PNNL-17583

2006 Annual Synthesis Report

Pallid Sturgeon Population Assessment Project and Associated Fish Community Monitoring for the Missouri River

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August 2008

Eric Oldenburg
Ryan Harnish
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Prepared for the

Missouri River Recovery – Integrated Science Program

U.S. Army Corps of Engineers

Yankton, South Dakota

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

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Pacific Northwest National Laboratory

Richland, WA 99354

Executive Summary

Pallid sturgeon, *Scaphirhynchus albus*, have declined throughout the Missouri River since dam construction and inception of the Bank Stabilization and Navigation Project in 1912. Their decline likely is due to the loss and degradation of their natural habitat as a result of changes in the river's structure and function, as well as the pallid sturgeon's inability to adapt to these changes. The U. S. Army Corps of Engineers has been working with state and federal agencies to develop and conduct a Pallid Sturgeon Population Assessment Program (PAP), with the goal of recovering pallid sturgeon populations. The PAP has organized the monitoring and assessment efforts into distinct geographic segments, with state and federal resource management agencies possessing primary responsibility for one or more segment. To date, the results from annual monitoring have been reported for individual PAP segments. However, monitoring results have not been summarized or evaluated for larger spatial scales, encompassing more than one PAP segment.

This report describes a summary conducted by the Pacific Northwest National Laboratory (PNNL) that synthesizes the 2006 sampling year monitoring results from individual segments. The study area encompasses the Missouri River from Fort Peck Dam, Montana at river mile (RM) 1772 downstream to the confluence of the Missouri and Mississippi Rivers near St. Louis, Missouri (RM 0). The Pallid Sturgeon Population Assessment Team has designated 14 sampling segments on the Missouri River mainstem and the lower Kansas River encompassing high priority management areas for pallid sturgeon. Segments 1-4, encompass the area from Fort Peck Dam to the headwaters of Lake Sakakawea, comprising the upper basin monitoring area. Segments 5-14, encompass the region from Fort Randall Dam to the mouth of the Missouri River and comprise the lower basin monitoring area. The data were summarized for the entire study area (combined basins), as well as individually for the upper and lower basins.

Sampling and data collection were conducted by the Pallid Sturgeon Population Assessment Teams in accordance with standard operating procedures established by a panel of representatives from various state and federal agencies involved with pallid sturgeon recovery on the Missouri River (Drobish 2006a) and compiled in the Missouri

Department of Conservation (MDC) database. Records from the MDC database were transferred to PNNL for data evaluation and summarization.

For the 2006 sampling year in the Missouri River basin, four gear types were used to sample a range of 106 to 130 bends during the sturgeon and fish community seasons. In the upper basin, three gear types were used to sample 35 to 36 bends during the sturgeon and fish community seasons. Inside bends and outside bends were the most frequently sampled macrohabitats during both seasons in the upper basin, where approximately 25% and 24%, respectively, of the sampling effort occurred. Main channel borders and island tips were the most frequently sampled mesohabitats during the sturgeon season in the upper basin, with approximately 87% and 13%, respectively, of the sampling effort occurring there. During the fish community season, approximately 64% of the sampling effort occurred in main channel border mesohabitats, while 28% of the sampling effort occurred in sand bar habitats, owing to the deployment of gear (mini-fyke nets) specific to that mesohabitat. In the lower basin, four gear types were used to sample a range of 88 to 106 bends during the sturgeon and fish community seasons. The inside bends and channel crossovers were the most frequently sampled macrohabitats during both seasons in the lower basin, where approximately 58% and 23%, respectively, of the sampling effort occurred. Main channel borders and pools were the most frequently sampled mesohabitats during the sturgeon season in the lower basin, with approximately 76% and 22%, respectively, of the sampling effort occurring there. During the fish community season in the lower basin, approximately 69% of the sampling effort occurred in main channel border mesohabitats, while 29% of the sampling effort occurred in sand bar habitats.

A total of 133 pallid sturgeon were captured during the sturgeon season, while 89 were captured during the fish community season. Sampling from the lower basin during the sturgeon season resulted in 110 pallid sturgeon captured, comprising 83% of the catch during the sturgeon sampling season. The relative abundance of pallid sturgeon captured with trammel nets during the sturgeon sampling season was generally greater in the lower basin than the upper basin, with the mean catch per unit effort (CPUE) ranging from 0.00 fish/100 m to approximately 0.06 fish/100 m in the lower basin. During the sturgeon sampling season the relative abundance of pallid sturgeon captured with otter trawls was generally similar in the lower basin (for segments with CPUE > 0.0) and upper basin. During the fish community season, the geographic trend in catch changed such that sampling from the upper basin resulted in 73% (*N* = 65) of the pallid sturgeon catch. Accordingly, the geographic trend in relative abundance during the fish community season changed such that trammel net and otter trawl sampling from the upper basin resulted in comparatively larger mean CPUE than from the lower basin. The mean trammel net CPUE during the fish community season ranged from 0.00 fish/100 m to approximately 0.07 fish/100 m in the upper basin. Random sampling with standard gears resulted in catches of more juvenile (< 840 mm) pallid sturgeon than adult (≥ 840 mm) pallid sturgeon. In the upper basin 39 juvenile pallid sturgeon were captured during the 2006 sampling year; 17 during the sturgeon season and 22 during the fish community season. There were 3 adult pallid sturgeon captured during the 2006 sampling year in the upper basin; all during the fish community season. In the lower basin, 75 juvenile pallid sturgeon were captured during the 2006 sampling year; 64 during the sturgeon season and 11 during the fish community season. There were 7 adult pallid sturgeon captured from the lower basin during the 2006 sampling year, all during the sturgeon season. In both the upper and lower basin, most juvenile pallid sturgeon were captured from main channel inside bend macrohabitats, and main channel border mesohabitats, where most of the total sampling effort occurred. During the sturgeon season, 4 of the 7 adult pallid sturgeon captured with gill nets were from main channel crossover macrohabitat, which received only 25% of the effort during that season; 6 of these fish were captured from pool mesohabitats. During the fish community season, the 3 adult pallid sturgeon were captured in main channel crossover and inside bend macrohabitat, all located within main channel border mesohabitat. The length frequency distribution of pallid sturgeon captured during the 2006 sampling year is positively skewed, with juvenile fish representing the vast majority of fish sampled. The fork lengths of all pallid sturgeon captured ranged from 120 to 1410 mm, including 13 fish larger than 840 mm.

During the 2006 sampling year in the upper and lower basins of the Missouri River 12,198 shovelnose sturgeon *Scaphirhynchus platorynchus* were captured during the sturgeon season, while 2924 were captured during the fish community season. Sampling from the lower basin during the sturgeon season resulted in 11,883 shovelnose sturgeon captured, comprising 97% of the catch during the sturgeon sampling season. During the fish community season, there were no marked differences in shovelnose sturgeon catch from the upper basin and lower basin. The mean trammel net CPUE during the fish community season decreased markedly from the 2005 sampling year to the 2006 sampling year, resulting in a decrease in overall mean CPUE from 1.6 fish/100 m to 0.9 fish/100 m, respectively. During the sturgeon sampling season the relative abundance of shovelnose sturgeon captured with trammel nets was generally larger in the lower basin than the upper basin, with the mean CPUE ranging from 0.4 fish/100 m to approximately 3.2 fish/100 m in the lower basin. During the fish community season, the geographic trend in relative abundance remained relatively unchanged such that trammel net sampling from the lower basin resulted in comparatively larger mean CPUE than from the upper basin. As with trammel nets, the mean otter trawl CPUE during the fish community season decreased from the 2005 sampling year to the 2006 sampling year, resulting in a small decrease in overall mean CPUE from 0.6 fish/100 m to 0.5 fish/100 m, respectively. During the 2006 sturgeon season, the mean CPUE of shovelnose sturgeon captured with otter trawls ranged from 0.07 fish/100 m to 1.6 fish/100 m in the lower basin, and 0.04 fish/100 m to 0.40 fish/100 m in the upper basin. During the 2006 fish community season, the geographic trend in relative abundance remained relatively unchanged such that otter trawl sampling from the lower basin resulted in comparatively larger mean CPUE than from the upper basin. During both sampling seasons, most shovelnose sturgeon were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred. The majority of shovelnose sturgeon were captured from main channel border mesohabitats, which for most gears was also the location of greatest effort. The length frequency distribution of shovelnose sturgeon captured during the 2006 sampling year is negatively skewed, with juvenile fish representing a small component of fish sampled. The fork lengths of all shovelnose sturgeon captured ranged from approximately 30 to 890 mm, with a mode near 570 mm.

During the 2006 sampling year in the upper and lower basins of the Missouri River 461 sturgeon chub *Macrhybopsis gelida* were captured during the sturgeon season, while 1229 were captured during the fish community season. Sampling from the upper basin during the sturgeon season resulted in 397 sturgeon chub captured, comprising 86% of the catch during the sturgeon sampling season. During the fish community season, sturgeon chub catch from the lower basin segments increased, however catch from the upper basin segments remained markedly larger, comprising 65% of the total catch during the season. A total of 523 sicklefin chub *Macrhybopsis meeki* were captured during the sturgeon season, while 1028 were captured during the fish community season. Sampling from the upper basin during the sturgeon season resulted in 103 sicklefin chub captured, comprising 20% of the catch during the sturgeon sampling season. During the fish community season sicklefin chub catch from the upper basin increased to 328 fish, comprising 32% of the total seasonal catch. Speckled chub *Macrhybopsis aestivalis* were captured only from the lower basin of the Missouri River during the 2006 sampling year, where a total of 963 speckled chub were captured during the sturgeon season, while 2685 were captured during the fish community season. During the 2006 sampling year in the upper and lower basins of the Missouri River 2289 blue suckers *Cycleptus elongates* were captured during the sturgeon season, while 973 were captured during the fish community season. Sampling from the lower basin during the sturgeon season resulted in 2275 blue suckers captured, comprising 99% of the catch during the sturgeon sampling season. Sampling from the lower basin during the fish community season resulted in 957 blue suckers captured, comprising 98% of the catch during the fish community sampling season. A total of 519 sauger *Sander canadense* were captured during the 2006 sturgeon season, while 428 were captured during the fish community season. Sampling from the lower basin during the sturgeon season resulted in 398 sauger captured, comprising 77% of the catch during the sturgeon sampling season. A total of 272 sauger were captured from the upper basin during the fish community season, comprising 64% of the total catch. During the 2006 sampling year in the upper and lower basins of the Missouri River nine sand shiners *Notropis stramineus* were captured during the sturgeon season, while 7266 were captured during the fish community season. Sampling from the lower basin during the sturgeon season resulted in 8 sand shiners captured, while one was captured from the upper basin. A total of 5232 sand shiners were captured from the lower basin during the fish community season, comprising 72% of the total catch. A total of 40 fish of the genus *Hybognathus* were captured during the sturgeon season, while 883 were captured during the fish community season. Sampling from the lower basin during the sturgeon season resulted in 33 *Hybognathus* captured, while seven were captured from the upper basin. A total of 790 *Hybognathus* were captured from the upper basin during the fish community season, comprising 89% of the total catch.

Oldenburg, E.W., T.P. Hanrahan, R.A. Harnish, B.J. Bellgraph, J.P. Duncan, and C.H. Allwardt. 2008. 2006 Annual Synthesis Report, Pallid Sturgeon Population Assessment Project and Associated Fish Community Monitoring for the Missouri River. PNNL-17583. Pacific Northwest National Laboratory, Richland, WA.

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1.0 Introduction

Pallid sturgeon, *Scaphirhynchus albus*, which have adapted to life in the turbid river systems of the Missouri, Yellowstone, and Mississippi rivers, have declined in numbers to the point where they are in danger of extinction. Pallid sturgeon have declined throughout the Missouri River since dam construction and inception of the Bank Stabilization and Navigation Project in 1912 (Carlson et al. 1985). Their decline is due to many factors including the loss and degradation of their natural habitat as a result of changes in the river's structure and function, as well as incidental harvest through commercial fishing for shovelnose sturgeon *Scaphirhynchus platorynchus*.

On November 30, 2000, the U.S. Fish and Wildlife Service (USFWS) completed the "Biological Opinion on the Operation of the Missouri River Main Stem System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System" (2000 BiOp). In response to the 2000 BiOp, the U. S. Army Corps of Engineers (Corps) developed monitoring and restoration projects to avoid jeopardizing pallid sturgeon populations. As part of their Implementation Plan, the Corps is working with USFWS, state and federal agencies, and universities to develop and conduct a Pallid Sturgeon Population Assessment Project (PAP). Rather than evaluate a single endangered species, the PAP was designed to monitor and evaluate the pallid sturgeon and nine native Missouri River fish species. The nine native Missouri River fish species that were targeted for assessment included shovelnose sturgeon, sturgeon chub *Macrhybopsis gelida*, sicklefin chub *Macrhybopsis meeki*, speckled chub *Macryhobopsis aestivalis,* blue sucker *Cycleptus elongates*, sauger *Sander canadense*, western silvery minnow *Hybognathus argyritis*, plains minnow *Hybognathus placitus* (the two *Hybognathus* species are pooled and analyzed together under the PAP), and sand shiner *Notropis stramineus*. The objectives of the PAP are as follows:

1. Document annual results and long-term trends in pallid sturgeon population abundance and geographic distribution throughout the Missouri River System.
2. Document annual results and long-term trends of habitat use of wild pallid sturgeon and hatchery stocked pallid sturgeon by season and life stage.

3. Document population structure and dynamics of pallid sturgeon in the Missouri River System.
4. Evaluate annual results and long-term trends in native target species population abundance and geographic distribution throughout the Missouri River system.
5. Document annual results and long-term trends of habitat usage of the native target species by season and life stage.
6. Document annual results and long-term trends of all non-target species population abundance and geographic distribution throughout the Missouri River system, where sample size is greater than fifty individuals.

The objectives of the PAP are addressed by developing and implementing a monitoring and assessment scheme for the entire Missouri River Basin (Drobish 2006b). The PAP has organized the monitoring and assessment efforts into distinct geographic segments (described below), with state and federal resource management agencies possessing primary responsibility for one or more segment. To date, the results from annual monitoring have been reported for individual PAP segments. However, monitoring results have not been summarized or evaluated for larger spatial scales, encompassing more than one PAP segment.

The objective of this report is to summarize PAP data from multiple segments. The intent of this larger spatial scale summary is to address the six PAP objectives identified above by synthesizing annual monitoring results from multiple sampling segments.

2.0 Study Area

The study area encompasses the Missouri River from Fort Peck Dam, Montana at river mile (RM) 1771.5 downstream to the confluence of the Missouri and Mississippi Rivers near St. Louis, Missouri (RM 0) and the lower reach of the Kansas River. The Pallid Sturgeon Population Assessment Team has designated 14 sampling segments on the Missouri River mainstem and the lower Kansas River encompassing high priority management areas for pallid sturgeon (Figure 2.1). Segments are delineated as follows:

1. Fort Peck Dam downstream to the Milk River (RM 1771.5-1760)
2. Milk River downstream to Wolf Point (RM 1760-1701)
3. Wolf Point downstream to the confluence with Yellowstone River (RM 1701-1582)
4. Confluence with the Yellowstone River through the headwaters of Lake Sakakawea (RM 1582-1568)
5. Fort Randall Dam downstream to the Niobrara River (RM 880-845)
6. Niobrara River downstream to the headwaters of Lewis and Clark Lake (RM 845-825)
7. Gavins Point Dam downstream to Lower Ponca Bend (RM 811-753)
8. Lower Ponca Bend downstream to the Platte River (RM 753-595.5)
9. Platte River downstream to Kansas River (RM 595.5-367.5)
10. Kansas River downstream to Grand River (RM 367.5-250)
11. Kansas River upstream to Johnson County Weir
12. Grand River to Glasgow-Combined into segment 13-Effective 7/01/2005.
13. Grand River to the Osage River (RM 250-130)
14. Osage River downstream to the mouth (RM 130-0)

Segments 1-4, encompass the area from Fort Peck Dam to the headwaters of Lake Sakakawea, comprising the upper basin monitoring area of the PAP (hereafter referred to as upper basin). Segments 5-14, encompass the region from Fort Randall Dam to the mouth of the Missouri River and comprise the lower basin monitoring area of the PAP (hereafter referred to as lower basin).

Segments were further divided into a number of "bends" for sampling purposes. Each bend is comprised of three continuous macrohabitats, a main channel outside bend, a main channel inside bend, and a main channel crossover. Additional distinct macrohabitats present some bends to included large tributary mouths; small tributary mouths; tributary confluences; large and small secondary connected channels; non-connected secondary channels; deranged; braided; dendritic; and wild (all other macrohabitats).

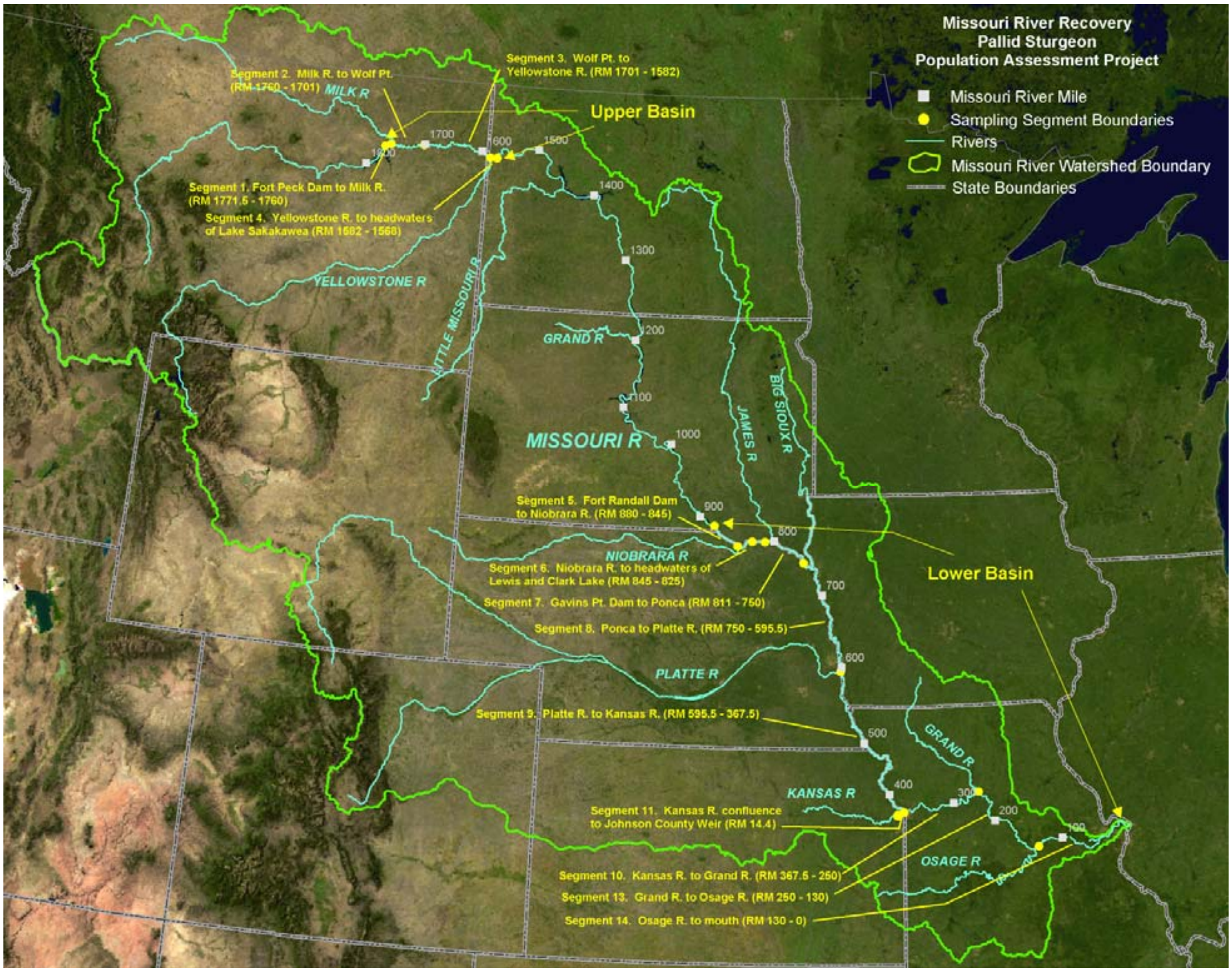

Figure 2.1. Pallid Sturgeon Population Assessment Project Study Area

3.0 Methods

Sampling and data collection were conducted by the Pallid Sturgeon Population Assessment Team in accordance with standard operating procedures established by a panel of representatives from various state and federal agencies involved with pallid sturgeon recovery on the Missouri River (Drobish 2006a). The sampling year was divided into two seasons, sturgeon season (start date based on water temperature) and fish community season (beginning July 1). The sturgeon season generally encompassed the fall through spring period and focused on sturgeon populations. The fish community season occurred during the summer and continued to assess the sturgeon species, but placed additional emphasis on the native fish community. Detailed explanations of methods and study design can be obtained from Drobish (2006a and b).

Data were compiled in the Missouri Department of Conservation (MDC) database. Records from the MDC database were transferred to Pacific Northwest National Laboratory for data evaluation and summarization. This report summarizes data for the upper and lower basins of the Missouri River from 2003 - 2006.

3.1 Habitat Classifications

Habitat classifications for the Missouri River environment were developed by the Pallid Sturgeon Population Assessment Team to describe regions of sampling efforts. Bend macrohabitat classifications include: a main channel crossover (CHXO), main channel outside bend (OSB), and main channel inside bend (ISB). Ten additional macrohabitats present within the river system include large tributary mouths (TRML), small tributary mouths (TRMS), tributary confluence areas (CONF), large secondary connected channels (SCCL), small secondary connected channels (SCCS), deranged channels (DRNG), braided channels (BRAD), dendritic channels (DEND), non-connected secondary channels (SCCN), and wild (WILD), which includes habitats not previously defined. Mesohabitats, located within macrohabitats, include sand bars (BARS), dam tailwater (DTWT), main channel border (CHNB), island tip (ITIP), pool (POOL), and thalweg (TLWG). A complete list of habitat types and their associated definitions can be found in Appendix A.

3.2 Sampling Gears

Sampling gear and methods were developed by the Pallid Sturgeon Population Assessment Team and are described in detail within Drobish (2006a). A comprehensive list of gear types used in this study can be obtained from Appendix B. A brief summary of methods used for the primary gear types analyzed in this report are as follows.

Trammel Net

Trammel nets were used during both seasons within the upper and lower basins of the Missouri River. The standard trammel net was 125 feet (38.1 m) long by 8 feet (2.4 m) high and had 1-inch (2.5 cm) inner panel bar mesh and 8-inch (20.3 cm) outer panel bar mesh. The top of the trammel nets was supported by foam float line while the bottom contained lead line. Green dyed trammel nets of identical dimensions to the aforementioned trammel nets were also utilized in this study. Green dyed trammel nets are now considered a standard gear; however, these nets were considered wild gears at the time of data collection and were thus excluded from analyses of standard gears in this report. Trammel nets were drifted a minimum of 75 m and a maximum of 300 m.

Otter Trawl

Otter trawls were used during both seasons within the upper and lower basins of the Missouri River. The standard otter trawl had a mouth of 16 feet (4.9 m) wide, and was 3 feet (0.9 m) high, and 25 feet (7.6 m) long. Otter trawls had ¼ -inch (6 mm) inner bar mesh, ¾ -inch (19 mm) outer bar mesh, and a cod-end opening of 16 inches (40.6 cm). Trawl doors were 30 inches (76.2 cm) by 15 inches (38.1 cm) and were used to keep the trawl deployed while on the bottom of the river. Otter trawls were fished in a downstream direction with the distance of the trawl dependant on the size of the macrohabitat and mesohabitat being sampled. Otter trawls were towed a minimum of 75 m and a maximum of 300 m.

Gill Net

Gill nets were used only during the sturgeon season within the lower basin of the Missouri River. The standard gill net (i.e., GN14 and GN41) was a 100-foot (30.5-m) long by 8-foot (2.4-m) high experimental gill net that consisted of four 25-foot (7.6-m) long panels. Each net had one panel each of 1.5-inch (3.8-cm), 2-inch (5.1-cm), 3-inch (7.6-cm), and 4-inch (10.2-cm) multifilament square/bar mesh. A 200-foot (61.0-m) experimental gill net (i.e., GN18 and GN81) was also used and consisted of two 100-foot nets attached together. The first panel set was randomly selected. Gill nets were set over night with a maximum set time of 24 hours.

Mini-fyke Net

Mini-fyke nets were used only during the fish community season within the upper and lower basins of the Missouri River. The standard mini-fyke net consisted of two rectangular frames, both 3.9 feet (1.2 m) wide and 2 feet (0.6 m) high, and two, 2-foot (0.6-m) diameter hoops. A 15-foot (4.5-m) by 2-foot (0.6-m) lead was connected to the second frame. The mini-fyke net had 1/8-inch (3-mm) ace mesh with a 65 pound (29.5 kg) lead core line. Mini-fyke nets were set over night with a maximum set time of 24 hours. Green dyed gill nets of identical dimensions to the aforementioned gill nets were also utilized in this study. Green dyed gill nets are now considered a standard gear; however, these nets were considered wild gears at the time of data collection and were thus excluded from analyses of standard gears in this report.

3.3 Data Analysis

Data was processed and analyzed using Microsoft Access, Excel, and Statistical Analysis Systems (SAS Institute, Inc., Version 9.1). Figures were generated using SigmaPlot (Systat Software, Inc., Version 10.0).

Relative Abundance

Relative abundance was reported as catch per unit effort (CPUE) with the range of variability expressed as plus or minus two standard errors (SE). Catch per unit effort for trammel nets was reported as the number of fish sampled per 100 meters drifted. Catch per unit effort for otter trawls was reported as the number of fish sampled per 100 meters towed. Catch per unit effort for gill nets was reported as the number of fish sampled per

100-foot gill net night (200-foot gill nets were reported as two net nights). Catch per unit effort for mini-fyke nets was reported as number of fish sampled per net night. Catch per unit effort was calculated using random sampling data from the PAP. Standard one-inch trammel net and otter trawl data was used to evaluate the intra-annual aspects of relative abundance, as these gears were the only standard gears used during both the sturgeon and fish community seasons. The standardized sampling unit during this study was the bend. Catch per unit effort was calculated for each individual deployment. Deployment CPUEs were then averaged to get mean CPUE for each bend sampled. Mean bend CPUE and associated variability (2 SE) was calculated for each reach of interest [i.e., basin or 30-mile reach (see below)].

Geographic Distribution

Geographic distribution was analyzed for the lower basin of the Missouri River. Only data obtained through random sampling was utilized in these analyses. The lower basin was divided into twenty-nine 30-mile long reaches [mean reach length (± 2 SE) = 29.9 ± 0.7 miles; see Appendix F]. Catch per unit effort and associated variability was calculated for each 30-mile reach by averaging all bends within each given reach. Geographic distribution was reported in scatter plots. Scatter plot loci with no dots represent 30-mile reaches in which no bends were sampled during the sampling period of interest (i.e., season or year). Scatter plot loci with no associated error bars represent 30-mile reaches in which only one bend was sampled during the sampling period of interest.

Habitat Associations

Habitat associations were evaluated by comparing the percent of the total catch captured within a given macrohabitat or mesohabitat type to the percent of the overall effort put into the given habitat type for each standard gear type. Only random sampling data was utilized in habitat association analysis. For pallid sturgeon, habitat associations were completed separately for pallid sturgeon less than 840 mm and greater than or equal to 840 mm length categories.

Population Structure

Length frequency distribution was used to evaluate population structure. Sturgeon lengths are reported as fork length, while all other fish lengths are reported as total length. Length frequency was calculated using all captures from standard and wild gears. Two-panel length frequency figures include random and non-random sampling data in the upper panel and only random sampling data in the lower panel.

4.0 Results

4.1 Effort

4.1.1 Combined Basins

For the 2006 sampling year in the upper and lower basins of the Missouri River, four gear types were used to sample a range of 106 to 130 bends during the sturgeon and fish community seasons (Table 4.1). The inside bends and channel crossovers were the most frequently sampled macrohabitats during both seasons, where approximately 53% and 23%, respectively, of the sampling effort occurred. Main channel borders and pools were the most frequently sampled mesohabitats during the sturgeon season, with approximately 78% and 19%, respectively, of the sampling effort occurring there (Table 4.2). During the fish community season, approximately 68% of the sampling effort occurred in main channel border mesohabitats, while 29% of the sampling effort occurred in sand bar habitats, owing to the deployment of gear (mini-fyke nets) specific to that mesohabitat.

Gear deployments during the sturgeon season included one-inch trammel nets, gill nets (lower basin only), and otter trawls. On average, the greatest mean effort per bend was with gill nets, whereby the equivalent of 20 net nights per bend was applied. A total of 106 bends were sampled with gill nets, which were deployed for an equivalent of 2121 net nights. Main channel border and pool mesohabitats comprised 59% and 39%, respectively, of the gill net effort, which occurred predominantly in inside bend (52%) and main channel crossover (49%) macrohabitats. Trammel nets were used to sample 130 bends, with a total effort equivalent to 1277 one hundred-meter deployments. Ninety-five percent of these deployments occurred in main channel border mesohabitats, mostly within inside bend and main channel crossover macrohabitats. Otter trawls were used to sample 130 bends during the sturgeon season, with a total effort equivalent to 1085 one hundred-meter deployments. Ninety-four percent of otter trawl deployments were located in main channel border mesohabitats, mostly within inside bend and channel crossover macrohabitat.

Gear deployments during the fish community season included one-inch trammel nets, mini-fyke nets, and otter trawls. Trammel nets were used to sample 124 bends, with a total effort equivalent to 1132 one hundred-meter deployments. Ninety-six percent of these deployments occurred in main channel border mesohabitats, mostly within inside bend (54%) and main channel crossover (24%) macrohabitats. A total of 129 bends were sampled with mini-fyke nets, which were deployed for an equivalent of 1024 net nights. Sand bar mesohabitats comprised 95% of the mini-fyke net effort, which occurred predominantly in inside bend, main channel crossover, and small secondary connected channel macrohabitats. Otter trawls were used to sample 128 bends during the fish community season, with a total effort equivalent to 1260 one hundred-meter deployments. Ninety-seven percent of otter trawl deployments were located in main channel border mesohabitats, mostly within inside bend and channel crossover macrohabitat.

Trammel nets sampled at least one bend from all but two of the 30-mile reaches in the Missouri River in 2006 (Figure 4.1). However, the total distance drifted per bend was greater in the upper basin and lower 30-mile reaches of the lower basin (RM 0 - 300) than in the upper 30-mile reaches of the lower basin (RM 300 - 800). Otter trawls also sampled at least one bend from all but two of the 30-mile reaches in the Missouri River. However, the total distance otter trawls were towed per bend was generally greater in the lower basin as compared to the upper basin (Figure 4.2). Similar to otter trawls, mini-fyke nets sampled all but two bends and the total number of net nights per bend was generally greater in the lower basin as compared to the upper basin (Figure 4.3). Gill nets were not utilized in the upper basin but were used to sample at least one bend from each 30-mile reach within the lower basin. The total number of net nights per bend was generally greater in the lower reaches (RM 0 – 300) as compared to the upper reaches (RM 300 - 900) of the lower basin (Figure 4.4).

Table 4.1. Number of bends sampled, mean effort per bend (mean number of deployments), and total effort by macrohabitat (total number of deployments) for the upper and lower basins of the Missouri River during the sturgeon and fish community seasons of the 2006 sampling year.

Gear	Number of Bends	Mean Effort	Macrohabitat													
			BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Fall through Spring - Sturgeon Season																
1-Inch Trammel Net	130	9.8	41	291	16	13	14	657	124	103	10	0	0	0	0	8
Gill Net [a]	106	20.0	68	519	12	10	8	1,257	167	54	18	0	0	8	0	0
Otter Trawl	130	8.3	51	249	9	10	6	520	112	99	24	0	0	5	0	0
Summer – Fish Community Season																
1-Inch Trammel Net	124	9.1	36	274	7	8	8	608	120	51	18	0	0	2	0	0
Mini-Fyke Net	129	7.9	49	171	5	2	2	442	94	77	141	19	2	2	18	0
Otter Trawl	128	9.8	53	304	8	7	10	673	120	66	15	0	0	4	0	0

[a]Each 200 foot gill net (i.e., GN18 and GN81) deployment recorded as two deployments

Table 4.2. Number of bends sampled, mean effort per bend (mean number of deployments), and total effort by mesohabitat (total number of deployments) for the upper and lower basins of the Missouri River during the sturgeon and fish community seasons of the 2006 sampling year.

Gear	Number of bends	Mean Effort	Mesohabitat					
			BAR	POOL	CHNB	TLWG	ITIP	DTWT
Fall through Spring – Sturgeon Season								
1-Inch Trammel Net	130	9.8	0	0	1,213	2	54	8
Gill Net [a]	106	20.0	0	836	1,251	0	34	0
Otter Trawl	130	8.3	0	2	1,015	3	65	0
Summer – Fish Community Season								
1-Inch Trammel Net	124	9.1	1	0	1,086	1	44	0
Mini-Fyke Net	129	7.9	977	0	12	0	27	0
Otter Trawl	128	9.8	0	0	1,225	0	35	0

[a]Each 200 foot gill net (i.e., GN18 and GN81) deployment recorded as two deployments

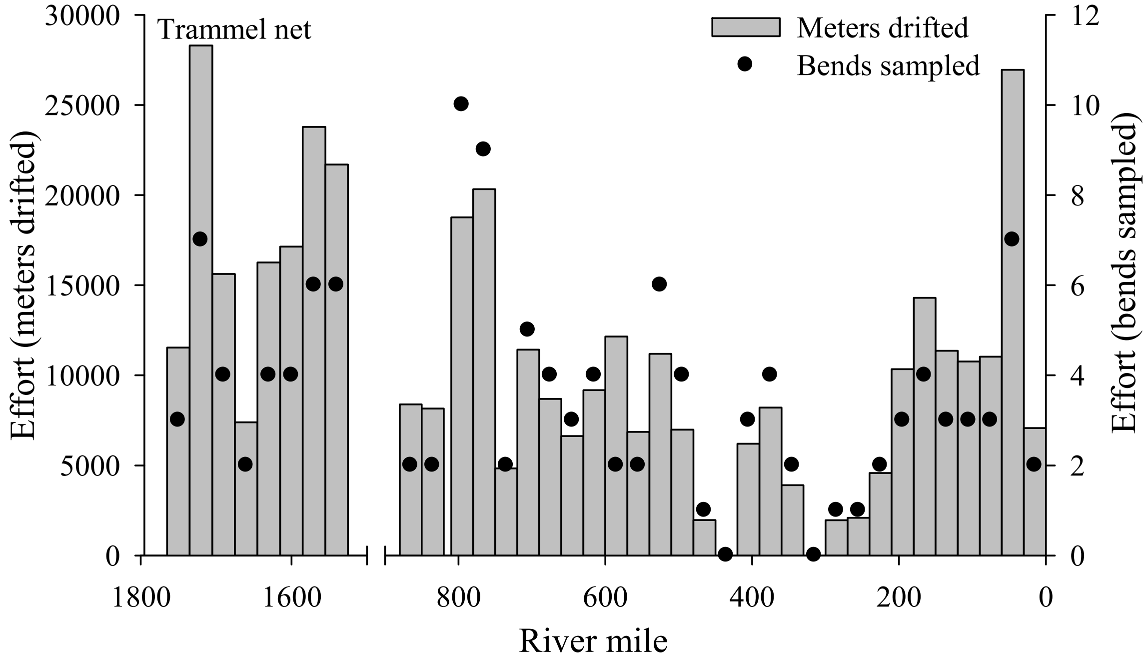

Figure 4.1. Trammel net sampling effort by river mile (30-mile bins) for the upper and lower basins of the Missouri River in 2006. The histogram demonstrates the number of meters drifted while the scatter plot shows the number of bends sampled per 30-mile reach.

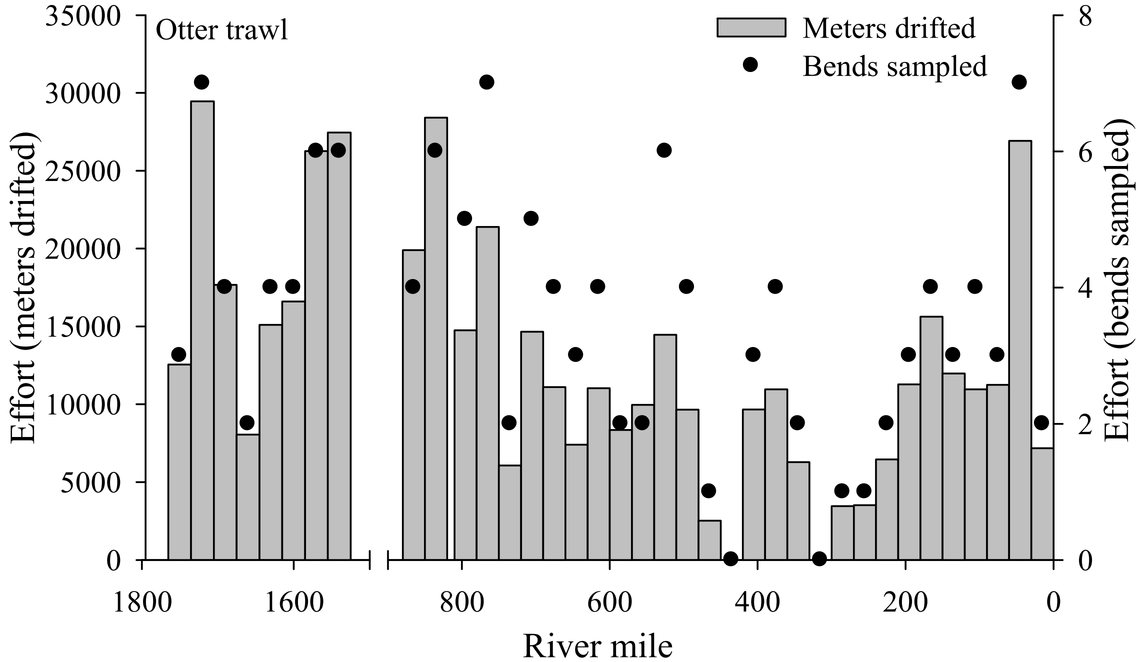

Figure 4.2. Otter trawl sampling effort by river mile (30-mile bins) for the upper and lower basins of the Missouri River in 2006. The histogram demonstrates the number of meters towed while the scatter plot shows the number of bends sampled per 30-mile reach.

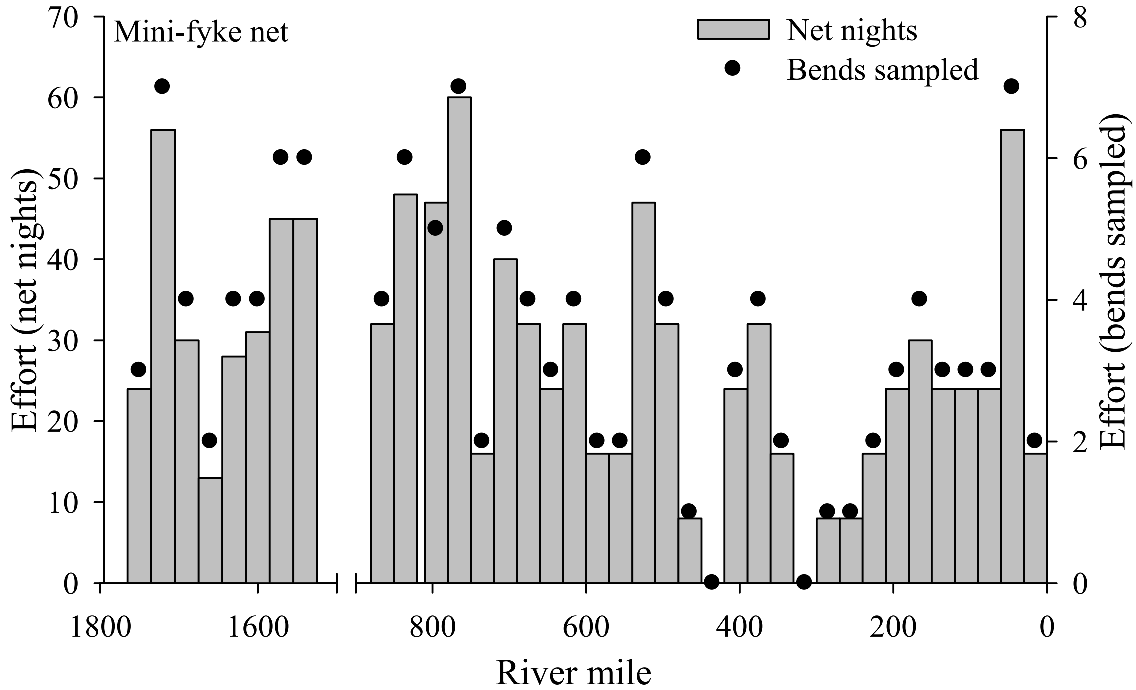

Figure 4.3. Mini-fyke net sampling effort by river mile (30-mile bins) for the upper and lower basins of the Missouri River in 2006. The histogram demonstrates the number of net nights while the scatter plot shows the number of bends sampled per 30-mile reach.

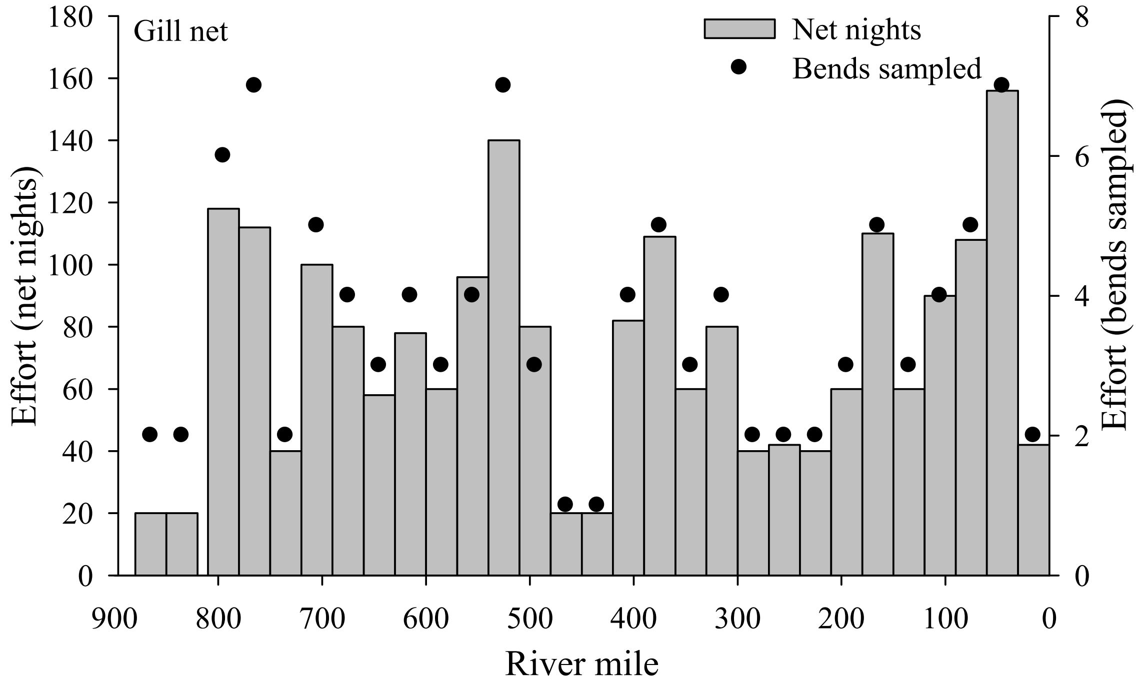

Figure 4.4. Gill net sampling effort by river mile (30-mile bins) for the lower basin of the Missouri River in 2006. The histogram demonstrates the number of net nights while the scatter plot shows the number of bends sampled per 30-mile reach.

4.1.2 Upper Basin

For the 2006 sampling year in the upper basin of the Missouri River, three gear types were used to sample 35 to 36 bends during the sturgeon and fish community seasons (Table 4.3). The inside bends and outside bends were the most frequently sampled macrohabitats during both seasons, where approximately 25% and 24% of the sampling effort occurred, respectively. Channel crossover macrohabitats also received considerable effort, accounting for 22% of the total for both seasons. Main channel borders and island tips were the most frequently sampled mesohabitats during the sturgeon season, with approximately 87% and 13%, respectively, of the sampling effort occurring there (Table 4.4). During the fish community season, approximately 64% of the sampling effort occurred in main channel border mesohabitats, while 28% of the sampling effort occurred in sand bar habitats, owing to the deployment of gear (mini-fyke nets) specific to that mesohabitat.

Gear deployments during the sturgeon season included one-inch trammel nets and otter trawls. On average a similar mean effort per bend was applied with both gears, whereby the equivalent of approximately 9 one hundred-meter deployments per bend was applied. Trammel nets were used to sample 36 bends. Eighty-eight percent of these deployments occurred in main channel border mesohabitats, mostly within inside bend, outside bend, and main channel crossover macrohabitats. Otter trawls were used to sample 36 bends during the sturgeon season. Eighty-five percent of otter trawl deployments were located in main channel border mesohabitats, mostly within inside bend, outside bend, and channel crossover macrohabitat.

Gear deployments during the fish community season included one-inch trammel nets, mini-fyke nets, and otter trawls. Trammel nets were used to sample 36 bends, with a total effort equivalent to 318 one hundred-meter deployments. Ninety percent of these deployments occurred in main channel border mesohabitats, mostly within inside bend, outside bend, and main channel crossover macrohabitats. A total of 36 bends were sampled with mini-fyke nets, which were deployed for an equivalent of 272 net nights. Sand bar mesohabitats comprised 92% of the mini-fyke net effort, which occurred predominantly in inside bend, as well as small and large secondary connected channel macrohabitats. Otter trawls were used to sample 35 bends during the fish community season, with a total effort equivalent to 289 one hundred-meter deployments. Ninety-four percent of otter trawl deployments were located in main channel border mesohabitats, mostly within outside bend and inside bend macrohabitats.

Table 4.3. Number of bends sampled, mean effort per bend (mean number of deployments), and total effort by macrohabitat (total number of deployments) for the upper basin of the Missouri River during the sturgeon and fish community seasons of the 2006 sampling year.

Gear	Number of Bends	Mean Effort	Macrohabitat													
			BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Fall through Spring - Sturgeon Season																
1-Inch Trammel Net	36	8.8	0	77	2	0	0	96	84	58	0	0	0	0	0	0
Otter Trawl	36	8.7	0	77	2	0	0	87	78	58	10	0	0	0	0	0
Summer – Fish Community Season																
1-Inch Trammel Net	36	8.8	0	85	0	0	0	99	88	33	11	0	0	2	0	0
Mini-Fyke Net	36	7.6	0	21	2	0	0	90	31	54	55	17	0	0	2	0
Otter Trawl	35	8.3	0	77	2	0	0	86	88	33	3	0	0	0	0	0

Table 4.4. Number of bends sampled, mean effort per bend (mean number of deployments), and total effort by mesohabitat (total number of deployments) for the upper basin of the Missouri River during the sturgeon and fish community seasons of the 2006 sampling year.

Gear	Number of bends	Mean Effort	Mesohabitat				
			BAR	POOL	CHNB	TLWG	ITIP
Fall through Spring – Sturgeon Season							
1-Inch Trammel Net	36	8.8	0	0	279	2	36
Otter Trawl	36	8.7	0	0	266	3	43
Summer – Fish Community Season							
1-Inch Trammel Net	36	8.8	1	0	285	1	31
Mini-Fyke Net	36	7.3	243	0	3	0	18
Otter Trawl	35	8.3	0	0	273	0	16

4.1.3 Lower Basin

For the 2006 sampling year in the lower basin of the Missouri River, four gear types were used to sample a range of 88 to 106 bends during the sturgeon and fish community seasons (Table 4.5). The inside bends and channel crossovers were the most frequently sampled macrohabitats during both seasons, where approximately 58% and 23%, of the sampling effort occurred, respectively. Main channel borders and pools were the most frequently sampled mesohabitats during the sturgeon season, with approximately 76% and 22%, respectively, of the sampling effort occurring there (Table 4.6). During the fish community season, approximately 69% of the sampling effort occurred in main channel border mesohabitats, while 29% of the sampling effort occurred in sand bar habitats, owing to the deployment of gear (mini-fyke nets) specific to that mesohabitat.

Gear deployments during the sturgeon season included one-inch trammel nets, gill nets, and otter trawls. On average the greatest mean effort per bend was with gill nets, whereby the equivalent of 20 net nights per bend was applied. A total of 106 bends were sampled with gill nets, which were deployed for an equivalent of 2121 net nights. Main channel border and pool mesohabitats comprised 59% and 39%, respectively, of the gill net effort, which occurred predominantly in inside bend (52%) and main channel crossover (49%) macrohabitats. Trammel nets were used to sample 94 bends, with a total effort equivalent to 960 one hundred-meter deployments. Ninety-seven percent of these deployments occurred in main channel border mesohabitats, mostly within inside bend and main channel crossover macrohabitats. Otter trawls were used to sample 94 bends during the sturgeon season, with a total effort equivalent to 773 one hundred-meter deployments. Ninety-seven percent of otter trawl deployments were located in main channel border mesohabitats, mostly within inside bend and channel crossover macrohabitats.

Gear deployments during the fish community season included one-inch trammel nets, mini-fyke nets, and otter trawls. Trammel nets were used to sample 88 bends, with a total effort equivalent to 814 one hundred-meter deployments. Ninety-eight percent of these deployments occurred in main channel border mesohabitats, mostly within inside bend (63%) and main channel crossover (23%) macrohabitats. A total of 93 bends were sampled with mini-fyke nets, which were deployed for an equivalent of 752 net nights. Sand bar mesohabitats comprised 98% of the mini-fyke net effort, which occurred predominantly in inside bend, main channel crossover, and small secondary connected channel macrohabitats. Otter trawls were used to sample 93 bends during the fish community season, with a total effort equivalent to 971 one hundred-meter deployments. Ninety-eight percent of otter trawl deployments were located in main channel border mesohabitats, mostly within inside bend and channel crossover macrohabitats.

Table 4.5. Number of bends sampled, mean effort per bend (mean number of deployments), and total effort by macrohabitat (total number of deployments) for the lower basin of the Missouri River during the sturgeon and fish community seasons of the 2006 sampling year.

Gear	Number of Bends	Mean Effort	Macrohabitat													
			BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Fall through Spring - Sturgeon Season																
1-Inch Trammel Net	94	10.2	41	214	14	13	14	561	40	45	10	0	0	0	0	8
Gill Net [a]	106	20.0	68	519	12	10	8	1,257	167	54	18	0	0	8	0	0
Otter Trawl	94	8.2	51	172	7	10	6	433	34	41	14	0	0	5	0	0
Summer – Fish Community Season																
1-Inch Trammel Net	88	9.3	36	189	7	8	8	509	32	18	7	0	0	0	0	0
Mini-Fyke Net	93	8.1	49	150	3	2	2	352	63	23	86	2	2	2	16	0
Otter Trawl	93	10.4	53	227	6	7	10	587	32	33	12	0	0	4	0	0

[a]Each 200 foot gill net (i.e., GN18 and GN81) deployment recorded as two deployments

Table 4.6. Number of bends sampled, mean effort per bend (mean number of deployments), and total effort by mesohabitat (total number of deployments) for the lower basin of the Missouri River during the sturgeon and fish community seasons of the 2006 sampling year.

Gear	Number of bends	Mean Effort	Mesohabitat					
			BAR	POOL	CHNB	TLWG	ITIP	DTWT
Fall through Spring – Sturgeon Season								
1-Inch Trammel Net	94	10.2	0	0	934	0	18	8
Gill Net [a]	106	20.0	0	836	1,251	0	34	0
Otter Trawl	94	8.2	0	2	749	0	22	0
Summer – Fish Community Season								
1-Inch Trammel Net	88	9.3	0	0	801	0	13	0
Mini-Fyke Net	93	8.1	734	0	9	0	9	0
Otter Trawl	93	10.4	0	0	952	0	19	0

[a]Each 200 foot gill net (i.e., GN18 and GN81) deployment recorded as two deployments

4.2 Pallid Sturgeon

4.2.1 Combined Basins

During the 2006 sampling year in the upper and lower basins of the Missouri River, 133 pallid sturgeon were captured during the sturgeon season, while 89 were captured during the fish community season (Figure 4.5). Sampling from the lower basin during the sturgeon season resulted in 110 pallid sturgeon captured, comprising 83% of the catch during the sturgeon sampling season. Sampling from segment 6 alone (RM 825 – 845) resulted in 26% (N = 29) of the lower basin total for the sturgeon season. During the fish community season, the geographic trend in catch changed such that sampling from the upper basin resulted in 73% (N = 65) of the pallid sturgeon catch. Sampling from segment 6 yielded 13 pallid sturgeon, or 54% of the lower basin catch during that sampling season. Very few pallid sturgeon were caught during the fish community season in other segments within the lower basin. During both sampling seasons in the upper basin, segments 3 and 4 (RM 1568 – 1701) accounted for most of the pallid sturgeon catch.

Relative abundance of pallid sturgeon differed between sampling seasons and years. During the fish community season, the mean CPUE of hatchery-reared pallid sturgeon captured with trammel nets was 0.011 fish/100 m, which decreased to 0.008 fish/100 m during the sturgeon season (Figure 4.6). The mean CPUE of wild and unknown origin pallid sturgeon captured with trammel nets was comparatively low for both sampling seasons, ranging from approximately 0.001 to 0.002 fish/100 m. While no wild-origin pallid sturgeon were captured with otter trawls during the fish community season, the otter trawl mean CPUE of hatchery origin fish was approximately 0.007 fish/100 m during both the fish community and sturgeon sampling seasons (Figure 4.6). The mean CPUE of unknown origin pallid sturgeon captured with otter trawls was comparatively low for both sampling seasons, with the greatest values around 0.001 fish/100 m. The mean CPUE of hatchery-reared pallid sturgeon captured with trammel nets and otter trawls was larger during 2006 than 2005; conversely, the mean CPUE of wild pallid sturgeon with both gears was lower during 2006 than 2005 (Figure 4.7).

Relative abundance of pallid sturgeon also differed among sampling segments. During the sturgeon sampling season the relative abundance of pallid sturgeon captured with trammel nets was generally greater in the lower basin than the upper basin, with the mean CPUE ranging from 0.00 fish/100 m to approximately 0.06 fish/100 m in the lower basin (Figure 4.8). Sampling from the upper reaches of segments 8 and 9 (RM 367 – 750) resulted in some of the largest trammel net CPUE during the sturgeon season, a finding also observed for segment 9 (RM 367 – 595) during the fish community season. During the fish community season, the geographic trend in relative abundance changed such that trammel net sampling from the upper basin resulted in comparatively larger mean CPUE than from the lower basin. The mean trammel net CPUE during the fish community season ranged from 0.00 fish/100 m to approximately 0.07 fish/100 m in the upper basin. Sampling from segments 3 and 4 (RM 1568 – 1701) resulted in some of the largest trammel net CPUE in the upper basin. No pallid sturgeon were caught with trammel nets between RMs 0 and 500, or between RMs 600 and 800 during the fish community season. During the sturgeon sampling season the relative abundance of pallid sturgeon captured with otter trawls was generally similar in the lower basin (for segments with CPUE > 0) and upper basin (Figure 4.9). No pallid sturgeon were caught with otter trawls between RMs 0 and 500 during the sturgeon season. During the fish community season, the geographic trend in relative abundance changed such that otter trawl sampling from the upper basin resulted in comparatively larger mean CPUE than from the lower basin. With the exception of the vicinity of RM 350, no pallid sturgeon were caught with otter trawls between RMs 0 and 650 during the fish community season (Figure 4.9).

Relative abundance of pallid sturgeon has generally increased during the period from 2003 to 2006, in both the upper and lower basins, as the sampling program has become fully implemented. When combining sampling seasons in 2006, the relative abundance of pallid sturgeon captured with trammel nets was similar between the upper and lower basins (0.00 to 0.05 fish/100 m; Figure 4.10). During 2005 and 2006, the mean trammel net CPUE seemed to be highest in upper basin segments 3 and 4 (RM 1568 – 1701) and lower basin segments 8 and 9 (RM 368 – 750). The relative abundance of pallid sturgeon captured with otter trawls had a slightly larger range in the upper basin (0.00 to 0.04 fish/100 m) than the lower basin (0.00 to 0.02 fish/100 m) for combined sampling seasons in 2006 (Figure 4.11). For both trammel net and otter trawl sampling in 2006, it appears that the mean CPUE from the upper segments (Segments 5 through 9; RM 368 – 880) of the lower basin are most similar to the mean CPUE from the upper basin. Within the lower basin segments 10 through 13 (RM 130 – 368), the relative abundance of pallid sturgeon captured with otter trawls decreased from sampling years 2005 to 2006. While gill net sampling only occurred in the lower basin, the relative abundance of pallid sturgeon sampled with this gear has also generally increased during the period from 2003 to 2006 (Figure 4.12). During 2006, there appeared to be no significant geographic trends throughout the lower basin for pallid sturgeon relative abundance sampled with gill nets, where mean CPUE ranged from 0.00 to 0.05 fish/net night.

Random sampling with standard gears resulted in catches of more juvenile (< 840 mm) pallid sturgeon than adult (≥ 840 mm) pallid sturgeon. One hundred fourteen juvenile pallid sturgeon were captured during the 2006 sampling year; 81 during the sturgeon season and 33 during the fish community season (Table 4.7). During both seasons, most juvenile pallid sturgeon were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred. The vast majority of all juvenile pallid sturgeon were captured from main channel border mesohabitats, which for most gears was also the location of greatest effort (Table 4.8). Ten adult pallid sturgeon were captured during the 2006 sampling year; 7 during the sturgeon season and 3 during the fish community season (Table 4.9). During the sturgeon season 4 of the 7 adult pallid sturgeon captured with gill nets were from main channel crossover macrohabitat, which received only 25% of the effort during that season; 6 of these fish were captured from pool mesohabitats (Table 4.10). During the fish community season, the 3 adult pallid sturgeon were captured in main channel crossover and inside bend macrohabitat, all located within main channel border mesohabitat.

The population structure of pallid sturgeon captured during the 2006 sampling year was positively skewed, with hatchery-reared juvenile fish representing the vast majority of fish sampled (Figure 4.13). The fork lengths of all 222 pallid sturgeon captured ranged from 120 to 1410 mm, including 12 fish (1 hatchery-reared, 5 wild, 6 unknown origin) larger than 840 mm. Random sampling accounted for 69% (N = 154) of the pallid sturgeon captured. The length frequency distribution from random sampling was similar to that from a combination or random and non-random sampling.

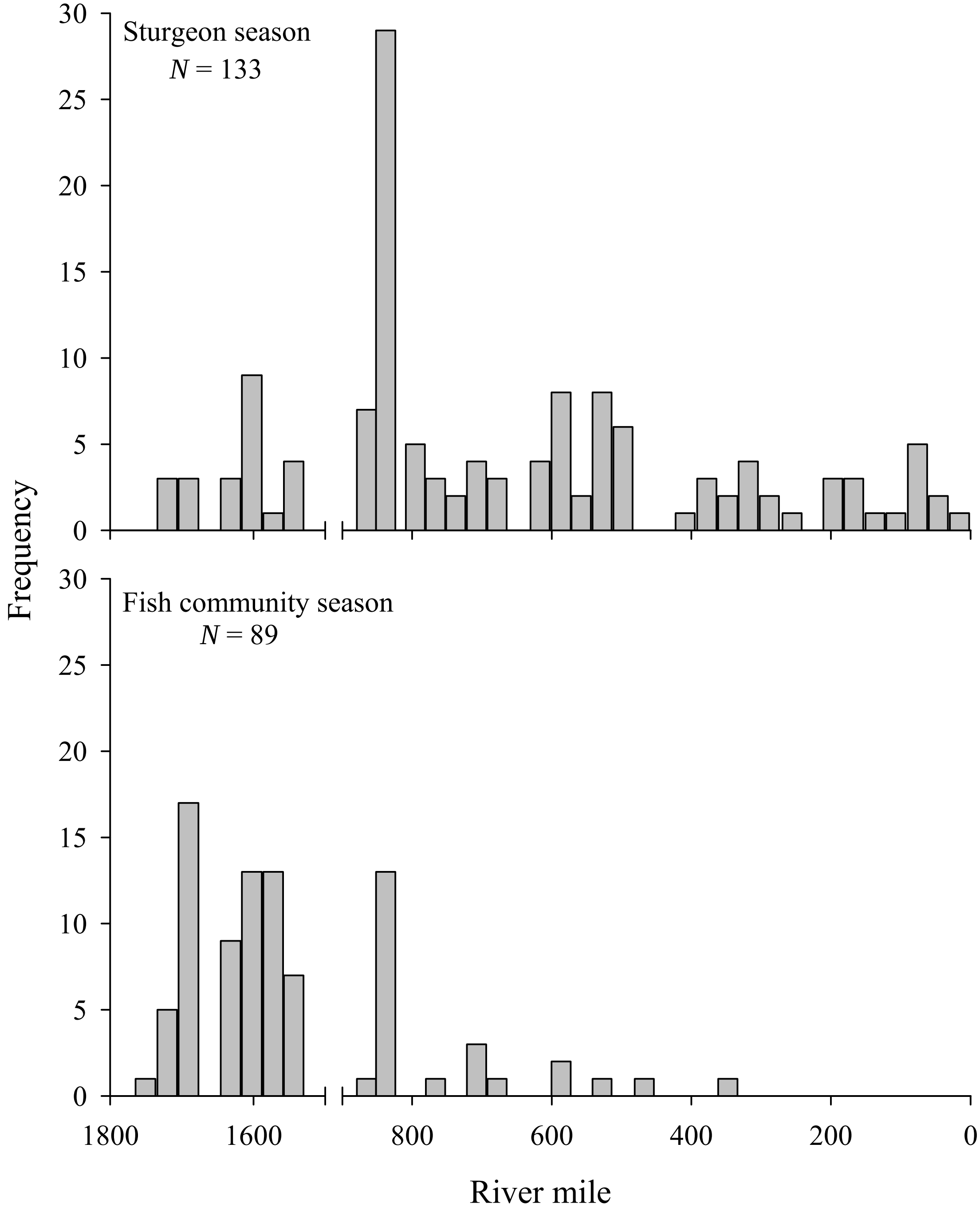

Figure 4.5. Seasonal catch by river mile (30-mile bins) of pallid sturgeon in the upper and lower basins of the Missouri River in the 2006 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

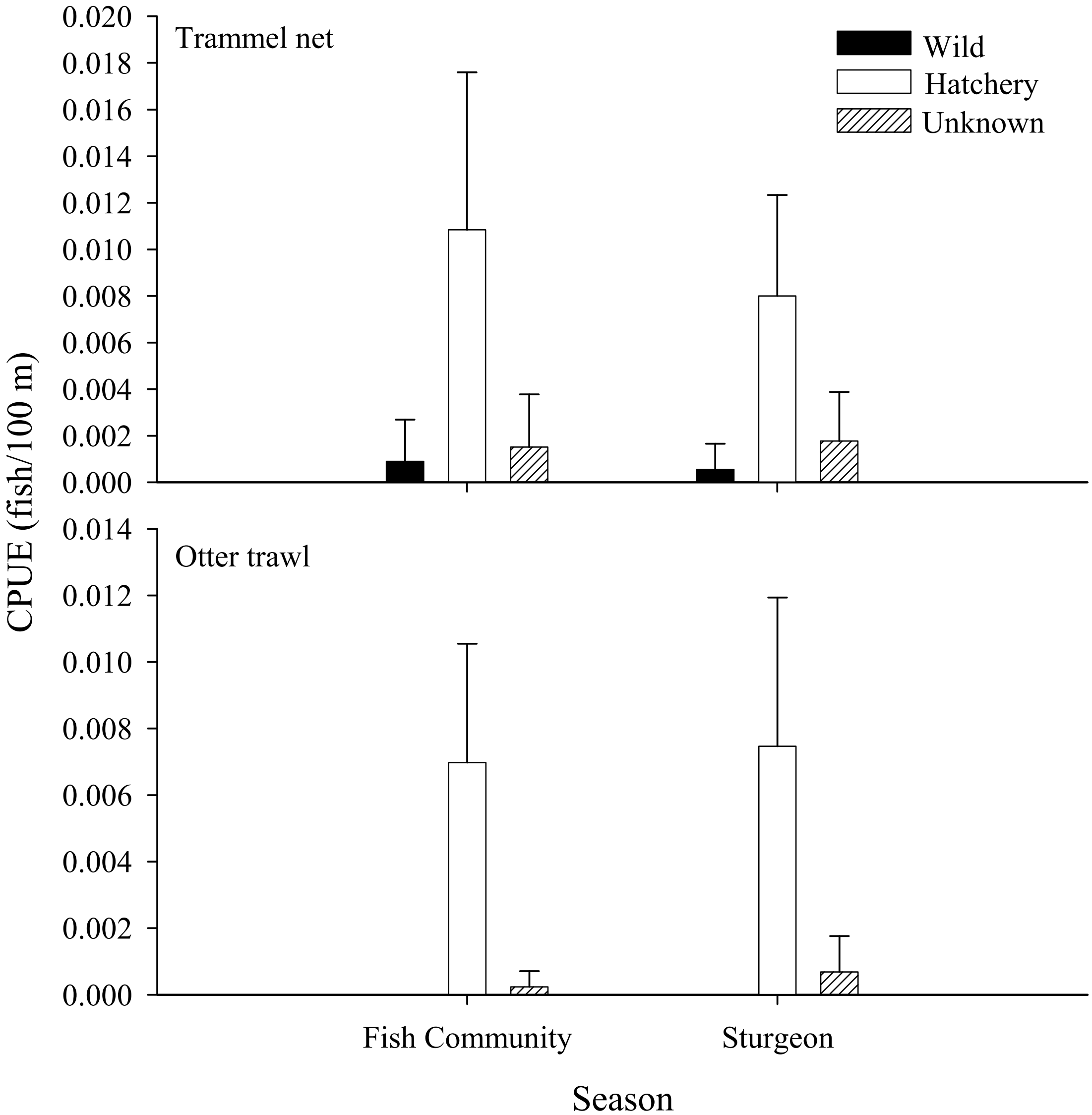

Figure 4.6. Mean seasonal catch per unit effort (± 2 SE) for wild, unknown, and hatchery reared pallid sturgeon using one-inch trammel nets and otter trawls in the upper and lower basins of the Missouri River in the 2006 sampling year.

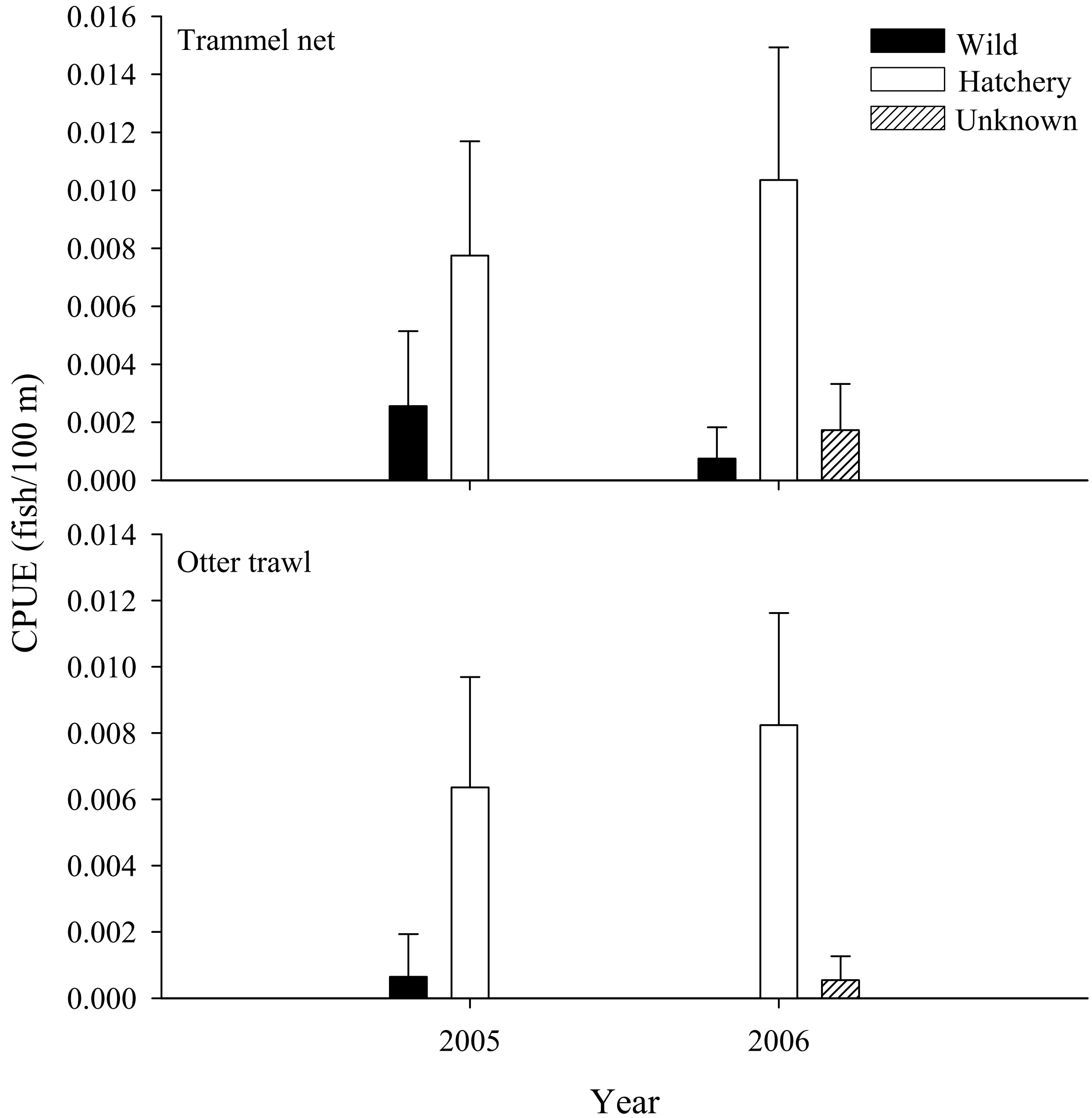

Figure 4.7. Mean annual catch per unit effort (± 2 SE) for wild, unknown, and hatchery reared pallid sturgeon using one-inch trammel nets and otter trawls in the upper and lower basins of the Missouri River for the 2005 and 2006 sampling years.

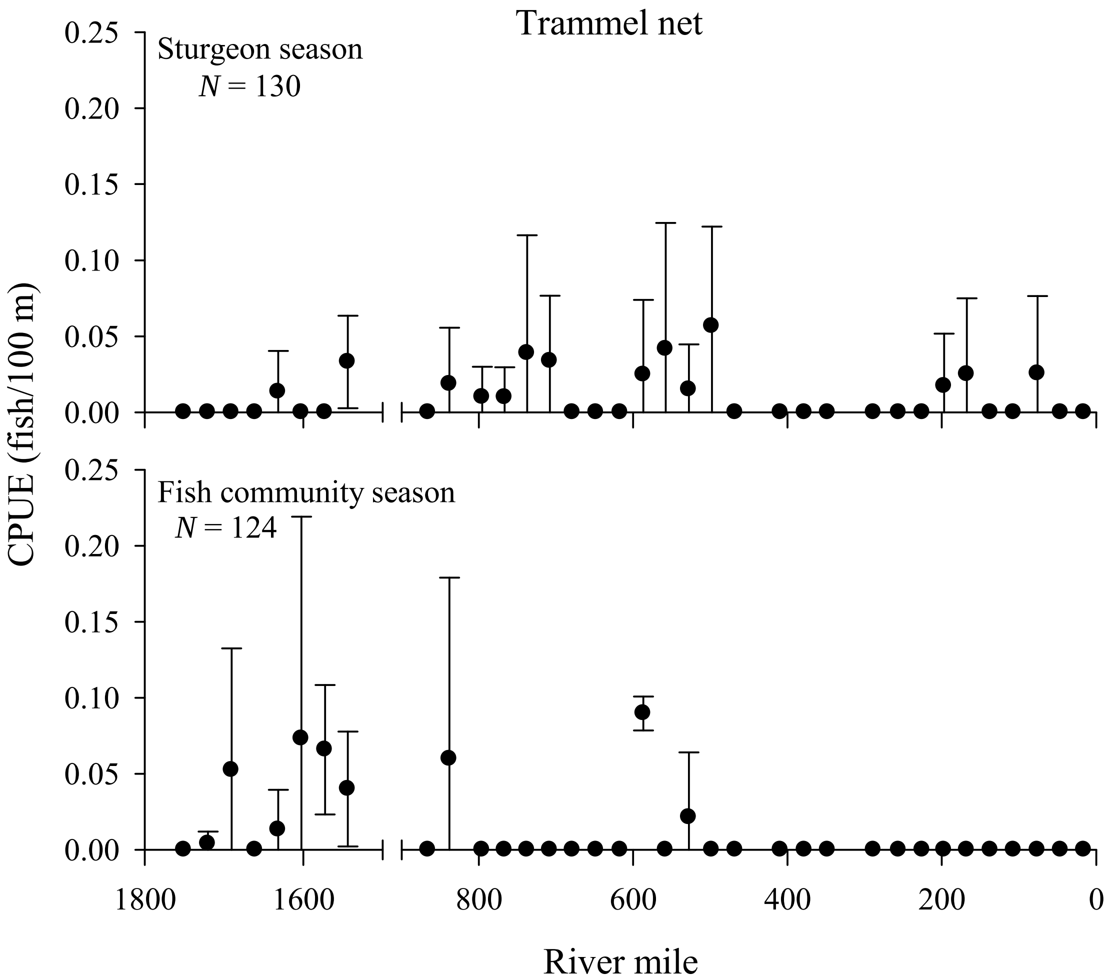

Figure 4.8. Mean seasonal catch per unit effort (± 2 SE) of pallid sturgeon by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2006 sampling year. Data obtained through random sampling using one-inch trammel nets. Sample size denotes the number of bends sampled.

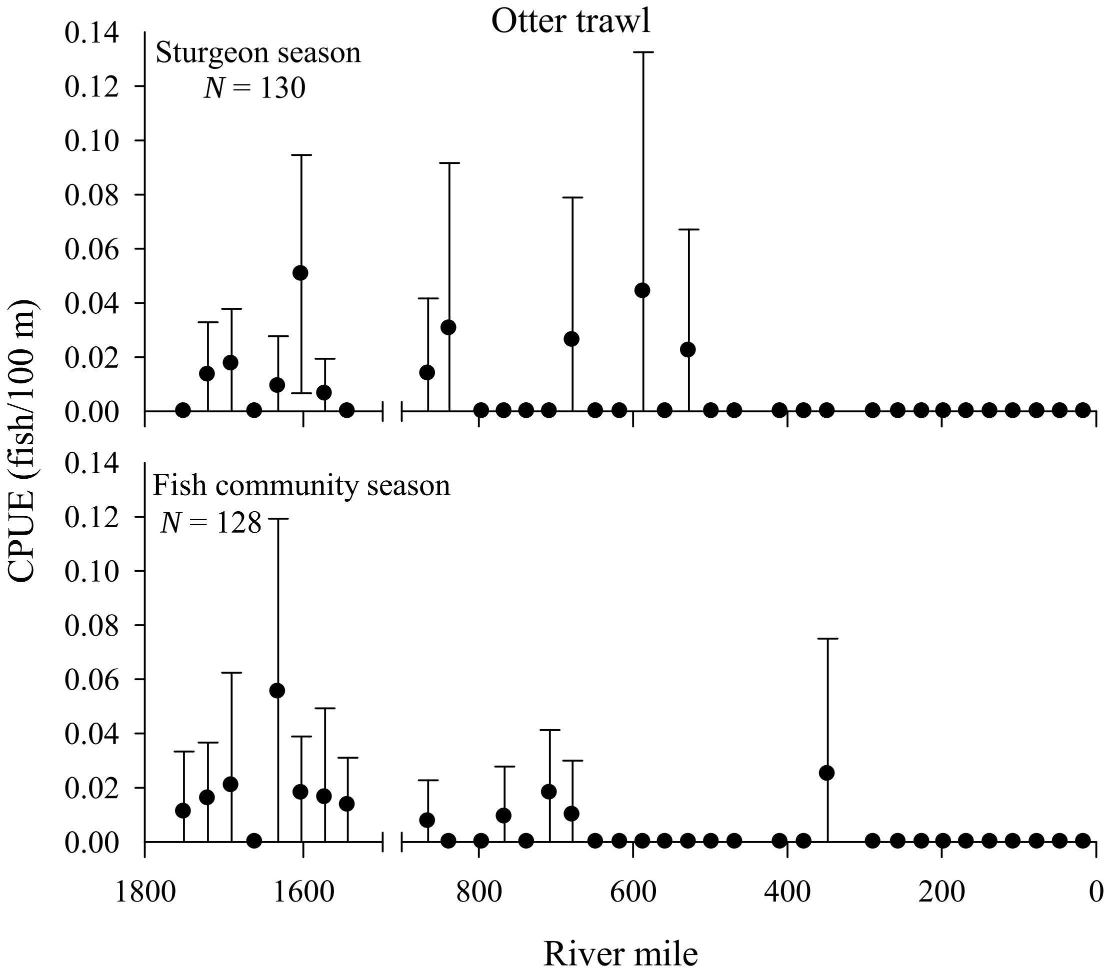

Figure 4.9. Mean seasonal catch per unit effort (± 2 SE) of pallid sturgeon by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2006 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

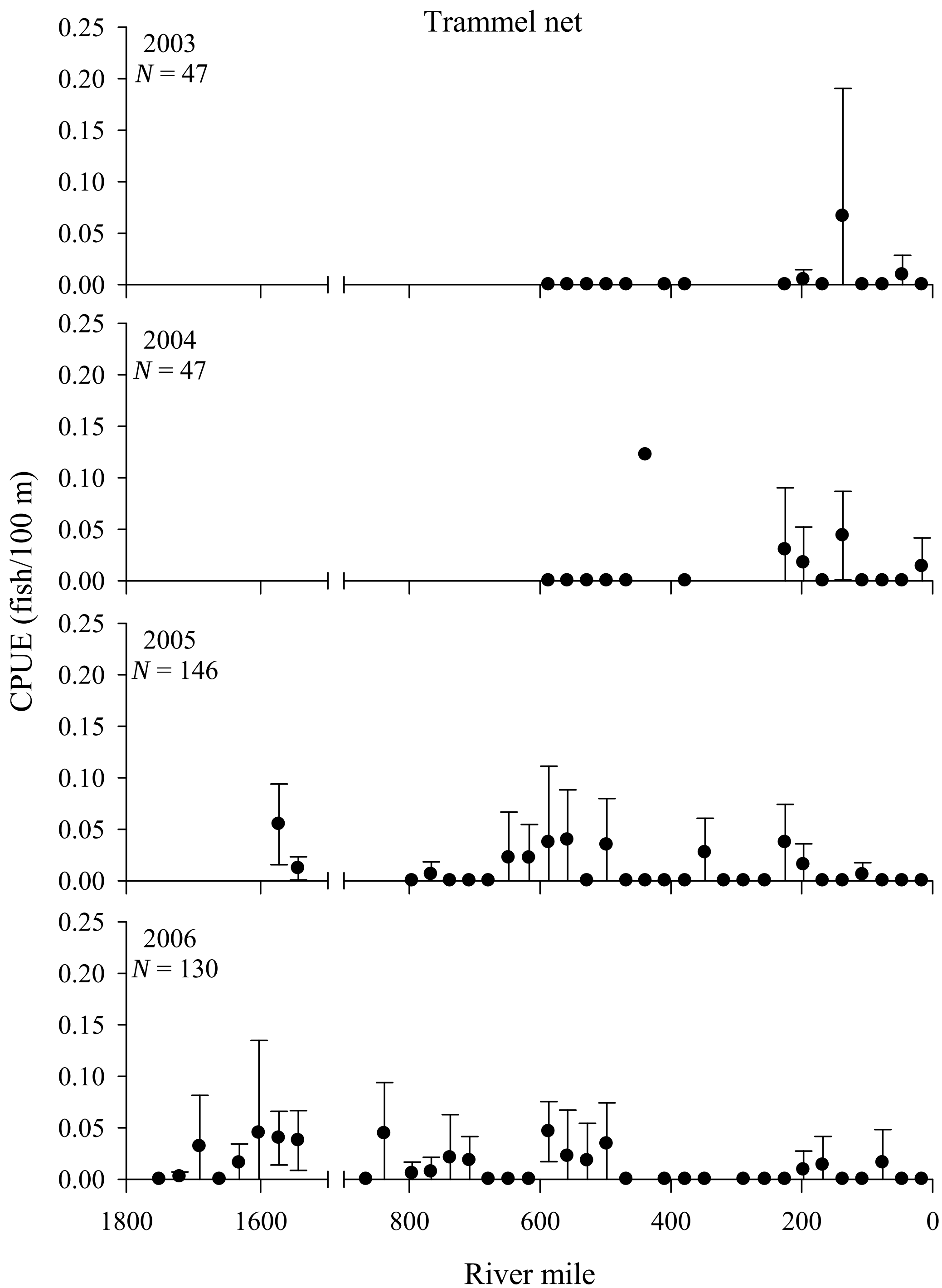

Figure 4.10. Mean annual catch per unit effort (± 2 SE) of pallid sturgeon by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2003 – 2006 sampling years. Data obtained through random sampling using one-inch trammel nets. Sample size denotes the number of bends sampled.

