PNNL-17539

# 2005 Annual Synthesis Report

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

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August 2008

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

PACIFIC NORTHWEST NATIONAL LABORATORY
*operated by*
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Craig Allwardt

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 Project (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 Program 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 2005 sampling year monitoring results from individual segments. 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. 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. In 2005, segment 4 was the only segment in the upper basin to be sampled, so these data are not presented in this report as they are available in the 2005 Annual Report for Segment 4. This report represents a compilation and evaluation of data for segments 5 through 14 (lower basin) for the 2005 sampling year.

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 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 2005 sampling year in the lower basin of the Missouri River, four gear types were used to sample a range of 55 to 93 bends during the sturgeon and fish community seasons. The inside bends and channel crossovers were the most frequently sampled macrohabitats during both seasons, where approximately 57% 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 75% and 21%, respectively, of the sampling effort occurring there. During the fish community season, approximately 67% of the sampling effort occurred in main channel border mesohabitats, while 31% of the sampling effort occurred in sand bar habitats, owing to the deployment of gear (mini-fyke nets) specific to that mesohabitat.

Seventy-three pallid sturgeon were captured during the sturgeon season, while 45 were captured during the fish community season. Sampling from segments 13 and 14 (RM 250 - 0) during the sturgeon season resulted in 36 pallid sturgeon captured, comprising 49% of the catch during the sturgeon sampling season. During the fish community season, sampling from segments 13 and 14 yielded only three pallid sturgeon, or 7% of the catch during that sampling season. Sampling from segments 5 and 6 (RM 825 – 880) resulted in comparatively large numbers of pallid sturgeon captures during both seasons, including 42% of the total catch during the fish community season. During the fish community season, the mean catch per unit effort (CPUE) of hatchery-reared pallid sturgeon captured with trammel nets was 0.008 fish/100 m, which decreased to 0.002 fish/100 m during the sturgeon season. 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 0.006 and 0.007 fish/100 m during the fish community and sturgeon season, respectively. Random sampling with standard gears

resulted in catches of more juvenile (< 840 mm) pallid sturgeon than adult (≥ 840 mm) pallid sturgeon. Fifty-five juvenile pallid sturgeon were captured (using random sampling with standard gears) during the 2005 sampling year; most were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred. Three adult (≥ 840 mm) pallid sturgeon were captured during the 2005 sampling year (using random sampling with standard gears); all three fish were captured in main channel inside bend macrohabitats, including one in a channel border mesohabitat and 2 in pool mesohabitats. The population structure of pallid sturgeon captured during the 2005 sampling year is positively skewed, with juvenile fish representing the vast majority of fish sampled. The fork lengths of all 118 pallid sturgeon captured ranged from 198 to 1068 mm, including seven fish larger than 800 mm.

During the 2005 sampling year in the lower basin of the Missouri River, 11,553 shovelnose sturgeon *Scaphirhynchus platorynchus* were captured during the sturgeon season, while 2940 were captured during the fish community season. Sampling from segments 13 and 14 (RM 0 - 250) during the sturgeon season resulted in 7054 shovelnose sturgeon captured, comprising 61% of the catch during the sturgeon sampling season. During the fish community season approximately 52% ($N$ = 1536) of the shovelnose sturgeon were captured downstream of the Kansas River (RM 368).

During the sturgeon season 110 sturgeon chub *Macrhybopsis gelida* were captured, while 100 were captured during the fish community season. Sampling from near RM 400 – 470 in the lower reaches of segment 9 during the sturgeon season resulted in a catch of 58 sturgeon chub, comprising 53% of the total catch during that season. During the fish community season approximately 63% ($N$ = 63) of the sturgeon chub were captured downstream of the Kansas River (RM 368). A total of 812 sicklefin chub *Macrhybopsis meeki* were captured during the sturgeon season, while 602 were captured during the fish community season. Sampling from segments 13 and 14 (RM 0 - 250) during the sturgeon season resulted in 735 sicklefin chub captured, comprising 91% of the catch during the sturgeon sampling season. A total of 626 speckled chub *Macrhybopsis aestivalis* were captured during the sturgeon season, while 909 were captured during the fish community season. Sampling from segments 13 and 14 (RM 0 - 250) during the sturgeon season

resulted in 401 speckled chub captured, comprising 64% of the catch during the sturgeon sampling season. A total of 1322 blue suckers *Cycleptus elongatus* were captured during the sturgeon season, while 511 were captured during the fish community season. Sampling from segments 5 through 9 (RM 368 – 880) during the sturgeon season resulted in 1002 blue suckers captured, comprising 76% of the catch during the sturgeon sampling season. A total of 254 saugers *Sander canadense* were captured during the sturgeon season, while 114 were captured during the fish community season. Sampling from segments 13 and 14 (RM 0 - 250) during the sturgeon season resulted in 105 saugers caught, comprising 41% of the catch during the sturgeon sampling season. Sampling from segment 6 (RM 825 – 845) during the sturgeon season resulted in 73 saugers caught, accounting for 29% of the total catch for that sampling season. During the fish community season, notably fewer saugers were caught from the downstream segments compared with the upstream segments, a reversal of the geographic catch trend observed during the sturgeon season. A total of 12 sand shiners *Notropis stramineus* were captured during the sturgeon season, while 1937 were captured during the fish community season. During the fish community season there was a markedly larger catch of sand shiners in segment 7 (RM 750 – 811) than in all other segments, comprising 65% ($N$ = 1251) of all sand shiners caught that season. During the 2005 sampling year in the lower Missouri River basin, no *Hybognathus* spp. were captured during the sturgeon season, while 491 were captured during the fish community season. During the fish community season there was a markedly larger catch of *Hybognathus* spp. near RM 470 in segment 9 (RM 368 – 596) than in all other segments, comprising 75% ($N$ = 367) of all *Hybognathus* spp. caught that season.

Oldenburg, E.W., T.P. Hanrahan, R.A. Harnish, B.J. Bellgraph, J.P. Duncan, and C.H. Allwardt. 2008. 2005 Annual Synthesis Report, Pallid Sturgeon Population Assessment Project and Associated Fish Community Monitoring for the Missouri River. PNNL-17539. Pacific Northwest National Laboratory, Richland, WA.

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# 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 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 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.

# 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 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). In 2005, segment 4 was the only segment in the upper basin to be sampled, so this data is not presented in this report as it is available in the 2005 Annual Report for Segment 4 (Wilson et al. 2006). This report represents a compilation and evaluation of data for segments 5-10, 13, and 14 (lower basin) for the 2005 sampling year.

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 were identified, and not consistently present in each bend, including: 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).

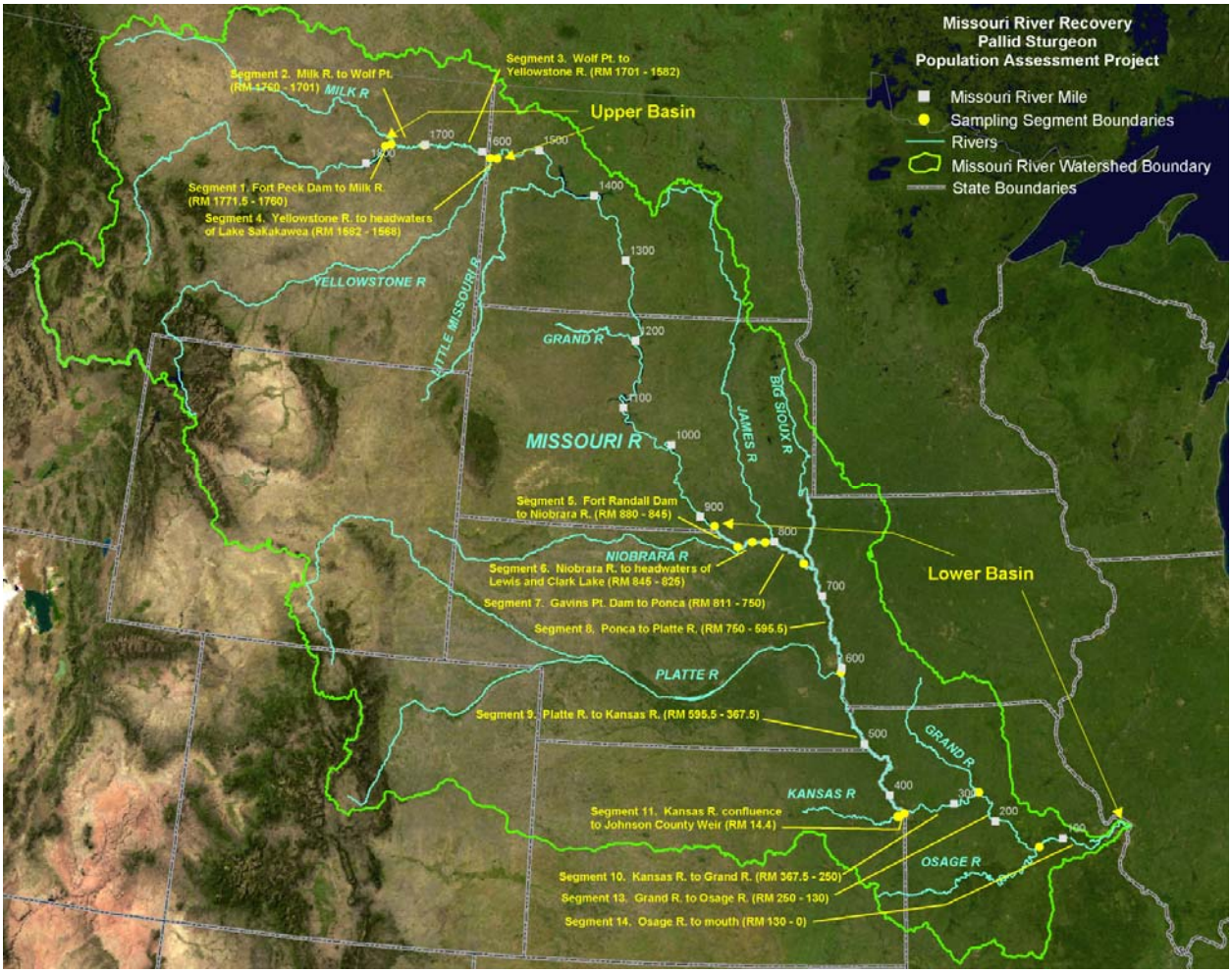


**Figure 1.** Pallid Sturgeon Population Assessment Project Study Area

# 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 and fish community season, based on water temperature. 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 was 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. Only the lower basin data for 2005 was evaluated and summarized for this report.

## 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.

## 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 lower basin 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 lower basin 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 dependent 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 (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 (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. 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.

### *Mini-fyke Net*

Mini-fyke nets were used only during the fish community season within the lower basin 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.

## 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 (e.g., 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 only 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 were the only ones used during both the sturgeon and fish community seasons. The standardized sampling unit during this study was the bend. Therefore, 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 E]. Catch per unit effort and associated variability was calculated for each 30-mile reach by averaging all bends within each reach. Geographic distribution was reported in scatter plots. Scatter plot loci with no dot 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 reported 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.

# Results

## Effort

For the 2005 sampling year in the lower basin of the Missouri River, four gear types were used to sample a range of 55 to 93 bends during the sturgeon and fish community seasons (Table 1). The inside bends and channel crossovers were the most frequently sampled macrohabitats during both seasons, where approximately 57% 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 75% and 21%, respectively, of the sampling effort occurring there (Table 2). During the fish community season, approximately 67% of the sampling effort occurred in main channel border mesohabitats, while 31% 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 1-inch trammel nets, gill nets, and otter trawls. On average the greatest mean effort per bend was with gill nets, whereby the equivalent of almost 20 net nights per bend was applied. A total of 55 bends were sampled with gill nets, which were deployed for an equivalent of 1093 net nights. Main channel border and pool mesohabitats comprised 50% and 45%, respectively, of the gill net effort, which occurred predominantly in inside bend, outside bend, and main channel crossover macrohabitats. Trammel nets were used to sample 76 bends, with a total effort equivalent to 637 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 72 bends during the sturgeon season, with a total effort equivalent to 630 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 macrohabitat.

Gear deployments during the fish community season included 1-inch trammel nets, mini-fyke nets, and otter trawls. Trammel nets were used to sample 84 bends, with a total effort equivalent to 712 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. A total of 88 bends were sampled with

mini-fyke nets, which were deployed for an equivalent of 690 net nights. Sand bar mesohabitats comprised 98% of the mini-fyke net effort, which occurred predominantly in inside bend, and main channel crossover macrohabitats. Otter trawls were used to sample 93 bends during the fish community season, with a total effort equivalent to 780 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 macrohabitat.

**Table 1.** 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 2005 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** | 76 | 8.4 | 6 | 146 | 10 | 2 | 4 | 399 | 22 | 25 | 21 | 0 | 0 | 2 | 0 | 0 |
| **Gill Net[a]** | 55 | 19.9 | 0 | 230 | 14 | 0 | 0 | 582 | 183 | 44 | 32 | 0 | 0 | 8 | 0 | 0 |
| **Otter Trawl** | 72 | 8.8 | 23 | 147 | 8 | 2 | 0 | 378 | 36 | 21 | 11 | 0 | 0 | 4 | 0 | 0 |
| **Summer – Fish Community Season** | | | | | | | | | | | | | | | | |
| **1 Inch Trammel Net** | 84 | 8.5 | 14 | 171 | 5 | 2 | 6 | 456 | 22 | 22 | 13 | 0 | 0 | 0 | 1 | 0 |
| **Mini-Fyke Net** | 88 | 7.8 | 55 | 150 | 5 | 2 | 0 | 319 | 65 | 20 | 53 | 8 | 0 | 4 | 9 | 0 |
| **Otter Trawl** | 93 | 8.4 | 58 | 187 | 4 | 0 | 2 | 458 | 38 | 17 | 10 | 0 | 0 | 6 | 0 | 0 |

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

**Table 2.** 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 2005 sampling year.

| Gear | Number of bends | Mean Effort | Mesohabitat | | | | |
|---|---|---|---|---|---|---|---|
| | | | BAR | POOL | CHNB | TLWG | ITIP |
| **Fall through Spring – Sturgeon Season** | | | | | | | |
| **1 Inch Trammel Net** | 76 | 8.4 | 1 | 2 | 604 | 3 | 27 |
| **Gill Net**[a] | 55 | 19.9 | 0 | 495 | 546 | 6 | 46 |
| **Otter Trawl** | 72 | 8.8 | 0 | 0 | 615 | 0 | 15 |
| **Summer – Fish Community Season** | | | | | | | |
| **1 Inch Trammel Net** | 84 | 8.5 | 2 | 0 | 690 | 0 | 20 |
| **Mini-Fyke Net** | 88 | 7.8 | 676 | 0 | 14 | 0 | 0 |
| **Otter Trawl** | 93 | 8.4 | 0 | 0 | 766 | 0 | 14 |

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

## Pallid sturgeon

One hundred eighteen pallid sturgeon were sampled during the 2005 sampling season in the lower basin of the Missouri River. Seventy-three pallid sturgeon were sampled during the sturgeon season, while forty-five were sampled during the fish community season (Figure 2). Further, 75% of the 118 pallid sturgeon sampled in 2005 were of hatchery origin, 22% were wild fish, and the remaining 3% were of unknown origin. Sampling from segments 13 and 14 (RM 0 – 250) during the sturgeon season resulted in 36 pallid sturgeon captured, comprising 49% of the catch during the sturgeon sampling season. Segment 10 (RM 250 – 368) was not sampled during the sturgeon season. During the fish community season, sampling from segments 13 and 14 yielded only three pallid sturgeon, or 7% of the catch during that sampling season. Sampling from segments 5 and 6 (RM 825 – 880) resulted in comparatively large numbers of pallid sturgeon captures during both seasons, including 64% of the total catch during the fish community season.

Relative abundance of pallid sturgeon varied slightly between sampling seasons and among sampling segments. During the fish community season, the mean CPUE of hatchery-reared pallid sturgeon captured with trammel nets was 0.008 fish/100 m, which decreased to 0.002 fish/100 m during the sturgeon season (Figure 3). Sampling in segments 8 and 9 (RM 368 – 750) resulted in some of the largest trammel net CPUE during the fish community season, a finding also observed for segment 9 (RM 368 – 596) during the sturgeon season (Figure 4). 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 0.006 and 0.007 fish/100 m during the fish community and sturgeon season, respectively (Figure 3). Sampling in segments 8 and 9 (RM 368 – 750) resulted in some of the largest otter trawl CPUE during the sturgeon season, a finding also observed for segment 8 (RM 596 – 750) during the fish community season (Figure 5).

Random sampling with standard gears resulted in catches of more juvenile (< 840 mm) pallid sturgeon than adult (≥ 840 mm) pallid sturgeon. Fifty-five juvenile pallid sturgeon were captured during the 2005 sampling year; 35 during the sturgeon season and

20 during the fish community season (Table 3). 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). Three adult (≥ 840 mm) pallid sturgeon were captured during the 2005 sampling year, all during the sturgeon season. All three fish were captured in main channel inside bend macrohabitats, including one in channel border and two in pool mesohabitats (Table 5 and Table 6).

The population structure of pallid sturgeon captured during the 2005 sampling year is positively skewed, with juvenile fish (< 840 mm) representing the vast majority of fish sampled (Figure 6). Hatchery-reared pallid sturgeon comprised most of the catch in 2005 and were smaller on average than wild individuals. The fork lengths of all 118 pallid sturgeon captured ranged from 198 to 1068 mm, including seven fish larger than 800 mm (Figure 6). Random sampling accounted for 85% ($N$ = 100) of the pallid sturgeon captured. The length frequency distribution from random sampling is very similar to that from non-random sampling.

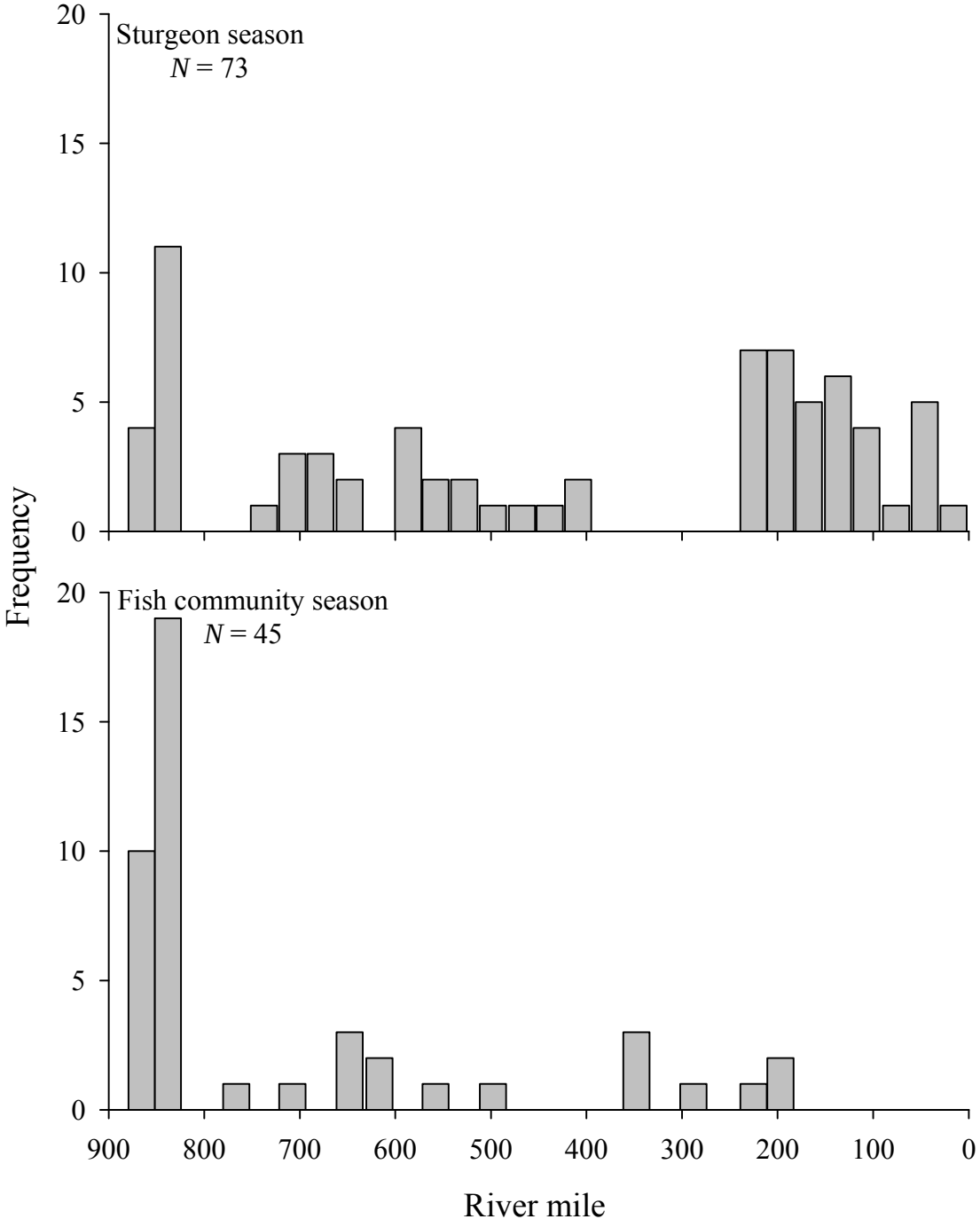


**Figure 2.** Seasonal catch by river mile (30-mile bins) of pallid sturgeon in the lower basin of the Missouri River in the 2005 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

