.028 (0.056)	0.417 (0.402)				
QLBK	1	0.006 (0.012)								
BMBF*	5	0.026 (0.036)				0.167 (0.333)				
SHRH	41	0.256 (0.057)	0.221 (0.182)		0.392 (0.322)	0.5 (0.366)			1.0 (**)	

Appendix F. (continued).

Species	Total catch	Overall CPUE	OSB		ISB		CHXO		CONF	
			CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	POOL
			<hr/>							
			Ictaluridae – bullhead catfishes							
CNCF	42	0.234 (0.164)	0.074 (0.088)		0.083 (0.112)	1.833 (2.894)		0.242 (0.346)		
FHCF	1	0.006 (0.012)	0.010 (0.020)							
			Esocidae – pikes							
NTPK	1	0.006 (0.012)	0.038 (0.076)							
			Centrarchidae – sunfishes							
SMBS	1	0.006 (0.012)	0.011 (0.022)							
			Percidae – perches							
SGER*	43	0.239 (0.086)	0.196 (0.180)		0.167 (0.188)	0.417 (0.654)		0.250 (0.230)		
WLEY	46	0.269 (0.214)	0.571 (0.760)			0.167 (0.210)		0.342 (0.390)	1.0 (**)	
SGWE	5	0.032 (0.034)	0.026 (0.052)					0.1 (0.200)	1.0 (**)	

Appendix G. 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 trammel nets from fall through spring (sturgeon season) for segments 5 and 6 of the unchannelized Missouri River during 2004. Species captured are listed phylogenetically 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. Double asterisks indicate sample size < 5 (i.e. < 5 bends with that particular habitat) and SE was not calculated.

Species	Total catch	Overall CPUE	OSB		ISB		CHXO		CONF	
			CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	POOL
Ascipenseridae - sturgeons										
PDSG*	7	0.031 (0.026)	0.012 (0.024)	0.190 (**)			0.018 (0.036)			
SNSG*	25	0.123 (0.058)	0.063 (0.070)		0.170 (0.116)		0.079 (0.084)			
Cyprinidae – carps and minnows										
CARP	8	0.039 (0.032)	0.056 (0.074)		0.042 (0.084)		0.042 (0.060)			
Catostomidae – suckers										
RVCS	9	0.040 (0.032)	0.010 (0.020)		0.064 (0.090)		0.089 (0.108)			
SMBF	2	0.008 (0.012)	0.025 (0.050)							
SHRH	6	0.026 (0.026)		0.190 (**)	0.069 (0.092)		0.018 (0.036)			
Ictaluridae – bullhead catfishes										
CNCF	71	0.294 (0.154)	0.510 (0.518)	1.714 (**)	0.101 (0.110)		0.329 (0.430)			
Percichthyidae – temperate basses										
WTBS	4	0.019 (0.024)			0.042 (0.084)		0.039 (0.056)			
Centrarchidae – sunfishes										
SMBS	1	0.005 (0.010)					0.016 (0.032)			
Percidae – perches										
SGER*	23	0.102 (0.064)	0.108 (0.150)	0.571 (**)	0.019 (0.038)		0.100 (0.096)			
WLEY	11	0.053 (0.040)	0.088 (0.144)	0.190 (**)	0.053 (0.054)	0.5 (1.0)	0.016 (0.032)			

Appendix G. (continued).

Species	Total catch	Overall CPUE	OSB		ISB		CHXO		CONF	
			CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	POOL
SGWE	2	0.008 (0.012)	0.010 (0.020)							

Appendix H. 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 a beam-trawl fall through spring (sturgeon season) for segments 5 and 6 of the unchannelized Missouri River. Species captured are listed phylogenetically 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. Double asterisks indicate sample size < 5 (i.e. < 5 bends with that particular habitat) and SE was not calculated.