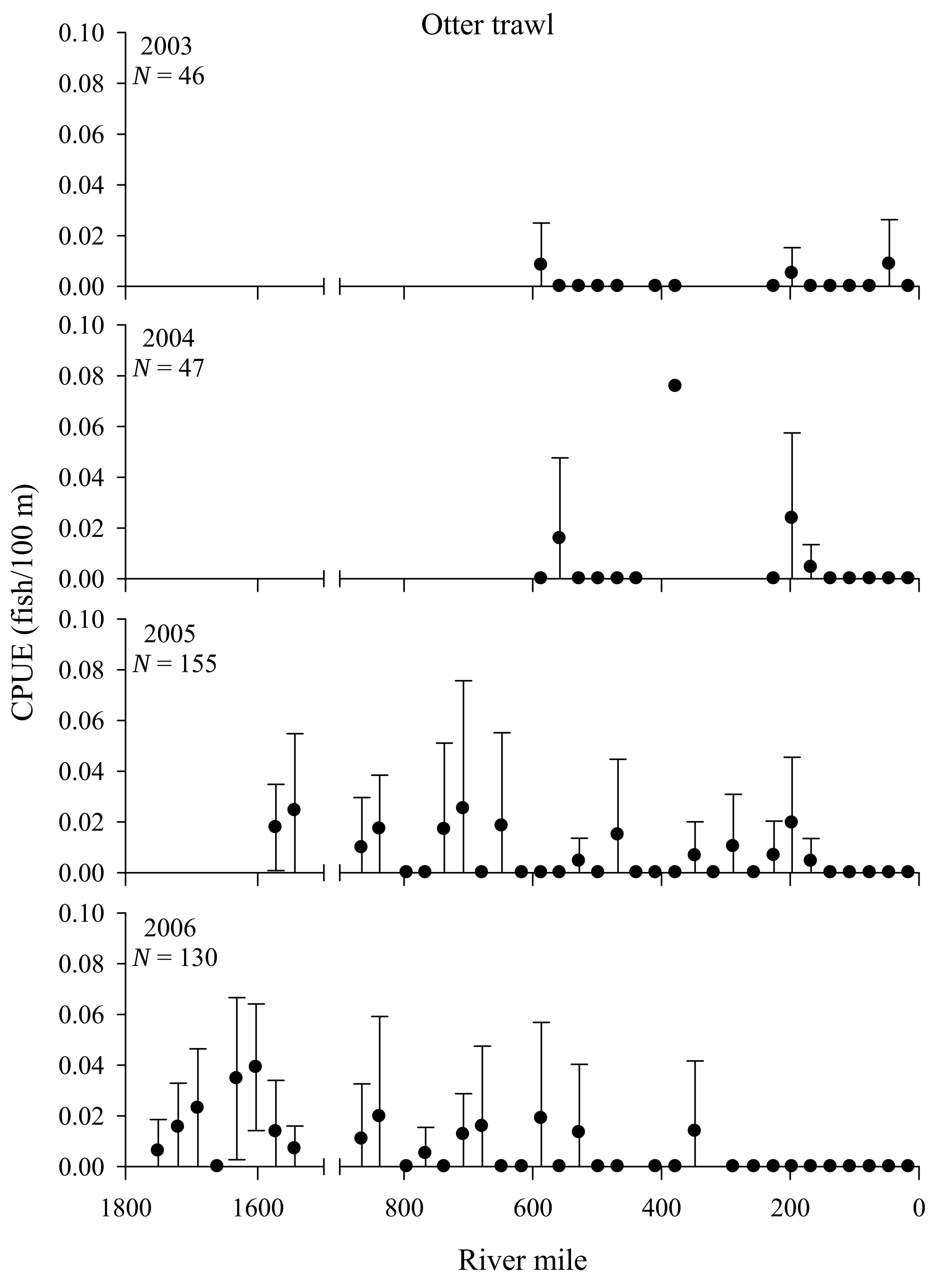

Figure 4.11. Mean annual catch per unit effort (± 2 SE) of pallid sturgeon by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2003 – 2006 sampling years. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

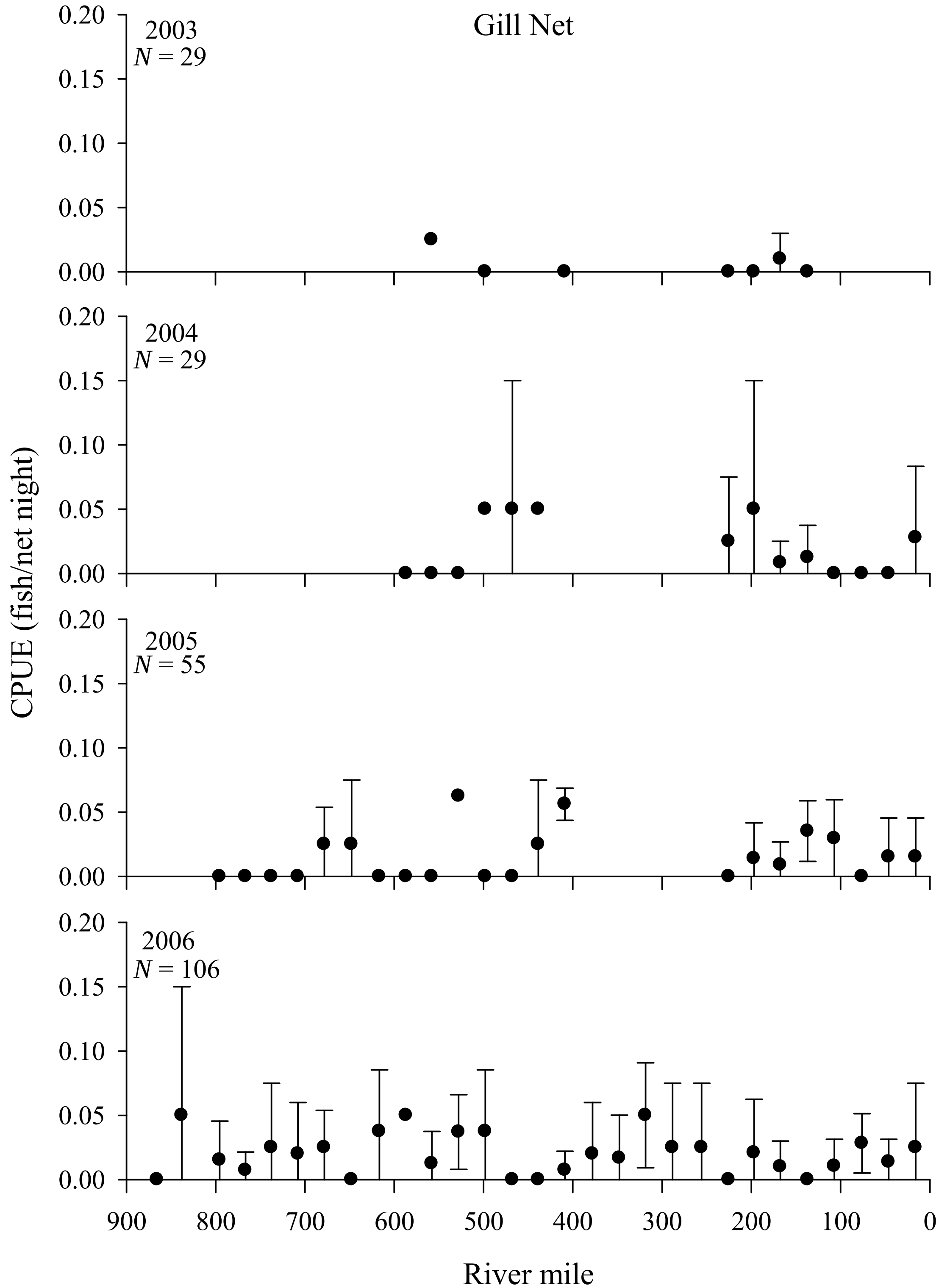

Figure 4.12. Mean annual catch per unit effort (± 2 SE) of pallid sturgeon by river mile (30-mile bins) in the lower basin of the Missouri River for the 2003 – 2006 sampling years. Data obtained through random sampling using gill nets. Sample size denotes the number of bends sampled.

Table 4.7. Total number of pallid sturgeon (< 840 mm) captured for each gear during each season and the percentage caught within each macrohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	24	8.3	8.3	8.3	4.2	0	58.3	0	12.5	0	0	0	0	0	0
		(3.2)	(22.8)	(1.3)	(1.0)	(1.1)	(51.4)	(9.7)	(8.1)	(0.8)	(0)	(0)	(0)	(0)	(0.6)
Gill Net	36	2.8	19.4	2.8	0	0	69.4	2.8	0	2.8	0	0	0	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.4)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	21	14.3	14.3	0	0	0	33.3	19.0	14.3	0	0	0	4.8	0	0
		(4.7)	(22.9)	(0.8)	(0.9)	(0.6)	(47.9)	(10.3)	(9.1)	(2.2)	(0)	(0)	(0.5)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	17	5.9	23.5	0	0	0	35.3	17.6	0	17.6	0	0	0	0	0
		(3.2)	(24.2)	(0.6)	(0.7)	(0.7)	(53.7)	(10.6)	(4.5)	(1.6)	(0)	(0)	(0.2)	(0)	(0)
Mini-Fyke Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(4.8)	(16.7)	(0.5)	(0.2)	(0.2)	(43.2)	(9.2)	(7.5)	(13.8)	(1.9)	(0.2)	(0.2)	(1.8)	(0)
Otter Trawl	16	0	25.0	0	0	6.3	43.8	6.3	18.8	0	0	0	0	0	0
		(4.2)	(24.1)	(0.6)	(0.6)	(0.8)	(53.4)	(9.5)	(5.2)	(1.2)	(0)	(0)	(0.3)	(0)	(0)

Table 4.8. Total number of pallid sturgeon (< 840 mm) captured for each gear during each season and the percentage caught within each mesohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	24	0	100.0	0	0	0	0
		(0)	(94.8)	(0.6)	(4.4)	(0)	(0.2)
Gill Net	36	0	52.8	0	2.8	44.4	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	21	0	100.0	0	0	0	0
		(0)	(93.6)	(0)	(5.9)	(0.2)	(0.3)
Fish Community Season (Summer)							
1-Inch Trammel Net	17	0	82.4	0	17.6	0	0
		(0.1)	(96.0)	(0)	(3.9)	(0)	(0.1)
Mini-Fyke Net	0	0	0	0	0	0	0
		(96.2)	(1.2)	(0)	(2.6)	(0)	(0)
Otter Trawl	16	0	93.8	0	6.3	0	0
		(0)	(97.1)	(0)	(2.9)	(0)	(0)

Table 4.9. Total number of pallid sturgeon (≥ 840 mm) captured for each gear during each season and the percentage caught within each macrohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	**N**	**Macrohabitat**													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.2)	(22.8)	(1.3)	(1.0)	(1.1)	(51.4)	(9.7)	(8.1)	(0.8)	(0)	(0)	(0)	(0)	(0.6)
Gill Net	7	14.3	57.1	0	0	0	28.6	0	0	0	0	0	0	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.4)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(4.7)	(22.9)	(0.8)	(0.9)	(0.6)	(47.9)	(10.3)	(9.1)	(2.2)	(0)	(0)	(0.5)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	2	0	50.0	0	0	0	50.0	0	0	0	0	0	0	0	0
		(3.2)	(24.2)	(0.6)	(0.7)	(0.7)	(53.7)	(10.6)	(4.5)	(1.6)	(0)	(0)	(0.2)	(0)	(0)
Mini-Fyke Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(4.8)	(16.7)	(0.5)	(0.2)	(0.2)	(43.2)	(9.2)	(7.5)	(13.8)	(1.9)	(0.2)	(0.2)	(1.8)	(0)
Otter Trawl	1	0	100.0	0	0	0	0	0	0	0	0	0	0	0	0
		(4.2)	(24.1)	(0.6)	(0.6)	(0.8)	(53.4)	(9.5)	(5.2)	(1.2)	(0)	(0)	(0.3)	(0)	(0)

Table 4.10. Total number of pallid sturgeon (≥ 840 mm) captured for each gear during each season and the percentage caught within each mesohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(94.8)	(0.6)	(4.4)	(0)	(0.2)
Gill Net	7	0	14.3	0	0	85.7	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	0	0	0	0	0	0	0
		(0)	(93.6)	(0)	(5.9)	(0.2)	(0.3)
Fish Community Season (Summer)							
1-Inch Trammel Net	2	0	100.0	0	0	0	0
		(0.1)	(96.0)	(0)	(3.9)	(0)	(0.1)
Mini-Fyke Net	0	0	0	0	0	0	0
		(96.2)	(1.2)	(0)	(2.6)	(0)	(0)
Otter Trawl	1	0	100.0	0	0	0	0
		(0)	(97.1)	(0)	(2.9)	(0)	(0)

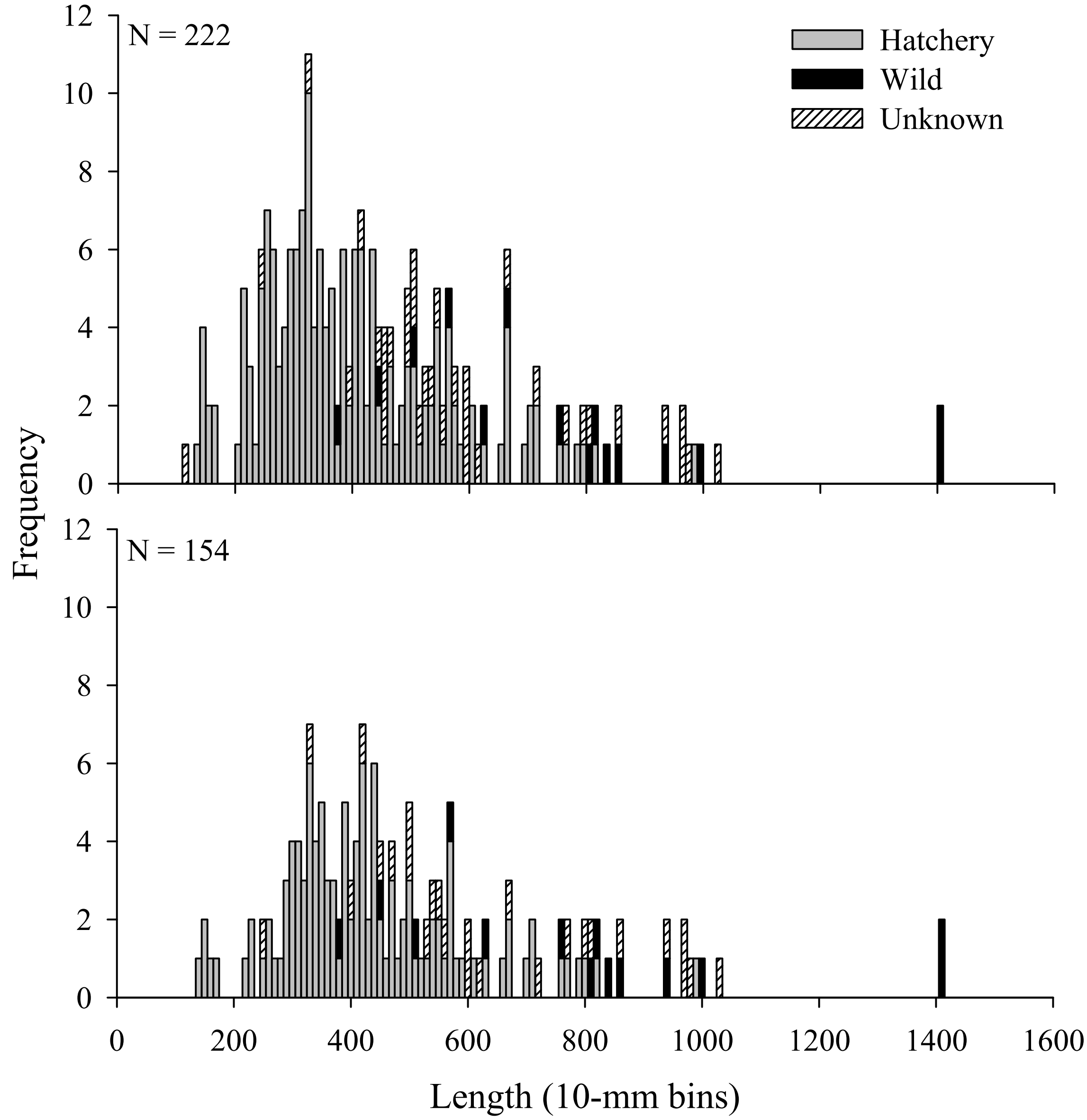

Figure 4.13. Length frequency distribution of pallid sturgeon of hatchery, wild, and unknown origin captured in the upper and lower basins of the Missouri River during the 2006 sampling year using standard and wild gears. Upper panel includes random and nonrandom sampling. Lower panel includes only random sampling.

4.2.2 Upper Basin

Relative abundance of pallid sturgeon differed between seasons during the 2006 sampling year. During the fish community season, the mean catch per unit effort (CPUE) of hatchery-reared pallid sturgeon captured with trammel nets was 0.030 fish/100 m, which decreased to 0.006 fish/100 m during the sturgeon season (Figure 4.14). The mean CPUE of wild and unknown origin pallid sturgeon captured with trammel nets was comparatively low for both sampling seasons, ranging from 0.000 to 0.003 fish/100 m. While no wild origin pallid sturgeon were captured with otter trawls during either sampling season, the otter trawl mean CPUE of hatchery origin fish was approximately 0.018 fish/100 m during the fish community season and 0.011 fish/100 m during the sturgeon sampling season (Figure 4.14). The mean CPUE of unknown origin pallid sturgeon captured with otter trawls was comparatively low for both sampling seasons, ranging from 0.000 to 0.001 fish/100 m. The mean CPUE of hatchery-reared pallid sturgeon captured with trammel nets and otter trawls was greater during 2005 than 2006 (Figure 4.15).

Random sampling with standard gears resulted in catches of more juvenile (< 840 mm) pallid sturgeon than adult (≥ 840 mm) pallid sturgeon. Thirty-nine juvenile pallid sturgeon were captured during the 2006 sampling year; 17 during the sturgeon season and 22 during the fish community season (Table 4.11). During the sturgeon season, most juvenile pallid sturgeon were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred. During the fish community season, juvenile pallid sturgeon were captured from more macrohabitats, including main channel crossover, inside bend, outside bend, and small and large secondary connected channels. During the sturgeon sampling season, all 17 juvenile pallid sturgeon were captured from main channel border mesohabitats, which for both gears was also the location of greatest effort (Table 4.12). Sampling from main channel border mesohabitats during the fish community season resulted in 82% (N = 18) of the juvenile pallid sturgeon catch, while four fish were captured from island tip mesohabitat (Table 4.12). There were three adult pallid sturgeon captured during the 2006 sampling year (all during the fish community season; Table 4.13). Two adult pallid sturgeon were captured in main channel crossover macrohabitat, while the other was captured in inside bend macrohabitat. All three adult pallid sturgeon were sampled within main channel border mesohabitat (Table 4.14). Mini-fyke nets did not capture any juvenile or adult pallid sturgeon, despite considerable effort (Table 4.3).

The length frequency distribution of pallid sturgeon captured during the 2006 sampling year is positively skewed, with hatchery-reared juvenile fish representing the vast majority of fish sampled (Figure 4.16). The fork lengths of all 88 pallid sturgeon captured ranged from 120 to 1410 mm, including 3 fish of wild origin larger than 840 mm. Random sampling accounted for 49% (N = 43) of the pallid sturgeon captured. The length frequency distribution from random sampling is similar to that from a combination of random and non-random sampling.

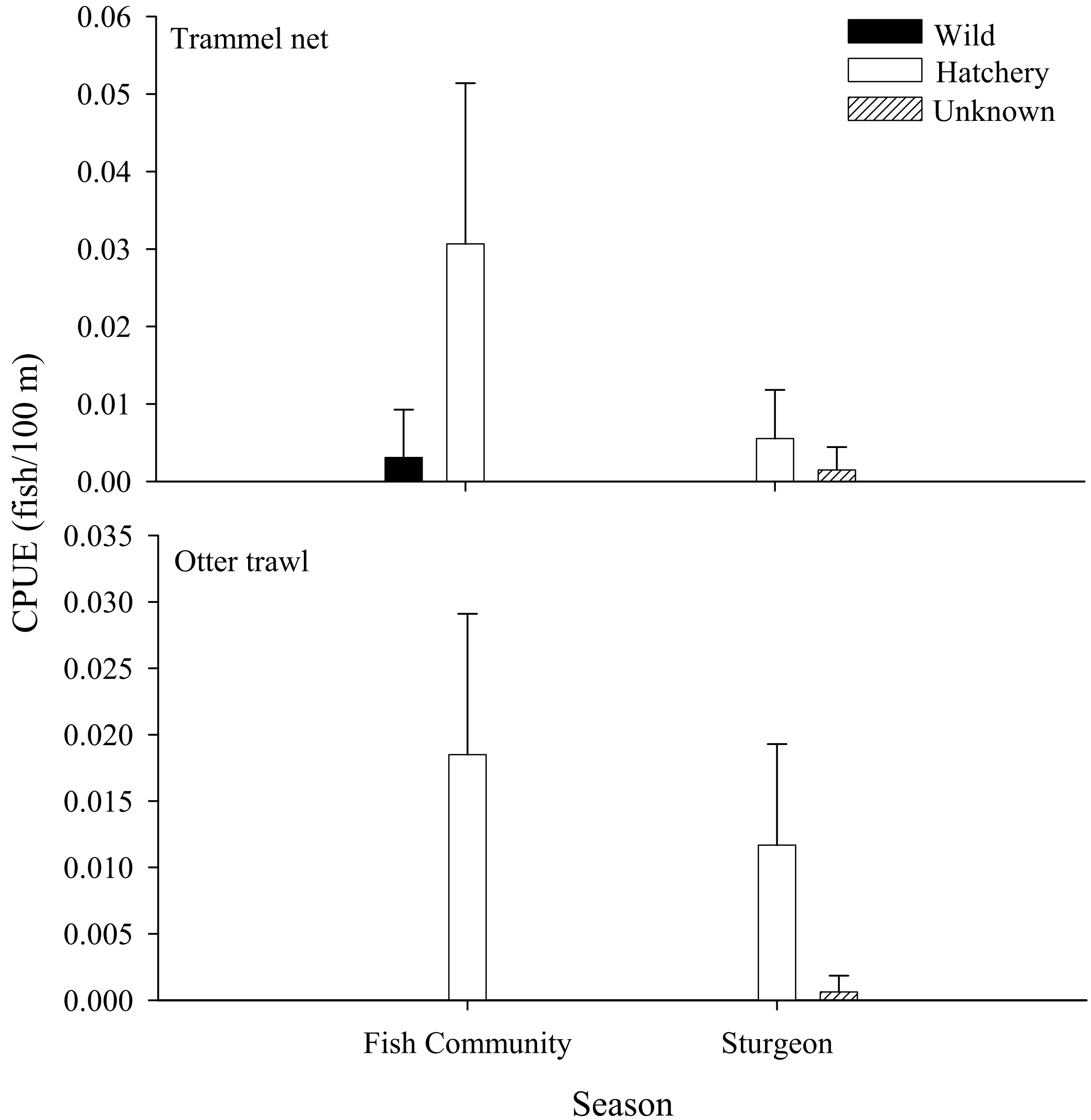

Figure 4.14. Mean seasonal catch per unit effort (± 2 SE) for wild, unknown, and hatchery reared pallid sturgeon using one-inch trammel nets and otter trawls in the upper basin of the Missouri River in the 2006 sampling year.

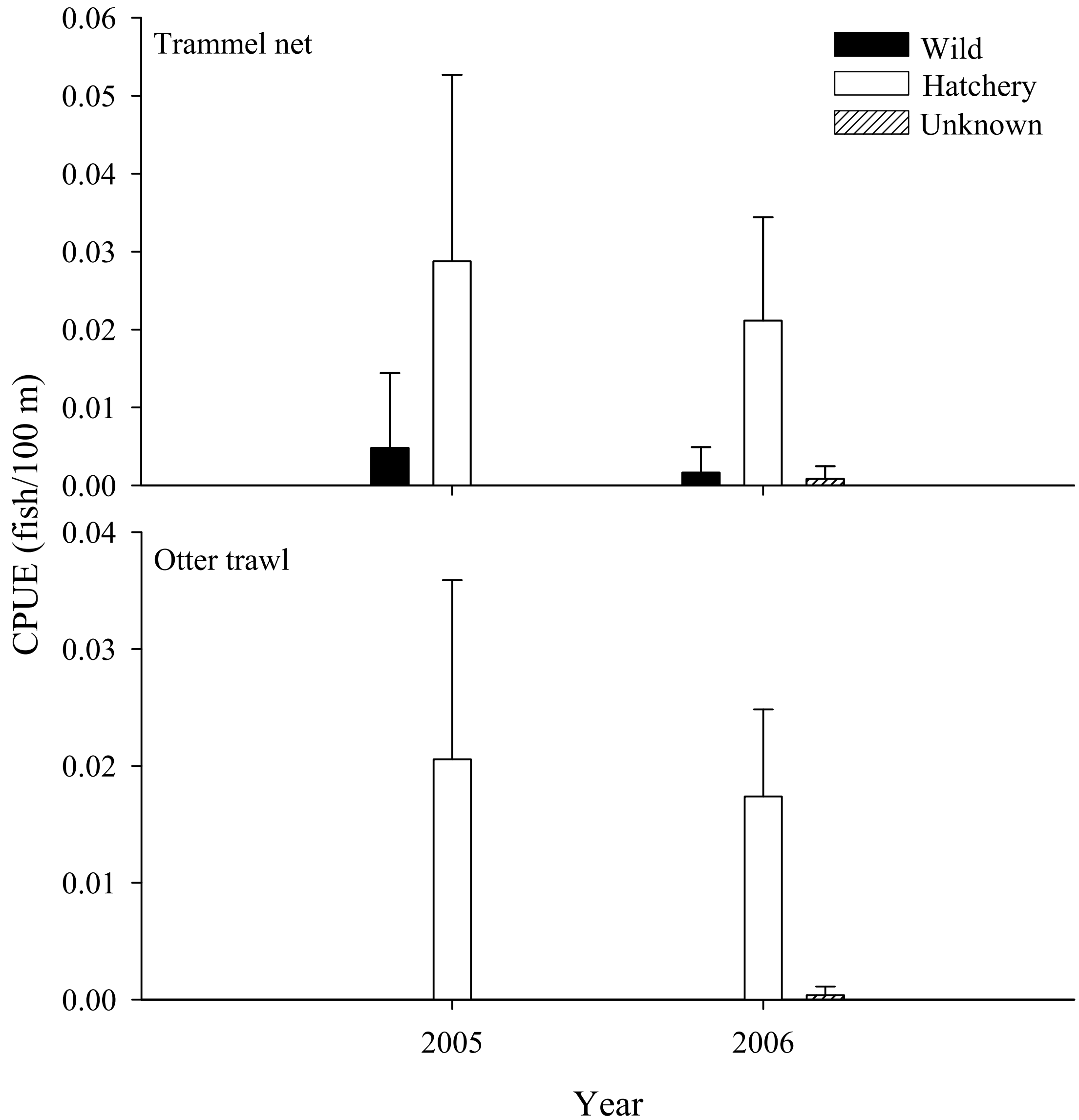

Figure 4.15. Mean annual catch per unit effort (± 2 SE) for wild, unknown, and hatchery reared pallid sturgeon using one-inch trammel nets and otter trawls in the upper basin of the Missouri River for the 2005 and 2006 sampling years.

Table 4.11. Total number of pallid sturgeon (< 840 mm) captured for each gear during each season and the percentage caught within each macrohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	5	0	0	0	0	0	100.0	0	0	0	0	0	0	0	0
		(0)	(24.3)	(0.6)	(0)	(0)	(30.3)	(26.5)	(18.3)	(0)	(0)	(0)	(0)	(0)	(0)
Otter Trawl	12	0	16.7	0	0	0	41.7	25.0	16.7	0	0	0	0	0	0
		(0)	(24.7)	(0.6)	(0)	(0)	(27.9)	(25.0)	(18.6)	(3.2)	(0)	(0)	(0)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	13	0	30.8	0	0	0	23.1	23.1	0	23.1	0	0	0	0	0
		(0)	(26.7)	(0)	(0)	(0)	(31.1)	(27.7)	(10.4)	(3.5)	(0)	(0)	(0.6)	(0)	(0)
Mini-Fyke Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(0)	(7.7)	(0.7)	(0)	(0)	(33.1)	(11.4)	(19.9)	(20.2)	(6.3)	(0)	(0)	(0.7)	(0)
Otter Trawl	9	0	33.3	0	0	0	22.2	11.1	33.3	0	0	0	0	0	0
		(0)	(26.6)	(0.7)	(0)	(0)	(29.8)	(30.4)	(11.4)	(1.0)	(0)	(0)	(0)	(0)	(0)

Table 4.12. Total number of pallid sturgeon (< 840 mm) captured for each gear during each season and the percentage caught within each mesohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	5	0	100.0	0	0	0	0
		(0)	(88.0)	(0)	(11.4)	(0)	(0.6)
Otter Trawl	12	0	100.0	0	0	0	0
		(0)	(85.3)	(0)	(13.8)	(0)	(1.0)
Fish Community Season (Summer)							
1-Inch Trammel Net	13	0	76.9	0	23.1	0	0
		(0.3)	(89.6)	(0)	(9.7)	(0)	(0.3)
Mini-Fyke Net	0	0	0	0	0	0	0
		(92.0)	(1.1)	(0)	(6.8)	(0)	(0)
Otter Trawl	9	0	88.9	0	11.1	0	0
		(0)	(94.5)	(0)	(5.5)	(0)	(0)

Table 4.13. Total number of pallid sturgeon (≥ 840 mm) captured for each gear during each season and the percentage caught within each macrohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(0)	(24.3)	(0.6)	(0)	(0)	(30.3)	(26.5)	(18.3)	(0)	(0)	(0)	(0)	(0)	(0)
Otter Trawl	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(0)	(24.7)	(0.6)	(0)	(0)	(27.9)	(25.0)	(18.6)	(3.2)	(0)	(0)	(0)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	2	0	50.0	0	0	0	50.0	0	0	0	0	0	0	0	0
		(0)	(26.7)	(0)	(0)	(0)	(31.1)	(27.7)	(10.4)	(3.5)	(0)	(0)	(0.6)	(0)	(0)
Mini-Fyke Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(0)	(7.7)	(0.7)	(0)	(0)	(33.1)	(11.4)	(19.9)	(20.2)	(6.3)	(0)	(0)	(0.7)	(0)
Otter Trawl	1	0	100.0	0	0	0	0	0	0	0	0	0	0	0	0
		(0)	(26.6)	(0.7)	(0)	(0)	(29.8)	(30.4)	(11.4)	(1.0)	(0)	(0)	(0)	(0)	(0)

Table 4.14. Total number of pallid sturgeon (≥ 840 mm) captured for each gear during each season and the percentage caught within each mesohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(88.0)	(0)	(11.4)	(0)	(0.6)
Otter Trawl	0	0	0	0	0	0	0
		(0)	(85.3)	(0)	(13.8)	(0)	(1.0)
Fish Community Season (Summer)							
1-Inch Trammel Net	2	0	100.0	0	0	0	0
		(0.3)	(89.6)	(0)	(9.7)	(0)	(0.3)
Mini-Fyke Net	0	0	0	0	0	0	0
		(92.0)	(1.1)	(0)	(6.8)	(0)	(0)
Otter Trawl	1	0	100.0	0	0	0	0
		(0)	(94.5)	(0)	(5.5)	(0)	(0)

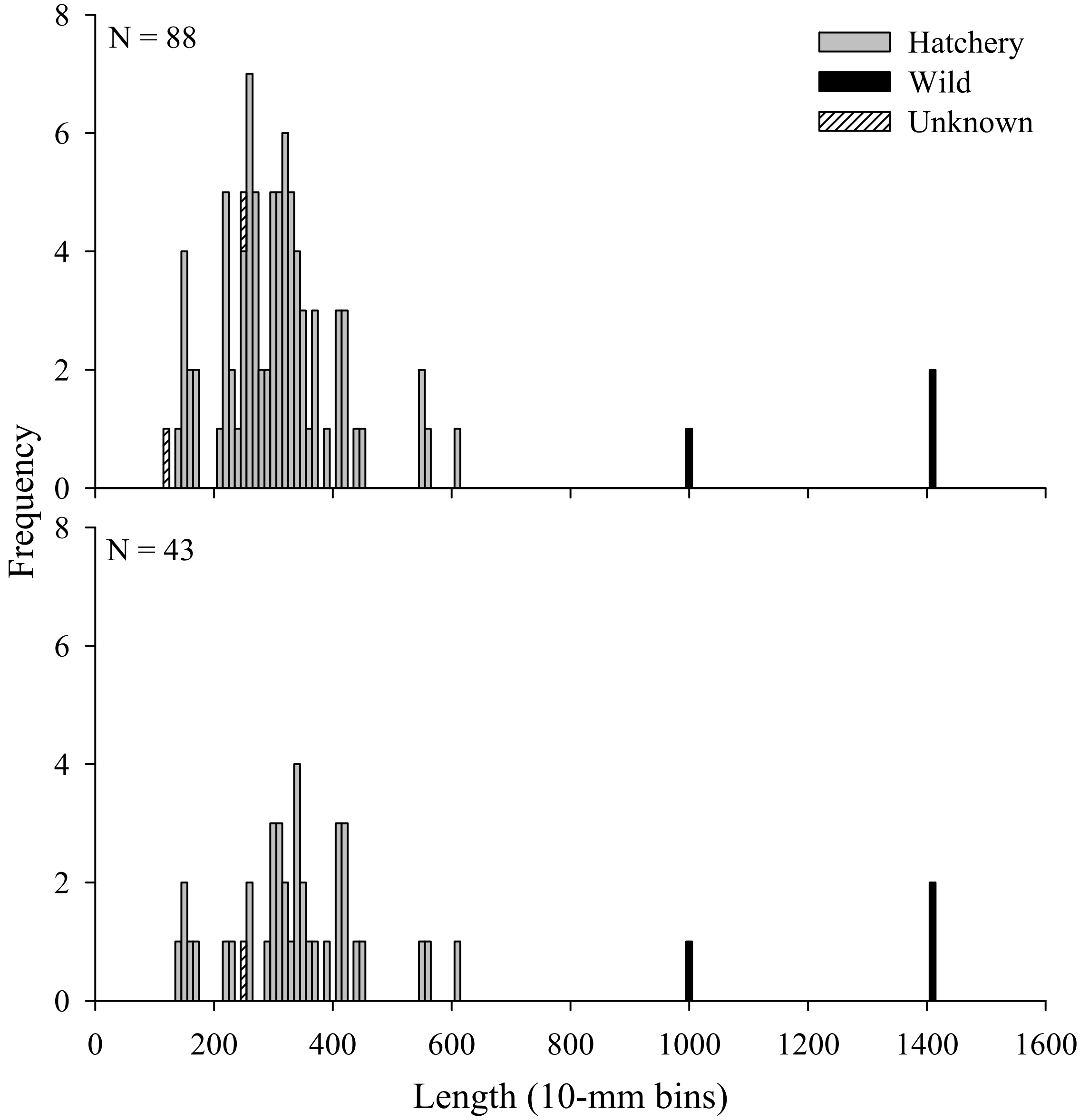

Figure 4.16. Length frequency distribution of pallid sturgeon of hatchery, wild, and unknown origin captured in the upper basin of the Missouri River during the 2006 sampling year using standard and wild gears. Upper panel includes random and nonrandom sampling. Lower panel includes only random sampling.

4.2.3 Lower Basin

Relative abundance of pallid sturgeon differed markedly between seasons during the 2006 sampling year. During the fish community season, the mean catch per unit effort (CPUE) of hatchery-reared pallid sturgeon captured with trammel nets was 0.003 fish/100 m, which increased to 0.009 fish/100 m during the sturgeon season (Figure 4.17). The mean CPUE of wild and unknown origin pallid sturgeon captured with trammel nets was comparatively low for both sampling seasons, ranging from 0.000 to 0.002 fish/100 m. While no wild origin pallid sturgeon were captured with otter trawls during either sampling season, the otter trawl mean CPUE of hatchery origin fish was approximately 0.003 fish/100 m during the fish community season and 0.006 fish/100 m during the sturgeon sampling season (Figure 4.17). The mean CPUE of unknown origin pallid sturgeon captured with otter trawls was comparatively low for both sampling seasons (≤ 0.001 fish/100 m). The mean CPUE of hatchery-reared pallid sturgeon captured with trammel nets and otter trawls was similar during 2005 and 2006, with an overall increasing trend during the period from 2003 to 2006 (Figure 4.18). The mean CPUE of wild pallid sturgeon captured with trammel nets has decreased from 0.007 fish/100 m in 2003 to < 0.001 fish/100 m in 2006. There were no wild pallid sturgeon captured with gill nets from sampling years 2003 through 2006, however during that time period the relative abundance of hatchery origin pallid sturgeon captured with gill nets increased from 0.001 fish/net night in 2003 to 0.011 fish/net night in 2006 (Figure 4.19).

Random sampling with standard gears resulted in catches of more juvenile (< 840 mm) pallid sturgeon than adult (≥ 840 mm) pallid sturgeon. A total of 75 juvenile pallid sturgeon were captured during the 2006 sampling year; 64 during the sturgeon season and 11 during the fish community season (Table 4.15). During both seasons, most juvenile pallid sturgeon were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred. One exception resulted from otter trawl sampling during the sturgeon season when 3 of the 9 fish captured with that gear were located in braided channel macrohabitat where only 7% of the gear effort was applied. The vast majority of all juvenile pallid sturgeon were captured from main channel border mesohabitats, which was also the location of greatest effort for most gear types (Table

4.16). Gill nets captured 56% (N = 36) of the juvenile pallid sturgeon during the sturgeon season, with 16 of those fish located in pool mesohabitat. Seven adult pallid sturgeon were captured during the sturgeon season of the 2006 sampling year; while none were captured during the fish community season (Table 4.17). All seven adult pallid sturgeon were captured with gill nets, and were located in channel crossover, inside bend, and braided channel macrohabitat. Six of the seven adult pallid sturgeon were captured from pool mesohabitats where 39% of the gill net effort was applied (Table 4.18).

The length frequency distribution of pallid sturgeon captured during the 2006 sampling year was slightly positively skewed, with hatchery-reared juvenile fish representing the vast majority of fish sampled (Figure 4.20). The fork lengths of all 88 pallid sturgeon captured ranged from 230 to 1030 mm, including 10 fish (1 hatchery-reared, 2 wild, 6 unknown origin) larger than 840 mm. Random sampling accounted for 83% (N = 111) of the pallid sturgeon captured. The length frequency distribution from random sampling is similar to that from a combination of random and non-random sampling.

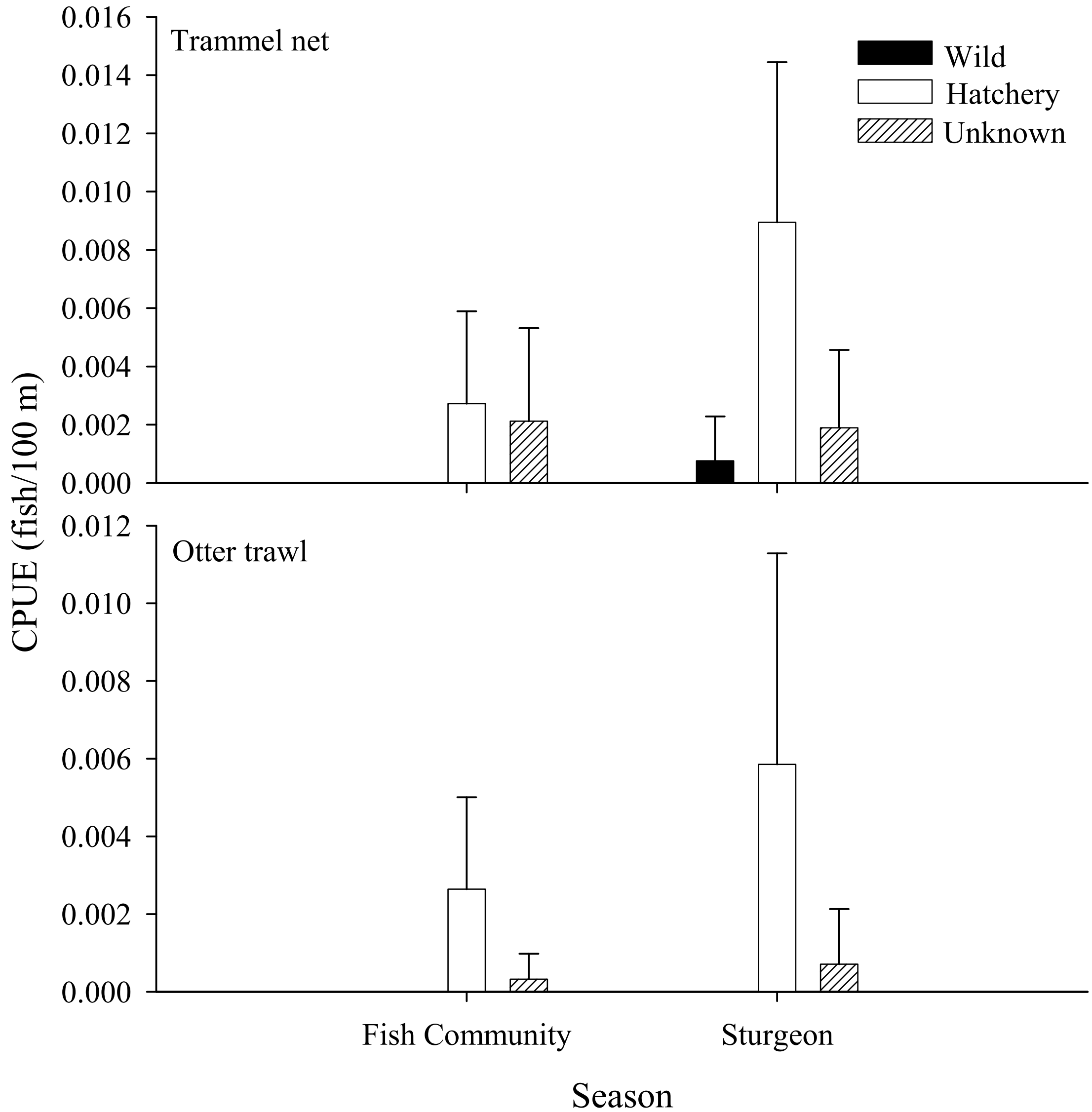

Figure 4.17. Mean seasonal catch per unit effort (± 2 SE) for wild, unknown, and hatchery reared pallid sturgeon using one-inch trammel nets and otter trawls in the lower basin of the Missouri River in the 2006 sampling year.

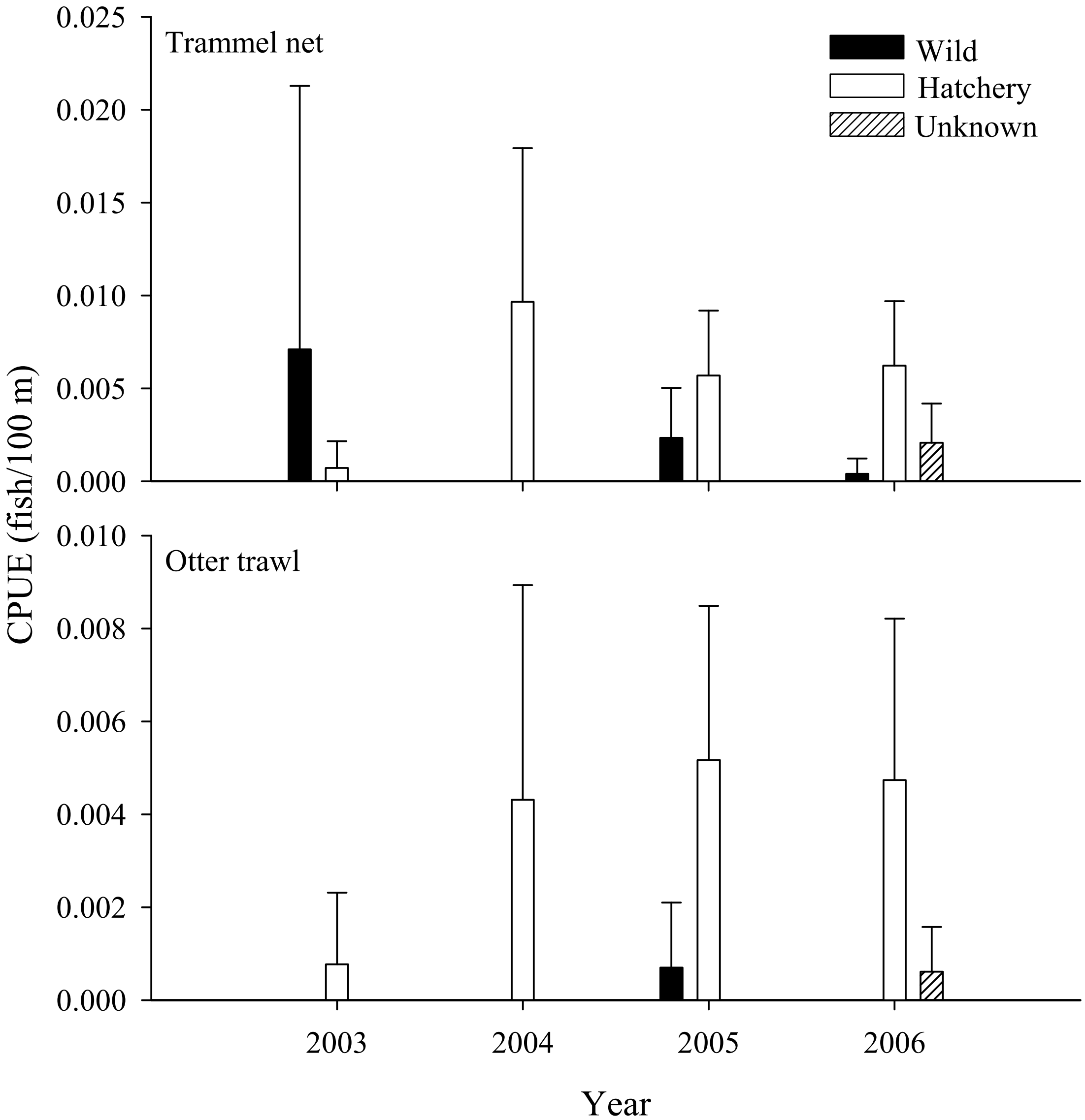

Figure 4.18. Mean annual catch per unit effort (± 2 SE) for wild, unknown, and hatchery reared pallid sturgeon using one-inch trammel nets and otter trawls in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

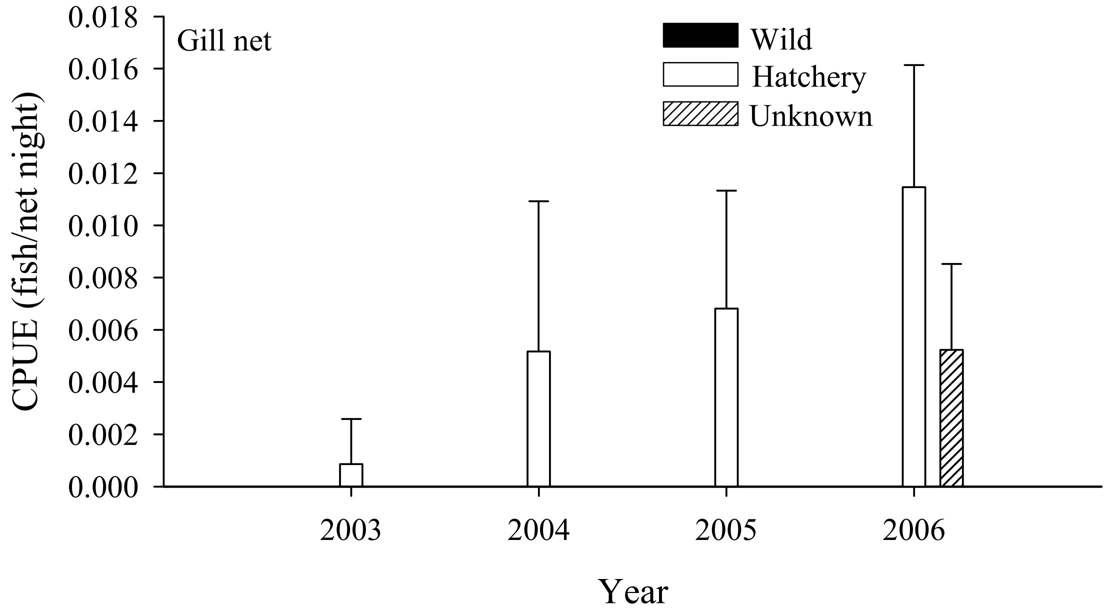

Figure 4.19. Mean annual catch per unit effort (± 2 SE) for wild, unknown, and hatchery reared pallid sturgeon using gill nets in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

Table 4.15. Total number of pallid sturgeon (< 840 mm) captured for each gear during each season and the percentage caught within each macrohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1 Inch Trammel Net	19	10.5	10.5	10.5	5.3	0	47.4	0	15.8	0	0	0	0	0	0
		(4.3)	(22.3)	(1.5)	(1.4)	(1.5)	(58.4)	(4.2)	(4.7)	(1.0)	(0)	(0)	(0)	(0)	(0.8)
Gill Net	36	2.8	19.4	2.8	0	0	69.4	2.8	0	2.8	0	0	0	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.4)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	9	33.3	11.1	0	0	0	22.2	11.1	11.1	0	0	0	11.1	0	0
		(6.6)	(22.3)	(0.9)	(1.3)	(0.8)	(56.0)	(4.4)	(5.3)	(1.8)	(0)	(0)	(0.6)	(0)	(0)
Fish Community Season (Summer)															
1 Inch Trammel Net	4	25.0	0	0	0	0	75.0	0	0	0	0	0	0	0	0
		(4.4)	(23.2)	(0.9)	(1.0)	(1.0)	(62.5)	(3.9)	(2.2)	(0.9)	(0)	(0)	(0)	(0)	(0)
Mini-Fyke Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(6.5)	(19.9)	(0.4)	(0.3)	(0.3)	(46.8)	(8.4)	(3.1)	(11.4)	(0.3)	(0.3)	(0.3)	(2.1)	(0)
Otter Trawl	7	0	14.3	0	0	14.3	71.4	0	0	0	0	0	0	0	0
		(5.5)	(23.4)	(0.6)	(0.7)	(1.0)	(60.5)	(3.3)	(3.4)	(1.2)	(0)	(0)	(0.4)	(0)	(0)

Table 4.16. Total number of pallid sturgeon (< 840 mm) captured for each gear during each season and the percentage caught within each mesohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1 Inch Trammel Net	19	0	100.0	0	0	0	0
		(0)	(97.3)	(0.8)	(1.9)	(0)	(0)
Gill Net	36	0	52.8	0	2.8	44.4	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	9	0	100.0	0	0	0	0
		(0)	(96.9)	(0)	(2.8)	(0.3)	(0)
Fish Community Season (Summer)							
1 Inch Trammel Net	4	0	100.0	0	0	0	0
		(0)	(98.4)	(0)	(1.6)	(0)	(0)
Mini-Fyke Net	0	0	0	0	0	0	0
		(97.6)	(1.2)	(0)	(1.2)	(0)	(0)
Otter Trawl	7	0	100.0	0	0	0	0
		(0)	(98.0)	(0)	(2.0)	(0)	(0)

Table 4.17. Total number of pallid sturgeon (≥ 840 mm) captured for each gear during each season and the percentage caught within each macrohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1 Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(4.3)	(22.3)	(1.5)	(1.4)	(1.5)	(58.4)	(4.2)	(4.7)	(1.0)	(0)	(0)	(0)	(0)	(0.8)
Gill Net	7	14.3	57.1	0	0	0	28.6	0	0	0	0	0	0	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.4)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(6.6)	(22.3)	(0.9)	(1.3)	(0.8)	(56.0)	(4.4)	(5.3)	(1.8)	(0)	(0)	(0.6)	(0)	(0)
Fish Community Season (Summer)															
1 Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(4.4)	(23.2)	(0.9)	(1.0)	(1.0)	(62.5)	(3.9)	(2.2)	(0.9)	(0)	(0)	(0)	(0)	(0)
Mini-Fyke Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(6.5)	(19.9)	(0.4)	(0.3)	(0.3)	(46.8)	(8.4)	(3.1)	(11.4)	(0.3)	(0.3)	(0.3)	(2.1)	(0)
Otter Trawl	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(5.5)	(23.4)	(0.6)	(0.7)	(1.0)	(60.5)	(3.3)	(3.4)	(1.2)	(0)	(0)	(0.4)	(0)	(0)

Table 4.18. Total number of pallid sturgeon (≥ 840 mm) captured for each gear during each season and the percentage caught within each mesohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1 Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(97.3)	(0.8)	(1.9)	(0)	(0)
Gill Net	7	0	14.3	0	0	85.7	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	0	0	0	0	0	0	0
		(0)	(96.9)	(0)	(2.8)	(0.3)	(0)
Fish Community Season (Summer)							
1 Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(98.4)	(0)	(1.6)	(0)	(0)
Mini-Fyke Net	0	0	0	0	0	0	0
		(97.6)	(1.2)	(0)	(1.2)	(0)	(0)
Otter Trawl	0	0	0	0	0	0	0
		(0)	(98.0)	(0)	(2.0)	(0)	(0)

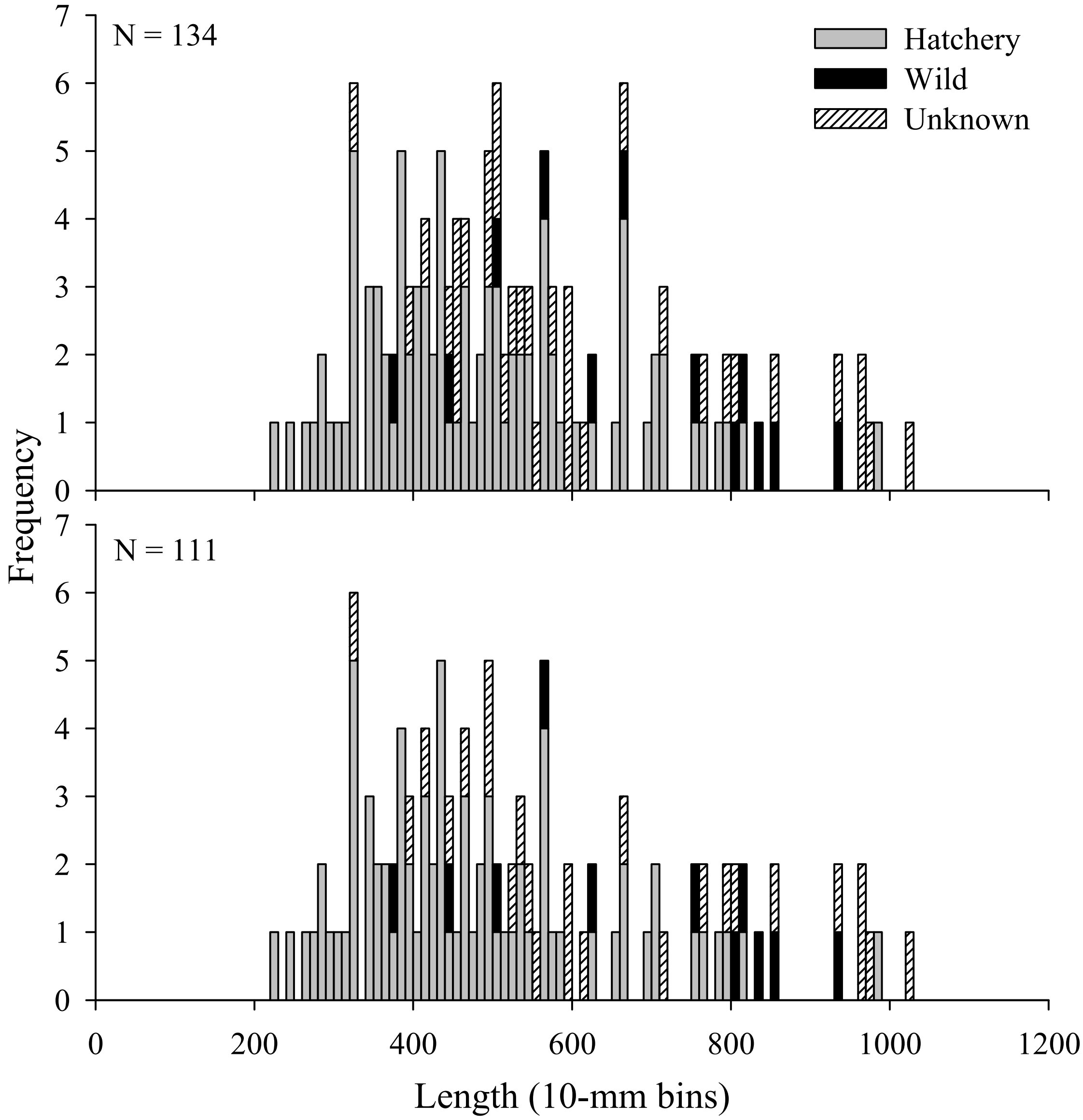

Figure 4.20. Length frequency distribution of pallid sturgeon of hatchery, wild, and unknown origin captured in the lower basin of the Missouri River during the 2006 sampling year using standard and wild gears. Upper panel includes random and nonrandom sampling. Lower panel includes only random sampling.

4.3 Targeted Native River Species

4.3.1 Shovelnose sturgeon

4.3.1.1 Combined Basins

During the 2006 sampling year in the upper and lower basins of the Missouri River 12,198 shovelnose sturgeon *Scaphirhynchus platorynchus* were captured during the sturgeon season, while 2924 were captured during the fish community season (Figure 4.21). Sampling from the lower basin during the sturgeon season resulted in 11,883 shovelnose sturgeon captured, comprising 97% of the catch during the sturgeon sampling season. Sampling from segments 13 and 14 (RM 0 – 250) resulted in approximately 45% of the lower basin total for the sturgeon season. Sampling from the upper reaches of segment 9 near the Platte River (RM 596) also yielded significant numbers of shovelnose sturgeon during the sturgeon season. During the fish community season, there were no marked differences in shovelnose sturgeon catch from the upper basin and lower basin. During the fish community season, sampling from segments 3 and 4 (RM 1568 – 1701) in the upper basin accounted for most of the shovelnose sturgeon catch for that part of the basin. Sampling from segment 14 (RM 0 – 130) in the lower basin during the fish community season yielded some of the highest shovelnose sturgeon catch per river mile (Figure 4.21).

Relative abundance of shovelnose sturgeon differed markedly between sampling seasons and years. During the 2006 sampling year, the mean CPUE of shovelnose sturgeon captured with trammel nets was similar for the fish community and sturgeon seasons, with a mean of approximately 0.9 fish/100 m (Figure 4.22). The mean trammel net CPUE during the fish community season decreased markedly from the 2005 sampling year to the 2006 sampling year, resulting in a decrease in overall mean CPUE from 1.6 fish/100 m to 0.9 fish/100 m, respectively. During the 2006 sampling year, the mean CPUE of shovelnose sturgeon captured with otter trawls was larger during the sturgeon season (0.6 fish/100 m) than during the fish community season (0.4 fish/100 m; Figure 4.22). As with trammel nets, the mean otter trawl CPUE during the fish community season decreased from the 2005 sampling year to the 2006 sampling year, resulting in a small decrease in overall mean CPUE from 0.6 fish/100 m to 0.5 fish/100 m, respectively.

Relative abundance of shovelnose sturgeon also differed markedly among sampling segments. During the sturgeon sampling season the relative abundance of shovelnose sturgeon captured with trammel nets was generally larger in the lower basin than the upper basin, with the mean CPUE ranging from 0.4 fish/100 m to approximately 3.2 fish/100 m in the lower basin (Figure 4.23). Sampling from segments 9 through 13 (RM 130 – 596) resulted in some of the largest trammel net CPUE during the sturgeon season, a finding also observed during the fish community season. During the fish community season, the geographic trend in relative abundance remained relatively unchanged such that trammel net sampling from the lower basin resulted in comparatively larger mean CPUE than from the upper basin. The mean trammel net CPUE during the fish community season increased from that of the sturgeon season for nearly all upper basin sampling reaches, ranging from 0.1 fish/100 m to approximately 1.4 fish/100 m (Figure 4.23). As with trammel nets, during the sturgeon sampling season the relative abundance of shovelnose sturgeon captured with otter trawls was generally larger in the lower basin than in the upper basin (Figure 4.24). During the 2006 sturgeon season, the mean CPUE of shovelnose sturgeon captured with otter trawls ranged from 0.1 fish/100 m to 1.6 fish/100 m in the lower basin, and < 0.1 fish/100 m to 0.4 fish/100 m in the upper basin. During the 2006 fish community season, the geographic trend in relative abundance remained relatively unchanged such that otter trawl sampling from the lower basin resulted in comparatively larger mean CPUE than from the upper basin (Figure 4.24).

Overall, the relative abundance of shovelnose sturgeon within the Missouri River has decreased from 2005 through 2006 (Figure 4.22). As such, mean CPUE decreased in many sampling segments from both basins during this time as the sampling program has become fully implemented (Figure 4.25, Figure 4.26, and Figure 4.27). When combining sampling seasons in 2006, the relative abundance of shovelnose sturgeon captured with trammel nets was comparatively larger in the lower basin (0.1 to 2.8 fish/100 m) than the upper basin (0.1 to 1.3 fish/100 m; Figure 4.25). During 2006, the mean trammel net CPUE seemed to be highest in upper basin segment 1 (RM 1760 – 1772) and lower basin segment 9 (RM 368 – 596). As with trammel nets, the relative abundance of shovelnose sturgeon captured with otter trawls during 2006 was comparatively larger in the lower basin (0.1 to 1.3 fish/100 m) than the upper basin (< 0.1 to 0.2 fish/100 m; Figure 4.26). During the 2006 sampling year, there appeared to be no geographic trend in relative abundance within either the lower basin or upper basin. While gill net sampling only occurred in the lower basin, the relative abundance of shovelnose sturgeon sampled with this gear appears to have generally decreased during the period from 2003 to 2006 (Figure 4.27). Gill net sampling from segment 13 (RM 130 – 250) in 2003 yielded mean CPUE of approximately 13.0 to 15.0 fish/net night, which decreased to 1.0 to 6.0 fish/net night in 2006. During 2006, there appeared to be no significant geographic trends throughout the lower basin for shovelnose sturgeon relative abundance sampled with gill nets, with the exception of some of the lowest mean CPUE resulting from sampling in segments 5 through 7 (RM 750 – 880).

Random sampling with standard gears accounted for approximately 84% (N = 10,210) of the total shovelnose sturgeon catch during the 2006 sturgeon season, and 83% (N = 2429) of the catch during the 2006 fish community season (Table 4.19). During both seasons, most shovelnose sturgeon were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred. Main channel crossover macrohabitats were also sampled with a relatively large effort, which resulted in proportional catches of shovelnose sturgeon with all gear types and during both seasons. One exception was large secondary connected channel macrohabitat during the sturgeon season, which accounted for 24% of the trammel net catch while only 8% of the gear effort was applied there (Table 4.19). The majority of shovelnose sturgeon were captured from main channel border mesohabitats, which for most gears was also the location of greatest effort (Table 4.20). During the sturgeon season, pool mesohabitats comprised 39% of the gill net sampling effort, resulting in approximately 43% of the total shovelnose sturgeon catch with all gears for that season. Mini-fyke nets, used during fish community season, caught three shovelnose sturgeon, all from sand bar mesohabitat.

The length frequency distribution of shovelnose sturgeon captured during the 2006 sampling year was negatively skewed, with juvenile fish representing a small component of fish sampled (Figure 4.28). The fork lengths of all shovelnose sturgeon captured ranged from approximately 30 to 890 mm, with a mode near 570 mm. Random sampling accounted for 96% (N = 14,520) of the shovelnose sturgeon captured. The length frequency distribution from random sampling was very similar to that from a combination of random and non-random sampling (Figure 4.28).

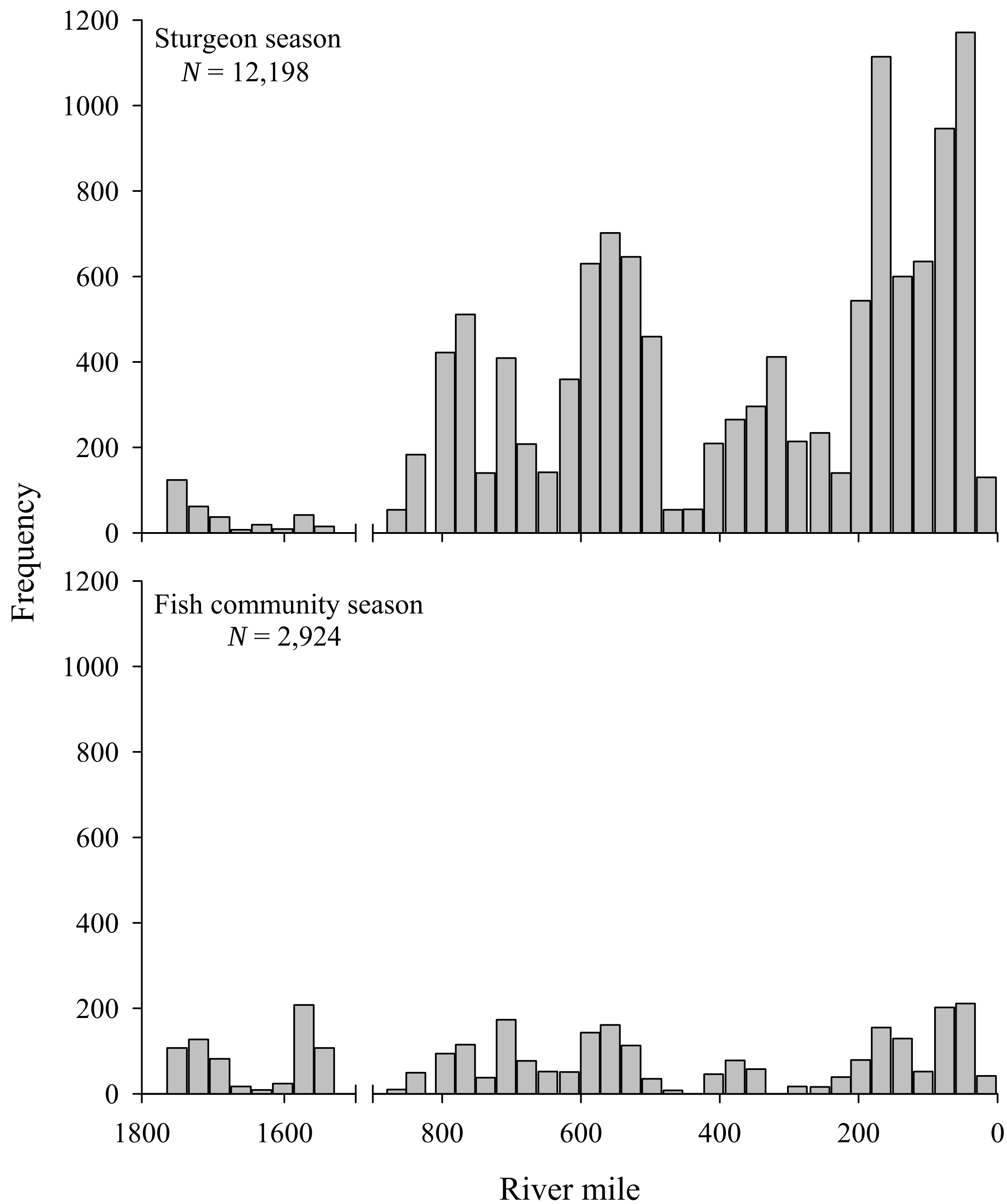

Figure 4.21. Seasonal catch by river mile (30-mile bins) of shovelnose sturgeon in the upper and lower basins of the Missouri River in the 2006 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

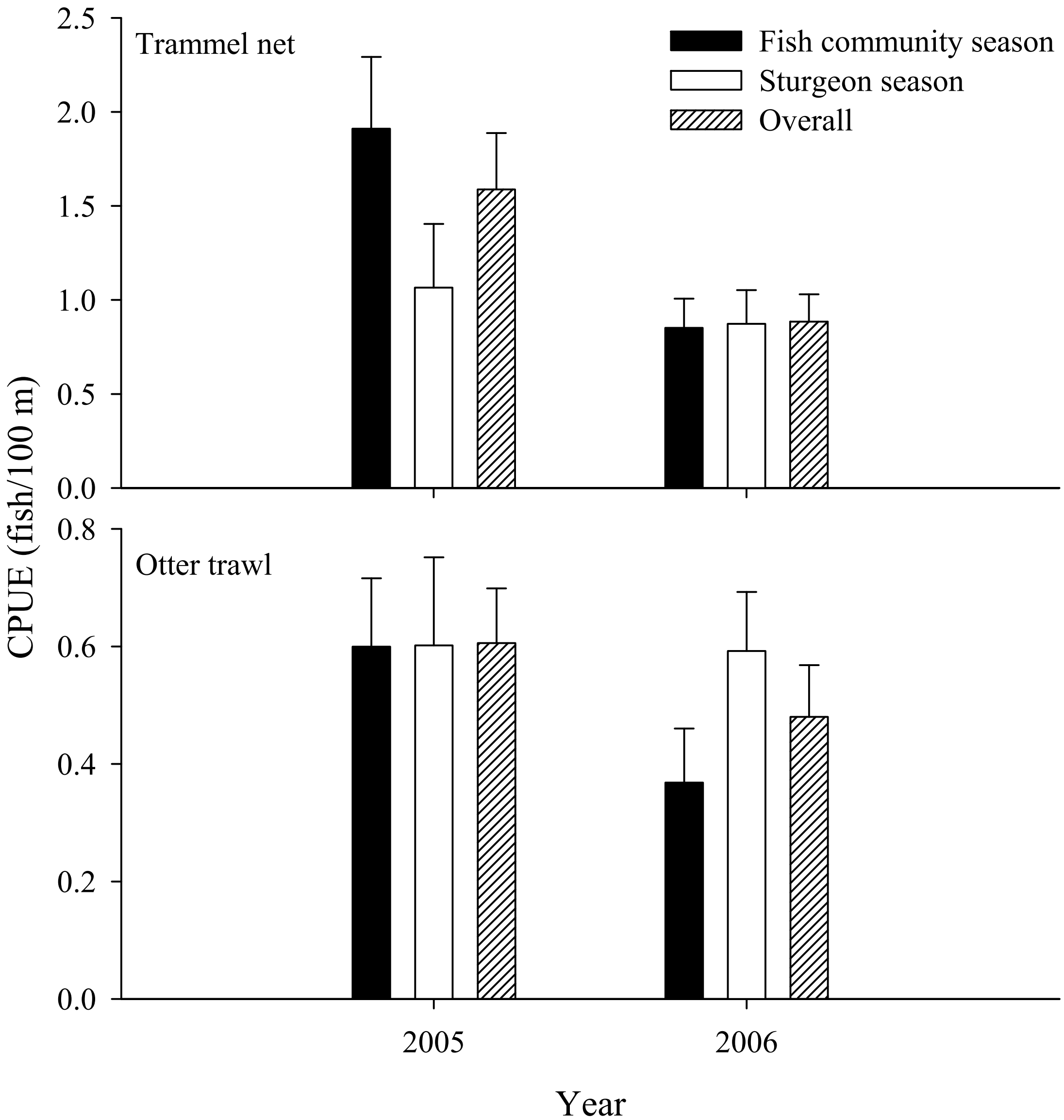

Figure 4.22. Mean annual catch per unit effort (± 2 SE) by season for shovelnose sturgeon using one-inch trammel nets and otter trawls in the upper and lower basins of the Missouri River for the 2005 and 2006 sampling years.

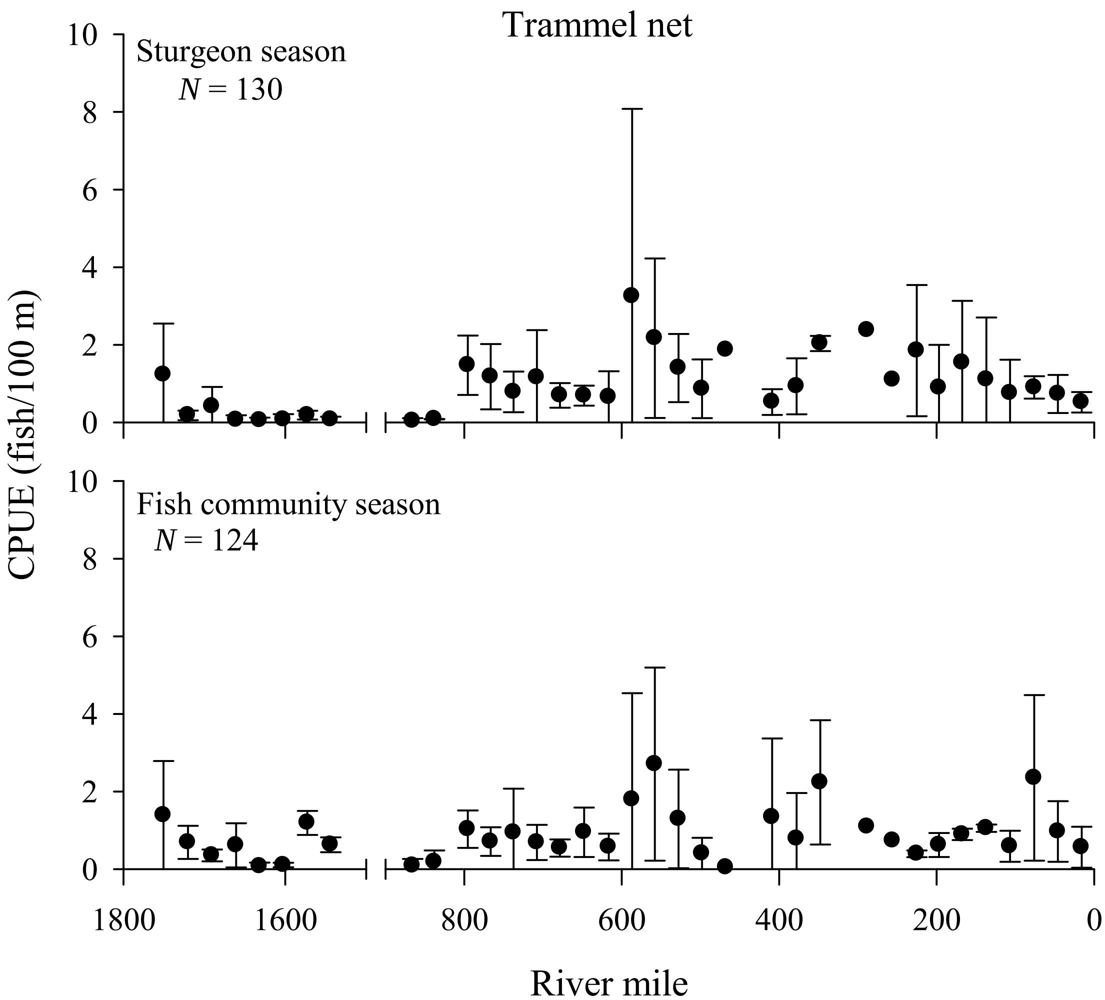

Figure 4.23. Mean seasonal catch per unit effort (± 2 SE) of shovelnose sturgeon by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2006 sampling year. Data obtained through random sampling using one-inch trammel nets. Sample size denotes the number of bends sampled.