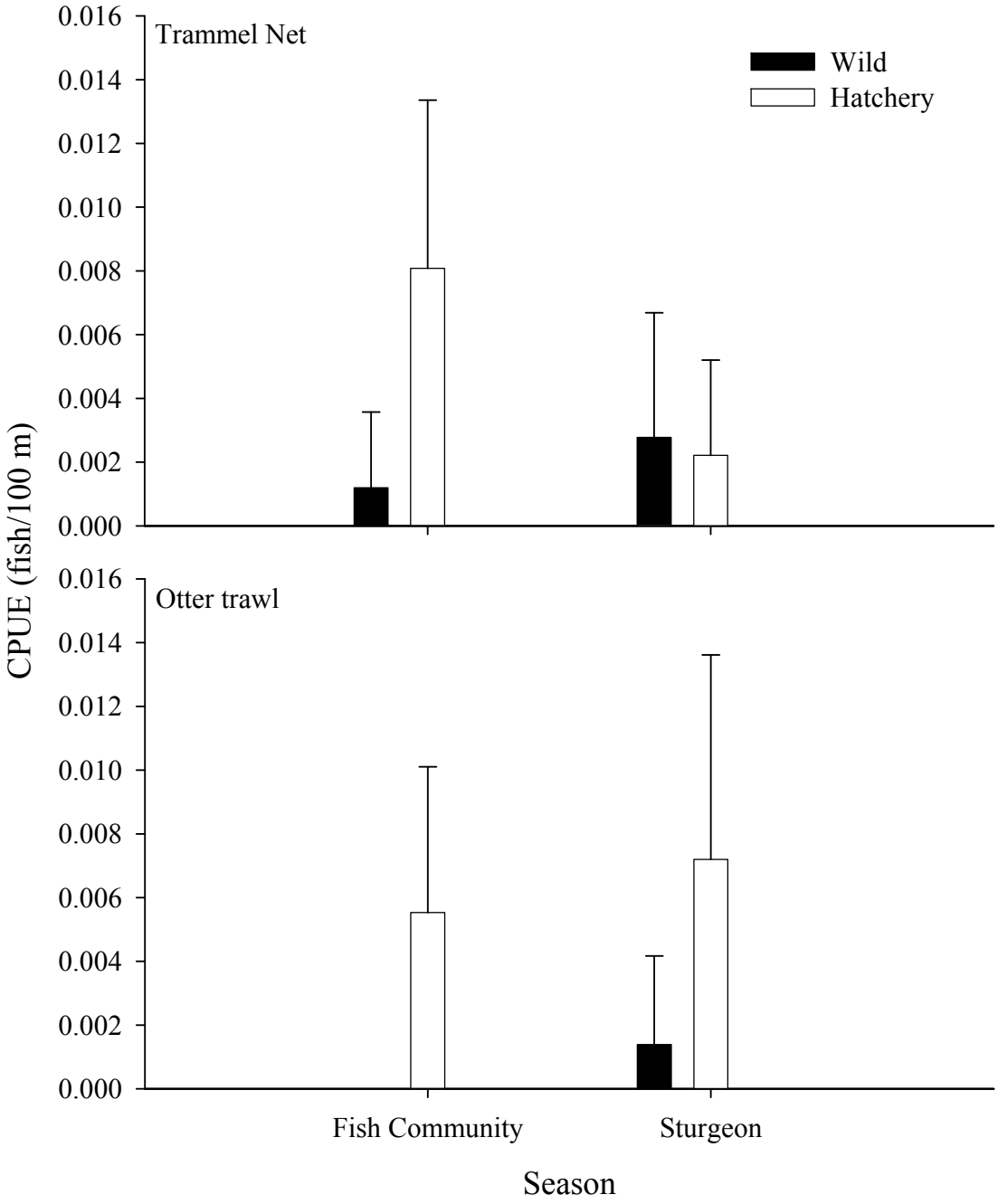


**Figure 3.** Mean seasonal catch per unit effort (± 2 SE) for wild, unknown, and hatchery reared pallid sturgeon using one-inch trammel nets and otter trawls in the lower basin of the Missouri River in the 2005 sampling year**.**

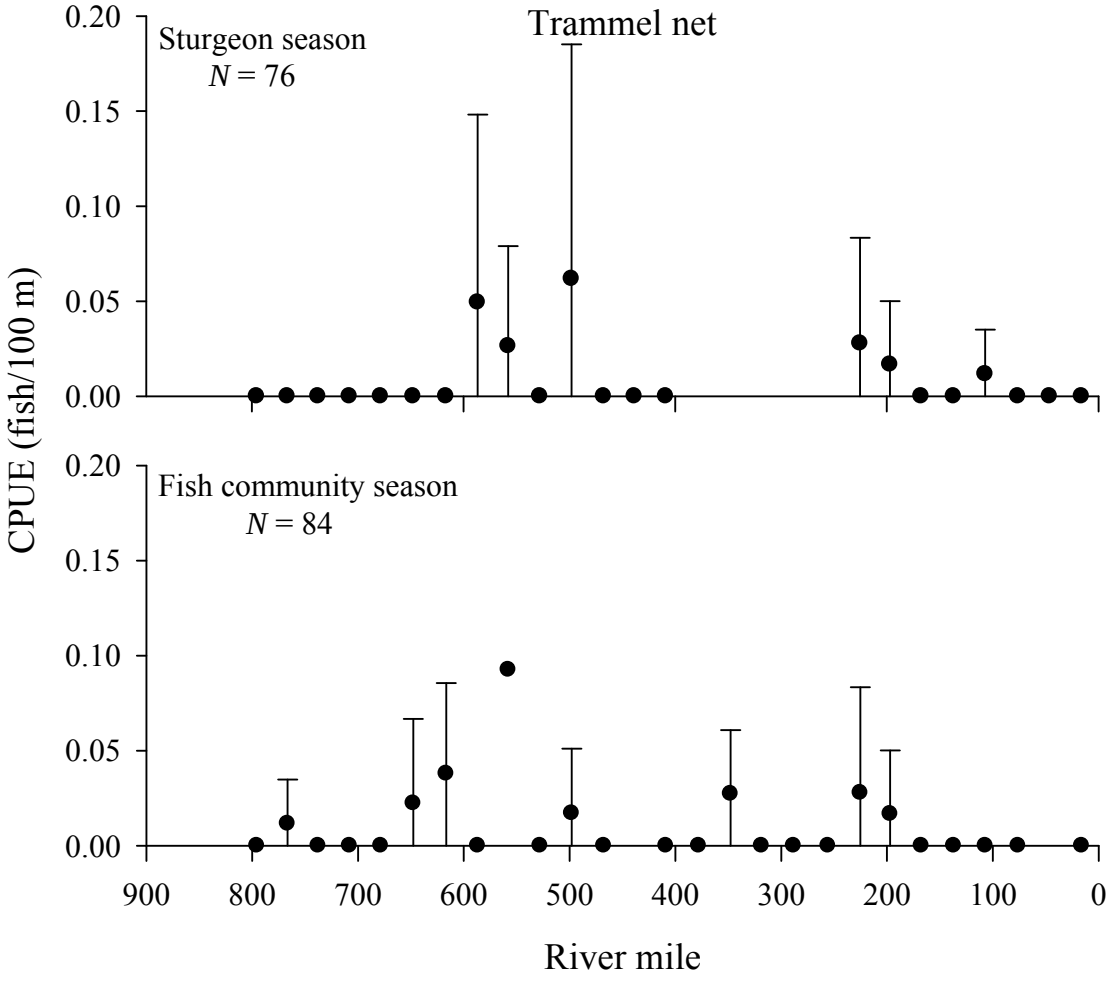


**Figure 4.** Mean catch per unit effort (± 2 SE) of pallid sturgeon by river mile (30-mile bins) in the lower basin of the Missouri River during the sturgeon and fish community seasons in the 2005 sampling year. Data obtained through random sampling using one-inch trammel nets. Sample size denotes the number of bends sampled.

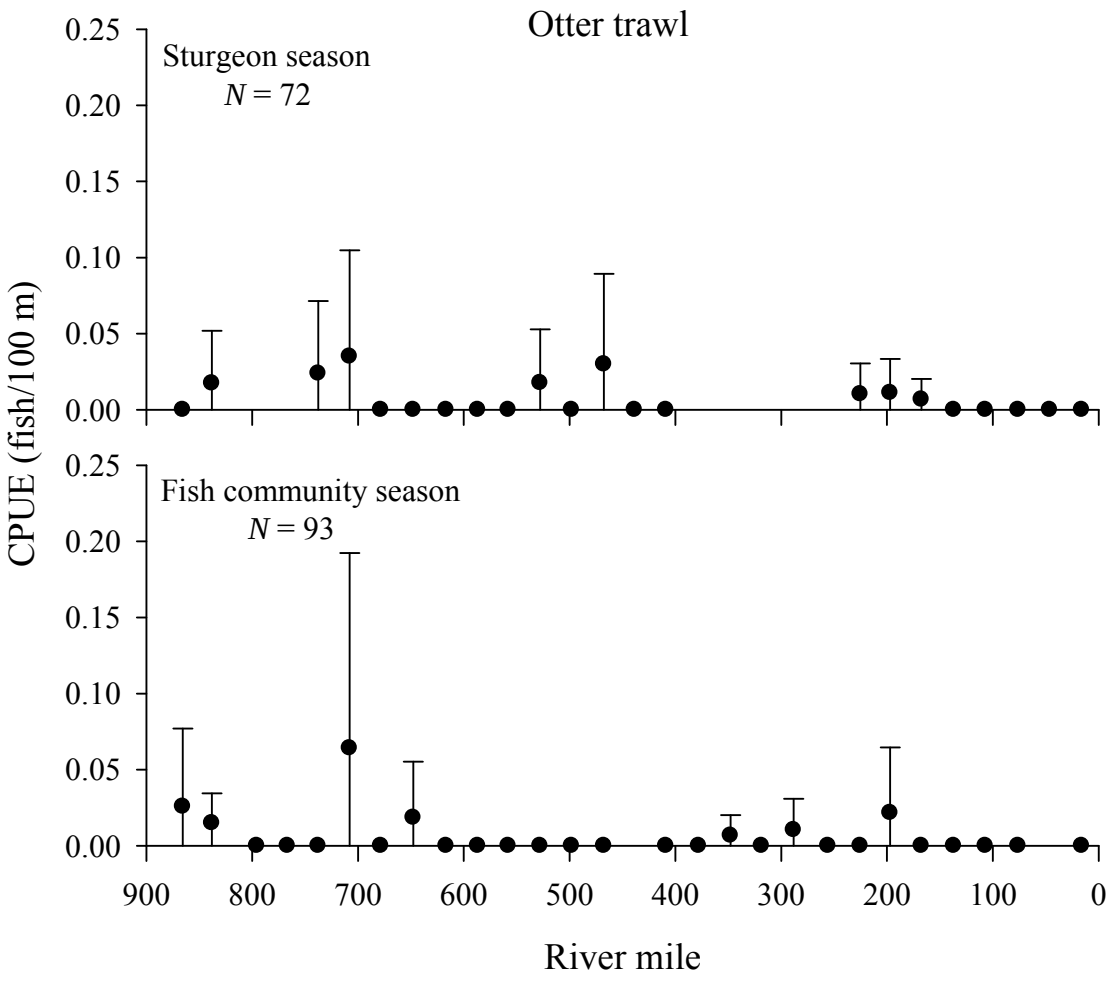


**Figure 5.** Mean catch per unit effort (± 2 SE) of pallid sturgeon by river mile (30-mile bins) in the lower basin of the Missouri River during the sturgeon and fish community seasons in the 2005 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

**Table 3.** 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 2005 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** | 6 | 0 | 0 | 0 | 0 | 0 | 66.7 | 0 | 33.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0.9) | (22.9) | (1.6) | (0.3) | (0.6) | (62.6) | (3.5) | (3.9) | (3.3) | (0) | (0) | (0.3) | (0) | (0) |
| **Gill Net** | 14 | 0 | 7.1 | 0 | 0 | 0 | 64.3 | 21.4 | 0 | 7.1 | 0 | 0 | 0 | 0 | 0 |
| | | (0) | (21.0) | (1.3) | (0) | (0) | (53.2) | (16.7) | (4.0) | (2.9) | (0) | (0) | (0.7) | (0) | (0) |
| **Otter Trawl** | 15 | 0 | 26.7 | 0 | 0 | 0 | 53.3 | 13.3 | 6.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (3.7) | (23.3) | (1.3) | (0.3) | (0) | (60.0) | (5.7) | (3.3) | (1.7) | (0) | (0) | (0.6) | (0) | (0) |
| **Fish Community Season (Summer)** | | | | | | | | | | | | | | | |
| **1 Inch Trammel Net** | 10 | 0 | 10.0 | 0 | 0 | 0 | 80.0 | 0 | 0 | 10.0 | 0 | 0 | 0 | 0 | 0 |
| | | (2.0) | (24.0) | (0.7) | (0.3) | (0.8) | (64.0) | (3.1) | (3.1) | (1.8) | (0) | (0) | (0) | (0.1) | (0) |
| **Mini-Fyke Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (8.0) | (21.7) | (0.7) | (0.3) | (0) | (46.2) | (9.4) | (2.9) | (7.7) | (1.2) | (0) | (0.6) | (1.3) | (0) |
| **Otter Trawl** | 10 | 30.0 | 10.0 | 0 | 0 | 0 | 60.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (7.4) | (24.0) | (0.5) | (0) | (0.3) | (58.7) | (4.9) | (2.2) | (1.3) | (0) | (0) | (0.8) | (0) | (0) |

**Table 4.** 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 2005 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** | 6 | 0 | 83.3 | 0 | 0 | 0 | 16.7 |
| | | (0.2) | (94.8) | (0) | (4.2) | (0.3) | (0.5) |
| **Gill Net** | 14 | 0 | 78.6 | 0 | 7.1 | 14.3 | 0 |
| | | (0) | (50.0) | (0) | (4.2) | (45.3) | (0.5) |
| **Otter Trawl** | 15 | 0 | 100.0 | 0 | 0 | 0 | 0 |
| | | (0) | (97.6) | (0) | (2.4) | (0) | (0) |
| **Fish Community Season (Summer)** | | | | | | | |
| **1 Inch Trammel Net** | 10 | 0 | 90.0 | 0 | 10.0 | 0 | 0 |
| | | (0.3) | (96.9) | (0) | (2.8) | (0) | (0) |
| **Mini-Fyke Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (98.0) | (2.0) | (0) | (0) | (0) | (0) |
| **Otter Trawl** | 10 | 0 | 100.0 | 0 | 0 | 0 | 0 |
| | | (0) | (98.2) | (0) | (1.8) | (0) | (0) |

**Table 5.** 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 2005 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** | 1 | 0 | 0 | 0 | 0 | 0 | 100.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0.9) | (22.9) | (1.6) | (0.3) | (0.6) | (62.6) | (3.5) | (3.9) | (3.3) | (0) | (0) | (0.3) | (0) | (0) |
| **Gill Net** | 2 | 0 | 0 | 0 | 0 | 0 | 100.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0) | (21.0) | (1.3) | (0) | (0) | (53.2) | (16.7) | (4.0) | (2.9) | (0) | (0) | (0.7) | (0) | (0) |
| **Otter Trawl** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (3.7) | (23.3) | (1.3) | (0.3) | (0) | (60.0) | (5.7) | (3.3) | (1.7) | (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 |
| | | (2.0) | (24.0) | (0.7) | (0.3) | (0.8) | (64.0) | (3.1) | (3.1) | (1.8) | (0) | (0) | (0) | (0.1) | (0) |
| **Mini-Fyke Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (8.0) | (21.7) | (0.7) | (0.3) | (0) | (46.2) | (9.4) | (2.9) | (7.7) | (1.2) | (0) | (0.6) | (1.3) | (0) |
| **Otter Trawl** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (7.4) | (24.0) | (0.5) | (0) | (0.3) | (58.7) | (4.9) | (2.2) | (1.3) | (0) | (0) | (0.8) | (0) | (0) |

**Table 6.** 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 2005 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** | 1 | 0 | 100.0 | 0 | 0 | 0 | 0 |
| | | (0.2) | (94.8) | (0) | (4.2) | (0.3) | (0.5) |
| **Gill Net** | 2 | 0 | 0 | 0 | 0 | 100.0 | 0 |
| | | (0) | (50.0) | (0) | (4.2) | (45.3) | (0.5) |
| **Otter Trawl** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0) | (97.6) | (0.0) | (2.4) | (0) | (0) |
| **Fish Community Season (Summer)** | | | | | | | |
| **1 Inch Trammel Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0.3) | (96.9) | (0) | (2.8) | (0.0) | (0.0) |
| **Mini-Fyke Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (98.0) | (2.0) | (0) | (0) | (0) | (0) |
| **Otter Trawl** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0) | (98.2) | (0) | (1.8) | (0) | (0) |

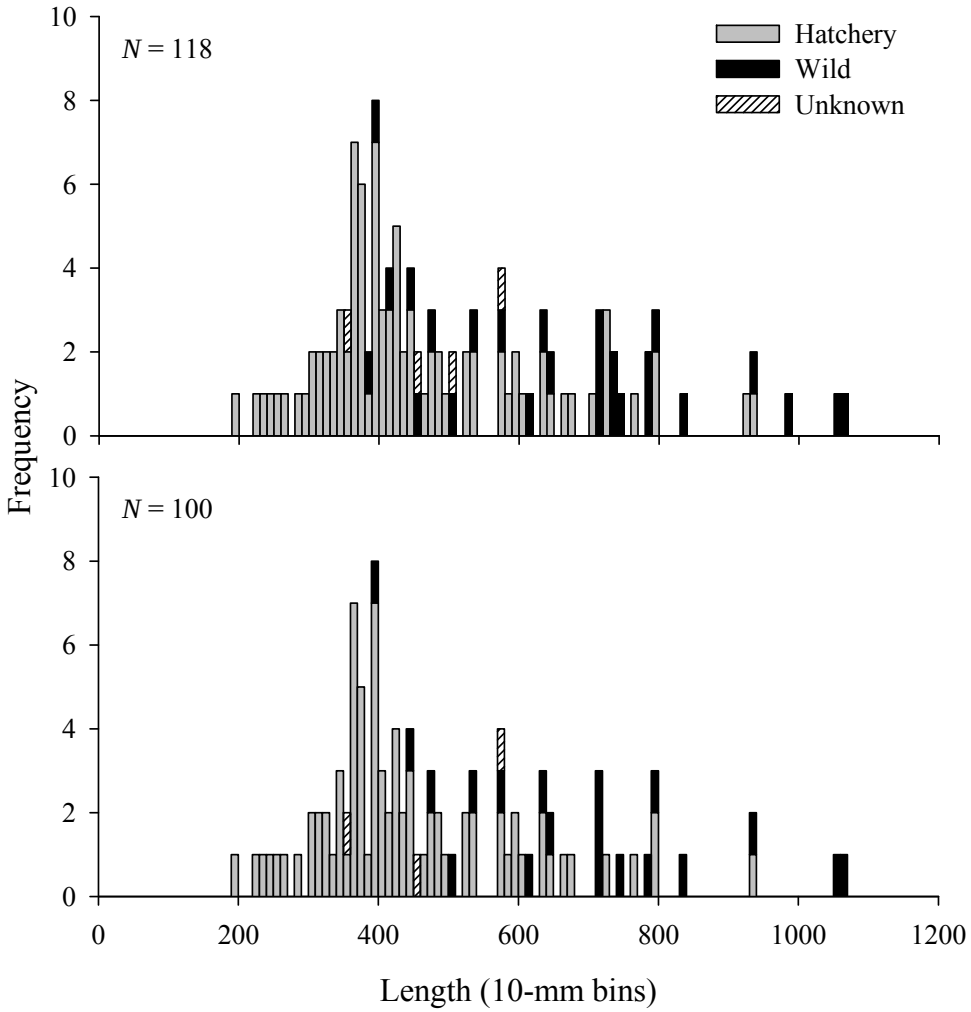


**Figure 6.** Length frequency distribution of pallid sturgeon of hatchery, wild, and unknown origin captured in the lower basin of the Missouri River during the 2005 sampling year using standard and wild gears. Upper panel includes random and nonrandom sampling. Lower panel includes only random sampling.

## Targeted Native River Species

### Shovelnose Sturgeon

During the 2005 sampling year in the lower basin of the Missouri River, 11,553 shovelnose sturgeon *Scaphirhynchus platorynchus* were captured during the sturgeon season, while 2940 were captured during the fish community season (Figure 7). Sampling from segments 13 and 14 (RM 0 – 250) during the sturgeon season resulted in 7054 shovelnose sturgeon captured, comprising 61% of the catch during the sturgeon sampling season. An additional 19% ($N$ = 2189) were captured near the Platte River (RM 596) at the upstream end of segment 9. Segment 10 (RM 250 – 368) was not sampled during the sturgeon season. During the fish community season, there were no notable geographic trends in the catch of shovelnose sturgeon. Approximately 52% ($N$ = 1536) of the shovelnose sturgeon were captured downstream of the Kansas River (RM 368). Sampling from segment 10 during the fish community season resulted in similar numbers of fish caught as in other segments.