Species	Total catch	Overall CPUE	OSB		ISB		CHXO		CONF	
			CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	POOL
Ascipenseridae - sturgeons										
SNSG*	3	0.014 (0.016)	0.028 (0.056)	0.021 (0.042)						
Cyprinidae – carps and minnows										
SVCB	11	0.055 (0.038)	0.042 (0.056)	0.021 (0.042)	1.00 (**)	0.107 (0.170)				
Catostomidae - suckers										
SHRH	1	0.004 (0.008)	0.014 (0.028)							
Ictaluridae – bullhead catfishes										
CNCF	20	0.086 (0.076)	0.203 (0.322)	0.045 (0.058)		0.020 (0.040)				
FHCF	2	0.010 (0.014)	0.028 (0.056)							
Centrarchidae - sunfishes										
SMBS	1	0.004 (0.008)					0.020 (0.040)			
Percidae - perches										
SGER*	1	0.004 (0.008)								

Appendix H. (extended).

Species	TRML		SCCL		BRAD		DEND		DRNG	
Macro- Meso-	CHNB	POOL	ITIP	CHNB	POOL	CHNB	POOL	CHNB	POOL	
SNSG*										
SVCB										
SHRH										
CNCF										
FHCF										
SMBS										
SGER*										

Appendix I. 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 trammel nets in summer (fish community season) for segments 5 and 6 of the unchannelized Missouri River during 2004. Species captured are listed phylogenetically 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. Double asterisks indicate sample size < 5 (i.e. < 5 bends with that particular habitat) and SE was not calculated.

Species	Total catch	Overall CPUE	OSB		ISB		CHXO		CONF	
			CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	POOL
Ascipenseridae – sturgeons										
PDSG*	6	0.028 (0.022)	0.024 (0.048)					0.032 (0.064)		
SNSG*	15	0.078 (0.050)	0.088 (0.138)					0.016 (0.032)		
Lepisosteidae – gars										
SNGR	2	0.012 (0.024)			0.073 (0.146)					
Catostomidae – suckers										
RVCS	1	0.006 (0.012)			0.037 (0.074)					
SHRH	4	0.028 (0.034)	0.041 (0.082)					0.070 (0.108)		
Ictaluridae – bullhead catfishes										
CNCF	22	0.146 (0.088)	0.077 (0.118)		0.351 (0.564)			0.169 (0.138)		
Centrarchidae – sunfishes										
SMBS	1	0.006 (0.012)			0.037 (0.074)					
Percidae – perches										
SGER*	3	0.020 (0.024)	0.056 (0.112)					0.032 (0.064)		
WLEY	2	0.022 (0.032)						0.041 (0.082)		

Appendix J. 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 beam trawl in summer (fish community season) for segments 5 and 6 of the unchannelized Missouri River during 2004. Species captured are listed phylogenetically 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. Double asterisks indicate sample size < 5 (i.e. < 5 bends with that particular habitat) and SE was not calculated.

Species	Total catch	Overall CPUE	OSB		ISB		CHXO		CONF	
			CHNB	POOL	CHNB	POOL	CHNB	POOL	CHNB	POOL
Ascipenseridae - sturgeons										
SNSG*	2	0.008 (0.012)	0.016 (0.032)							
Cyprinidae – carps and minnows										
SVCB	1	0.004 (0.008)	0.016 (0.032)							
ERSN	3	0.013 (0.018)								
SFSN	1	0.008 (0.016)		0.029 (0.058)						
Catostomidae - suckers										
RVCS	1	0.004 (0.008)	0.024 (0.048)							
Ictaluridae – bullhead catfishes										
CNCF	5	0.024 (0.024)	0.024 (0.048)							
Centrarchidae - sunfishes										
SMBS	1	0.004 (0.008)		0.024 (0.048)						
WTCP	1	0.004 (0.008)	0.024 (0.048)							

Appendix J. (extended).