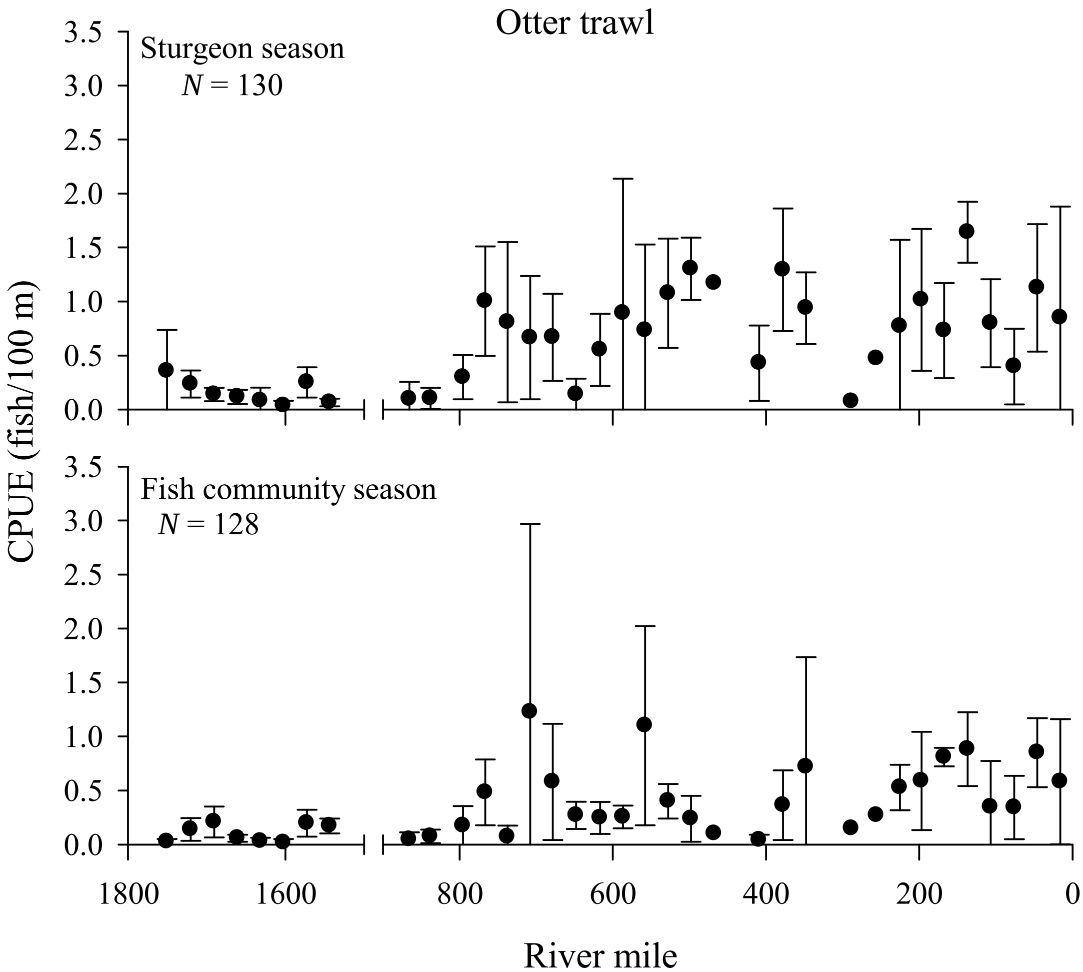

Figure 4.24. Mean seasonal catch per unit effort (± 2 SE) of shovelnose sturgeon by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2006 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

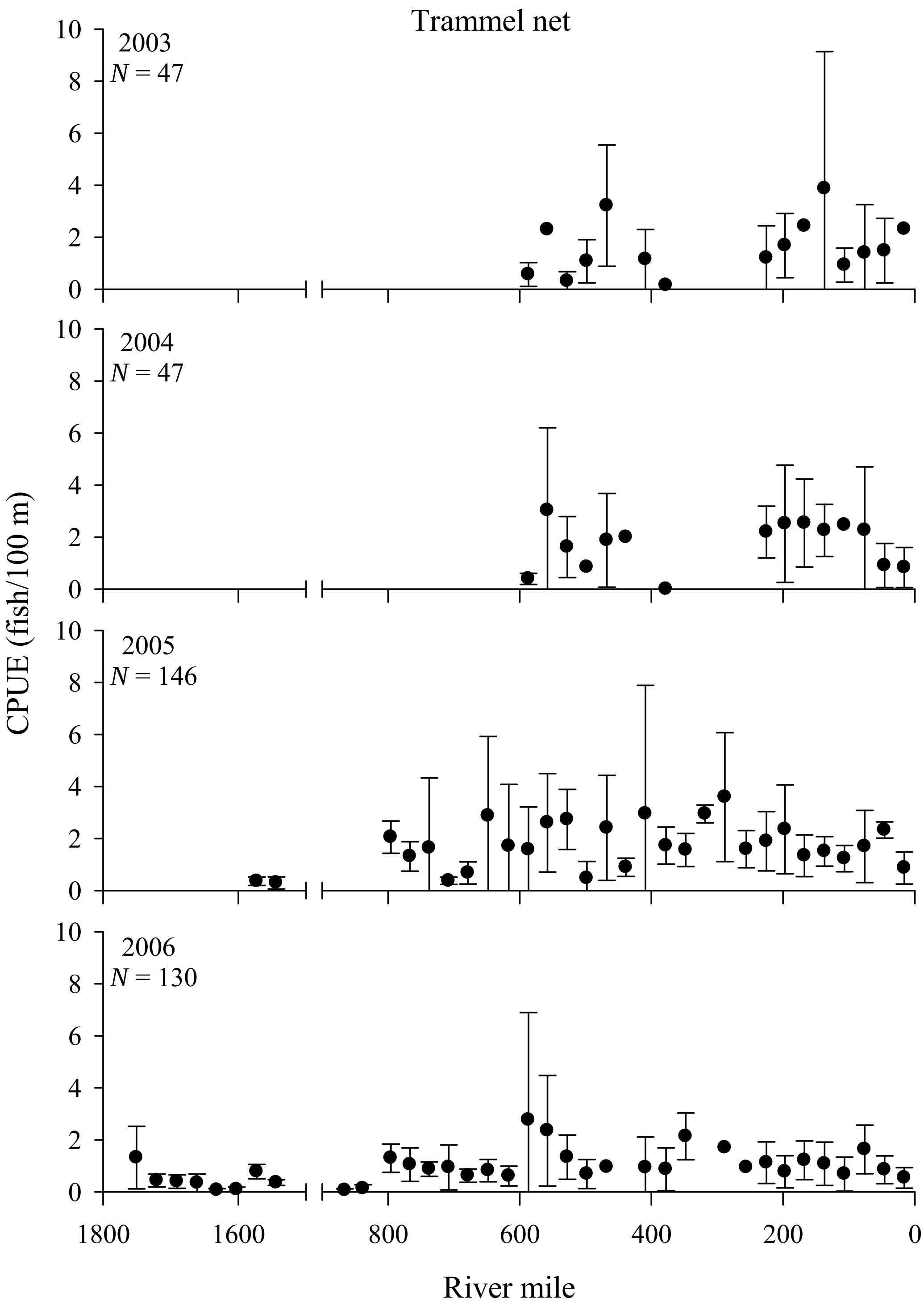

Figure 4.25. Mean annual catch per unit effort (± 2 SE) of shovelnose sturgeon by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2003 to 2006 sampling years. Data obtained through random sampling using one-inch trammel nets. Sample size denotes the number of bends sampled.

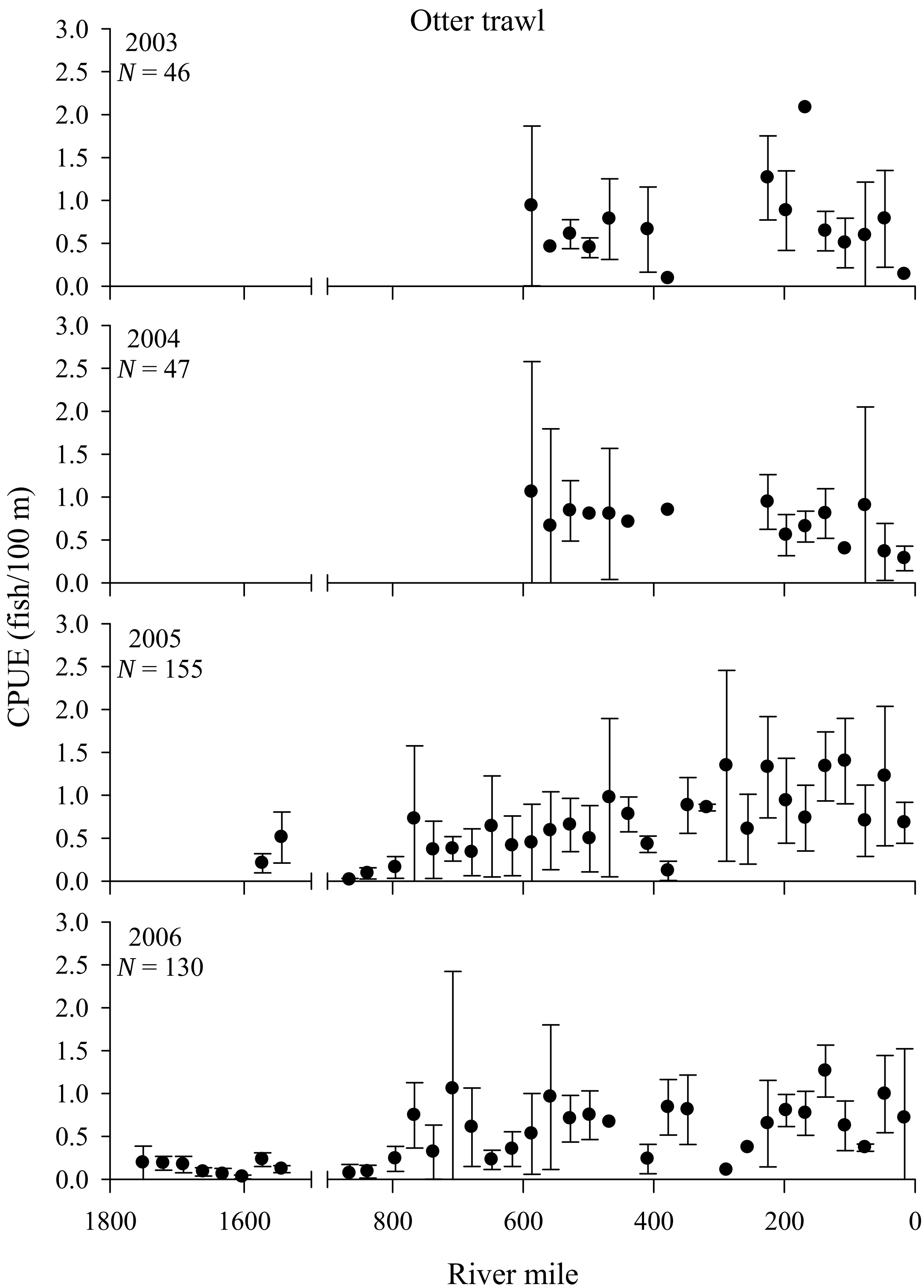

Figure 4.26. Mean annual catch per unit effort (± 2 SE) of shovelnose sturgeon by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2003 to 2006 sampling years. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

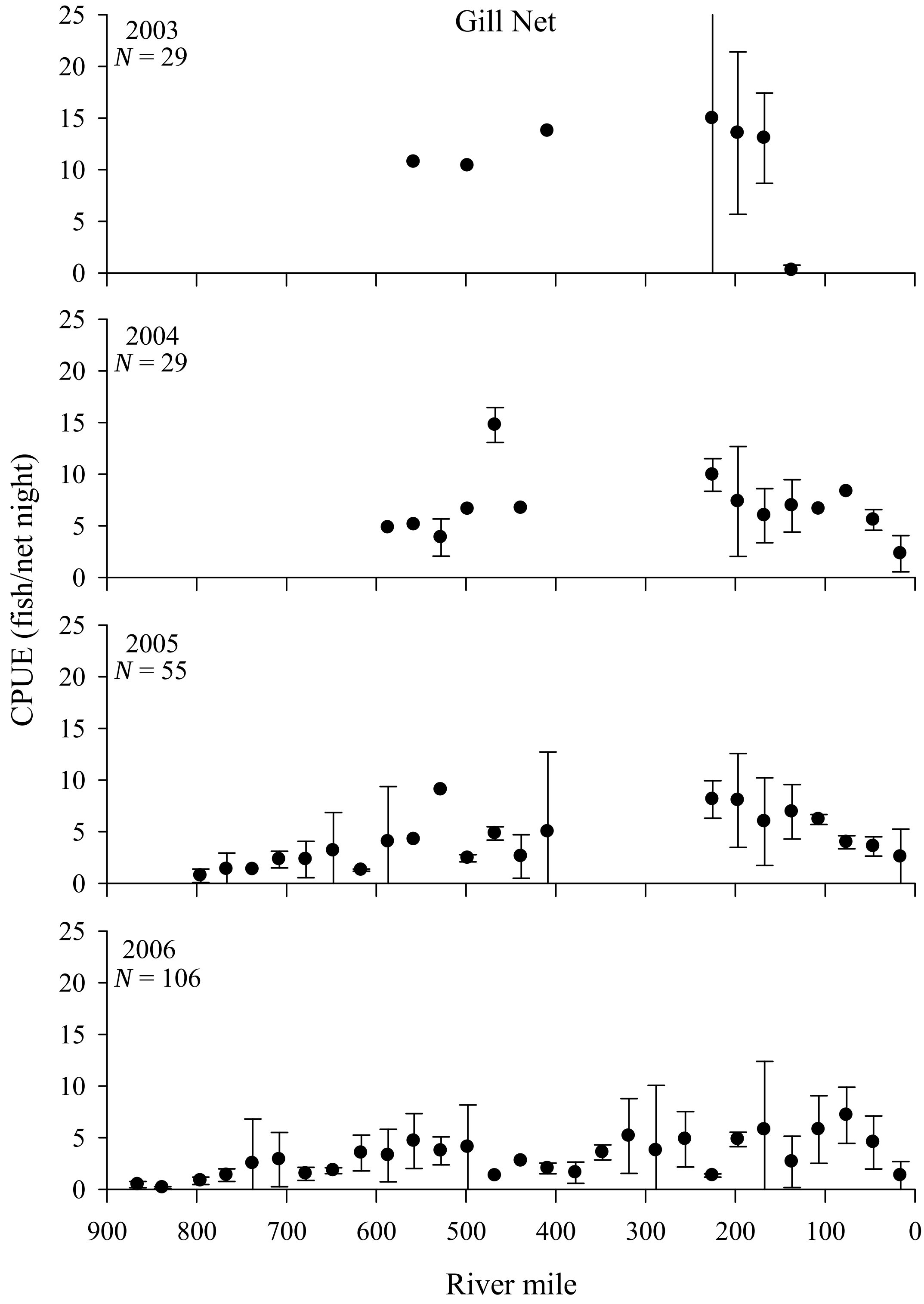

Figure 4.27. Mean annual catch per unit effort (± 2 SE) of shovelnose sturgeon by river mile (30-mile bins) in the lower basin of the Missouri River for the 2003 to 2006 sampling years. Data obtained through random sampling using gill nets. Sample size denotes the number of bends sampled.

Table 4.19. Total number of shovelnose sturgeon captured for each gear during each season and the percentage caught within each macrohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1 Inch Trammel Net	1796	4.2	7.7	3.5	0.3	1.0	53.2	6.1	23.6	0.4	0	0	0	0	0
		(3.2)	(22.8)	(1.3)	(1.0)	(1.1)	(51.4)	(9.7)	(8.1)	(0.8)	(0)	(0)	(0)	(0)	(0.6)
Gill Net	7252	0.9	30.5	1.3	0	0.1	57.0	6.7	2.3	1.0	0	0	0.2	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.4)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	1162	4.8	19.8	1.3	0.6	0.6	56.5	3.7	7.5	4.3	0	0	0.9	0	0
		(4.7)	(22.9)	(0.8)	(0.9)	(0.6)	(47.9)	(10.3)	(9.1)	(2.2)	(0)	(0)	(0.5)	(0)	(0)
Fish Community Season (Summer)															
1 Inch Trammel Net	1532	1.3	15.8	1.0	0.3	0.6	54.3	14.0	10.6	2.2	0	0	0	0	0
		(3.2)	(24.2)	(0.6)	(0.7)	(0.7)	(53.7)	(10.6)	(4.5)	(1.6)	(0)	(0)	(0.2)	(0)	(0)
Mini-Fyke Net	3	0	0	0	0	0	100.0	0	0	0	0	0	0	0	0
		(4.8)	(16.7)	(0.5)	(0.2)	(0.2)	(43.2)	(9.2)	(7.5)	(13.8)	(1.9)	(0.2)	(0.2)	(1.8)	(0)
Otter Trawl	894	2.8	18.9	0.3	0.6	0.9	65.1	4.1	4.9	2.3	0	0	0	0	0
		(4.2)	(24.1)	(0.6)	(0.6)	(0.8)	(53.4)	(9.5)	(5.2)	(1.2)	(0)	(0)	(0.3)	(0)	(0)

Table 4.20. Total number of shovelnose sturgeon captured for each gear during each season and the percentage caught within each mesohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1 Inch Trammel Net	1796	0	97.2	0	2.8	0	0.1
		(0)	(94.8)	(0.6)	(4.4)	(0)	(0.2)
Gill Net	7252	0	37.3	0	1.5	61.2	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	1162	0	93.6	0	6.0	0.3	0.1
		(0)	(93.6)	(0)	(5.9)	(0.2)	(0.3)
Fish Community Season (Summer)							
1 Inch Trammel Net	1532	0	95.8	0	4.2	0	0
		(0.1)	(96.0)	(0)	(3.9)	(0)	(0.1)
Mini-Fyke Net	3	100.0	0	0	0	0	0
		(96.2)	(1.2)	(0)	(2.6)	(0)	(0)
Otter Trawl	894	0	96.6	0	3.4	0	0
		(0)	(97.1)	(0)	(2.9)	(0)	(0)

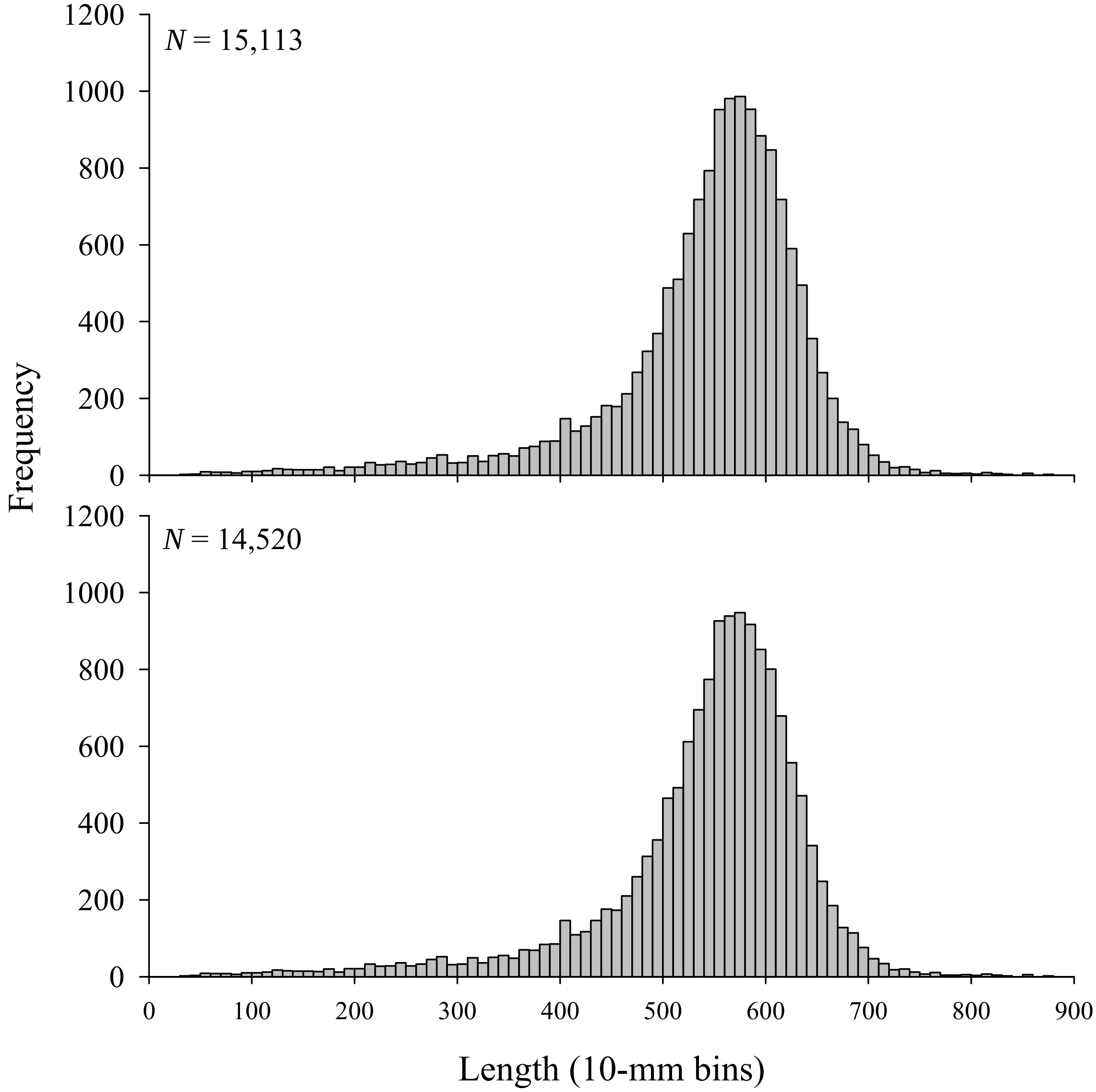

Figure 4.28. Length frequency distribution of shovelnose sturgeon captured in the upper and lower basins of the Missouri River during the 2006 sampling year using standard and wild gears. Upper panel includes random and nonrandom sampling. Lower panel includes only random sampling.

4.3.1.2 Upper Basin

Within the upper basin sampling segments of the Missouri River, relative abundance of shovelnose sturgeon differed markedly between sampling seasons and years. During the 2006 sampling year, the mean CPUE of shovelnose sturgeon captured with trammel nets was markedly larger during the fish community season (0.65 fish/100 m) than during the sturgeon season (0.24 fish/100 m; Figure 4.29). While the mean trammel net CPUE during the fish community season was relatively unchanged from the 2005 sampling year to the 2006 sampling year, relative abundance during the sturgeon season increased from 0.07 fish/100 m in 2005 to 0.24 fish/100 m in 2006. The overall mean CPUE resulting from trammel net deployments was similar for the 2005 and 2006 sampling years. During the 2006 sampling year, the mean CPUE of shovelnose sturgeon captured with otter trawls was similar during the sturgeon season (0.16 fish/100 m) and the fish community season (0.12 fish/100 m; Figure 4.29). During the sturgeon season of the 2005 sampling year, there were no shovelnose sturgeon captured with otter trawls. The mean otter trawl CPUE during the fish community season decreased from 0.33 fish/100 m in the 2005 sampling year to 0.12 fish/100 m in the 2006 sampling year, resulting in a decrease in overall mean CPUE from 0.33 fish/100 m to 0.14 fish/100 m, respectively.

Within the upper basin sampling segments, 844 shovelnose sturgeon were captured during the 2006 sampling year; 286 during the sturgeon season and 558 during the fish community season (Table 4.21). During the sturgeon season, most shovelnose sturgeon were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred. During the fish community season, shovelnose sturgeon were captured from more macrohabitats, including main channel crossover, inside bend, outside bend, and small and large secondary connected channels. During the sturgeon sampling season, 87% (N = 248) of the shovelnose sturgeon were captured from main channel border mesohabitats, which for both gears was also the location of greatest effort (Table 4.22). Sampling from main channel border mesohabitats during the fish community season resulted in 94% (N = 524) of the shovelnose sturgeon catch. Mini-fyke nets, used during the fish community season, did not catch any shovelnose sturgeon during the 2006 sampling year.

The length frequency distribution of shovelnose sturgeon captured during the 2006 sampling year was negatively skewed, with juvenile fish representing a small component of fish sampled (Figure 4.30). The fork lengths of all shovelnose sturgeon captured ranged from approximately 40 to 890 mm, with a mode near 570 mm. Random sampling accounted for 88% (N = 877) of the shovelnose sturgeon captured. The length frequency distribution from random sampling was very similar to that from a combination of random and non-random sampling (Figure 4.30).

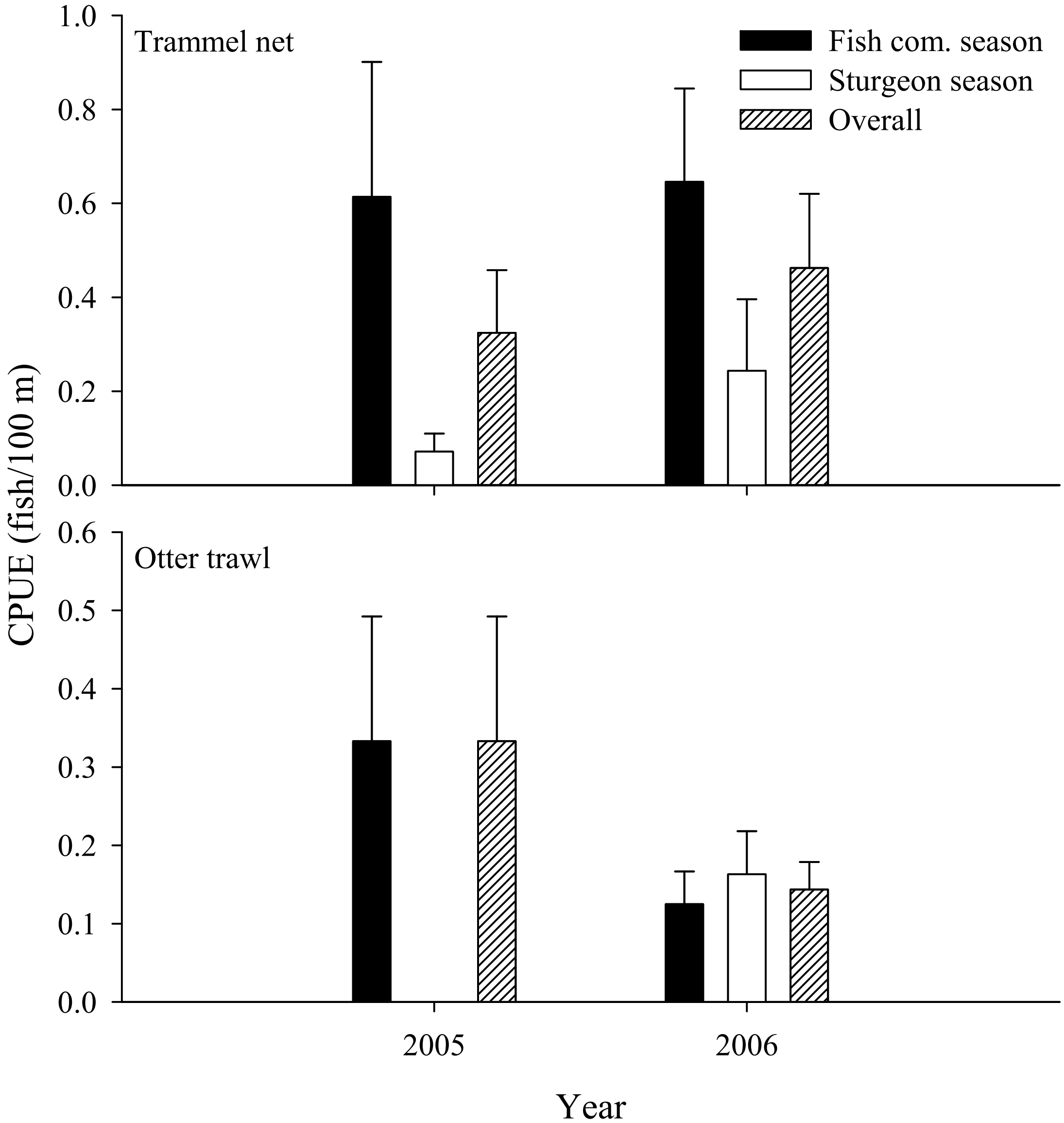

Figure 4.29. Mean annual catch per unit effort (± 2 SE) by season for shovelnose sturgeon using one-inch trammel nets and otter trawls in the upper basin of the Missouri River for the 2005 and 2006 sampling years.

Table 4.21. Total number of shovelnose sturgeon captured for each gear during each season and the percentage caught within each macrohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1 Inch Trammel Net	168	0	8.9	0	0	0	46.4	19.6	25.0	0	0	0	0	0	0
		(0)	(24.3)	(0.6)	(0)	(0)	(30.3)	(26.5)	(18.3)	(0)	(0)	(0)	(0)	(0)	(0)
Otter Trawl	118	0	24.6	0	0	0	28.8	24.6	17.8	4.2	0	0	0	0	0
		(0)	(24.7)	(0.6)	(0)	(0)	(27.9)	(25.0)	(18.6)	(3.2)	(0)	(0)	(0)	(0)	(0)
Fish Community Season (Summer)															
1 Inch Trammel Net	447	0	25.3	0	0	0	26.0	40.5	4.7	3.6	0	0	0	0	0
		(0)	(26.7)	(0)	(0)	(0)	(31.1)	(27.7)	(10.4)	(3.5)	(0)	(0)	(0.6)	(0)	(0)
Mini-Fyke Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(0)	(7.7)	(0.7)	(0)	(0)	(33.1)	(11.4)	(19.9)	(20.2)	(6.3)	(0)	(0)	(0.7)	(0)
Otter Trawl	111	0	21.6	0	0	0	46.8	24.3	6.3	0.9	0	0	0	0	0
		(0)	(26.6)	(0.7)	(0)	(0)	(29.8)	(30.4)	(11.4)	(1.0)	(0)	(0)	(0)	(0)	(0)

Table 4.22. Total number of shovelnose sturgeon captured for each gear during each season and the percentage caught within each mesohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1 Inch Trammel Net	168	0	87.5	0	11.9	0	0.6
		(0)	(88.0)	(0)	(11.4)	(0)	(0.6)
Otter Trawl	118	0	85.6	0	13.6	0	0.8
		(0)	(85.3)	(0)	(13.8)	(0)	(1.0)
Fish Community Season (Summer)							
1 Inch Trammel Net	447	0	92.8	0	7.2	0	0
		(0.3)	(89.6)	(0)	(9.7)	(0)	(0.3)
Mini-Fyke Net	0	0	0	0	0	0	0
		(92.0)	(1.1)	(0)	(6.8)	(0)	(0)
Otter Trawl	111	0	98.2	0	1.8	0	0
		(0)	(94.5)	(0)	(5.5)	(0)	(0)

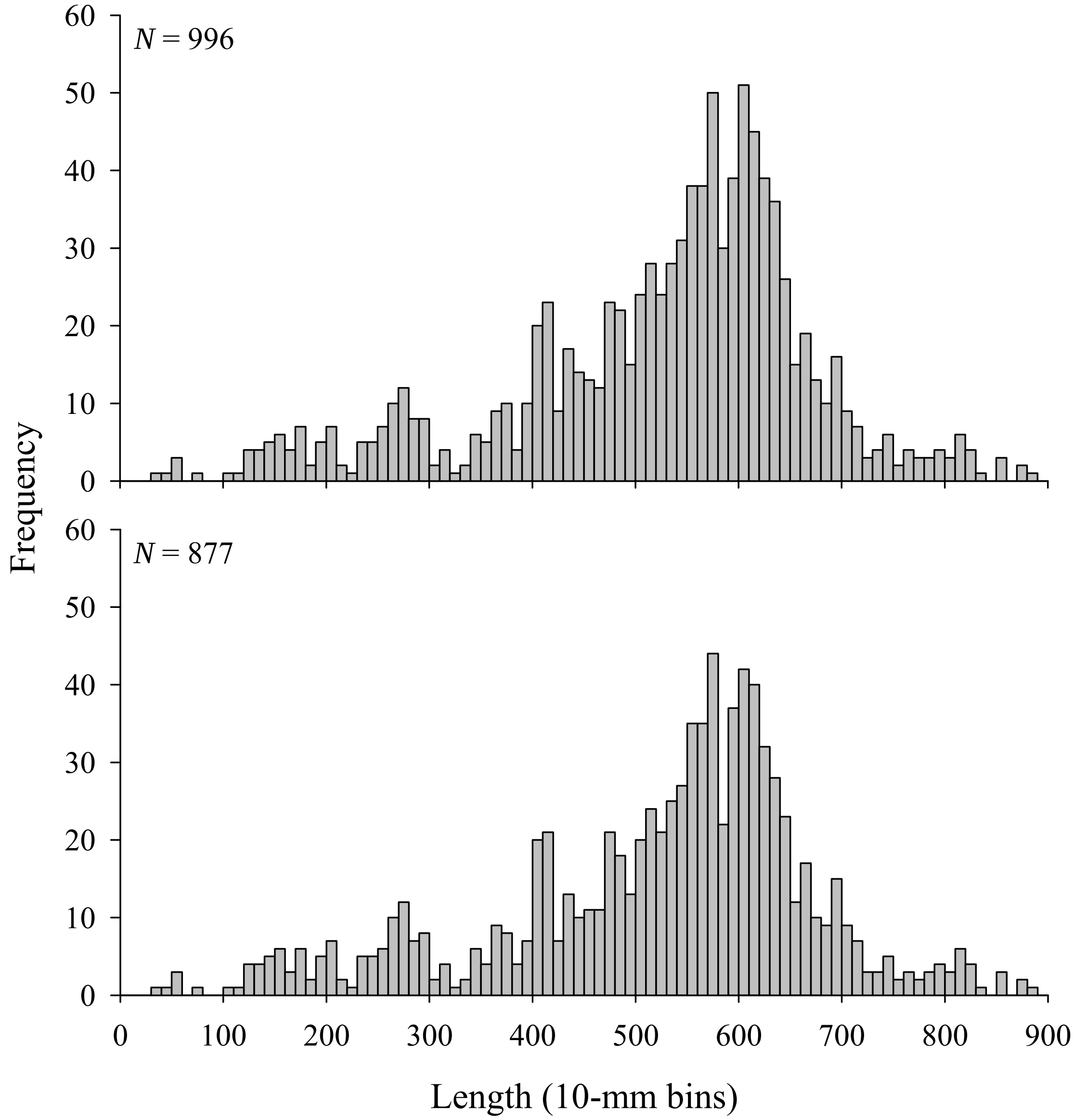

Figure 4.30. Length frequency distribution of shovelnose sturgeon captured in the upper basin of the Missouri River during the 2006 sampling year using standard and wild gears. Upper panel includes random and nonrandom sampling. Lower panel includes only random sampling.

4.3.1.3 Lower Basin

Within the lower basin sampling segments of the Missouri River, relative abundance of shovelnose sturgeon differed markedly between sampling seasons and years. During the 2006 sampling year, the mean CPUE of shovelnose sturgeon captured with trammel nets was slightly lower during the fish community season (0.9 fish/100 m) than during the sturgeon season (1.1 fish/100 m; Figure 4.31). While the mean trammel net CPUE during the sturgeon season was relatively unchanged from the 2005 sampling year to the 2006 sampling year, relative abundance during the fish community season decreased from 2.1 fish/100 m in 2005 to 0.9 fish/100 m in 2006. The overall mean CPUE resulting from trammel net deployments has decreased over the years since initiating the sampling program, from a high of 2.3 fish/100 m in 2004 to a low of 1.0 fish/100 m in 2006 (Figure 4.31). During the 2006 sampling year, the mean CPUE of shovelnose sturgeon captured with otter trawls was notably larger during the sturgeon season (0.8 fish/100 m) than during the fish community season (0.5 fish/100 m; Figure 4.31). The mean otter trawl CPUE during the fish community season decreased from the 2005 sampling year (0.6 fish/100 m) to the 2006 sampling year (0.5 fish/100 m), while the mean otter trawl CPUE during the sturgeon season increased from the 2005 sampling year (0.6 fish/100 m) to the 2006 sampling year (0.8 fish/100 m). The overall mean CPUE resulting from otter trawl deployments has decreased over the years since initiating the sampling program, from a high of 0.7 fish/100 m in 2003 to a low of 0.6 fish/100 m in 2006 (Figure 4.31). Shovelnose sturgeon relative abundance estimates from gill net sampling have decreased much more markedly over the years since initiating the sampling program, from a high of 12.3 fish/net night in 2003 to a low of 3.3 fish/net night in 2006 (Figure 4.32).

Within the lower basin sampling segments, 11,795 shovelnose sturgeon were captured during the 2006 sampling year; 9924 during the sturgeon season and 1871 during the fish community season (Table 4.23). During the sturgeon and fish community seasons, most shovelnose sturgeon were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred. Gill nets captured 73% (N = 7252) of the shovelnose sturgeon catch during the sturgeon season, with 61% of these fish coming from pool mesohabitats (Table 4.24). During the sturgeon sampling season, 26% (N = 2586) of the shovelnose sturgeon were captured from main channel border mesohabitats with trammel nets and otter trawls, which for both gears was also the location of greatest effort (Table 4.24). Sampling from main channel border mesohabitats during the fish community season resulted in 97% (N = 1809) of the shovelnose sturgeon catch. Mini-fyke nets, used during the fish community season, captured three shovelnose sturgeon during the 2006 sampling year, all from sand bar mesohabitats.

The length frequency distribution of shovelnose sturgeon captured during the 2006 sampling year was negatively skewed, with juvenile fish representing a small component of fish sampled (Figure 4.33). The fork lengths of all shovelnose sturgeon captured ranged from approximately 30 to 860 mm, with a mode near 560 mm. Random sampling accounted for 97% (N = 13,643) of the shovelnose sturgeon captured. The length frequency distribution from random sampling was very similar to that from a combination of random and non-random sampling (Figure 4.33).

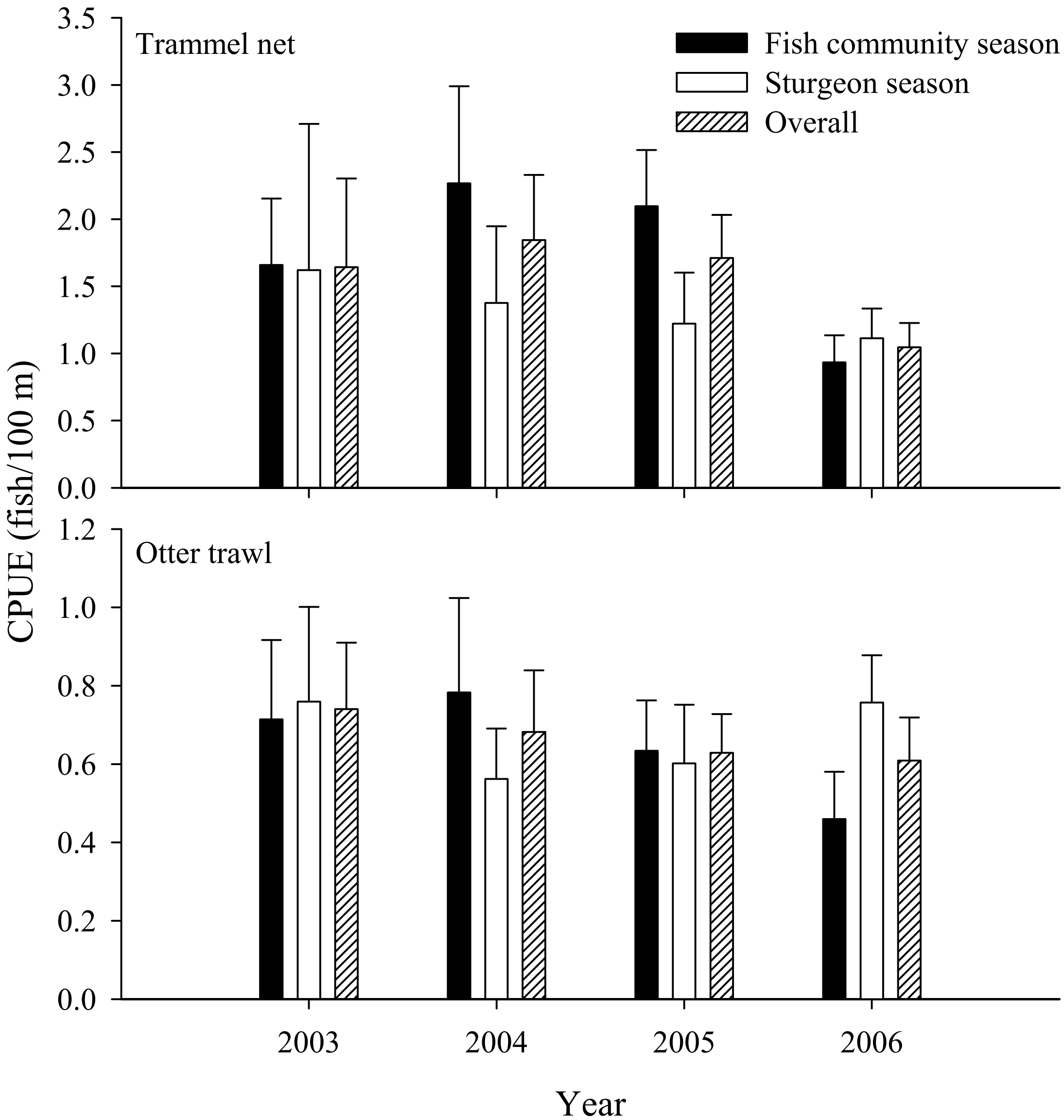

Figure 4.31. Mean annual catch per unit effort (± 2 SE) by season for shovelnose sturgeon using one-inch trammel nets and otter trawls in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

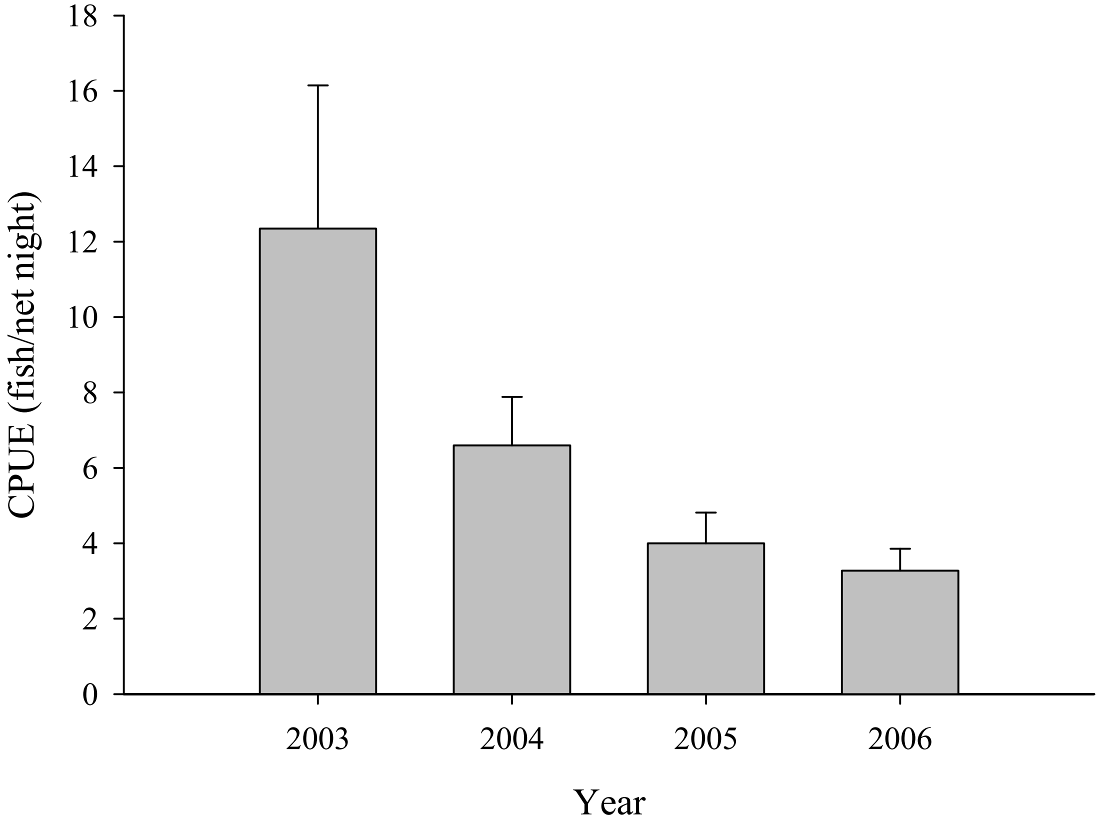

Figure 4.32. Mean annual catch per unit effort (± 2 SE) for shovelnose sturgeon using gill nets in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

Table 4.23. Total number of shovelnose sturgeon captured for each gear during each season and the percentage caught within each macrohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1 Inch Trammel Net	1628	4.7	7.6	3.8	0.4	1.1	53.9	4.7	23.4	0.5	0	0	0	0	0
		(4.3)	(22.3)	(1.5)	(1.4)	(1.5)	(58.4)	(4.2)	(4.7)	(1.0)	(0)	(0)	(0)	(0)	(0.8)
Gill Net	7252	0.9	30.5	1.3	0	0.1	57.0	6.7	2.3	1.0	0	0	0.2	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.4)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	1044	5.4	19.3	1.4	0.7	0.7	59.6	1.3	6.3	4.3	0	0	1.1	0	0
		(6.6)	(22.3)	(0.9)	(1.3)	(0.8)	(56.0)	(4.4)	(5.3)	(1.8)	(0)	(0)	(0.6)	(0)	(0)
Fish Community Season (Summer)															
1 Inch Trammel Net	1085	1.8	11.9	1.4	0.4	0.8	66.0	3.0	13.0	1.7	0	0	0	0	0
		(4.4)	(23.2)	(0.9)	(1.0)	(1.0)	(62.5)	(3.9)	(2.2)	(0.9)	(0)	(0)	(0)	(0)	(0)
Mini-Fyke Net	3	0	0	0	0	0	100.0	0	0	0	0	0	0	0	0
		(6.5)	(19.9)	(0.4)	(0.3)	(0.3)	(46.8)	(8.4)	(3.1)	(11.4)	(0.3)	(0.3)	(0.3)	(2.1)	(0)
Otter Trawl	783	3.2	18.5	0.4	0.6	1.0	67.7	1.3	4.7	2.6	0	0	0	0	0
		(5.5)	(23.4)	(0.6)	(0.7)	(1.0)	(60.5)	(3.3)	(3.4)	(1.2)	(0)	(0)	(0.4)	(0)	(0)

Table 4.24. Total number of shovelnose sturgeon captured for each gear during each season and the percentage caught within each mesohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	**N**	**Mesohabitat**					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1 Inch Trammel Net	1628	0	98.2	0	1.8	0	0
		(0)	(97.3)	(0.8)	(1.9)	(0)	(0)
Gill Net	7252	0	37.3	0	1.5	61.2	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	1044	0	94.5	0	5.2	0.3	0
		(0)	(96.9)	(0)	(2.8)	(0.3)	(0)
Fish Community Season (Summer)							
1 Inch Trammel Net	1085	0	97.1	0	2.9	0	0
		(0)	(98.4)	(0)	(1.6)	(0)	(0)
Mini-Fyke Net	3	100.0	0	0	0	0	0
		(97.6)	(1.2)	(0)	(1.2)	(0)	(0)
Otter Trawl	783	0	96.4	0	3.6	0	0
		(0)	(98.0)	(0)	(2.0)	(0)	(0)

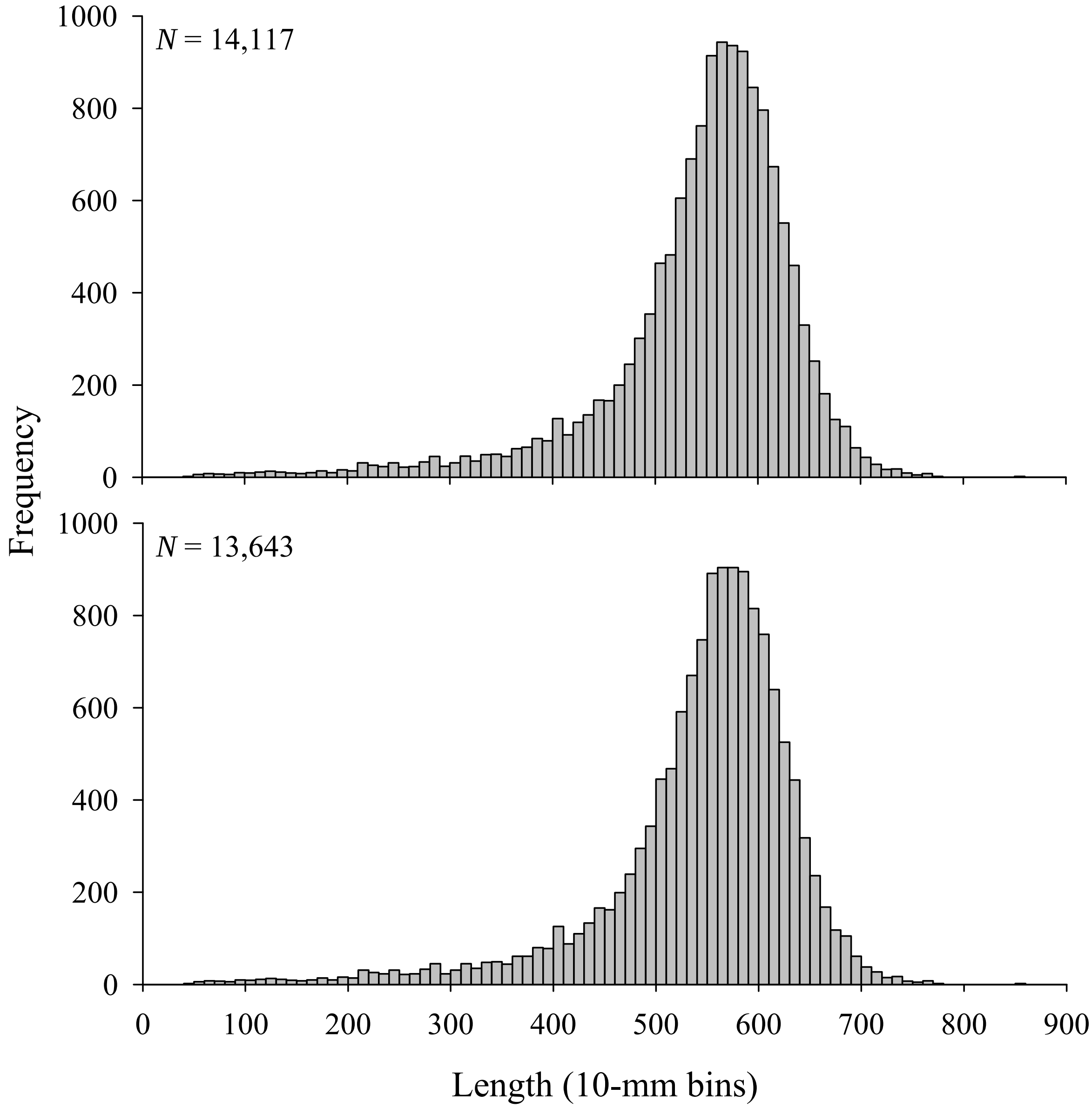

Figure 4.33. Length frequency distribution of shovelnose sturgeon captured in the lower basin of the Missouri River during the 2006 sampling year using standard and wild gears. Upper panel includes random and nonrandom sampling. Lower panel includes only random sampling.

4.3.2 Sturgeon chub

4.3.2.1 Combined Basins

During the 2006 sampling year in the upper and lower basins of the Missouri River 461 sturgeon chub *Macrhybopsis gelida* were captured during the sturgeon season, while 1229 were captured during the fish community season (Figure 4.34). Sampling from the upper basin during the sturgeon season resulted in 397 sturgeon chub captured, comprising 86% of the catch during that season. Sampling from the lower reaches of segments 3 and 4 (RM 1568 – 1701) resulted in approximately 74% of the upper basin catch for the sturgeon season. During the fish community season, sturgeon chub catch from the lower basin segments increased, however catch from the upper basin segments remained markedly larger, comprising 65% of the total catch during the season. During the fish community season sampling from the lower reaches of segments 3 and 4 (RM 1568 – 1701) in the upper basin accounted for 87% of the sturgeon chub catch for that part of the basin. Sampling from segment 9 (RM 368 – 596) in the lower basin during the fish community season yielded some of the highest sturgeon chub catch per river mile, including 72% of the lower basin total for the season (Figure 4.34).

Relative abundance of sturgeon chub was similar among sampling seasons and between years. During the sturgeon and fish community seasons, 100% and 99%, respectively, of the sturgeon chub were captured with otter trawls. During the 2006 sampling year, the mean CPUE of sturgeon chub captured with otter trawls was similar for the fish community (0.17 fish/100 m) and sturgeon seasons (0.15 fish/100 m; Figure 4.35). The mean otter trawl CPUE during both the sturgeon and fish community seasons increased from the 2005 sampling year to the 2006 sampling year, resulting in an increase in overall mean CPUE from 0.13 fish/100 m to 0.16 fish/100 m, respectively.

Relative abundance of sturgeon chub differed markedly among sampling segments. During the sturgeon sampling season the relative abundance of sturgeon chub captured with otter trawls was generally larger in the upper basin than the lower basin, with the mean CPUE ranging from 0.07 fish/100 m to approximately 0.9 fish/100 m in the upper basin (Figure 4.36). Sampling from the lower reaches of segments 3 and 4 (RM 1568 – 1701) resulted in some of the largest otter trawl CPUE during the sturgeon season, a finding also observed during the fish community season. During the fish community season, the geographic trend in relative abundance remained relatively unchanged such that otter trawl sampling from the upper basin resulted in comparatively larger mean CPUE than from the lower basin. The mean otter trawl CPUE during the fish community season increased from that of the sturgeon season for many lower basin sampling reaches, ranging from 0.00 fish/100 m to approximately 0.86 fish/100 m (Figure 4.36). Sampling from segment 9 (RM 368 – 596) in the lower basin during the fish community season resulted in some of the largest otter trawl CPUE during that season.

Relative abundance of sturgeon chub has generally increased in many sampling segments during the period from 2003 to 2006, in both the upper and lower basins, as the sampling program has become fully implemented. Exceptions occurred from sampling year 2005 to 2006 in the lower basin where it appears that mean CPUE decreased for most sampling segments (Figure 4.37). When combining sampling seasons in 2006, the relative abundance of sturgeon chub captured with otter trawls was comparatively larger in the upper basin (0.03 to 0.80 fish/100 m) than the lower basin (0.0 to 0.42 fish/100 m) (Figure 4.37). During 2006, the mean otter trawl CPUE seemed to be highest in upper basin segments 3 and 4 (RM 1568 – 1701) and lower basin segment 9 (RM 368 – 596).

Random sampling with standard gears accounted for approximately 91% (N = 420) of the total sturgeon chub catch during the 2006 sturgeon season, and 37% (N = 456) of the catch during the 2006 fish community season (Table 4.25). Otter trawls captured 100% of the sturgeon chub during the sturgeon season and 99% during the fish community season. During both seasons, most sturgeon chub were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred. Main channel crossover, outside bend, and large secondary connected channels were also sampled with a relatively large effort, which resulted in proportional catches during both seasons. Channel border mesohabitats were the location where 86% of the sturgeon chub were captured during the sturgeon season, and 96% were captured during the fish community season (Table 4.26).

A total of 1488 sturgeon chub were captured in the upper and lower basins during the 2006 sampling year. Lengths ranged from 10 to 95 mm, with a mode near 45 mm (Figure 4.38).

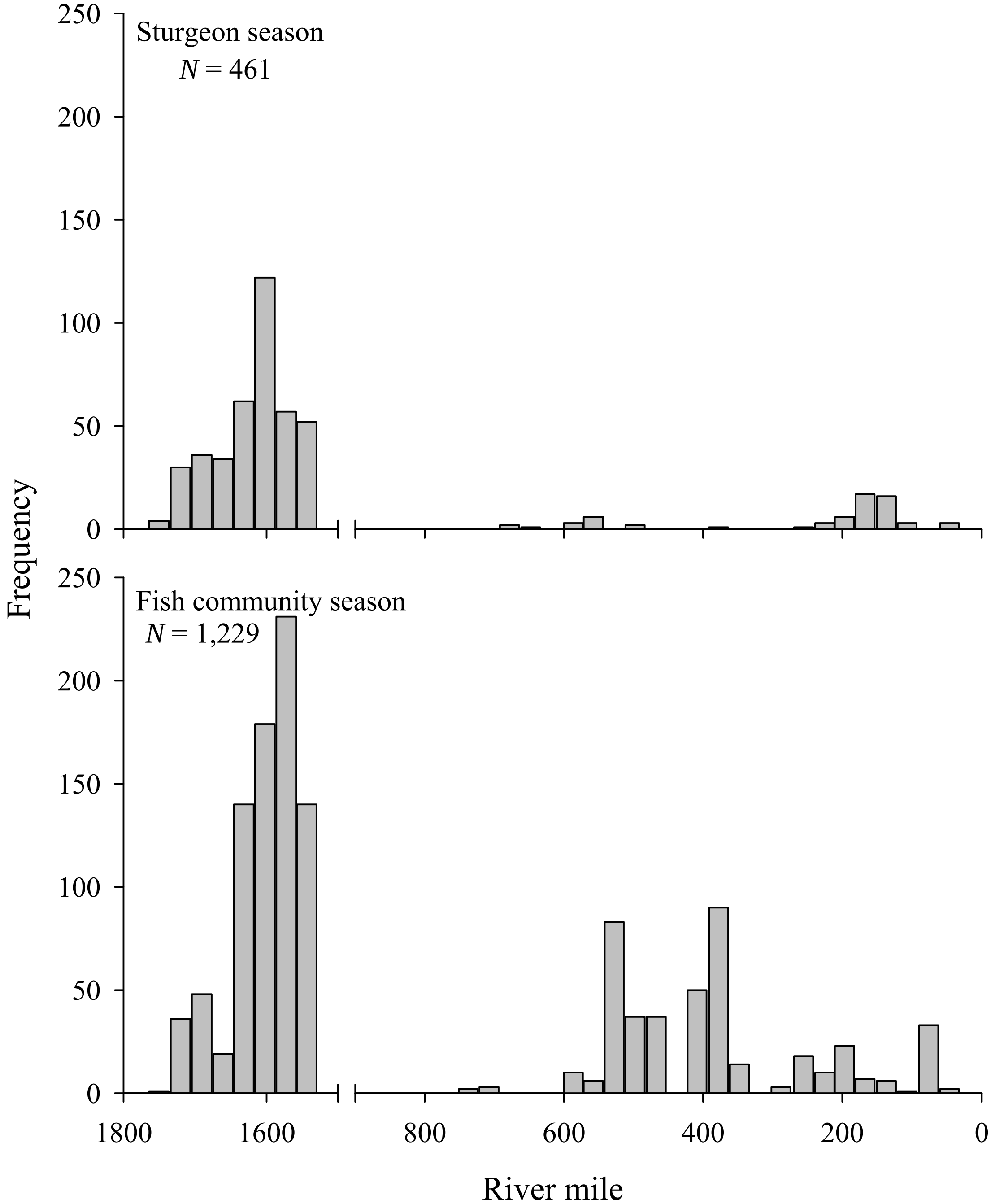

Figure 4.34. Seasonal catch by river mile (30-mile bins) of sturgeon chub in the upper and lower basins of the Missouri River in the 2006 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

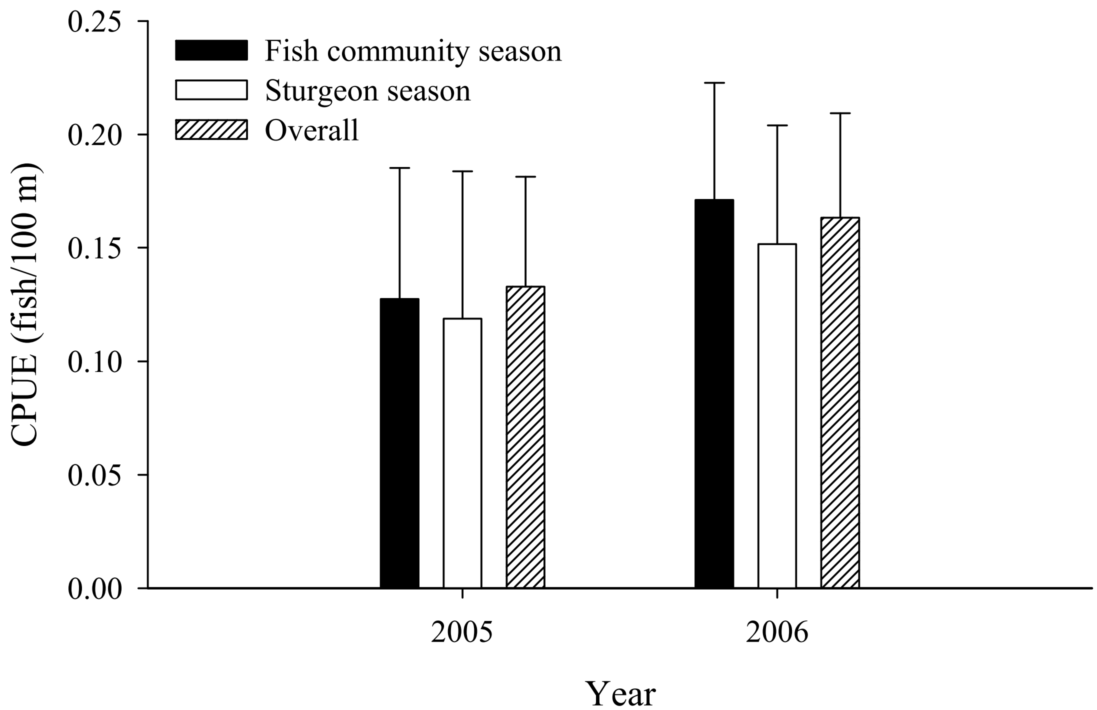

Figure 4.35. Mean annual catch per unit effort (± 2 SE) by season for sturgeon chub using otter trawls in the upper and lower basins of the Missouri River for 2005 and 2006 sampling years.

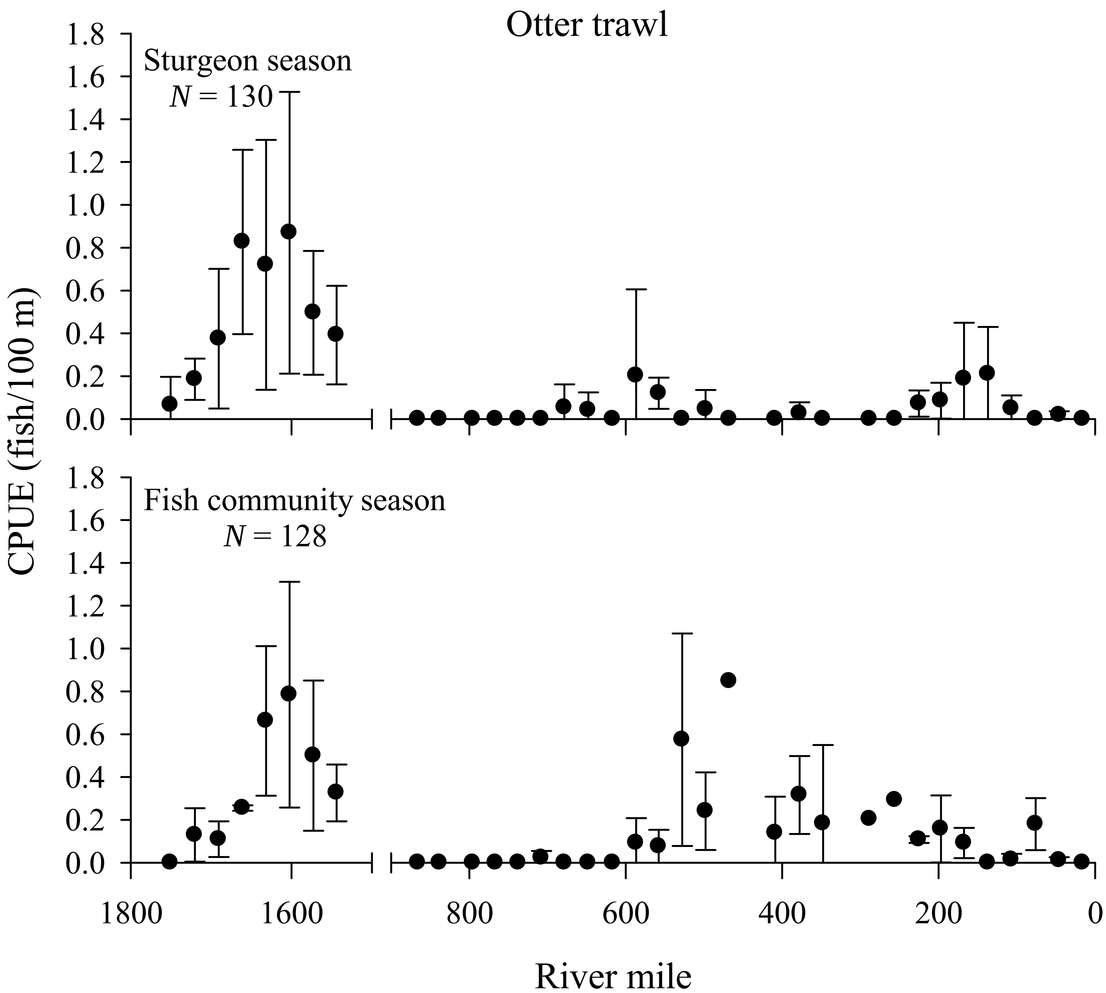

Figure 4.36. Mean seasonal catch per unit effort (± 2 SE) of sturgeon chub by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2006 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

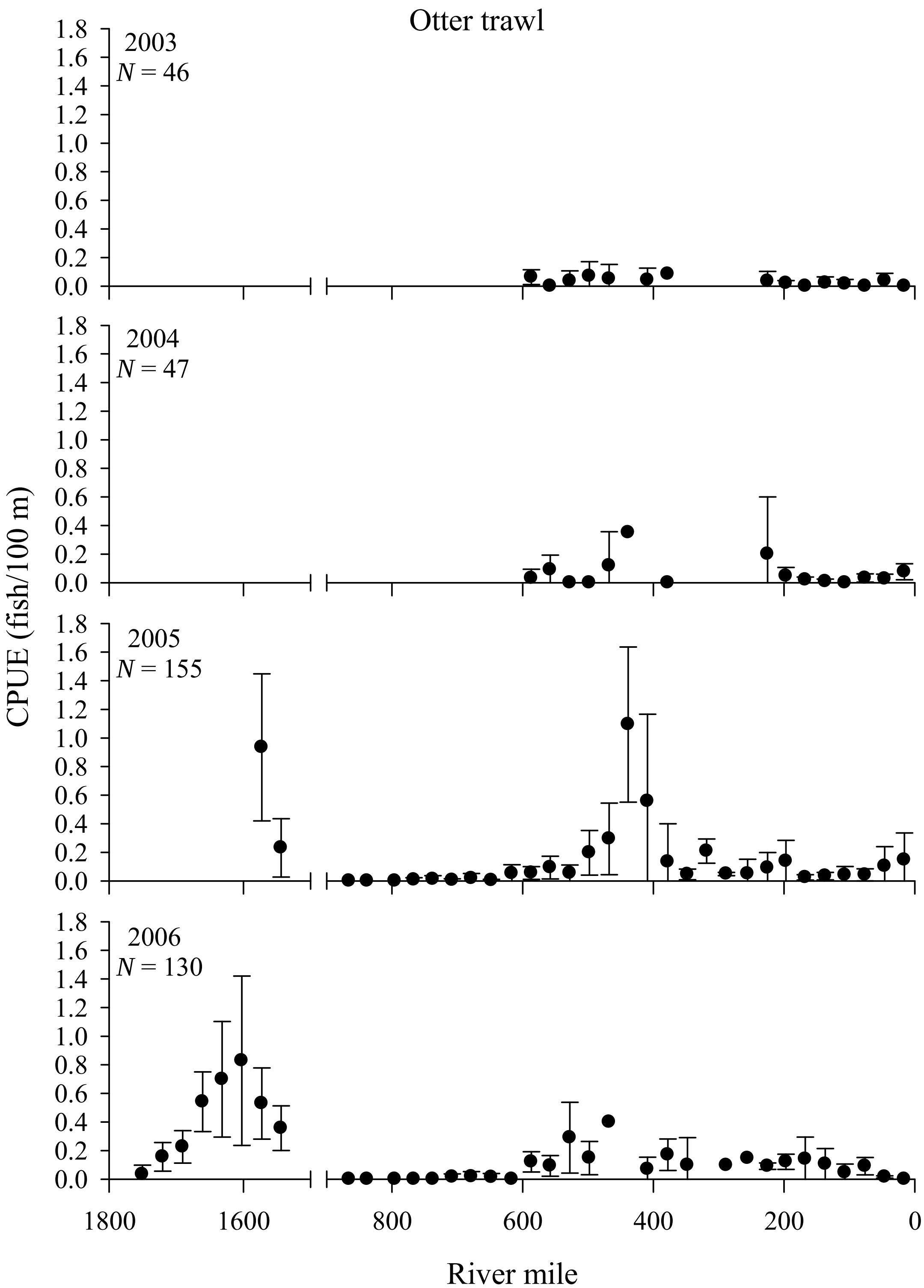

Figure 4.37. Mean annual catch per unit effort (± 2 SE) of sturgeon chub by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2003 to 2006 sampling years. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

Table 4.25. Total number of sturgeon chub captured for each gear during each season and the percentage caught within each macrohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1 Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.6)	(22.5)	(1.2)	(1.0)	(1.1)	(51.5)	(9.6)	(8.0)	(0.8)	(0)	(0)	(0)	(0)	(0.6)
Gill Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.4)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	420	0	19.8	0	0	0	38.8	17.6	19.8	4.0	0	0	0	0	0
		(5.6)	(22.4)	(0.8)	(0.9)	(0.5)	(47.3)	(10.8)	(9.1)	(2.1)	(0)	(0)	(0.4)	(0)	(0)
Fish Community Season (Summer)															
1 Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.4)	(24.0)	(0.6)	(0.7)	(0.7)	(52.9)	(10.9)	(5.2)	(1.6)	(0)	(0)	(0.2)	(0)	(0)
Mini-Fyke Net	5	0	40.0	0	0	0	40.0	0	20.0	0	0	0	0	0	0
		(4.8)	(16.7)	(0.5)	(0.2)	(0.2)	(43.2)	(9.2)	(7.5)	(13.8)	(1.9)	(0.2)	(0.2)	(1.8)	(0)
Otter Trawl	451	0	24.8	0.2	0	0	52.3	13.1	9.1	0.4	0	0	0	0	0
		(4.3)	(24.0)	(0.6)	(0.5)	(0.8)	(53.3)	(9.2)	(5.8)	(1.1)	(0)	(0)	(0.3)	(0)	(0)

Table 4.26. Total number of sturgeon chub captured for each gear during each season and the percentage caught within each mesohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1 Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(95.0)	(0.6)	(4.2)	(0)	(0.2)
Gill Net	0	0	0	0	0	0	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	420	0	86.4	0	12.9	0	0.7
		(0)	(93.5)	(0)	(6.0)	(0.2)	(0.3)
Fish Community Season (Summer)							
1 Inch Trammel Net	0	0	0	0	0	0	0
		(0.1)	(95.9)	(0)	(3.9)	(0)	(0.1)
Mini-Fyke Net	5	100.0	0	0	0	0	0
		(96.2)	(1.2)	(0)	(2.7)	(0)	(0)
Otter Trawl	451	0	96.7	0	3.3	0	0
		(0)	(97.2)	(0)	(2.8)	(0)	(0.1)

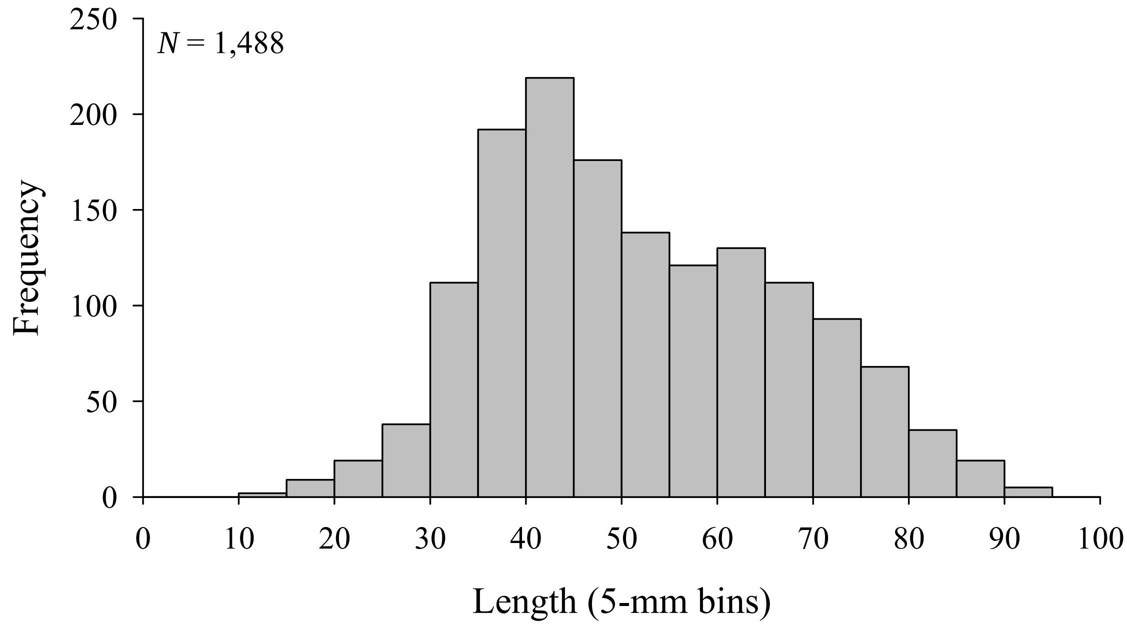

Figure 4.38. Length frequency distribution of sturgeon chub captured in the upper and lower basins of the Missouri River during the 2006 sampling year using random and nonrandom sampling with standard and wild gears.

4.3.2.2 Upper Basin

Within the upper basin sampling segments of the Missouri River, relative abundance of sturgeon chub was similar between sampling seasons, but different between years. During the 2006 sampling year, the mean CPUE of sturgeon chub captured with otter trawls was similar for the fish community (0.3 fish/100 m) and sturgeon seasons (0.5 fish/100 m; Figure 4.39). The mean otter trawl CPUE during the fish community season decreased markedly from the 2005 sampling year to the 2006 sampling year, resulting in a decrease in overall mean CPUE from 0.6 fish/100 m to 0.4 fish/100 m, respectively.

During the sturgeon and fish community seasons, most sturgeon chub were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred (Table 4.27). Main channel crossover, outside bend, and large secondary connected channels were also sampled with a relatively large effort, which resulted in proportional catches during both seasons. Channel border mesohabitats were the location where 87% of the sturgeon chub were captured during the sturgeon season, and 94% were captured during the fish community season (Table 4.28). Three sturgeon chub were captured with mini-fyke nets from sand bar mesohabitat during the fish community season. Otter trawls captured 100% of the sturgeon chub during the sturgeon season and 99% during the fish community season.

A total of 991 sturgeon chub were captured in the upper basin during the 2006 sampling year. Lengths ranged from 10 to 95 mm, with a mode near 50 mm (Figure 4.40).

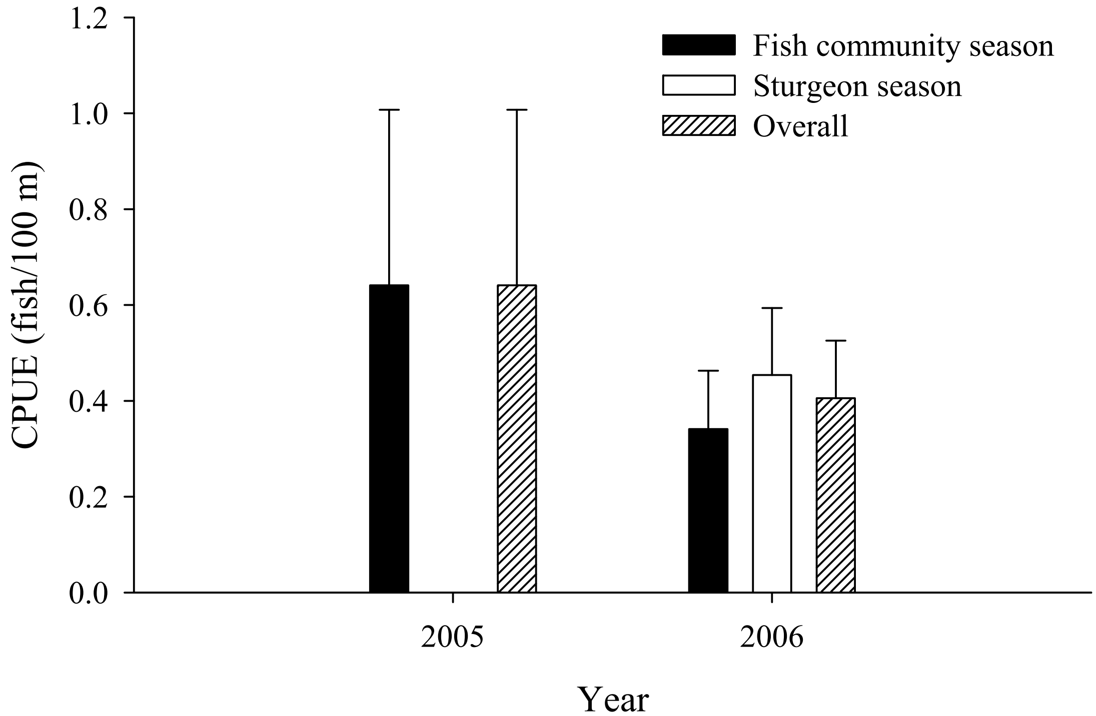

Figure 4.39. Mean annual catch per unit effort (± 2 SE) by season for sturgeon chub using otter trawls in the upper basin of the Missouri River for the 2005 and 2006 sampling years.