Relative abundance of shovelnose sturgeon differed slightly between sampling seasons and among sampling segments. During the fish community season, the mean CPUE of shovelnose sturgeon captured with trammel nets (2.1 fish/100 m) was nearly twice as high as the mean CPUE during the sturgeon season (1.22 fish/100 m; Figure 8). Sampling in segment 9 (RM 368 – 596) resulted in some of the largest trammel net CPUE during the fish community and sturgeon seasons (Figure 9). In segments 7 and 8 (RM 596 – 811), trammel net mean CPUE was markedly lower during the sturgeon season than during the fish community season. Otter trawl mean CPUE was nearly the same during the fish community and sturgeon seasons, with an overall mean CPUE of approximately 0.6 fish/100 m (Figure 8). Sampling in segments 13 and 14 (RM 0 – 250) resulted in some of the largest otter trawl CPUE during the sturgeon season, where mean CPUE ranged from 0.35 to 2.19 fish/100 m (Figure 10). During the fish community season there was no discernible geographic trend in relative abundance from otter trawl sampling, with mean CPUE ranging from 0.009 to 1.35 fish/100 m throughout the lower basin of the Missouri River (Figure 10).

Random sampling with standard gears accounted for approximately 60% ($N$ = 6924) of the total shovelnose sturgeon catch during the sturgeon season, and 97% ($N$ = 2861) of the catch during the fish community season (Table 7). 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. The majority of all shovelnose sturgeon were captured from main channel border mesohabitats, which for most gears was also the location of greatest effort (Table 8). During the sturgeon season, pool mesohabitats comprised 45% of the gill net sampling effort, resulting in approximately 48% of the total shovelnose sturgeon catch with all gears for that season. Mini-fyke nets, used during fish community season, caught one shovelnose sturgeon from a sand bar mesohabitat.

The population structure of shovelnose sturgeon captured during the 2005 sampling year is negatively skewed, with juvenile fish representing a small component of fish sampled (Figure 11). The fork lengths of all shovelnose sturgeon captured ranged from approximately 30 to 800 mm, with modal length of about 580 mm. The length frequency distribution from random sampling is very similar to that from non-random sampling (Figure 11).

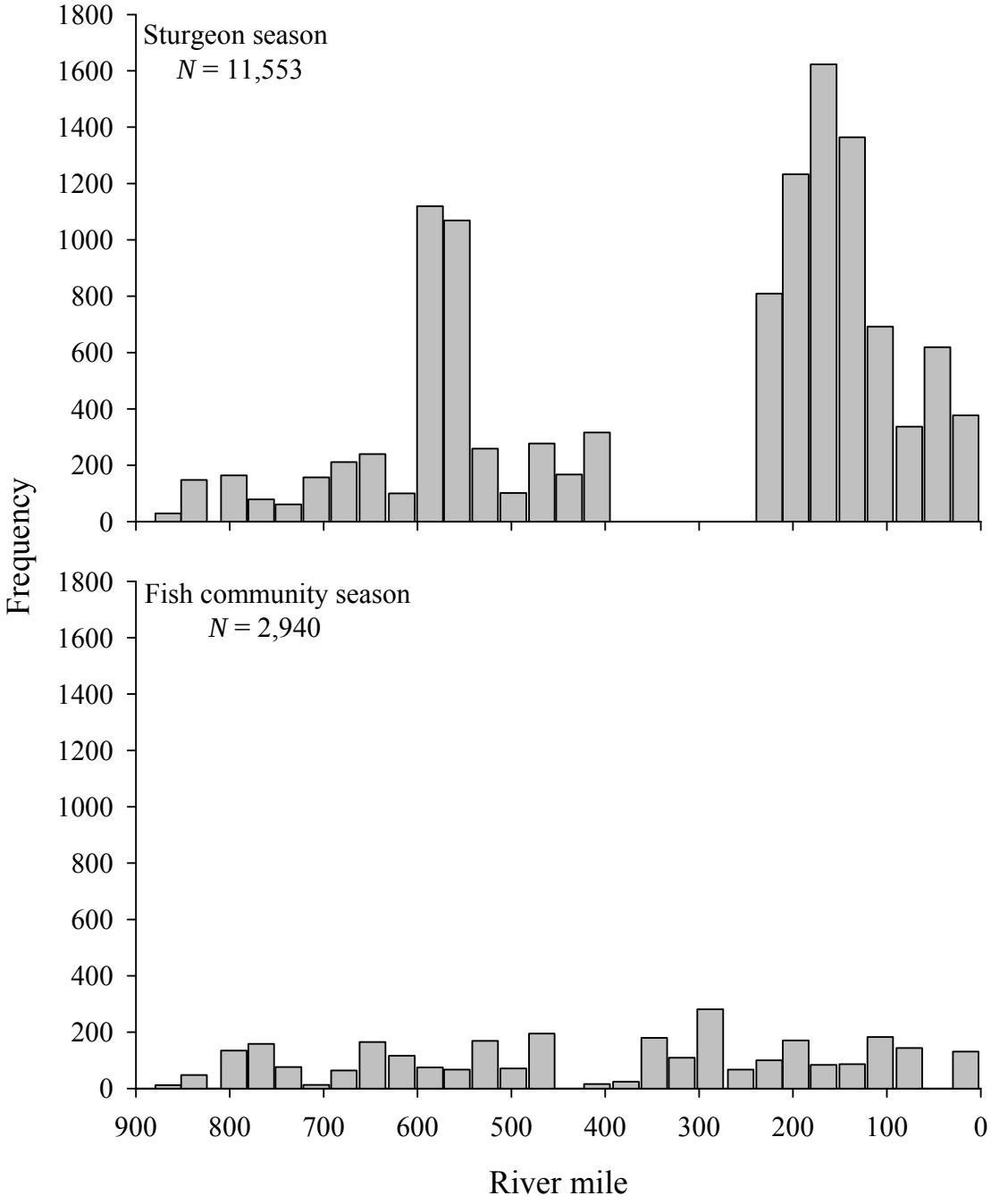


**Figure 7.** Seasonal catch by river mile (30-mile bins) of shovelnose sturgeon in the lower basin of the Missouri River in the 2005 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

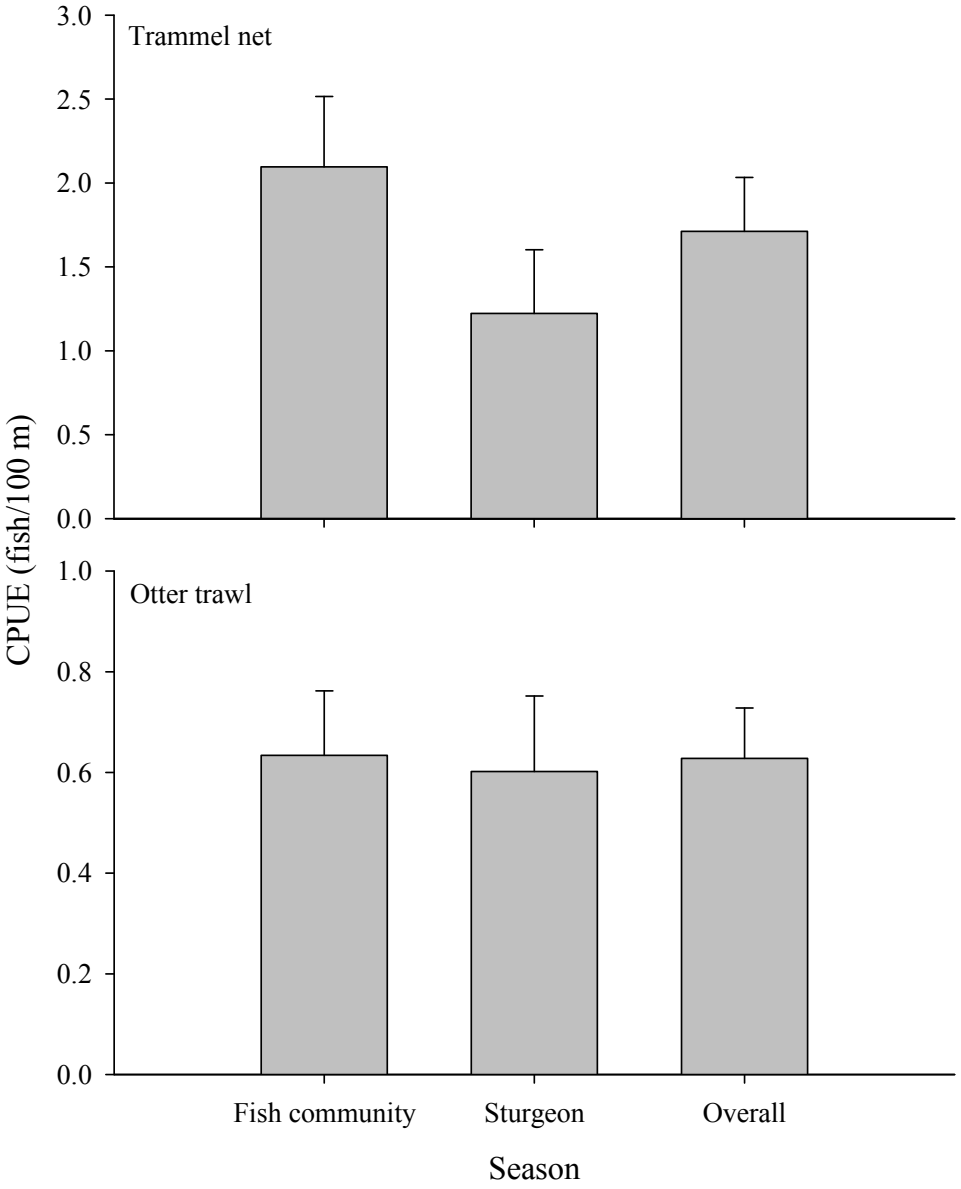


**Figure 8.** Mean seasonal catch per unit effort (± 2 SE) for shovelnose sturgeon using one-inch trammel nets and otter trawls in the lower basin of the Missouri River in the 2005 sampling year.

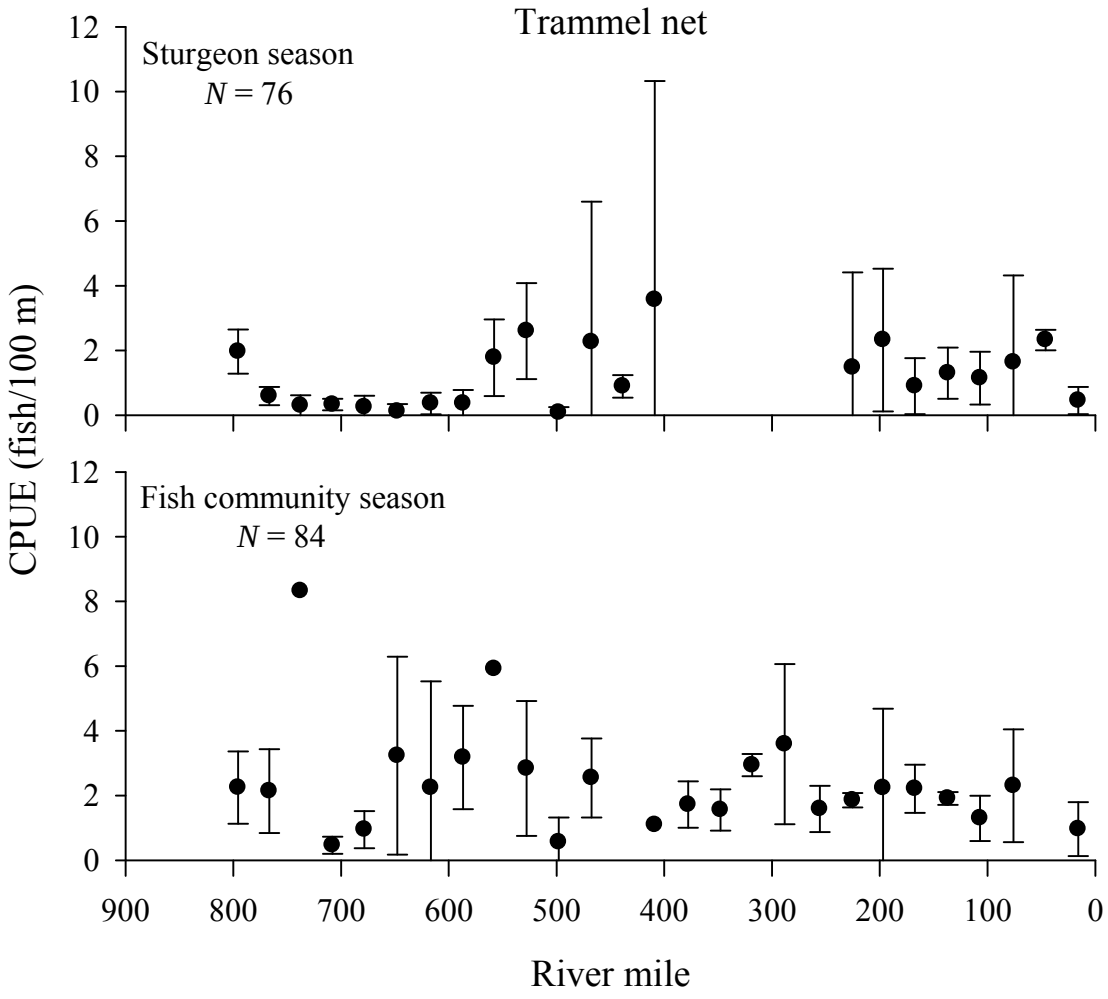


**Figure 9.** Mean catch per unit effort (± 2 SE) of shovelnose sturgeon by river mile (30-mile bins) in the lower basin of the Missouri River during the sturgeon and fish community seasons in the 2005 sampling year. Data obtained through random sampling using one-inch trammel nets. Sample size denotes the number of bends sampled.

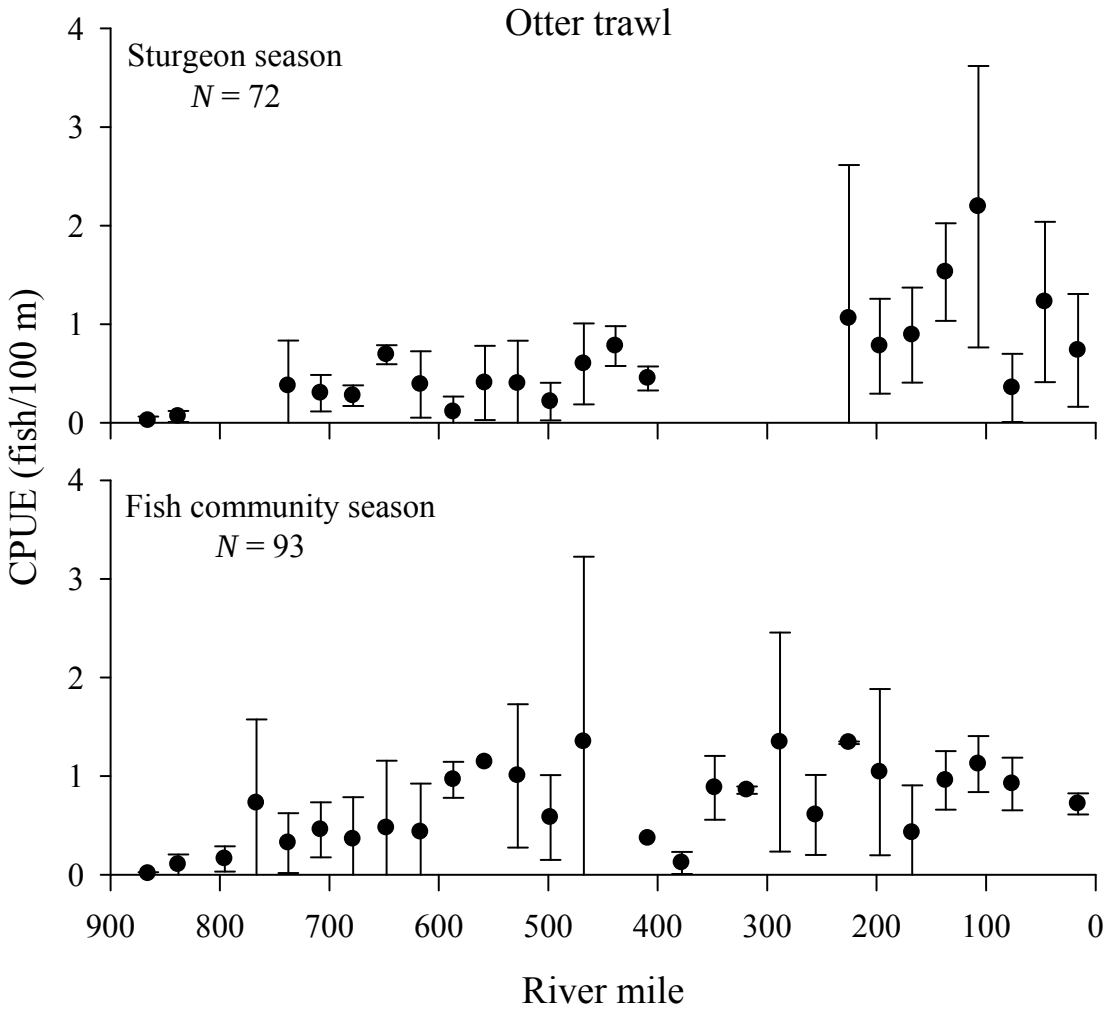


**Figure 10.** Mean catch per unit effort (± 2 SE) of shovelnose sturgeon by river mile (30-mile bins) in the lower basin of the Missouri River during the sturgeon and fish community seasons in the 2005 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

**Table 7.** 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 2005 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** | 1216 | 0.7 | 16.6 | 2.8 | 0.2 | 0.3 | 68.0 | 2.3 | 6.7 | 1.3 | 0 | 0 | 1.0 | 0 | 0 |
| | | (0.9) | (22.9) | (1.6) | (0.3) | (0.6) | (62.6) | (3.5) | (3.9) | (3.3) | (0) | (0) | (0.3) | (0) | (0) |
| **Gill Net** | 4856 | 0 | 22.5 | 0.1 | 0 | 0 | 50.4 | 17.6 | 3.4 | 5.3 | 0 | 0 | 0.7 | 0 | 0 |
| | | (0) | (21.0) | (1.3) | (0) | (0) | (53.2) | (16.7) | (4.0) | (2.9) | (0) | (0) | (0.7) | (0) | (0) |
| **Otter Trawl** | 852 | 0.6 | 23.1 | 2.5 | 0 | 0 | 56.1 | 5.5 | 10.1 | 1.6 | 0 | 0 | 0.5 | 0 | 0 |
| | | (3.7) | (23.3) | (1.3) | (0.3) | (0) | (60.0) | (5.7) | (3.3) | (1.7) | (0) | (0) | (0.6) | (0) | (0) |
| **Fish Community Season (Summer)** | | | | | | | | | | | | | | | |
| **1 Inch Trammel Net** | 1867 | 1.1 | 23.7 | 1.1 | 0 | 0.6 | 69.1 | 0.2 | 3.2 | 1.0 | 0 | 0 | 0 | 0 | 0 |
| | | (2.0) | (24.0) | (0.7) | (0.3) | (0.8) | (64.0) | (3.1) | (3.1) | (1.8) | (0) | (0) | (0) | (0.1) | (0) |
| **Mini-Fyke Net** | 1 | 0 | 100.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (8.0) | (21.7) | (0.7) | (0.3) | (0) | (46.2) | (9.4) | (2.9) | (7.7) | (1.2) | (0) | (0.6) | (1.3) | (0) |
| **Otter Trawl** | 993 | 1.9 | 31.4 | 0.5 | 0 | 0 | 59.4 | 1.5 | 0.8 | 3.3 | 0 | 0 | 1.1 | 0 | 0 |
| | | (7.4) | (24.0) | (0.5) | (0) | (0.3) | (58.7) | (4.9) | (2.2) | (1.3) | (0) | (0) | (0.8) | (0) | (0) |

**Table 8.** 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 2005 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** | 1216 | 0 | 95.7 | 0 | 2.8 | 0.2 | 1.3 |
| | | (0.2) | (94.8) | (0) | (4.2) | (0.3) | (0.5) |
| **Gill Net** | 4856 | 0 | 25.4 | 0 | 4.7 | 67.7 | 2.1 |
| | | (0) | (50.0) | (0) | (4.2) | (45.3) | (0.5) |
| **Otter Trawl** | 852 | 0 | 96.4 | 0 | 3.6 | 0 | 0 |
| | | (0) | (97.6) | (0) | (2.4) | (0) | (0) |
| **Fish Community Season (Summer)** | | | | | | | |
| **1 Inch Trammel Net** | 1867 | 0.1 | 96.9 | 0 | 3.0 | 0 | 0 |
| | | (0.3) | (96.9) | (0) | (2.8) | (0) | (0) |
| **Mini-Fyke Net** | 1 | 100.0 | 0 | 0 | 0 | 0 | 0 |
| | | (98.0) | (2.0) | (0) | (0) | (0) | (0) |
| **Otter Trawl** | 993 | 0 | 96.5 | 0 | 3.5 | 0 | 0 |
| | | (0) | (98.2) | (0) | (1.8) | (0) | (0) |