Species	TRML		SCCL		BRAD		DEND		DRNG	
Macro- Meso-	CHNB	POOL	ITIP	CHNB	POOL	CHNB	POOL	CHNB	POOL	
SNSG*				Ascipenseridae - sturgeons						
					0.014					
					(0.032)					
				Cyprinidae – carps and minnows						
SVCB					0.016					
ERSN					(0.032)					
				Catostomidae - suckers						
RVCS				Ictaluridae – bullhead catfishes						
CNCF		0.068			0.043					
		(0.136)			(0.046)					
				Centrarchidae - sunfishes						
SMBS										
WTCP										

Appendix K. Total catch, overall mean catch per unit effort (± 2 SE), and mean CPUE (fish/m²) by mesohabitat within a macrohabitat for all species caught with bag seines in the summer (fish community season) for segment 5 and 6 of the unchannelized Missouri River during 2004. Species captured are listed phylogenetically 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. Double asterisks indicate sample size < 5 (i.e. < 5 bends with that particular habitat) and SE was not calculated.

Species	Total catch	Overall CPUE	OSB BAR	ISB BAR	CHXO BAR	SCCL BAR	SCCS BAR	SCN BAR	TRML BAR	TRMS BAR	CONF BAR
Lepisosteidae – gars											
SNGR	1	0.007 (0.014)						0.015 (0.030)			
Clupeidae - herrings											
GZSD	77	0.568 (0.410)	1.797 (2.348)	0.346 (0.612)				0.239 (0.282)			
Cyprinidae – carps and minnows											
RDSN	12	0.087 (0.080)	0.039 (0.077)	0.178 (0.206)							
SFSN	502	3.697 (3.980)	1.578 (2.368)	6.802 (7.686)		1.233 (0.184)					
ERSN	678	5.411 (1.476)	7.976 (3.598)	4.666 (3.174)		7.695 (8.550)		11.275 (**)			
RVSN	2	0.015 (0.030)		0.028 (0.056)							
BMSN	2	0.015 (0.020)		0.014 (0.028)							
STSN	20	0.146 (0.140)	0.402 (0.508)	0.014 (0.028)		0.103 (0.146)					
SNSN*	33	0.250 (0.134)	0.471 (0.490)	0.259 (0.288)		0.107 (0.142)					
BNMW	3	0.022 (0.032)	0.096 (0.192)			0.079 (0.128)					
Catostomidae - suckers											
RVCS	6	0.044 (0.062)		0.094 (0.128)							

Appendix K. (continued).

Species	Total catch	Overall CPUE	OSB BAR	ISB BAR	CHXO BAR	SCCL BAR	SCCS BAR	SCN BAR	TRML BAR	TRMS BAR	CONF BAR
UCS	45	0.328 (0.320)	0.646 (0.732)	0.211 (0.346)		0.058 (0.096)					
SHRH	13	0.095 (0.082)	0.288 (0.404)	0.014 (0.028)		0.088 (0.126)					
URH	31	0.226 (0.216)	0.164 (0.218)	0.014 (0.028)		0.420 (0.414)					
Esocidae – pikes											
NTPK	1	0.007 (0.014)		0.014 (0.028)							
Osmeridae – smelts											
RBST	2	0.015 (0.030)				0.018 (0.036)					
Percichthyidae – temperate basses											
WTPH	1	0.007 (0.014)				0.009 (0.018)					
WTBS	13	0.113 (0.080)	0.100 (0.122)	0.033 (0.044)		0.105 (0.142)					
Centrarchidae – sunfishes											
RKBS	4	0.029 (0.046)	0.135 (0.228)								
GNSF	3	0.022 (0.26)		0.019 (0.038)		0.057 (0.096)					
BLGL	13	0.095 (0.074)	0.545 (0.548)	0.119 (0.166)							
SMBS	98	0.714 (0.340)	1.313 (1.238)	0.912 (1.198)		0.628 (0.466)					
LMBS	26	0.190 (0.130)	0.031 (0.042)	0.197 (0.186)		0.195 (0.222)		0.513 (**)			
WTCP	3	0.022 (0.026)	0.116 (0.082)			0.048 (0.096)					

Appendix K. (continued).