Table 4.27. Total number of sturgeon chub captured for each gear during each season and the percentage caught within each macrohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1 Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(0)	(24.3)	(0.6)	(0)	(0)	(30.3)	(26.5)	(18.3)	(0)	(0)	(0)	(0)	(0)	(0)
Otter Trawl	357	0	20.7	0	0	0	34.2	20.7	22.1	2.2	0	0	0	0	0
		(0)	(24.7)	(0.6)	(0)	(0)	(27.9)	(25.0)	(18.6)	(3.2)	(0)	(0)	(0)	(0)	(0)
Fish Community Season (Summer)															
1 Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(0)	(26.7)	(0)	(0)	(0)	(31.1)	(27.7)	(10.4)	(3.5)	(0)	(0)	(0.6)	(0)	(0)
Mini-Fyke Net	3	0	33.3	0	0	0	33.3	0	33.3	0	0	0	0	0	0
		(0)	(7.7)	(0.7)	(0)	(0)	(33.1)	(11.4)	(19.9)	(20.2)	(6.3)	(0)	(0)	(0.7)	(0)
Otter Trawl	292	0	30.8	0	0	0	38.4	20.2	9.9	0.7	0	0	0	0	0
		(0)	(26.6)	(0.7)	(0)	(0)	(29.8)	(30.4)	(11.4)	(1.0)	(0)	(0)	(0)	(0)	(0)

Table 4.28. Total number of sturgeon chub captured for each gear during each season and the percentage caught within each mesohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1 Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(88.0)	(0)	(11.4)	(0)	(0.6)
Otter Trawl	357	0	86.6	0	12.6	0	0.8
		(0)	(85.3)	(0)	(13.8)	(0)	(1.0)
Fish Community Season (Summer)							
1 Inch Trammel Net	0	0	0	0	0	0	0
		(0.3)	(89.6)	(0)	(9.7)	(0)	(0.3)
Mini-Fyke Net	3	100.0	0	0	0	0	0
		(92.0)	(1.1)	(0)	(6.8)	(0)	(0)
Otter Trawl	292	0	94.9	0	5.1	0	0
		(0)	(94.5)	(0)	(5.5)	(0)	(0)

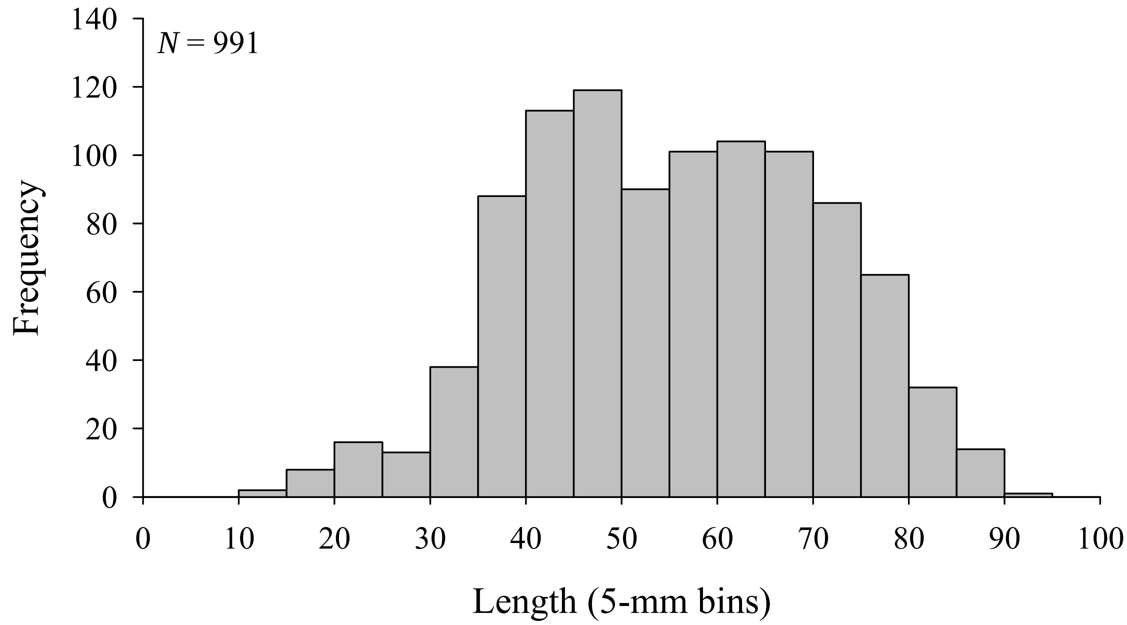

Figure 4.40. Length frequency distribution of sturgeon chub captured in the upper basin of the Missouri River during the 2006 sampling year using random and nonrandom sampling with standard and wild gears.

4.3.2.3 Lower Basin

Within the lower basin sampling segments of the Missouri River, relative abundance of sturgeon chub was notably different between sampling seasons and among years. During the 2006 sampling year, the mean CPUE of sturgeon chub captured with otter trawls was larger for the fish community season (0.11 fish/100 m) than the sturgeon season (0.04fish/100 m; Figure 4.41). While the mean otter trawl CPUE during the fish community season increased from the 2005 sampling year to the 2006 sampling year, the mean CPUE during the sturgeon season decreased markedly from 2005 to 2006, resulting in a decrease in overall mean CPUE from 0.09 fish/100 m to 0.07 fish/100 m, respectively. The overall mean CPUE of sturgeon chub in the lower basin increased from the inception of the sampling program in 2003 through sampling year 2005, before decreasing during the 2006 sampling year (Figure 4.41).

During the sturgeon and fish community seasons, most sturgeon chub were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred (Table 4.29). Main channel crossovers were also sampled with a relatively large effort, which resulted in proportional catches during both seasons. Channel border mesohabitats were the location where 86% of the sturgeon chub were captured during the sturgeon season, and 99% were captured during the fish community season (Table 4.30). Two sturgeon chub were captured with mini-fyke nets from sand bar mesohabitat during the fish community season. Otter trawls captured 100% of the sturgeon chub during the sturgeon season and 99% during the fish community season.

A total of 497 sturgeon chub were captured in the lower basin during the 2006 sampling year. Lengths ranged from 15 to 95 mm, with a mode near 45 mm (Figure 4.42).

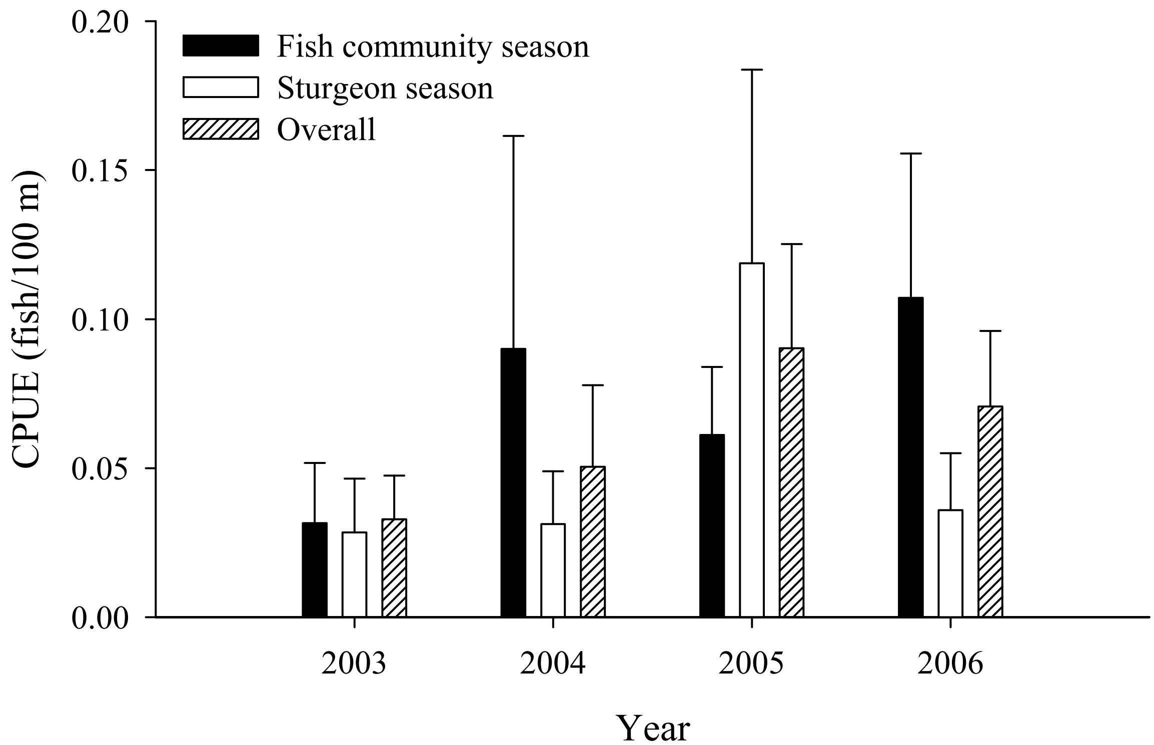

Figure 4.41. Mean annual catch per unit effort (± 2 SE) by season for sturgeon chub using otter trawls in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

Table 4.29. Total number of sturgeon chub captured for each gear during each season and the percentage caught within each macrohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1 Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(4.3)	(22.3)	(1.5)	(1.4)	(1.5)	(58.4)	(4.2)	(4.7)	(1.0)	(0)	(0)	(0)	(0)	(0.8)
Gill Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.8)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	63	0	14.3	0	0	0	65.1	0	6.3	14.3	0	0	0	0	0
		(6.6)	(22.3)	(0.9)	(1.3)	(0.8)	(56.0)	(4.4)	(5.3)	(1.8)	(0)	(0)	(0.6)	(0)	(0)
Fish Community Season (Summer)															
1 Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(4.4)	(23.2)	(0.9)	(1.0)	(1.0)	(62.5)	(3.9)	(2.2)	(0.9)	(0)	(0)	(0)	(0)	(0)
Mini-Fyke Net	2	0	50.0	0	0	0	50.0	0	0	0	0	0	0	0	0
		(6.5)	(19.9)	(0.4)	(0.3)	(0.3)	(46.8)	(8.4)	(3.1)	(11.4)	(0.3)	(0.3)	(0.3)	(2.1)	(0)
Otter Trawl	159	0	13.8	0.6	0	0	78.0	0	7.5	0	0	0	0	0	0
		(5.5)	(23.4)	(0.6)	(0.7)	(1.0)	(60.5)	(3.3)	(3.4)	(1.2)	(0)	(0)	(0.4)	(0)	(0)

Table 4.30. Total number of sturgeon chub captured for each gear during each season and the percentage caught within each mesohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1 Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(97.3)	(0.8)	(1.9)	(0)	(0)
Gill Net	0	0	0	0	0	0	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	63	0	85.7	0	14.3	0	0
		(0)	(96.9)	(0)	(2.8)	(0.3)	(0)
Fish Community Season (Summer)							
1 Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(98.4)	(0)	(1.6)	(0)	(0)
Mini-Fyke Net	2	100.0	0	0	0	0	0
		(97.6)	(1.2)	(0)	(1.2)	(0)	(0)
Otter Trawl	159	0	100.0	0	0	0	0
		(0)	(98.0)	(0)	(2.0)	(0)	(0)

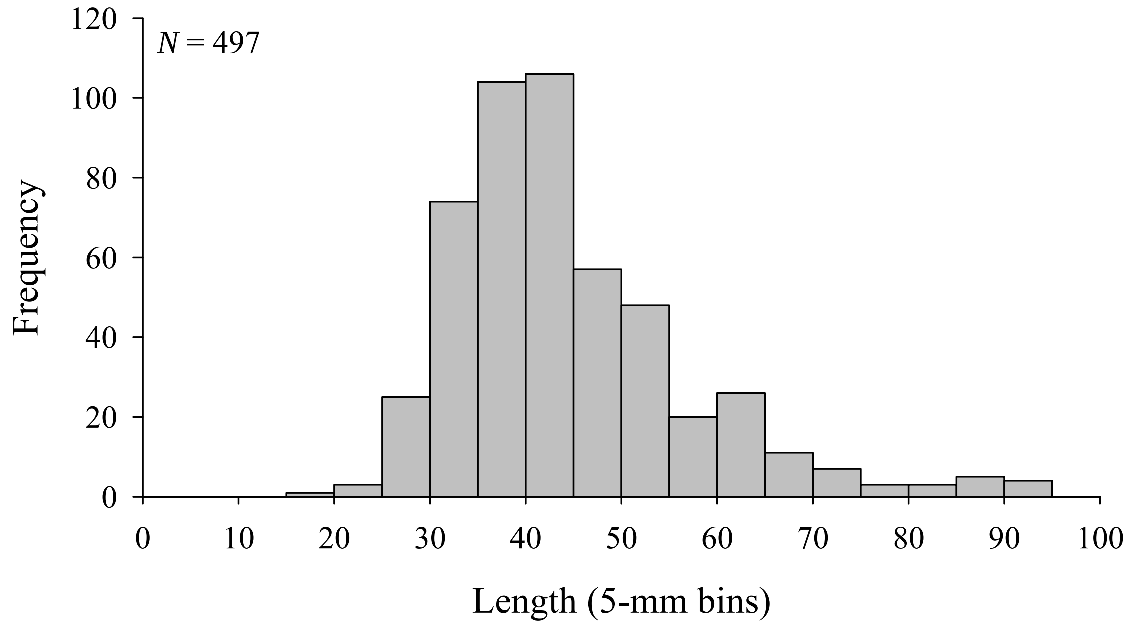

Figure 4.42. Length frequency distribution of sturgeon chub captured in the lower basin of the Missouri River during the 2006 sampling year using random and nonrandom sampling with standard and wild gears.

4.3.3 Sicklefin chub

4.3.3.1 Combined Basins

During the 2006 sampling year in the upper and lower basins of the Missouri River 523 sicklefin chub *Macrhybopsis meeki* were captured during the sturgeon season, while 1028 were captured during the fish community season (Figure 4.43). Sampling from the upper basin during the sturgeon season resulted in 103 sicklefin chub captured, comprising 20% of the catch during the sturgeon sampling season. Sampling from the lower reaches of segments 3 and 4 (RM 1568 – 1701) resulted in approximately 80% of the upper basin total for the sturgeon season. Sampling from segments 13 and 14 (RM 0 – 250) in the lower basin resulted in 52% of the total catch, and 65% of the lower basin catch, for the sturgeon season. During the fish community season, sicklefin chub catch from the upper basin and lower basin segments increased. During the fish community season sampling from the lower reaches of segments 3 and 4 (RM 1568 – 1701) in the upper basin accounted for 92% of the sicklefin chub catch for that part of the basin. Sampling from segments 13 and 14 (RM 0 – 250) in the lower basin resulted in 34% of the total catch, and 50% of the lower basin catch, for the fish community season. Sampling from the lower reaches of segment 9 (RM 367.5 – 595.5) in the lower basin during the fish community season yielded some of the highest sicklefin chub catch per river mile (Figure 4.43).

Relative abundance of sicklefin chub was similar between sampling seasons, but different between years. During the 2006 sampling year, the mean CPUE of sicklefin chub captured with otter trawls was similar for the fish community (0.20 fish/100 m) and sturgeon seasons (0.22 fish/100 m; Figure 4.44). The mean otter trawl CPUE during both the sturgeon and fish community seasons decreased markedly from the 2005 sampling year to the 2006 sampling year, resulting in a decrease in overall mean CPUE from 0.47 fish/100 m to 0.21 fish/100 m, respectively. Relative abundance estimates from mini-fyke nets, deployed only during the fish community season, also decreased from the 2005 sampling year (0.03 fish/net night) to the 2006 sampling year (0.01 fish/net night; Figure 4.45).

Relative abundance of sicklefin chub differed markedly among sampling segments. During the sturgeon sampling season the relative abundance of sicklefin chub captured with otter trawls was generally larger in the lower basin than the upper basin, with the mean CPUE ranging from 0.0 fish/100 m to approximately 1.2 fish/100 m in the lower basin (Figure 4.46). Sampling from segments 9 through 13 (RM 130 – 596) in the lower basin resulted in some of the largest otter trawl CPUE during the sturgeon season, a finding also observed during the fish community season. During the fish community season, the geographic trend in relative abundance remained relatively unchanged such that otter trawl sampling from the lower basin resulted in comparatively larger mean CPUE than from the upper basin. The mean otter trawl CPUE during the fish community season increased from that of the sturgeon season for many lower basin sampling reaches, ranging from 0.0 fish/100 m to approximately 1.7 fish/100 m (Figure 4.46). Sampling from segment 4 (RM 1568 – 1582) in the upper basin during the fish community season resulted in some of the largest otter trawl CPUE for sicklefin chub (0.6 fish/100 m) during that season.

Relative abundance of sicklefin chub has generally increased in many sampling segments during the period from 2003 to 2006, in both the upper and lower basins, as the sampling program has become fully implemented. Exceptions occurred from sampling year 2005 to 2006 in both parts of the Missouri River basin where it appears that mean CPUE decreased for most sampling segments (Figure 4.47). When combining sampling seasons in 2006, the relative abundance of sicklefin chub captured with otter trawls was comparatively larger in the lower basin (0.0 to 1.0 fish/100 m) than the upper basin (0.0 to 0.5 fish/100 m; Figure 4.47). During 2006, the mean otter trawl CPUE seemed to be highest in upper basin segment 4 (RM 1568 – 1582) and lower basin segments 9 through 13 (RM 130 – 596). Sampling with mini-fyke nets revealed an apparent decrease in sicklefin chub relative abundance from sampling years 2004 to 2006, when the sampling program became fully implemented (Figure 4.48). During 2006, a total of only 10 sicklefin chub were captured with mini-fyke nets in the Missouri River basin.

Random sampling with standard gears accounted for approximately 93% (N = 485) of the total sicklefin chub catch during the 2006 sturgeon season, and 50% (N = 512) of the catch during the 2006 fish community season (Table 4.31). Otter trawls captured 100%

of the sicklefin chub during the sturgeon season and 98% during the fish community season. During both seasons, most sicklefin chub were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred. Main channel crossover, outside bend, and small and large secondary connected channels were also sampled with a relatively large effort, which resulted in proportional catches during both seasons. Channel border mesohabitats were the location where 90% of the sicklefin chub were captured during the sturgeon season, and 97% were captured during the fish community season (Table 4.32).

A total of 1503 sicklefin chub were captured in the upper and lower basins during the 2006 sampling year. Lengths ranged from 10 to 115 mm, with a mode near 45 mm (Figure 4.49).

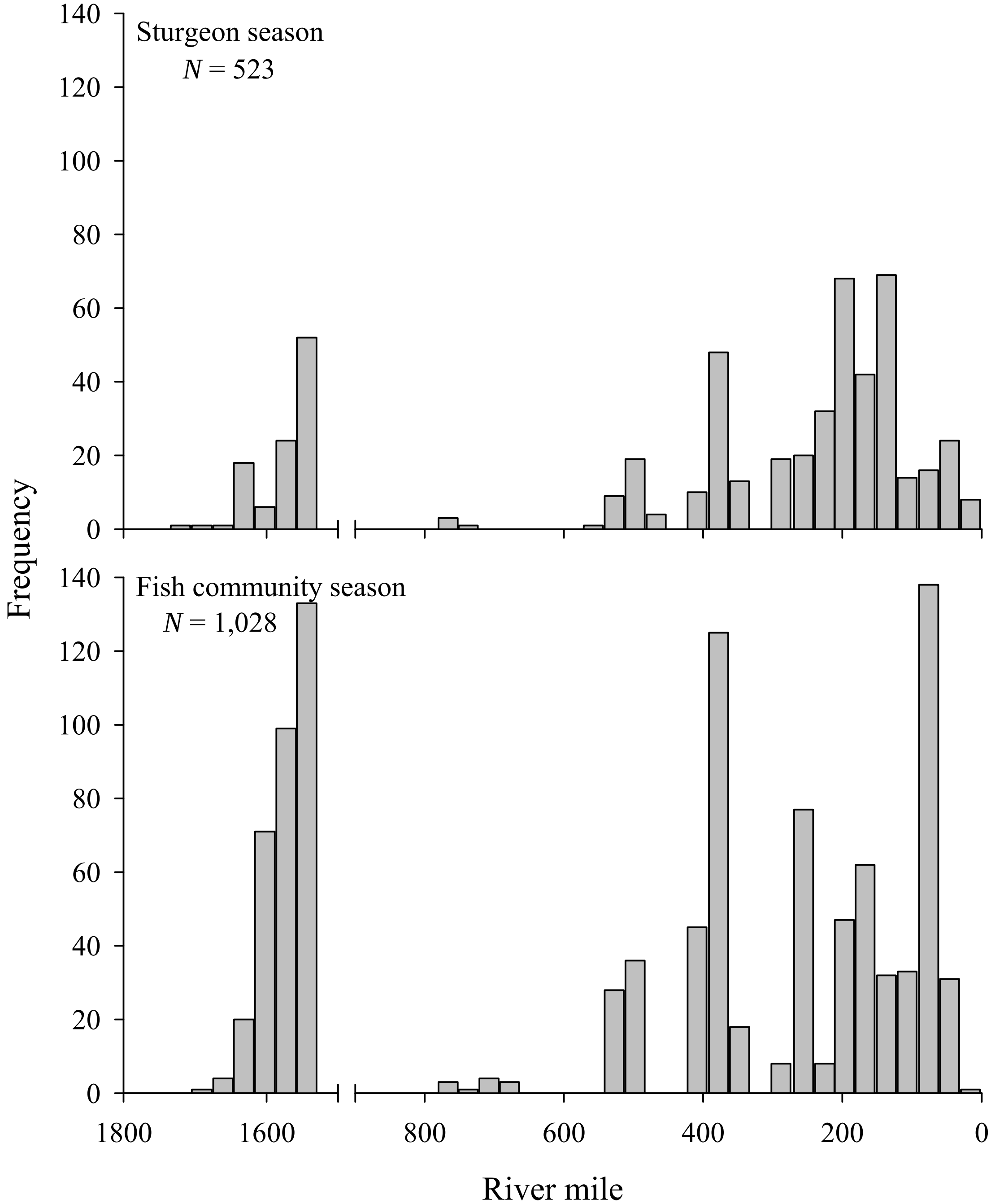

Figure 4.43. Seasonal catch by river mile (30-mile bins) of sicklefin chub in the upper and lower basins of the Missouri River in the 2006 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

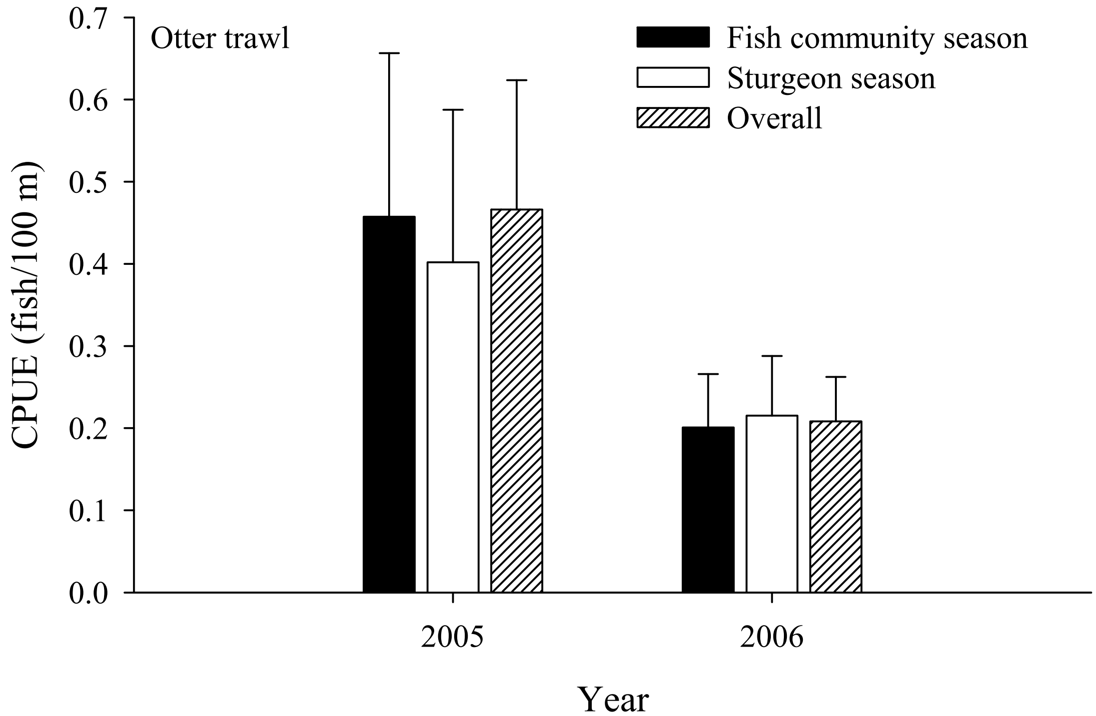

Figure 4.44. Mean annual catch per unit effort (± 2 SE) by season for sicklefin chub using otter trawls in the upper and lower basins of the Missouri River for the 2003 to 2006 sampling years.

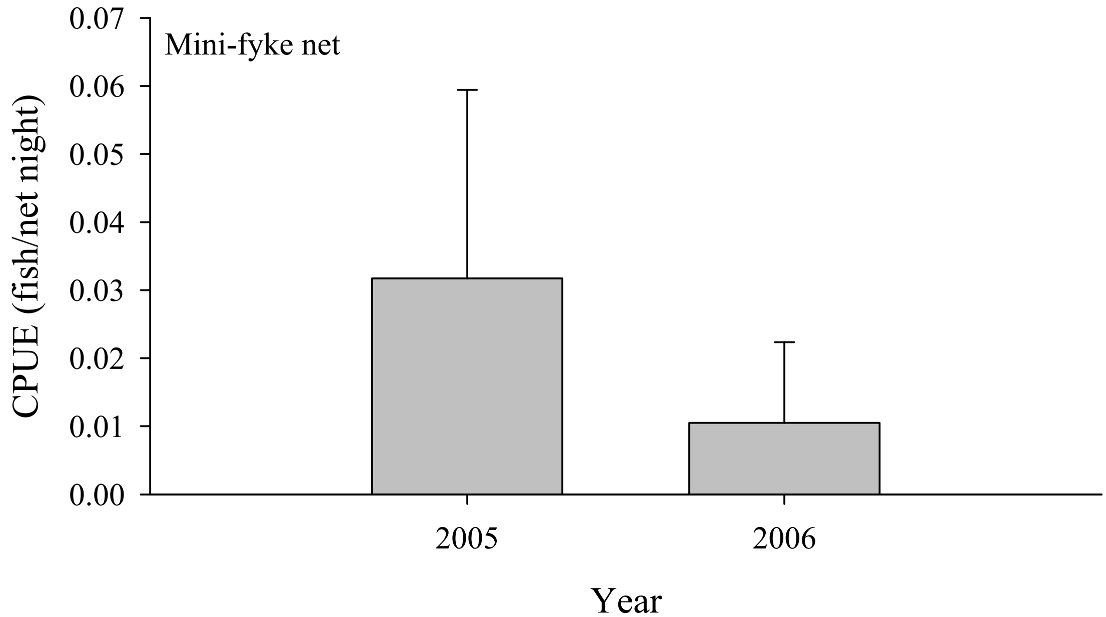

Figure 4.45. Mean annual catch per unit effort (± 2 SE) for sicklefin chub using otter trawls in the upper and lower basins of the Missouri River for the 2005 and 2006 sampling years.

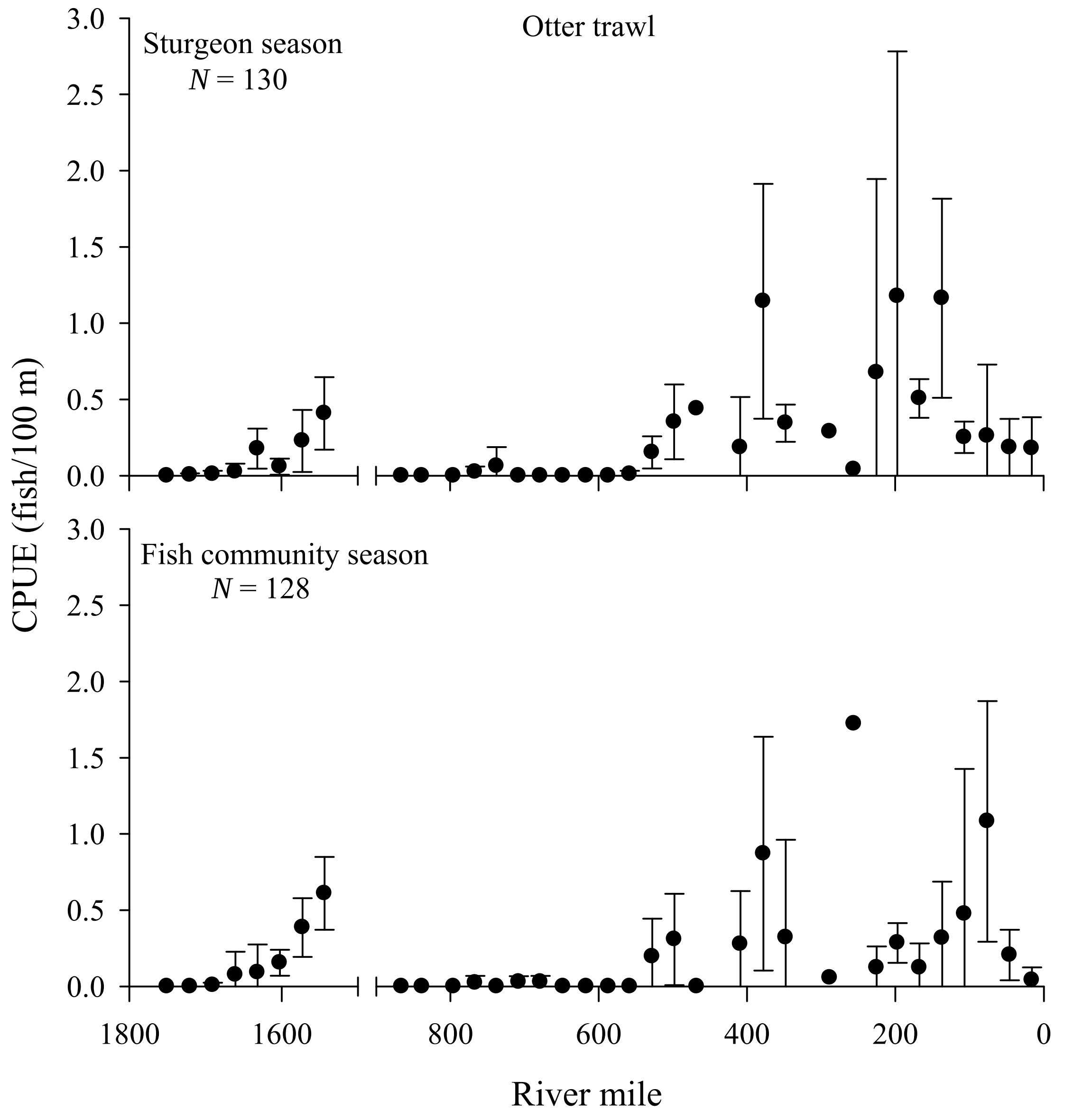

Figure 4.46. Mean seasonal catch per unit effort (± 2 SE) of sicklefin chub by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2006 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

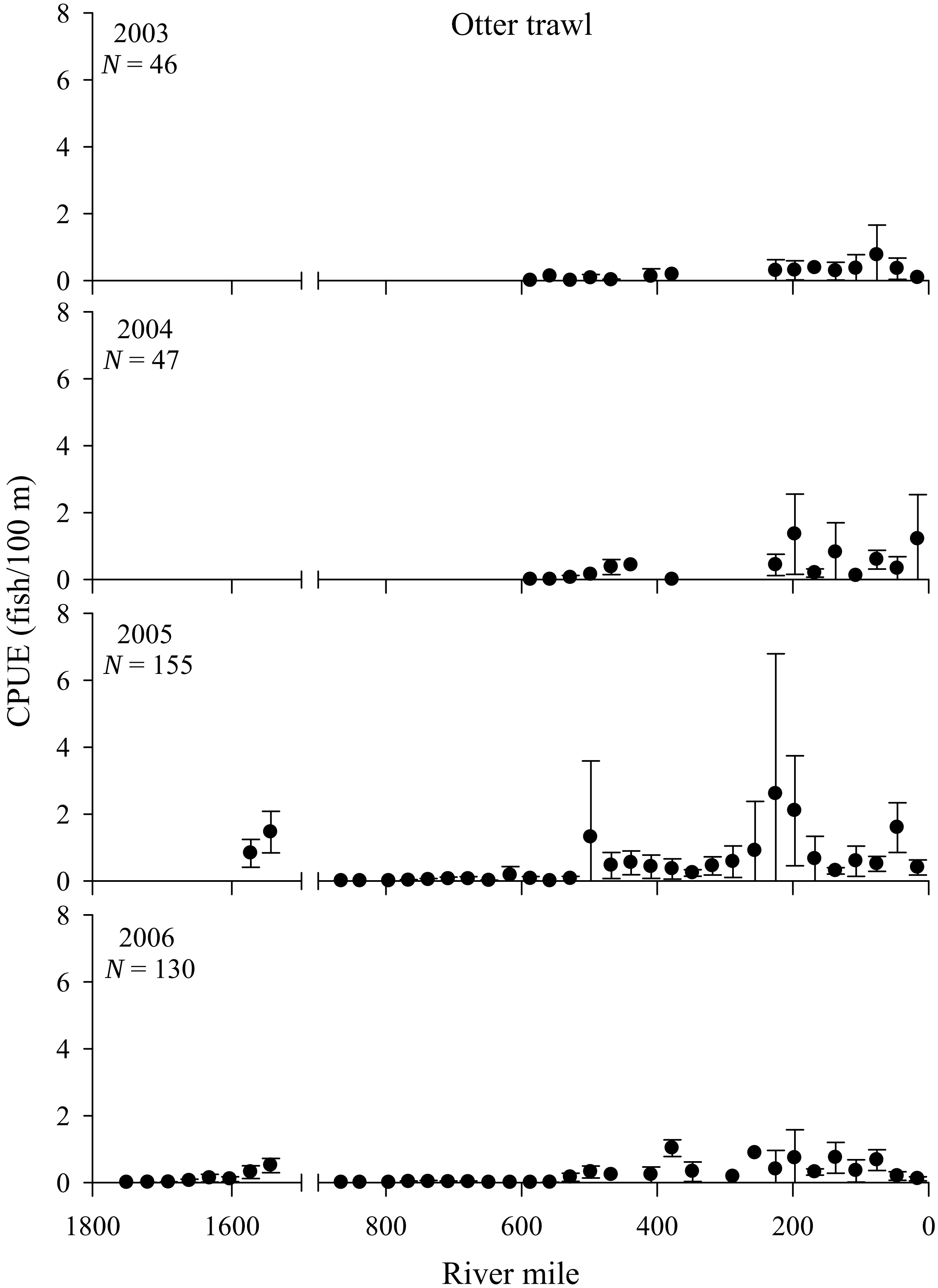

Figure 4.47. Mean annual catch per unit effort (± 2 SE) of sicklefin chub by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2003 to 2006 sampling years. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

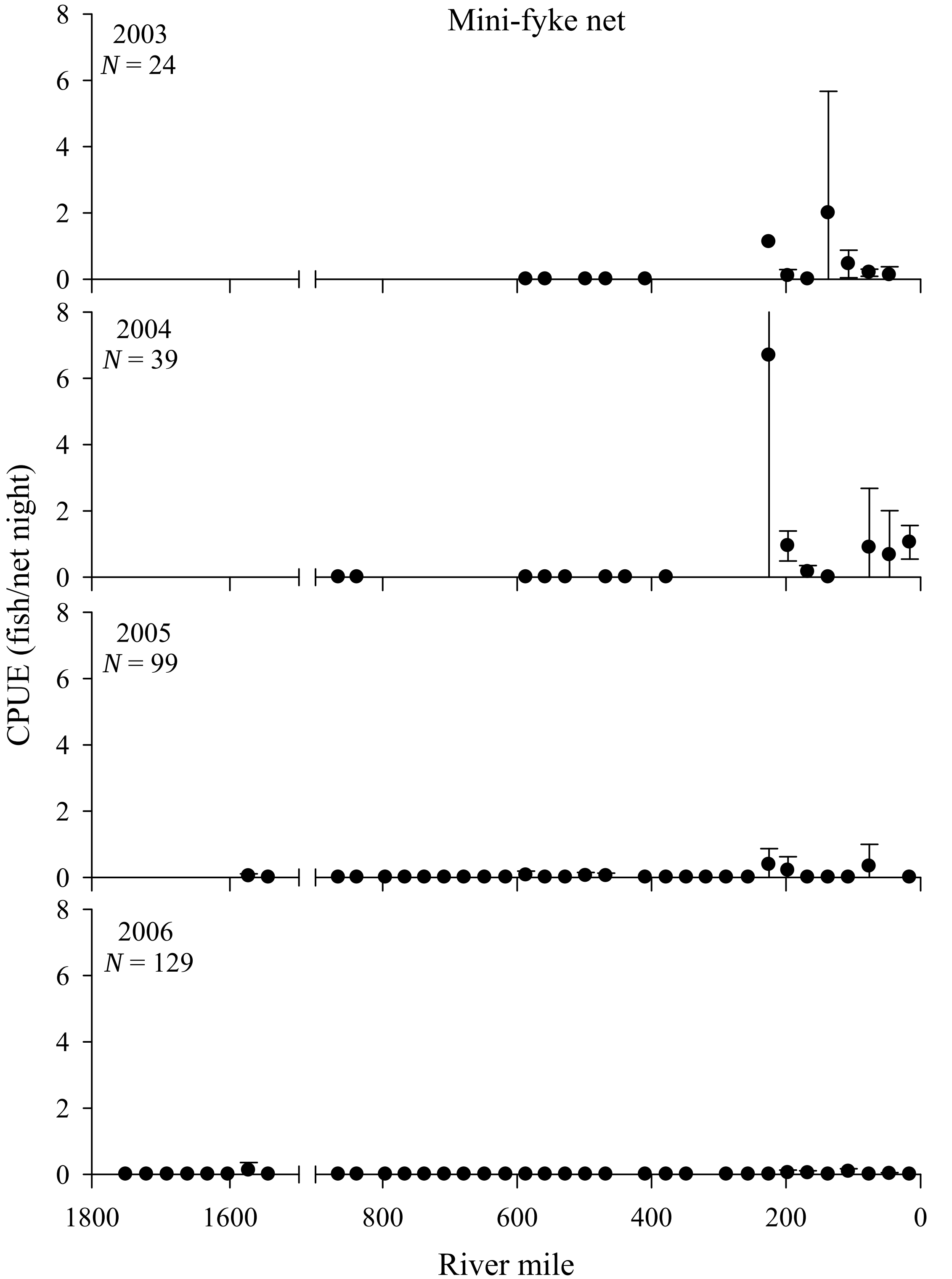

Figure 4.48. Mean annual catch per unit effort (± 2 SE) of sicklefin chub by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2003 to 2006 sampling years. Data obtained through random sampling using mini-fyke nets. Sample size denotes the number of bends sampled.

Table 4.31. Total number of sicklefin chub captured for each gear during each season and the percentage caught within each macrohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.6)	(22.5)	(1.2)	(1.0)	(1.1)	(51.5)	(9.6)	(8.0)	(0.8)	(0)	(0)	(0)	(0)	(0.6)
Gill Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.4)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	485	0.4	17.9	0	0	0.2	63.3	6.4	3.9	7.8	0	0	0	0	0
		(5.6)	(22.4)	(0.8)	(0.9)	(0.5)	(47.3)	(10.8)	(9.1)	(2.1)	(0)	(0)	(0.4)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.4)	(24.0)	(0.6)	(0.7)	(0.7)	(52.9)	(10.9)	(5.2)	(1.6)	(0)	(0)	(0.2)	(0)	(0)
Mini-Fyke Net	10	0	20.0	0	0	0	80.0	0	0	0	0	0	0	0	0
		(4.8)	(16.7)	(0.5)	(0.2)	(0.2)	(43.2)	(9.2)	(7.5)	(13.8)	(1.9)	(0.2)	(0.2)	(1.8)	(0)
Otter Trawl	502	0	20.1	0	0	0	66.1	11.0	1.6	1.2	0	0	0	0	0
		(4.3)	(24.0)	(0.6)	(0.5)	(0.8)	(53.3)	(9.2)	(5.8)	(1.1)	(0)	(0)	(0.3)	(0)	(0)

Table 4.32. Total number of sicklefin chub captured for each gear during each season and the percentage caught within each mesohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(95.0)	(0.6)	(4.2)	(0)	(0.2)
Gill Net	0	0	0	0	0	0	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	485	0	90.1	0	9.5	0.4	0
		(0)	(93.5)	(0)	(6.0)	(0.2)	(0.3)
Fish Community Season (Summer)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0.1)	(95.9)	(0)	(3.9)	(0)	(0.1)
Mini-Fyke Net	10	100.0	0	0	0	0	0
		(96.2)	(1.2)	(0)	(2.7)	(0)	(0)
Otter Trawl	502	0	98.8	0	1.2	0	0
		(0)	(97.2)	(0)	(2.8)	(0)	(0.1)

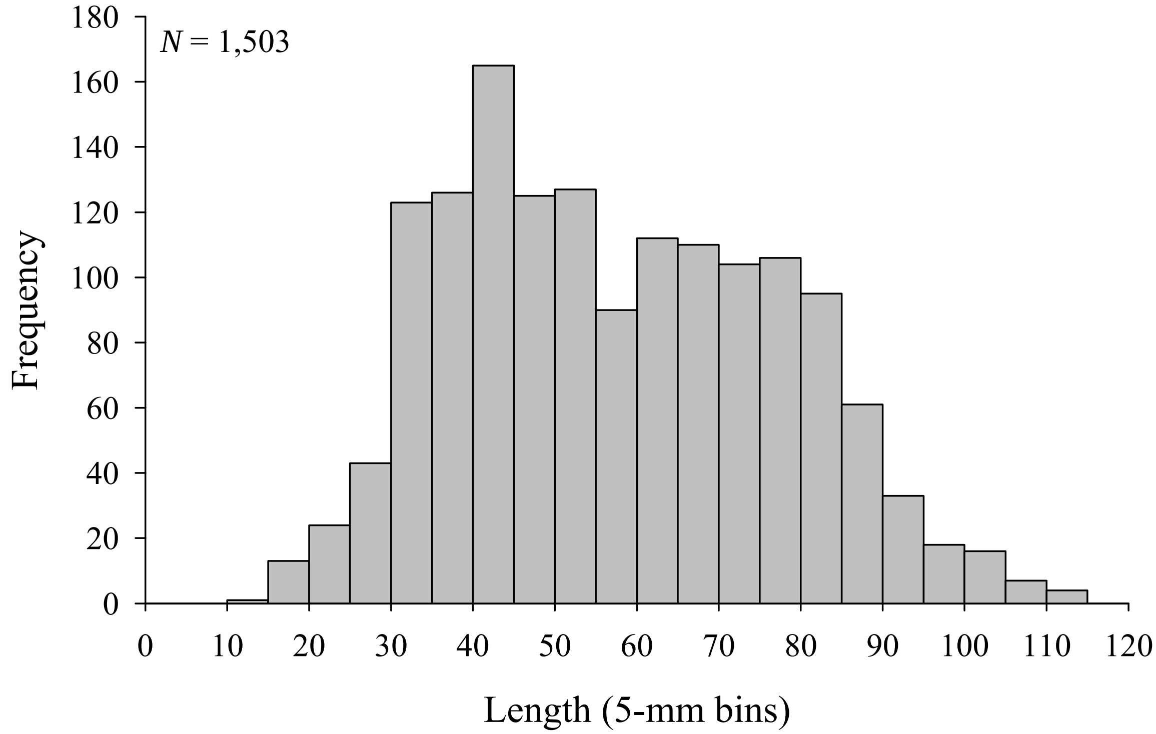

Figure 4.49. Length frequency distribution of sicklefin chub captured in the upper and lower basins of the Missouri River during the 2006 sampling year using random and nonrandom sampling with standard and wild gears.

4.3.3.2 Upper Basin

Within the upper basin sampling segments of the Missouri River, relative abundance of sicklefin chub was similar between sampling seasons, but different between years. During the 2006 sampling year, the mean CPUE of sicklefin chub captured with otter trawls was similar for the fish community (0.21 fish/100 m) and sturgeon seasons (0.14 fish/100 m; Figure 4.50). The mean otter trawl CPUE during the fish community season decreased markedly from the 2005 sampling year to the 2006 sampling year, resulting in a decrease in overall mean CPUE from 1.1 fish/100 m to 0.2 fish/100 m, respectively. Relative abundance estimates of sicklefin chub captured with mini-fyke nets, deployed only during the fish community season, were similar in sampling years 2005 and 2006, with a mean CPUE of approximately 0.02 fish/net night (Figure 4.51).

During the sturgeon and fish community seasons, most sicklefin chub were caught in main channel inside bend and outside bend macrohabitats, where most of the total sampling effort occurred (Table 4.33). Otter trawls captured 100% of the sicklefin chub during the sturgeon season and 99% during the fish community season. Main channel crossover and large secondary connected channels were also sampled with a relatively large effort, which resulted in proportional catches during both seasons. Channel border mesohabitats were the location where 91% of the sicklefin chub were captured during the sturgeon season, and 91% were captured during the fish community season (Table 4.34). Five sicklefin chub were captured with mini-fyke nets from sand bar mesohabitat during the fish community season.

A total of 420 sicklefin chub were captured in the upper basin during the 2006 sampling year. Lengths ranged from 15 to 110 mm, with a mode near 75 mm (Figure 4.52).

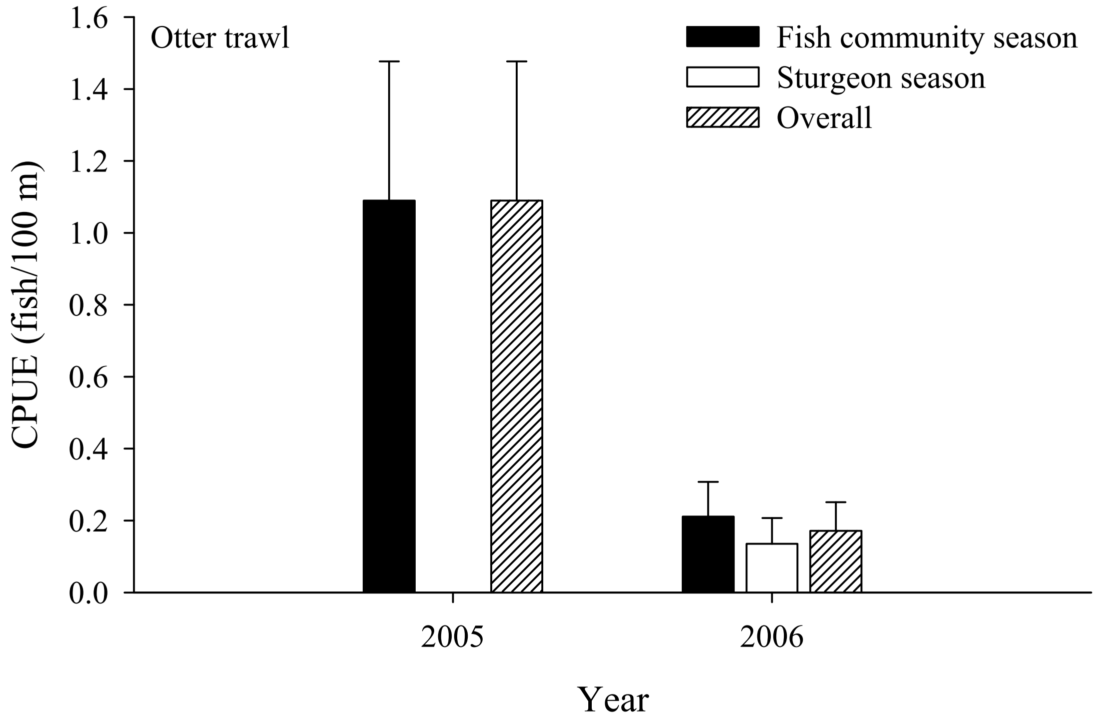

Figure 4.50. Mean annual catch per unit effort (± 2 SE) by season for sicklefin chub using otter trawls in the upper basin of the Missouri River for the 2005 and 2006 sampling years.

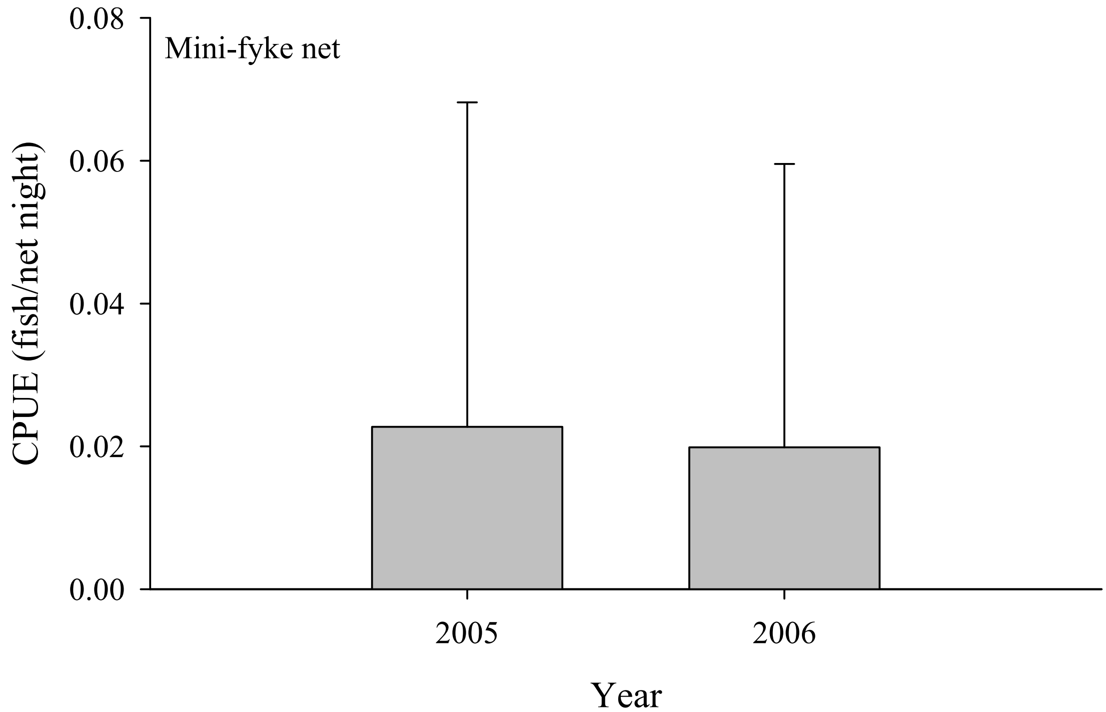

Figure 4.51. Mean annual catch per unit effort (± 2 SE) by season for sicklefin chub using mini-fyke nets in the upper basin of the Missouri River for the 2005 and 2006 sampling years.

Table 4.33. Total number of sicklefin chub captured for each gear during each season and the percentage caught within each macrohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(0)	(24.3)	(0.6)	(0)	(0)	(30.3)	(26.5)	(18.3)	(0)	(0)	(0)	(0)	(0)	(0)
Otter Trawl	101	0	19.8	0	0	0	33.7	29.7	15.8	1.0	0	0	0	0	0
		(0)	(24.7)	(0.6)	(0)	(0)	(27.9)	(25.0)	(18.6)	(3.2)	(0)	(0)	(0)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(0)	(26.7)	(0)	(0)	(0)	(31.1)	(27.7)	(10.4)	(3.5)	(0)	(0)	(0.6)	(0)	(0)
Mini-Fyke Net	5	0	0	0	0	0	100.0	0	0	0	0	0	0	0	0
		(0)	(7.7)	(0.7)	(0)	(0)	(33.1)	(11.4)	(19.9)	(20.2)	(6.3)	(0)	(0)	(0.7)	(0)
Otter Trawl	171	0	29.8	0	0	0	31.0	32.2	3.5	3.5	0	0	0	0	0
		(0)	(26.6)	(0.7)	(0)	(0)	(29.8)	(30.4)	(11.4)	(1.0)	(0)	(0)	(0)	(0)	(0)

Table 4.34. Total number of sicklefin chub captured for each gear during each season and the percentage caught within each mesohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(88.0)	(0)	(11.4)	(0)	(0.6)
Otter Trawl	101	0	91.1	0	8.9	0	0
		(0)	(85.3)	(0)	(13.8)	(0)	(1.0)
Fish Community Season (Summer)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0.3)	(89.6)	(0)	(9.7)	(0)	(0.3)
Mini-Fyke Net	5	100.0	0	0	0	0	0
		(92.0)	(1.1)	(0)	(6.8)	(0)	(0)
Otter Trawl	171	0	96.5	0	3.5	0	0
		(0)	(94.5)	(0)	(5.5)	(0)	(0)

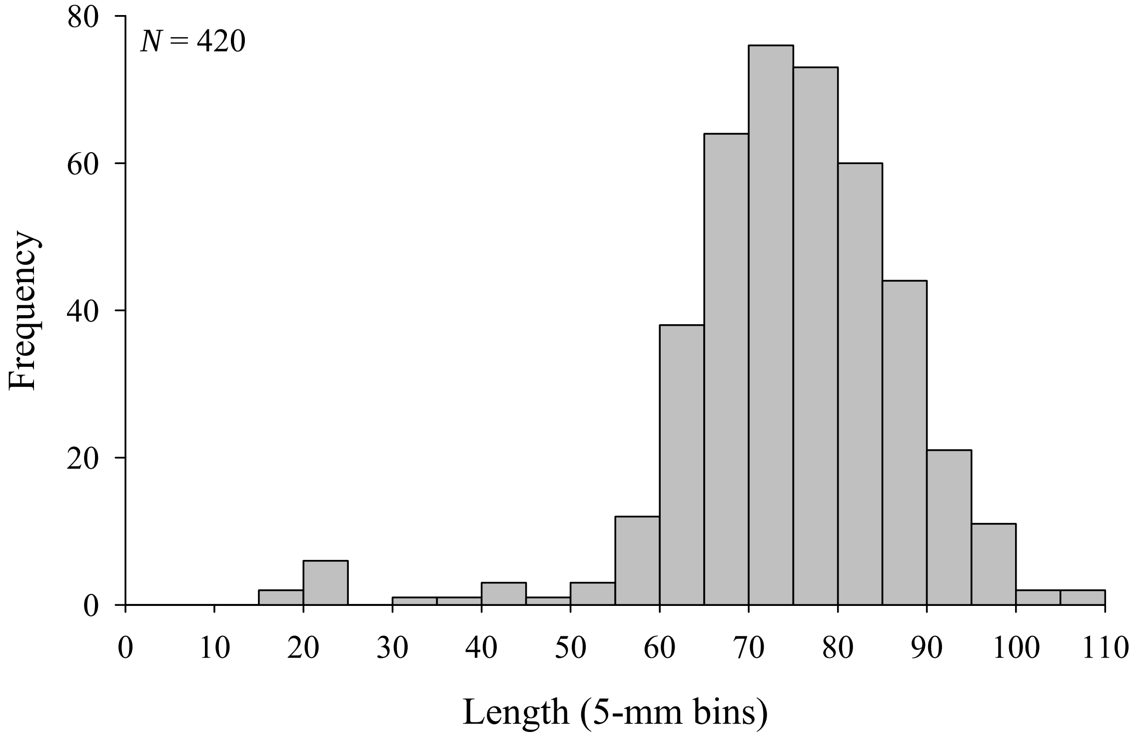

Figure 4.52. Length frequency distribution of sicklefin chub captured in the upper basin of the Missouri River during the 2006 sampling year using random and nonrandom sampling with standard and wild gears.

4.3.3.3 Lower Basin

Within the lower basin sampling segments of the Missouri River, relative abundance of sicklefin chub was notably different between sampling seasons and among years. During the 2006 sampling year, the mean CPUE of sicklefin chub captured with otter trawls was similar for the fish community season (0.21 fish/100 m) and the sturgeon season (0.25fish/100 m; Figure 4.53). While the mean otter trawl CPUE during the sturgeon season increased from the 2004 sampling year to the 2005 sampling year, the mean CPUE during the fish community season decreased markedly from 2004 to 2005, resulting in a decrease in overall mean CPUE from 0.5 fish/100 m to 0.4 fish/100 m, respectively. This decreasing trend in overall sicklefin chub relative abundance continued during the 2006 sampling year, with a mean otter trawl CPUE of 0.2 fish/100 m (Figure 4.53). A similar decreasing trend from mini-fyke net sampling was observed from 2004 (0.6 fish/net night) to 2006 (< 0.1 fish/net night), culminating with only five sicklefin chub randomly sampled in 2006 (Figure 4.54).

During the sturgeon and fish community seasons, most sicklefin chub were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred (Table 4.35). Otter trawls captured 100% of the sicklefin chub during the sturgeon season and 99% during the fish community season. Main channel crossovers were also sampled with a relatively large effort, which resulted in proportional catches during both seasons. Channel border mesohabitats were the location where 90% of the sicklefin chub were captured during the sturgeon season, and 99% were captured during the fish community season (Table 4.36). Five sicklefin chub were captured with mini-fyke nets from sand bar mesohabitat during the fish community season.

A total of 1083 sicklefin chub were captured in the lower basin during the 2006 sampling year. Lengths ranged from 10 to 115 mm, with a mode near 45 mm (Figure 4.55).

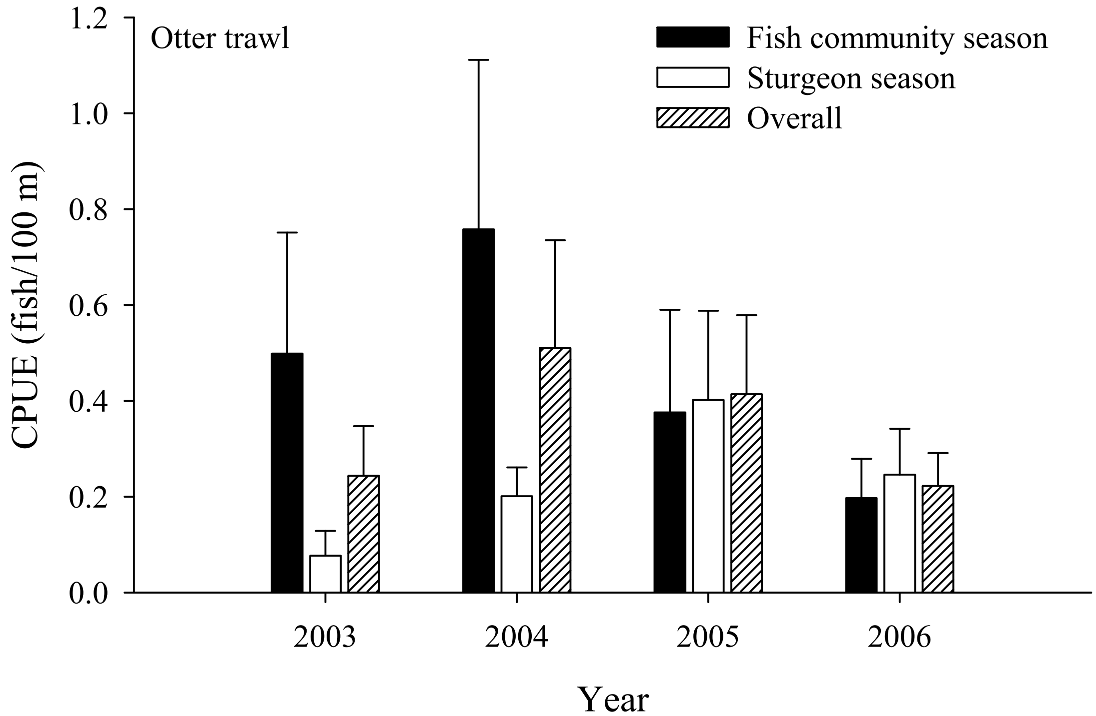

Figure 4.53. Mean annual catch per unit effort (± 2 SE) by season for sicklefin chub using otter trawls in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

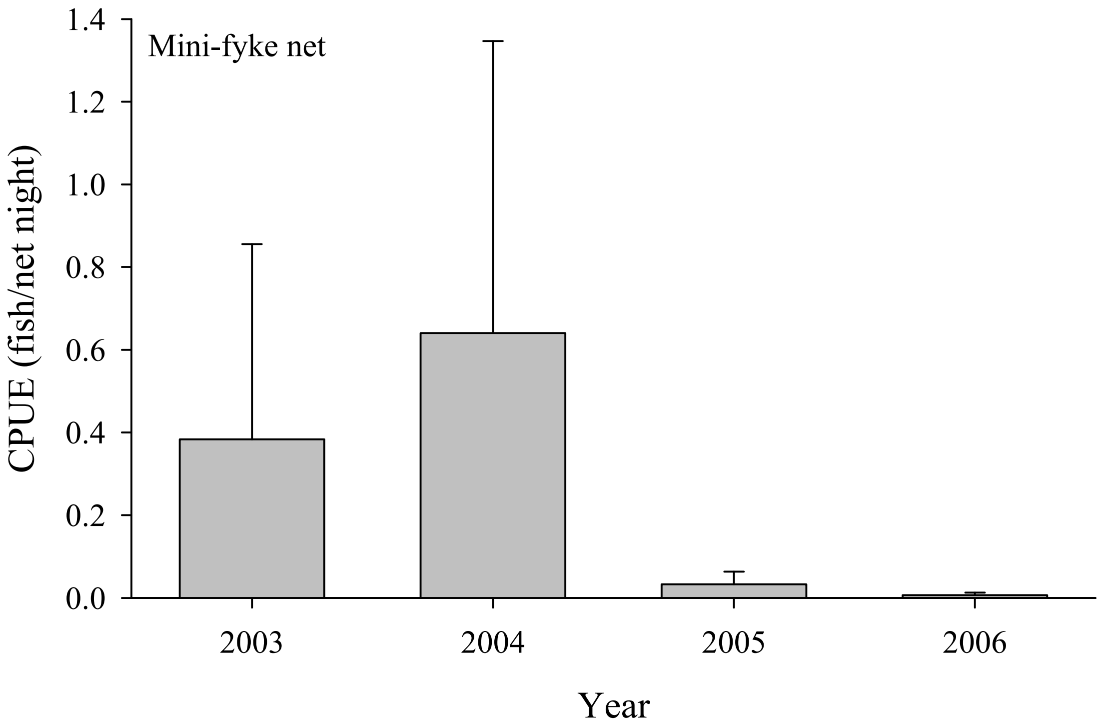

Figure 4.54. Mean annual catch per unit effort (± 2 SE) by season for sicklefin chub using mini-fyke nets in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

Table 4.35. Total number of sicklefin chub captured for each gear during each season and the percentage caught within each macrohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(4.3)	(22.3)	(1.5)	(1.4)	(1.5)	(58.4)	(4.2)	(4.7)	(1.0)	(0)	(0)	(0)	(0)	(0.8)
Gill Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.8)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	384	0.5	17.4	0	0	0.3	71.1	0.3	0.8	9.6	0	0	0	0	0
		(6.6)	(22.3)	(0.9)	(1.3)	(0.8)	(56.0)	(4.4)	(5.3)	(1.8)	(0)	(0)	(0.6)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(4.4)	(23.2)	(0.9)	(1.0)	(1.0)	(62.5)	(3.9)	(2.2)	(0.9)	(0)	(0)	(0)	(0)	(0)
Mini-Fyke Net	5	0	40.0	0	0	0	60.0	0	0	0	0	0	0	0	0
		(6.5)	(19.9)	(0.4)	(0.3)	(0.3)	(46.8)	(8.4)	(3.1)	(11.4)	(0.3)	(0.3)	(0.3)	(2.1)	(0)
Otter Trawl	331	0	15.1	0	0	0	84.3	0	0.6	0	0	0	0	0	0
		(5.5)	(23.4)	(0.6)	(0.7)	(1.0)	(60.5)	(3.3)	(3.4)	(1.2)	(0)	(0)	(0.4)	(0)	(0)

Table 4.36. Total number of sicklefin chub captured for each gear during each season and the percentage caught within each mesohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(97.3)	(0.8)	(1.9)	(0)	(0)
Gill Net	0	0	0	0	0	0	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	384	0	89.8	0	9.6	0.5	0
		(0)	(96.9)	(0)	(2.8)	(0.3)	(0)
Fish Community Season (Summer)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(98.4)	(0)	(1.6)	(0)	(0)
Mini-Fyke Net	5	100.0	0	0	0	0	0
		(97.6)	(1.2)	(0)	(1.2)	(0)	(0)
Otter Trawl	331	0	100.0	0	0	0	0
		(0)	(98.0)	(0)	(2.0)	(0)	(0)

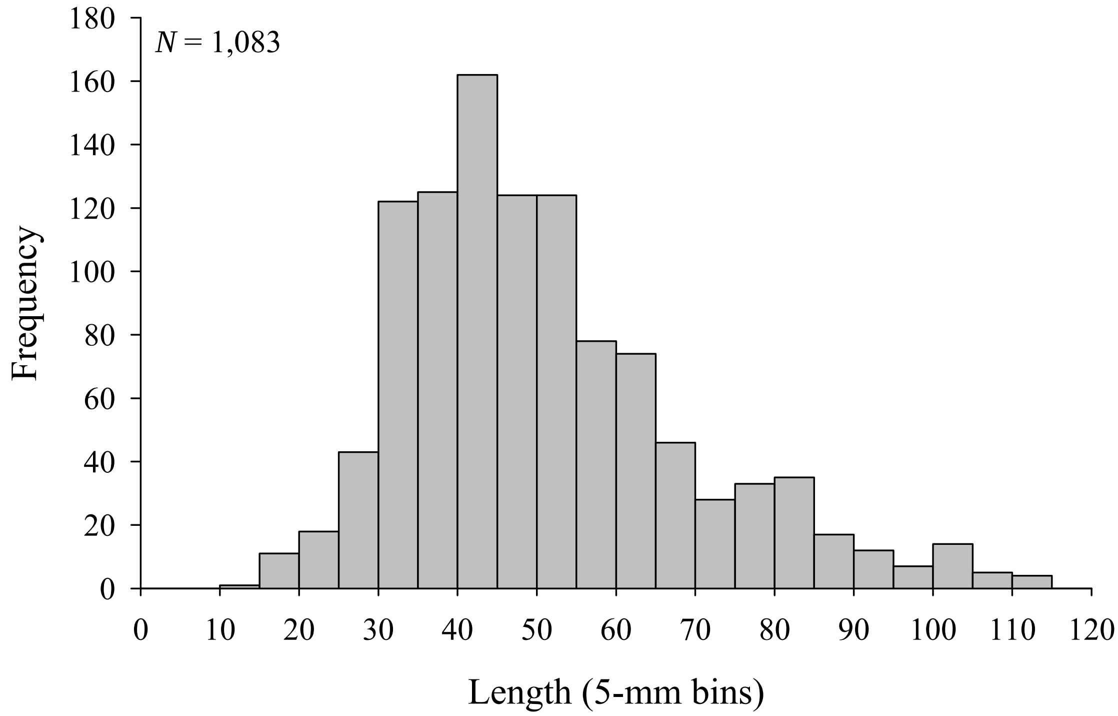

Figure 4.55. Length frequency distribution of sicklefin chub captured in the lower basin of the Missouri River during the 2006 sampling year using random and nonrandom sampling with standard and wild gears.

4.3.4 Speckled chub

4.3.4.1 Lower basin

Speckled chub *Macrhybopsis aestivalis* were captured only from the lower basin of the Missouri River. During the 2006 sampling year a total of 963 speckled chub were captured during the sturgeon season, while 2685 were captured during the fish community season (Figure 4.56). Sampling from segments 13 and 14 (RM 0 – 250) during the sturgeon season resulted in 678 speckled chub captured, comprising 70% of the catch during the sturgeon sampling season. Sampling from segment 9 (RM 368 – 596) resulted in 188 speckled chub (20%) caught during the sturgeon season. Relatively few speckled chub were caught in upstream segments 5 through 8 (RM 596 – 880). Total catch increased during the fish community season, with marked increases in catch of speckled chub in segments 9, 13 and 14 (Figure 4.56).

Relative abundance of speckled chub differed among sampling seasons and years. During the 2006 sampling year, the mean CPUE of speckled chub captured with otter trawls was lower during the fish community (0.33 fish/100 m) than during the sturgeon season (0.64 fish/100 m; Figure 4.57). The mean otter trawl CPUE during both the sturgeon and fish community seasons decreased from the 2004 sampling year to the 2006 sampling year, resulting in a decrease in overall mean CPUE from 0.71 fish/100 m to 0.51 fish/100 m, respectively. Relative abundance estimates from mini-fyke nets, deployed only during the fish community season, also decreased from the 2004 sampling year (0.5 fish/net night) to the 2006 sampling year (0.1 fish/net night; Figure 4.58).

Relative abundance of speckled chub differed markedly among sampling segments. During the sturgeon sampling season the relative abundance of speckled chub captured with otter trawls was generally larger in the downstream reaches of the lower basin (Figure 4.59). Sampling from segments 13 and 14 (RM 0 – 250) during the sturgeon season resulted in some of the largest mean CPUE, ranging from 0.0 fish/100 m to 2.3 fish/100 m. During the fish community season, the geographic trend in relative abundance remained relatively unchanged such that otter trawl sampling from the downstream reaches of lower basin resulted in comparatively larger mean CPUE than from the upstream sampling segments within the lower basin. The mean otter trawl CPUE during the fish community season decreased from that of the sturgeon season for many lower basin sampling reaches, ranging from 0.0 fish/100 m to approximately 2.8 fish/100 m (Figure 4.59).

Relative abundance of speckled chub increased in many sampling segments during the period from 2003 to 2005, while decreasing from 2005 to 2006 as the sampling program has become fully implemented (Figure 4.60). When combining sampling seasons in 2006, the relative abundance of speckled chub captured with otter trawls was comparatively larger in the downstream sampling segments of the lower basin (0.1 to 2.7 fish/100 m) than the upper reaches (0.0 to 0.9 fish/100 m; Figure 4.60). During 2006, the mean otter trawl CPUE was highest in segment 14 (RM 0 – 130), with a mean of 2.7 fish/100 m. Sampling with mini-fyke nets revealed an apparent decrease in speckled chub relative abundance from sampling years 2004 to 2006, when the sampling program became fully implemented (Figure 4.61). During 2006, a total of 49 speckled chub were captured with mini-fyke nets in the Missouri River basin.

During the sturgeon and fish community seasons, most speckled chub were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred (Table 4.37). Otter trawls captured 100% of the speckled chub during the sturgeon season and 92% during the fish community season. Main channel crossovers were also sampled with a relatively large effort, which resulted in proportional catches during both seasons. Channel border mesohabitats were the location where 98% of the speckled chub were captured during the sturgeon season, and 90% were captured during the fish community season (Table 4.38). Forty-nine speckled chub were captured with mini-fyke nets, with 45 from sand bar and 4 from island tip mesohabitats.

A total of 2912 speckled chub were captured in the lower basin during the 2006 sampling year. Lengths ranged from 10 to 115 mm, with a mode near 45 mm (Figure 4.62).