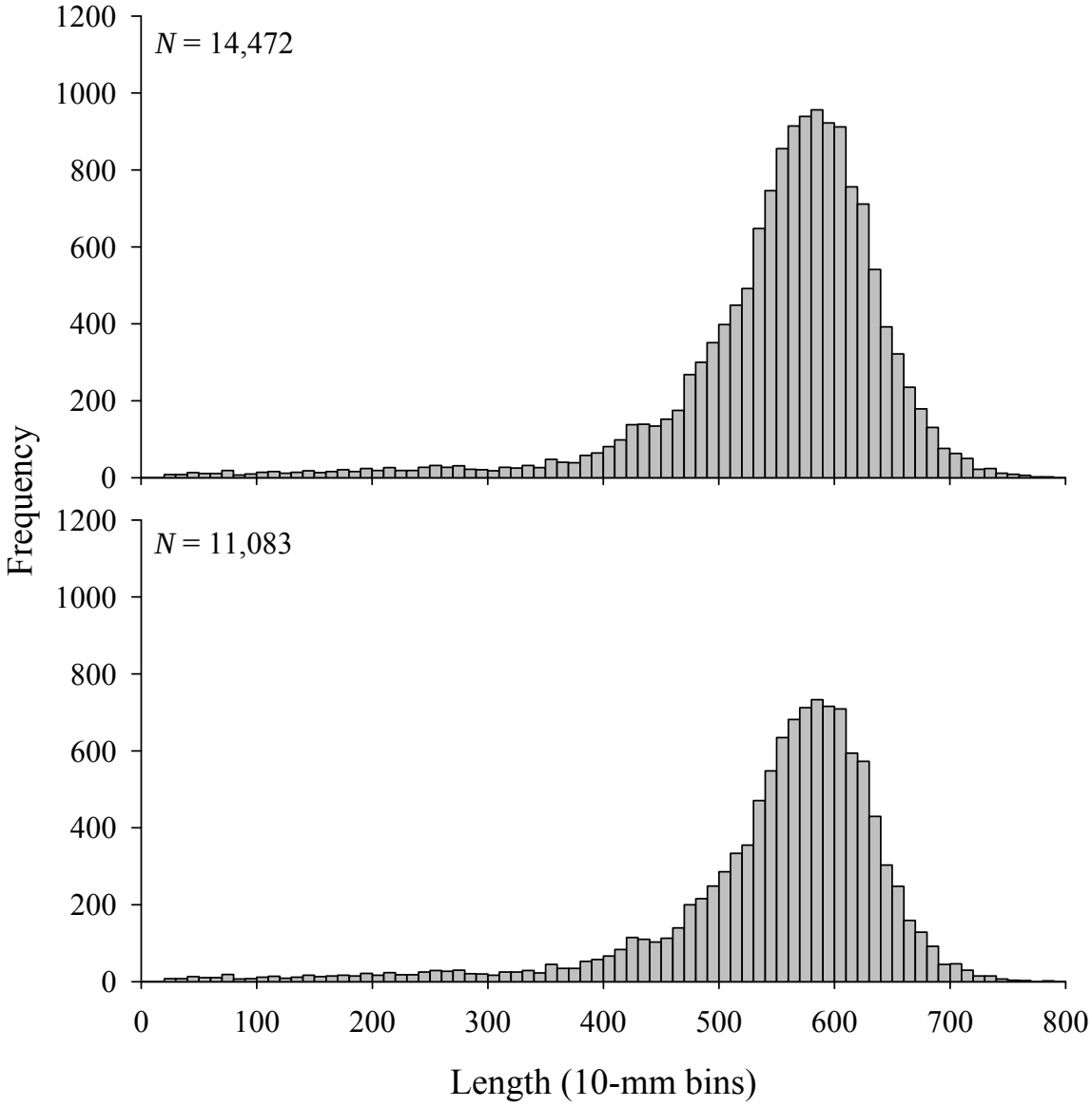


**Figure 11.** Length frequency distribution of shovelnose sturgeon captured in the lower basin of the Missouri River during the 2005 sampling year using standard and wild gears. Upper panel includes random and nonrandom sampling. Lower panel includes only random sampling.

**Sturgeon Chub**

During the 2005 sampling year in the lower basin of the Missouri River, 110 sturgeon chub *Macrhybopsis gelida* were captured during the sturgeon season, while 100 were captured during the fish community season (Figure 12). Sampling from near RM 400 – 470 in the lower reaches of segment 9 during the sturgeon season resulted in a catch of 58 sturgeon chub, comprising 53% of the total catch during that season. An additional 30% ($N = 33$) were captured from segments 13 and 14 (RM 0 – 250) during the sturgeon season. Segment 10 (RM 250 – 368) was not sampled during the sturgeon season. During the fish community season, there appeared to be a trend of increased sturgeon chub catch in the downstream sampling segments. Approximately 63% ($N = 63$) of the sturgeon chub were captured downstream of the Kansas River (RM 368) during the fish community season.

Relative abundance of sturgeon chub differed markedly between sampling seasons and among sampling segments. During the sturgeon and fish community seasons, 100% and 99%, respectively, of the sturgeon chub were captured with otter trawls. During the sturgeon season, the mean CPUE of sturgeon chub captured with otter trawls (0.12 fish/100 m) was nearly twice as high as the mean CPUE during the fish community season (0.06 fish/100 m; Figure 13). Sampling in segment 9 (RM 368 – 596) resulted in some of the largest otter trawl CPUE during the sturgeon season (Figure 14). During the fish community season there appeared to be a geographic trend of increased relative abundance from otter trawl sampling in downstream segments, with mean CPUE ranging from 0.0 to 0.25 fish/100 m throughout the lower basin of the Missouri River (Figure 14).

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 9). Main channel crossover macrohabitats were also sampled with a relatively large effort, which resulted in proportional catches of sturgeon chub during both seasons. Random sampling in channel border mesohabitats resulted in 100% and 99% of the sturgeon chub catch during the sturgeon and fish community seasons, respectively (Table 10).

A total of 210 sturgeon chub were captured in the lower basin during the 2005 sampling year. Lengths ranged from 25 to 102 mm, and averaged 54 mm (Figure 15).

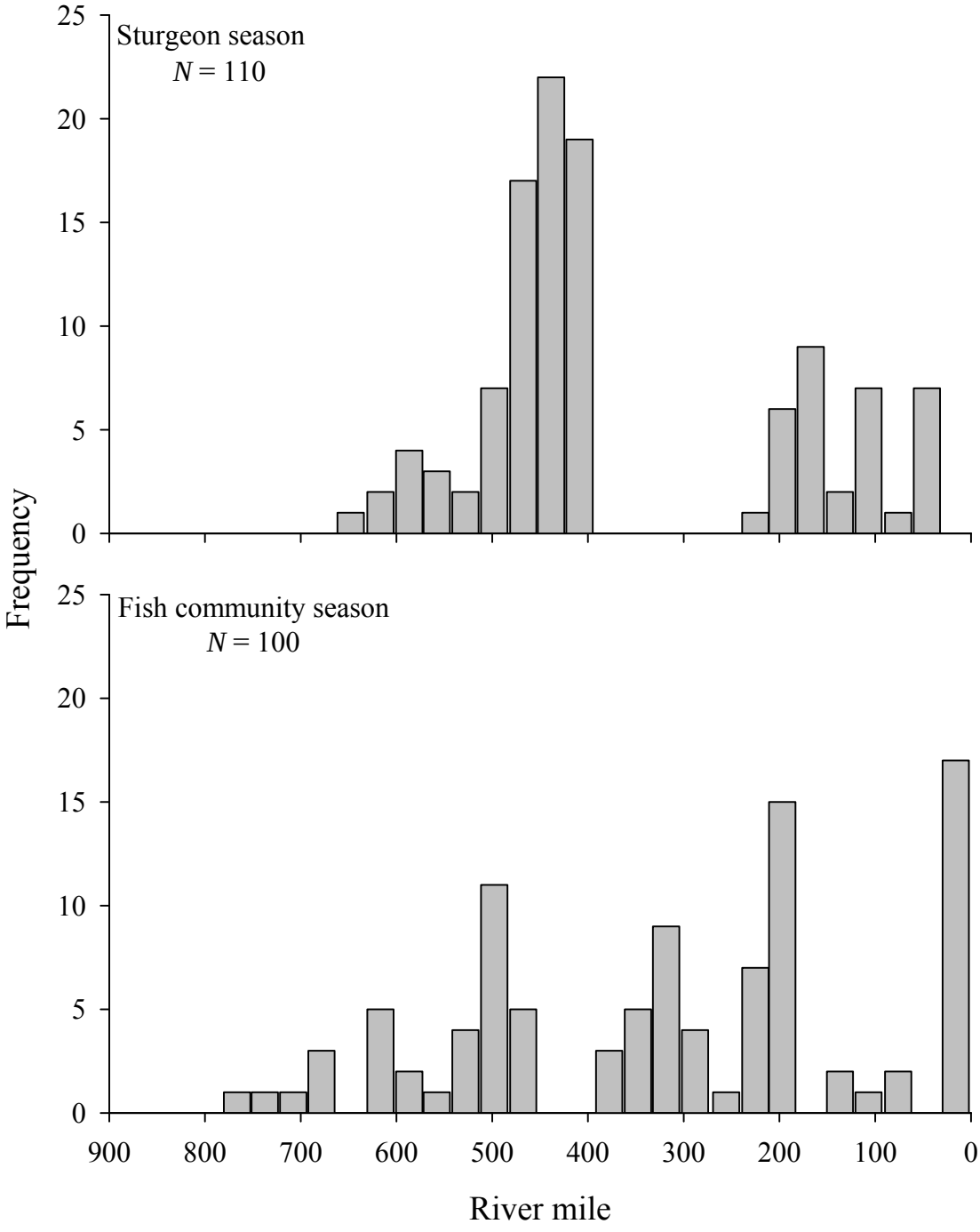


**Figure 12.** Seasonal catch by river mile (30-mile bins) of sturgeon chub in the lower basin of the Missouri River in the 2005 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

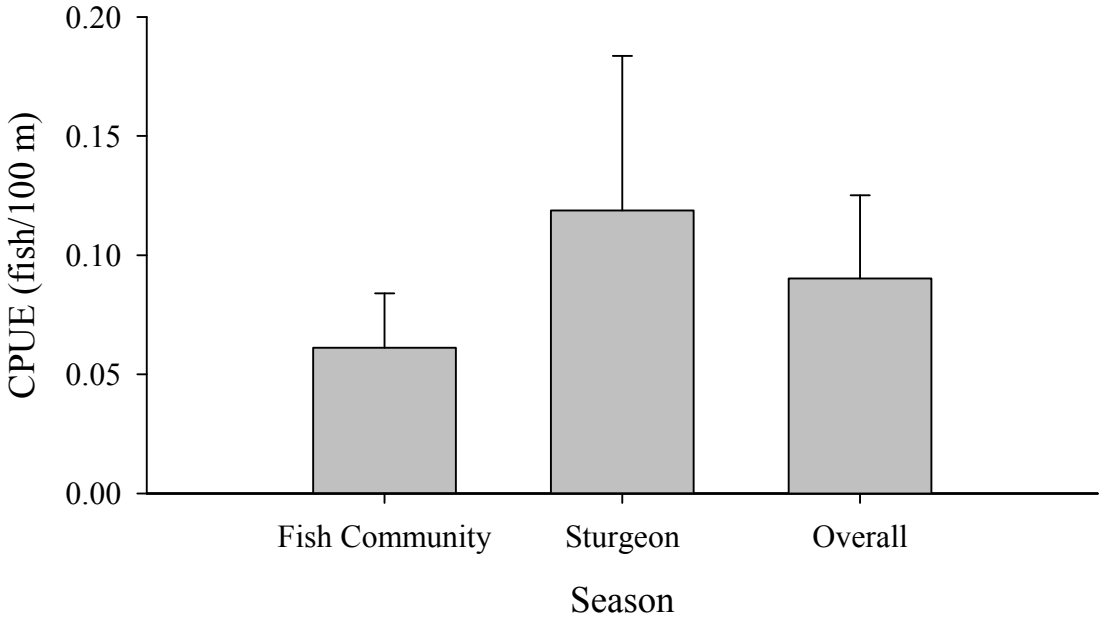


**Figure 13.** Mean seasonal catch per unit effort (± 2 SE) for sturgeon chub using otter trawls in the lower basin of the Missouri River in the 2005 sampling year.

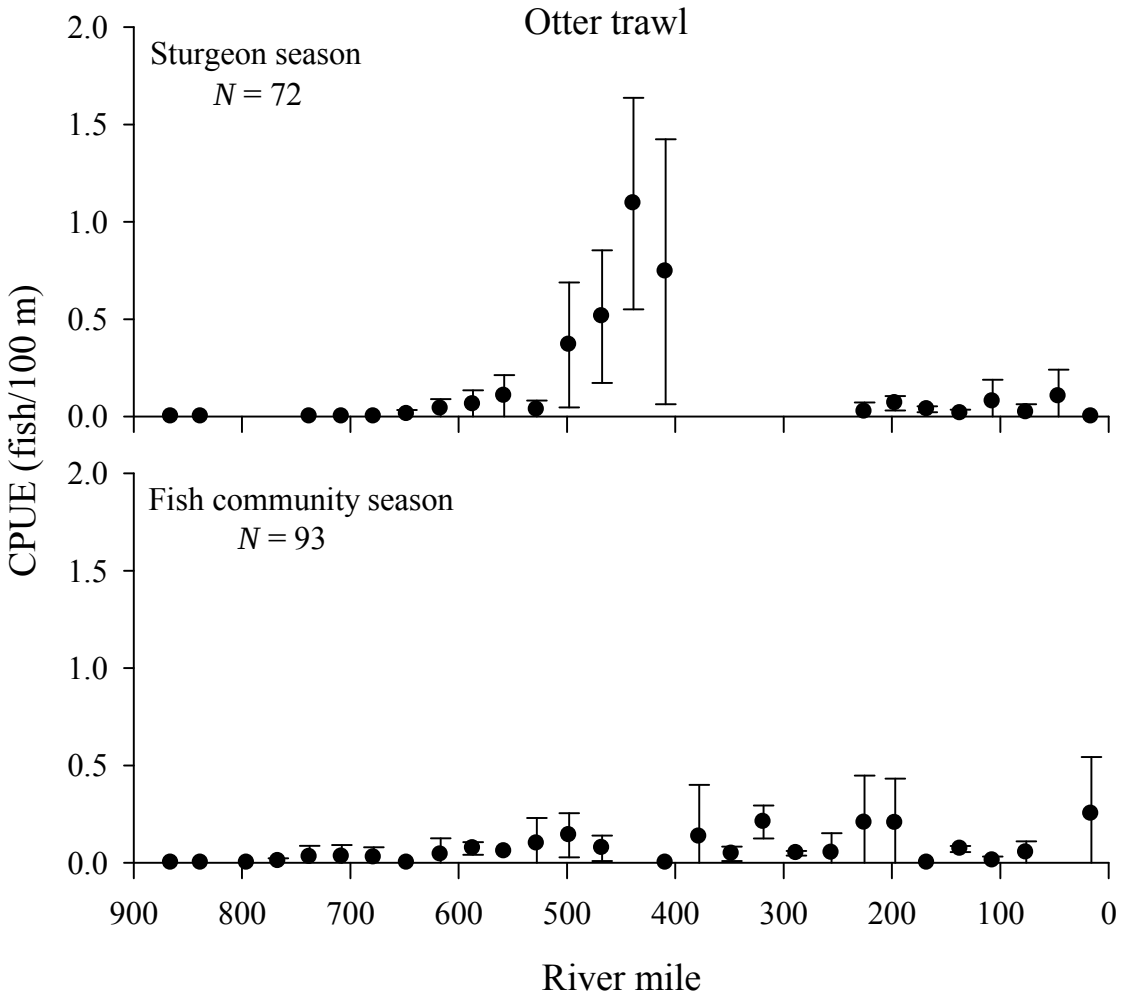


**Figure 14.** Mean catch per unit effort (± 2 SE) of sturgeon chub by river mile (30-mile bins) in the lower basin of the Missouri River during the sturgeon and fish community seasons in the 2005 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

**Table 9.** 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 2005 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 |
| | | (0.9) | (22.9) | (1.6) | (0.3) | (0.6) | (62.6) | (3.5) | (3.9) | (3.3) | (0) | (0) | (0.3) | (0) | (0) |
| **Gill Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0) | (21.0) | (1.3) | (0) | (0) | (53.2) | (16.7) | (4.0) | (2.9) | (0) | (0) | (0.7) | (0) | (0) |
| **Otter Trawl** | 103 | 0 | 11.7 | 0 | 0 | 0 | 84.5 | 0 | 3.9 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (3.7) | (23.3) | (1.3) | (0.3) | (0) | (60.0) | (5.7) | (3.3) | (1.7) | (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 |
| | | (2.0) | (24.0) | (0.7) | (0.3) | (0.8) | (64.0) | (3.1) | (3.1) | (1.8) | (0) | (0) | (0) | (0.1) | (0) |
| **Mini-Fyke Net** | 1 | 0 | 0 | 0 | 0 | 0 | 100.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (8.0) | (21.7) | (0.7) | (0.3) | (0) | (46.2) | (9.4) | (2.9) | (7.7) | (1.2 | (0) | (0.6) | (1.3) | (0) |
| **Otter Trawl** | 96 | 0 | 29.2 | 0 | 0 | 0 | 69.8 | 1.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (7.4) | (24.0) | (0.5) | (0) | (0.3) | (58.7) | (4.9) | (2.2) | (1.3) | (0) | (0) | (0.8) | (0) | (0) |

**Table 10.** 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 2005 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 |
| | | (0.2) | (94.8) | (0) | (4.2) | (0.3) | (0.5) |
| **Gill Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0) | (50.0) | (0) | (4.2) | (45.3) | (0.5) |
| **Otter Trawl** | 103 | 0 | 100.0 | 0 | 0 | 0 | 0 |
| | | (0) | (97.6) | (0) | (2.4) | (0) | (0) |
| **Fish Community Season (Summer)** | | | | | | | |
| **1 Inch Trammel Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0.3) | (96.9) | (0) | (2.8) | (0) | (0) |
| **Mini-Fyke Net** | 1 | 100.0 | 0 | 0 | 0 | 0 | 0 |
| | | (98.0) | (2.0) | (0) | (0) | (0) | (0) |
| **Otter Trawl** | 96 | 0 | 100.0 | 0 | 0 | 0 | 0 |
| | | (0) | (98.2) | (0) | (1.8) | (0) | (0) |

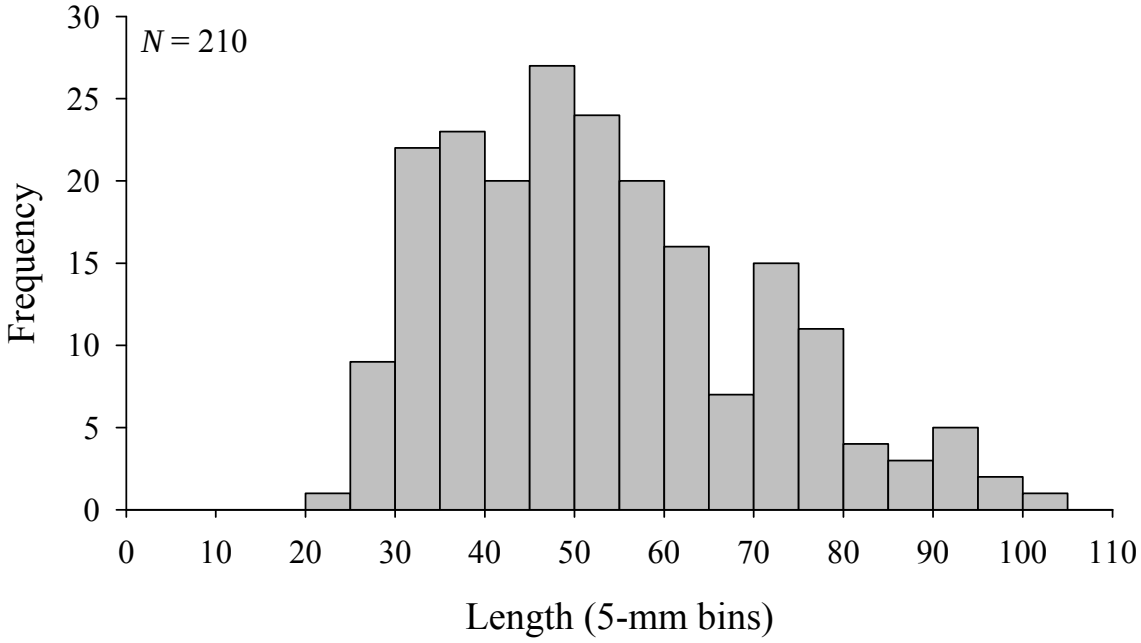


**Figure 15.** Length frequency distribution of sturgeon chub captured in the lower basin of the Missouri River during the 2005 sampling year using random and nonrandom sampling with standard and wild gears.

**Sicklefin Chub**

A total of 812 sicklefin chub *Macrhybopsis meeki* were captured during the sturgeon season, while 602 were captured during the fish community season (Figure 16). Sampling from segments 13 and 14 (RM 0 – 250) during the sturgeon season resulted in 735 sicklefin chub captured, comprising 91% of the catch during the sturgeon sampling season. Segment 10 (RM 250 – 368) was not sampled during the sturgeon season, and very few sicklefin chub were caught in upstream segments 5 through 9 (RM 368 – 880). While total catch decreased during the fish community season, there was a marked increase in catch of sicklefin chub near RM 500 in segment 9. The trend of increased sicklefin chub catch in the downstream sampling segments continued during the fish community season. Sampling from segment 10 during the fish community season resulted in similar numbers of fish caught as in other segments.

Relative abundance of sicklefin chub was similar between sampling seasons (Figure 17). During the sturgeon and fish community seasons, 100% and 97%, respectively, of the sicklefin chub were captured with otter trawls. During the sturgeon season, the mean CPUE of sicklefin chub captured with otter trawls was 0.39 fish/100 m, while during the fish community season mean CPUE was 0.37 fish/100 m. Sampling in segments 13 and 14 (RM 0 – 250) resulted in some of the largest otter trawl CPUE during the sturgeon season (Figure 18). Mean CPUE ranged from 0.0 to 4.0 fish/100 m throughout the lower basin of the Missouri River (Figure 18).