Species	Total catch	Overall CPUE	OSB BAR	ISB BAR	CHXO BAR	SCCL BAR	SCCS BAR	SCN BAR	TRML BAR	TRMS BAR	CONF BAR
Percidae - perches											
YWPH	49	0.357 (0.238)	0.096 (0.154)	0.313 (0.272)		0.598 (0.636)					
JYDR	22	0.160 (0.178)	0.197 (0.242)	0.384 (0.508)							
WLEY	2	0.015 (0.020)		0.014 (0.028)		0.048 (0.096)					
UST	2	0.015 (0.030)				0.096 (0.192)					

Appendix K. (extended).

Species	SCCL BAR	SCCL ITIP	SCCS BAR	SCCS ITIP	BRAD BAR	DEND BAR	DRNG BAR	
			Lepisosteidae – gars					
SNGR								
			Clupeidae - herrings					
GZSD								
			Cyprinidae – carps and minnows					
RDSN								
SFSN								
CARP								
ERSN								
RVSN								
BMSN								
STSN								
SNSN*								
BNMW								
			Catostomidae - suckers					
RVCS								
UCS								
SHRH								
URH								
			Esocidae - pikes					
NTPK								
MSKG								
TGMG								
			Osmeridae - smelts					
RBST								
			Percichthyidae – temperate basses					
WTPH								
WTBS								

Appendix K. (extended).

Species

Macro- Meso-	SCCL BAR	SCCL ITIP	SCCS BAR	SCCS ITIP	BRAD BAR	DEND BAR	DRNG BAR
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Centrarchidae - sunfishes

RKBS
GNSF
BLGL
SMBS
LMBS
WTCP

Percidae - perches

JYDR
YWPH
SGER*
WLEY
UST

Appendix L. Total catch, overall mean catch per unit effort (± 2 SE), and mean CPUE (fish/net night) by mesohabitat within a macrohabitat for all species caught with mini-fyke nets in summer (fish community season) for segments 5 and 6 of the unchannelized Missouri River during 2004. Species captured are listed phylogenetically 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. Double asterisks indicate sample size < 5 (i.e. < 5 bends with that particular habitat) and SE was not calculated.

Species	Total catch	Overall CPUE	OSB BAR	ISB BAR	CHXO BAR	SCCL BAR	SCCS BAR	SCN BAR	TRML BAR	TRMS BAR	CONF BAR
Lepisosteidae – gars											
LNGR	1	0.010 (0.020)	0.03 (0.062)								
SNGR	14	0.133 (0.086)	0.062 (0.088)	0.139 (0.142)	1.000 (2.000)	1.943 (5.592)					
Clupeidae - herrings											
GZSD	5	0.048 (0.056)	0.125 (0.250)	0.083 (0.122)							
Cyprinidae – carps and minnows											
RDSN	23	0.219 (0.184)	0.135 (0.208)	0.389 (0.446)		0.086 (0.096)					
SFSN	491	4.676 (1.328)	5.004 (3.168)	5.694 (2.506)		3.286 (10.244)	7.00 (**)				
CARP	4	0.038 (0.046)	0.046 (0.060)			0.057 (0.676)					
ERSN	447	4.257 (1.248)	3.631 (1.512)	5.472 (2.596)	0.500 (1.000)	3.686 (11.860)	1.000 (**)	1.000 (**)			
STSN	31	0.295 (0.212)	0.083 (0.126)	0.500 (0.544)		0.286 (0.266)					
SNSN*	173	1.648 (0.834)	1.379 (1.280)	1.861 (1.432)		0.800 (3.354)	25.000 (**)	4.000 (**)			
BNMW	18	0.171 (0.140)	0.565 (0.654)	0.083 (0.094)		0.029 (0.338)					
UCY	14	0.133 (0.102)	0.056 (0.074)	0.306 (0.274)		0.029 (0.058)					

Appendix L. (continued).