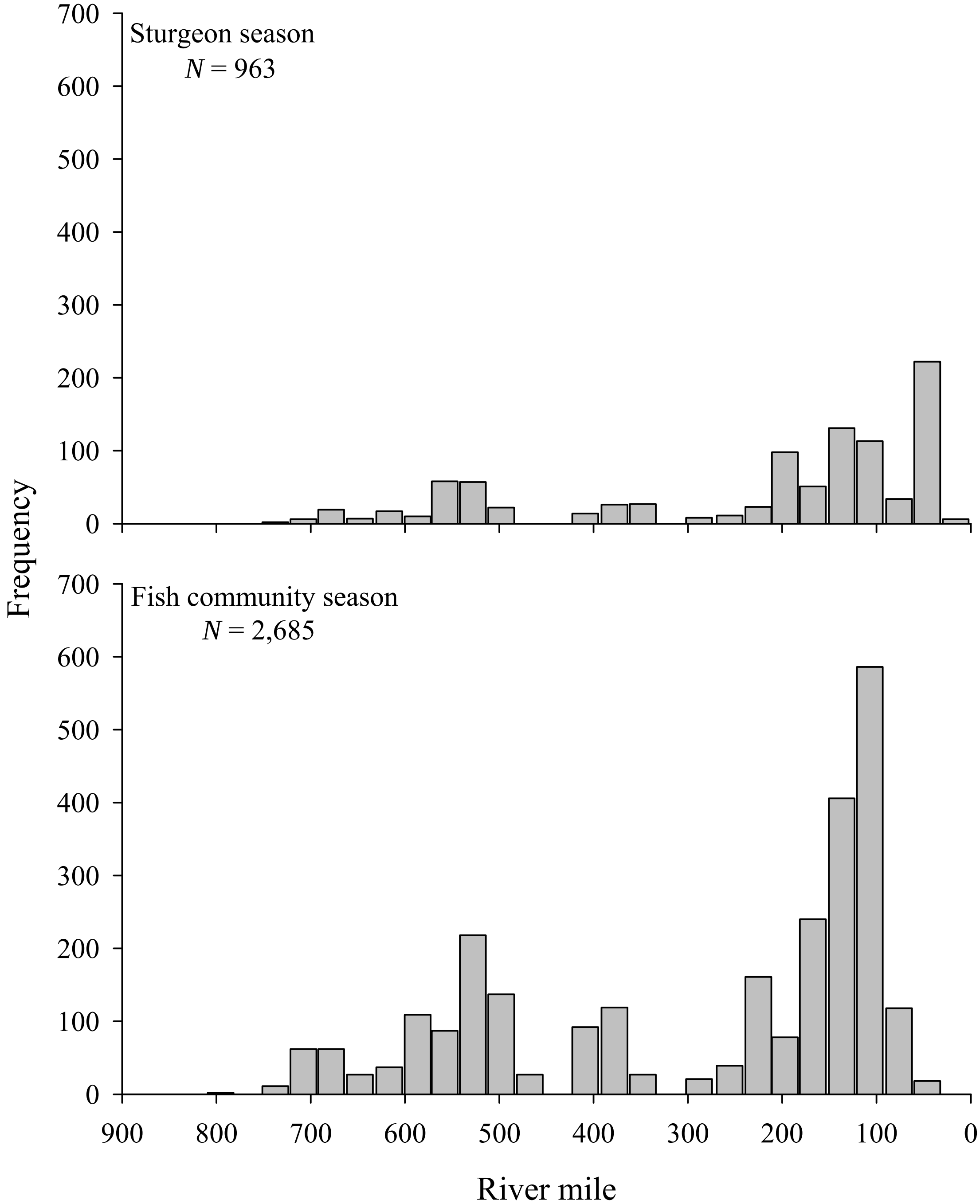

Figure 4.56. Seasonal catch by river mile (30-mile bins) of speckled chub in the lower basin of the Missouri River in the 2006 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

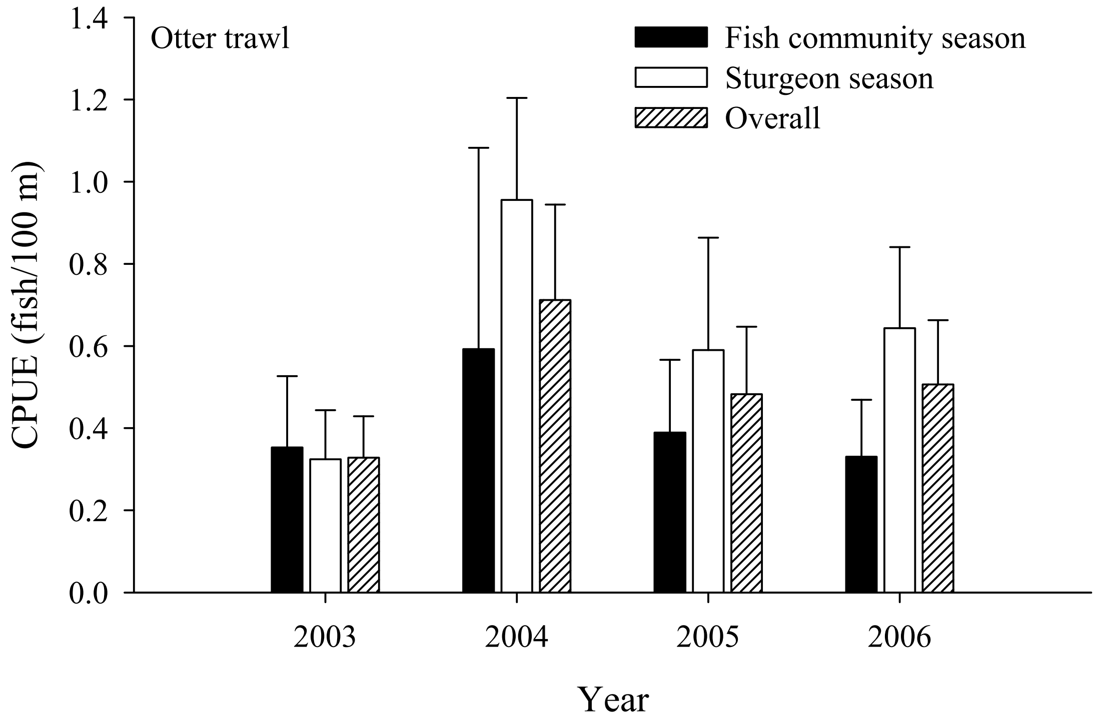

Figure 4.57. Mean annual catch per unit effort (± 2 SE) by season for speckled chub using otter trawls in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

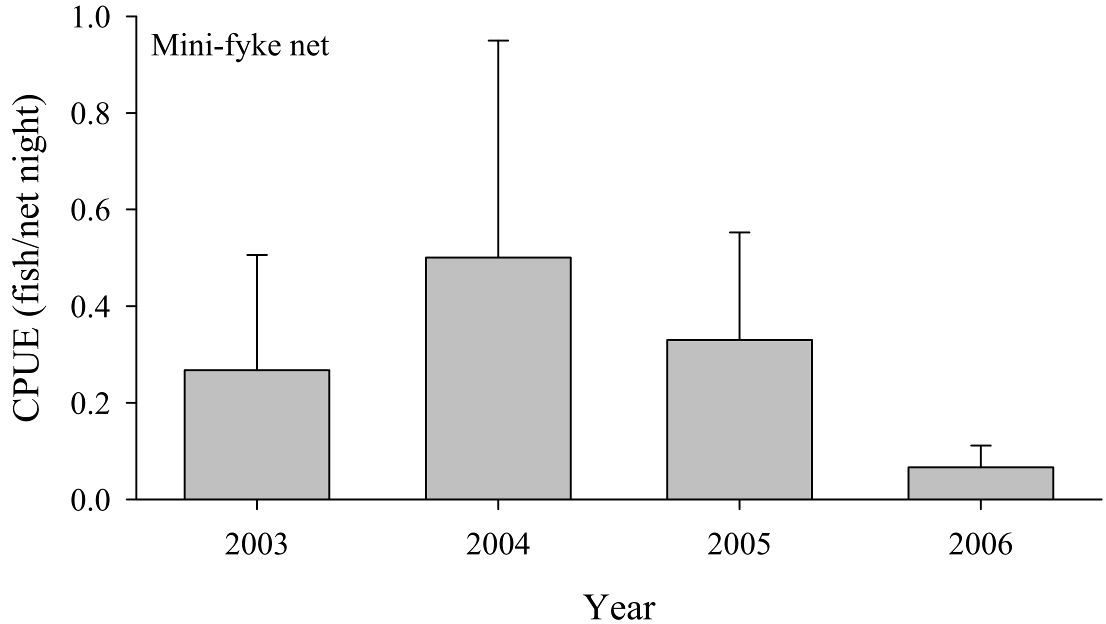

Figure 4.58. Mean annual catch per unit effort (± 2 SE) for speckled chub using mini-fyke nets in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

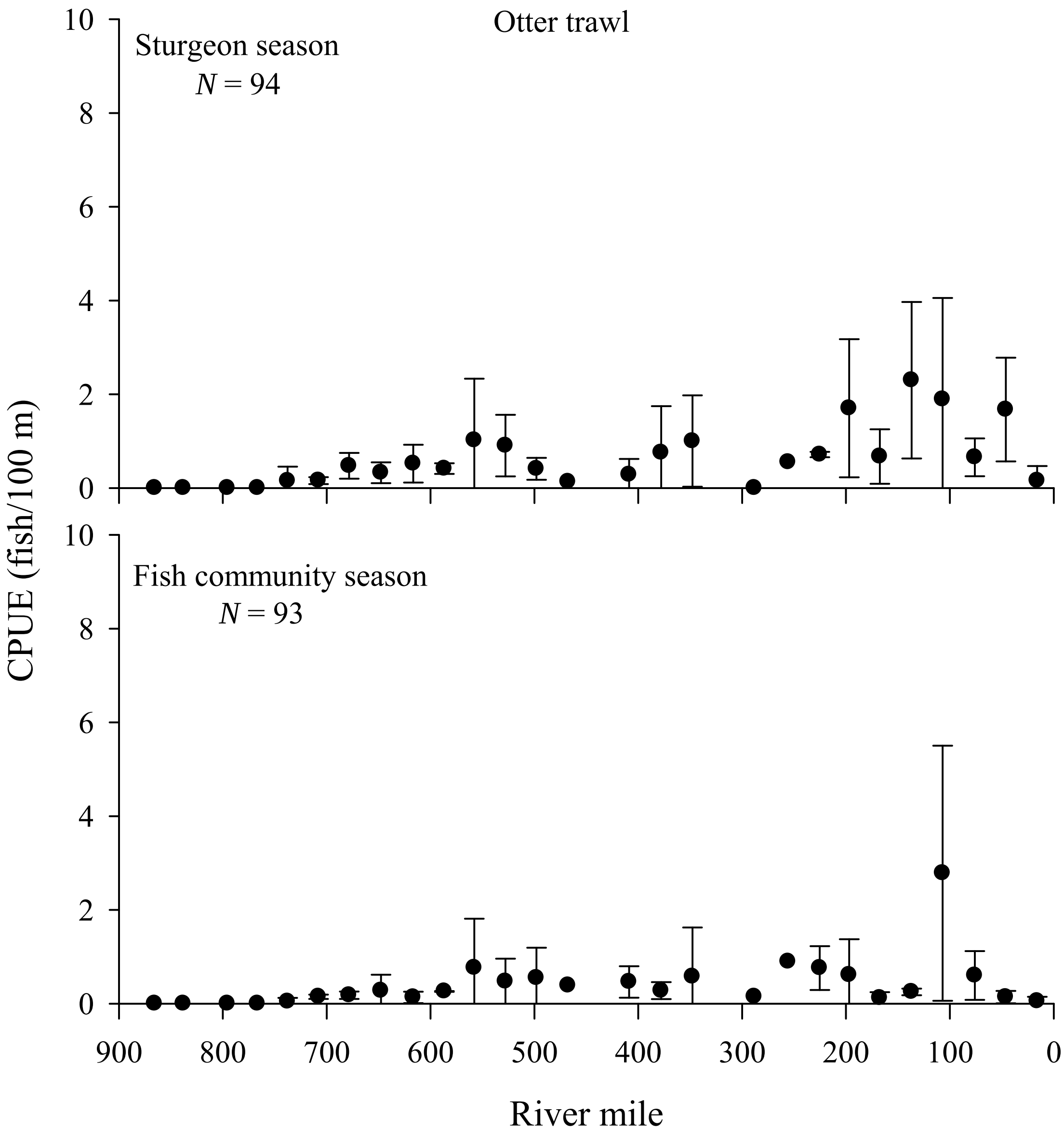

Figure 4.59. Mean seasonal catch per unit effort (± 2 SE) of speckled chub by river mile (30-mile bins) in the lower basin of the Missouri River for the 2006 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

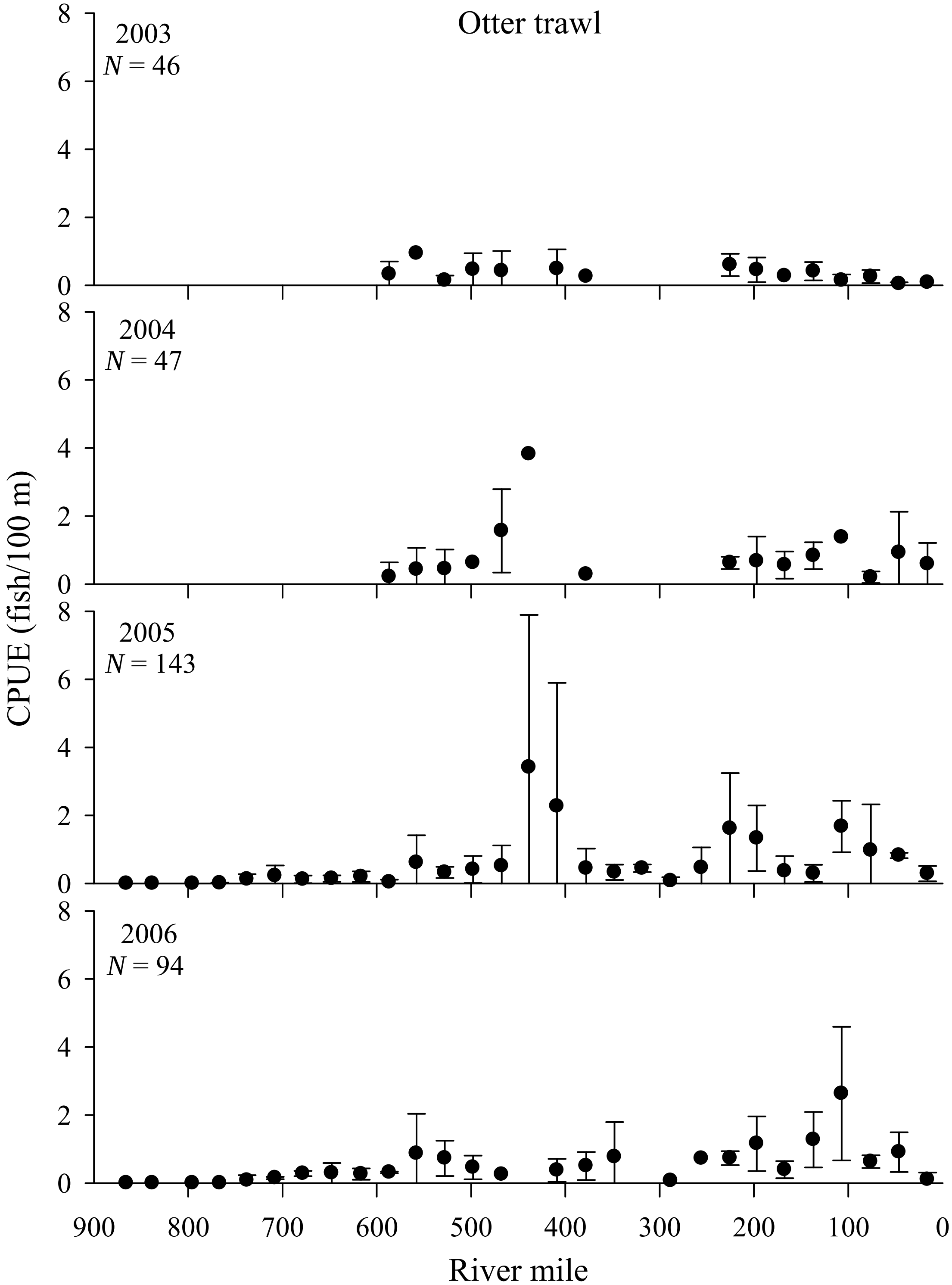

Figure 4.60. Mean annual catch per unit effort (± 2 SE) of speckled chub by river mile (30-mile bins) in the lower basin of the Missouri River for the 2003 to 2006 sampling years. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

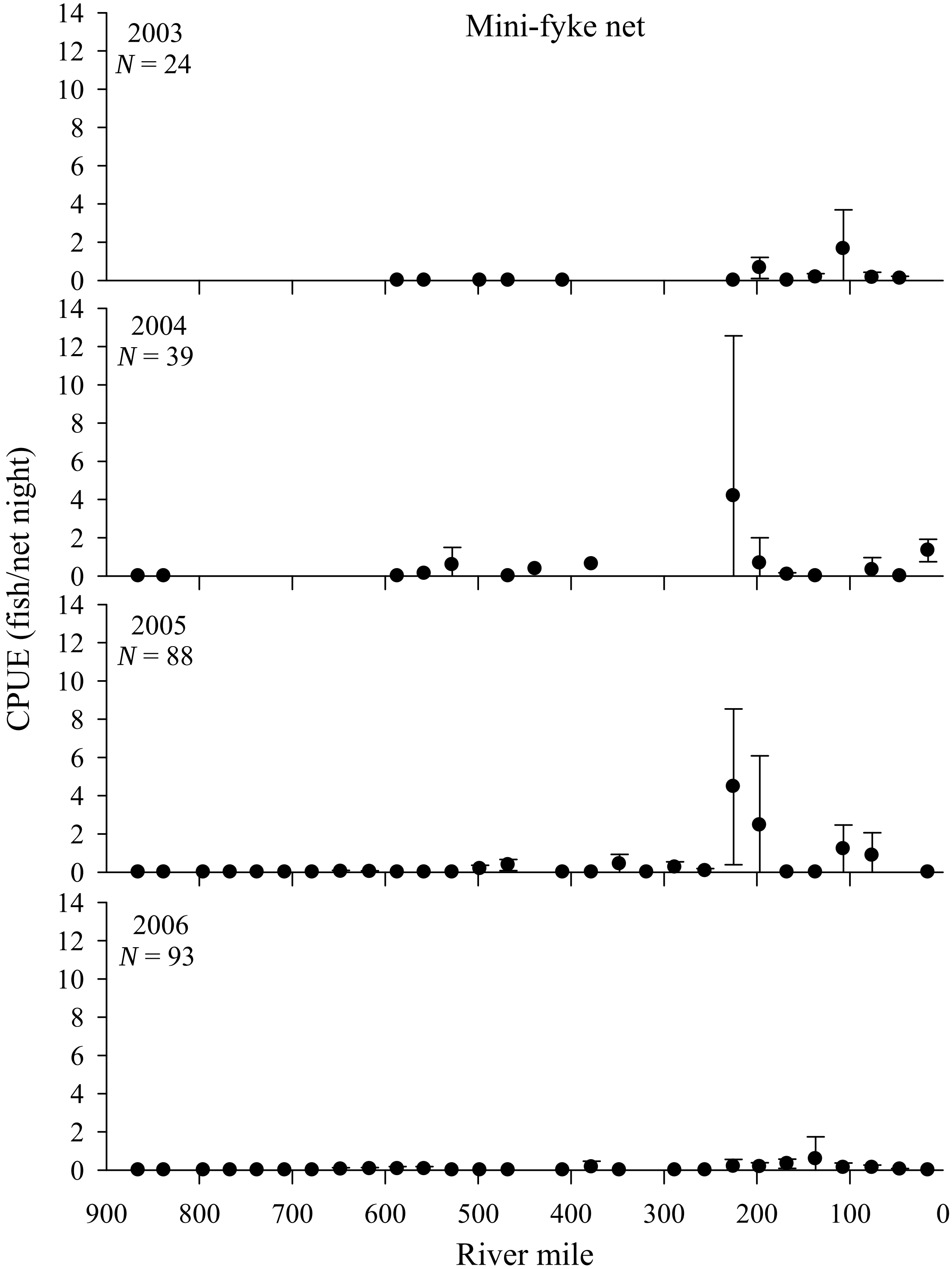

Figure 4.61. Mean annual catch per unit effort (± 2 SE) of speckled chub by river mile (30-mile bins) in the lower basin of the Missouri River for the 2003 to 2006 sampling years. Data obtained through random sampling using mini-fyke nets. Sample size denotes the number of bends sampled.

Table 4.37. Total number of speckled chub captured for each gear during each season and the percentage caught within each macrohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(4.3)	(22.3)	(1.5)	(1.4)	(1.5)	(58.4)	(4.2)	(4.7)	(1.0)	(0)	(0)	(0)	(0)	(0.8)
Gill Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.8)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	915	0	16.1	0.1	0	0	73.7	0	9.1	0.9	0	0	0.2	0	0
		(6.6)	(22.3)	(0.9)	(1.3)	(0.8)	(56.0)	(4.4)	(5.3)	(1.8)	(0)	(0)	(0.6)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(4.4)	(23.2)	(0.9)	(1.0)	(1.0)	(62.5)	(3.9)	(2.2)	(0.9)	(0)	(0)	(0)	(0)	(0)
Mini-Fyke Net	49	0	24.5	0	0	0	22.4	0	28.6	24.5	0	0	0	0	0
		(6.5)	(19.9)	(0.4)	(0.3)	(0.3)	(46.8)	(8.4)	(3.1)	(11.4)	(0.3)	(0.3)	(0.3)	(2.1)	(0)
Otter Trawl	537	0	13.2	0.2	0	0	83.4	0	1.3	1.1	0	0	0.7	0	0
		(5.5)	(23.4)	(0.6)	(0.7)	(1.0)	(60.5)	(3.3)	(3.4)	(1.2)	(0)	(0)	(0.4)	(0)	(0)

Table 4.38. Total number of speckled chub captured for each gear during each season and the percentage caught within each mesohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(97.3)	(0.8)	(1.9)	(0)	(0)
Gill Net	0	0	0	0	0	0	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	915	0	98.4	0	1.3	0.3	0
		(0)	(96.9)	(0)	(2.8)	(0.3)	(0)
Fish Community Season (Summer)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(98.4)	(0)	(1.6)	(0)	(0)
Mini-Fyke Net	49	91.8	0	0	8.2	0	0
		(97.6)	(1.2)	(0)	(1.2)	(0)	(0)
Otter Trawl	537	0	98.7	0	1.3	0	0
		(0)	(98.0)	(0)	(2.0)	(0)	(0)

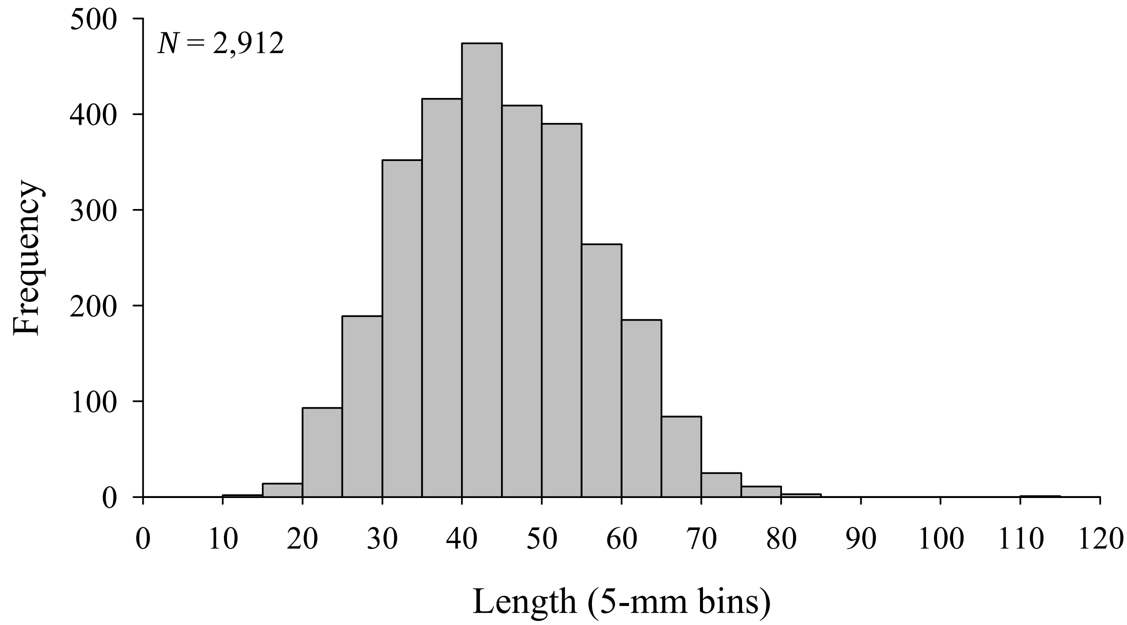

Figure 4.62. Length frequency distribution of speckled chub captured in the lower basin of the Missouri River during the 2006 sampling year using random and nonrandom sampling with standard and wild gears.

4.3.5 Blue sucker

4.3.5.1 Combined Basins

During the 2006 sampling year in the upper and lower basins of the Missouri River 2289 blue suckers *Cycleptus elongatus* were captured during the sturgeon season, while 973 were captured during the fish community season (Figure 4.63). Sampling from the lower basin during the sturgeon season resulted in 2275 blue suckers captured, comprising 99% of the catch during the sturgeon sampling season. Sampling from segments 7, 8, and 9 (RM 368 – 811) resulted in approximately 83% of the lower basin total for the sturgeon season. Sampling from the upper reaches of segment 7 downstream from Gavins Point Dam yielded significant numbers of blue suckers during the sturgeon season. While the total catch of blue suckers decreased during the fish community season, the trend of lower catches from the upper basin sampling segments continued. Sampling from the lower basin during the fish community season resulted in 957 blue suckers captured, comprising 98% of the catch during the fish community sampling season. Sampling from segments 7, 8, and 9 (RM 367.5 – 811) resulted in approximately 91% of the lower basin total for the fish community season. Sampling from segment 7 downstream from Gavins Point Dam during the fish community season yielded some of the highest blue sucker catches per river mile (Figure 4.63).

Relative abundance of blue suckers differed between sampling seasons and years. During the 2006 sampling year, the mean CPUE of blue suckers captured with trammel nets was similar for the fish community season (0.34 fish/100 m) and sturgeon season (0.28 fish/100 m; Figure 4.64). The mean trammel net CPUE during the fish community season decreased from the 2005 sampling year to the 2006 sampling year, resulting in a decrease in overall mean CPUE from 0.37 fish/100 m to 0.31 fish/100 m, respectively. During the 2006 sampling year, the mean CPUE of blue suckers captured with otter trawls was larger during the fish community season (0.13 fish/100 m) than during the sturgeon season (0.08 fish/100 m; Figure 4.64). The mean otter trawl CPUE during the fish community season increased from the 2005 sampling year to the 2006 sampling year, resulting in a small increase in overall mean CPUE from 0.09 fish/100 m to 0.11 fish/100 m, respectively.

Relative abundance of blue suckers also differed markedly among sampling segments. During the sturgeon sampling season the relative abundance of blue suckers captured with trammel nets was generally larger in the lower basin than the upper basin, with the mean CPUE ranging from < 0.1 fish/100 m to approximately 1.7 fish/100 m in the lower basin (Figure 4.65). Sampling from segments 7, 8, and 9 (RM 368 – 811) resulted in some of the largest trammel net CPUE during the sturgeon season, a finding also observed during the fish community season. During the fish community season, the geographic trend in relative abundance remained largely unchanged such that trammel net sampling from the lower basin resulted in comparatively larger mean CPUE than from the upper basin. The mean trammel net CPUE during the fish community season increased from that of the sturgeon season for many lower basin sampling reaches in segments 7 - 9, ranging from 0.1 fish/100 m to approximately 1.6 fish/100 m (Figure 4.65). As with trammel nets, during the sturgeon sampling season the relative abundance of blue suckers captured with otter trawls was generally larger in the lower basin than in the upper basin (Figure 4.66). During the 2006 sturgeon season, the mean CPUE of blue suckers captured with otter trawls ranged from 0.00 fish/100 m to 0.73 fish/100 m in the lower basin, and 0.00 fish/100 m to 0.03 fish/100 m in the upper basin. During the 2006 fish community season, the geographic trend in relative abundance remained largely unchanged such that otter trawl sampling from the lower basin resulted in comparatively larger mean CPUE than from the upper basin (Figure 4.66).

Relative abundance of blue suckers has generally increased in many sampling segments during the period from 2003 to 2006 as the sampling program has become fully implemented. For combined sampling seasons in 2006, the relative abundance of blue suckers captured with trammel nets was comparatively larger in the lower basin (0.03 to 1.52 fish/100 m) than the upper basin (0.0 to 0.1 fish/100 m; Figure 4.67). During 2006, the mean trammel net CPUE seemed to be highest in upper basin segment 1 (RM 1760 – 1772) and lower basin segments 7, 8, and 9 (RM 368 – 811). As with trammel nets, the relative abundance of blue suckers captured with otter trawls during 2006 was comparatively larger in the lower basin (0.00 to 0.72 fish/100 m) than the upper basin (0.00 to 0.02 fish/100 m; Figure 4.68). During the 2006 sampling year, the greatest mean otter trawl CPUE in the upper basin occurred segment 1 (RM 1760 – 1772) the greatest lower basin mean CPUE were found in segments 7, 8, and 9 (RM 368 – 811). While gill net sampling only occurred in the lower basin, the relative abundance of blue suckers sampled with this gear appears to have generally increased during the period from 2003 to 2006 (Figure 4.69). Gill net sampling from segments 7, 8, and 9 (RM 368 – 811) in 2005 and 2006 yielded the highest mean CPUE within the lower basin sampling segments, ranging from 0.0 to 2.7 fish/net night in 2005 and 0.0 to 2.0 fish/net night in 2006.

Random sampling with standard gears accounted for approximately 63% (*N* = 1453) of the total blue sucker catch during the 2006 sturgeon season, and 78% (*N* = 759) of the catch during the 2006 fish community season (Table 4.39). During both seasons, most blue suckers were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred. Main channel crossover macrohabitats were also sampled with a relatively large effort, which resulted in proportional catches of blue suckers with all gear types and during both seasons. During the sturgeon season, sampling with gill nets accounted for 58 % (*N* = 849) of the blue sucker catch. The majority of all blue suckers were captured from main channel border mesohabitats, which for most gears was also the location of greatest effort (Table 4.40). During the sturgeon season, pool mesohabitats comprised 39% of the gill net sampling effort, resulting in approximately 29% of the total blue sucker catch with all gears for that season. Mini-fyke nets, used during fish community season, caught two blue suckers, both from sand bar mesohabitat.

The population structure of blue suckers captured during the 2006 sampling year is negatively skewed, with juvenile fish representing a small component of fish sampled (Figure 4.70). The lengths of all blue suckers captured ranged from approximately 40 to 880 mm, with a mode near 660 mm. Random sampling accounted for 97% (N = 3168) of the blue suckers captured. The length frequency distribution from random sampling is very similar to that from non-random sampling (Figure 4.70).

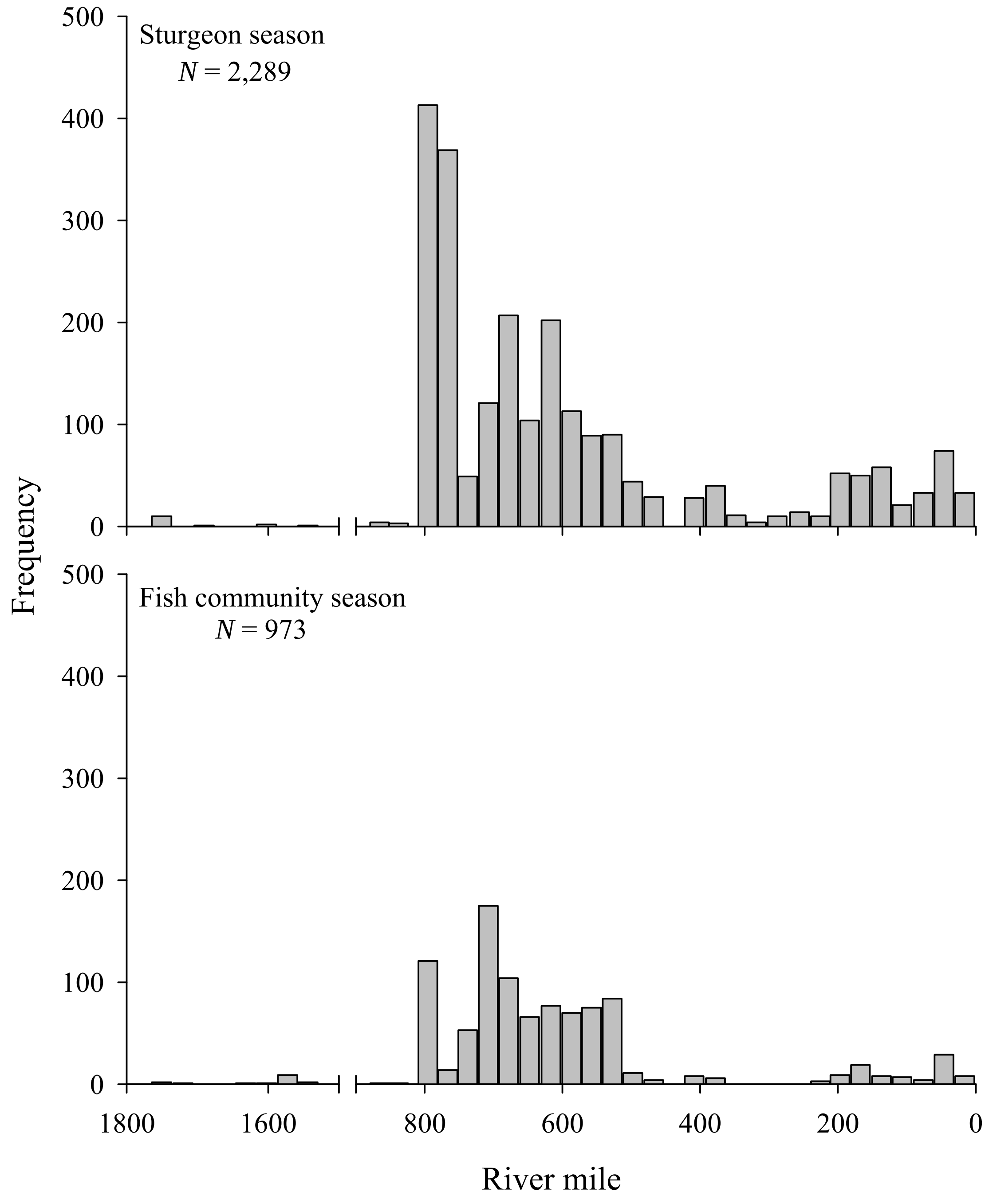

Figure 4.63. Seasonal catch by river mile (30-mile bins) of blue suckers in the upper and lower basins of the Missouri River in the 2006 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

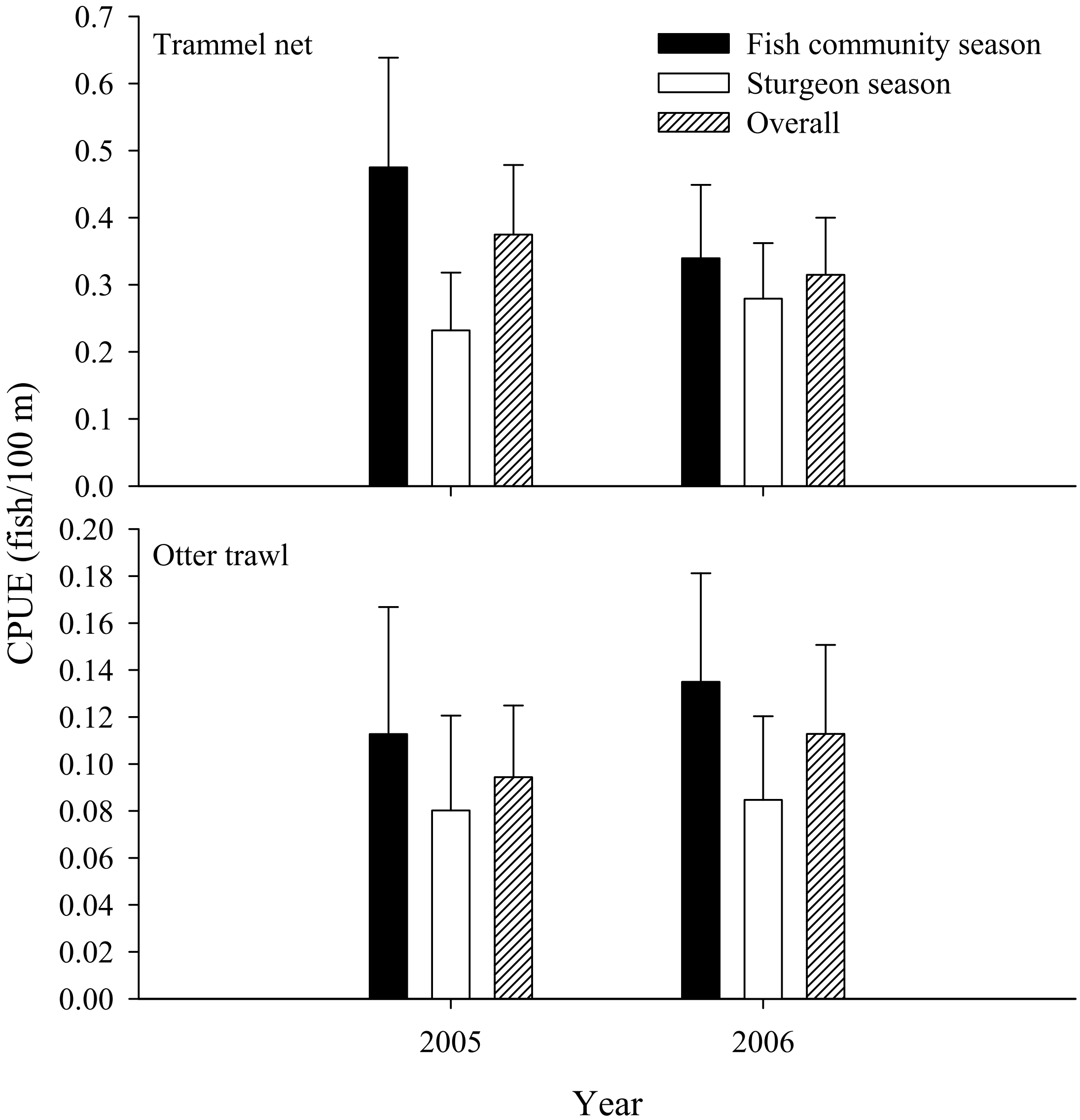

Figure 4.64. Mean annual catch per unit effort (± 2 SE) by season for blue suckers using one-inch trammel nets and otter trawls in the upper and lower basins of the Missouri River for the 2005 and 2006 sampling years.

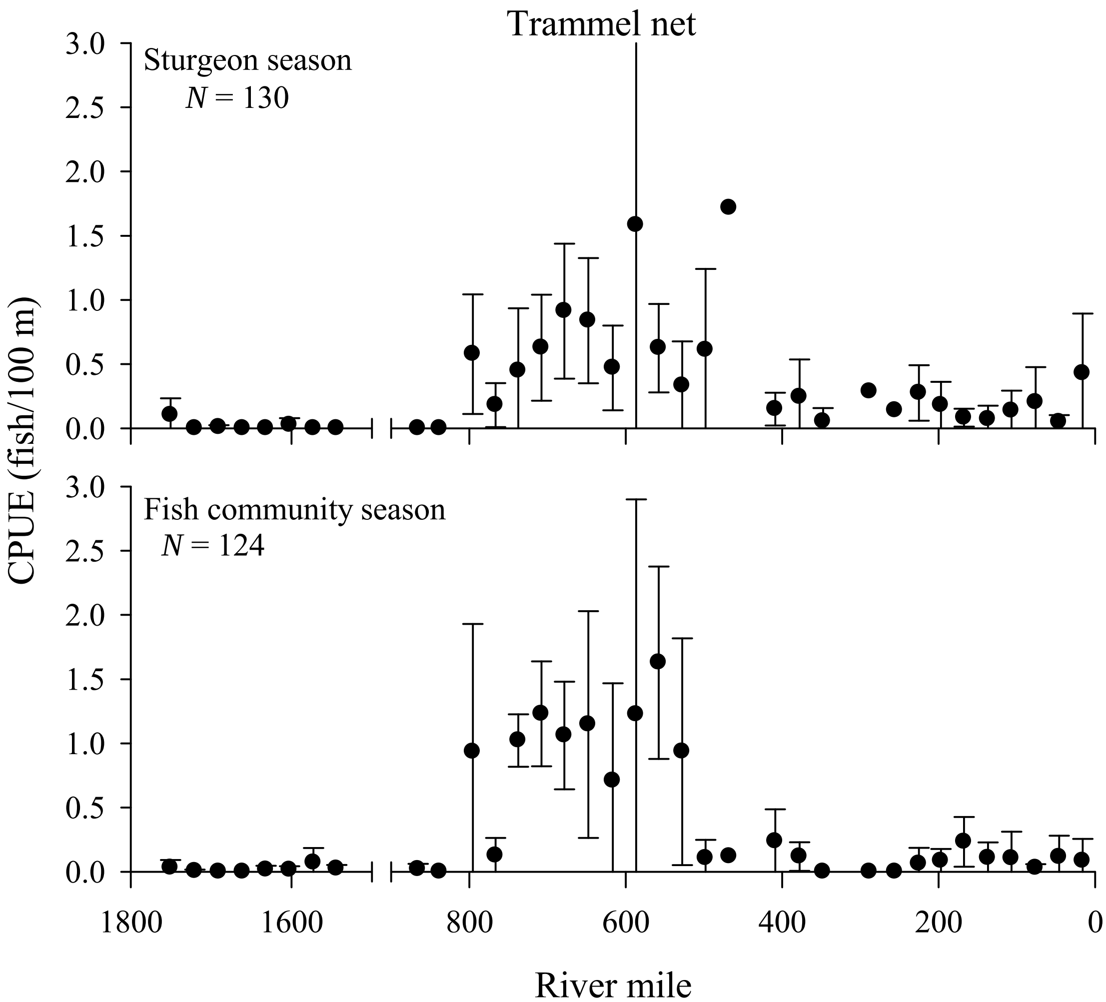

Figure 4.65. Mean seasonal catch per unit effort (± 2 SE) of blue suckers by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2006 sampling year. Data obtained through random sampling using one-inch trammel nets. Sample size denotes the number of bends sampled.

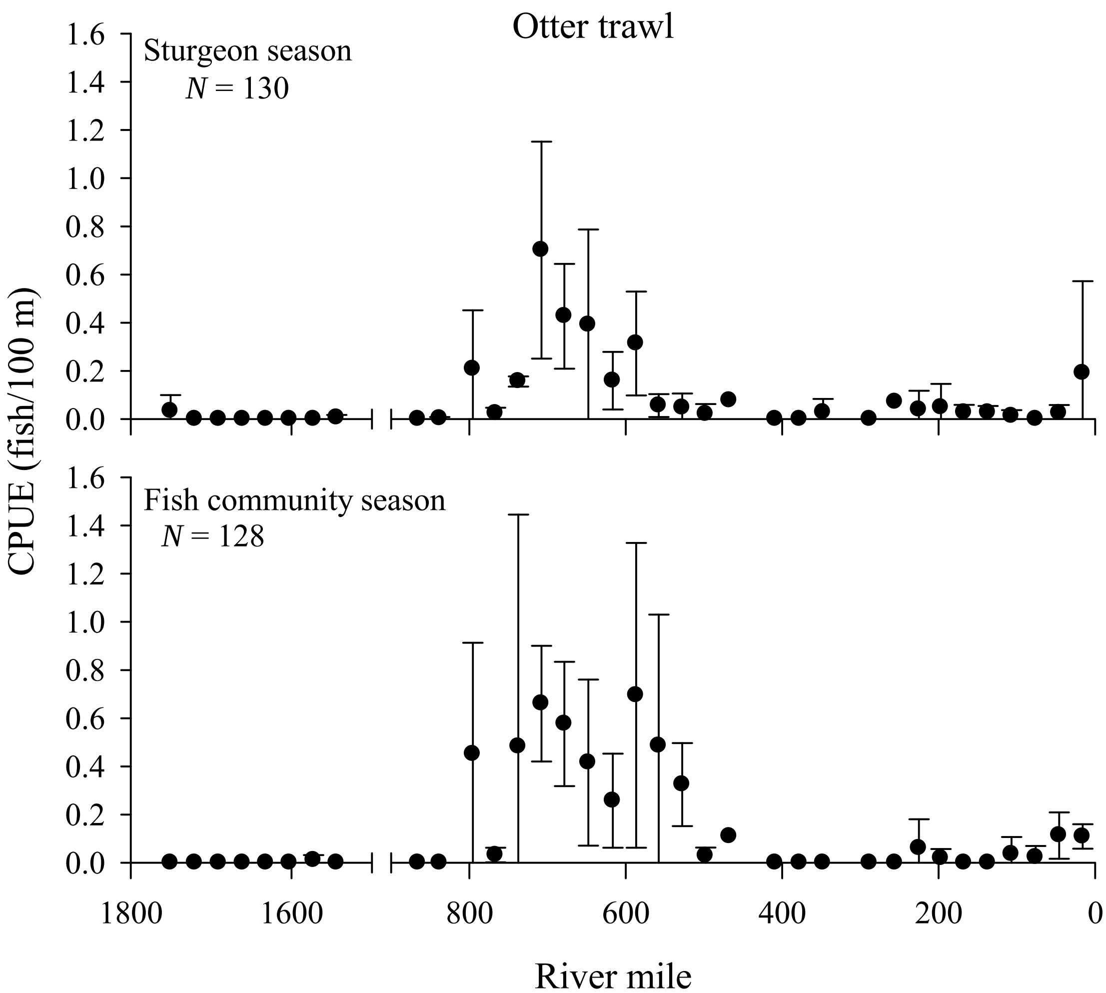

Figure 4.66. Mean seasonal catch per unit effort (± 2 SE) of blue suckers by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2006 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

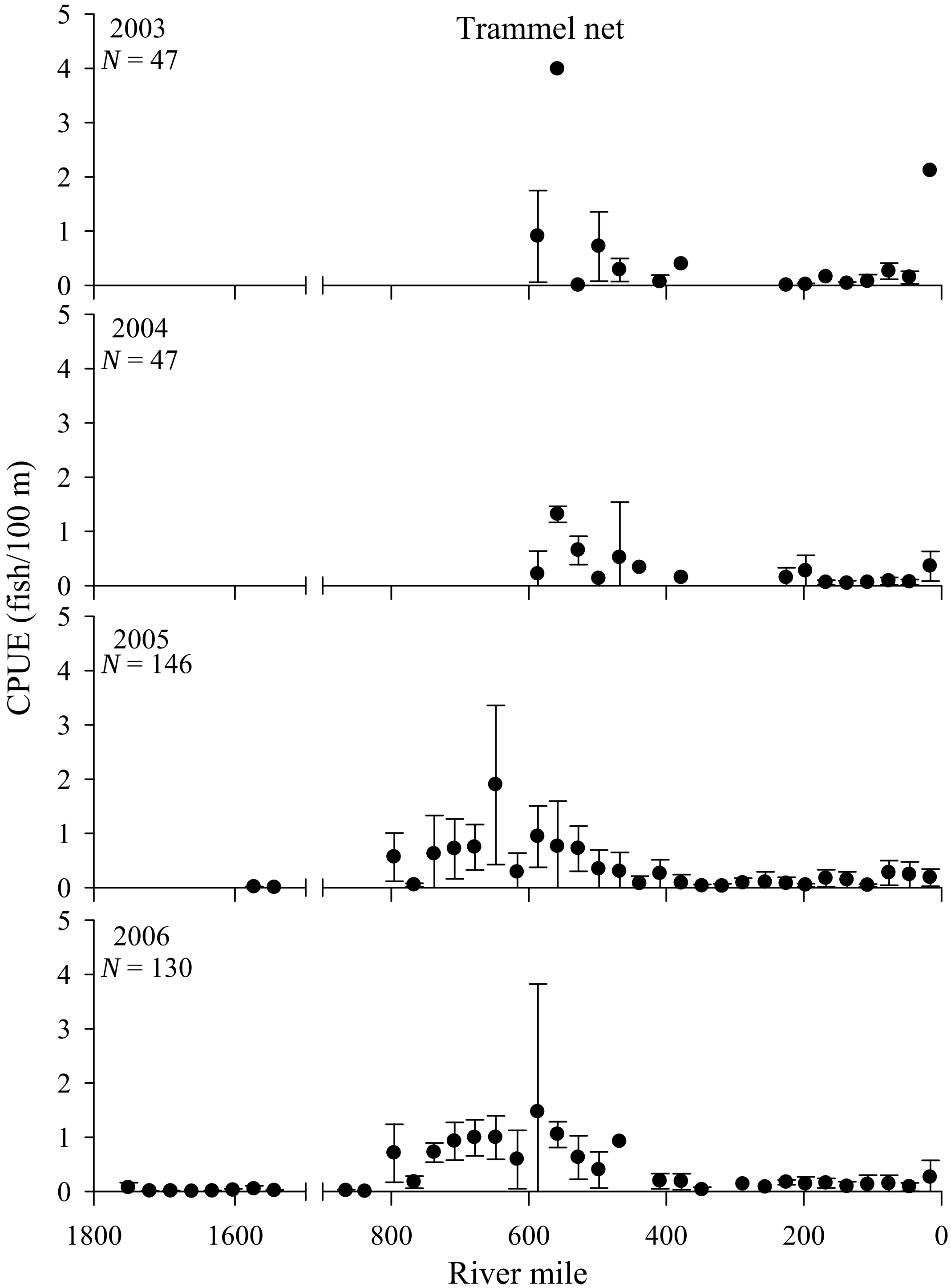

Figure 4.67. Mean annual catch per unit effort (± 2 SE) of blue suckers by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2003 – 2006 sampling years. Data obtained through random sampling using one-inch trammel nets. Sample size denotes the number of bends sampled.

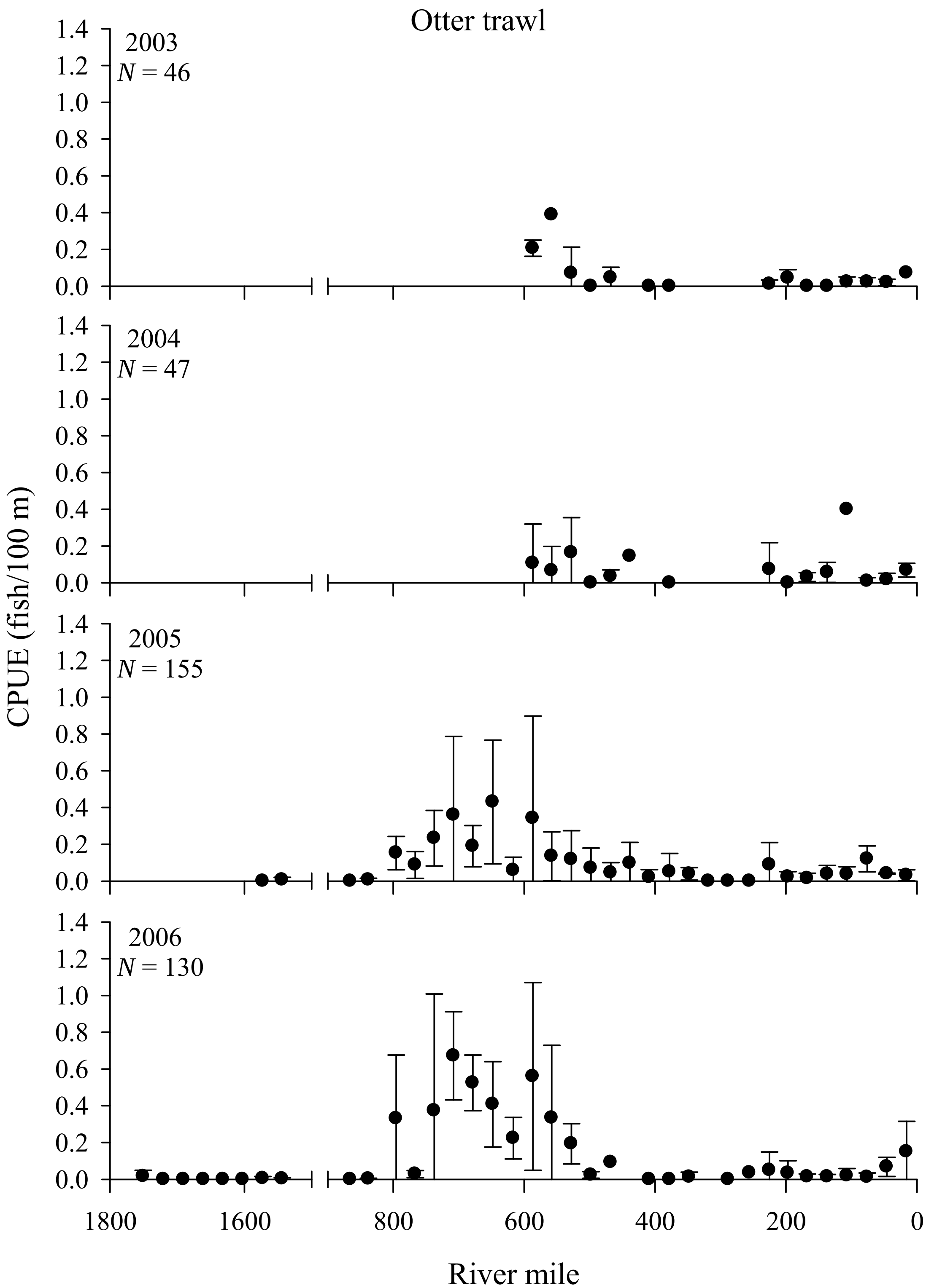

Figure 4.68. Mean annual catch per unit effort (± 2 SE) of blue suckers by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2003 – 2006 sampling years. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

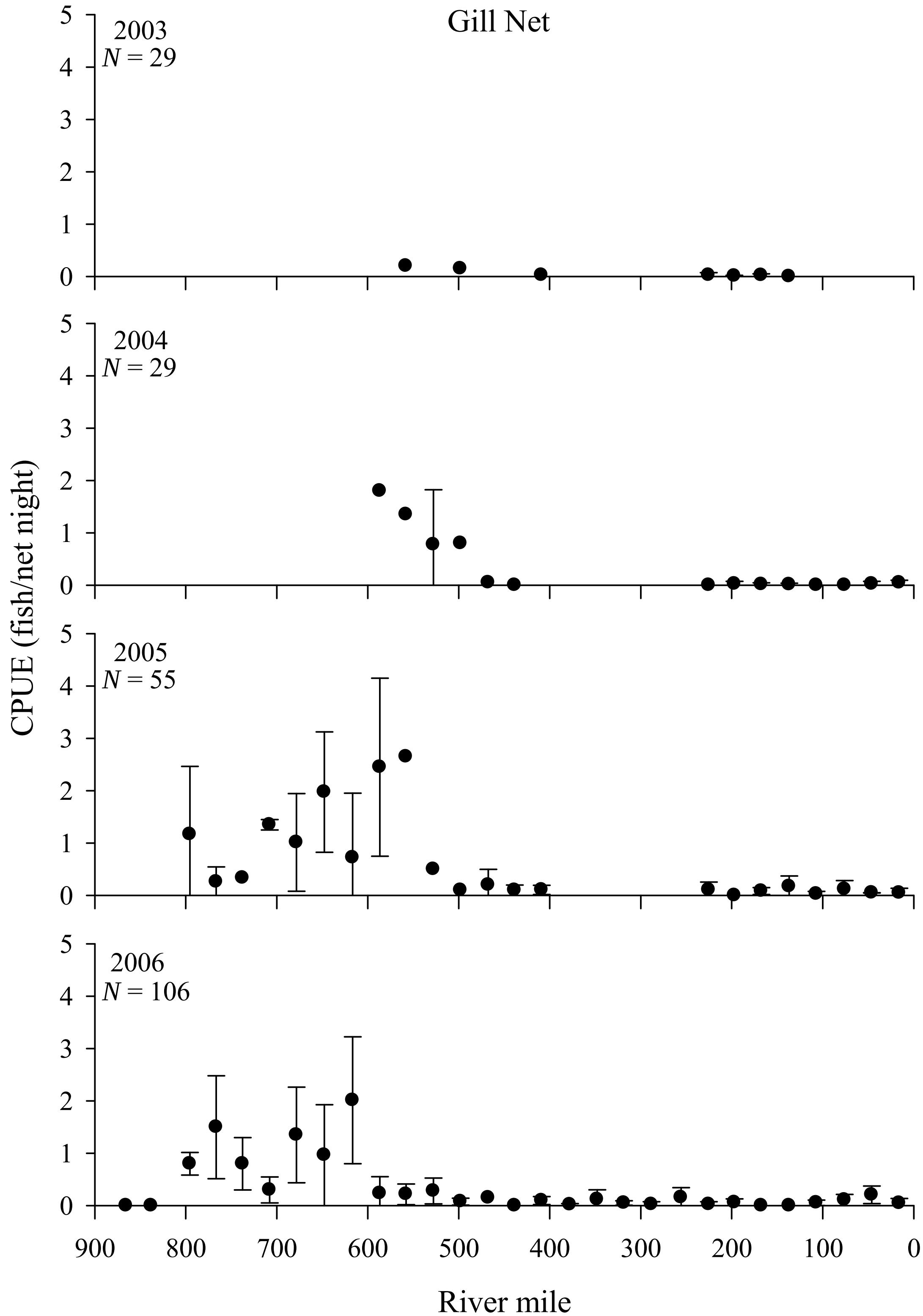

Figure 4.69. Mean annual catch per unit effort (± 2 SE) of blue suckers by river mile (30-mile bins) in the lower basin of the Missouri River for the 2003 – 2006 sampling years. Data obtained through random sampling using gill nets. Sample size denotes the number of bends sampled.

Table 4.39. Total number of blue suckers captured for each gear during each season and the percentage caught within each macrohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	488	0.6	16.4	2.0	0.6	2.0	70.5	1.6	2.7	0	0	0	0	0	3.5
		(3.6)	(22.5)	(1.2)	(1.0)	(1.1)	(51.5)	(9.6)	(8.0)	(0.8)	(0)	(0)	(0)	(0)	(0.6)
Gill Net	849	7.2	17.2	2.0	0.1	0.4	55.8	7.5	2.6	3.4	0	0	3.8	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.4)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	116	0.9	22.4	0.9	0	0.9	63.8	4.3	5.2	1.7	0	0	0	0	0
		(5.6)	(22.4)	(0.8)	(0.9)	(0.5)	(47.3)	(10.8)	(9.1)	(2.1)	(0)	(0)	(0.4)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	464	0.2	13.6	0.4	0.2	0.2	78.0	5.2	1.3	0.9	0	0	0	0	0
		(3.4)	(24.0)	(0.6)	(0.7)	(0.7)	(52.9)	(10.9)	(5.2)	(1.6)	(0)	(0)	(0.2)	(0)	(0)
Mini-Fyke Net	2	0	0	0	0	0	100.0	0	0	0	0	0	0	0	0
		(4.8)	(16.7)	(0.5)	(0.2)	(0.2)	(43.2)	(9.2)	(7.5)	(13.8)	(1.9)	(0.2)	(0.2)	(1.8)	(0)
Otter Trawl	293	0.7	19.8	1.0	0	0	70.6	4.1	3.1	0.3	0	0	0.3	0	0
		(4.3)	(24.0)	(0.6)	(0.5)	(0.8)	(53.3)	(9.2)	(5.8)	(1.1)	(0)	(0)	(0.3)	(0)	(0)

Table 4.40. Total number of blue suckers captured for each gear during each season and the percentage caught within each mesohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	488	0	95.7	3.5	0.8	0	0
		(0)	(95.0)	(0.6)	(4.2)	(0)	(0.2)
Gill Net	849	0	45.3	0	4.7	49.9	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	116	0	98.3	0	1.7	0	0
		(0)	(93.5)	(0)	(6.0)	(0.2)	(0.3)
Fish Community Season (Summer)							
1-Inch Trammel Net	464	0	98.9	0	1.1	0	0
		(0.1)	(95.9)	(0)	(3.9)	(0)	(0.1)
Mini-Fyke Net	2	100.0	0	0	0	0	0
		(96.2)	(1.2)	(0)	(2.7)	(0)	(0)
Otter Trawl	293	0	99.3	0	0.7	0	0
		(0)	(97.2)	(0)	(2.8)	(0)	(0.1)

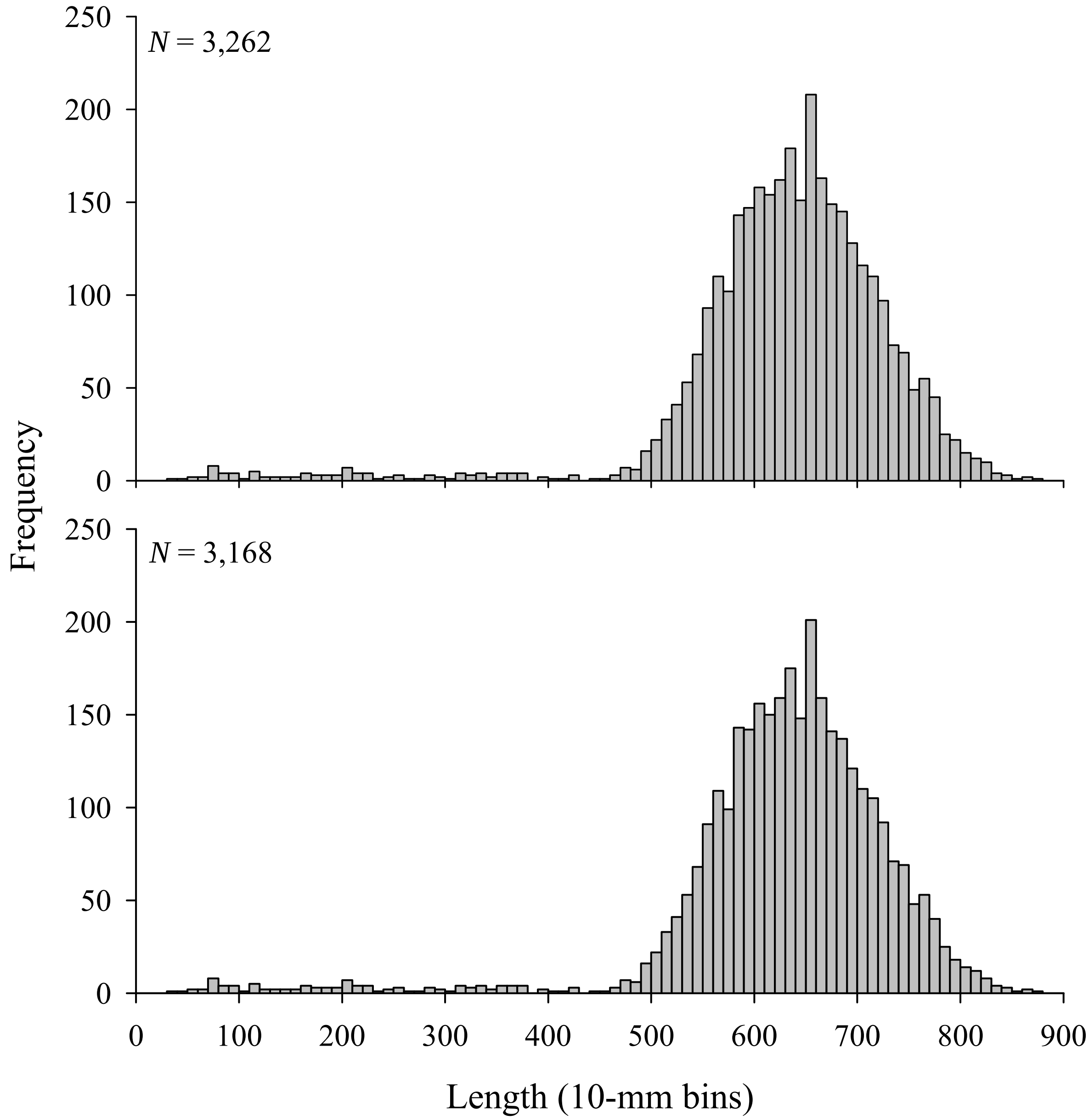

Figure 4.70. Length frequency distribution of blue suckers captured in the upper and lower basins of the Missouri River during the 2006 sampling year using standard and wild gears. Upper panel includes random and nonrandom sampling. Lower panel includes only random sampling.

4.3.5.2 Upper Basin

Within the upper basin sampling segments of the Missouri River very few blue suckers were captured relative to the effort expended. Relative abundance of blue suckers differed between sampling seasons and years. During the 2006 sampling year, the mean CPUE of blue suckers captured with trammel nets was larger during the fish community season (0.02 fish/100 m) than during the sturgeon season (0.01 fish/100 m; Figure 4.71). The mean trammel net CPUE during the fish community season increased from the 2005 sampling year to the 2006 sampling year, resulting in an increase in overall blue sucker relative abundance from < 0.01 fish/100 m in 2005 to 0.19 fish/100 m in 2006. During the 2006 sampling year, the mean CPUE of blue suckers captured with otter trawls was larger during the sturgeon season (0.004 fish/100 m) than during the fish community season (0.002 fish/100 m; Figure 4.71). The mean otter trawl CPUE during the fish community season decreased from the 2005 sampling year (0.003 fish/100 m) to the 2006 sampling year (0.002 fish/100 m).

Within the upper basin sampling segments, 27 blue suckers were captured during the 2006 sampling year; 11 during the sturgeon season and 16 during the fish community season (Table 4.41). During the sturgeon season, most blue suckers were caught in main channel crossover macrohabitats, where approximately 24% of the total sampling effort occurred. Sampling from main channel outside and inside bend macrohabitats yielded blue sucker catches proportional to the effort. Sampling from main channel border mesohabitats resulted in 100% (N = 11) of the blue sucker catch during the sturgeon season and 94% (N = 15) of the catch during the fish community season (Table 4.42). Mini-fyke nets, used during the fish community season, did not catch any blue suckers during the 2006 sampling year.

The lengths of all blue suckers captured ranged from approximately 370 to 790 mm, with a mode near 570 mm (Figure 4.72). Random sampling accounted for 90% (N = 27) of the blue suckers captured. The length frequency distribution from random sampling is very similar to that from non-random sampling.

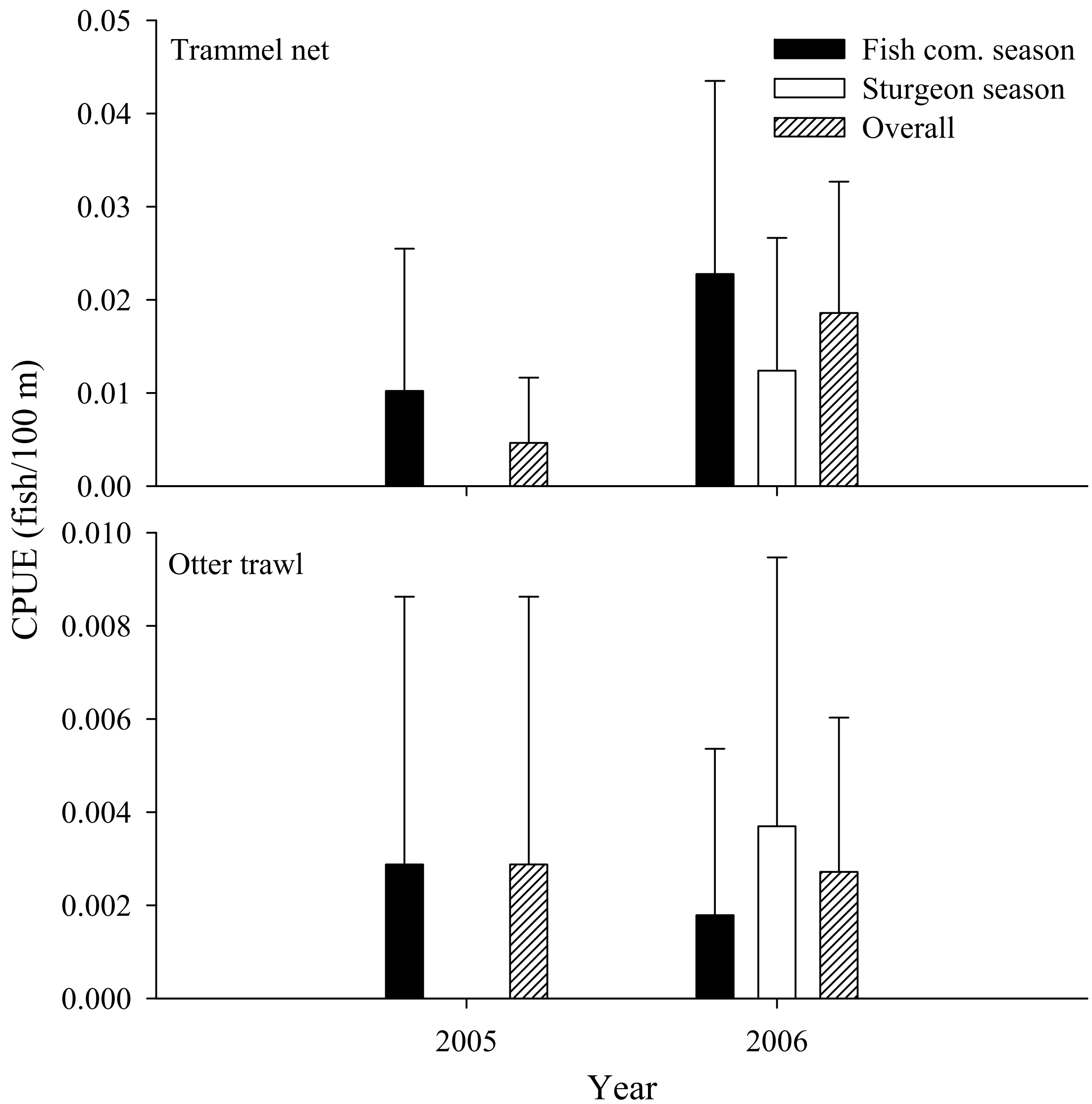

Figure 4.71. Mean annual catch per unit effort (± 2 SE) by season for blue suckers using one-inch trammel nets and otter trawls in the upper basin of the Missouri River for the 2005 and 2006 sampling years.

Table 4.41. Total number of blue suckers captured for each gear during each season and the percentage caught within each macrohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	9	0	44.4	0	0	0	22.2	33.3	0	0	0	0	0	0	0
		(0)	(24.3)	(0.6)	(0)	(0)	(30.3)	(26.5)	(18.3)	(0)	(0)	(0)	(0)	(0)	(0)
Otter Trawl	2	0	50.0	0	0	0	0	50.0	0	0	0	0	0	0	0
		(0)	(24.7)	(0.6)	(0)	(0)	(27.9)	(25.0)	(18.6)	(3.2)	(0)	(0)	(0)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	15	0	53.3	0	0	0	20.0	20.0	6.7	0	0	0	0	0	0
		(0)	(26.7)	(0)	(0)	(0)	(31.1)	(27.7)	(10.4)	(3.5)	(0)	(0)	(0.6)	(0)	(0)
Mini-Fyke Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(0)	(7.7)	(0.7)	(0)	(0)	(33.1)	(11.4)	(19.9)	(20.2)	(6.3)	(0)	(0)	(0.7)	(0)
Otter Trawl	1	0	0	0	0	0	0	100.0	0	0	0	0	0	0	0
		(0)	(26.6)	(0.7)	(0)	(0)	(29.8)	(30.4)	(11.4)	(1.0)	(0)	(0)	(0)	(0)	(0)

Table 4.42. Total number of blue suckers captured for each gear during each season and the percentage caught within each mesohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	9	0	100.0	0	0	0	0
		(0)	(88.0)	(0)	(11.4)	(0)	(0.6)
Otter Trawl	2	0	100.0	0	0	0	0
		(0)	(85.3)	(0)	(13.8)	(0)	(1.0)
Fish Community Season (Summer)							
1-Inch Trammel Net	15	0	93.3	0	6.7	0	0
		(0.3)	(89.6)	(0)	(9.7)	(0)	(0.3)
Mini-Fyke Net	0	0	0	0	0	0	0
		(92.0)	(1.1)	(0)	(6.8)	(0)	(0)
Otter Trawl	1	0	100.0	0	0	0	0
		(0)	(94.5)	(0)	(5.5)	(0)	(0)

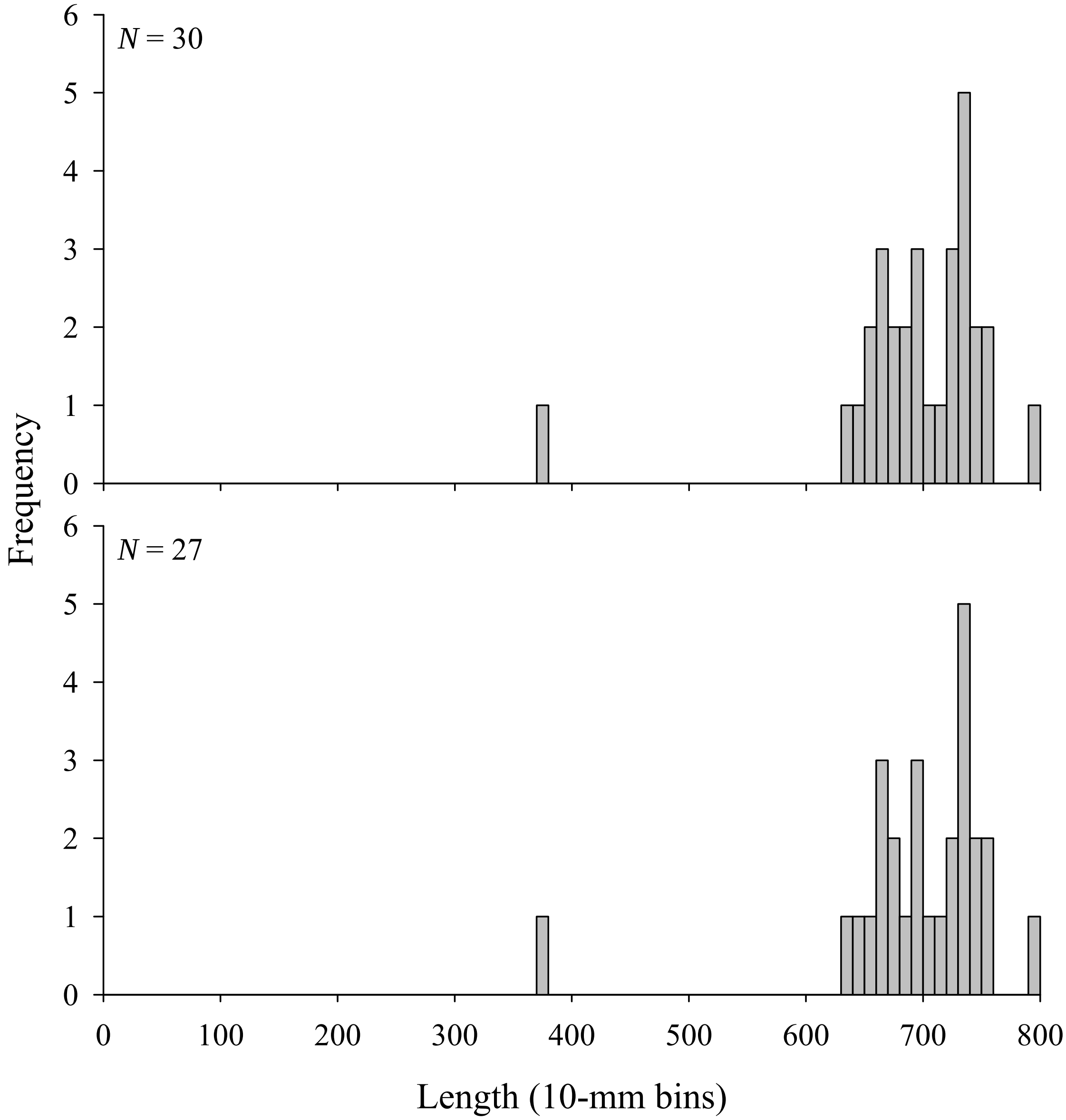

Figure 4.72. Length frequency distribution of blue suckers captured in the upper basin of the Missouri River during the 2006 sampling year using standard and wild gears. Upper panel includes random and nonrandom sampling. Lower panel includes only random sampling.

4.3.5.3 Lower Basin

Within the lower basin sampling segments of the Missouri River, relative abundance of blue suckers differed markedly between sampling seasons and years. During the 2006 sampling year, the mean CPUE of blue suckers captured with trammel nets was slightly larger during the fish community season (0.47 fish/100 m) than during the sturgeon season (0.38 fish/100 m; Figure 4.73). While the mean trammel net CPUE during the sturgeon season increased from the 2005 sampling year to the 2006 sampling year, relative abundance during the fish community season decreased from 0.54 fish/100 m in 2005 to 0.47 fish/100 m in 2006. The overall mean CPUE resulting from trammel net deployments has increased slightly over the years since initiating the sampling program, from 0.35 fish/100 m in 2003 to 0.43fish/100 m in 2006 (Figure 4.73). During the 2006 sampling year, the mean CPUE of blue suckers captured with otter trawls was notably larger during the fish community season (0.19 fish/100 m) than during the sturgeon season (0.12 fish/100 m; Figure 4.73). The mean otter trawl CPUE during the fish community and sturgeon seasons increased from the 2005 sampling year to the 2006 sampling year, resulting in an increase in overall mean CPUE during that time period. The overall blue sucker mean CPUE resulting from otter trawl deployments has increased over the years since initiating the sampling program, from 0.05 fish/100 m in 2003 to 0.15 fish/100 m in 2006 (Figure 4.73). Blue suckers relative abundance estimates from gill net sampling increased from a low of 0.02 fish/net night in 2003 to 0.54 fish/net night in 2005, before decreasing to 0.4 fish/net night in 2006 (Figure 4.74).

Within the lower basin sampling segments, 2185 blue suckers were captured during the 2006 sampling year; 1442 during the sturgeon season and 743 during the fish community season (Table 4.43). During the sturgeon and fish community seasons, most blue suckers were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred. Gill nets captured 59% (N = 849) of the blue sucker catch during the sturgeon season, with 29% of these fish coming from pool mesohabitats (Table 4.44). During the sturgeon sampling season, 40% (N = 570) of the blue suckers were captured from main channel border mesohabitats with trammel nets and otter trawls, which for both gears was also the location of greatest effort (Table 4.44). Sampling from main channel border mesohabitats during the fish community season resulted in 99% (N = 735) of the blue sucker catch. Mini-fyke nets, used during the fish community season, captured two blue suckers during the 2006 sampling year, both from sand bar mesohabitats.

The population structure of blue suckers captured during the 2006 sampling year is negatively skewed, with juvenile fish representing a small component of fish sampled (Figure 4.75). The lengths of all blue suckers captured ranged from approximately 40 to 880 mm, with a mode near 660 mm. Random sampling accounted for 97% (N = 3141) of the blue suckers captured. The length frequency distribution from random sampling is very similar to that from non-random sampling (Figure 4.75).

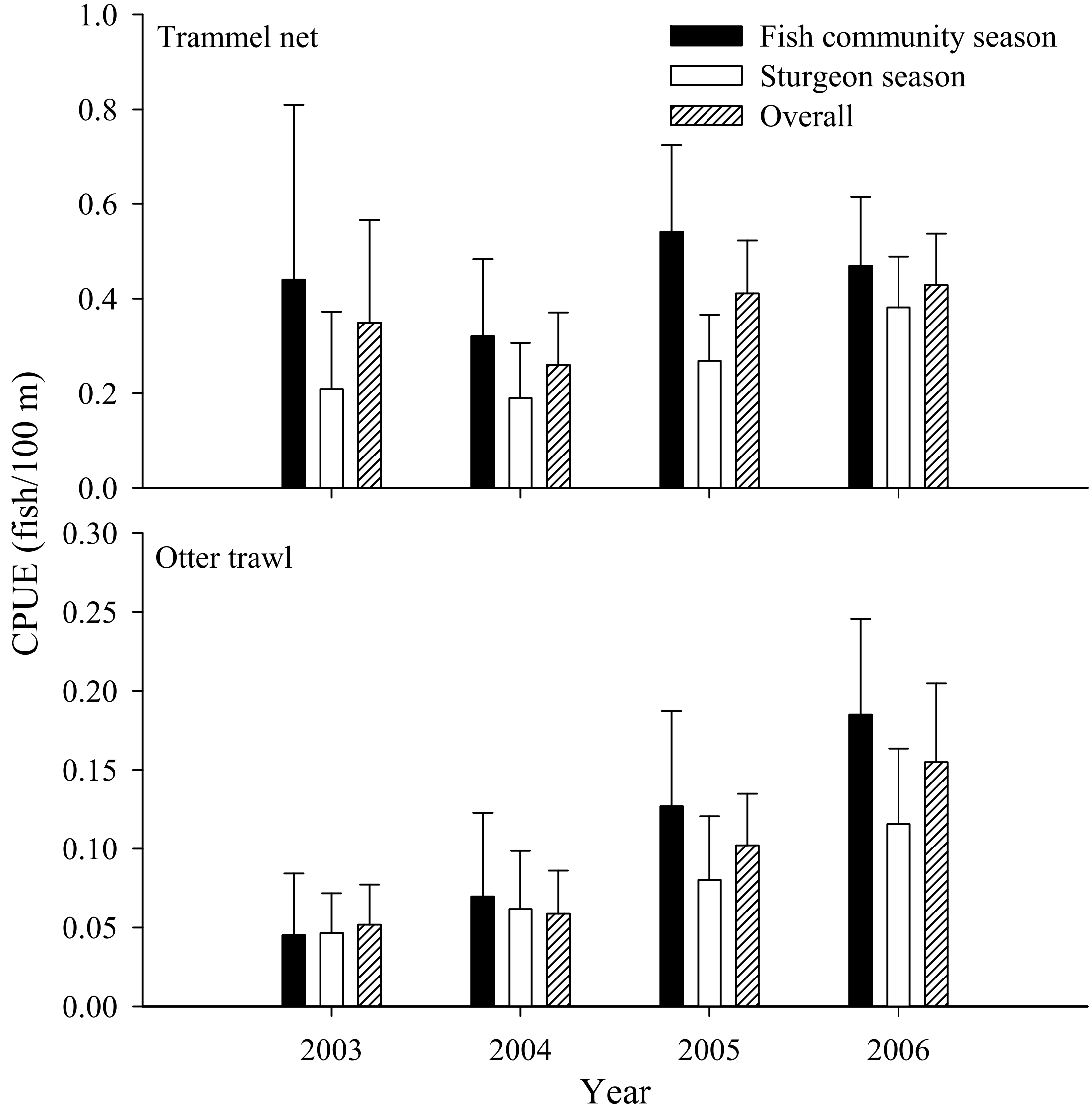

Figure 4.73. Mean annual catch per unit effort (± 2 SE) by season for blue suckers using one-inch trammel nets and otter trawls in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

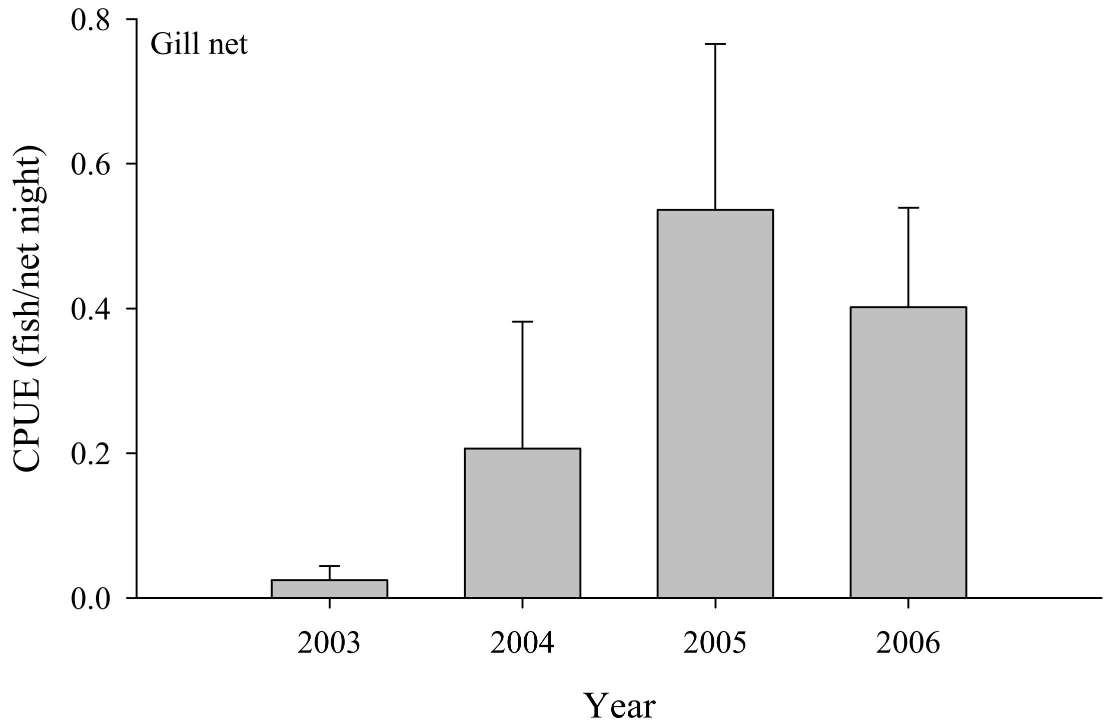

Figure 4.74. Mean annual catch per unit effort (± 2 SE) for blue suckers using gill nets in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

Table 4.43. Total number of blue suckers captured for each gear during each season and the percentage caught within each macrohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	479	0.6	15.9	2.1	0.6	2.1	71.4	1.0	2.7	0	0	0	0	0	3.5
		(4.3)	(22.3)	(1.5)	(1.4)	(1.5)	(58.4)	(4.2)	(4.7)	(1.0)	(0)	(0)	(0)	(0)	(0.8)
Gill Net	849	7.2	17.2	2.0	0.1	0.4	55.8	7.5	2.6	3.4	0	0	3.8	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.8)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	114	0.9	21.9	0.9	0	0.9	64.9	3.5	5.3	1.8	0	0	0	0	0
		(6.6)	(22.3)	(0.9)	(1.3)	(0.8)	(56.0)	(4.4)	(5.3)	(1.8)	(0)	(0)	(0.6)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	449	0.2	12.2	0.4	0.2	0.2	80.0	4.7	1.1	0.9	0	0	0	0	0
		(4.4)	(23.2)	(0.9)	(1.0)	(1.0)	(62.5)	(3.9)	(2.2)	(0.9)	(0)	(0)	(0)	(0)	(0)
Mini-Fyke Net	2	0	0	0	0	0	100.0	0	0	0	0	0	0	0	0
		(6.5)	(19.9)	(0.4)	(0.3)	(0.3)	(46.8)	(8.4)	(3.1)	(11.4)	(0.3)	(0.3)	(0.3)	(2.1)	(0)
Otter Trawl	292	0.7	19.9	1.0	0	0	70.9	3.8	3.1	0.3	0	0	0.3	0	0
		(5.5)	(23.4)	(0.6)	(0.7)	(1.0)	(60.5)	(3.3)	(3.4)	(1.2)	(0)	(0)	(0.4)	(0)	(0)

Table 4.44. Total number of blue suckers captured for each gear during each season and the percentage caught within each mesohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	479	0	95.6	3.5	0.8	0	0
		(0)	(97.3)	(0.8)	(1.9)	(0)	(0)
Gill Net	849	0	45.3	0	4.7	49.9	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	114	0	98.2	0	1.8	0	0
		(0)	(96.9)	(0)	(2.8)	(0.3)	(0)
Fish Community Season (Summer)							
1-Inch Trammel Net	449	0	99.1	0	0.9	0	0
		(0)	(98.4)	(0)	(1.6)	(0)	(0)
Mini-Fyke Net	2	100.0	0	0	0	0	0
		(97.6)	(1.2)	(0)	(1.2)	(0)	(0)
Otter Trawl	292	0	99.3	0	0.7	0	0
		(0)	(98.0)	(0)	(2.0)	(0)	(0)

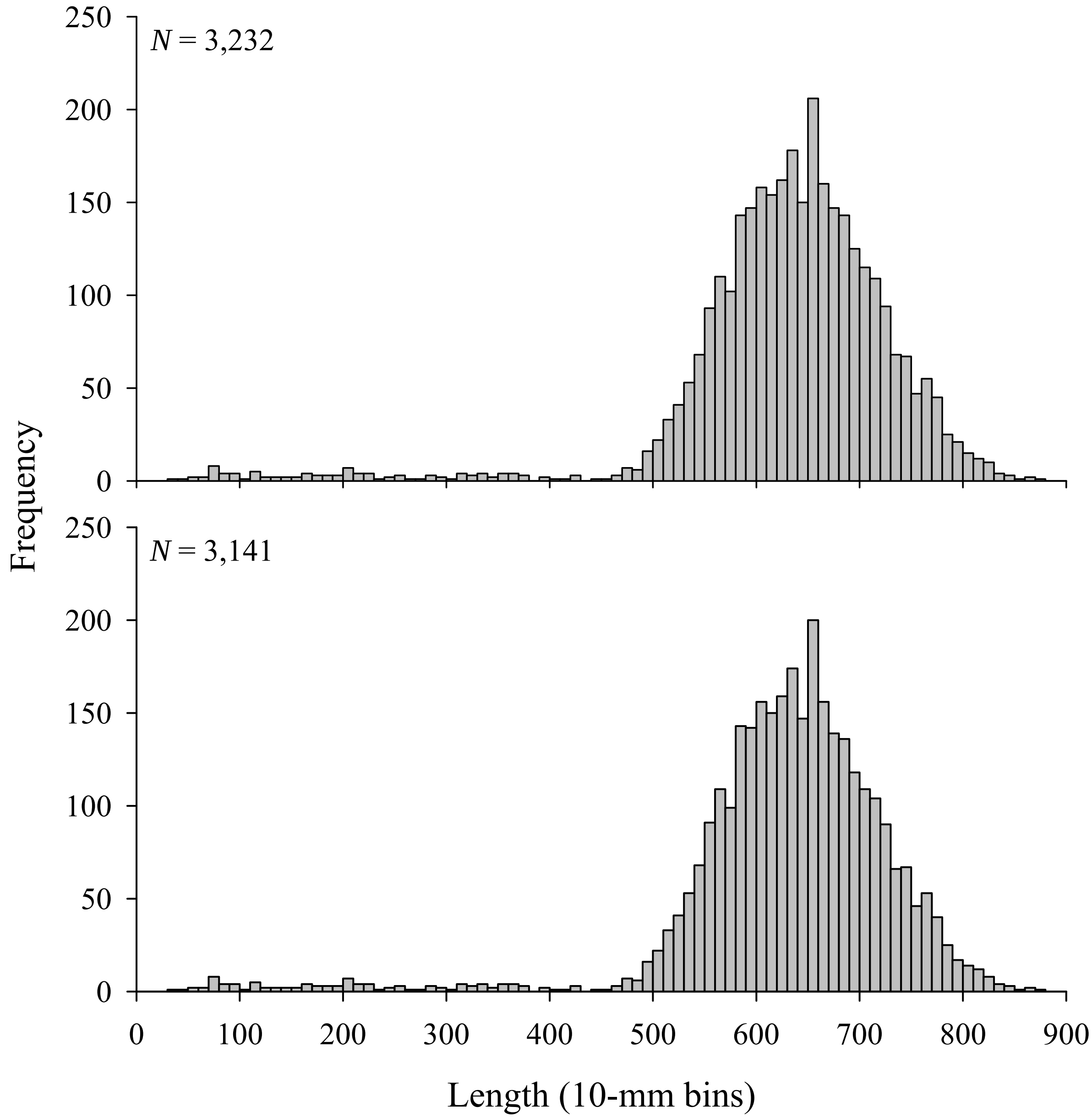

Figure 4.75. Length frequency distribution of blue suckers captured in the lower basin of the Missouri River during the 2006 sampling year using standard and wild gears. Upper panel includes random and nonrandom sampling. Lower panel includes only random sampling.