Random sampling with standard gears accounted for approximately 86% ($N = 701$) of the total sicklefin chub catch during the sturgeon season, and 99% ($N = 597$) of the catch during the fish community season (Table 11). 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 macrohabitats were also sampled with a relatively large effort, which resulted in proportional catches of sicklefin chub during both seasons. The majority of all sicklefin chub were captured from main channel border mesohabitats, which for most gears was also the location of greatest effort (Table 12). Mini-fyke nets, used during fish community season, caught 19 sicklefin chub from sand bar mesohabitats, where 98% of the effort for that gear was expended.

A total of 1305 sicklefin chub were captured in the lower basin during the 2005 sampling year. Lengths ranged from 15 to 131 mm, with a mean of 57 mm (Figure 19).

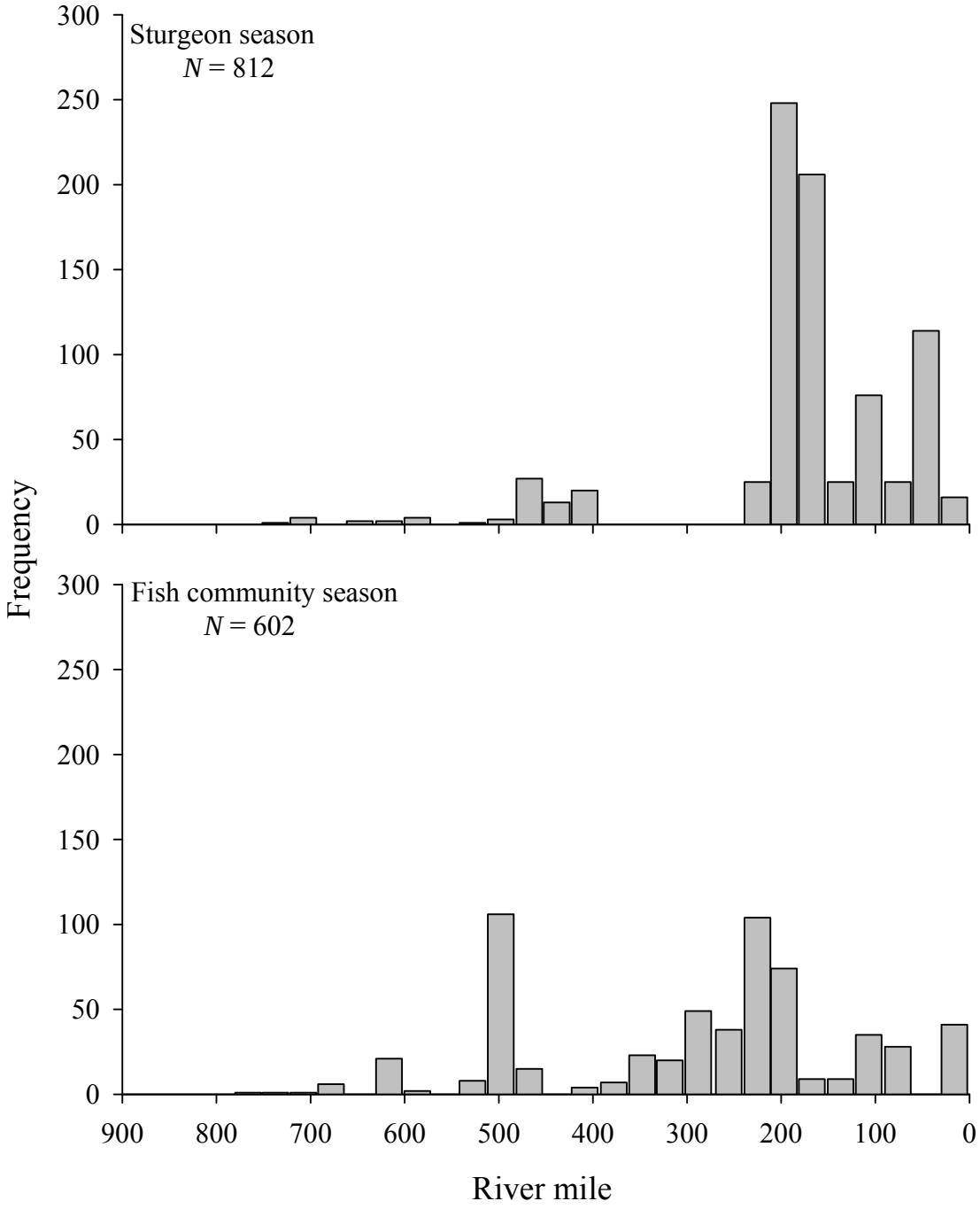


**Figure 16.** Seasonal catch by river mile (30-mile bins) of sicklefin chub in the lower basin of the Missouri River in the 2005 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

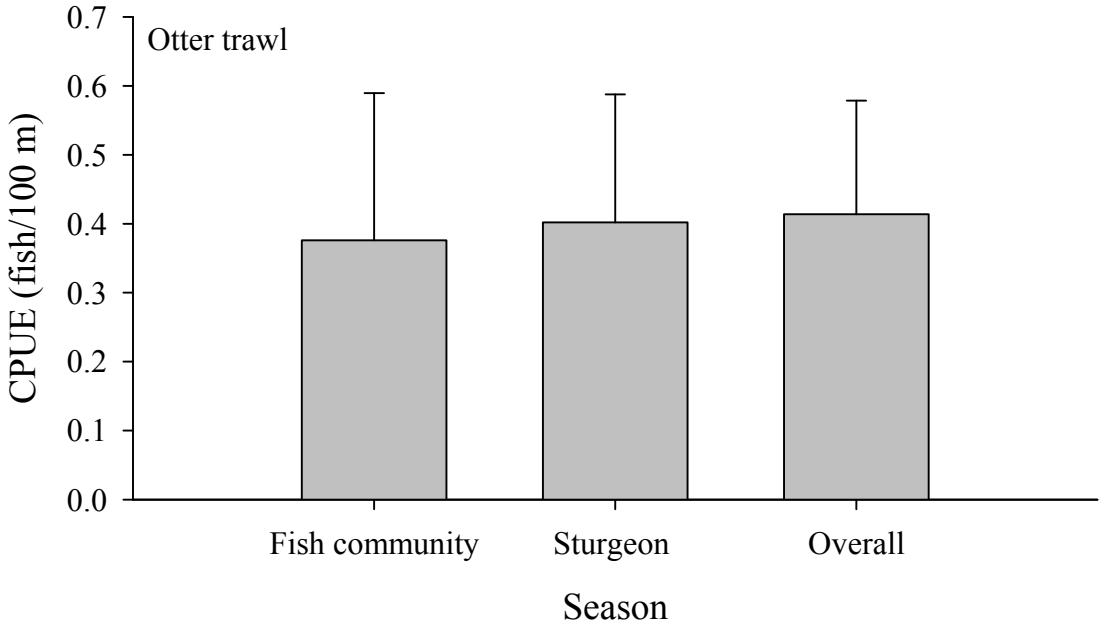


**Figure 17.** Mean seasonal catch per unit effort (± 2 SE) for sicklefin chub using otter trawls in the lower basin of the Missouri River in the 2005 sampling year.

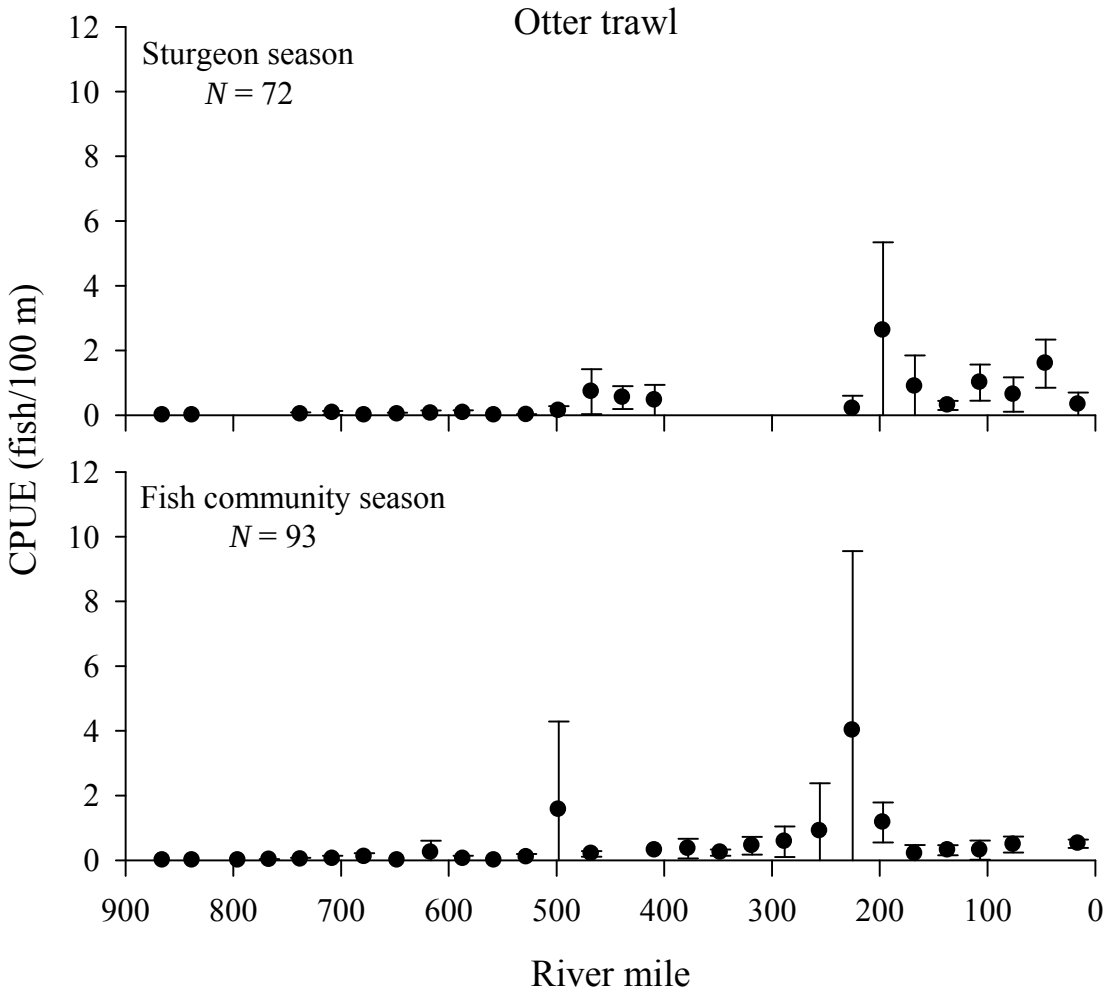


**Figure 18.** Mean catch per unit effort (± 2 SE) of sicklefin chub by river mile (30-mile bins) in the lower basin of the Missouri River during the sturgeon and fish community seasons in the 2005 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

**Table 11.** 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 2005 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 |
| | | (0.9) | (22.9) | (1.6) | (0.3) | (0.6) | (62.6) | (3.5) | (3.9) | (3.3) | (0) | (0) | (0.3) | (0) | (0) |
| **Gill Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0) | (21.0) | (1.3) | (0) | (0) | (53.2) | (16.7) | (4.0) | (2.9) | (0) | (0) | (0.7) | (0) | (0) |
| **Otter Trawl** | 701 | 0 | 12.1 | 0.4 | 0 | 0 | 71.5 | 2.4 | 7.3 | 6.3 | 0 | 0 | 0 | 0 | 0 |
| | | (3.7) | (23.3) | (1.3) | (0.3) | (0) | (60.0) | (5.7) | (3.3) | (1.7) | (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 |
| | | (2.0) | (24.0) | (0.7) | (0.3) | (0.8) | (64.0) | (3.1) | (3.1) | (1.8) | (0) | (0) | (0) | (0.1) | (0) |
| **Mini-Fyke Net** | 19 | 0 | 5.3 | 0 | 0 | 0 | 68.4 | 5.3 | 0 | 21.1 | 0 | 0 | 0 | 0 | 0 |
| | | (8.0) | (21.7) | (0.7) | (0.3) | (0) | (46.2) | (9.4) | (2.9) | (7.7) | (1.2 | (0) | (0.6) | (1.3) | (0) |
| **Otter Trawl** | 578 | 0 | 43.3 | 0 | 0 | 0 | 54.8 | 0.7 | 0.3 | 0.7 | 0 | 0 | 0.2 | 0 | 0 |
| | | (7.4) | (24.0) | (0.5) | (0) | (0.3) | (58.7) | (4.9) | (2.2) | (1.3) | (0) | (0) | (0.8) | (0) | (0) |

**Table 12.** 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 2005 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 |
| | | (0.2) | (94.8) | (0) | (4.2) | (0.3) | (0.5) |
| **Gill Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0) | (50.0) | (0) | (4.2) | (45.3) | (0.5) |
| **Otter Trawl** | 701 | 0 | 93.2 | 0 | 6.8 | 0 | 0 |
| | | (0) | (97.6) | (0) | (2.4) | (0) | (0) |
| **Fish Community Season (Summer)** | | | | | | | |
| **1 Inch Trammel Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0.3) | (96.9) | (0) | (2.8) | (0) | (0) |
| **Mini-Fyke Net** | 19 | 100.0 | 0 | 0 | 0 | 0 | 0 |
| | | (98.0) | (2.0) | (0) | (0) | (0) | (0) |
| **Otter Trawl** | 578 | 0 | 99.3 | 0 | 0.7 | 0 | 0 |
| | | (0) | (98.2) | (0) | (1.8) | (0) | (0) |

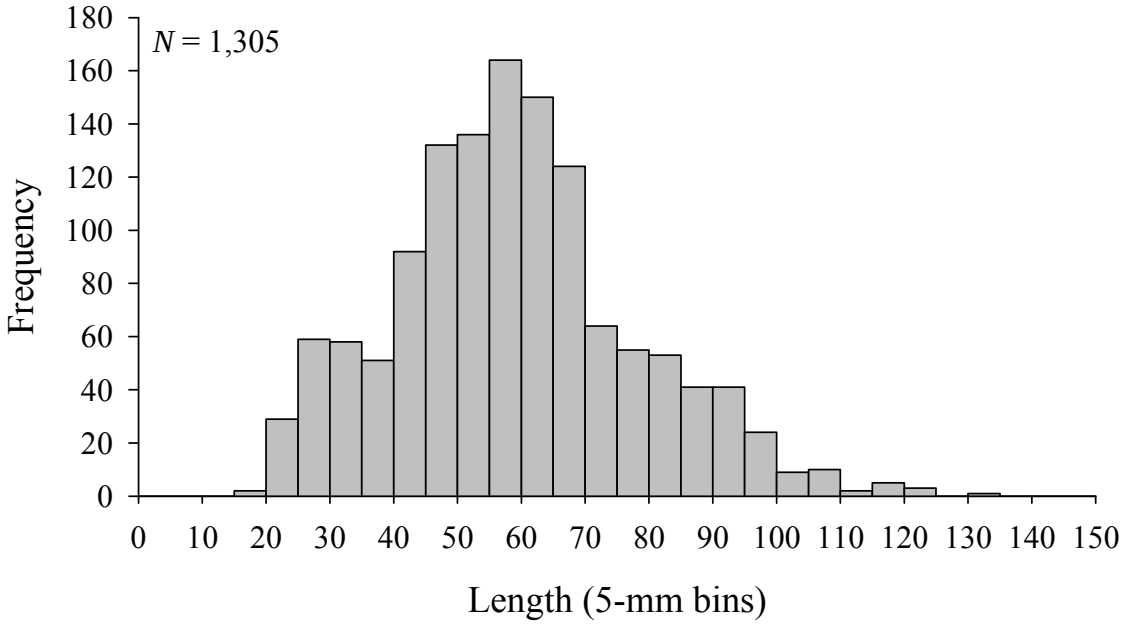


**Figure 19.** Length frequency distribution of sicklefin chub captured in the lower basin of the Missouri River during the 2005 sampling year using random and nonrandom sampling with standard and wild gears.

**Speckled Chub**

A total of 626 speckled chub *Macrhybopsis aestivalis* were captured during the sturgeon season, while 909 were captured during the fish community season (Figure 20). Sampling from segments 13 and 14 (RM 0 – 250) during the sturgeon season resulted in 401 speckled chub captured, comprising 64% of the catch during the sturgeon sampling season. Segment 10 (RM 250 – 368) was not sampled during the sturgeon season. Sampling from the downstream reaches of segment 9 (RM 368 – 596) resulted in 163 speckled chub (26%) caught during the sturgeon season. Relatively few speckled chub were caught in upstream segments 5 through 8 (RM 368 – 596). Total catch increased during the fish community season, with marked increases in catch of speckled chub in segments 13 and 14 (Figure 20). The trend of increased speckled chub catch in the downstream sampling segments continued during the fish community season. Sampling from segment 10 during the fish community season resulted in similar numbers of fish caught as in the upstream segments.

Relative abundance of speckled chub differed slightly between sampling seasons and among sampling segments. During the sturgeon and fish community seasons, 100% and 74%, respectively, of the speckled chub were captured with otter trawls. During the sturgeon season, the mean CPUE of speckled chub captured with otter trawls was 0.59 fish/100 m, while during the fish community season the mean CPUE was 0.39 fish/100 m (Figure 21). Sampling from the downstream reaches of segment 9 (RM 368 – 596) resulted in some of the largest otter trawl CPUE during the sturgeon season (Figure 22). During the fish community season, mean CPUE decreased dramatically in segment 9, while increasing in segments 13 and 14. During the fish community season there appeared to be a geographic trend of increased relative abundance from otter trawl sampling in downstream segments, with mean CPUE ranging from 0.0 to 2.0 fish/100 m throughout the lower basin of the Missouri River (Figure 22).

Random sampling with standard gears accounted for approximately 96% ($N = 602$) of the total speckled chub catch during the sturgeon season, and 88% ($N = 803$) of the catch during the fish community season (Table 13). During both seasons, most speckled chub 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 speckled chub during both seasons. The majority of all speckled chub were captured from main channel border mesohabitats, which for most gears was also the location of greatest effort (Table 14). During fish community season mini-fyke nets caught 98% of the speckled chub from sand bar mesohabitats where 98% of the effort for that gear was expended. Small connected secondary channel macrohabitats accounted for 26% of the mini-fyke net catch, while comprising only 8% of the effort for that gear (Table 13).

A total of 1297 speckled chub were captured in the lower basin during the 2005 sampling year. Lengths ranged from 14 to 126 mm, with a mean length of 44 mm (Figure 23).