Species	Total catch	Overall CPUE	OSB BAR	ISB BAR	CHXO BAR	SCCL BAR	SCCS BAR	SCN BAR	TRML BAR	TRMS BAR	CONF BAR
Catostomidae - suckers											
RVCS	2	0.019 (0.038)	0.050 (0.100)								
UCS	2	0.019 (0.038)		0.056 (0.112)							
BMBF*	2	0.019 (0.038)									
SHRH	8	0.076 (0.088)	0.031 (0.062)	0.194 (0.250)							
URH	44	0.419 (0.426)	0.417 (0.229)	0.694 (1.138)		0.114 (0.136)					
Ictaluridae – bullhead catfishes											
BKBH	2	0.019 (0.026)		0.056 (0.078)							
CNCF	7	0.067 (0.082)	0.042 (0.084)	0.167 (0.232)							
STCT	3	0.029 (0.032)		0.056 (0.078)							
Osmeridae - smelts											
RBST	3	0.029 (0.032)	0.031 (0.062)	0.056 (0.078)							
Percichthyidae – temperate basses											
WTBS	16	0.152 (0.160)	0.063 (0.250)	0.194 (0.388)		0.200 (0.256)					
Centrarchidae - sunfishes											
RKBS	8	0.076 (0.070)		0.056 (0.078)		0.057 (0.080)					
GNSF	7	0.067 (0.056)	0.063 (0.126)	0.056 (0.078)		0.114 (0.136)					
OSSF	1	0.010 (0.020)			0.500 (1.000)						

Appendix L. (continued).

Species	Total catch	Overall CPUE	OSB BAR	ISB BAR	CHXO BAR	SCCL BAR	SCCS BAR	SCN BAR	TRML BAR	TRMS BAR	CONF BAR
BLGL	22	0.210 (0.124)	0.306 (0.318)	0.278 (0.272)		0.086 (0.126)					
SMBS	711	6.771 (10.118)	17.808 (33.204)	1.972 (1.208)		1.943 (0.946)	2.00 (**)				
LMBS	39	0.371 (0.290)	0.156 (0.162)	0.556 (0.786)		0.371 (0.272)					
WTCP	27	0.257 (0.158)	0.067 (0.092)	0.556 (0.418)	0.500 (1.000)	0.114 (0.136)					
BKCP	11	0.105 (0.140)	0.033 (0.066)	0.083 (0.122)		0.200 (0.400)					
Percidae - perches											
JYDR	84	0.800 (0.314)	0.333 (0.222)	1.000 (0.602)		1.000 (0.662)	3.000 (**)				
YWPH	52	0.495 (0.362)	0.267 (0.406)	0.806 (0.886)		0.429 (0.474)					
SGER*	2	0.019 (0.026)		0.028 (0.056)		0.029 (0.058)					
WLEY	3	0.029 (0.032)	0.067 (0.092)		0.500 (1.000)						
Sciaenidae - drums											
FWDM	4	0.038 (0.060)		0.083 (0.166)	0.500 (1.000)						

Appendix L. (extended).

Species	SCCL BAR	SCCL ITIP	SCCS BAR	SCCS ITIP	BRAD BAR	DEND BAR	DRNG BAR	
			Lepisosteidae – gars					
LNGR SNGR								
			Clupeidae - herrings					
GZSD								
			Cyprinidae – carps and minnows					
RDSN SFSN CARP ERSN STSN SNSN* BNMW UCY								
			Catostomidae - suckers					
RVCS UCS BMBF* SHRH URH								
			Ictaluridae – bullhead catfishes					
BKBH CNCF STCT								
			Osmeridae - smelts					
RBST								
			Percichthyidae – temperate basses					
WTBS								

Appendix L. (extended).

Species

Macro- Meso-	SCCL BAR	SCCL ITIP	SCCS BAR	SCCS ITIP	BRAD BAR	DEND BAR	DRNG BAR
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Centrarchidae - sunfishes

RKBS
GNSF
OSSF
BLGL
SMBS
LMBS
WTCP
BKCP

Percidae - perches

JYDR
YWPH
SGER*
WLEY

Sciaenidae - drums

FWDM