4.3.6 Sauger

4.3.6.1 Combined Basins

During the 2006 sampling year in the upper and lower basins of the Missouri River 519 sauger *Sander canadense* were captured during the sturgeon season, while 428 were captured during the fish community season (Figure 4.76). Sampling from the lower basin during the sturgeon season resulted in 398 sauger captured, comprising 77% of the catch during the sturgeon sampling season. Sampling from segments 8 and 9 (RM 368 – 750) resulted in approximately 46% of the lower basin total for the sturgeon season. Sampling from segment 6 (RM 825 – 845) in the lower basin resulted in 77 sauger captured, comprising 19% of the lower basin catch for the sturgeon season. During the fish community season, sauger catch from the upper basin increased while catch from the lower basin segments decreased. A total of 272 sauger were captured from the upper basin during the fish community season, comprising 64% of the total catch (Figure 4.76). Sampling from segment 4 (RM 1568 – 1582) in the upper basin accounted for approximately 54% of the sauger catch for that part of the basin during the fish community season. As during the sturgeon season, sampling from segments 6, 8, and 9 in the lower basin accounted for a large proportion of the fish community season sauger catch (75%, N = 117) in the lower basin sampling segments (Figure 4.76).

Relative abundance of sauger differed between sampling seasons and years. During the 2006 sampling year, the mean CPUE of sauger captured with trammel nets was lower for the fish community season (0.04 fish/100 m) than during the sturgeon season (0.56 fish/100 m; Figure 4.77). The mean trammel net CPUE during the fish community season decreased from the 2005 sampling year to the 2006 sampling year, while during that period the mean trammel net CPUE during the sturgeon season increased markedly, resulting in an increase in overall mean CPUE from 0.03 fish/100 m in 2005 to 0.05 fish/100 m in 2006. During the 2006 sampling year, the relative abundance of sauger captured with otter trawls was similar during the sturgeon and fish community seasons, with a mean CPUE of approximately 0.04 fish/100 m (Figure 4.77). The mean otter trawl CPUE during the sturgeon and fish community seasons increased from the 2005 sampling year to the 2006 sampling year, resulting in a notable increase in overall mean CPUE from approximately 0.02 fish/100 m to 0.04 fish/100 m, respectively. Relative abundance estimates from mini-fyke nets, deployed only during the fish community season, were similar during the 2005 sampling year (0.15 fish/net night) to the 2006 sampling year (0.13 fish/net night; Figure 4.78).

Relative abundance of sauger also differed markedly among sampling segments. During the sturgeon sampling season the relative abundance of sauger captured with trammel nets was generally larger in the upper basin than the lower basin, with the mean CPUE ranging from 0.08 fish/100 m to approximately 0.23 fish/100 m in the upper basin (Figure 4.79). Sampling from segment 4 (RM 1568 – 1582) resulted in a large trammel net CPUE during the sturgeon season, a finding also observed during the fish community season. Sampling from segments 5 and 6 (RM 825 – 880) resulted in the largest mean CPUE from the lower basin during the sturgeon season, ranging from approximately 0.1 fish/100 m to 0.3 fish/100 m. During the fish community season, the geographic trend in relative abundance remained largely unchanged such that trammel net sampling from the upper basin resulted in comparatively larger mean CPUE than from the lower basin. In contrast to trammel net sampling, the relative abundance of sauger captured with otter trawls during the sturgeon season was generally greater in the lower basin than in the upper basin (Figure 4.80). During the 2006 sturgeon season, the mean CPUE of sauger captured with otter trawls ranged from 0.0 fish/100 m to 0.5 fish/100 m in the lower basin, and 0.0 fish/100 m to 0.09 fish/100 m in the upper basin. During the 2006 fish community season, the relative abundance of sauger generally increased in most upper basin segments while decreasing in many lower basin segments. Overall, the geographic trend in relative abundance remained largely unchanged such that otter trawl sampling from the lower basin resulted in comparatively larger mean CPUE than from the upper basin (Figure 4.80).

Relative abundance of sauger has generally increased in many sampling segments during the period from 2003 to 2006 as the sampling program has become fully implemented. When combining sampling seasons in 2006, the relative abundance of sauger captured with trammel nets was comparatively larger in the upper basin (0.07 to 0.19 fish/100 m) than the lower basin (0.0 to 0.16 fish/100 m; Figure 4.81). During 2006, the mean trammel net CPUE seemed to be highest in upper basin segment 4 (RM 1568 –

1582) and lower basin segments 5 through 9 (RM 368 – 880). In contrast to trammel net sampling, the relative abundance of sauger captured with otter trawls during 2006 was comparatively larger in the lower basin (0.00 to 0.21 fish/100 m) than the upper basin (0.00 to 0.07 fish/100 m; Figure 4.82). During the 2006 sampling year, the mean otter trawl CPUE seemed to be highest in upper basin segment 2 (RM 1701 – 1760) and lower basin segments 8 and 9 (RM 368 – 750). While gill net sampling only occurred in the lower basin, the relative abundance of sauger sampled with this gear appears to be relatively unchanged during the period from 2003 to 2006 (Figure 4.83). During the 2006 sampling year there appeared to be no geographic trend in relative abundance of sauger captured with gill nets in the lower basin segments, with mean CPUE ranging from 0.0 to 0.35 fish/net night. During 2006, the relative abundance of sauger captured with mini-fyke nets, deployed only during the fish community season, was comparatively larger in the upper basin (0.05 to 1.0 fish/net night) than the lower basin (0.0 to 0.3 fish/net night; Figure 4.84). The mean mini-fyke net CPUE was highest in upper basin segment 4 (RM 1568 – 1582).

Random sampling with standard gears accounted for approximately 84% (N = 438) of the total sauger catch during the 2006 sturgeon season, and 68% (N = 290) of the catch during the 2006 fish community season (Table 4.45). During both seasons, most sauger were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred. Main channel crossover macrohabitats were also sampled with a relatively large effort, which resulted in proportional catches of sauger with all gear types and during both seasons. During the sturgeon season, sampling with gill nets accounted for 54% (N = 236) of the sauger catch. The majority of all sauger were captured from main channel border mesohabitats, which for most gears was also the location of greatest effort (Table 4.45). During the sturgeon season, pool mesohabitats comprised 39% of the gill net sampling effort, resulting in approximately 30% of the total sauger catch with all gears for that season. Mini-fyke nets, used during fish community season, captured 42% (N = 127) of the total sauger catch during the season. Approximately 80% of these fish were captured from sand bar mesohabitats, while another 19% were captured from island tip mesohabitats where only 3% of the gear effort was applied.

The length frequency distribution of sauger captured during the 2006 sampling year approximates a bimodal distribution, with a lower mode near 100 mm and an upper mode near 350 mm (Figure 4.85). The lengths of all sauger captured ranged from approximately 30 to 610 mm. Random sampling accounted for 93% (*N* = 883) of the sauger captured. The length frequency distribution from random sampling was very similar to that from a combination of random and non-random sampling (Figure 4.85).

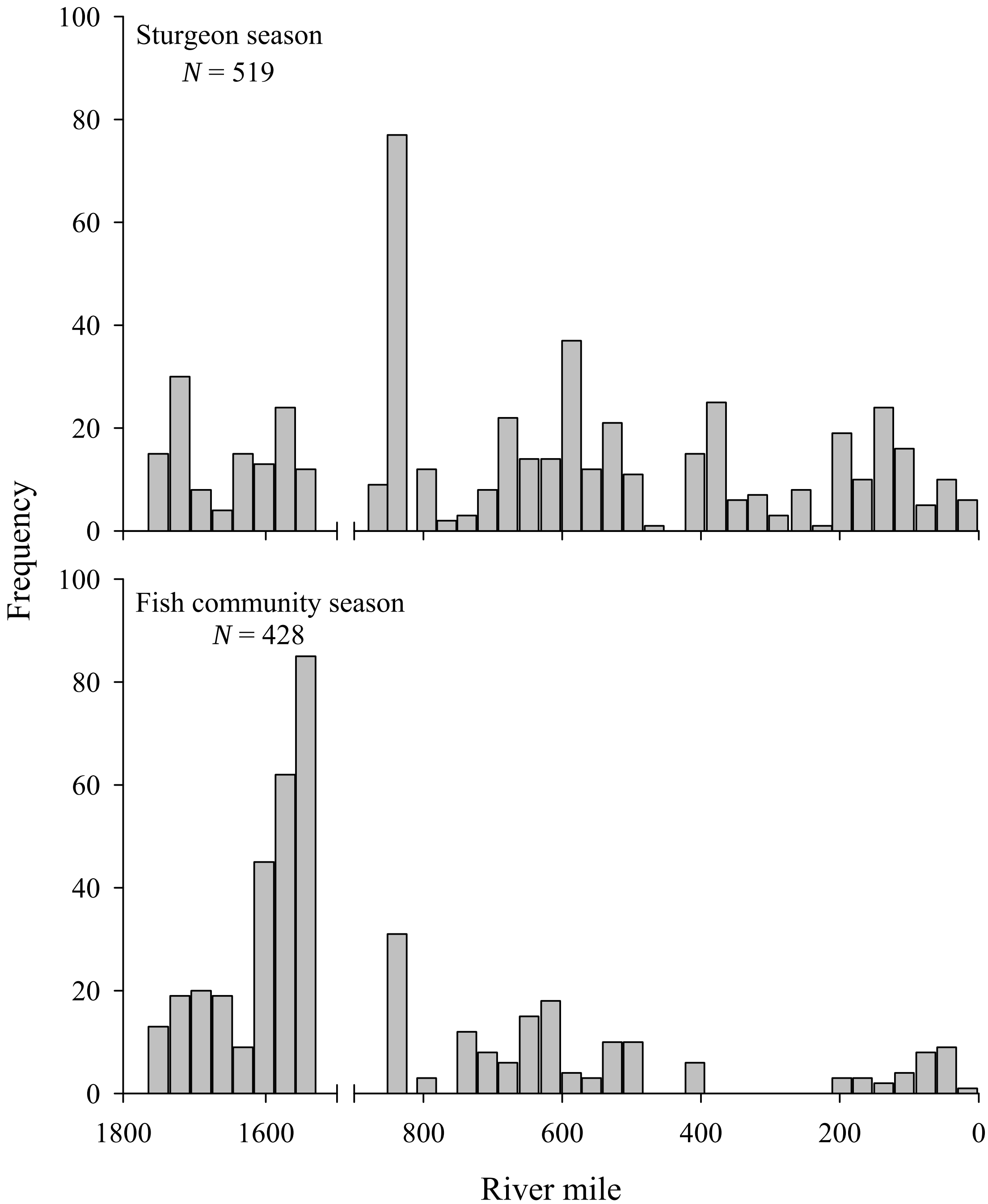

Figure 4.76. Seasonal catch by river mile (30-mile bins) of sauger in the upper and lower basins of the Missouri River in the 2006 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

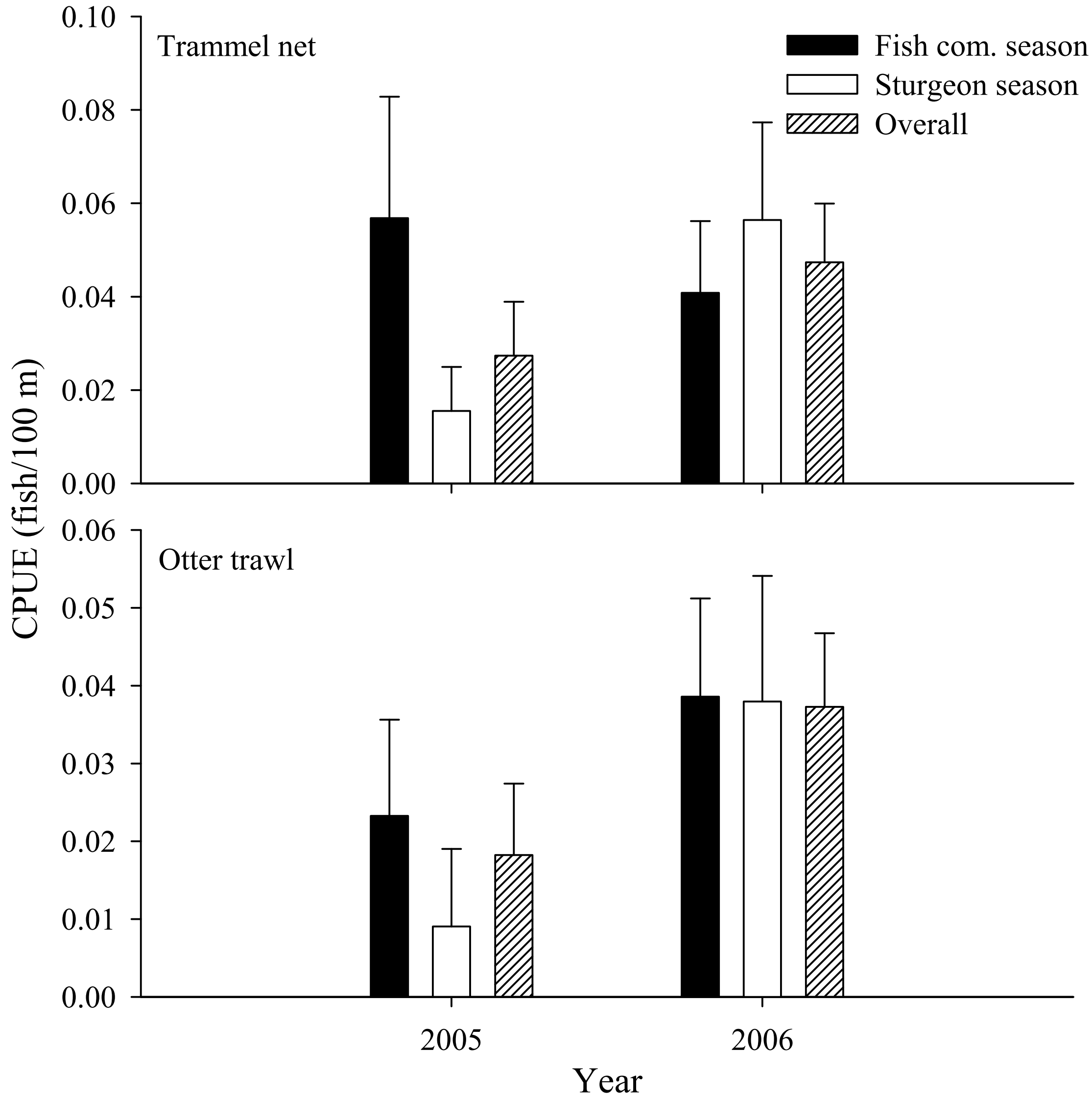

Figure 4.77. Mean annual catch per unit effort (± 2 SE) by season for sauger using one-inch trammel nets and otter trawls in the upper and lower basins of the Missouri River for the 2005 and 2006 sampling years.

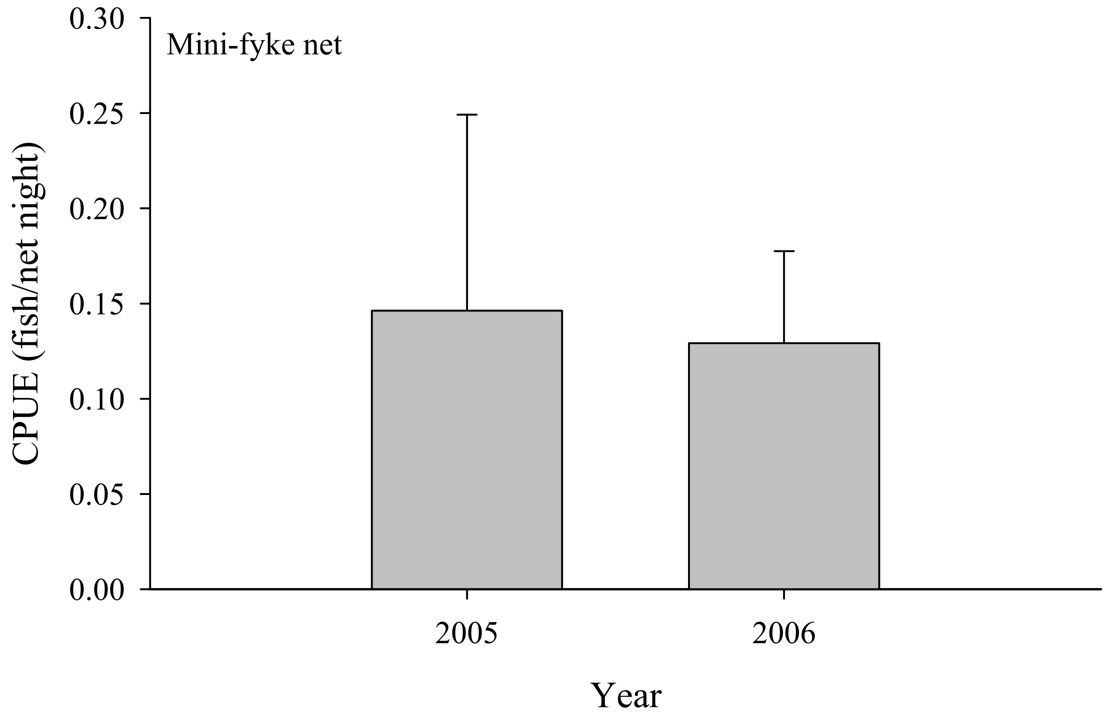

Figure 4.78. Mean annual catch per unit effort (± 2 SE) for sauger using mini-fyke nets in the upper and lower basins of the Missouri River for the 2005 and 2006 sampling years.

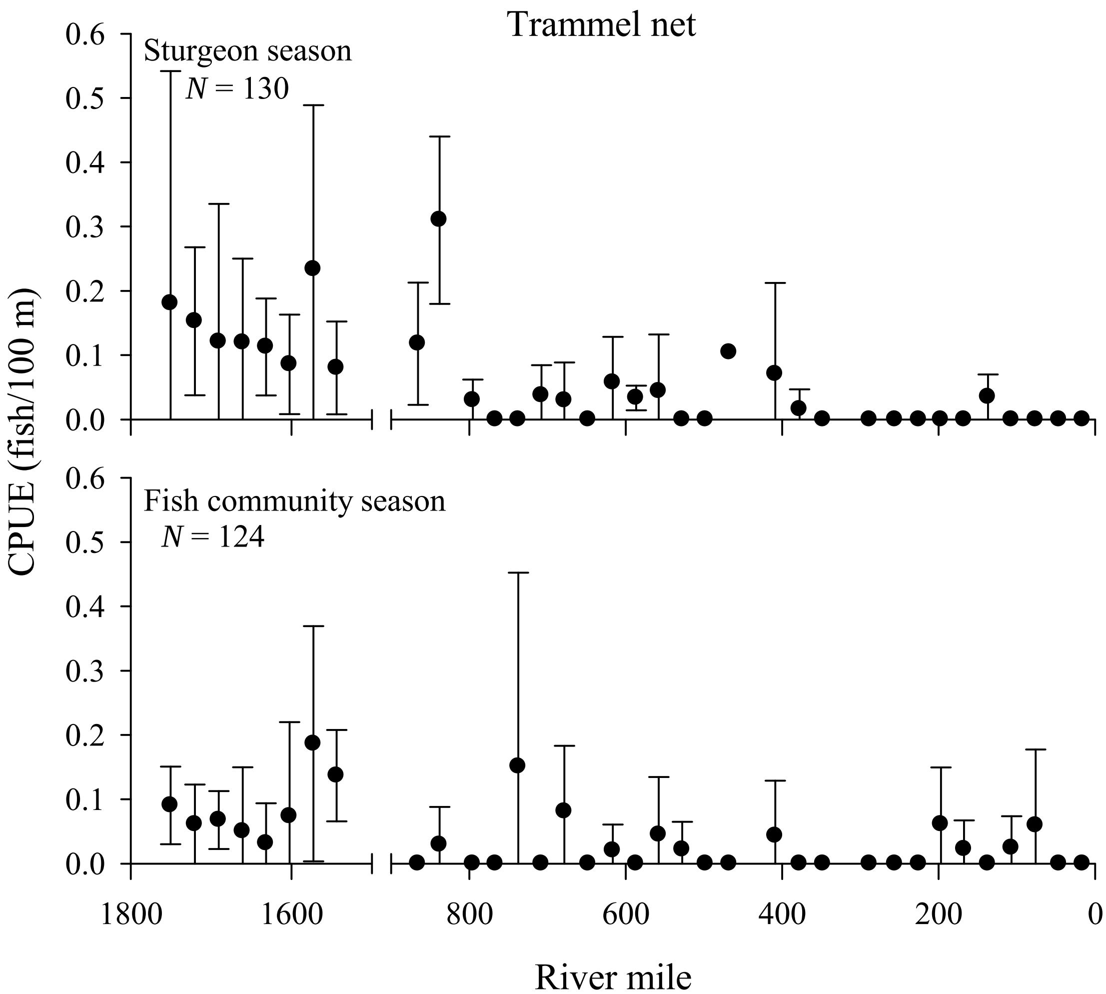

Figure 4.79. Mean seasonal catch per unit effort (± 2 SE) of sauger by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2006 sampling year. Data obtained through random sampling using one-inch trammel nets. Sample size denotes the number of bends sampled.

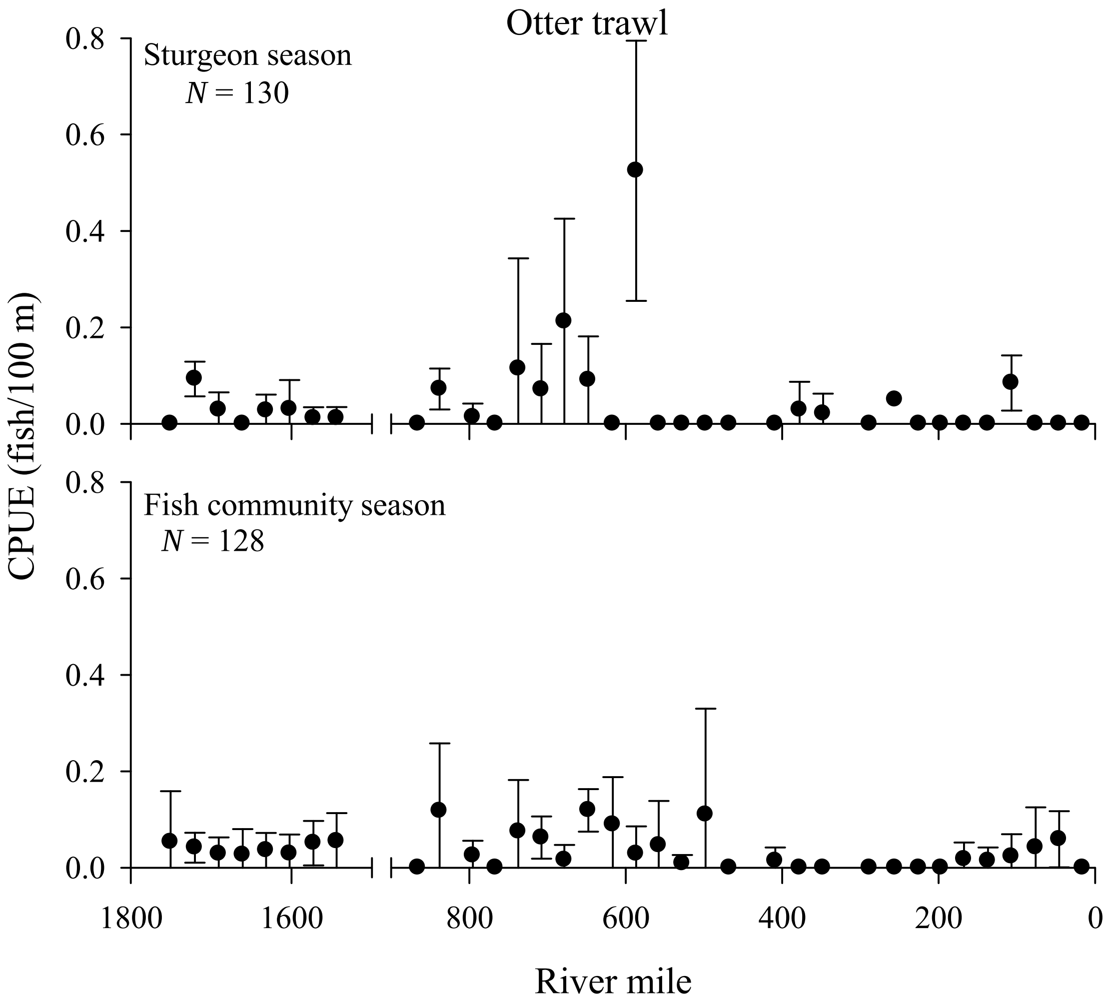

Figure 4.80. Mean seasonal catch per unit effort (± 2 SE) of sauger by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2006 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

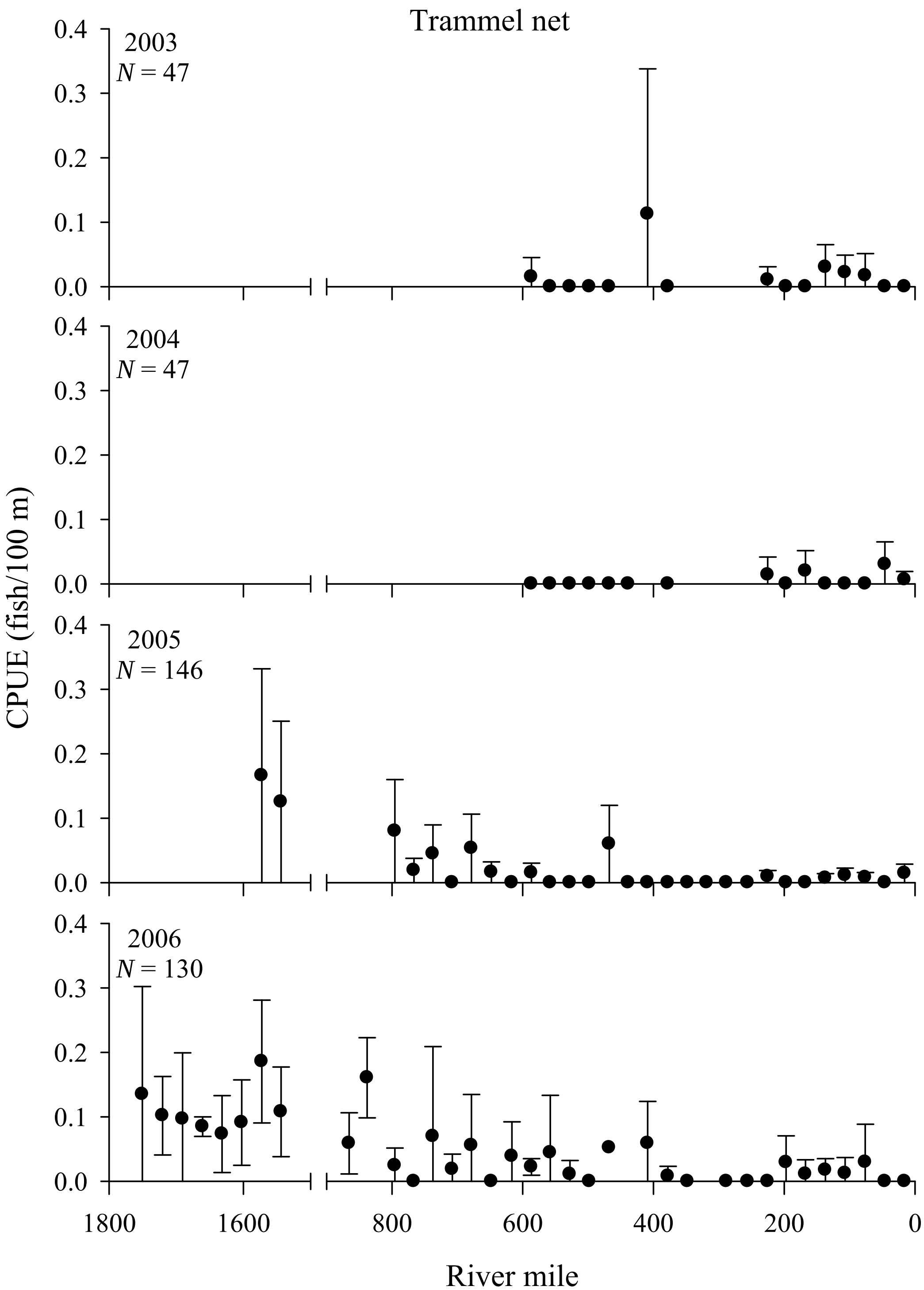

Figure 4.81. Mean annual catch per unit effort (± 2 SE) of sauger by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2003 to 2006 sampling years. Data obtained through random sampling using one-inch trammel nets. Sample size denotes the number of bends sampled.

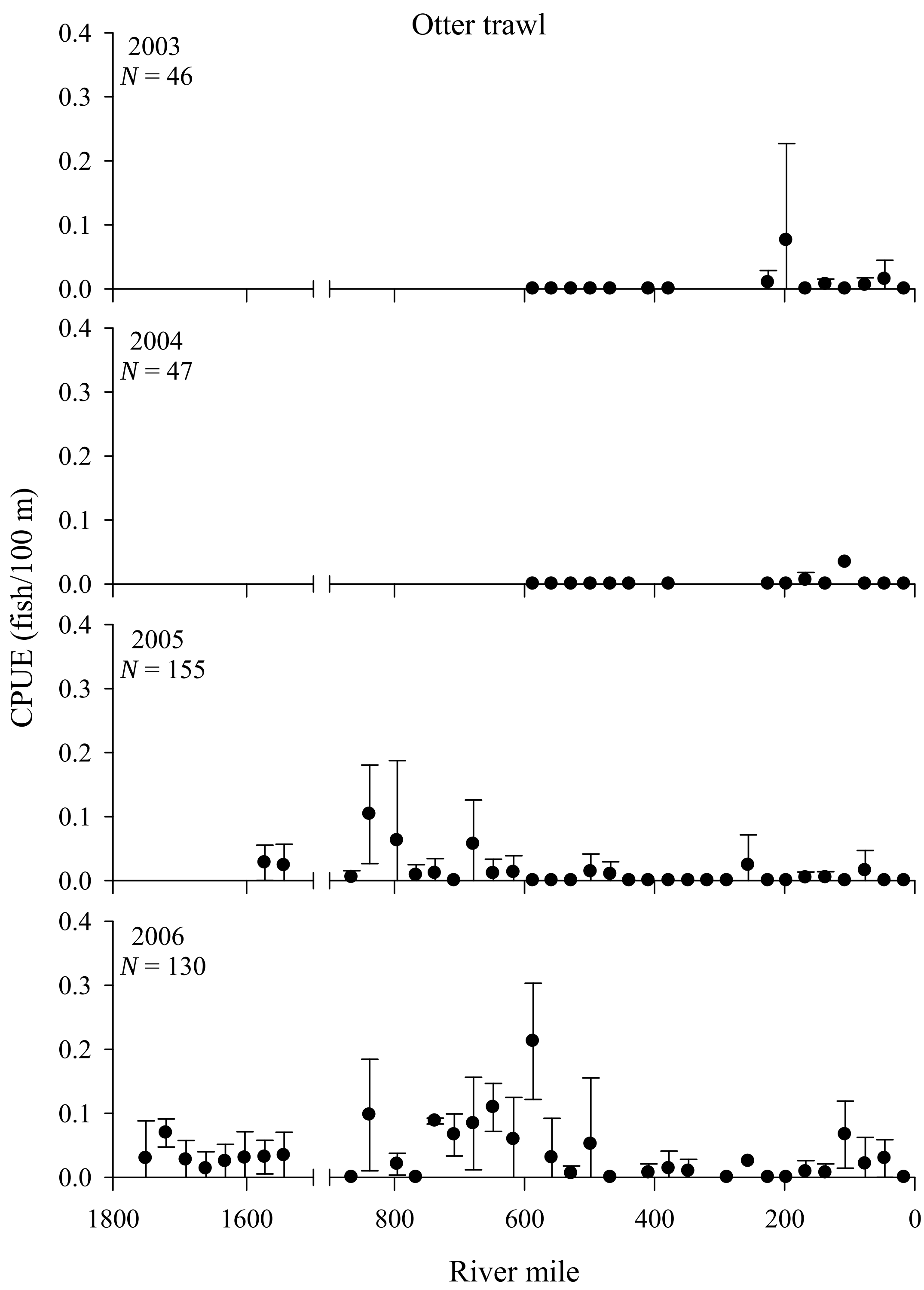

Figure 4.82. Mean annual catch per unit effort (± 2 SE) of sauger by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2003 to 2006 sampling years. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

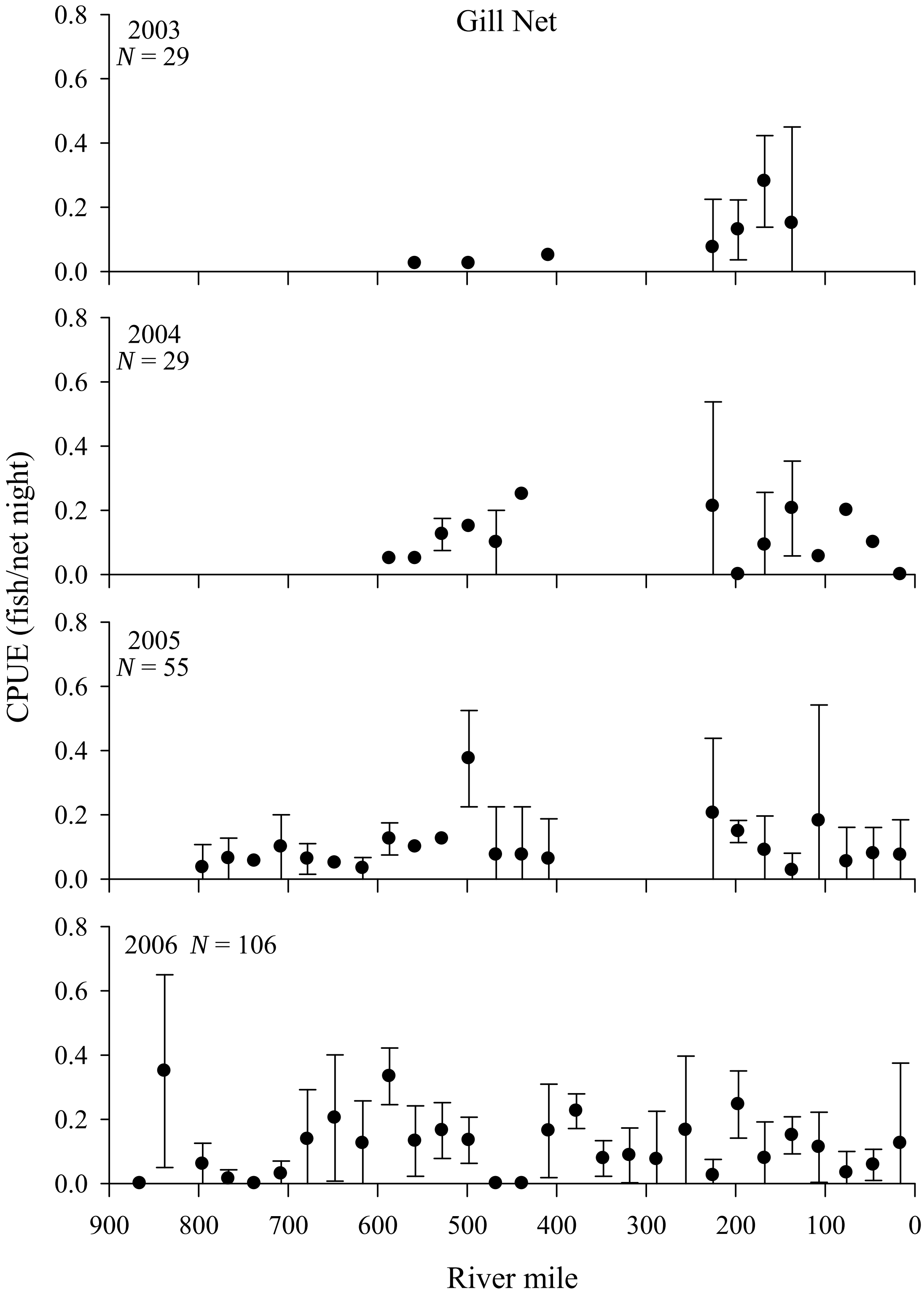

Figure 4.83. Mean annual catch per unit effort (± 2 SE) of sauger by river mile (30-mile bins) in the lower basin of the Missouri River for the 2003 to 2006 sampling years. Data obtained through random sampling using gill nets. Sample size denotes the number of bends sampled.

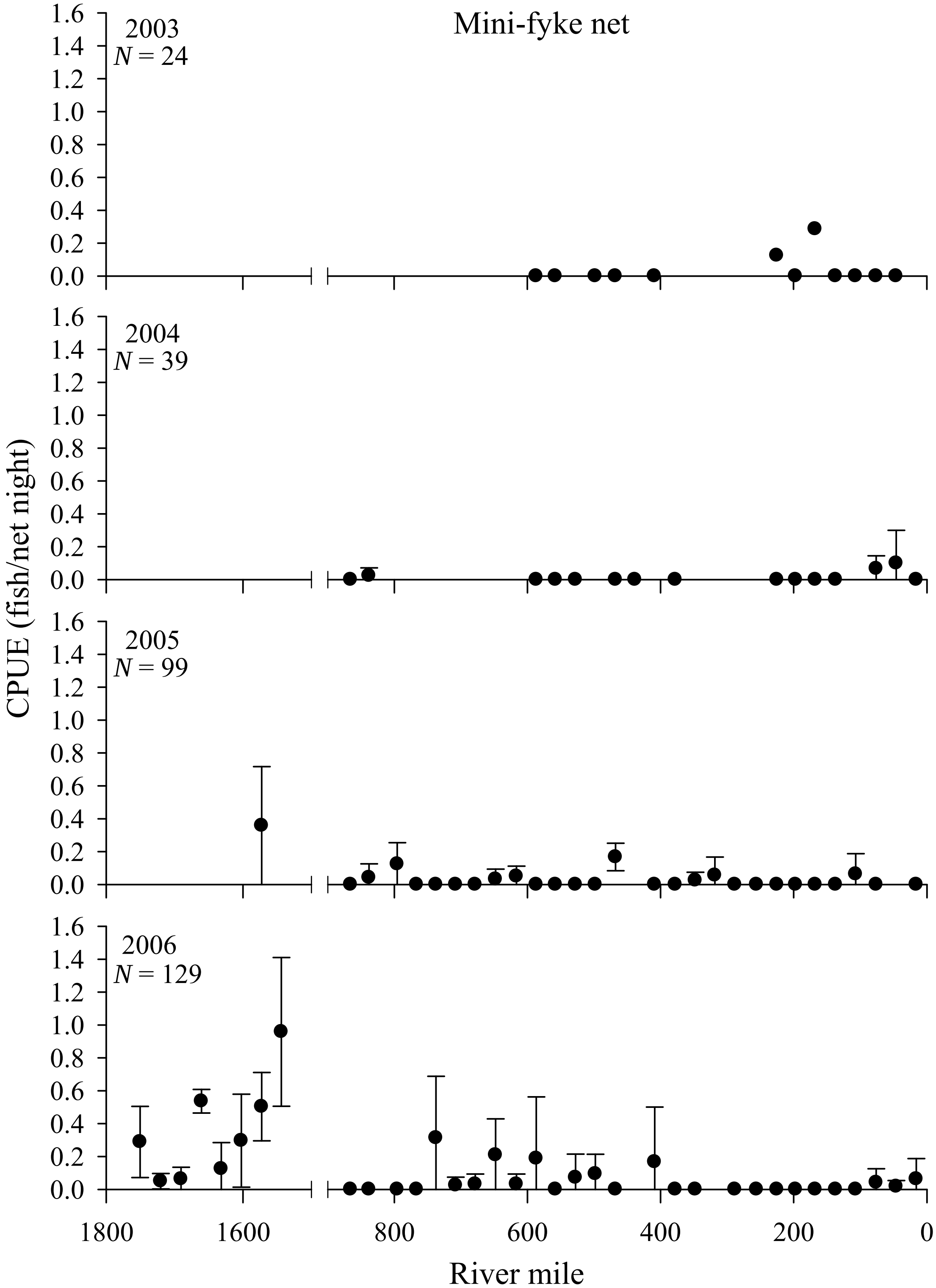

Figure 4.84. Mean annual catch per unit effort (± 2 SE) of sauger by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2003 to 2006 sampling years. Data obtained through random sampling using mini-fyke nets. Sample size denotes the number of bends sampled.

Table 4.45. Total number of sauger captured for each gear during each season and the percentage caught within each macrohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	128	11.7	18.8	0	0	0	35.9	18.0	15.6	0	0	0	0	0	0
		(3.2)	(22.8)	(1.3)	(1.0)	(1.1)	(51.4)	(9.7)	(8.1)	(0.8)	(0)	(0)	(0)	(0)	(0.6)
Gill Net	236	3.0	27.1	3.4	0	0	56.8	5.9	2.5	0.4	0	0	0.8	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.4)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	74	9.5	23.0	0	0	0	35.1	17.6	13.5	0	0	0	1.4	0	0
		(4.7)	(22.9)	(0.8)	(0.9)	(0.6)	(47.9)	(10.3)	(9.1)	(2.2)	(0)	(0)	(0.5)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	70	0	20.0	0	0	0	47.1	14.3	10.0	7.1	0	0	1.4	0	0
		(3.2)	(24.2)	(0.6)	(0.7)	(0.7)	(53.7)	(10.6)	(4.5)	(1.6)	(0)	(0)	(0.2)	(0)	(0)
Mini-Fyke Net	127	0	7.1	3.1	0	0	39.4	0.8	23.6	16.5	5.5	0	0	3.9	0
		(4.8)	(16.7)	(0.5)	(0.2)	(0.2)	(43.2)	(9.2)	(7.5)	(13.8)	(1.9)	(0.2)	(0.2)	(1.8)	(0)
Otter Trawl	93	15.1	25.8	3.2	0	0	44.1	6.5	5.4	0	0	0	0	0	0
		(4.2)	(24.1)	(0.6)	(0.6)	(0.8)	(53.4)	(9.5)	(5.2)	(1.2)	(0)	(0)	(0.3)	(0)	(0)

Table 4.46. Total number of sauger captured for each gear during each season and the percentage caught within each mesohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	128	0	96.1	0	3.9	0	0
		(0)	(94.8)	(0.6)	(4.4)	(0)	(0.2)
Gill Net	236	0	41.1	0	3.0	55.9	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	74	0	97.3	0	2.7	0	0
		(0)	(93.6)	(0)	(5.9)	(0.2)	(0.3)
Fish Community Season (Summer)							
1-Inch Trammel Net	70	4.3	84.3	0	11.4	0	0
		(0.1)	(96.0)	(0)	(3.9)	(0)	(0.1)
Mini-Fyke Net	122	80.3	0.8	0	18.9	0	0
		(96.2)	(1.2)	(0)	(2.6)	(0)	(0)
Otter Trawl	93	0	95.7	0	4.3	0	0
		(0)	(97.1)	(0)	(2.9)	(0)	(0)

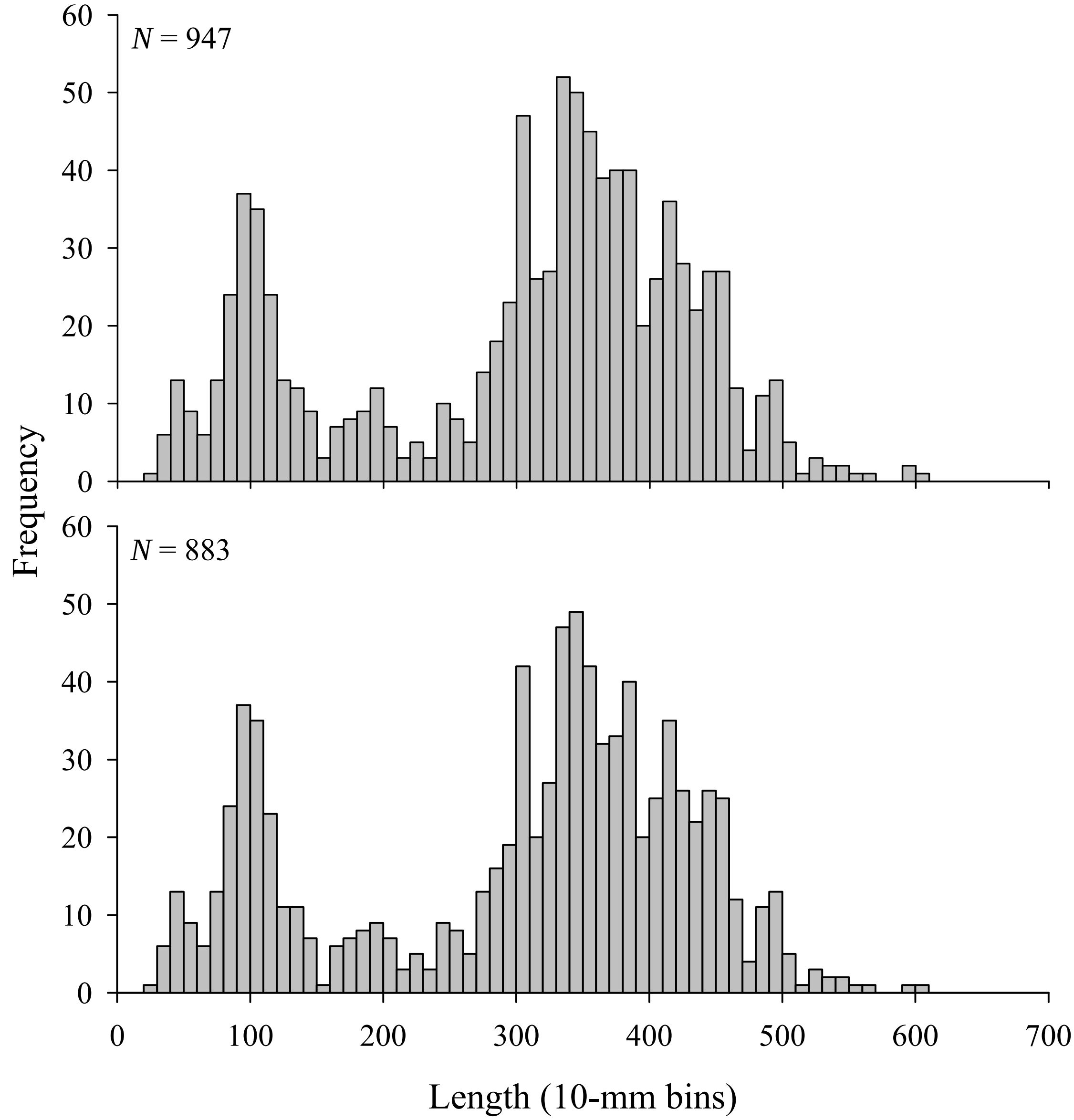

Figure 4.85. Length frequency distribution of sauger captured in the upper and lower basins of the Missouri River during the 2006 sampling year using standard and wild gears. Upper panel includes random and nonrandom sampling. Lower panel includes only random sampling.

4.3.6.2 Upper Basin

Within the upper basin sampling segments of the Missouri River, relative abundance of sauger was similar between sampling seasons, but different between years. During the 2006 sampling year, the mean CPUE of sauger captured with trammel nets was larger during the sturgeon season (0.14 fish/100 m) than during the fish community season (0.09 fish/100 m; Figure 4.86). The mean trammel net CPUE during the fish community season decreased markedly from the 2005 sampling year to the 2006 sampling year, while the mean CPUE during the sturgeon season increased, resulting in a small decrease in overall sauger relative abundance from 0.15 fish/100 m in 2005 to 0.11 fish/100 m in 2006. During the 2006 sampling year, the mean CPUE of sauger captured with otter trawls was larger during the fish community season (0.04 fish/100 m) than during the sturgeon season (0.03 fish/100 m; Figure 4.86). The mean otter trawl CPUE during the fish community season increased from the 2005 sampling year to the 2006 sampling year, resulting in an increase in overall mean CPUE from 0.03 fish/100 m to 0.04 fish/100 m, respectively. Relative abundance estimates of sauger captured with mini-fyke nets, deployed only during the fish community season, were larger in sampling year 2005 than in 2006, with a mean CPUE of approximately 1.14 fish/net night and 0.36 fish/net night, respectively (Figure 4.87).

During the sturgeon and fish community seasons, most sauger were caught in main channel inside bend and outside bend macrohabitats, where most of the total sampling effort occurred (Table 4.47). Main channel crossover and large secondary connected channels were also sampled with a relatively large effort, which resulted in proportional catches during both seasons. Channel border mesohabitats were the location where 94% of the sauger were captured during the sturgeon season, and 36% were captured during the fish community season (Table 4.48). A total of 93 sauger were captured with mini-fyke nets (51% of the seasonal total catch) during the fish community season, 75% from sand bar mesohabitats and 25% from island tip mesohabitats.

The length frequency distribution of sauger captured from the upper basin during the 2006 sampling year approximates a bimodal distribution, with a lower mode near 100 mm and an upper mode near 310 mm (Figure 4.88). The lengths of all sauger captured ranged from approximately 40 to 590 mm. Random sampling accounted for 87% (N = 342) of the sauger captured. The length frequency distribution from random sampling was very similar to that from a combination of random and non-random sampling (Figure 4.88).

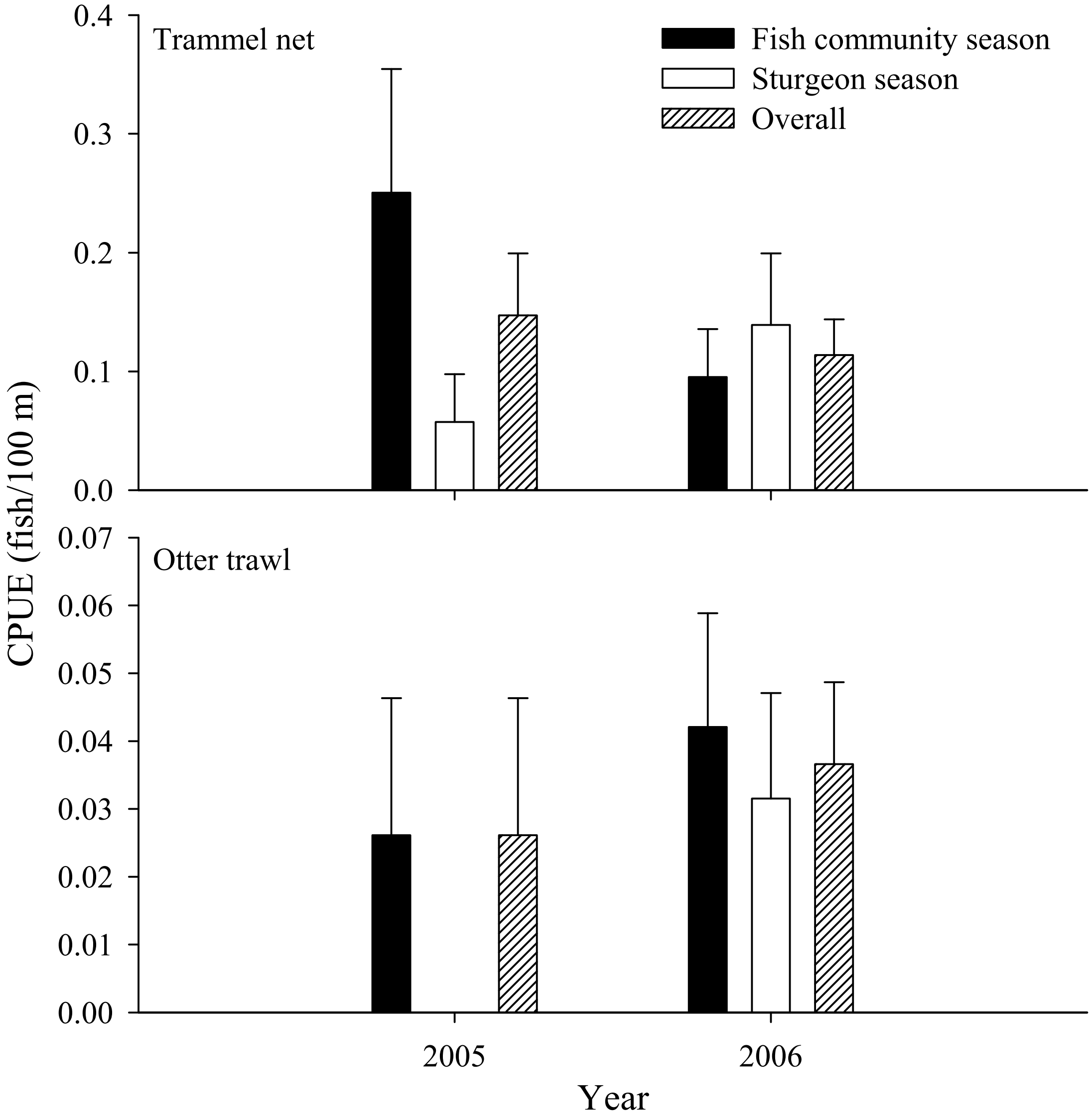

Figure 4.86. Mean annual catch per unit effort (± 2 SE) by season for sauger using one-inch trammel nets and otter trawls in the upper basin of the Missouri River for the 2005 and 2006 sampling years.

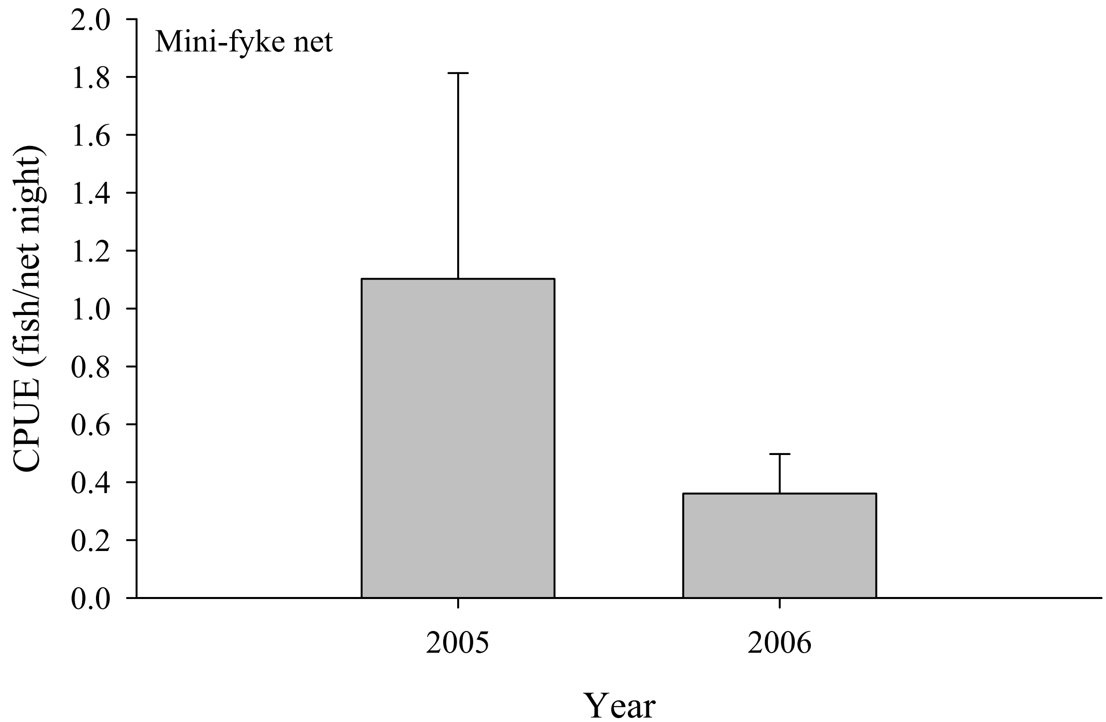

Figure 4.87. Mean annual catch per unit effort (± 2 SE) for sauger using mini-fyke nets and otter trawls in the upper basin of the Missouri River for the 2005 and 2006 sampling years.

Table 4.47. Total number of sauger captured for each gear during each season and the percentage caught within each macrohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	89	0	23.6	0	0	0	34.8	21.3	20.2	0	0	0	0	0	0
		(0)	(24.3)	(0.6)	(0)	(0)	(30.3)	(26.5)	(18.3)	(0)	(0)	(0)	(0)	(0)	(0)
Otter Trawl	26	0	15.4	0	0	0	19.2	46.2	19.2	0	0	0	0	0	0
		(0)	(24.7)	(0.6)	(0)	(0)	(27.9)	(25.0)	(18.6)	(3.2)	(0)	(0)	(0)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	52	0	25.0	0	0	0	30.8	19.2	13.5	9.6	0	0	1.9	0	0
		(0)	(26.7)	(0)	(0)	(0)	(31.1)	(27.7)	(10.4)	(3.5)	(0)	(0)	(0.6)	(0)	(0)
Mini-Fyke Net	98	0	2.0	4.1	0	0	28.6	1.0	30.6	21.4	7.1	0	0	5.1	0
		(0)	(7.7)	(0.7)	(0)	(0)	(33.1)	(11.4)	(19.9)	(20.2)	(6.3)	(0)	(0)	(0.7)	(0)
Otter Trawl	31	0	19.4	9.7	0	0	35.5	19.4	16.1	0	0	0	0	0	0
		(0)	(26.6)	(0.7)	(0)	(0)	(29.8)	(30.4)	(11.4)	(1.0)	(0)	(0)	(0)	(0)	(0)

Table 4.48. Total number of sauger captured for each gear during each season and the percentage caught within each mesohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	89	0	94.4	0	5.6	0	0
		(0)	(88.0)	(0)	(11.4)	(0)	(0.6)
Otter Trawl	26	0	92.3	0	7.7	0	0
		(0)	(85.3)	(0)	(13.8)	(0)	(1.0)
Fish Community Season (Summer)							
1-Inch Trammel Net	52	5.8	78.8	0	15.4	0	0
		(0.3)	(89.6)	(0)	(9.7)	(0)	(0.3)
Mini-Fyke Net	93	75.3	0	0	24.7	0	0
		(92.0)	(1.1)	(0)	(6.8)	(0)	(0)
Otter Trawl	31	0	87.1	0	12.9	0	0
		(0)	(94.5)	(0)	(5.5)	(0)	(0)

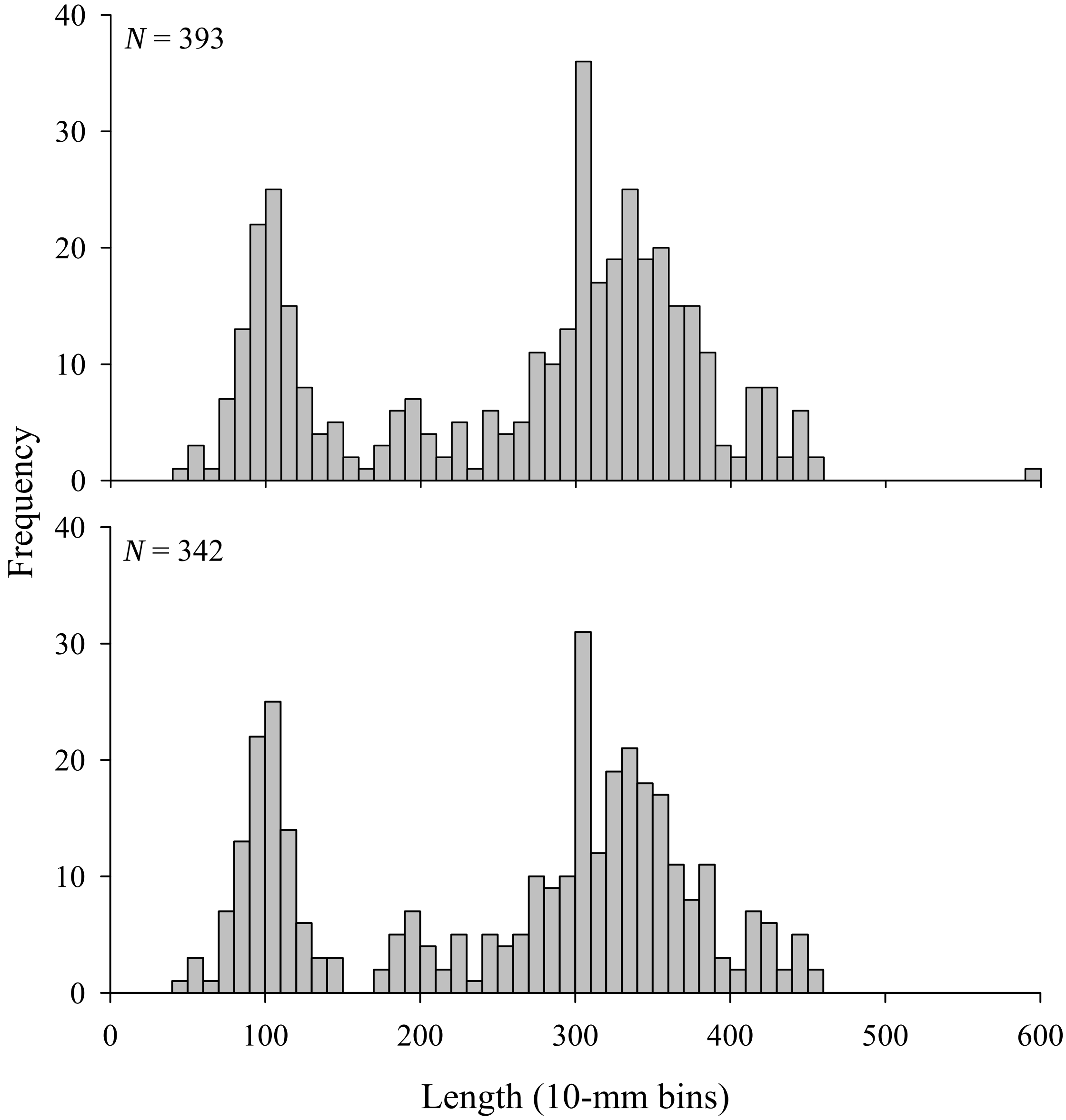

Figure 4.88. Length frequency distribution of sauger captured in the upper basin of the Missouri River during the 2006 sampling year using standard and wild gears. Upper panel includes random and nonrandom sampling. Lower panel includes only random sampling.

4.3.6.3 Lower Basin

Within the lower basin sampling segments of the Missouri River, relative abundance of sauger was similar between sampling seasons, but different among years. During the 2006 sampling year, the mean CPUE of sauger captured with trammel nets was larger during the sturgeon season (0.024 fish/100 m) than during the fish community season (0.019 fish/100 m; Figure 4.89). The overall mean CPUE resulting from trammel net deployments has increased slightly over the years since initiating the sampling program, from a low of 0.007 fish/100 m in 2004 to 0.023 fish/100 m in 2006. During the 2006 sampling year, the mean CPUE of sauger captured with otter trawls was larger during the sturgeon season (0.043 fish/100 m) than during the fish community season (0.037 fish/100 m; Figure 4.89). The mean otter trawl CPUE during the fish community season increased from the 2004 sampling year to the 2006 sampling year, resulting in an increase in overall mean CPUE from 0.002 fish/100 m to 0.037 fish/100 m, respectively. Relative abundance estimates of sauger captured with gill nets, deployed only during the sturgeon season, declined from a high of 0.17 fish/net night in 2003 to 0.11 fish /net night in 2006 (Figure 4.90). Relative abundance estimates of sauger captured with mini-fyke nets, deployed only during the fish community season, were larger in sampling year 2006 than in 2003, with a mean CPUE of approximately 0.04 fish/net night and 0.02 fish/net night, respectively (Figure 4.90).

During the sturgeon and fish community seasons, most sauger were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred (Table 4.49). Main channel crossovers were also sampled with a relatively large effort, which resulted in proportional catches during both seasons. During the sturgeon season 39% (N = 15) of the sauger captured with trammel nets were located in braided channel macrohabitats, where only 4% of the gear effort was applied. Gill net sampling during the sturgeon season accounted for 73% (N = 236) of the sauger catch during the season, with 56% of those fish coming from pool mesohabitats (Table 4.50). Channel border mesohabitats were the location where 57% of the sauger were captured during the sturgeon season, and 74% were captured during the fish community season (Table 4.50). A total of 29 sauger were captured with mini-fyke nets (27% of the seasonal total catch) during the fish community season, 97% from sand bar mesohabitats and 3% from channel border mesohabitats.

The length frequency distribution of sauger captured from the lower basin during the 2006 sampling year approximates a bimodal distribution, with a lower mode near 90 mm and an upper mode near 350 mm (Figure 4.91). The lengths of all sauger captured ranged from approximately 30 to 610 mm. Random sampling accounted for 98% (N = 541) of the sauger captured. The length frequency distribution from random sampling was very similar to that from a combination of random and non-random sampling (Figure 4.91).

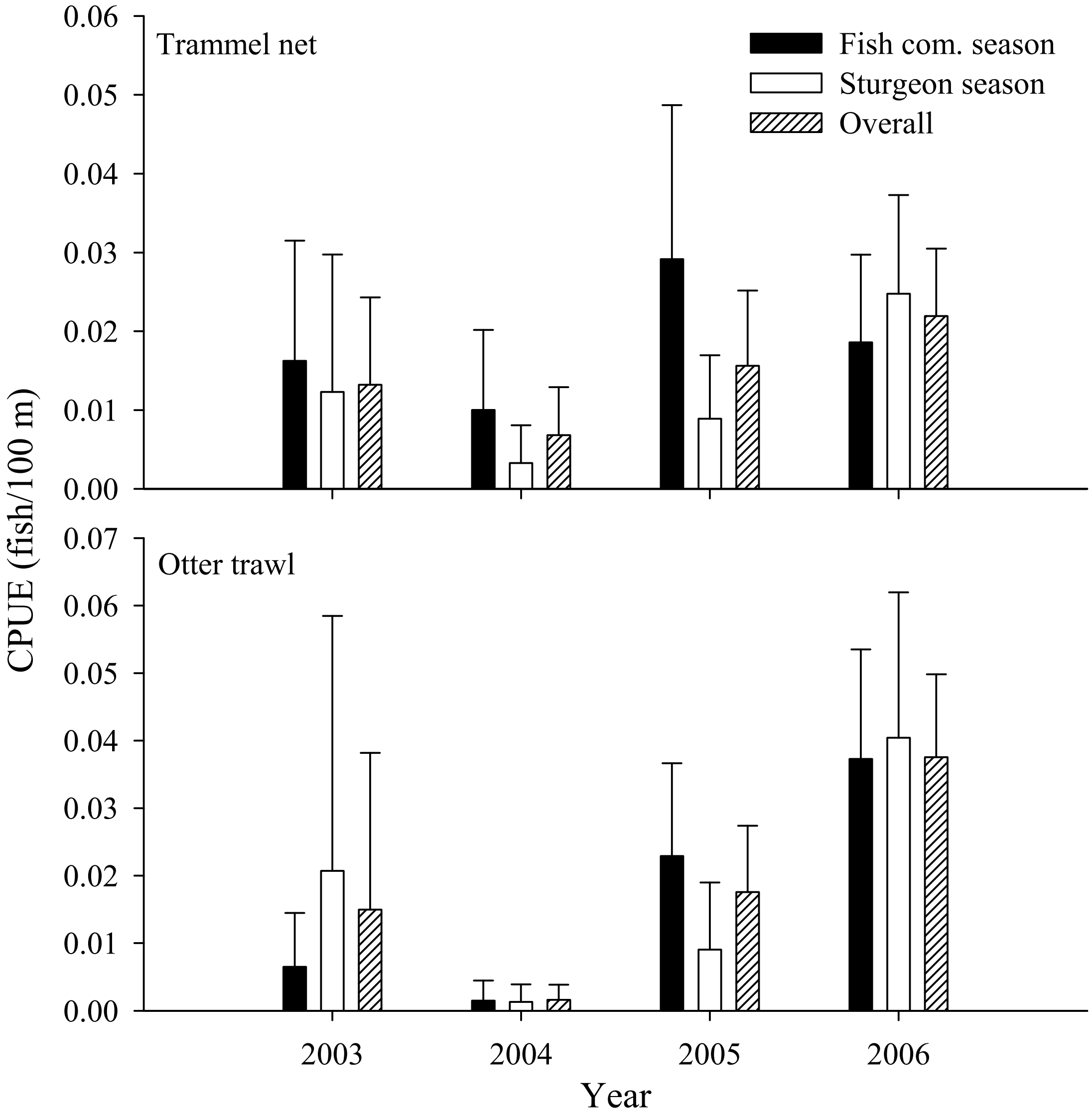

Figure 4.89. Mean annual catch per unit effort (± 2 SE) by season for sauger using one-inch trammel nets and otter trawls in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

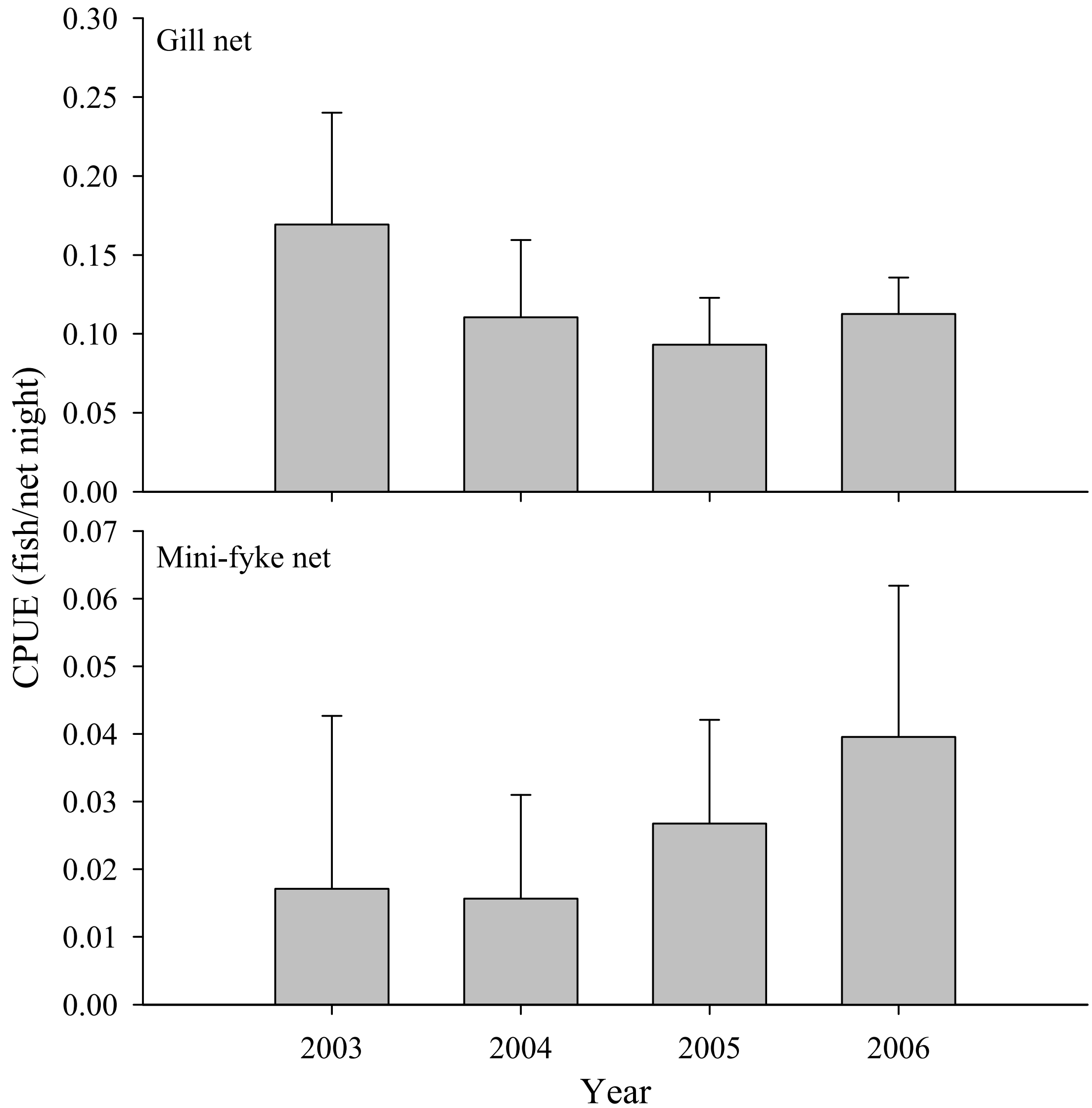

Figure 4.90. Mean annual catch per unit effort (± 2 SE) for sauger using gill nets and mini-fyke nets in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

Table 4.49. Total number of sauger captured for each gear during each season and the percentage caught within each macrohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	39	38.5	7.7	0	0	0	38.5	10.3	5.1	0	0	0	0	0	0
		(4.3)	(22.3)	(1.5)	(1.4)	(1.5)	(58.4)	(4.2)	(4.7)	(1.0)	(0)	(0)	(0)	(0)	(0.8)
Gill Net	236	3.0	27.1	3.4	0	0	56.8	5.9	2.5	0.4	0	0	0.8	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.4)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	48	14.6	27.1	0	0	0	43.8	2.1	10.4	0	0	0	2.1	0	0
		(6.6)	(22.3)	(0.9)	(1.3)	(0.8)	(56.0)	(4.4)	(5.3)	(1.8)	(0)	(0)	(0.6)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	18	0	5.6	0	0	0	94.4	0	0	0	0	0	0	0	0
		(4.4)	(23.2)	(0.9)	(1.0)	(1.0)	(62.5)	(3.9)	(2.2)	(0.9)	(0)	(0)	(0)	(0)	(0)
Mini-Fyke Net	29	0	24.1	0	0	0	75.9	0	0	0	0	0	0	0	0
		(6.5)	(19.9)	(0.4)	(0.3)	(0.3)	(46.8)	(8.4)	(3.1)	(11.4)	(0.3)	(0.3)	(0.3)	(2.1)	(0)
Otter Trawl	62	22.6	29.0	0	0	0	48.4	0	0	0	0	0	0	0	0
		(5.5)	(23.4)	(0.6)	(0.7)	(1.0)	(60.5)	(3.3)	(3.4)	(1.2)	(0)	(0)	(0.4)	(0)	(0)

Table 4.50. Total number of sauger captured for each gear during each season and the percentage caught within each mesohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	**N**	**Mesohabitat**					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	39	0	100.0	0	0	0	0
		(0)	(97.3)	(0.8)	(1.9)	(0)	(0)
Gill Net	236	0	41.1	0	3.0	55.9	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	48	0	100.0	0	0	0	0
		(0)	(96.9)	(0)	(2.8)	(0.3)	(0)
Fish Community Season (Summer)							
1-Inch Trammel Net	18	0	100.0	0	0	0	0
		(0)	(98.4)	(0)	(1.6)	(0)	(0)
Mini-Fyke Net	29	96.6	3.4	0	0	0	0
		(97.6)	(1.2)	(0)	(1.2)	(0)	(0)
Otter Trawl	62	0	100.0	0	0	0	0
		(0)	(98.0)	(0)	(2.0)	(0)	(0)

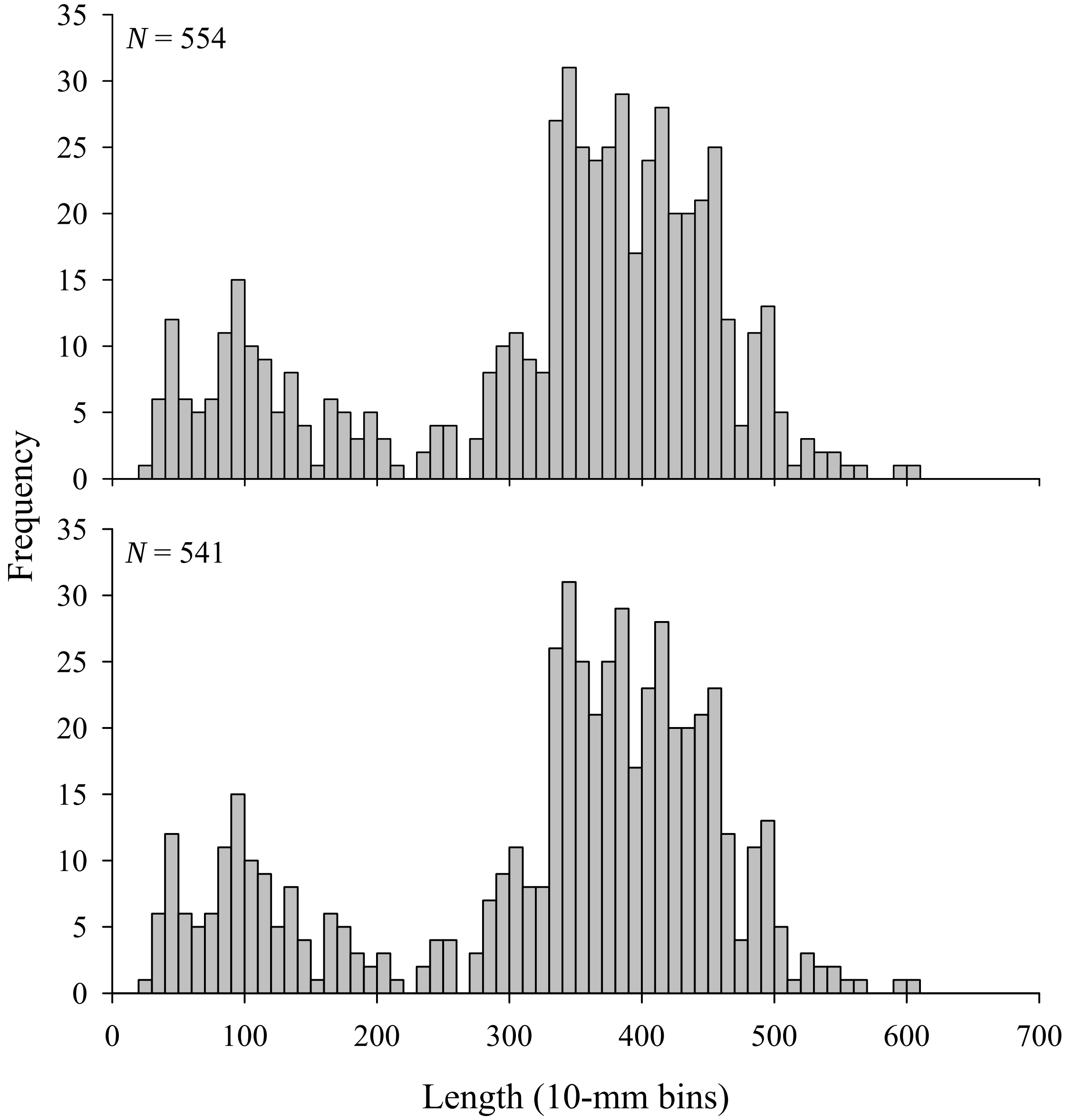

Figure 4.91. Length frequency distribution of sauger captured in the lower basin of the Missouri River during the 2006 sampling year using standard and wild gears. Upper panel includes random and nonrandom sampling. Lower panel includes only random sampling.