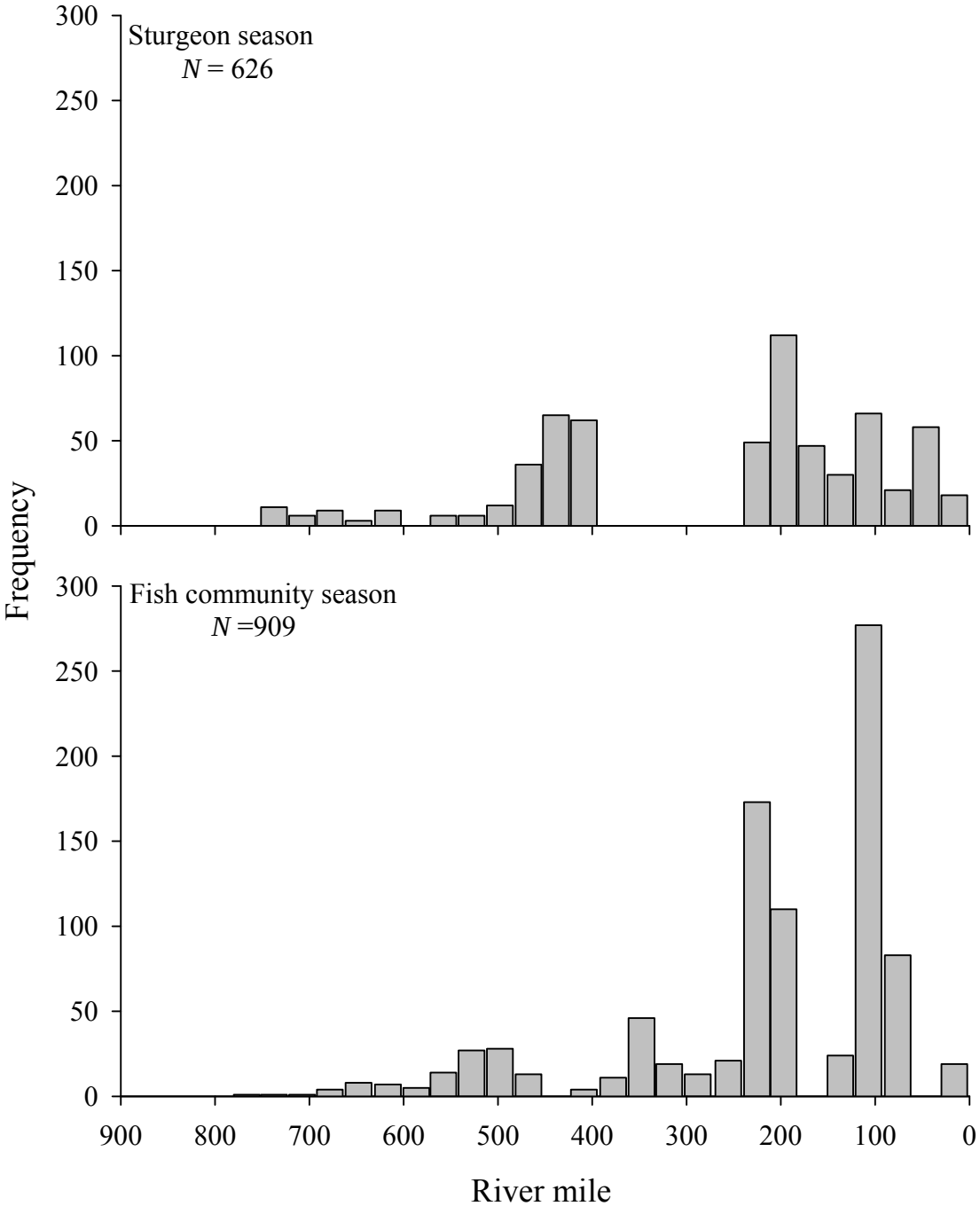


**Figure 20.** Seasonal catch by river mile (30-mile bins) of speckled chub in the lower basin of the Missouri River in the 2005 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

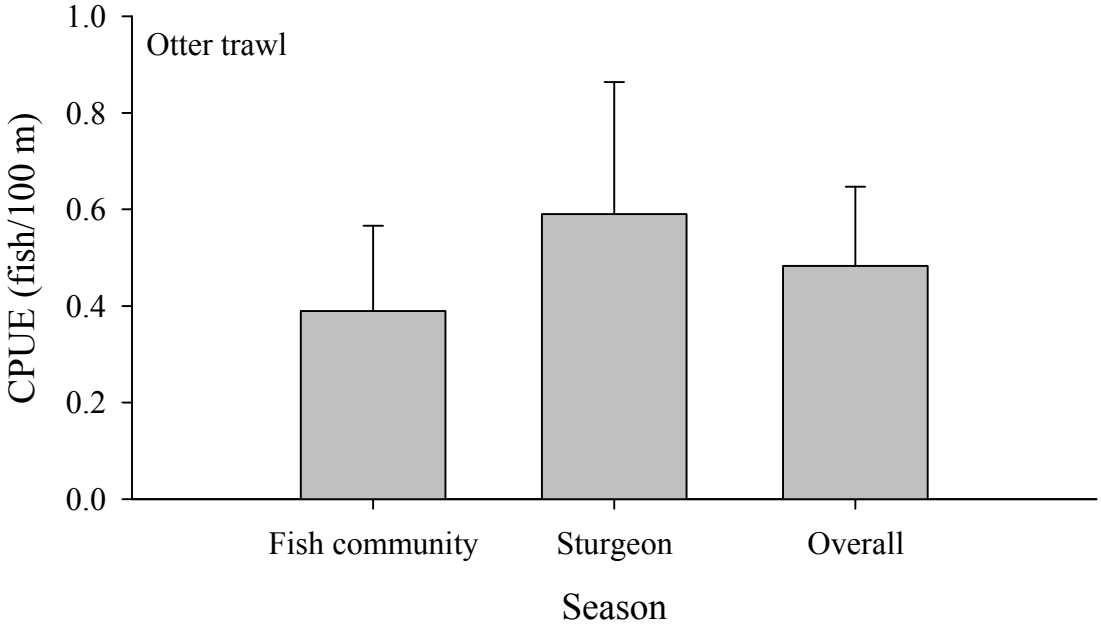


**Figure 21.** Mean seasonal catch per unit effort (± 2 SE) for speckled chub using otter trawls in the lower basin of the Missouri River in the 2005 sampling year.

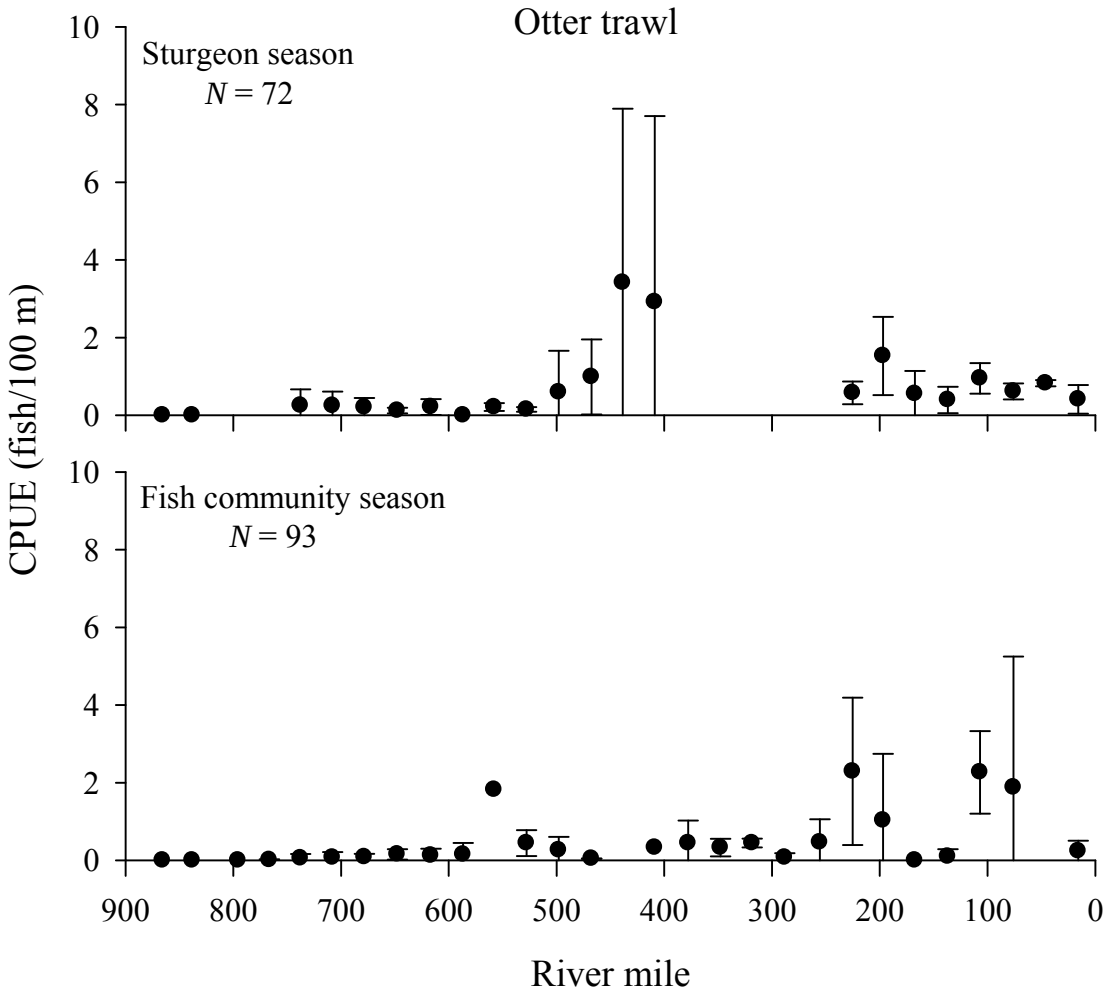


**Figure 22.** Mean catch per unit effort (± 2 SE) of speckled chub by river mile (30-mile bins) in the lower basin of the Missouri River during the sturgeon and fish community seasons in the 2005 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

**Table 13.** 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 2005 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 |
| | | (0.9) | (22.9) | (1.6) | (0.3) | (0.6) | (62.6) | (3.5) | (3.9) | (3.3) | (0) | (0) | (0.3) | (0) | (0) |
| **Gill Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0) | (21.0) | (1.3) | (0) | (0) | (53.2) | (16.7) | (4.0) | (2.9) | (0) | (0) | (0.7) | (0) | (0) |
| **Otter Trawl** | 602 | 0 | 15.3 | 0.3 | 0 | 0 | 63.3 | 6.5 | 8.5 | 5.8 | 0 | 0 | 0.3 | 0 | 0 |
| | | (3.7) | (23.3) | (1.3) | (0.3) | (0) | (60.0) | (5.7) | (3.3) | (1.7) | (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 |
| | | (2.0) | (24.0) | (0.7) | (0.3) | (0.8) | (64.0) | (3.1) | (3.1) | (1.8) | (0) | (0) | (0) | (0.1) | (0) |
| **Mini-Fyke Net** | 212 | 0 | 30.7 | 0 | 0 | 0 | 37.3 | 2.8 | 2.8 | 26.4 | 0 | 0 | 0 | 0 | 0 |
| | | (8.0) | (21.7) | (0.7) | (0.3) | (0) | (46.2) | (9.4) | (2.9) | (7.7) | (1.2) | (0) | (0.6) | (1.3) | (0) |
| **Otter Trawl** | 591 | 0 | 26.9 | 0 | 0 | 0 | 58.0 | 4.6 | 1.2 | 9.3 | 0 | 0 | 0 | 0 | 0 |
| | | (7.4) | (24.0) | (0.5) | (0) | (0.3) | (58.7) | (4.9) | (2.2) | (1.3) | (0) | (0) | (0.8) | (0) | (0) |

**Table 14.** 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 2005 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 |
| | | (0.2) | (94.8) | (0) | (4.2) | (0.3) | (0.5) |
| **Gill Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0) | (50.0) | (0) | (4.2) | (45.3) | (0.5) |
| **Otter Trawl** | 602 | 0 | 94.0 | 0 | 6.0 | 0 | 0 |
| | | (0) | (97.6) | (0) | (2.4) | (0) | (0) |
| **Fish Community Season (Summer)** | | | | | | | |
| **1 Inch Trammel Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0.3) | (96.9) | (0) | (2.8) | (0) | (0) |
| **Mini-Fyke Net** | 212 | 97.6 | 2.4 | 0 | 0 | 0 | 0 |
| | | (98.0) | (2.0) | (0) | (0) | (0) | (0) |
| **Otter Trawl** | 591 | 0 | 90.0 | 0 | 10.0 | 0 | 0 |
| | | (0) | (98.2) | (0) | (1.8) | (0) | (0) |

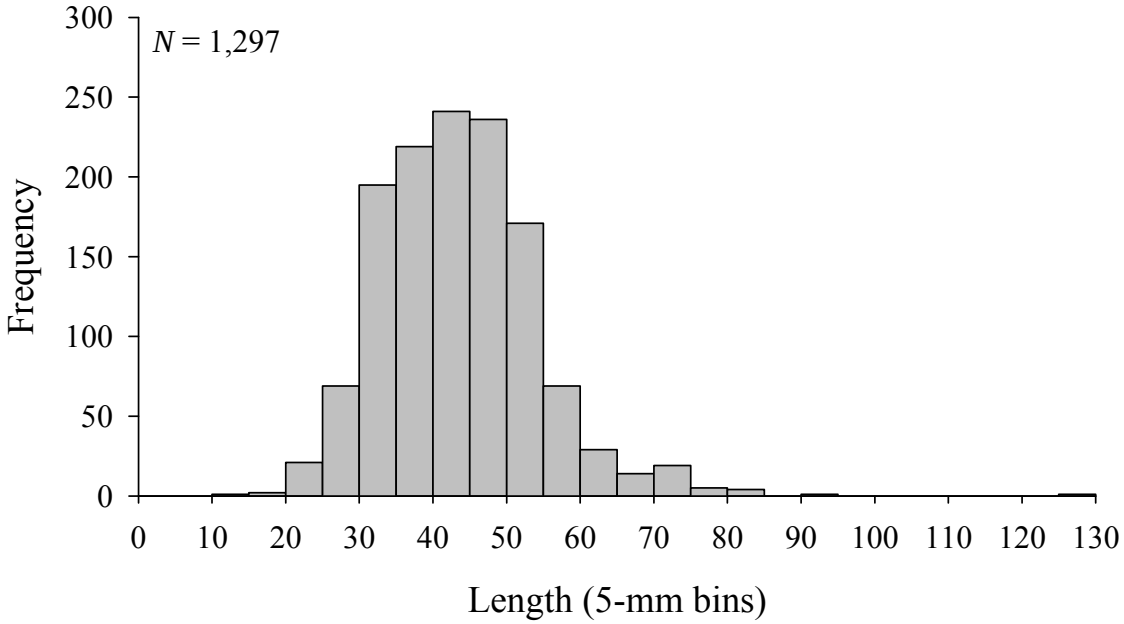


**Figure 23.** Length frequency distribution of speckled chub captured in the lower basin of the Missouri River during the 2005 sampling year using random and nonrandom sampling with standard and wild gears.

**Blue Sucker**

During the 2005 sampling year in the lower basin of the Missouri River, 1322 blue suckers *Cycleptus elongatus* were captured during the sturgeon season, while 511 were captured during the fish community season (Figure 24). Sampling from segments 5 through 9 (RM 368 – 880) during the sturgeon season resulted in 1002 blue suckers captured, comprising 76% of the catch during the sturgeon sampling season. Segment 10 (RM 250 – 368) was not sampled during the sturgeon season. While the total catch of blue suckers decreased during the fish community season, the trend of lower catches from downstream reaches continued. Approximately 87% ($N = 445$) of the blue suckers were captured from segments 5 through 9 during the fish community season. Sampling from segment 10 during the fish community season resulted in similar numbers of fish caught as in other downstream segments.

Relative abundance of blue suckers differed markedly between sampling seasons and among sampling segments. Although total catch of blue suckers was larger during the sturgeon season than during the fish community season, the mean CPUE for both trammel nets and otter trawls was notably larger during the fish community season than during the sturgeon season. During the fish community season, the CPUE of blue suckers captured with trammel nets was twice as large (0.54 fish/100 m) as the mean CPUE (0.27 fish/100 m) during the sturgeon season (Figure 25). Overall mean CPUE was larger for trammel nets (0.41 fish/100 m) than otter trawls (0.10 fish/100 m). Sampling in segments 7 through 9 (RM 367.5 – 811.0) resulted in some of the largest trammel net CPUE during the fish community and sturgeon seasons (Figure 26). During the fish community season the otter trawl mean CPUE was larger (0.13 fish/100 m) than the mean CPUE during the sturgeon season (0.08 fish/100 m; Figure 25). Sampling in segments 8 and 9 (RM 368 – 750) resulted in some of the largest otter trawl CPUE during both the sturgeon and fish community seasons (Figure 27).

Random sampling with standard gears accounted for approximately 61% ($N = 805$) of the total blue sucker catch during the sturgeon season, and 98% ($N = 499$) of the catch during the fish community season (Table 15). 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 sucker with all gear types and during both seasons. 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 16). During the sturgeon season, pool mesohabitats comprised 45% of the gill net sampling effort, resulting in approximately 52% of the total blue sucker catch with all gears for that season.

The population structure of blue suckers captured during the 2005 sampling year is negatively skewed, with juvenile fish representing a small component of fish sampled (Figure 28). The lengths of all blue suckers captured ranged from approximately 150 to 880 mm, with a mode near 630 mm. The length frequency distribution from random sampling is very similar to that from non-random sampling (Figure 28).

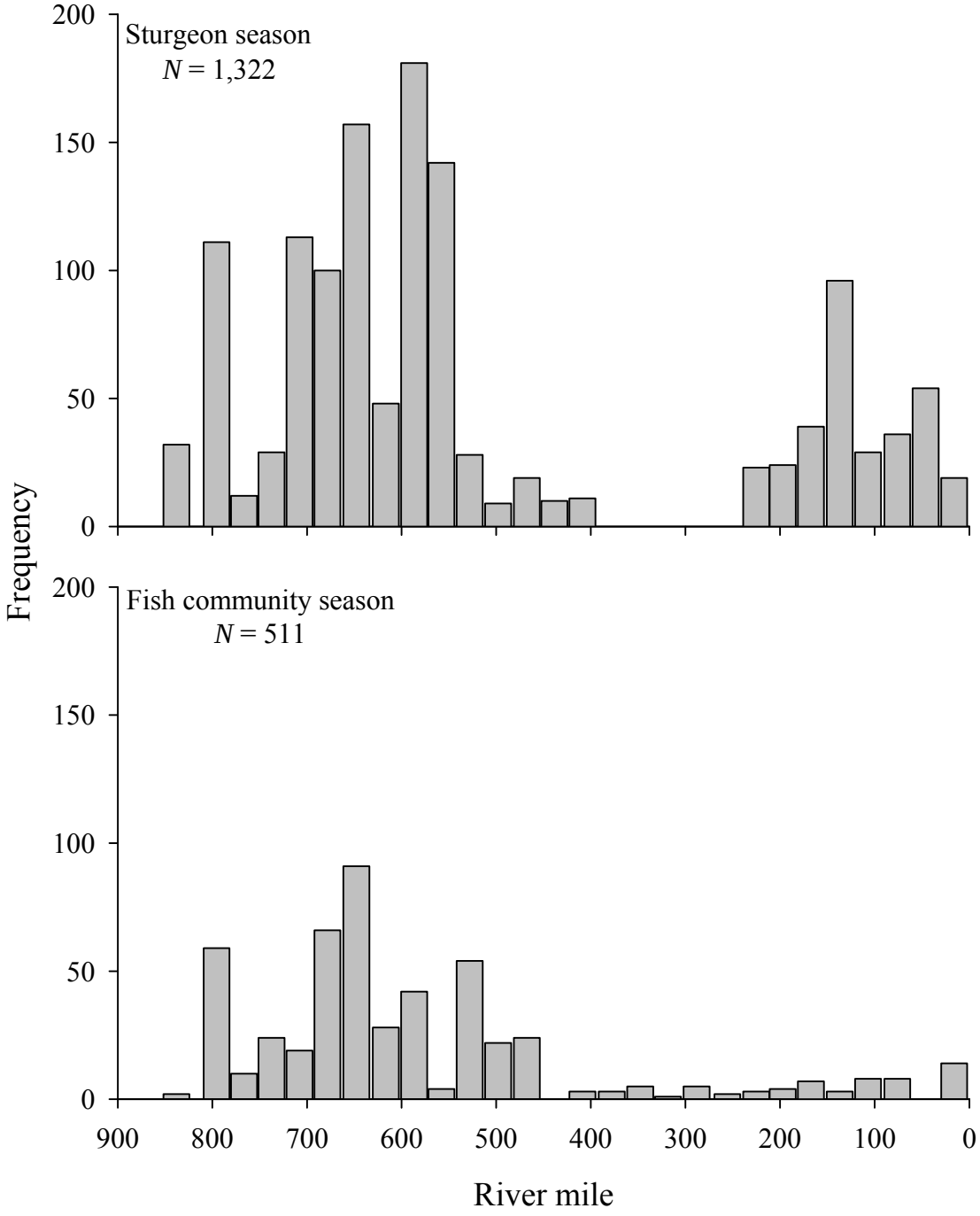


**Figure 24.** Seasonal catch by river mile (30-mile bins) of blue sucker in the lower basin of the Missouri River in the 2005 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

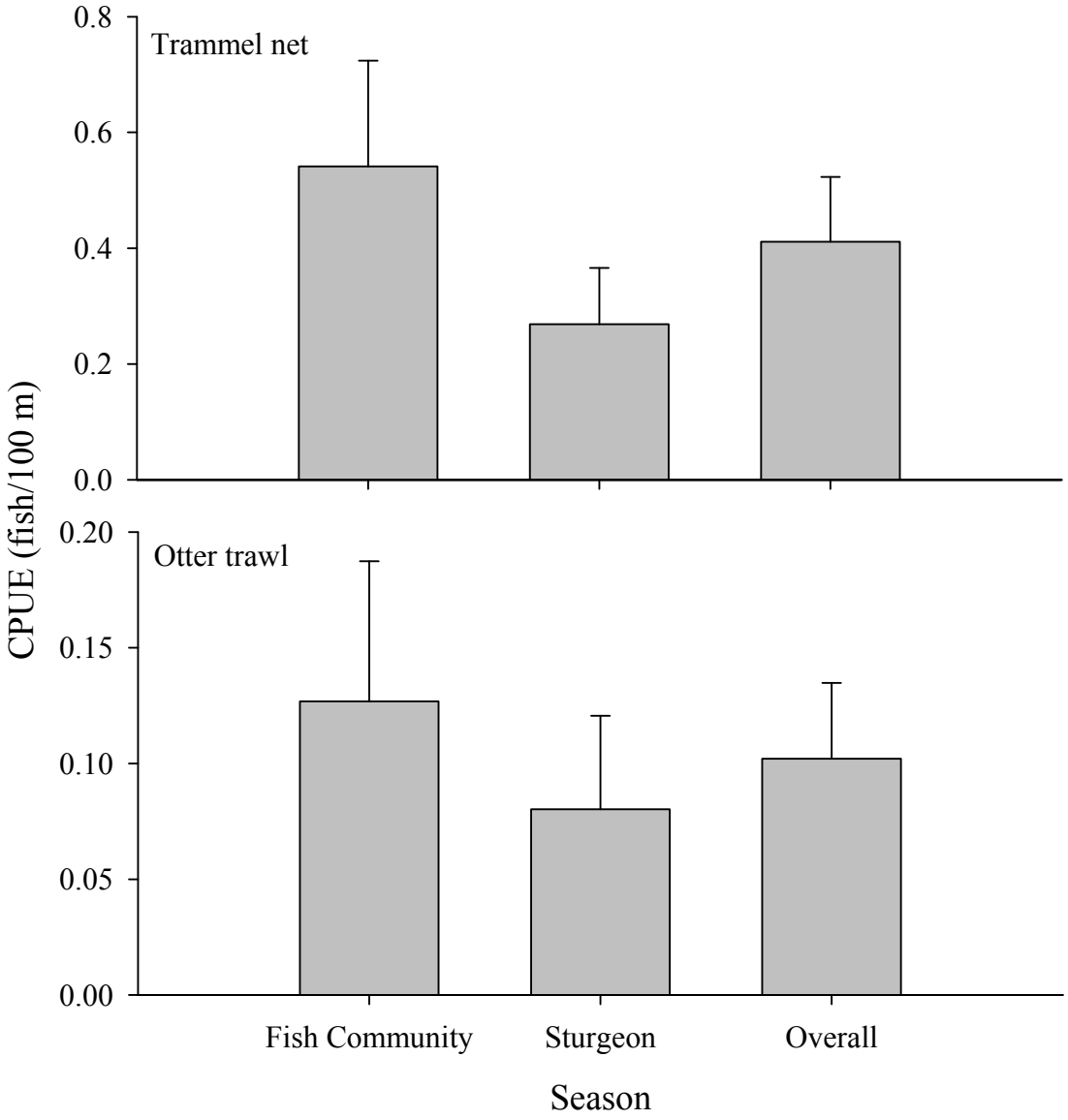


**Figure 25.** Mean seasonal catch per unit effort (± 2 SE) of blue sucker using one-inch trammel nets and otter trawls in the lower basin of the Missouri River in the 2005 sampling year.