4.3.7 Sand shiner

4.3.7.1 Combined Basins

During the 2006 sampling year in the upper and lower basins of the Missouri River nine sand shiners *Notropis stramineus* were captured during the sturgeon season, while 7266 were captured during the fish community season (Figure 4.92). Sampling from the lower basin during the sturgeon season resulted in 8 sand shiners captured; one was captured from the upper basin. A total of 5232 sand shiners were captured from the lower basin during the fish community season, comprising 72% of the total catch (Figure 4.92). Sampling from the lower reaches of segment 2 and the upper reaches of segment 3 in the upper basin accounted for approximately 65% of the sand shiner catch for that part of the basin during the fish community season. Sampling from segments 7, 8, and 9 in the lower basin accounted for a large proportion of the fish community season sand shiner catch (97%, N = 5054) in the lower basin sampling segments (Figure 4.92).

Relative abundance of sand shiners differed between sampling seasons and years. During the 2006 sampling year, the mean CPUE of sand shiners captured with otter trawls was higher during the fish community season (0.008 fish/100 m) than during the sturgeon season (0.004 fish/100 m; Figure 4.93). The mean otter trawl CPUE during the fish community season increased from the 2005 sampling year to the 2006 sampling year, while during that period the mean otter trawl CPUE during the sturgeon season decreased markedly, resulting in a decrease in overall mean CPUE from 0.009 fish/100 m in 2005 to 0.007 fish/100 m in 2006. Relative abundance estimates from mini-fyke nets, deployed only during the fish community season, were higher during the 2006 sampling year (6.2 fish/net night) than the 2005 sampling year (1.5 fish/net night; Figure 4.94).

Relative abundance of sand shiners also differed markedly among sampling segments. During the 2006 sturgeon season otter trawls captured all nine sand shiners, and the relative abundance of sand shiners captured with otter trawls was generally larger in the lower basin than in the upper basin (Figure 4.95). During the 2006 fish community season otter trawls captured 29 sand shiners (<1% of the seasonal catch) from the lower basin, with a mean relative abundance ranging from 0.00 fish/100 m to 0.26 fish/100 m.

Relative abundance of sand shiners has generally increased in many sampling segments during the period from 2003 to 2006 as the sampling program has become fully implemented. When combining sampling seasons in 2006, the relative abundance of sand shiners captured with otter trawls during 2006 was comparatively larger in the lower basin (0.00 to 0.16 fish/100 m) than the upper basin (0.000 to 0.004 fish/100 m; Figure 4.96). During the 2006 fish community season, mini-fyke nets captured 99% of the seasonal catch, with the relative abundance of sand shiners generally increasing in most sampling segments from 2005 to 2006 (Figure 4.97). The mean CPUE of sand shiners captured with mini-fyke nets was comparatively larger in the lower basin (0.0 to 36.0 fish/net night) than the upper basin (0.1 to 28.0 fish/net night). The mean mini-fyke net CPUE was highest in lower basin segments 8 and 9 (RM 368 – 750).

Random sampling with standard gears accounted for 100% (N = 9) of the total sand shiner catch during the 2006 sturgeon season, and approximately 92% (N = 6706) of the catch during the 2006 fish community season (Table 4.51). During both seasons, most sand shiners were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred. Main channel crossover macrohabitats and large secondary connected channels were also sampled with a relatively large effort, which resulted in proportional catches of sand shiners with otter trawls and mini-fyke nets during both seasons. All of the sand shiners caught with otter trawls were captured from main channel border mesohabitats, which was also the location of greatest effort for that gear (Table 4.52). During fish community season mini-fyke nets caught 99% of the sand shiners from sand bar mesohabitats; where 96% of the effort for that gear was expended.

For all the sand shiners captured in the upper and lower Missouri River basin during the 2006 sampling year, lengths ranged from 20 to 70 mm, with a mode near 35 mm (Figure 4.98).

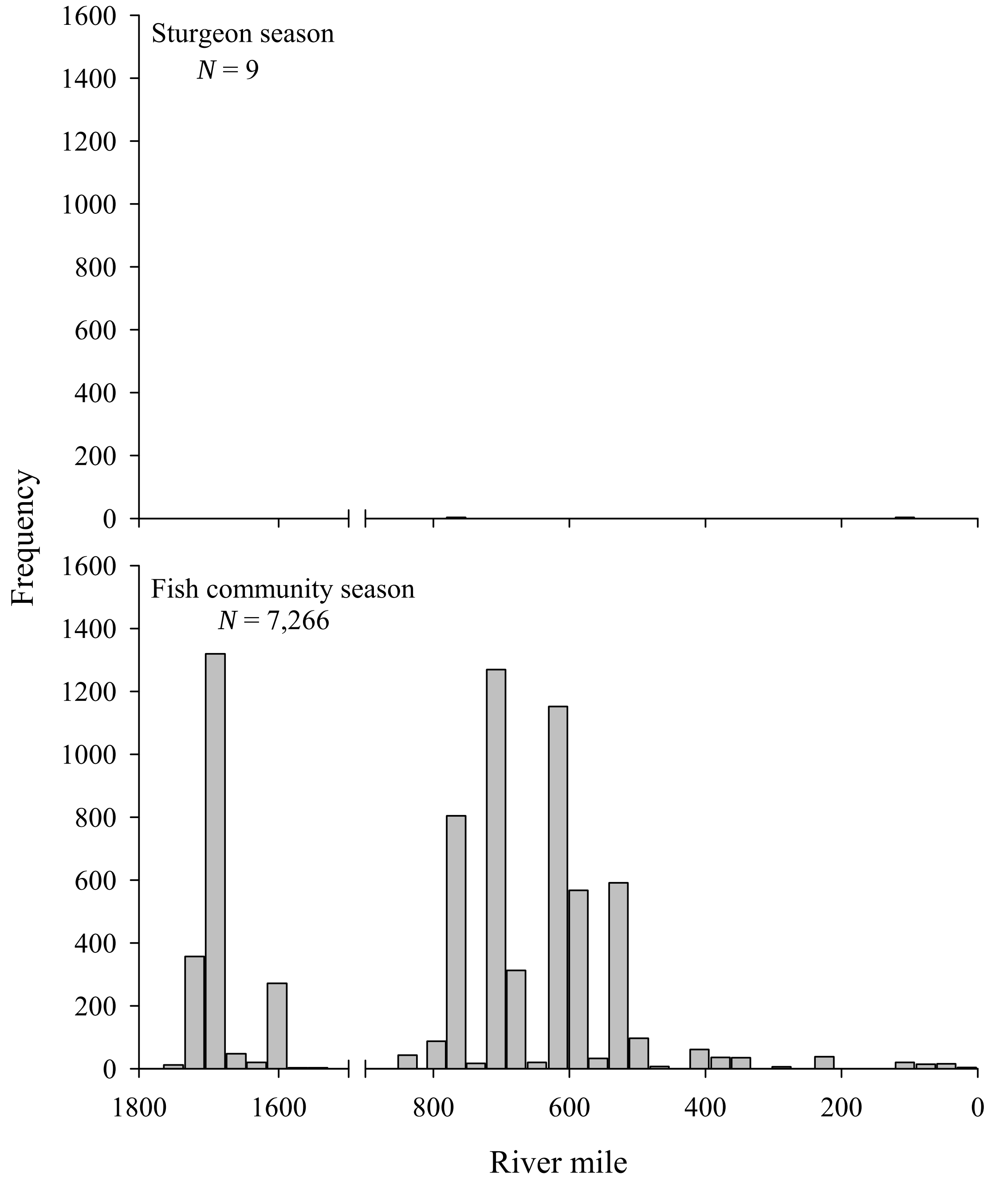

Figure 4.92. Seasonal catch by river mile (30-mile bins) of sand shiners in the upper and lower basins of the Missouri River in the 2006 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

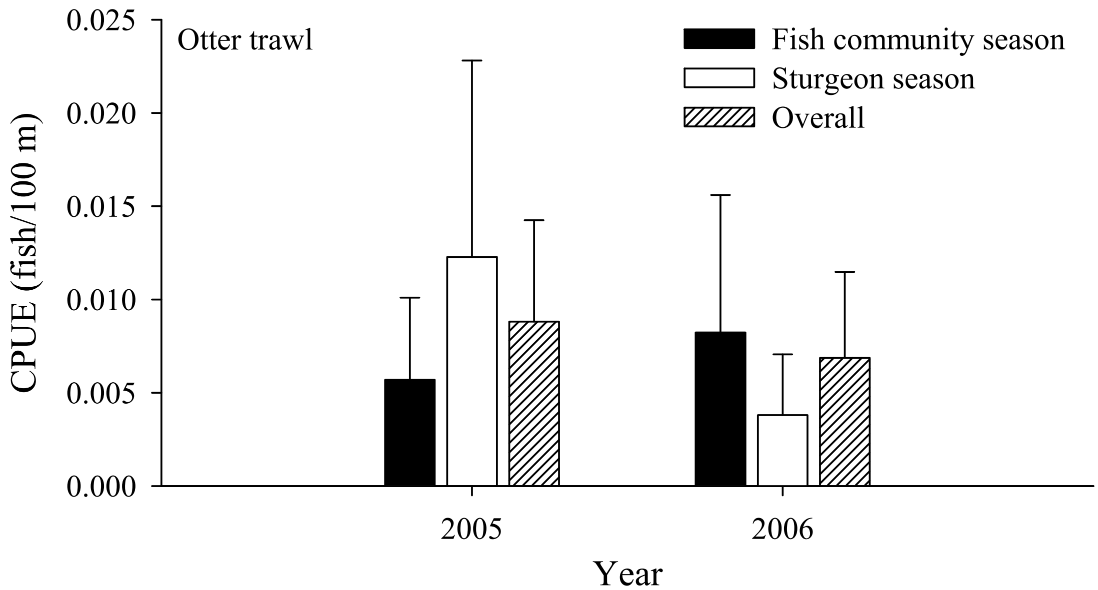

Figure 4.93. Mean annual catch per unit effort (± 2 SE) by season for sand shiners using otter trawls in the upper and lower basins of the Missouri River for the 2005 and 2006 sampling years.

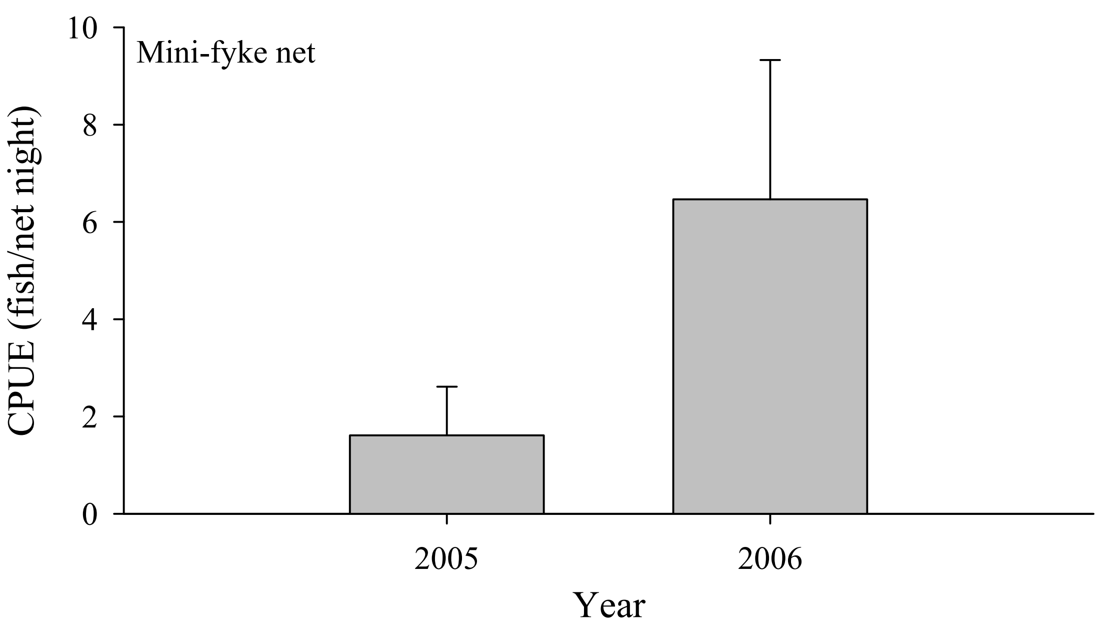

Figure 4.94. Mean annual catch per unit effort (± 2 SE) for sand shiners using mini-fyke nets in the upper and lower basins of the Missouri River for the 2005 and 2006 sampling years.

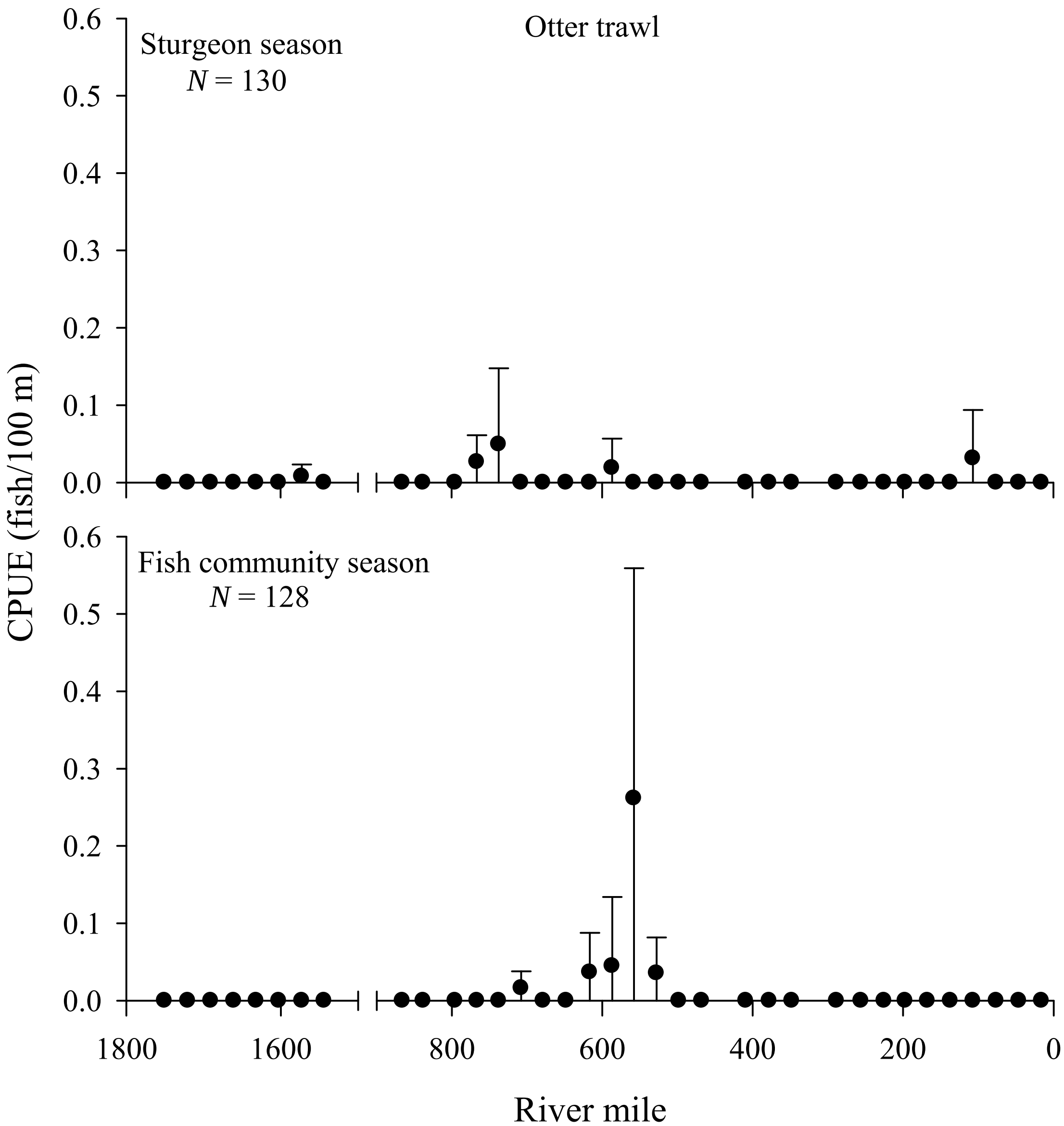

Figure 4.95. Mean seasonal catch per unit effort (± 2 SE) of sand shiners by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2006 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

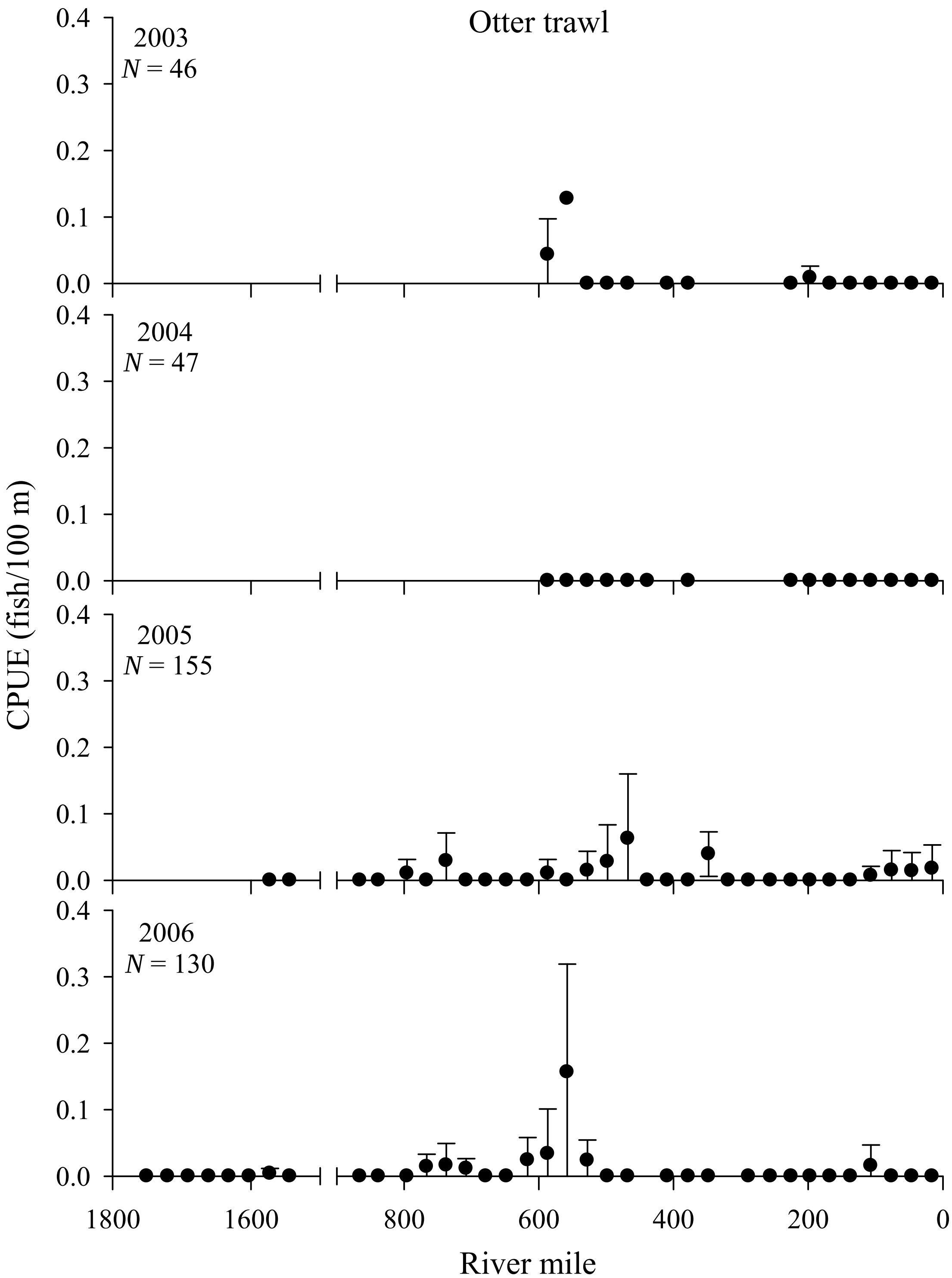

Figure 4.96. Mean annual catch per unit effort (± 2 SE) of sand shiners by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2003 to 2006 sampling years. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

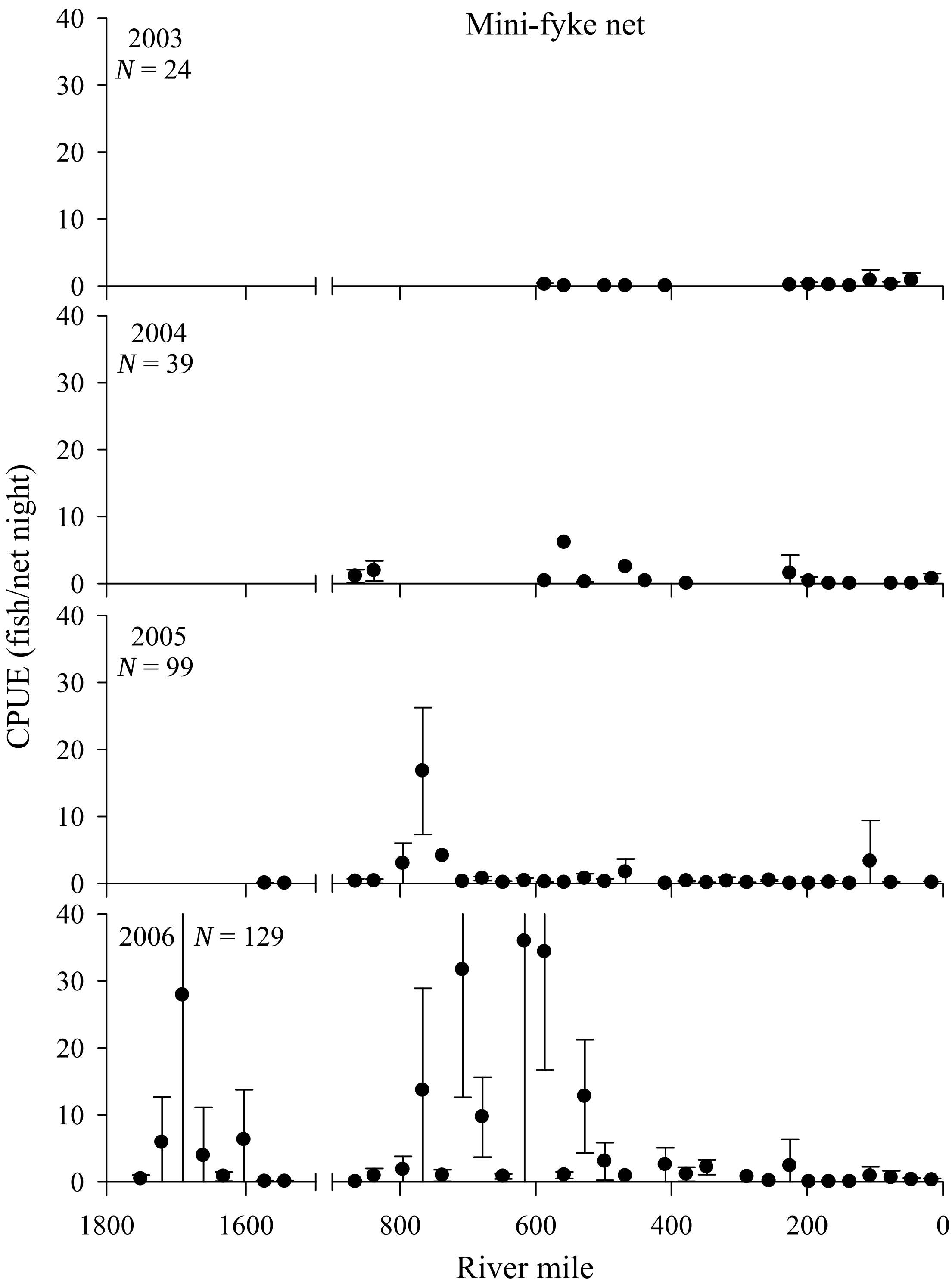

Figure 4.97. Mean annual catch per unit effort (± 2 SE) of sand shiners by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2003 to 2006 sampling years. Data obtained through random sampling using mini-fyke nets. Sample size denotes the number of bends sampled.

Table 4.51. Total number of sand shiners captured for each gear during each season and the percentage caught within each macrohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.6)	(22.5)	(1.2)	(1.0)	(1.1)	(51.5)	(9.6)	(8.0)	(0.8)	(0)	(0)	(0)	(0)	(0.6)
Gill Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.4)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	9	0	22.2	11.1	11.1	0	33.3	11.1	11.1	0	0	0	0	0	0
		(5.6)	(22.4)	(0.8)	(0.9)	(0.5)	(47.3)	(10.8)	(9.1)	(2.1)	(0)	(0)	(0.4)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.4)	(24.0)	(0.6)	(0.7)	(0.7)	(52.9)	(10.9)	(5.2)	(1.6)	(0)	(0)	(0.2)	(0)	(0)
Mini-Fyke Net	6677	2.3	19.3	0.3	6.7	(0)	43.9	6.0	3.4	14.8	0.4	(0)	(0)	2.8	0
		(4.8)	(16.7)	(0.5)	(0.2)	(0.2)	(43.2)	(9.2)	(7.5)	(13.8)	(1.9)	(0.2)	(0.2)	(1.8)	(0)
Otter Trawl	29	0	10.3	0	0	0	31.0	0	51.7	0	0	0	6.9	0	0
		(4.3)	(24.0)	(0.6)	(0.5)	(0.8)	(53.3)	(9.2)	(5.8)	(1.1)	(0)	(0)	(0.3)	(0)	(0)

Table 4.52. Total number of sand shiners captured for each gear during each season and the percentage caught within each mesohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(95.0)	(0.6)	(4.2)	(0)	(0.2)
Gill Net	0	0	0	0	0	0	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	9	0	100.0	0	0	0	0
		(0)	(93.5)	(0)	(6.0)	(0.2)	(0.3)
Fish Community Season (Summer)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0.1)	(95.9)	(0)	(3.9)	(0)	(0.1)
Mini-Fyke Net	6663	99.8	0.2	0	0	0	0
		(96.2)	(1.2)	(0)	(2.7)	(0)	(0)
Otter Trawl	29	0	100.0	0	0	0	0
		(0)	(97.2)	(0)	(2.8)	(0)	(0.1)

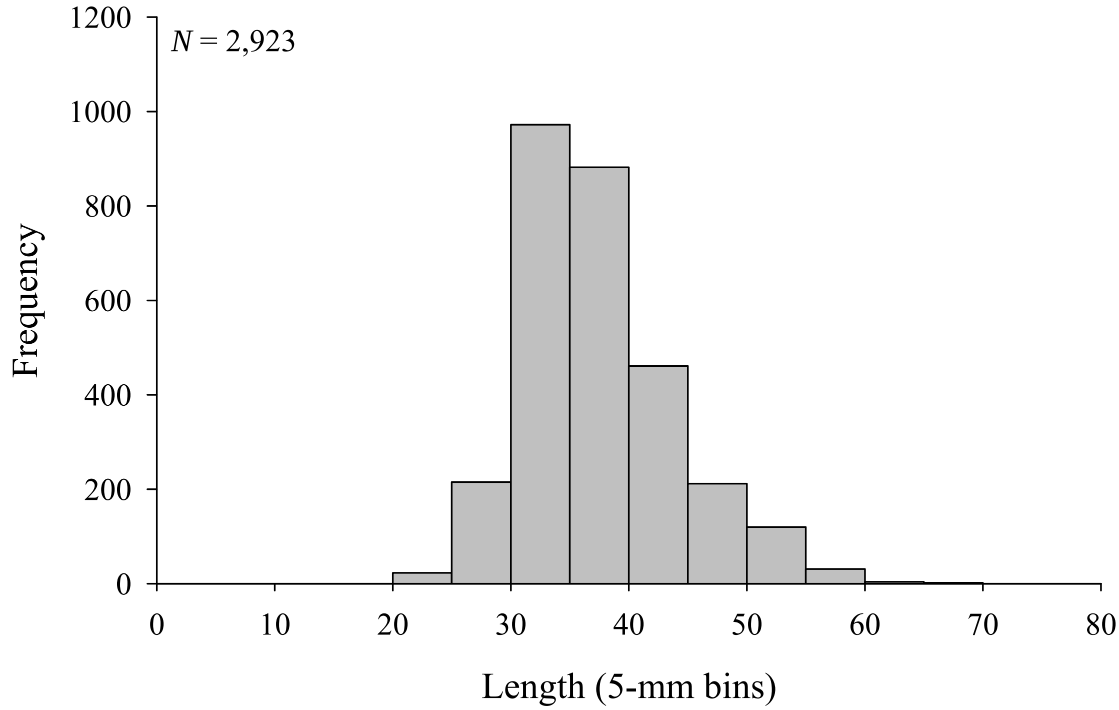

Figure 4.98. Length frequency distribution of sand shiners captured in the upper and lower basins of the Missouri River during the 2006 sampling year using random and nonrandom sampling with standard and wild gears.

4.3.7.2 Upper Basin

During the 2006 sampling year in the upper basin of the Missouri River, otter trawl deployment was ineffective at catching sand shiners during both the sturgeon and fish community seasons (Figure 4.99). All of the sand shiners caught during the fish community season resulted from mini-fyke net deployments, with a mean CPUE of approximately 5.0 fish/net night (Figure 4.100). Fifty-eight percent of these fish were captured from small secondary connected side channel macrohabitats, where 20% of the gear effort was applied (Table 4.53). Sand bar mesohabitats were the location from where nearly all (99.9%) of the sand shiners were captured (Table 4.54).

For all the sand shiners captured in the upper basin during the 2006 sampling year, lengths ranged from 20 to 75 mm, with a mode near 35 mm (Figure 4.101).

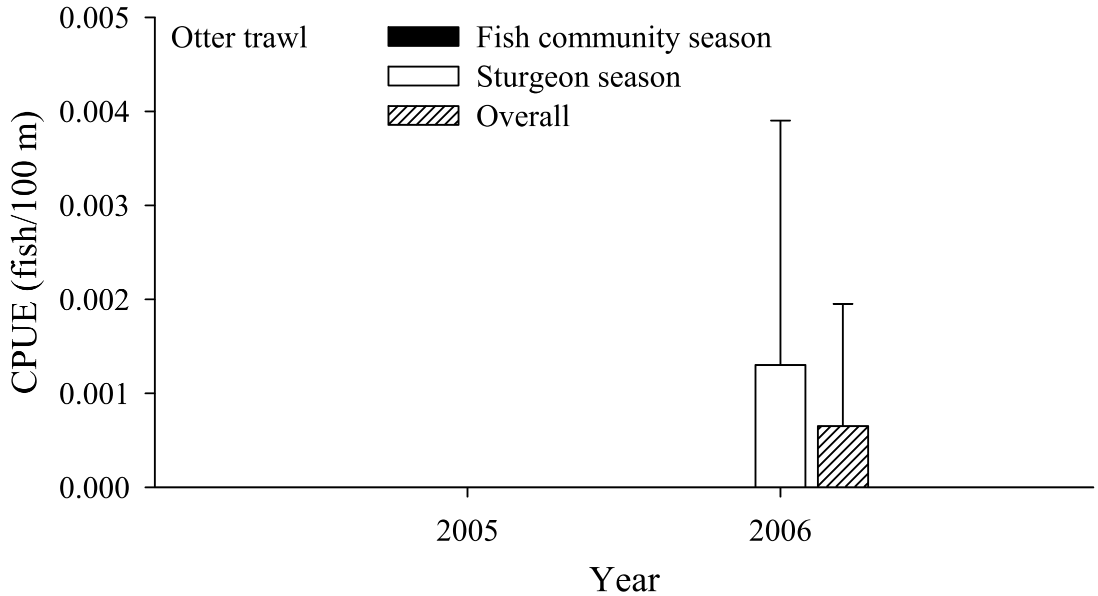

Figure 4.99. Mean annual catch per unit effort (± 2 SE) by season for sand shiners using otter trawls in the upper basin of the Missouri River for the 2005 and 2006 sampling years.

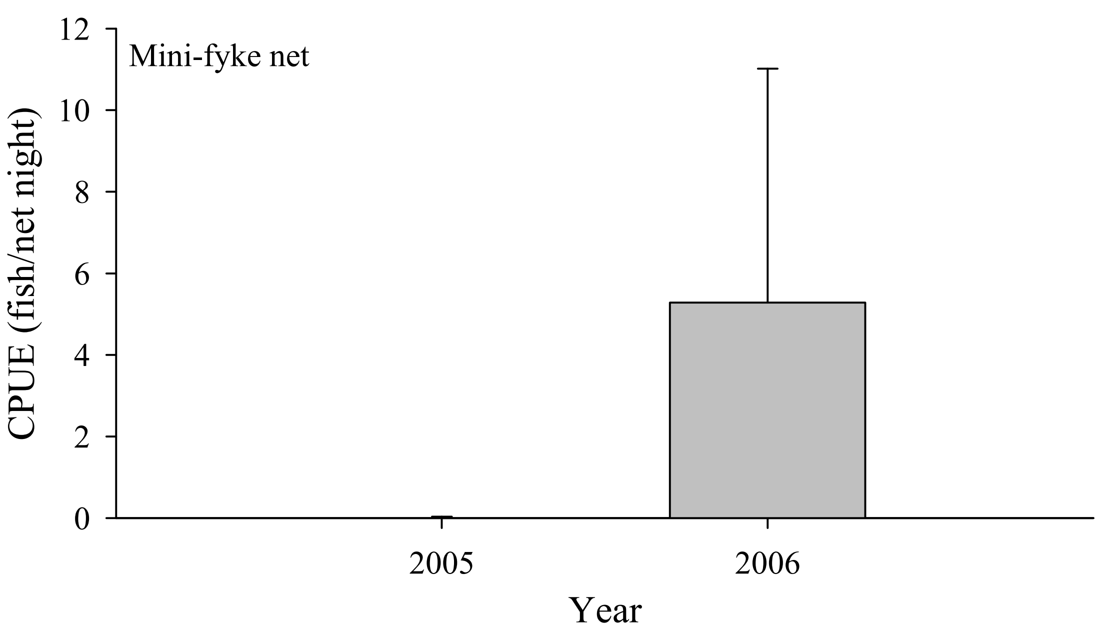

Figure 4.100. Mean annual catch per unit effort (± 2 SE) for sand shiners using mini-fyke nets in the upper basin of the Missouri River for the 2005 and 2006 sampling years.

Table 4.53. Total number of sand shiners captured for each gear during each season and the percentage caught within each macrohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(0)	(24.3)	(0.6)	(0)	(0)	(30.3)	(26.5)	(18.3)	(0)	(0)	(0)	(0)	(0)	(0)
Otter Trawl	1	0	0	0	0	0	0	100.0	0	0	0	0	0	0	0
		(0)	(24.7)	(0.6)	(0)	(0)	(27.9)	(25.0)	(18.6)	(3.2)	(0)	(0)	(0)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(0)	(26.7)	(0)	(0)	(0)	(31.1)	(27.7)	(10.4)	(3.5)	(0)	(0)	(0.6)	(0)	(0)
Mini-Fyke Net	1504	0	1.2	0.1	0	0	4.1	16.3	8.8	58.1	1.3	0	0	10.2	0
		(0)	(7.7)	(0.7)	(0)	(0)	(33.1)	(11.4)	(19.9)	(20.2)	(6.3)	(0)	(0)	(0.7)	(0)
Otter Trawl	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(0)	(26.6)	(0.7)	(0)	(0)	(29.8)	(30.4)	(11.4)	(1.0)	(0)	(0)	(0)	(0)	(0)

Table 4.54. Total number of sand shiners captured for each gear during each season and the percentage caught within each mesohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(88.0)	(0)	(11.4)	(0)	(0.6)
Otter Trawl	1	0	100.0	0	0	0	0
		(0)	(85.3)	(0)	(13.8)	(0)	(1.0)
Fish Community Season (Summer)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0.3)	(89.6)	(0)	(9.7)	(0)	(0.3)
Mini-Fyke Net	1490	99.9	0.1	0	0	0	0
		(92.0)	(1.1)	(0)	(6.8)	(0)	(0)
Otter Trawl	0	0	0	0	0	0	0
		(0)	(94.5)	(0)	(5.5)	(0)	(0)

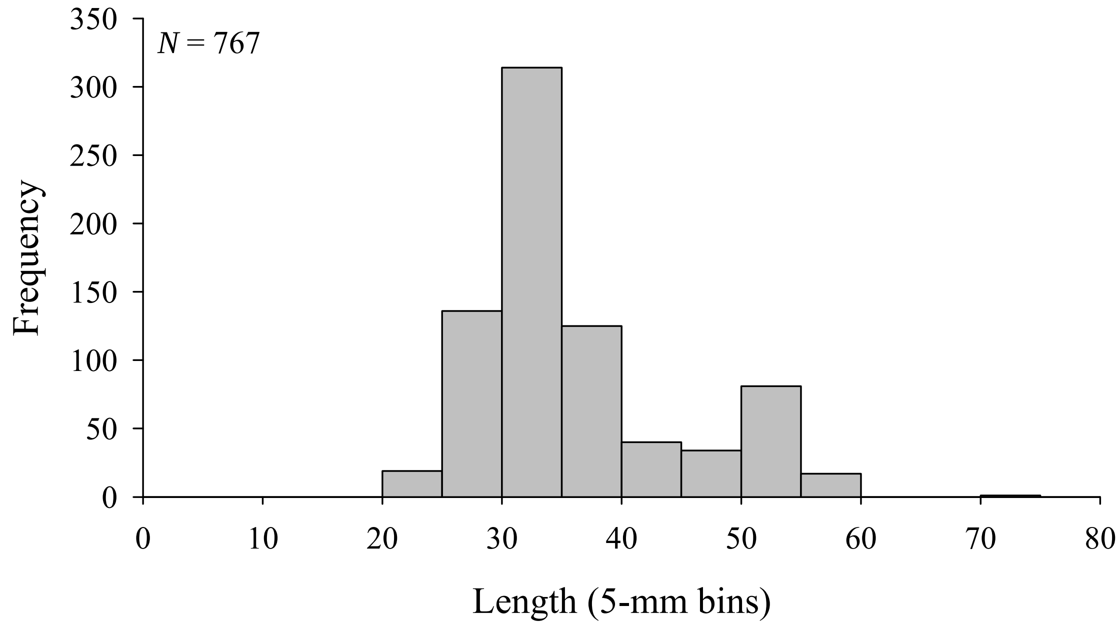

Figure 4.101. Length frequency distribution of sand shiners captured in the upper basin of the Missouri River during the 2006 sampling year using random and nonrandom sampling with standard and wild gears.

4.3.7.3 Lower Basin

Within the lower basin sampling segments of the Missouri River, relative abundance of sand shiners differed among sampling seasons and years. During the 2006 sampling year, the mean CPUE of sand shiners captured with otter trawls was larger during the fish community season (0.011 fish/100 m) than during the sturgeon season (0.005 fish/100 m; Figure 4.102). From the 2003 sampling year to the 2006 sampling year, the mean otter trawl CPUE increased during the fish community season and decreased during the sturgeon season, resulting in a similar overall mean CPUE of approximately 0.009 fish/100 m. Relative abundance estimates of sand shiners captured with mini-fyke nets, deployed only during the fish community season, have increased from sampling year 2003 to 2006, with a mean CPUE of approximately 0.2 fish/net night and 7.0 fish/net night, respectively (Figure 4.103).

During the sturgeon and fish community seasons, most sand shiners were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred (Table 4.55). Main channel crossovers were also sampled with a relatively large effort, which resulted in proportional catches during both seasons. Otter trawls captured eight fish during the sturgeon season and 29 fish during the fish community season (<1% of the seasonal catch). Sand bar mesohabitats were the location from where nearly all (99.9%) of the sand shiners were captured with mini-fyke nets (Table 4.56). Channel border mesohabitats were the otter trawl sampling location where all of the sand shiners were captured during the sturgeon and the fish community seasons.

For all the sand shiners captured in the lower basin during the 2006 sampling year, lengths ranged from 20 to 70 mm, with a mode near 40 mm (Figure 4.104).

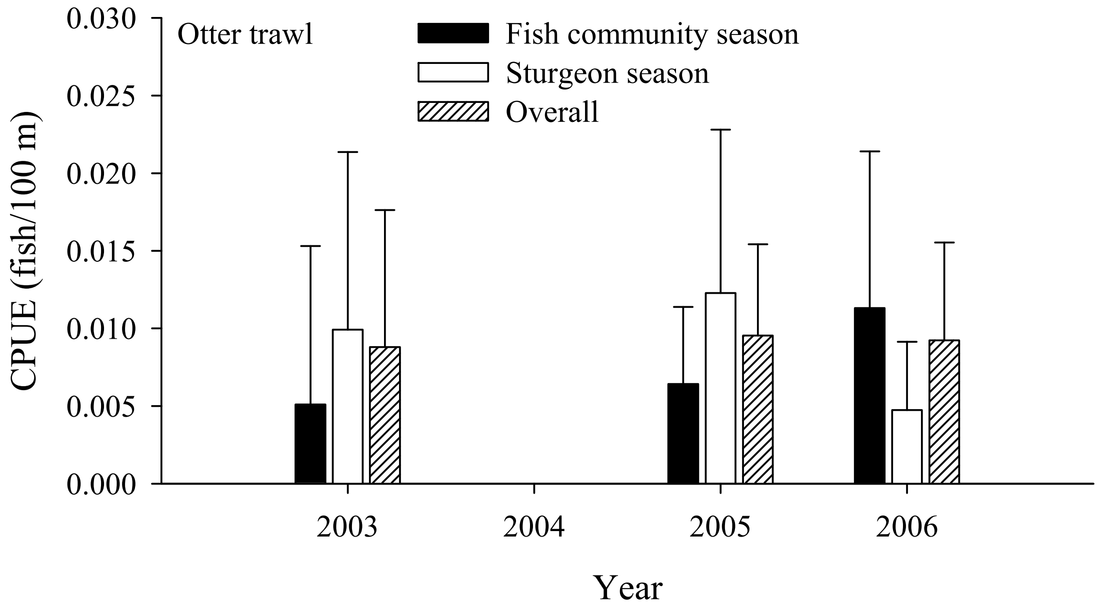

Figure 4.102. Mean annual catch per unit effort (± 2 SE) by season for sand shiners using otter trawls in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

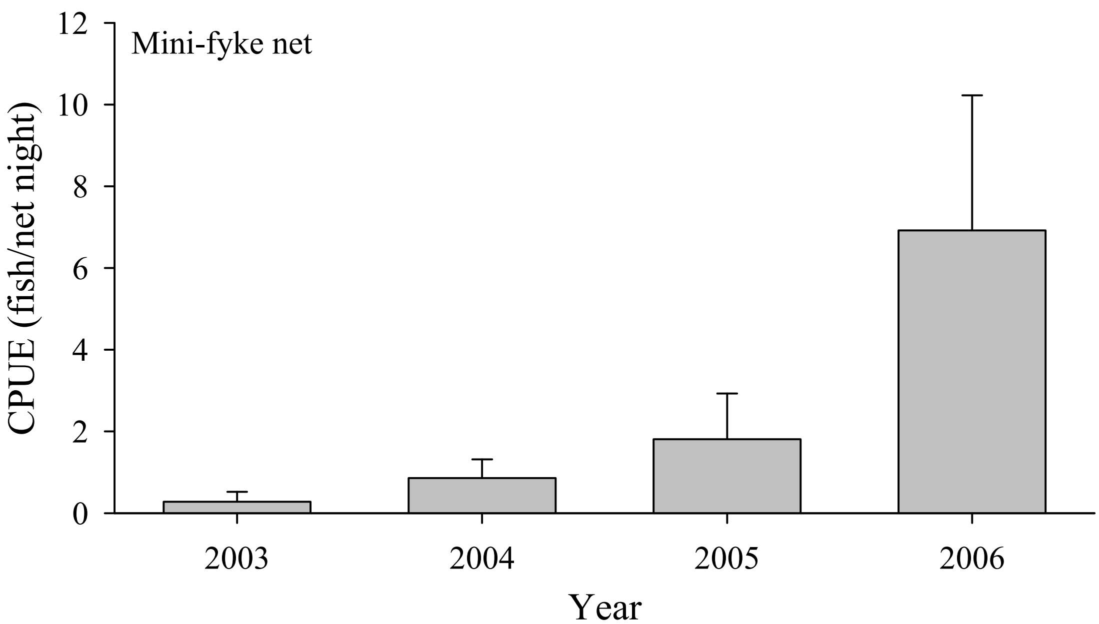

Figure 4.103. Mean annual catch per unit effort (± 2 SE) for sand shiners using mini-fyke nets in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

Table 4.55. Total number of sand shiners captured for each gear during each season and the percentage caught within each macrohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(5.8)	(13.9)	(3.6)	(1.0)	(1.6)	(54.7)	(4.3)	(14.0)	(0.4)	(0)	(0)	(0)	(0)	(0.7)
Gill Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(0.9)	(30.8)	(1.1)	(0)	(0.1)	(55.9)	(7.5)	(2.0)	(0.7)	(0)	(0)	(1.0)	(0)	(0)
Otter Trawl	8	0	25.0	12.5	12.5	0	37.5	0	12.5	0	0	0	0	0	0
		(3.0)	(21.8)	(0.6)	(0.3)	(0.3)	(60.5)	(1.4)	(6.9)	(2.5)	(0)	(0)	(2.8)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(2.4)	(16.9)	(1.1)	(0.5)	(0.6)	(67.1)	(3.6)	(6.7)	(1.1)	(0)	(0)	(0)	(0)	(0)
Mini-Fyke Net	5173	3.0	24.6	0.4	8.6	0	55.5	3.0	1.8	2.2	0.1	0	0	0.7	0
		(4.6)	(25.6)	(0.3)	(0.3)	(0)	(47.5)	(6.6)	(3.2)	(8.2)	(0.6)	(0.2)	(0.1)	(2.9)	(0)
Otter Trawl	29	0	10.3	0	0	0	31.0	0	51.7	0	0	0	6.9	0	0
		(1.1)	(21.9)	(0.8)	(0.3)	(0.1)	(66.4)	(0.6)	(4.7)	(2.1)	(0)	(0)	(2.0)	(0)	(0)

Table 4.56. Total number of sand shiners captured for each gear during each season and the percentage caught within each mesohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(97.3)	(0.7)	(1.9)	(0)	(0)
Gill Net	0	0	0	0	0	0	0
		(0)	(33.7)	(0)	(1.3)	(65.0)	(0)
Otter Trawl	8	0	100.0	0	0	0	0
		(0)	(95.7)	(0)	(2.8)	(1.5)	(0)
Fish Community Season (Summer)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(98.1)	(0)	(1.9)	(0)	(0)
Mini-Fyke Net	5173	99.8	0.2	0	0	0	0
		(97.8)	(1.0)	(0)	(1.2)	(0)	(0)
Otter Trawl	29	0	100.0	0	0	0	0
		(0)	(97.0)	(0)	(3.0)	(0)	(0)

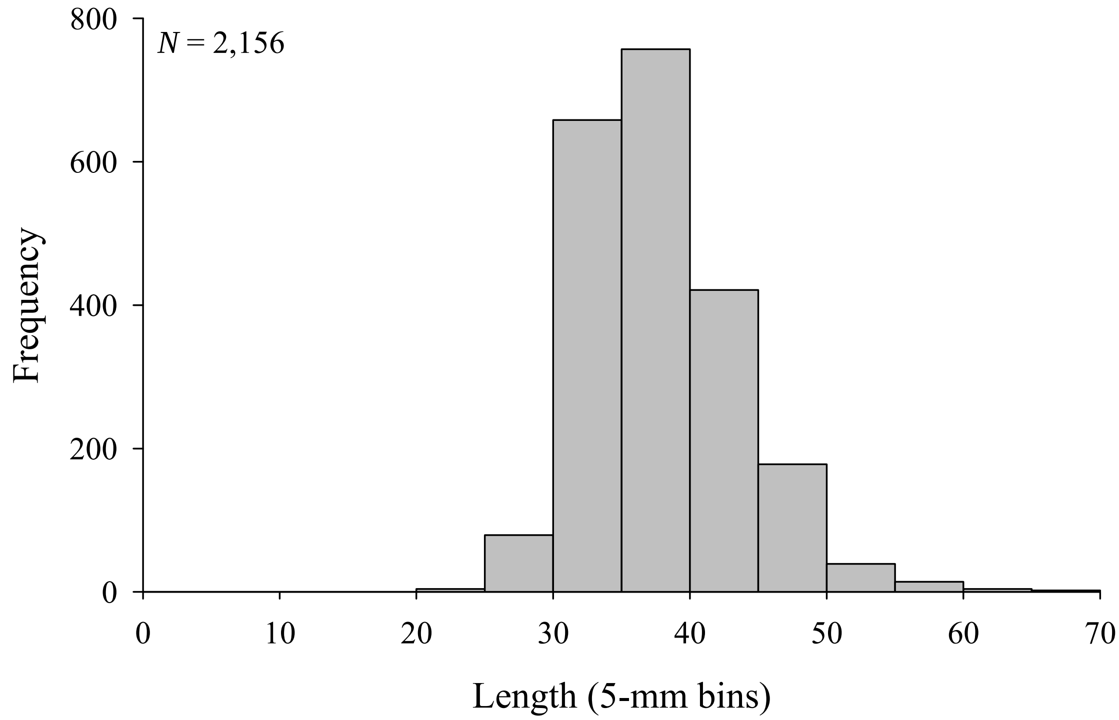

Figure 4.104. Length frequency distribution of sand shiners captured in the lower basin of the Missouri River during the 2006 sampling year using random and nonrandom sampling with standard and wild gears.

4.3.8 *Hybognathus* spp.

4.3.8.1 Combined Basins

During the 2006 sampling year in the upper and lower basins of the Missouri River, 40 *Hybognathus* were captured during the sturgeon season, while 883 were captured during the fish community season (Figure 4.105). Sampling from the lower basin during the sturgeon season resulted in 33 *Hybognathus* captured, while seven were captured from the upper basin. A total of 790 *Hybognathus* were captured from the upper basin during the fish community season, comprising 89% of the total catch (Figure 4.105). Sampling from segment 4 (RM 1568 – 1582) in the upper basin accounted for approximately 49% of the *Hybognathus* catch for that part of the basin during the fish community season. Sampling from segments 8 and 9 in the lower basin (near RM 600) accounted for a large proportion of the fish community season *Hybognathus* catch (51%, $N = 47$) in the lower basin sampling segments (Figure 4.105).

Relative abundance of *Hybognathus* differed between sampling seasons and years. During the 2006 sampling year, the mean CPUE of *Hybognathus* captured with otter trawls was higher during the sturgeon season (0.014 fish/100 m) than during the fish community season (0.002 fish/100 m; Figure 4.106). The overall mean otter trawl CPUE of *Hybognathus* increased from 0.002 fish/100 m during the 2005 sampling year to 0.008 fish/100 m during the 2006 sampling year. Relative abundance estimates from mini-fyke nets, deployed only during the fish community season, were higher during the 2005 sampling year (8.0 fish/net night) than the 2006 sampling year (0.4 fish/net night; Figure 4.107).

Relative abundance of *Hybognathus* also differed markedly among sampling segments. During the 2006 sturgeon season, otter trawls captured all 40 *Hybognathus*, and the relative abundance of *Hybognathus* captured with otter trawls was generally larger in the lower basin than in the upper basin (Figure 4.108). During the 2006 fish community season otter trawls captured only seven *Hybognathus* (<1% of the seasonal catch), with a mean relative abundance ranging from 0.0 fish/100 m to 0.02 fish/100 m.

Relative abundance of *Hybognathus* has generally increased in many sampling segments during the period from 2003 to 2006 as the sampling program has become fully implemented. When combining sampling seasons in 2006, the relative abundance of *Hybognathus* captured with otter trawls during 2006 was comparatively larger in the lower basin (0.0 to 0.16 fish/100 m) than the upper basin (0.0 to 0.02 fish/100 m; Figure 4.109). During the 2006 fish community season, mini-fyke nets captured 99% of the seasonal catch, with the relative abundance of *Hybognathus* decreasing markedly from 2005 to 2006 in several sampling segments (Figure 4.110). During 2006, the mean CPUE of *Hybognathus* captured with mini-fyke nets was comparatively larger in the upper basin (0.3 to 4.0 fish/net night) than the lower basin (0.0 to 1.4 fish/net night).

Random sampling with standard gears accounted for 93% (*N* = 37) of the total *Hybognathus* catch during the 2006 sturgeon season, and approximately 55% (*N* = 484) of the catch during the 2006 fish community season (Table 4.57). During both seasons, most *Hybognathus* were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred. Main channel crossover macrohabitats and small secondary connected channels were also sampled with a relatively large effort, which resulted in proportional catches of *Hybognathus* with otter trawls and mini-fyke nets during both seasons. All of the *Hybognathus* caught with otter trawls were captured from main channel border mesohabitats, which was also the location of greatest effort for that gear (Table 4.58). During fish community season mini-fyke nets caught 99% of the *Hybognathus* from sand bar mesohabitats; where 96% of the effort for that gear was expended.

The length frequency distribution of *Hybognathus* captured from the upper and lower basin of the Missouri River during the 2006 sampling year approximates a bimodal distribution, with a lower mode near 45 mm and an upper mode near 90 mm (Figure 4.111). The lengths of all *Hybognathus* captured ranged from approximately 20 to 150 mm.

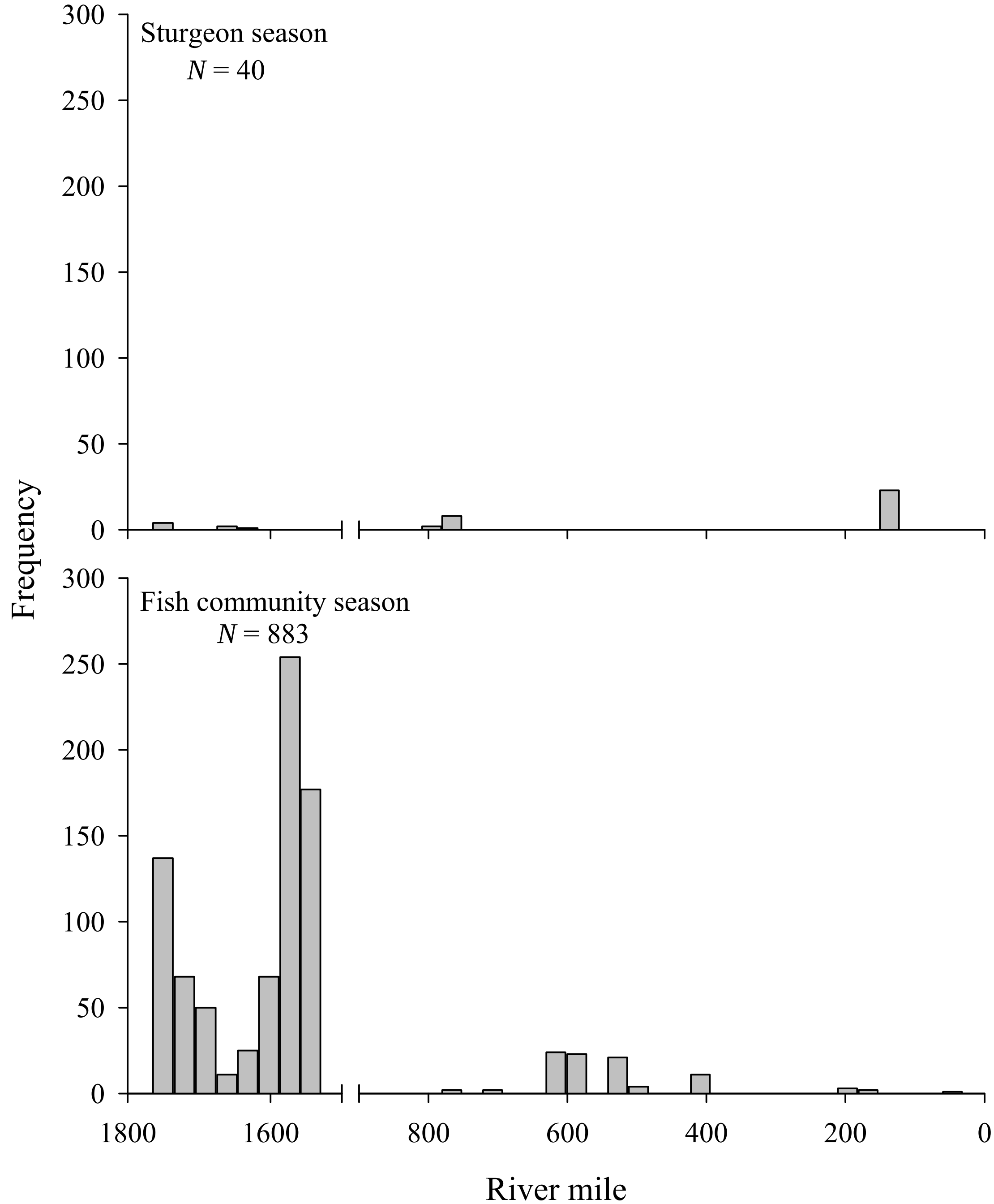

Figure 4.105. Seasonal catch by river mile (30-mile bins) of *Hybognathus* spp. in the upper and lower basins of the Missouri River in the 2006 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

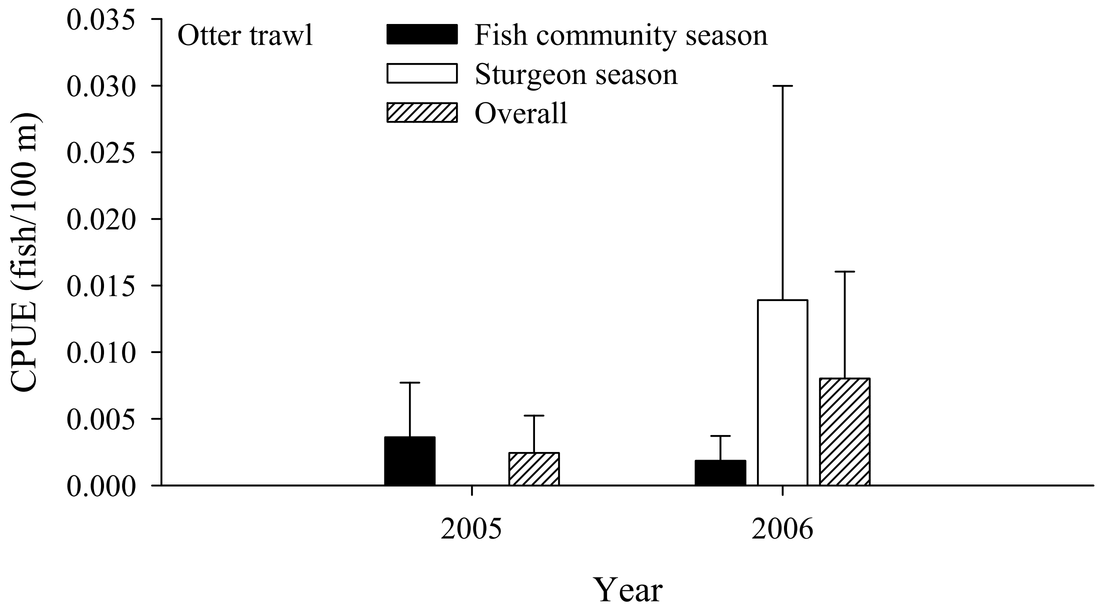

Figure 4.106. Mean annual catch per unit effort (± 2 SE) by season for *Hybognathus* spp. using otter trawls in the upper and lower basins of the Missouri River for the 2005 and 2006 sampling years.

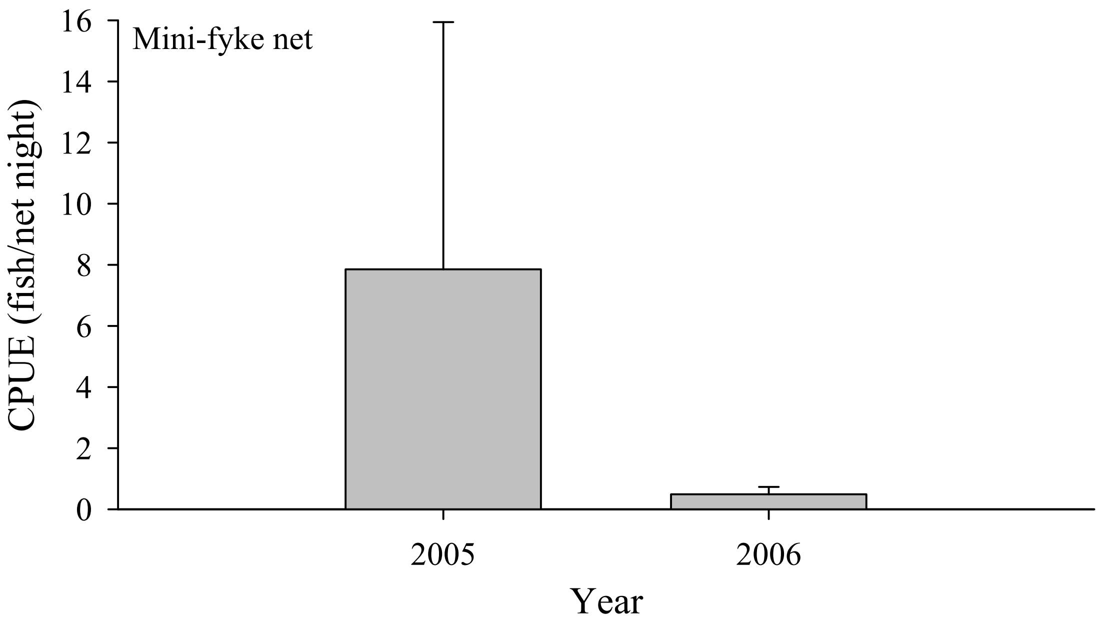

Figure 4.107. Mean annual catch per unit effort (± 2 SE) for *Hybognathus* spp. using mini-fyke nets in the upper and lower basins of the Missouri River for the 2005 and 2006 sampling years.

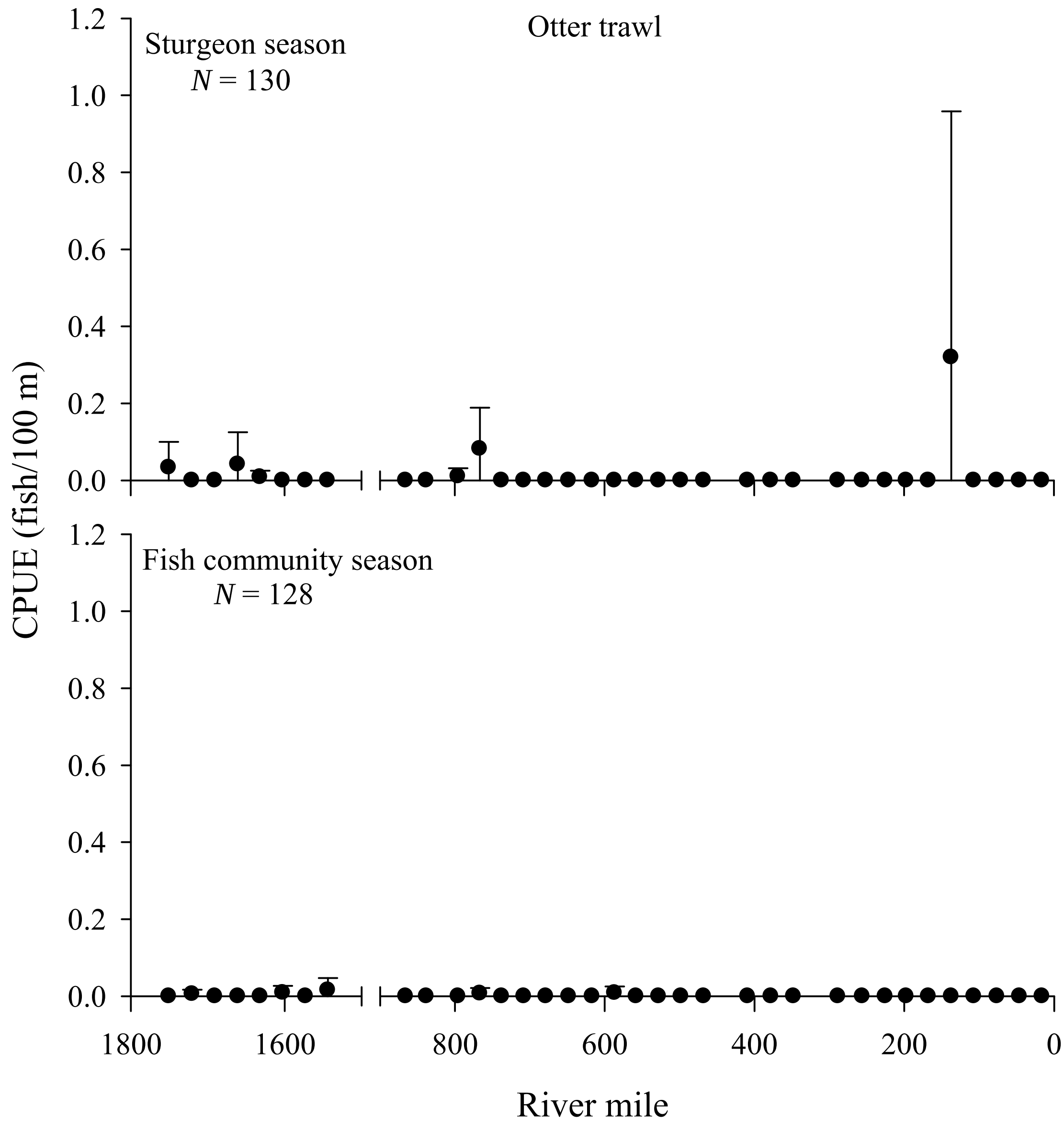

Figure 4.108. Mean seasonal catch per unit effort (± 2 SE) of *Hybognathus* spp. by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2006 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

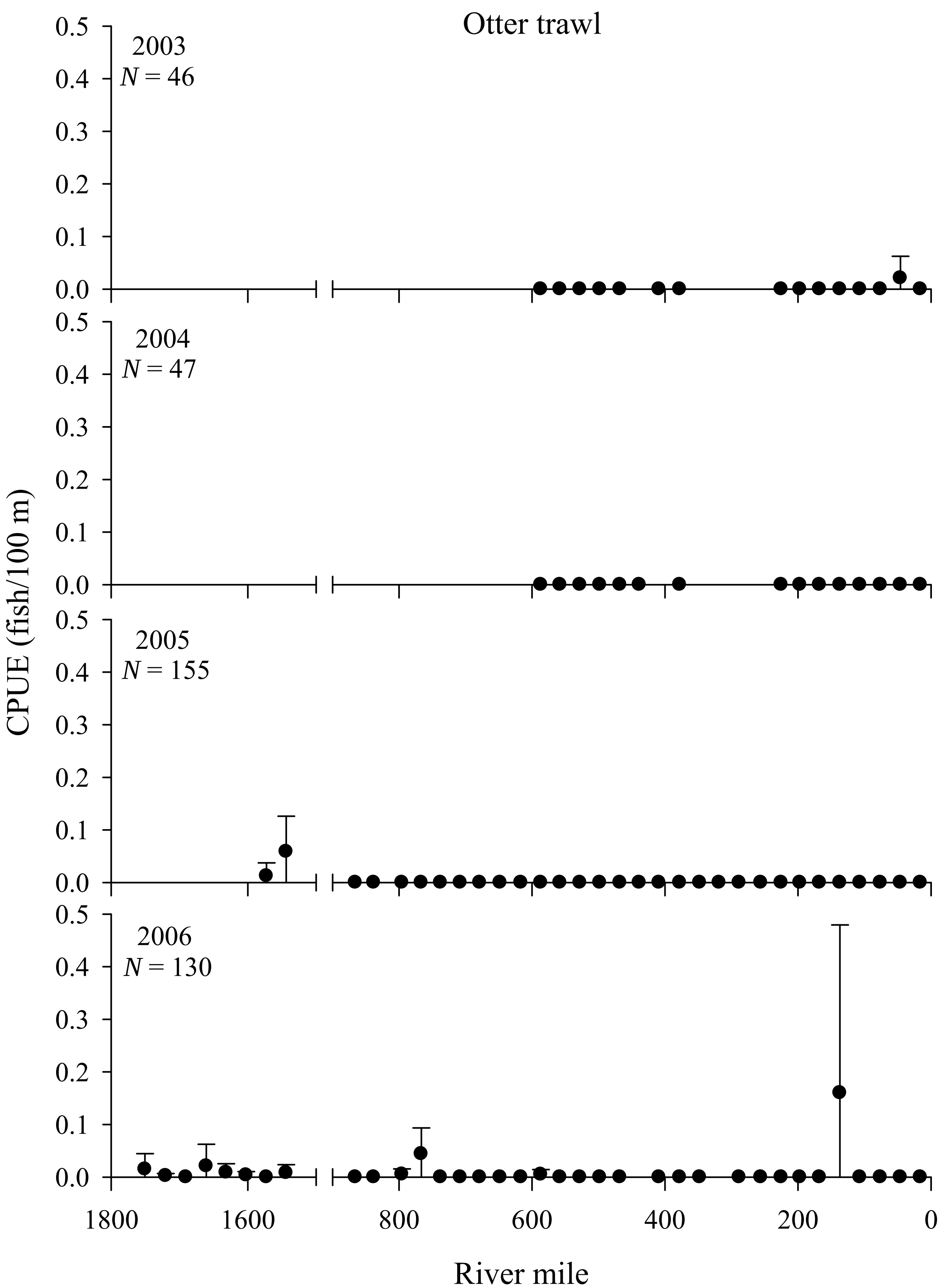

Figure 4.109. Mean annual catch per unit effort (± 2 SE) of *Hybognathus* spp. by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2003 to 2006 sampling years. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

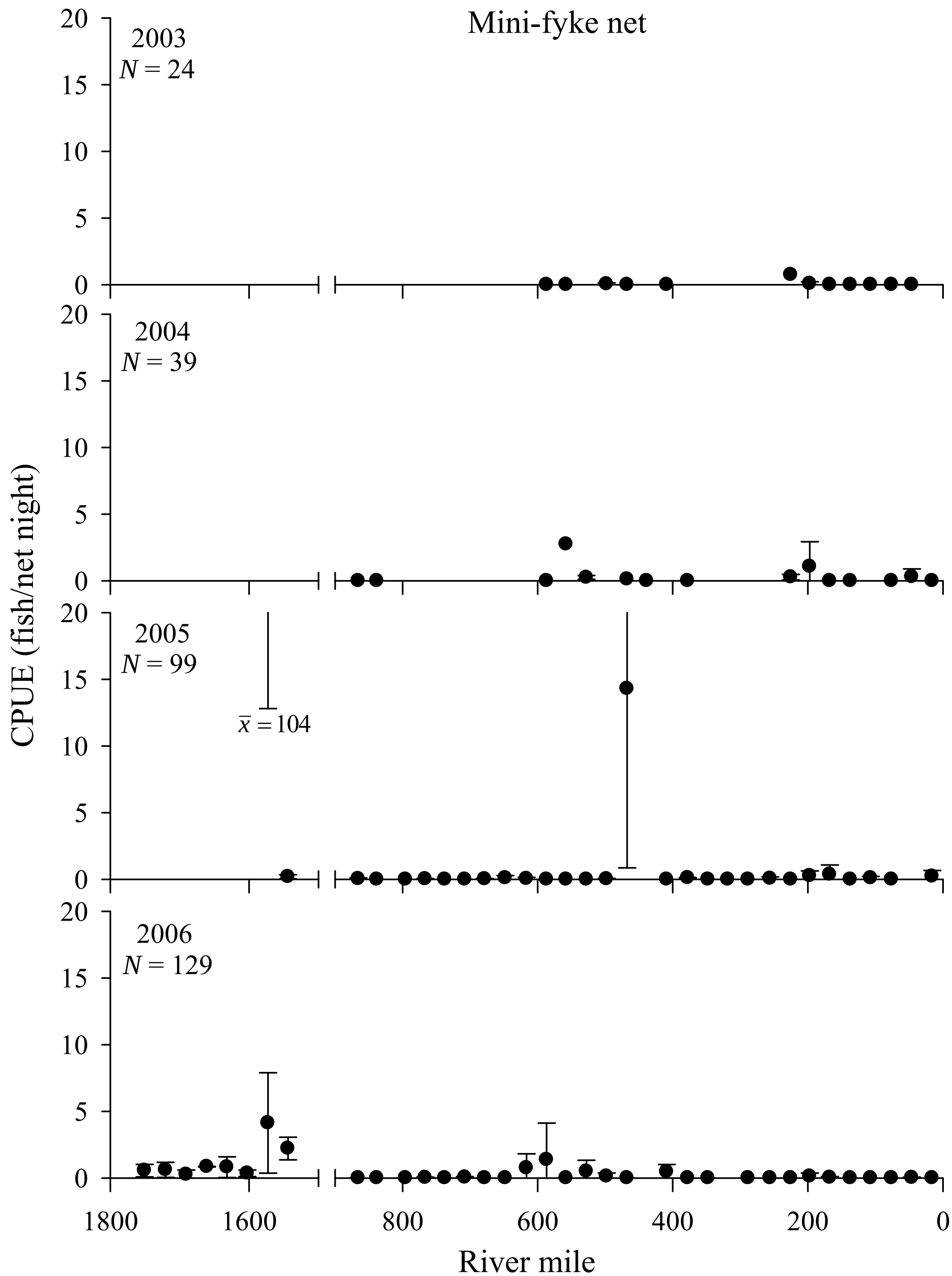

Figure 4.110. Mean annual catch per unit effort (± 2 SE) of *Hybognathus* spp. by river mile (30-mile bins) in the upper and lower basins of the Missouri River for the 2003 to 2006 sampling years. Data obtained through random sampling using mini-fyke nets. Sample size denotes the number of bends sampled.

Table 4.57. Total number of *Hybognathus* spp. captured for each gear during each season and the percentage caught within each macrohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.6)	(22.5)	(1.2)	(1.0)	(1.1)	(51.5)	(9.6)	(8.0)	(0.8)	(0)	(0)	(0)	(0)	(0.6)
Gill Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.4)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	37	2.7	2.7	8.1	0	2.7	70.3	0	13.5	0	0	0	0	0	0
		(5.6)	(22.4)	(0.8)	(0.9)	(0.5)	(47.3)	(10.8)	(9.1)	(2.1)	(0)	(0)	(0.4)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.4)	(24.0)	(0.6)	(0.7)	(0.7)	(52.9)	(10.9)	(5.2)	(1.6)	(0)	(0)	(0.2)	(0)	(0)
Mini-Fyke Net	477	0.2	8.6	1.5	0	0	59.5	1.5	8.4	9.2	5.5	0	0	5.7	0
		(4.8)	(16.7)	(0.5)	(0.2)	(0.2)	(43.2)	(9.2)	(7.5)	(13.8)	(1.9)	(0.2)	(0.2)	(1.8)	(0)
Otter Trawl	7	0	14.3	0	14.3	0	42.9	14.3	14.3	0	0	0	0	0	0
		(4.3)	(24.0)	(0.6)	(0.5)	(0.8)	(53.3)	(9.2)	(5.8)	(1.1)	(0)	(0)	(0.3)	(0)	(0)

Table 4.58. Total number of *Hybognathus* spp. captured for each gear during each season and the percentage caught within each mesohabitat type in the upper and lower basins of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(95.0)	(0.6)	(4.2)	(0)	(0.2)
Gill Net	0	0	0	0	0	0	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	37	0	100.0	0	0	0	0
		(0)	(93.5)	(0)	(6.0)	(0.2)	(0.3)
Fish Community Season (Summer)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0.1)	(95.9)	(0)	(3.9)	(0)	(0.1)
Mini-Fyke Net	467	92.7	1.3	0	6.0	0	0
		(96.2)	(1.2)	(0)	(2.7)	(0)	(0)
Otter Trawl	7	0	100.0	0	0	0	0
		(0)	(97.2)	(0)	(2.8)	(0)	(0.1)

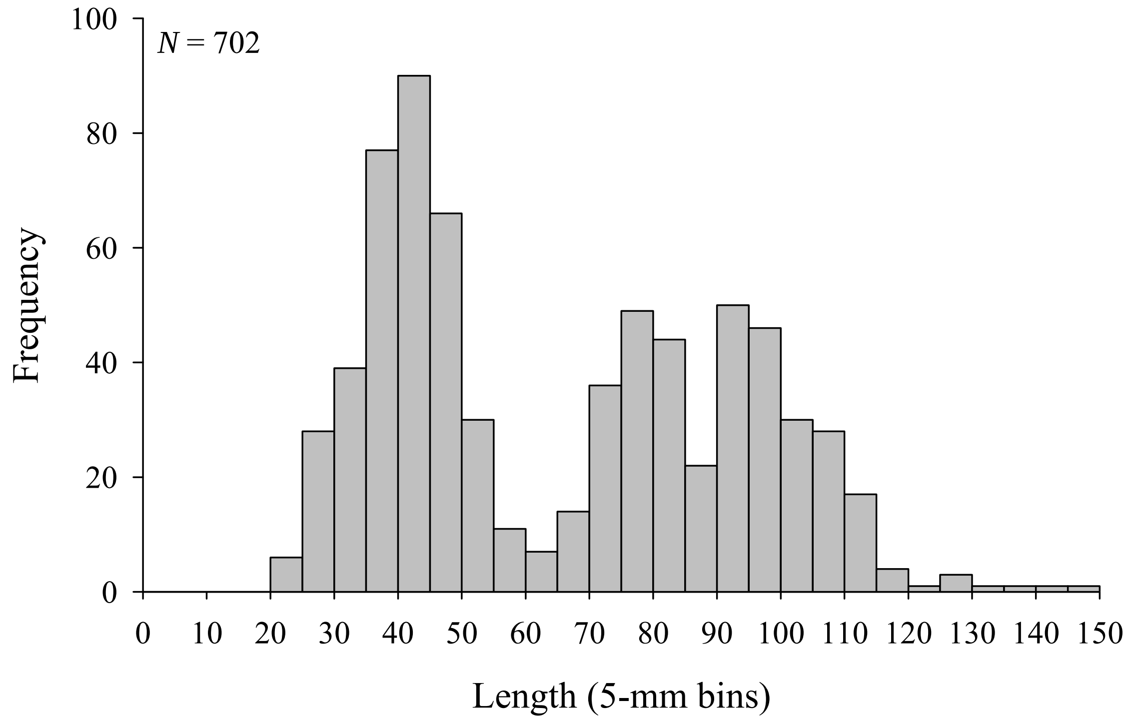

Figure 4.111. Length frequency distribution of *Hybognathus* spp. captured in the upper and lower basins of the Missouri River during the 2006 sampling year using random and nonrandom sampling with standard and wild gears.

4.3.8.2 Upper Basin

In the upper basin sampling segments, relative abundance of *Hybognathus* differed between sampling seasons and years. During the 2006 sampling year, the mean CPUE of *Hybognathus* captured with otter trawls was similar during the sturgeon and fish community seasons, with an overall mean otter trawl CPUE of 0.006 fish/100 m (Figure 4.112). The relative abundance of *Hybognathus* during the fish community season decreased from the 2005 sampling year (0.033 fish/100 m) to the 2006 sampling year (0.005 fish/100 m). Relative abundance estimates from mini-fyke nets, deployed only during the fish community season, were higher during the 2005 sampling year (67 fish/net night) than the 2006 sampling year (2 fish/net night; Figure 4.113).

During both the sturgeon and fish community seasons, most *Hybognathus* were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred (Table 4.59). Main channel crossover and small and large secondary connected channel macrohabitats were also sampled with a relatively large effort, which resulted in proportional catches of *Hybognathus* with otter trawls and mini-fyke nets during both seasons. All of the *Hybognathus* caught with otter trawls were captured from main channel border mesohabitats, which was also the location of greatest effort for that gear (Table 4.60). During fish community season mini-fyke nets caught 91% of the *Hybognathus* from sand bar mesohabitats; where 92% of the effort for that gear was expended.

The population structure of *Hybognathus* captured from the upper basin of the Missouri River during the 2006 sampling year approximates a bimodal distribution, with a lower mode near 50 mm and an upper mode near 90 mm (Figure 4.114). The lengths of all *Hybognathus* captured ranged from approximately 20 to 130 mm.

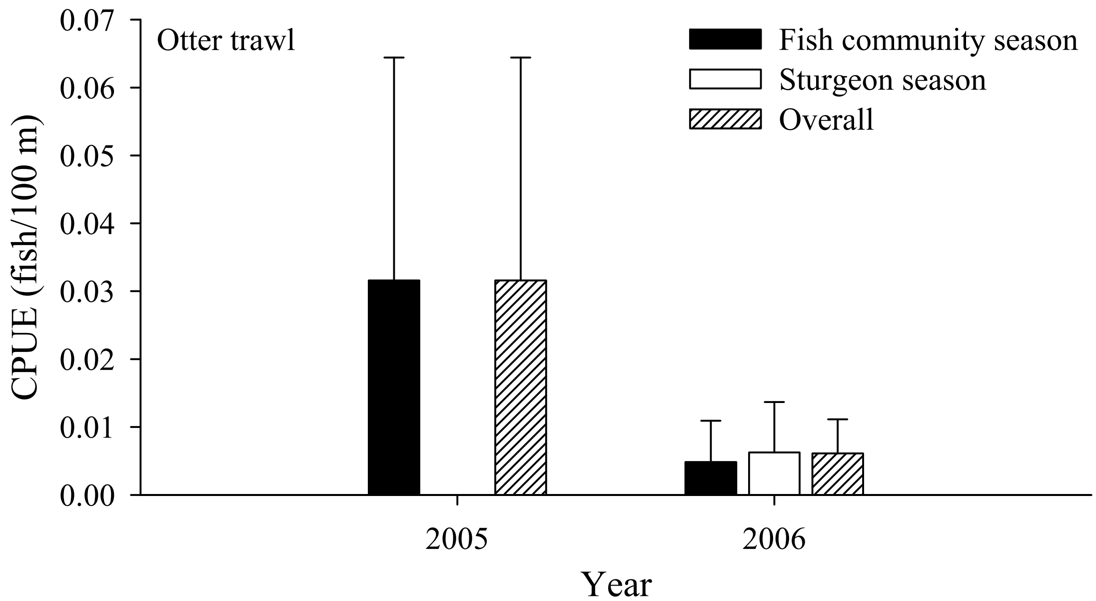

Figure 4.112. Mean annual catch per unit effort (± 2 SE) by season for *Hybognathus* spp. using otter trawls in the upper basin of the Missouri River for the 2005 and 2006 sampling years.

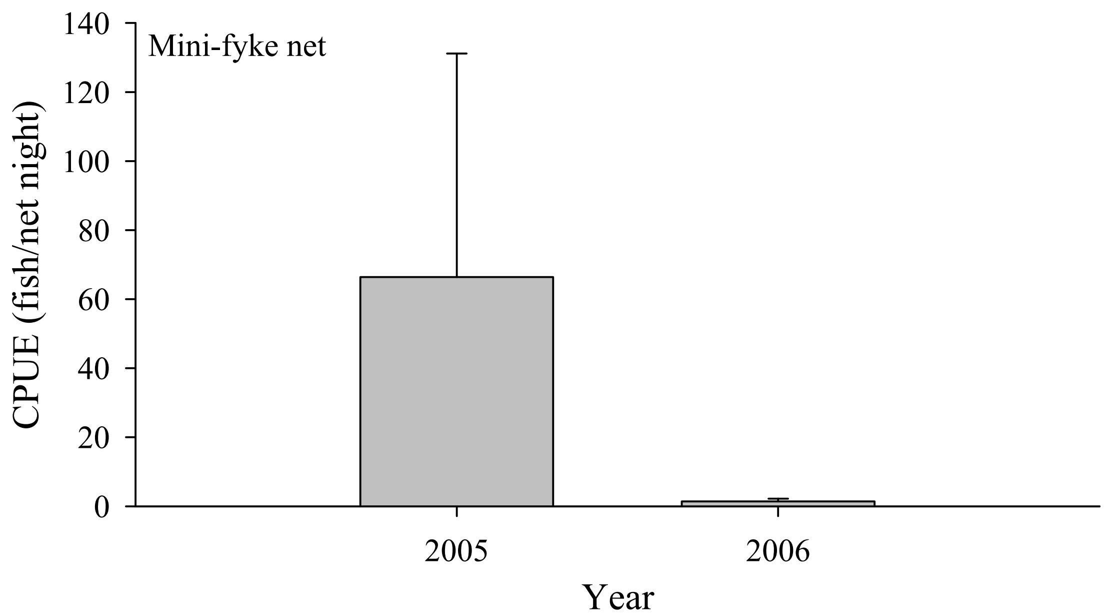

Figure 4.113. Mean annual catch per unit effort (± 2 SE) for *Hybognathus* spp. using mini-fyke nets in the upper basin of the Missouri River for the 2005 and 2006 sampling years.

Table 4.59. Total number of *Hybognathus* spp. captured for each gear during each season and the percentage caught within each macrohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(0)	(24.3)	(0.6)	(0)	(0)	(30.3)	(26.5)	(18.3)	(0)	(0)	(0)	(0)	(0)	(0)
Otter Trawl	5	0	20.0	40.0	0	0	40.0	0	0	0	0	0	0	0	0
		(0)	(24.7)	(0.6)	(0)	(0)	(27.9)	(25.0)	(18.6)	(3.2)	(0)	(0)	(0)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(0)	(26.7)	(0)	(0)	(0)	(31.1)	(27.7)	(10.4)	(3.5)	(0)	(0)	(0.6)	(0)	(0)
Mini-Fyke Net	387	0	7.5	1.8	0	0	54.5	1.6	10.3	10.6	6.7	0	0	7.0	0
		(0)	(7.7)	(0.7)	(0)	(0)	(33.1)	(11.4)	(19.9)	(20.2)	(6.3)	(0)	(0)	(0.7)	(0)
Otter Trawl	5	0	20.0	0	0	0	60.0	20.0	0	0	0	0	0	0	0
		(0)	(26.6)	(0.7)	(0)	(0)	(29.8)	(30.4)	(11.4)	(1.0)	(0)	(0)	(0)	(0)	(0)

Table 4.60. Total number of *Hybognathus* spp. captured for each gear during each season and the percentage caught within each mesohabitat type in the upper basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Mesohabitat					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(88.0)	(0)	(11.4)	(0)	(0.6)
Otter Trawl	5	0	100.0	0	0	0	0
		(0)	(85.3)	(0)	(13.8)	(0)	(1.0)
Fish Community Season (Summer)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0.3)	(89.6)	(0)	(9.7)	(0)	(0.3)
Mini-Fyke Net	377	91.0	1.6	0	7.4	0	0
		(92.0)	(1.1)	(0)	(6.8)	(0)	(0)
Otter Trawl	5	0	100.0	0	0	0	0
		(0)	(94.5)	(0)	(5.5)	(0)	(0)

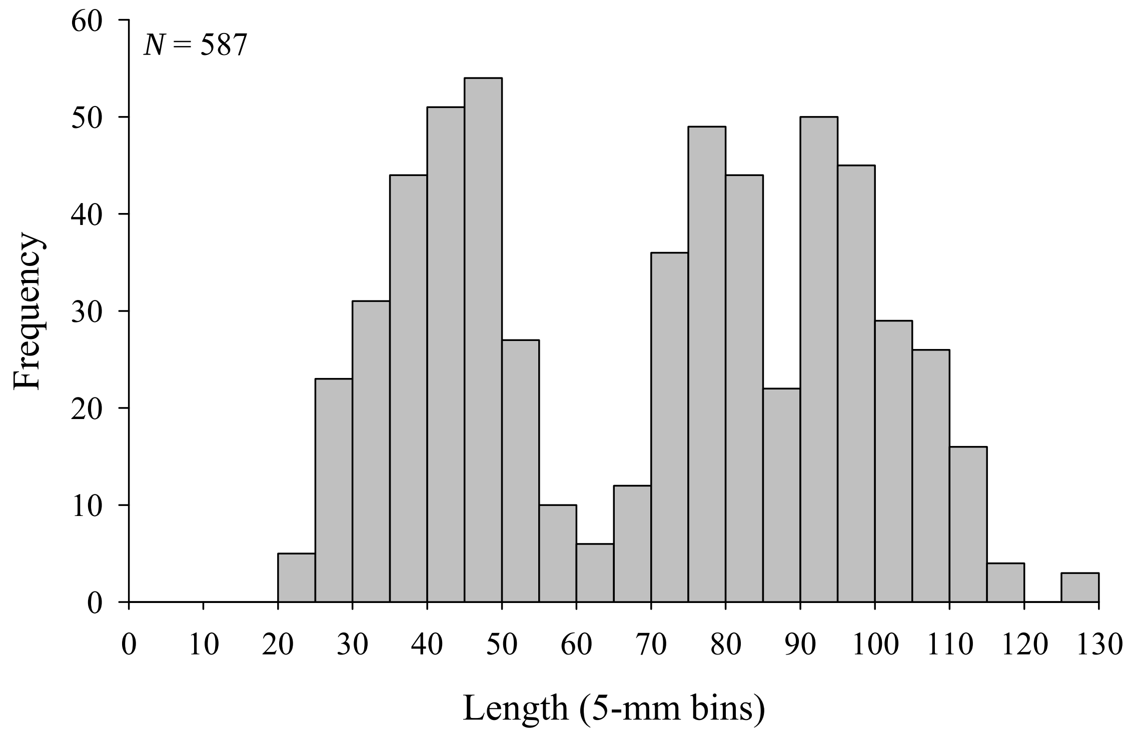

Figure 4.114. Length frequency distribution of *Hybognathus* spp. captured in the upper basin of the Missouri River during the 2006 sampling year using random and nonrandom sampling with standard and wild gears.

4.3.8.3 Lower Basin

Within the lower basin sampling segments of the Missouri River, relative abundance of *Hybognathus* differed among sampling seasons and years. During the 2006 sampling year, the mean CPUE of *Hybognathus* captured with otter trawls was larger during the sturgeon season (0.017 fish/100 m) than during the fish community season (0.001 fish/100 m; Figure 4.115), when only two fish were captured. No *Hybognathus* were captured with otter trawls during sampling years 2004 and 2005. From the 2003 sampling year to the 2006 sampling year, the mean otter trawl CPUE increased during the sturgeon season, resulting in an increase in overall mean CPUE from 0.003 fish/100 m to 0.009 fish/100 m, respectively. Relative abundance estimates of *Hybognathus* captured with mini-fyke nets, deployed only during the fish community season, have increased from sampling year 2003 to 2005, while decreasing during 2006 to a mean CPUE of approximately 0.5 fish/net night (Figure 4.116).

During the sturgeon and fish community seasons, most *Hybognathus* were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred (Table 4.61). Main channel crossovers were also sampled with a relatively large effort, which resulted in proportional catches during both seasons. Otter trawls captured all 32 fish during the sturgeon season and two fish during the fish community season (<1% of the seasonal catch). Sand bar mesohabitats were the location from where nearly all of the *Hybognathus* were captured with mini-fyke nets (Table 4.62).

For all of the *Hybognathus* captured in the lower basin during the 2006 sampling year, lengths ranged from 20 to 150 mm, with a mode near 45 mm (Figure 4.117).

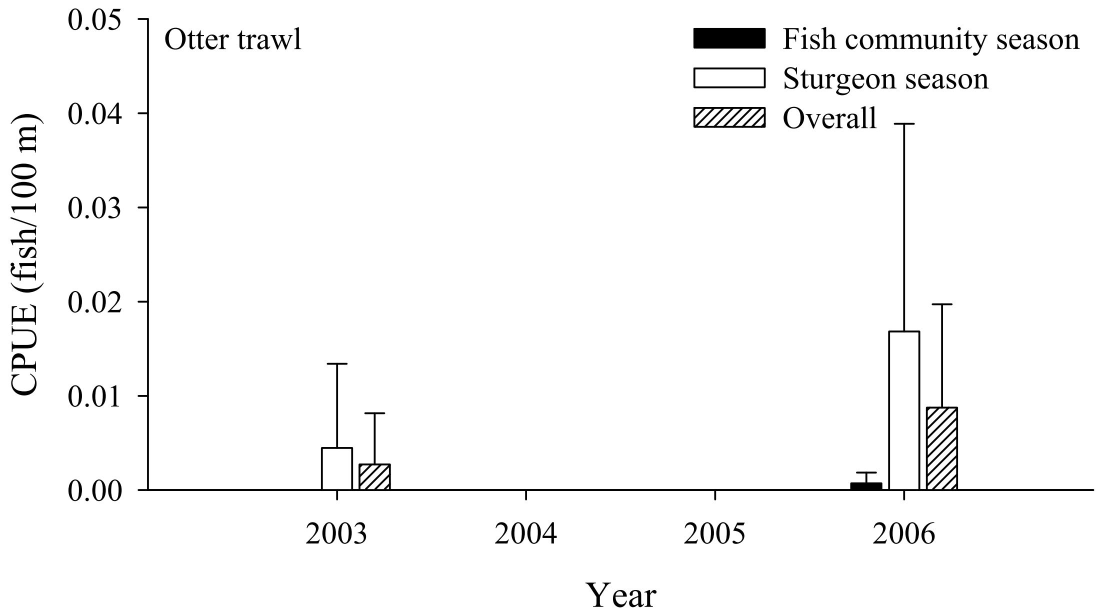

Figure 4.115. Mean annual catch per unit effort (± 2 SE) by season for *Hybognathus* spp. using otter trawls in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

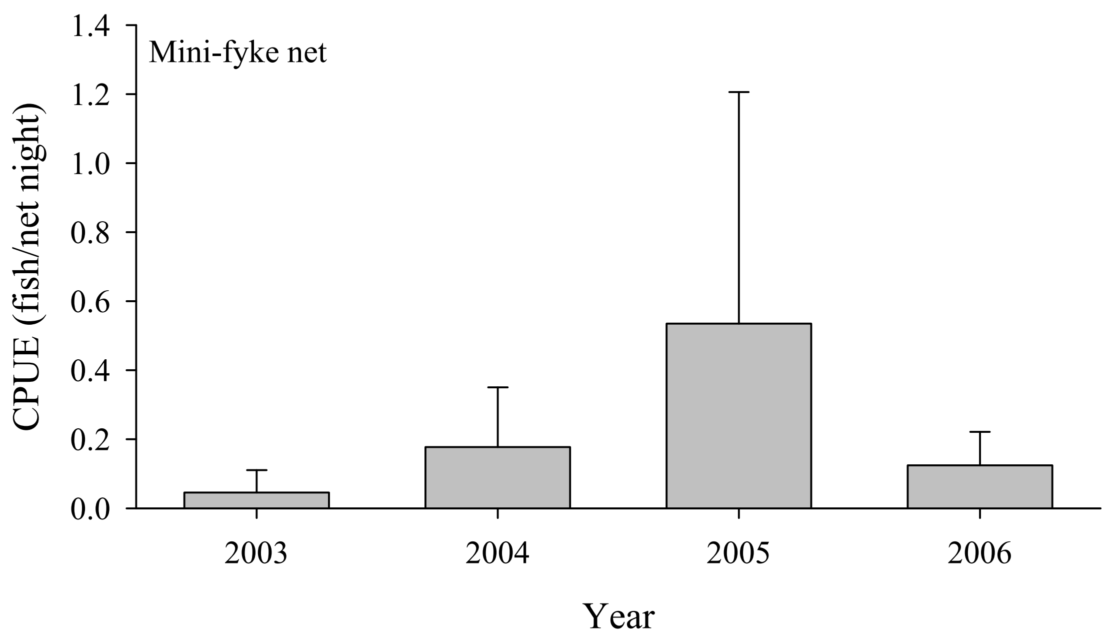

Figure 4.116. Mean annual catch per unit effort (± 2 SE) by season for *Hybognathus* spp. using mini-fyke nets in the lower basin of the Missouri River for the 2003 to 2006 sampling years.

Table 4.61. Total number of *Hybognathus* spp. captured for each gear during each season and the percentage caught within each macrohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	N	Macrohabitat													
		BRAD	CHXO	CONF	DEND	DRNG	ISB	OSB	SCCL	SCCS	SCCN	TRIB	TRML	TRMS	WILD
Sturgeon Season (Fall through Spring)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(4.3)	(22.3)	(1.5)	(1.4)	(1.5)	(58.4)	(4.2)	(4.7)	(1.0)	(0)	(0)	(0)	(0)	(0.8)
Gill Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(3.2)	(24.5)	(0.6)	(0.5)	(0.8)	(59.3)	(7.9)	(2.5)	(0.8)	(0)	(0)	(0.4)	(0)	(0)
Otter Trawl	32	3.1	0	3.1	0	3.1	75.0	0	15.6	0	0	0	0	0	0
		(6.6)	(22.3)	(0.9)	(1.3)	(0.8)	(56.0)	(4.4)	(5.3)	(1.8)	(0)	(0)	(0.6)	(0)	(0)
Fish Community Season (Summer)															
1-Inch Trammel Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		(4.4)	(23.2)	(0.9)	(1.0)	(1.0)	(62.5)	(3.9)	(2.2)	(0.9)	(0)	(0)	(0)	(0)	(0)
Mini-Fyke Net	90	1.1	13.3	0	0	0	81.1	1.1	0	3.3	0	0	0	0	0
		(6.5)	(19.9)	(0.4)	(0.3)	(0.3)	(46.8)	(8.4)	(3.1)	(11.4)	(0.3)	(0.3)	(0.3)	(2.1)	(0)
Otter Trawl	2	0	0	0	50.0	0	0	0	50.0	0	0	0	0	0	0
		(5.5)	(23.4)	(0.6)	(0.7)	(1.0)	(60.5)	(3.3)	(3.4)	(1.2)	(0)	(0)	(0.4)	(0)	(0)

Table 4.62. Total number of *Hybognathus* spp. captured for each gear during each season and the percentage caught within each mesohabitat type in the lower basin of the Missouri River in the 2006 sampling year. The percent of total effort for each gear in each habitat is presented on the second line of each gear type.

Gear	**N**	**Mesohabitat**					
		BARS	CHNB	DTWT	ITIP	POOL	TLWG
Sturgeon Season (Fall through Spring)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(97.3)	(0.8)	(1.9)	(0)	(0)
Gill Net	0	0	0	0	0	0	0
		(0)	(59.0)	(0)	(1.6)	(39.4)	(0)
Otter Trawl	32	0	100.0	0	0	0	0
		(0)	(96.9)	(0)	(2.8)	(0.3)	(0)
Fish Community Season (Summer)							
1-Inch Trammel Net	0	0	0	0	0	0	0
		(0)	(98.4)	(0)	(1.6)	(0)	(0)
Mini-Fyke Net	90	100.0	0	0	0	0	0
		(97.6)	(1.2)	(0)	(1.2)	(0)	(0)
Otter Trawl	2	0	100.0	0	0	0	0
		(0)	(98.0)	(0)	(2.0)	(0)	(0)

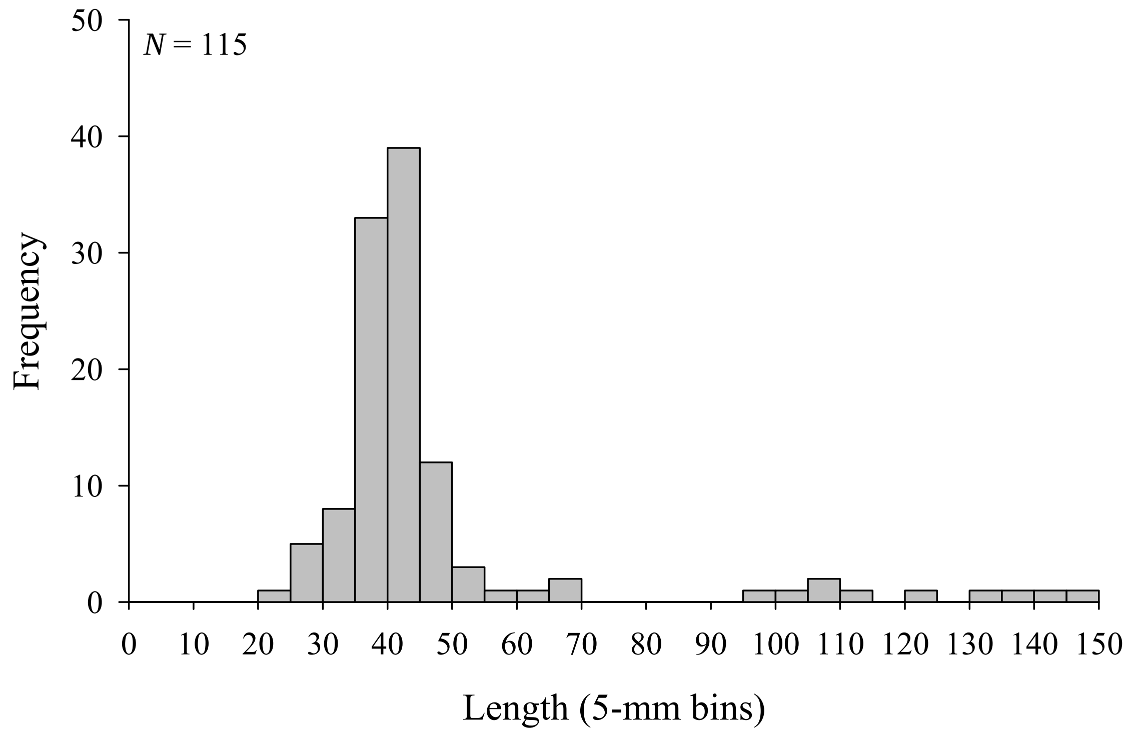

Figure 4.117. Length frequency distribution of *Hybognathus* spp. captured in the lower basin of the Missouri River during the 2006 sampling year using random and nonrandom sampling with standard and wild gears.

5.0 Discussion

Pallid Sturgeon

Stocking was initiated in the early 1990s in attempt to augment the pallid sturgeon population in the Missouri River system (see Appendices C, D, and E). Pallid sturgeon from ten year classes (i.e., 1992, 1997-1999, 2001-2006) were released in the Missouri River from 1994 - 2006. During that time 291,516 pallid sturgeon were released (juvenile N = 62,358; fingerling N = 74,158; fry N = 155,000). Of the 291,516 pallid sturgeon stocked in the Missouri River, 212,580 were stocked in the upper basin, 4,242 were stocked in the lower basin from Fort Randall Dam downstream to the headwaters of Lewis and Clark Lake, and the remaining 74,694 pallid sturgeon were stocked in the lower basin of the Missouri River from Gavins Point Dam downstream to the confluence with the Mississippi river (Appendices C, D, and E).

Two hundred twenty-two pallid sturgeon were sampled in the Missouri River during the 2006 sampling year. One hundred eighty-six were sampled with standard gears while thirty-six were sampled using wild gears (green dyed gill and trammel nets N = 31, other wild gears N = 5). Seventy percent (N = 130) of the individuals captured with standard gear types were sampled randomly while thirty percent (N = 56) were sampled using non-random methods. Overall, standard otter trawls were the most effective gear for sampling pallid sturgeon in the Missouri River in 2006. Standard otter trawls sampled 76 pallid sturgeon, followed by standard trammel nets (N = 67) and standard gill nets (N = 43). Eighty-eight of the pallid sturgeon sampled in the Missouri River in 2006 were captured in the upper basin while 134 were sampled in the lower basin. In the upper basin, the standard otter trawl was the most effective gear for sampling pallid sturgeon as 54% of the sampled pallid sturgeon were captured using standard otter trawls. Standard trammel nets sampled an additional 42% of the pallid sturgeon in the upper basin. However, gill nets were the most effective gear for sampling pallid sturgeon in the lower basin of the Missouri River (32% of the catch), followed by standard trammel nets (22% of the catch) and standard otter trawls (21% of the catch). Gill nets were not implemented in the upper basin of the Missouri River; thus, the overall catch of pallid sturgeon is likely a poor indicator of which gear is the most effective for sampling pallid sturgeon.

Few inferences can be made regarding seasonal relative abundance of wild origin pallid sturgeon due to low sample size. Hatchery-reared pallid sturgeon relative abundance was similar between the sturgeon and fish community seasons in 2006 (Figure 4.6). However, a difference in seasonal relative abundance trends was observed between basins. In the upper basin, mean CPUE was generally greater during the fish community season than sturgeon season, whereas mean CPUE was generally greater in the sturgeon season than fish community season in the lower basin (Figure 4.14 and Figure 4.17). It is unlikely that major shifts in seasonal relative abundance estimates reflect changes in the true population abundance or the balance between mortality and recruitment to gears in the lower basin of the Missouri River. One possible explanation is that gear efficiency changes throughout the year based on environmental factors (e.g., discharge, velocity, turbidity, suspended woody debris). Another possibility is that seasonal changes in fish behavior affect sampling efficiency. For example, during certain times of the year fish may move into tributaries or habitat types that are not sampled or that are sampled but where gear efficiency is diminished (e.g., different microhabitat types and water depths). Lastly, gear sampling efficiency may be altered by changes in activity level and diel movement patterns throughout the year.

Overall, annual relative abundance of hatchery-reared pallid sturgeon appears to be have increased from 2005 to 2006 in the Missouri River (Figure 4.7). This is not surprising as hatchery-reared pallid sturgeon have continually been stocked in the Missouri River since 2001 and mortality may be low in these relatively young fish. The trend of increasing relative abundance was observed in the lower basin from 2003 to 2006 (Figure 4.18). However, a slight decrease in mean CPUE from 2005 to 2006 was observed in the upper basin of the Missouri River (Figure 4.15). Relative abundance of wild pallid sturgeon appears have decreased from 2003 to 2006 in the Missouri River. This is also not surprising as little natural recruitment has been documented for pallid sturgeon and the majority of the remaining wild fish are in senescence.

The seasonal geographic distribution analysis yielded limited information. In the upper basin, mean CPUE of pallid sturgeon was generally greater during the fish community season than during the sturgeon season while the opposite trend was observed in the lower basin (Figure 4.8 and Figure 4.9). The number of bends that were sampled each year in the Missouri River has been increasing since 2003; thus, more information is available for 2006 than for the previous years regarding geographic distribution. Although relative abundance increased from 2003 to 2006, geographic distribution of pallid sturgeon was relatively similar among years. In the upper basin, it appears that relative abundance is greater in the middle and lower reaches than in the upper reaches with very few pallid sturgeon utilizing the reach immediately downstream of Fort Peck Dam. In the lower basin, relative abundance was generally greater in the upper reaches than in the lower reaches.

Inside bends appear to be important macrohabitats for juvenile (< 840 mm) pallid sturgeon in the Missouri River as the majority of randomly sampled pallid sturgeon were captured within this habitat type and the percentage of fish captured was generally greater than the percentage of effort allocated within inside bends (Table 4.7). Large and small connected secondary channels and braided channels may also be important macrohabitats as the percentage of fish captured was greater than the percentage of effort allocated to those macrohabitats for at least one gear type. However, relatively little effort was put into sampling these macrohabitats; thus, further investigation is warranted. Channel crossover may be a less important macrohabitat for juvenile pallid sturgeon as few individuals were caught relative to the amount of effort put forth in these areas. Few inferences can be made regarding habitat associations for juvenile pallid sturgeon for all remaining macrohabitat types as little effort was applied in these areas (Table 4.7, Table 4.11, and Table 4.15). Adult (≥ 840 mm) pallid sturgeon were sampled within braided channel, channel crossover, and inside bend macrohabitats (Table 4.9). Habitat associations for adult pallid sturgeon are difficult to evaluate due to the low number sampled. Interestingly, adult pallid sturgeon were sampled only during the sturgeon season using gill nets in the lower basin of the Missouri River, whereas, adult pallid sturgeon were sampled only during the fish community season within the upper basin.

Channel border appears to be an important mesohabitat for juvenile pallid sturgeon. The majority of juvenile pallid sturgeon were sampled within channel border habitats which was congruent with the amount of sampling effort allocated to these areas (Table 4.8). Pools may also be an important mesohabitat for juvenile pallid sturgeon; however, it appears that gill nets were the only gear type to effectively sample pool mesohabitat for juvenile pallid sturgeon. Further, pool mesohabitats were not sampled in the upper basin of the Missouri River as gill nets are not employed in this area (Table 4.12). Few inferences can be made regarding remaining mesohabitat types due to low sampling effort in those areas. Adult (≥ 840 mm) pallid sturgeon were sampled within channel border and pool mesohabitats (Table 4.10). Mesohabitat associations for adult pallid sturgeon are difficult to evaluate due to the low number sampled.

Length was recorded for 222 pallid sturgeon sampled in the upper and lower basins of the Missouri River in 2006. Little difference in length frequency distributions exists between random versus random and nonrandom sampling (Figure 4.13). This suggests that there was no length bias associated with nonrandom sampling or that the small sample sizes observed for these distributions were not great enough for bias to be recognized. Little difference was observed between the upper and lower basin length frequency distributions. However, fewer fish were sampled within the upper basin and a greater range of lengths were observed as compared to the lower basin (Figure 4.16 and Figure 4.20). Further, these length frequency data must be interpreted cautiously due to the size selectivity of different gear types. The 2006 pallid sturgeon length frequency distribution for the Missouri River yields little information as it likely misrepresents the true size structure of the population (Neumann and Allen 2007); however, it will be useful for monitoring for change among years.

Shovelnose Sturgeon

During the 2006 sampling season 15,465 shovelnose sturgeon were sampled in the upper and lower basins of the Missouri River. Of those, 87% (N = 13,524) were sampled using standard gears, while 13% (N = 1941) were sampled using wild gears. Further, 12,639 of the shovelnose sturgeon that were captured in 2006 were randomly sampled using the four primary standard gear types (i.e., trammel net, otter trawl, mini-fyke net, gill net). Gill nets were clearly the most effective gear for sampling shovelnose sturgeon followed by trammel nets and otter trawls as 57% (N = 7252) of the shovelnose sturgeon that were randomly sampled with primary standard gear types were captured with gill nets, 26% (N = 3328) were sampled with trammel nets, and 16% (N = 2056) were sampled using otter trawls. However, standard trammel nets were the most effective gear for sampling shovelnose sturgeon in the upper basin as gill nets were not used in this area.

Overall, it appears that shovelnose sturgeon relative abundance declined from 2005 to 2006 in the Missouri River (Figure 4.22). Similarly, it appears that relative abundance has been decreasing from 2003 to 2006 in the lower basin (Figure 4.31). This trend was epitomized through random sampling with gill nets in the lower basin (Figure 4.32). It is unknown whether the decrease in relative abundance is a reflection of changes in the actual abundance of shovelnose sturgeon within the Missouri River. An alternative hypothesis is that the smaller sample sizes observed during the first two years of this study yielded unreliable results. Another possibility is that the actual abundance of shovelnose sturgeon was lower in the areas that were not sampled during 2003 and 2004, thus decreasing mean CPUE in 2005 and 2006 when these areas were sampled. Although the cause of the decline in shovelnose sturgeon relative abundance is currently unknown, more years of sampling and close monitoring may allow managers to determine whether the decline is a reflection of actual abundance of shovelnose sturgeon. In general, random sampling with trammel nets yielded greater CPUE during the fish community season as opposed to the sturgeon season. No general trend in seasonal relative abundance of shovelnose sturgeon was observed for otter trawl sampling. Further, CPUE was generally greater in the lower basin than the upper basin of the Missouri River. This was further demonstrated by the geographic distribution analysis where CPUE generally increased with decreasing river mile. Although it appears that shovelnose sturgeon relative abundance has declined from 2003 to 2006 (within the lower basin), no other major trends in seasonal or annual geographic distribution were observed.

Random sampling in the Missouri River yielded little information regarding habitat associations of shovelnose sturgeon (Table 4.19). The majority of sampling effort was conducted in inside bend and channel crossover macrohabitats. It appears that the percentage of shovelnose sturgeon captured in inside bends was greater than the percentage of effort allocated to these macrohabitats for most gear types during both seasons. An opposite trend was observed in channel crossover habitats, suggesting that shovelnose sturgeon use this macrohabitat less than inside bends or that the primary standard gear types are more efficient in inside bend habitats. Although low numbers of individuals sampled makes inferences regarding habitat associations difficult to evaluate, it appears that shovelnose sturgeon had positive associations with large and small connected secondary channels and tributary confluence macrohabitats, whereas a negative association was observed in braided channels. However, it is unknown whether these associations are the product of habitat use or differences in efficiency among gears and habitat types. No associations could be made regarding the remaining macrohabitat types due to low effort put forth in these areas.

The preponderance of sampling effort was put forth in channel border mesohabitats where the highest percentage of shovelnose sturgeon were sampled. Shovelnose sturgeon also appear to utilize island tip mesohabitats as capture percentages were similar to effort percentages in these areas; however, sampling effort was low for island tip mesohabitat. Further, shovelnose sturgeon appear to have an affinity for pool mesohabitats as the percentage of capture was greater than the percentage of sampling effort with gill nets in these areas. Shovelnose sturgeon appear to be using the same mesohabitats in the upper and lower basins. However, no information is available regarding pool mesohabitats in the upper basin as pools were not sampled and gill nets were not implemented within the upper basin. Sampling effort was too low to make inferences regarding habitat associations for all other mesohabitat types in 2006.

Length was recorded for 15,113 shovelnose sturgeon sampled in the Missouri River in 2006. The majority of those fish (N = 14,117) were sampled in the lower basin, whereas only 996 fish were sampled in the upper basin. The length frequency distribution for the upper basin has a greater proportion of smaller fish relative to the entire distribution than does the distribution for the lower basin. This is likely a result of gill nets not being implemented in the upper basin; thus, a greater proportion of larger fish are sampled in the lower basin. Little difference exists between random versus random and nonrandom sampling length frequency distributions for shovelnose sturgeon

(Figure 4.28). This suggests that there was little length bias associated with nonrandom sampling. Further, these length frequency data must be interpreted cautiously due to size selective bias associated with different gear types. The 2006 shovelnose sturgeon length frequency distribution for the Missouri River yields little information as it likely misrepresents the true size structure of the population (Neumann and Allen 2007); however, it has utility in making comparisons between basins and will be useful for monitoring for change among years.

Sturgeon Chub

Otter trawls were the most effective gear for sampling sturgeon chub in the Missouri River in 2006. Standard otter trawls captured 61% (N = 1031) of the sturgeon chub sampled in 2006. Wild otter trawls sampled an additional 16% (N = 271) while beam trawls captured 23% (N = 382). Relative abundance of sturgeon chub increased in the Missouri River from 2005 to 2006 (Figure 4.31). However, mean CPUE in the upper basin decreased during this time (Figure 4.39). In the lower basin, a general trend of increasing relative abundance was observed from 2003 to 2006 (Figure 4.41). No discernable trend existed in seasonal relative abundance of sturgeon chub within the Missouri River for 2006. However, mean CPUE was generally greater during the fish community season compared to the sturgeon season in the lower basin from 2003 to 2006.

Although no seasonal differences existed in geographic distribution of sturgeon chub, relative abundance was greater in the upper basin than the lower basin in 2006 (Figure 4.36). It is difficult to make inferences regarding annual geographic distribution of sturgeon chub as relatively little sampling was conducted prior to 2005. However, within the lower basin the greatest relative abundance of sturgeon chub appears to be between RMs 360 and 600.

Sturgeon chub catches were congruent with the amount of effort put into each macro- and mesohabitat type (Table 4.26 and Table 4.27). It is clear that sturgeon chub utilize channel crossover, inside bend, and large connected secondary channel macrohabitats. However, more effort is needed within other macrohabitats to determine if they are utilized by sturgeon chub. Similarly, channel border habitats are the only mesohabitat sampled enough to make any habitat associations. Sturgeon chub clearly utilize this mesohabitat type as the vast majority of fish were sampled in this habitat.

Although bias does exist and population structure should be interpreted cautiously, the length frequency distribution for sturgeon chub likely portrays a more accurate estimate of the true population structure than the distributions for other Missouri River species as gear types with small mesh size (i.e., otter trawls, beam trawls) sampled nearly all of the sturgeon chub in 2006, reducing mesh size bias for all but the smallest of individuals. It appears that sturgeon chub are generally larger in the upper basin compared to the lower basin as the upper basin length frequency distribution contains a greater proportion of large individuals (> 45 mm). Although comparisons in population structure between basins yield interesting results, the greatest utility of the length frequency distribution for sturgeon chub will be in monitoring for change among years.

Sicklefin Chub

Similar to sturgeon chub, the standard otter trawl was the most effective gear for sampling sicklefin chub in the Missouri River in 2006. Standard otter trawls captured 68% (N = 1050) of the 1551 sicklefin chub sampled in 2006. Wild otter trawls captured an additional 25% (N = 392), while beam trawls and mini-fyke nets captured 6% and 1%, respectively. Little difference was observed in the seasonal relative abundance of sicklefin chub (Figure 4.44). However, mean CPUE decreased from 2005 to 2006 in both the upper and lower basins of the Missouri River and had a general trend of decreasing since 2004 in the lower basin (Figure 4.50 and Figure 4.53). Despite the trend of decreasing relative abundance, mean CPUE from random sampling with otter trawls for the lower basin in 2006 was similar to that in 2003. However, random sampling with mini-fyke nets yielded a similar trend of increasing relative abundance from 2003 to 2004 and decreasing relative abundance after 2004, yet the mean CPUE in 2006 was drastically lower than that in 2003. It is clear that sicklefin chub relative abundance has been decreasing since 2004; however, more sampling will be required to determine whether this is the product of natural variability or an actual decline in abundance.

Geographic distribution of sicklefin chub in the Missouri River was similar between sampling seasons in 2006. Based on random sampling with otter trawls, it appears that sicklefin chub had a trend of increasing relative abundance with decreasing river mile in both the upper and lower basins, with the greatest mean CPUEs from RM 0 to 400 (Figure 4.47). Although limited sampling was conducted in 2003 and 2004, it appears that mean CPUEs in 2006 in the lower basin were similar to those observed in 2003.

The majority of sampling was conducted in inside bend macrohabitat in 2006. In these areas, sicklefin chub capture percentages were greater than sampling effort percentages for both the upper and lower basins suggesting that inside bends are important habitat for sicklefin chub (Table 4.33 and Table 4.35). Sicklefin chub had a positive association with outside bends in the upper basin while capture percentages were lower than effort percentages in the lower basin. However, little effort was put into sampling outside bends in the lower basin. Channel crossovers were also utilized by sicklefin chub as percentage of capture was generally similar to percentage of effort in these areas (Figure 4.35). Interestingly, sicklefin chub appeared to use large connected secondary channels less than other areas. More effort is needed in all other macrohabitat types in order to determine sicklefin chub habitat associations in these areas. Channel border mesohabitats were clearly utilized by sicklefin chub. More sampling needs to be conducted in order to determine habitat associations in all other mesohabitat types.

Similar to sturgeon chub, sicklefin chub were generally larger in the upper basin compared to the lower basin as the upper basin length frequency distribution contained a greater proportion of large individuals (> 65 mm; Figure 4.52 and Figure 4.55). Although comparisons in population structure between basins yielded interesting results, the greatest utility of the length frequency distribution for sturgeon chub will be in monitoring for change among years.

Speckled Chub

Speckled chub were only sampled within the lower basin of the Missouri River in 2006. Congruent with other targeted Missouri River *Macrhybopsis* species, otter trawls were the most effective gear for sampling speckled chub in the lower basin. Standard otter trawls sampled 41% (N = 1507) of the total catch, while wild otter trawls sampled an additional 53% (N = 1951). Push trawls and mini-fyke nets sampled 4% and 1% of the total catch, respectively.

Mean CPUE of speckled chub randomly sampled with otter trawls was generally greater during the sturgeon season when compared to the fish community season (Figure 4.57). Although mean annual CPUE in the lower basin was greater for speckled chub than the other two *Macrhybopsis* species, the same general trend in annual relative abundance from 2003 to 2006 was observed among these three species. However, speckled chub mean CPUE did not decrease from 2005 to 2006 as was observed for sturgeon chub and sicklefin chub. With the exception of a large increase in mean CPUE in 2004, speckled chub relative abundance has shown an increasing trend since the inception of sampling in 2003 (Figure 4.57). However, the relative abundance of speckled chub sampled with mini-fyke nets has decreased since 2004 (Figure 4.58). This trend may be indicative of speckled chub using less shallow water habitat in 2006 than in previous years.

Although no seasonal differences existed in geographic distribution of speckled chub in the lower basin, a general trend of increasing relative abundance with decreasing river mile was observed (Figure 4.60 and Figure 4.61). It is difficult to make inferences regarding annual geographic distribution of sturgeon chub as relatively little sampling was conducted prior to 2005. However, little difference was observed in geographic distribution of sturgeon chub among years.

The preponderance of speckled chub were sampled from inside bend macrohabitats where the majority of effort was focused (Table 4.37). Channel crossover as well as large and small connected side channel macrohabitats also appeared to be important speckled chub habitat as the percentage of capture exceeded the percentage of effort for mini-fyke net sampling in those habitats. Further, although it is likely that all four of the aforementioned macrohabitats are important speckled chub habitats, it appears that the ratio of percentage of catch to percentage of sampling effort may reflect gear efficiency in each macrohabitat type as much or more than abundance within each habitat. For example, random sampling with mini-fyke nets yielded a negative association in inside bend habitats and a positive association in large connected secondary channels, whereas random sampling with otter trawls yielded an opposite trend (Table 4.37). It is difficult to make inferences regarding other macrohabitat types as sampling effort was low in these areas. Sand bar, channel border, and island tip mesohabitat sampling produced catch percentages of speckled chub similar to the percentage of effort exerted for both otter trawl and mini-fyke net sampling. No other mesohabitat types were sampled with adequate effort for otter trawl and mini-fyke net; thus, no inferences can be made regarding speckled chub habitat associations in these mesohabitats.

Blue Sucker

Of the 3262 blue suckers sampled in the Missouri River in 2006, 87% (*N* = 2841) were sampled with standard gears while 13% (*N* = 421) were sampled using wild gear types. Trammel net was the most effective gear type for sampling blue suckers in the Missouri River in 2006. One-inch trammel nets sampled 34% (*N* = 956) of the blue suckers captured with standard gears, while 2.5-inch trammel nets sampled an additional 22% (*N* = 622) of the catch. Gill nets were also an effective gear type sampling 30% (*N* = 850) while otter trawls sampled 14% (*N* = 411) of the catch.

Mean CPUE of blue suckers was generally greater during the fish community season compared to the sturgeon season for sampling conducted with both trammel nets and otter trawls (Figure 4.60). Possible explanations for the differences observed in seasonal relative abundance may be related to the efficiency of gears during different seasons or blue suckers may utilize less sampled habitats more during the sturgeon season. Although there were slight changes in mean CPUE between years for the upper basin, blue sucker relative abundance was relatively stable from 2005 through 2006. Further, although random sampling with one-inch trammel nets demonstrated little change in relative abundance from 2003 through 2006, random sampling with otter trawls and gill nets yielded a trend of increased mean CPUE during this time within the lower basin.

Based on random sampling with trammel nets and otter trawls, little difference existed in seasonal geographic distribution of blue sucker in 2006 (Figure 4.65 and Figure 4.66). Based on random sampling conducted with one-inch trammel nets and otter trawls, it is clear that relative abundance of blue sucker was greater in the upper reaches of the lower basin (RM 392 to 780) than below that location (Figure 4.67 and Figure 4.68). Random sampling with gill nets confirmed this trend, particularly from RM 605 to 780 (Figure 4.69).

Inside bends appear to be an important macrohabitat for blue suckers as the percentage of blue suckers captured in inside bends was generally greater than the proportion of effort but into inside bends during both seasons (Table 4.39). Braided channels, channel crossovers, outside bends, and large and small connected secondary channels are all used by blue suckers; however, the percentage of blue suckers captured in these macrohabitats was generally less than the percent of effort allocated to these areas. Thus, blue suckers likely inhabit these areas less than inside bends, or most gear types are not as efficient in sampling these areas. However, random sampling with gill nets yielded positive habitat association with blue suckers for braided channel and small and large connected secondary channel habitats. This discrepancy demonstrates that gear efficiency relative to habitat type may be reflected in habitat association figures more than habitat use of blue suckers. Further, although there was a negative association of blue suckers and outside bend macrohabitats overall in the Missouri River, the percentage of capture far exceeded the percentage of effort within this habitat type for the upper basin (Table 4.41). Not enough effort was allocated to remaining macrohabitat types to make inferences regarding habitat associations. Percentage of catch was similar to percentage of effort in channel border habitat for trammel net and otter trawl sampling indicating that this is likely an important mesohabitat type (Table 4.40). Conversely, gill net data suggests that channel borders were less important mesohabitat, as 45% of the catch came from 59% of the effort in these areas. This idiosyncrasy epitomizes the impact that gear efficiency under various conditions may have on apparent habitat associations and relative abundance results. It also demonstrates the importance of using multiple gears to sample different habitat types and that caution is necessary in the interpretation of habitat association data. Pools were also utilized by blue suckers as 50% of the blue sucker gill net catch came from pool mesohabitat while only 39% of the effort was allocated to these areas. Not enough sampling effort was conducted in remaining mesohabitat types to make inferences on blue sucker habitat associations in these areas.

Little difference exists between random versus random and nonrandom sampling length frequency distributions for blue sucker (Figure 4.70). This suggests that there was no length bias associated with nonrandom sampling or that the small sample sizes observed for these distributions were not great enough for bias to be recognized.

Interestingly, only one fish less than 63 cm was captured in the upper basin in 2006 whereas 63 cm was near the modal length of the distribution for the lower basin (Figure 4.72 and Figure 4.71). It is possible that juvenile blue suckers in the upper basin rear in tributaries to the Missouri River outside the sampling area (e.g., in the Yellowstone River); however, mean CPUEs in the lower basin were much greater than those in the upper basin suggesting that the population of blue suckers in the upper basin may be in senescence. The discrepancy between the catch of small blue suckers in the upper and lower basins is likely not related to differential gear type use between the basins as the primary difference is with gill net sampling and gill nets tend to sample larger individuals. Further investigation into the lack of small individuals sampled within the upper basin is warranted.

Sauger

Of the 947 sauger sampled in the Missouri River in 2006, 785 were sampled with standard gears while 162 were sampled using wild gear types. Overall, random sampling with gill nets was the most effective method for sampling sauger in the Missouri River. Gill nets captured 30% (N = 236) of the sauger sampled with standard gears, trammel nets sampled 29% (N = 224), otter trawls sampled 25% (N = 197), and mini-fyke nets sampled 16% (N = 128). However, trammel nets were the most effective gear for sampling sauger in the upper basin as gill nets were not used in this area. In the upper basin trammel nets sampled 48% (N = 166) of the total catch of sauger. Interestingly, trammel nets were one of the least effective gears in the lower basin capturing only 13% (N = 58) of the total catch in that area despite the fact that nearly three times the trammel net effort was applied in the lower basin compared to the upper basin.

No general trend was apparent in seasonal relative abundance for sauger sampled with trammel nets or otter trawls (Figure 4.77). Despite idiosyncrasies in mean annual CPUE among gear types, sauger relative abundance appears to be stable. In the upper basin, random sampling with trammel nets and mini-fyke nets yielded a decrease in mean CPUE from 2005 to 2006, whereas otter trawl sampling yielded an increase during that time. In the lower basin, random sampling with trammel nets and otter trawls demonstrated a decrease in annual mean CPUE from 2003 to 2004 and then an increase from 2004 to 2006. Sampling with gill nets showed a trend of decreased mean CPUE from 2003 to 2006, whereas sampling with mini-fyke nets showed an increase during this period. Overall, the relative abundance of sauger appears to be greater in the upper basin than in the lower basin.

No seasonal trends were observed in the seasonal geographic distribution of sauger in 2006 or in the annual geographic distribution from 2003 to 2006. However, mean CPUE was greater throughout the Missouri River in 2006 when compared with 2005.

Sauger appear to be strongly associated with braided channel, channel crossover, outside bend, and large connected secondary channel habitat as the percentage of sauger captured in these areas was generally greater than the percentage of effort put into these macrohabitats for most gears and across both seasons (Table 4.45). Further, the majority of sampling effort was allocated to inside bend macrohabitat where relatively few individuals were captured, suggesting that inside bends are utilized less than the aforementioned macrohabitats by sauger. Remaining macrohabitat types were not sampled with enough effort to make inferences regarding macrohabitat associations. Sand bar, channel border, island tip, and pool mesohabitats all appear to be utilized by sauger (Table 4.46). The importance of sampling with multiple gears was epitomized by sauger habitat associations. For example, trammel net, mini-fyke net, and otter trawl sampling resulted in positive associations for sauger in channel border mesohabitats, whereas random sampling with gill nets yielded a negative association. However, gill nets were the only gear to demonstrate that sauger were using pool habitat. Further, mini-fyke net was the only gear type that effectively sampled sand bar and island tip mesohabitat types for sauger.

Little difference existed between random versus random and nonrandom sampling length frequency distributions for sauger (Figure 4.85), suggesting that there was no length bias associated with nonrandom sampling or that the small sample sizes observed for these distributions were not great enough for bias to be recognized. The length frequency distributions of sauger sampled in the upper versus lower basin were similar, albeit sampling in the lower basin yielded a wider distribution of lengths sampled. The bimodal length frequency distribution for sauger can be explained by gear type. The first mode (< 200 mm) was comprised primarily of sauger sampled with bag seines and mini-fyke nets, whereas the preponderance of the second mode (≥ 200 mm) was observations obtained through sampling with gill nets and trammel nets (Figure 4.85 and Figure 5.1). However, sampling with otter trawls and beam trawls resulted in the capture of sauger with a wide range of lengths. Each gear type has differing size selectivity characteristics; thus, the relative population structure must be evaluated with care when comparisons are made between basins or among years, particularly if the amount of effort by each gear type varies.

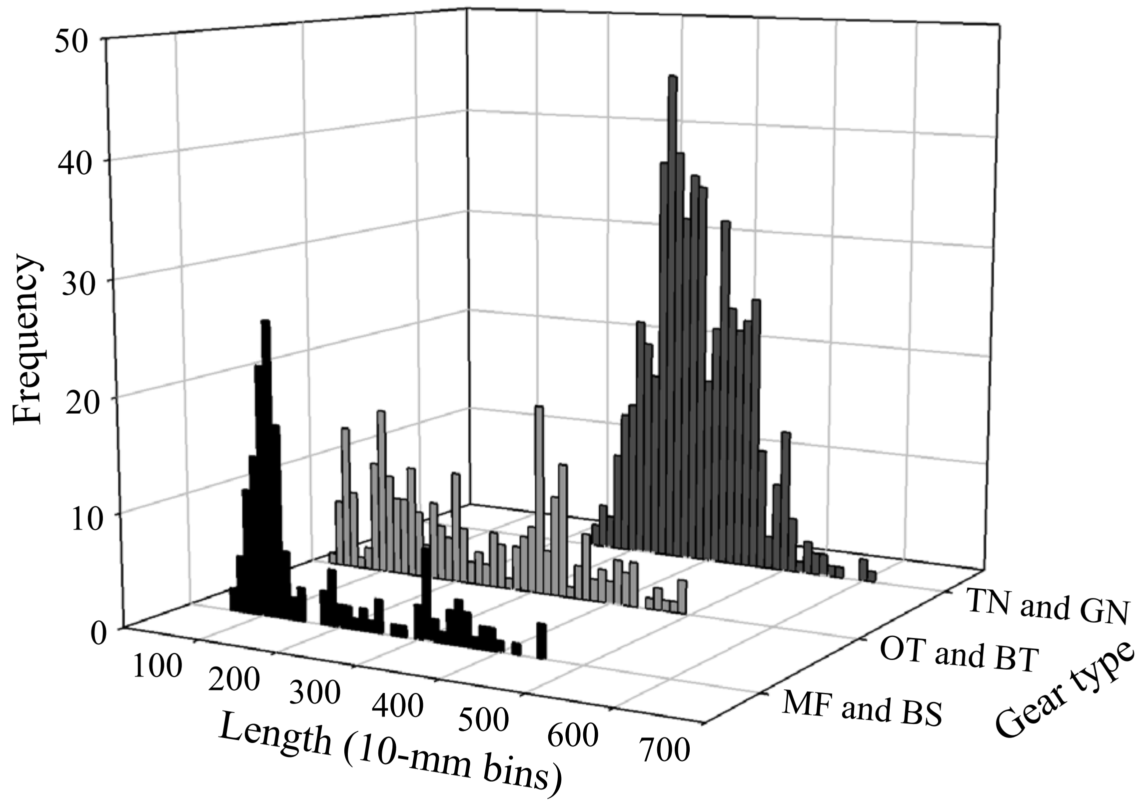

Figure 5.1. Length frequency distribution of sauger captured in the upper and lower basins of the Missouri River during the 2006 sampling year using random and nonrandom sampling by gear type (TN = trammel net, GN = gill net, OT = otter trawl, BT = beam trawl, MF = mini-fyke net, BS = bag seine).

Sand Shiner

Mini-fyke nets were the most effective gear for sampling sand shiners in the Missouri River in 2006. Ninety-eight percent (N = 7275) of the sand shiners sampled in 2006 were sampled with standard gears. Of those, 99% (N = 7115) were sampled with mini-fyke nets. Only 38 sand shiners were sampled using otter trawls; thus, seasonal relative abundance based on otter trawl sampling has little utility. However, mean annual CPUE of sand shiners captured with otter trawls has increased from 2005 to 2006 in the upper basin (Figure 4.99), while it has remained relatively stable in the lower basin from 2003 to 2005 (Figure 4.102). Mean annual CPUE of sand shiner sampled with mini-fyke nets drastically increased from 2005 to 2006 in the upper basin (Figure 4.100) and from 2003 to 2006 in the lower basin (Figure 4.103).

No trends in seasonal or annual geographic distribution were apparent for sand shiners. However, based on random sampling with mini-fyke nets it appears that sand shiners were most abundant in the upper reaches of the both the upper and lower basins, particularly from RM 400 to 800.

Mini-fyke net sampling provides the preponderance of useful information regarding sand shiner habitat associations as very few individuals were sampled using other gear types. As such, it should not be assumed that habitats in which mini-fyke nets did not sample sand shiners are not important as mini-fyke nets may be inefficient in sampling these areas. Based on mini-fyke net sampling, small connected secondary channels, channel crossovers, and inside bends appear to be important sand shiner habitats as the percent of individuals captured in these macrohabitats were greater than the percent of effort exerted (Table 4.51). Although sample size was low, random sampling with otter trawls demonstrated that large connected secondary channels were utilized by sand shiners as well. Interestingly, mini-fyke net sampling in the upper basin yielded a positive association of sand shiners with outside bend macrohabitat (Table 4.53), and a negative association with inside bend macrohabitat. An opposite trend was observed in the lower basin (Table 4.55). However, relatively little effort was exerted in outside bend macrohabitat within the lower basin. Sandbars were the only mesohabitat sampled with enough effort to evaluate. Thus, nearly 100% of the mini-fyke net catch came from sandbar mesohabitat. Further, all sand shiners that were randomly sampled with otter trawls were captured in channel border mesohabitat.

Hybognathus spp.

A total of 923 *Hybognathus* were sampled in the Missouri River in 2006. Mini-fyke nets were the most effective gear type for sampling *Hybognathus* in 2006. Standard mini-fyke nets (ace mesh) captured 56% (N = 519) of the total catch, while wild mini-fyke nets (delta mesh) sampled an additional 15% (N = 142). Bag seines were also an important gear comprising 22% (N = 212) of the total catch of *Hybognathus*. Otter trawls were relatively ineffective for sampling *Hybognathus* as they captured only 48 individuals in the Missouri River in 2006.

Mean CPUE of *Hybognathus* during the sturgeon season was generally greater than during the fish community season. Further, relative abundance of *Hybognathus* was greater in the upper basin compared to the lower basin for sampling conducted with both otter trawls and mini-fyke nets. Mean annual CPUE of *Hybognathus* sampled with mini-fyke nets and otter trawls decreased from 2005 to 2006 in the upper basin of the Missouri River (Figure 4.112 and Figure 4.113). However, more years of sampling will be required to determine if there has been a decline in the *Hybognathus* population as relatively little sampling effort was put forth in the upper basin in 2005. Mean CPUE of *Hybognathus* sampled with otter trawls in the lower basin was greater in 2006 than in the previous three years. However, sampling with mini-fyke nets demonstrated increasing relative abundance of *Hybognathus* from 2003 to 2005 and then a decrease in 2006 in the lower basin (Figure 4.116). Due to the low numbers of *Hybognathus* sampled, little information was obtained from seasonal or annual geographic distribution analysis.

Hybognathus appeared to be strongly associated with inside bend and large connected secondary channel macrohabitats as the percentage of fish captured in these areas was greater than the percentage of effort allocated (Table 4.57). Moreover, *Hybognathus* had a negative association with channel crossover macrohabitat for sampling conducted with both mini-fyke nets and otter trawls. Random sampling with mini-fyke nets demonstrated that *Hybognathus* are utilizing sand bar mesohabitat. *Hybognathus* also appeared to use channel border mesohabitat as 100% of the otter trawl catch was in these areas.

The bimodal length frequency distribution for *Hybognathus* can likely be explained by species. The first mode (< 60 mm) is likely comprised primarily of plains minnows *Hybognathus placitus*, whereas the preponderance of the second mode ($\geq$ 60 mm) is likely western silvery minnow *Hybognathus argyritis* (Figure 4.111 and Figure 5.2). However, caution is urged in the interpretation of inter-species results as *Hybognathus* spp. are difficult to differentiate in the field and may even be confused with other species such as flathead chub *Platygobio gracilis*.

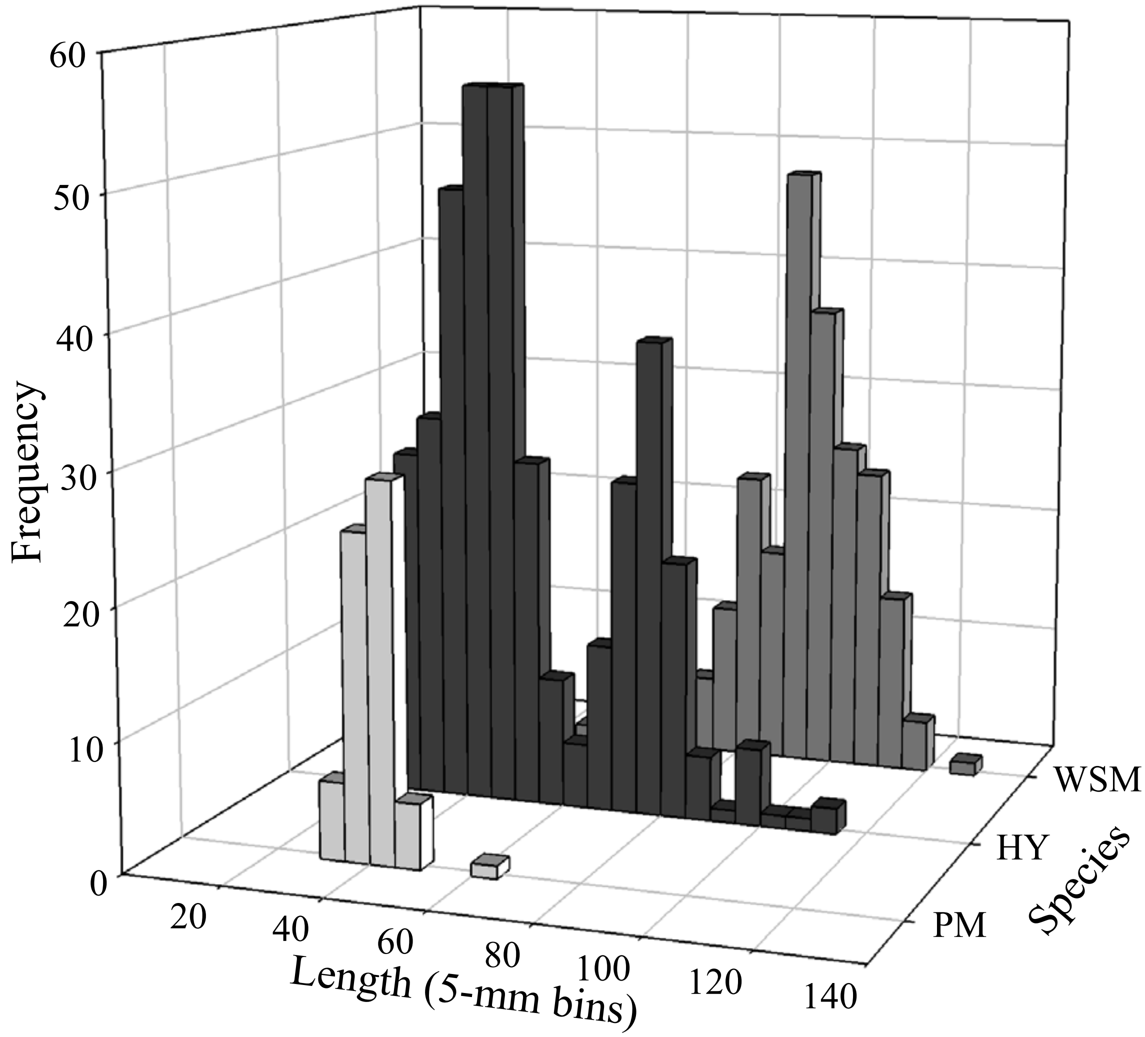

Figure 5.2. Length frequency distribution of *Hybognathus* spp. captured in the upper and lower basins of the Missouri River during the 2006 sampling year using random and nonrandom sampling by species (PM = plains minnow, HY = undifferentiated *Hybognathus* spp., WSM = western silvery minnow)

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8.0 Appendices

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

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

Appendix B. 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 for the long-term pallid sturgeon and associated fish community sampling program.

Gear	Code	Type	Season	Years	CPUE units
Trammel net – 1-inch inner mesh	TN	Standard	All	2003 - Present	fish/100 m drift
Trammel net – 2.5-inch inner mesh	TN25	Standard	Sturgeon	2005 - Present	fish/100 m drift
Gillnet – 4 meshes, small mesh set upstream	GN14	Standard	Sturgeon	2003 - Present	fish/net night
Gillnet – 4 meshes, large mesh set upstream	GN41	Standard	Sturgeon	2003 - Present	fish/net night
Gillnet – 8 meshes, small mesh set upstream	GN18	Standard	Sturgeon	2003 - Present	fish/net night
Gillnet – 8 meshes, large mesh set upstream	GN81	Standard	Sturgeon	2003 - Present	fish/net night
Otter trawl – 16-ft head rope	OT16	Standard	All	2003 - Present	fish/100 m trawled
Otter trawl – 16-ft SKT 4mm x 4mm HB2 MOR	OT01	Wild	Fish Comm.	2006 - Present	fish/100 m trawled
Push Trawl – 8-ft 4mm x 4mm	POT02	Wild	Fish Comm.	2006 - Present	fish/ m trawled
Beam trawl	BT	Standard*	All	2003 - 2004	fish/100 m trawled
Bag Seine – quarter arc method pulled upstream	BSQU	Wild	Fish Comm.	2003 - Present	fish/100 m^2
Bag Seine – quarter arc method pulled downstream	BSQD	Wild	Fish Comm.	2003 - Present	fish/100 m^2
Bag Seine – half arc method pulled upstream	BSHU	Wild	Fish Comm.	2003 - Present	fish/100 m^2
Bag Seine – half arc method pulled downstream	BSHD	Wild	Fish Comm.	2003 - Present	fish/100 m^2
Bag seine – rectangular method pulled upstream	BSRU	Wild	Fish Comm.	2003 - Present	fish/100 m^2
Bag seine – rectangular method pulled upstream	BSRD	Wild	Fish Comm.	2003 - Present	fish/100 m^2
Mini-fyke net	MF	Standard	Fish Comm.	2003 - Present	fish/net night
* Standard only in upper Missouri River segments					

Appendix C. Juvenile and adult pallid sturgeon stocking summary for the Missouri River from Fort Peck Dam (RM 1,772) downstream to the headwaters of Lake Sakakawea (RM 831) from 1992 – 2005.

Year class	Year of stocking	Age at stocking	*N*
1997	1998	1yo	780
1998	2000	2yo	200
1999	2000	1yo	478
2001	2002	1yo	3,060
2002	2003	1yo	3,986
2003	2004	1yo	2,467
2004	2004	Fry	155,000
2004	2004	Fingerling	16,809
2004	2005	1yo	1,043
2005	2005	Fingerling	12,479
2005	2006	1yo	9,362
2006	2006	Fingerling	6,916

Appendix D. Juvenile and adult pallid sturgeon stocking summary for the Missouri River from Fort Randall Dam (RM 880) downstream to the headwaters of Lewis and Clark Lake (RM 825) from 1992 to 2005.

Year class	Year of stocking	Age at stocking	*N*
1997	2000	3yo	416
1998	2000	2yo	98
1999	2002	3yo	181
2001	2002	1yo	558
2002	2003	1yo	601
2003	2004	1yo	515
2004	2005	1yo	868
2005	2006	1yo	1,005

Appendix E. Juvenile and adult pallid sturgeon stocking summary for the Missouri River from Gavins Point Dam (RM 811) downstream to the confluence with the Mississippi River (RM 0) from 1992 to 2005.

Year class	Year of stocking	Age at stocking	*N*
1992	1994	2yo	2,432
1992	1998	6yo	84
1992	1999	7yo	15
1997	1997	Fingerling	2,015
1997	2002	5yo	35
1999	2002	3yo	532
2001	2002	1yo	7,454
2002	2003	1yo	9,241
2003	2003	Fingerling	5,311
2003	2004	1yo	4,744
2004	2004	Fingerling	30,628
2004	2005	1yo	8,534
2004	2006	2yo	15
2005	2006	1yo	3,654

Appendix F. List of bends and associated river miles by basin and 30-mile reach.

Basin	Reach	Bend	River mile
Upper	1	1	1766.0
		2	1761.0
		3	1760.0
		4	1759.0
		5	1757.5
		6	1756.0
		7	1754.5
		8	1753.0
		9	1751.0
		10	1749.5
		11	1747.0
		12	1745.0
		13	1744.0
		14	1741.5
		15	1740.0
		16	1738.0
		17	1736.5
	2	18	1735.0
		19	1733.0
		20	1732.0
		21	1730.5
		22	1728.5
		23	1727.5
		24	1726.5
		25	1725.5
		26	1723.5
		27	1722.0
		28	1720.0
		29	1719.0
		30	1717.5
		31	1716.0
		32	1714.0
		33	1712.0
		34	1710.5
		35	1710.0
		36	1709.0
		37	1707.5
		38	1706.5

Basin	Reach	Bend	River mile
Upper	3	39	1705.5
		40	1704.5
		41	1703.0
		42	1701.5
		43	1700.0
		44	1698.5
		45	1697.5
		46	1696.0
		47	1695.0
		48	1693.5
		49	1692.0
		50	1690.5
		51	1689.0
		52	1687.5
		53	1685.5
		54	1684.5
		55	1683.0
		56	1681.5
		57	1680.0
		58	1678.5
		59	1677.0
	4	60	1675.5
		61	1674.0
		62	1672.5
		63	1671.0
		64	1670.0
		65	1668.5
		66	1667.0
		67	1666.0
		68	1665.0
		69	1664.0
		70	1663.0
		71	1661.5
		72	1660.0
		73	1659.0
		74	1657.0
		75	1656.0
		76	1655.0

Appendix F. (continued).

Basin	Reach	Bend	River mile
Upper	4	77	1654.0
		78	1653.0
		79	1651.0
		80	1650.0
		81	1648.5
		82	1647.0
	5	83	1646.0
		84	1644.5
		85	1643.0
		86	1641.5
		87	1640.5
		88	1639.5
		89	1638.5
		90	1637.5
		91	1636.5
		92	1635.5
		93	1634.5
		94	1633.5
		95	1632.5
		96	1631.5
		97	1630.5
		98	1629.5
		99	1628.5
		100	1627.0
		101	1625.5
		102	1624.0
		103	1623.0
		104	1622.0
		105	1620.5
		106	1619.5
		107	1618.5
	6	108	1617.5
		109	1616.5
		110	1615.0
		111	1613.5
		112	1612.0
		113	1611.0
		114	1610.0

Basin	Reach	Bend	River mile
Upper	6	115	1608.5
		116	1606.5
		117	1604.5
		118	1603.0
		119	1598.5
		120	1597.5
		121	1596.0
		122	1595.0
		123	1594.0
		124	1593.0
		125	1592.0
		126	1591.0
		127	1590.5
		128	1589.5
		129	1588.5
	7	130	1587.0
		131	1585.5
		132	1583.5
		133	1582.1
		134	1580.8
		135	1578.6
		136	1577.0
		137	1575.8
		138	1574.9
		139	1574.2
		140	1569.1
		141	1567.2
		142	1565.5
		143	1563.2
		144	1562.3
		145	1560.3
	8	146	1558.0
		147	1555.8
		148	1553.1
		149	1551.3
		150	1549.2
		151	1548.3
		152	1544.5

Appendix F. (continued).

Basin	Reach	Bend	River mile
Upper	8	153	1538.8
		154	1534.0
Lower	9	155	880.0
		156	878.9
		157	875.5
		158	873.5
		159	871.9
		160	870.3
		161	868.5
		162	866.0
		163	864.4
		164	863.4
		165	861.1
		166	853.2
		167	851.7
	10	168	851.0
		169	849.1
		170	847.5
		171	846.0
		172	844.0
		173	843.2
		174	842.1
		175	841.4
		176	840.0
		177	836.9
		178	835.3
		179	834.1
		180	832.0
		181	831.0
		182	829.5
	11	183	811.0
		184	810.0
		185	807.5
		186	805.0
		187	803.0
		188	801.0
		189	800.0
		190	799.0

Basin	Reach	Bend	River mile
Lower	11	191	797.5
		192	796.5
		193	795.0
		194	793.0
		195	789.0
		196	785.0
	12	197	780.0
		198	778.0
		199	776.5
		200	775.0
		201	772.5
		202	768.5
		203	767.0
		204	765.6
		205	764.0
		206	762.0
		207	761.0
		208	760.0
		209	757.5
		210	756.5
		211	755.5
		212	754.0
	13	213	753.0
		214	750.1
		215	747.0
		216	742.4
		217	738.4
		218	734.7
		219	732.8
		220	732.0
		221	726.2
		222	723.4
	14	223	722.0
		224	718.6
		225	716.2
		226	713.8
		227	710.8
		228	708.0

Appendix F. (continued).

Basin	Reach	Bend	River mile
Lower	14	229	706.3
		230	704.0
		231	702.6
		232	700.9
		233	697.5
	15	234	693.6
		235	691.4
		236	689.0
		237	687.4
		238	686.0
		239	683.3
		240	681.2
		241	679.9
		242	677.9
		243	676.7
		244	675.0
		245	672.8
		246	670.4
		247	666.5
	16	248	663.1
		249	660.8
		250	657.8
		251	654.8
		252	651.7
		253	649.1
		254	644.5
		255	642.0
		256	639.8
		257	638.5
		258	637.1
		259	634.1
	17	260	632.5
		261	631.1
		262	629.7
		263	627.8
		264	622.8
		265	617.5
		266	614.6

Basin	Reach	Bend	River mile
Lower	17	267	612.8
		268	608.8
		269	604.5
	18	270	600.8
		271	599.3
		272	598.0
		273	596.0
		274	595.0
		275	591.7
		276	589.0
		277	586.0
		278	582.7
		279	578.8
		280	576.4
		281	574.6
	19	282	572.5
		283	569.8
		284	565.0
		285	563.0
		286	559.7
		287	557.0
		288	554.9
		289	553.0
		290	550.4
		291	549.6
		292	546.2
		293	544.7
	20	294	543.3
		295	542.0
		296	539.8
		297	536.9
		298	534.7
		299	533.5
		300	531.7
		301	529.0
		302	526.0
		303	523.9
		304	522.4

Appendix F. (continued).

Basin	Reach	Bend	River mile
Lower	20	305	520.5
		306	518.4
		307	517.6
		308	516.0
	21	309	512.5
		310	508.4
		311	506.9
		312	504.5
		313	501.8
		314	500.3
		315	498.6
		316	494.4
		317	491.2
		318	489.8
		319	486.0
	22	320	483.4
		321	480.9
		322	477.7
		323	472.5
		324	469.0
		325	467.1
		326	463.0
		327	458.8
		328	454.9
	23	329	451.7
		330	449.4
		331	443.0
		332	438.1
		333	435.2
		334	431.5
		335	429.1
	24	336	425.3
		337	417.9
		338	415.8
		339	412.2
		340	410.0
		341	408.4
		342	407.0

Basin	Reach	Bend	River mile
Lower	24	343	404.2
		344	400.3
		345	398.9
		346	397.1
	25	347	392.4
		348	388.7
		349	385.0
		350	383.2
		351	378.5
		352	375.4
		353	371.9
		354	368.9
	26	355	363.3
		356	359.2
		357	354.1
		358	351.3
		359	346.6
		360	343.6
		361	342.4
		362	340.4
		363	338.9
		364	337.1
		365	335.2
	27	366	332.3
		367	327.0
		368	324.2
		369	321.5
		370	319.5
		371	318.0
		372	311.5
		373	309.6
		374	307.3
	28	375	304.6
		376	301.5
		377	299.6
		378	296.6
		379	290.2
		380	285.0

Appendix F. (continued).

Basin	Reach	Bend	River mile
Lower	28	381	282.4
		382	279.9
		383	275.7
		384	274.2
	29	385	271.9
		386	267.2
		387	265.1
		388	263.6
		389	261.4
		390	260.3
		391	257.3
		392	253.3
		393	250.3
		394	246.3
	30	395	239.5
		396	237.3
		397	234.3
		398	232.4
		399	228.3
		400	222.3
		401	220.0
		402	217.5
		403	214.0
	31	404	210.9
		405	209.1
		406	207.2
		407	205.3
		408	203.6
		409	201.2
		410	199.6
		411	197.1
		412	193.7
		413	192.0
		414	189.1
		415	186.9
		416	184.6
	32	417	183.3
		418	181.6

Basin	Reach	Bend	River mile
Lower	32	419	180.3
		420	178.4
		421	176.4
		422	174.3
		423	171.1
		424	166.9
		425	162.1
		426	158.6
		427	154.8
	33	428	151.6
		429	149.5
		430	145.9
		431	143.5
		432	142.0
		433	138.7
		434	137.3
		435	135.6
		436	134.7
		437	132.6
		438	130.2
		439	128.4
		440	127.0
		441	125.0
Lower	34	442	122.2
		443	121.0
		444	118.4
		445	115.9
		446	112.1
		447	110.1
		448	107.9
		449	106.3
		450	104.9
		451	103.4
		452	100.1
		453	97.9
		454	96.8
		455	95.3
		456	94.0

Appendix F. (continued).

Basin	Reach	Bend	River mile
Lower	35	457	91.8
		458	89.9
		459	87.9
		460	86.7
		461	85.4
		462	82.8
		463	80.9
		464	79.7
		465	77.9
		466	76.9
		467	74.5
		468	69.7
		469	66.7
		470	65.0
	36	471	60.3
		472	58.9
		473	56.5
		474	54.2
		475	51.2
		476	49.8
		477	48.5
		478	45.2
		479	43.8
		480	40.7
		481	38.8
		482	37.5
		483	34.0
	37	484	31.9
		485	28.6
		486	26.5
		487	25.4
		488	21.9
		489	17.0
		490	10.6
		491	9.3
		492	6.1
		493	3.4