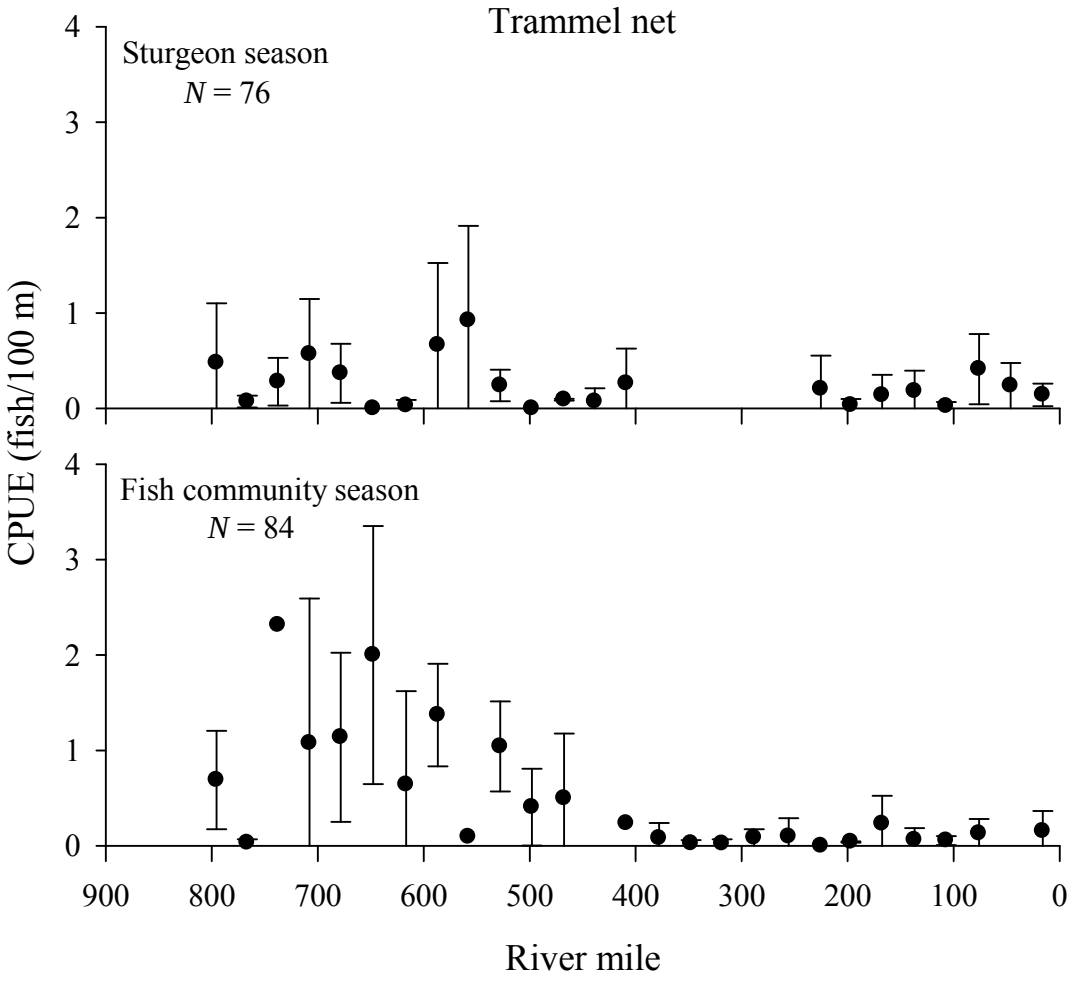


**Figure 26.** Mean catch per unit effort (± 2 SE) of blue sucker by river mile (30-mile bins) in the lower basin of the Missouri River during the sturgeon and fish community seasons in the 2005 sampling year. Data obtained through random sampling using one-inch trammel nets. Sample size denotes the number of bends sampled.

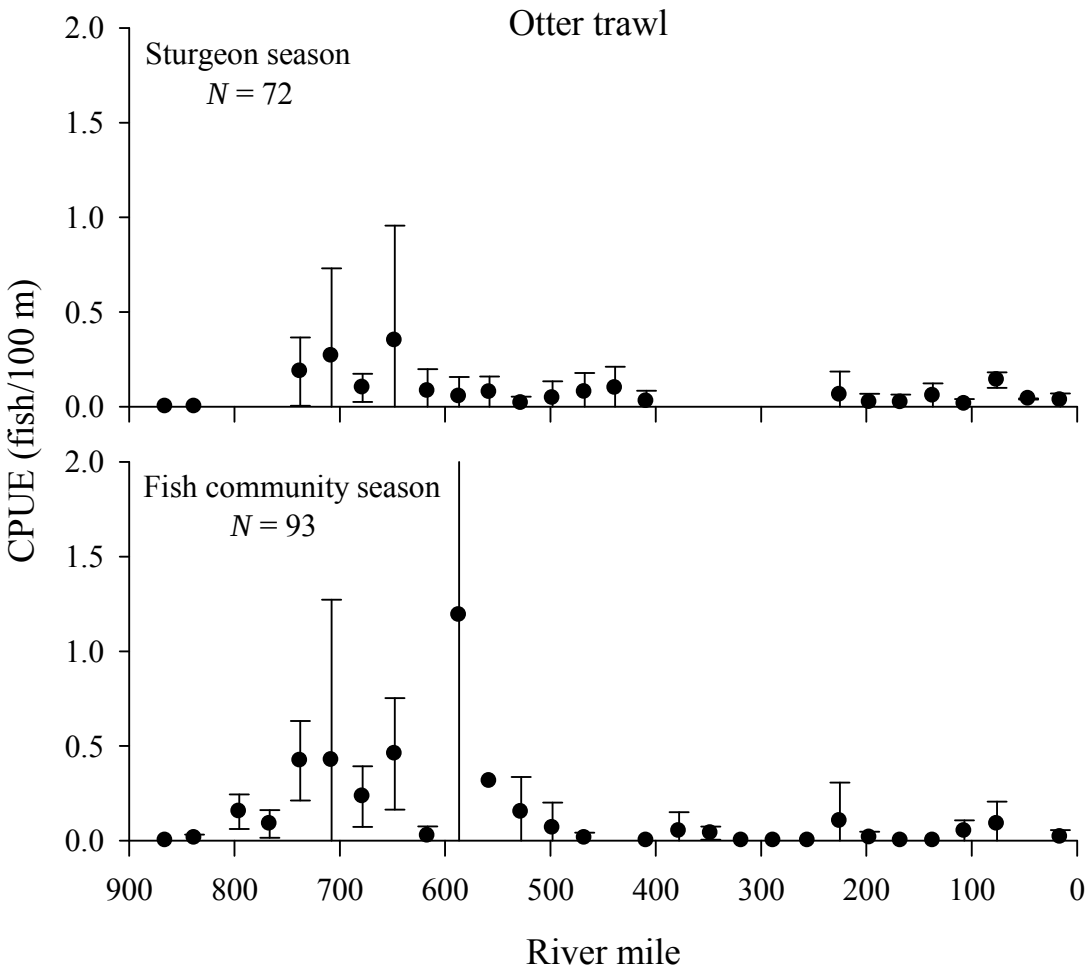


**Figure 27.** Mean catch per unit effort (± 2 SE) of blue sucker by river mile (30-mile bins) in the lower basin of the Missouri River during the sturgeon and fish community seasons in the 2005 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

**Table 15.** Total number of blue sucker 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 2005 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** | 210 | 0 | 30.0 | 1.4 | 0 | 0.5 | 63.8 | 1.4 | 0.5 | 2.4 | 0 | 0 | 0 | 0 | 0 |
| | | (0.9) | (22.9) | (1.6) | (0.3) | (0.6) | (62.6) | (3.5) | (3.9) | (3.3) | (0) | (0) | (0.3) | (0) | (0) |
| **Gill Net** | 533 | 0 | 20.1 | 0 | 0 | 0 | 70.4 | 7.1 | 0.4 | 0.4 | 0 | 0 | 1.7 | 0 | 0 |
| | | (0) | (21.0) | (1.3) | (0) | (0) | (53.2) | (16.7) | (4.0) | (2.9) | (0) | (0) | (0.7) | (0) | (0) |
| **Otter Trawl** | 62 | 0 | 16.1 | 6.5 | 0 | 0 | 74.2 | 0 | 1.6 | 0 | 0 | 0 | 1.6 | 0 | 0 |
| | | (3.7) | (23.3) | (1.3) | (0.3) | (0) | (60.0) | (5.7) | (3.3) | (1.7) | (0) | (0) | (0.6) | (0) | (0) |
| **Fish Community Season (Summer)** | | | | | | | | | | | | | | | |
| **1 Inch Trammel Net** | 382 | 1.0 | 17.0 | 5.0 | 0 | 0.3 | 74.1 | 0.8 | 1.0 | 0.8 | 0 | 0 | 0 | 0 | 0 |
| | | (2.0) | (24.0) | (0.7) | (0.3) | (0.8) | (64.0) | (3.1) | (3.1) | (1.8) | (0) | (0) | (0) | (0.1) | (0) |
| **Mini-Fyke Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (8.0) | (21.7) | (0.7) | (0.3) | (0) | (46.2) | (9.4) | (2.9) | (7.7) | (1.2 | (0) | (0.6) | (1.3) | (0) |
| **Otter Trawl** | 117 | 2.6 | 21.4 | 1.7 | 0 | 0 | 65.8 | 6.0 | 1.7 | 0.9 | 0 | 0 | 0 | 0 | 0 |
| | | (7.4) | (24.0) | (0.5) | (0) | (0.3) | (58.7) | (4.9) | (2.2) | (1.3) | (0) | (0) | (0.8) | (0) | (0) |

**Table 16.** Total number of blue sucker 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 2005 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** | 210 | 0 | 97.6 | 0 | 2.4 | 0 | 0 |
| | | (0.2) | (94.8) | (0) | (4.2) | (0.3) | (0.5) |
| **Gill Net** | 533 | 0 | 19.1 | 0 | 0.4 | 78.4 | 2.1 |
| | | (0) | (50.0) | (0) | (4.2) | (45.3) | (0.5) |
| **Otter Trawl** | 62 | 0 | 100.0 | 0 | 0 | 0 | 0 |
| | | (0) | (97.6) | (0) | (2.4) | (0) | (0) |
| **Fish Community Season (Summer)** | | | | | | | |
| **1 Inch Trammel Net** | 382 | 0 | 99.2 | 0 | 0.8 | 0 | 0 |
| | | (0.3) | (96.9) | (0) | (2.8) | (0) | (0) |
| **Mini-Fyke Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (98.0) | (2.0) | (0) | (0) | (0) | (0) |
| **Otter Trawl** | 117 | 0 | 99.1 | 0 | 0.9 | 0 | 0 |
| | | (0) | (98.2) | (0) | (1.8) | (0) | (0) |

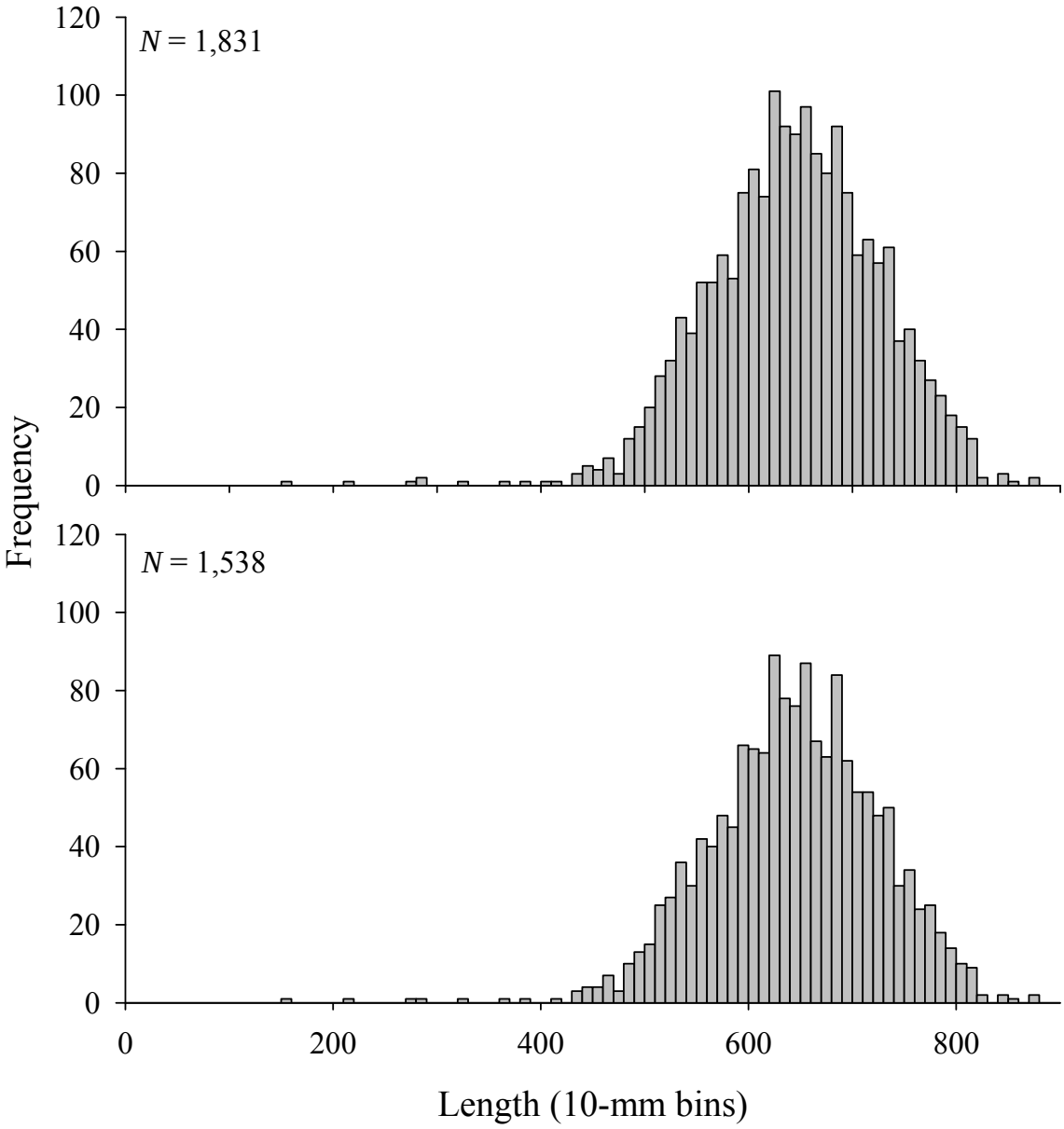


**Figure 28.** Length frequency distribution of blue sucker captured in the lower basin of the Missouri River during the 2005 sampling year using standard and wild gears. Upper panel includes random and nonrandom sampling. Lower panel includes only random sampling.

**Sauger**

During the 2005 sampling year in the lower basin of the Missouri River, 254 saugers *Sander canadense* were captured during the sturgeon season, while 114 were captured during the fish community season (Figure 29). Sampling from segments 13 and 14 (RM 0 – 250) during the sturgeon season resulted in 105 saugers captured, comprising 41% of the catch during the sturgeon sampling season. Sampling from segment 6 (RM 825 – 845) during the sturgeon season resulted in 73 saugers caught, accounting for 29% of the total catch for that sampling season. Segment 10 (RM 250 – 368) was not sampled during the sturgeon season. During the fish community season, notably fewer saugers were caught from the downstream segments compared with the upstream segments. The same trend was observed during the sturgeon season, though the difference was more subtle. Approximately 66% ($N = 75$) of the saugers were captured from segments 6 and 7 (RM 750 – 845) during the fish community season. Sampling from segment 10 during the fish community season resulted in similar numbers of fish caught as in other downstream segments.

Relative abundance of saugers differed markedly between sampling seasons and among sampling segments. Although total catch of saugers was larger during the sturgeon season than during the fish community season, the mean CPUE for both trammel nets and otter trawls was notably larger during the fish community season than during the sturgeon season. During the fish community season, the CPUE of saugers captured with trammel nets was more than twice as large (0.03 fish/100 m) as the mean CPUE (0.01 fish/100 m) during the sturgeon season (Figure 30). Overall mean CPUE was similar for trammel nets and otter trawls. Sampling in segments 7 through 9 (RM 368 – 811) resulted in some of the largest trammel net CPUE during the fish community and sturgeon seasons (Figure 31). During the fish community season the otter trawl mean CPUE was larger (0.022 fish/100 m) than the mean CPUE during the sturgeon season (0.009 fish/100 m; Figure 30). Sampling in segments 5 through 9 (RM 368 – 880) resulted in some of the largest otter trawl CPUE during both the sturgeon and fish community seasons (Figure 32).

Random sampling with standard gears accounted for approximately 51% ($N = 130$) of the total saugers caught during the sturgeon season, and 68% ($N = 77$) of the catch during

the fish community season (Table 17). During both seasons most saugers 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 saugers with all gear types and during both seasons. During the fish community season, otter trawl deployments in braided channel macrohabitats comprised only 7% of the gear effort yet yielded 57% of the gear catch (Table 17). The majority of all saugers were captured from main channel border mesohabitats, which for most gears was also the location of greatest effort (Table 18). During the sturgeon season, pool mesohabitats comprised 45% of the gill net sampling effort, resulting in approximately 56% of the total saugers caught with all gears for that season. Mini-fyke net sampling in sand bar mesohabitats yielded 19% of the total saugers caught during the fish community season (Table 18).

The population structure of saugers captured during the 2005 sampling year approximates a bimodal distribution, with juvenile fish representing a small component of fish sampled (Figure 33). The lengths of all saugers captured ranged from approximately 50 to 610 mm, with one mode near 80 mm and another near 370 mm. The length frequency distribution from random sampling is very similar to that from non-random sampling (Figure 33).

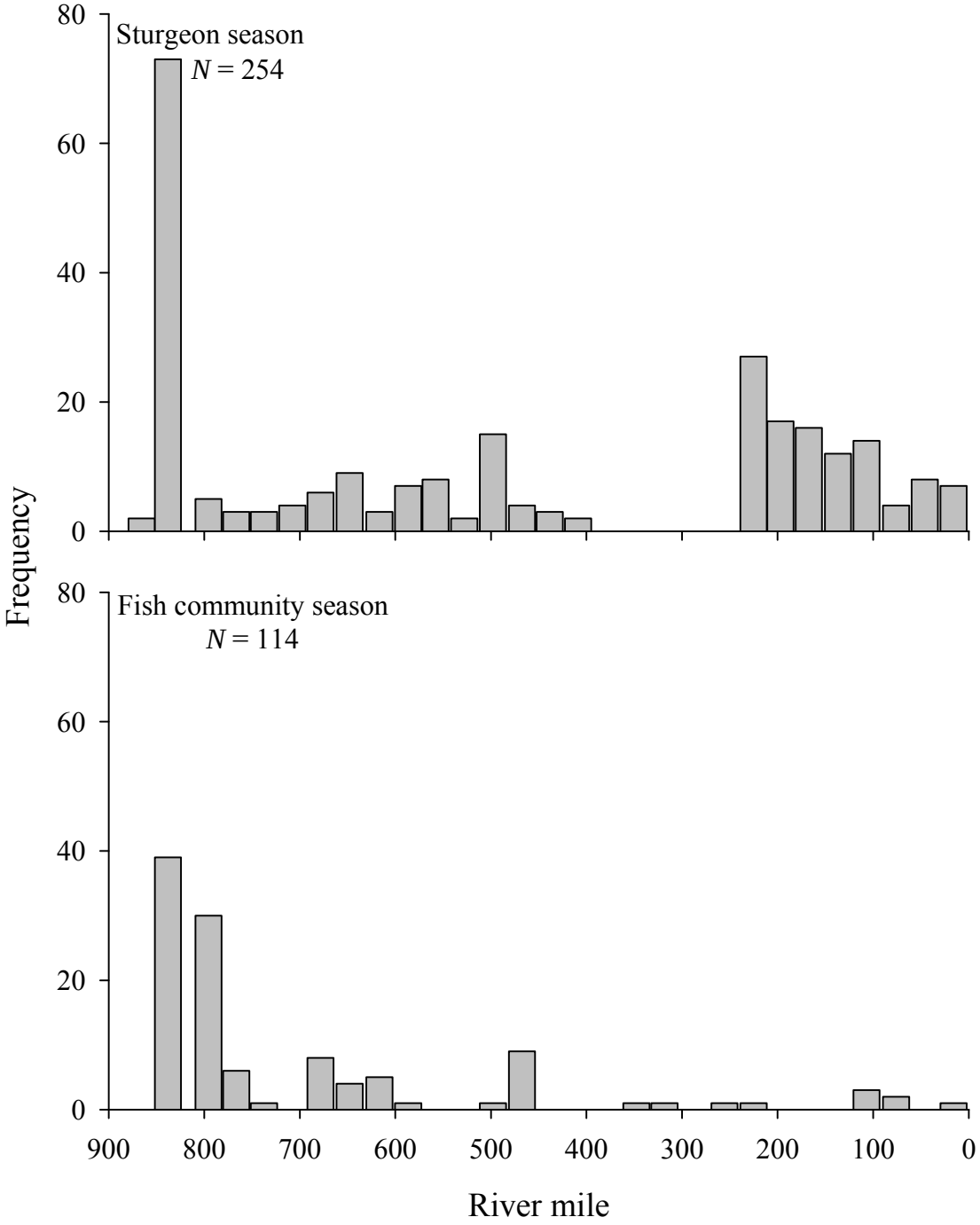


**Figure 29.** Seasonal catch by river mile (30-mile bins) of saugers in the lower basin of the Missouri River in the 2005 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

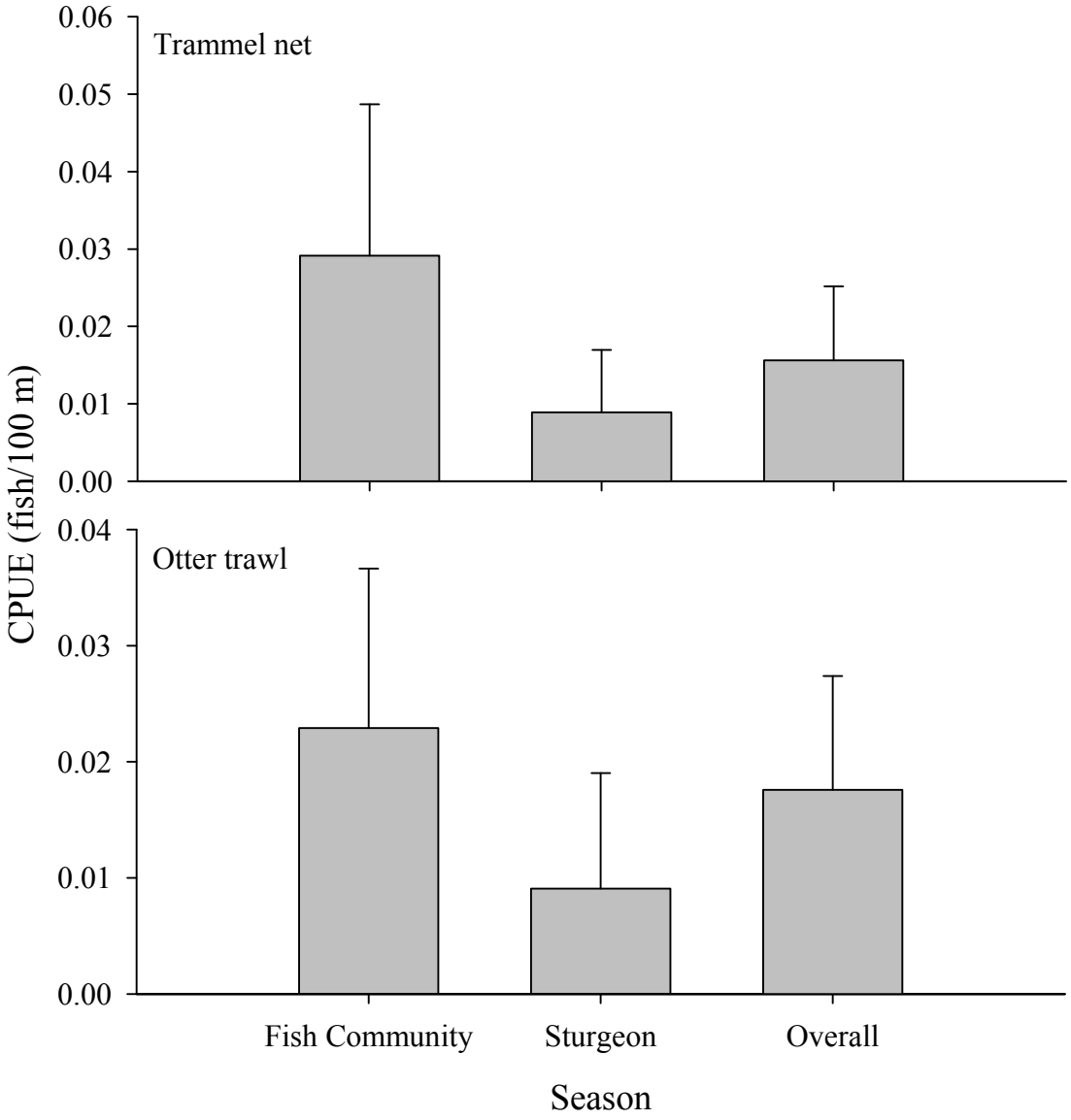


**Figure 30.** Mean seasonal catch per unit effort (± 2 SE) of saugers using one-inch trammel nets and otter trawls in the lower basin of the Missouri River in the 2005 sampling year.

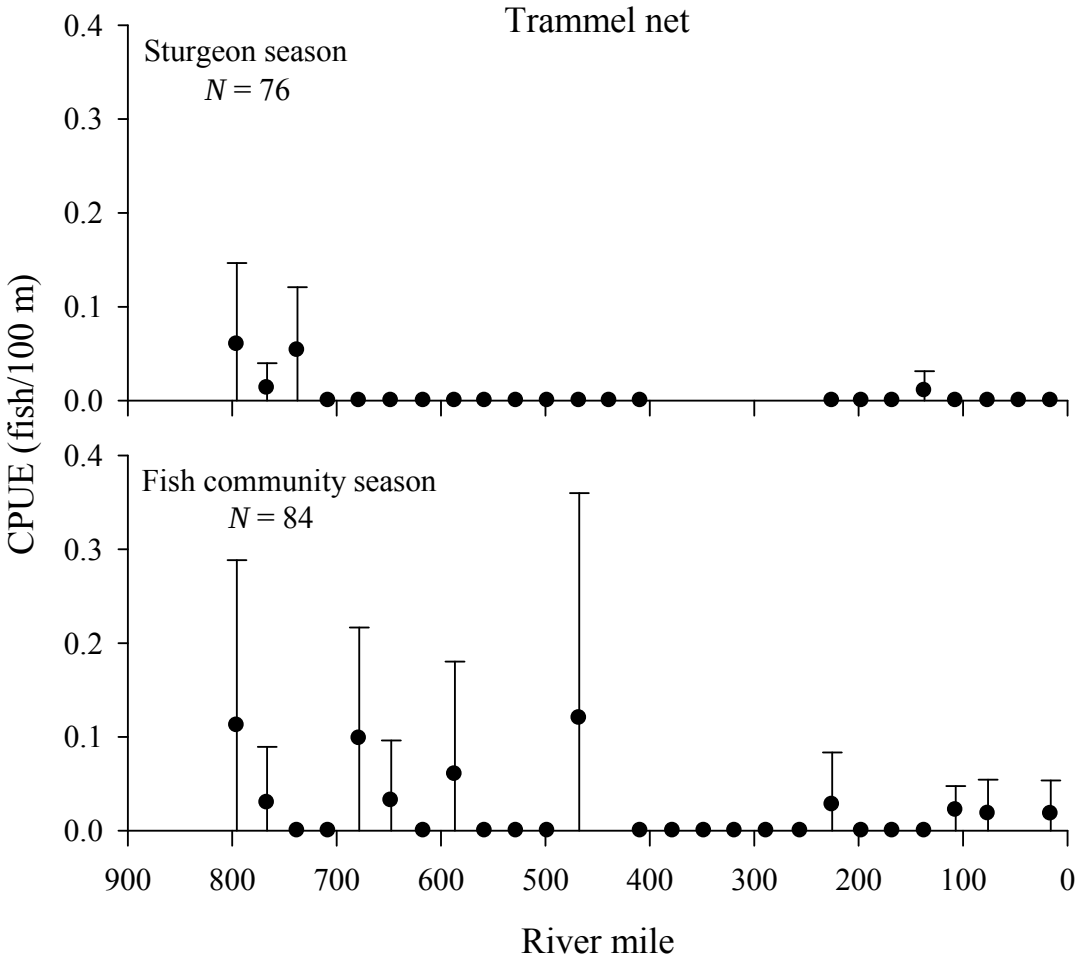


**Figure 31.** Mean catch per unit effort (± 2 SE) of saugers by river mile (30-mile bins) in the lower basin of the Missouri River during the sturgeon and fish community seasons in the 2005 sampling year. Data obtained through random sampling using one-inch trammel nets. Sample size denotes the number of bends sampled.

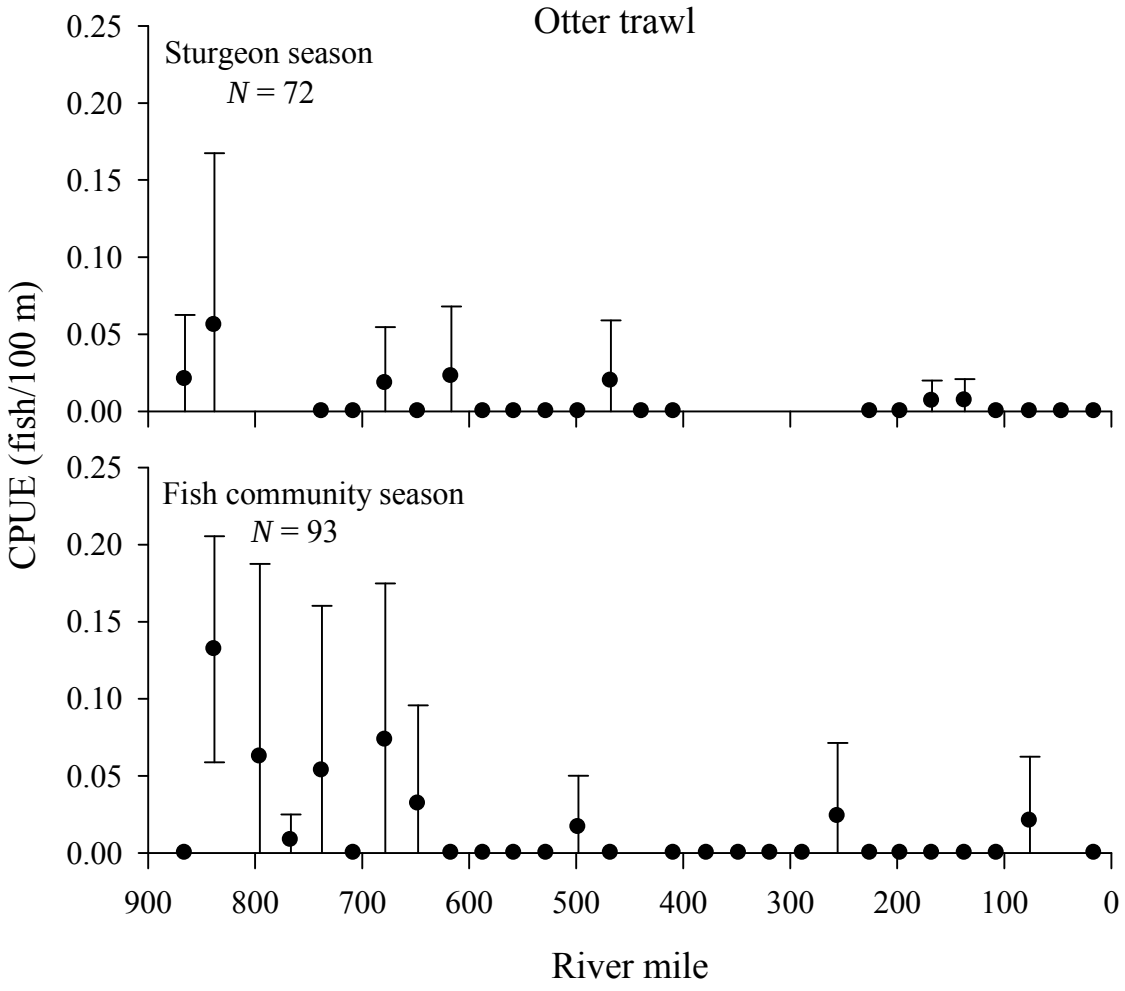


**Figure 32.** Mean catch per unit effort (± 2 SE) of saugers by river mile (30-mile bins) in the lower basin of the Missouri River during the sturgeon and fish community seasons in the 2005 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

**Table 17.** Total number of saugers 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 2005 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** | 7 | 0 | 28.6 | 0 | 0 | 0 | 57.1 | 0 | 14.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0.9) | (22.9) | (1.6) | (0.3) | (0.6) | (62.6) | (3.5) | (3.9) | (3.3) | (0) | (0) | (0.3) | (0) | (0) |
| **Gill Net** | 108 | 0 | 21.3 | 0 | 0 | 0 | 38.0 | 33.3 | 5.6 | 0.9 | 0 | 0 | 0.9 | 0 | 0 |
| | | (0) | (21.0) | (1.3) | (0) | (0) | (53.2) | (16.7) | (4.0) | (2.9) | (0) | (0) | (0.7) | (0) | (0) |
| **Otter Trawl** | 15 | 0 | 26.7 | 0 | 0 | 0 | 46.7 | 13.3 | 6.7 | 0 | 0 | 0 | 6.7 | 0 | 0 |
| | | (3.7) | (23.3) | (1.3) | (0.3) | (0) | (60.0) | (5.7) | (3.3) | (1.7) | (0) | (0) | (0.6) | (0) | (0) |
| **Fish Community Season (Summer)** | | | | | | | | | | | | | | | |
| **1 Inch Trammel Net** | 23 | 0 | 47.8 | 4.3 | 0 | 0 | 43.5 | 0 | 0 | 4.3 | 0 | 0 | 0 | 0 | 0 |
| | | (2.0) | (24.0) | (0.7) | (0.3) | (0.8) | (64.0) | (3.1) | (3.1) | (1.8) | (0) | (0) | (0) | (0.1) | (0) |
| **Mini-Fyke Net** | 19 | 10.5 | 21.1 | 0 | 0 | 0 | 42.1 | 5.3 | 5.3 | 15.8 | 0 | 0 | 0 | 0 | 0 |
| | | (8.0) | (21.7) | (0.7) | (0.3) | (0) | (46.2) | (9.4) | (2.9) | (7.7) | (1.2) | (0) | (0.6) | (1.3) | (0) |
| **Otter Trawl** | 35 | 57.1 | 5.7 | 0 | 0 | 0 | 25.7 | 8.6 | 0 | 2.9 | 0 | 0 | 0 | 0 | 0 |
| | | (7.4) | (24.0) | (0.5) | (0) | (0.3) | (58.7) | (4.9) | (2.2) | (1.3) | (0) | (0) | (0.8) | (0) | (0) |

**Table 18.** Total number of saugers 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 2005 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** | 7 | 0 | 100.0 | 0 | 0 | 0 | 0 |
| | | (0.2) | (94.8) | (0) | (4.2) | (0.3) | (0.5) |
| **Gill Net** | 108 | 0 | 29.6 | 0 | 2.8 | 67.6 | 0 |
| | | (0) | (50.0) | (0) | (4.2) | (45.3) | (0.5) |
| **Otter Trawl** | 15 | 0 | 100.0 | 0 | 0 | 0 | 0 |
| | | (0) | (97.6) | (0) | (2.4) | (0) | (0) |
| **Fish Community Season (Summer)** | | | | | | | |
| **1 Inch Trammel Net** | 23 | 0 | 95.7 | 0 | 4.3 | 0 | 0 |
| | | (0.3) | (96.9) | (0) | (2.8) | (0) | (0) |
| **Mini-Fyke Net** | 19 | 78.9 | 21.1 | 0 | 0 | 0 | 0 |
| | | (98.0) | (2.0) | (0) | (0) | (0) | (0) |
| **Otter Trawl** | 35 | 0 | 97.1 | 0 | 2.9 | 0 | 0 |
| | | (0) | (98.2) | (0) | (1.8) | (0) | (0) |

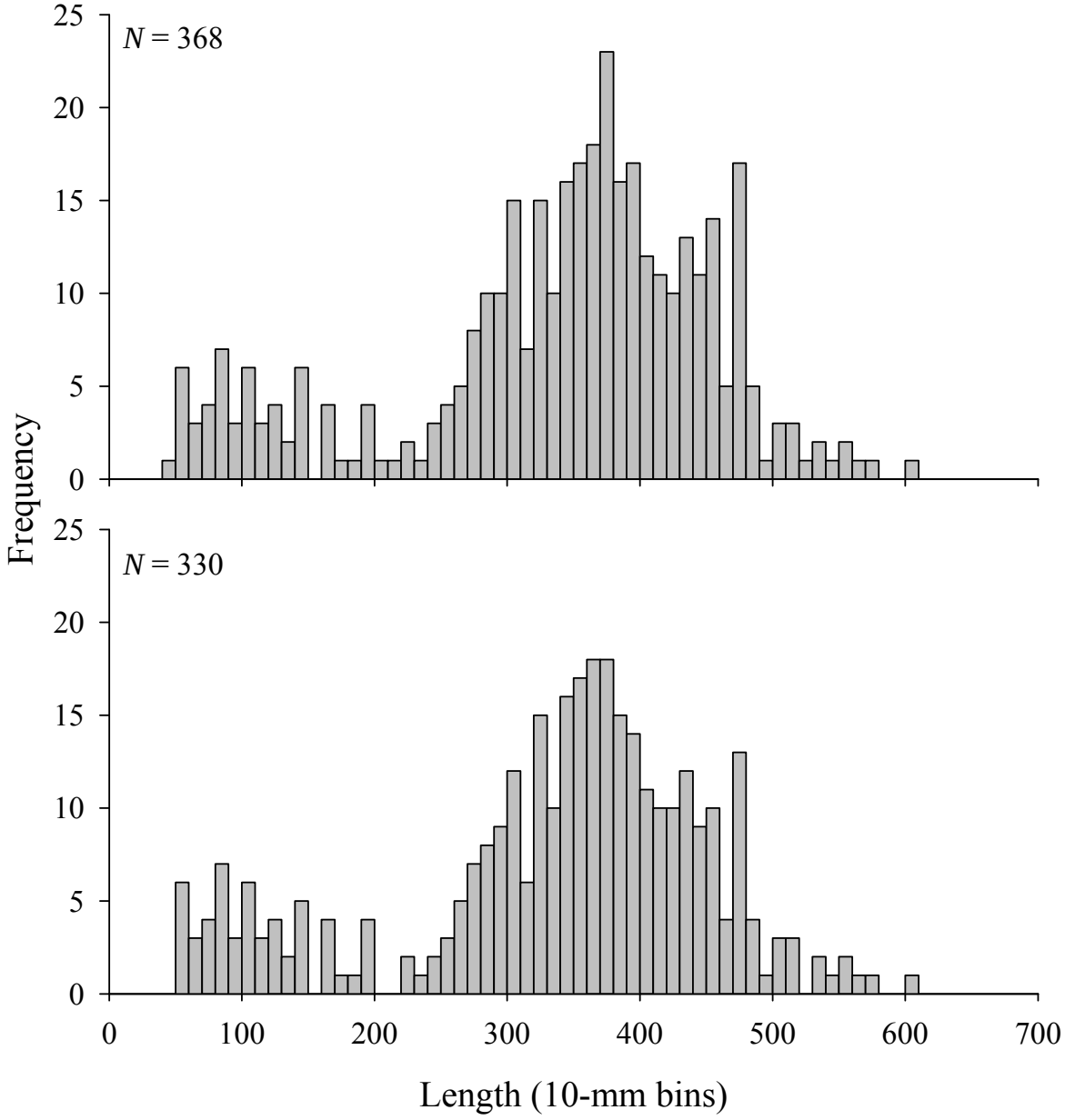


**Figure 33.** Length frequency distribution of saugers captured in the lower basin of the Missouri River during the 2005 sampling year using standard and wild gears. Upper panel includes random and nonrandom sampling. Lower panel includes only random sampling.

**Sand Shiner**

A total of 12 sand shiners *Notropis stramineu*s were captured during the sturgeon season, while 1937 were captured during the fish community season (Figure 34). During the fish community season there was a markedly larger catch of sand shiners in segment 7 (RM 750 – 811) than in all other segments, comprising 65% ($N$ = 1251) of all sand shiners caught that season (Figure 34). Sampling from the upstream reaches of segment 14 (RM 0 – 130) also resulted in comparatively large catches of sand shiners ($N$ = 163).

During the sturgeon season 11 of the 12 sand shiners caught were from otter trawl samples; during the fish community season less than 1% ($N$ = 8) were captured with otter trawls. During the sturgeon season, the mean CPUE of sand shiner captured with otter trawls was 0.012 fish/100 m, while during the fish community season the mean CPUE was 0.006 fish/100 m (Figure 35 and Figure 36).

Random sampling with standard gears accounted for approximately 92% ($N$ = 11) of the total sand shiner catch during the sturgeon season, and 68% (N = 1310) of the catch during the fish community season (Table 19). During both seasons, most sand shiner 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 sand shiner 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 20). During fish community season mini-fyke nets caught 99.9% of the sand shiners from sand bar mesohabitats; where 98% of the effort for that gear was expended (Table 20).

For all the sand shiners captured in the lower basin during the 2005 sampling year, lengths ranged from 20 to 70 mm, with an average of approximately 44 mm (Figure 37).

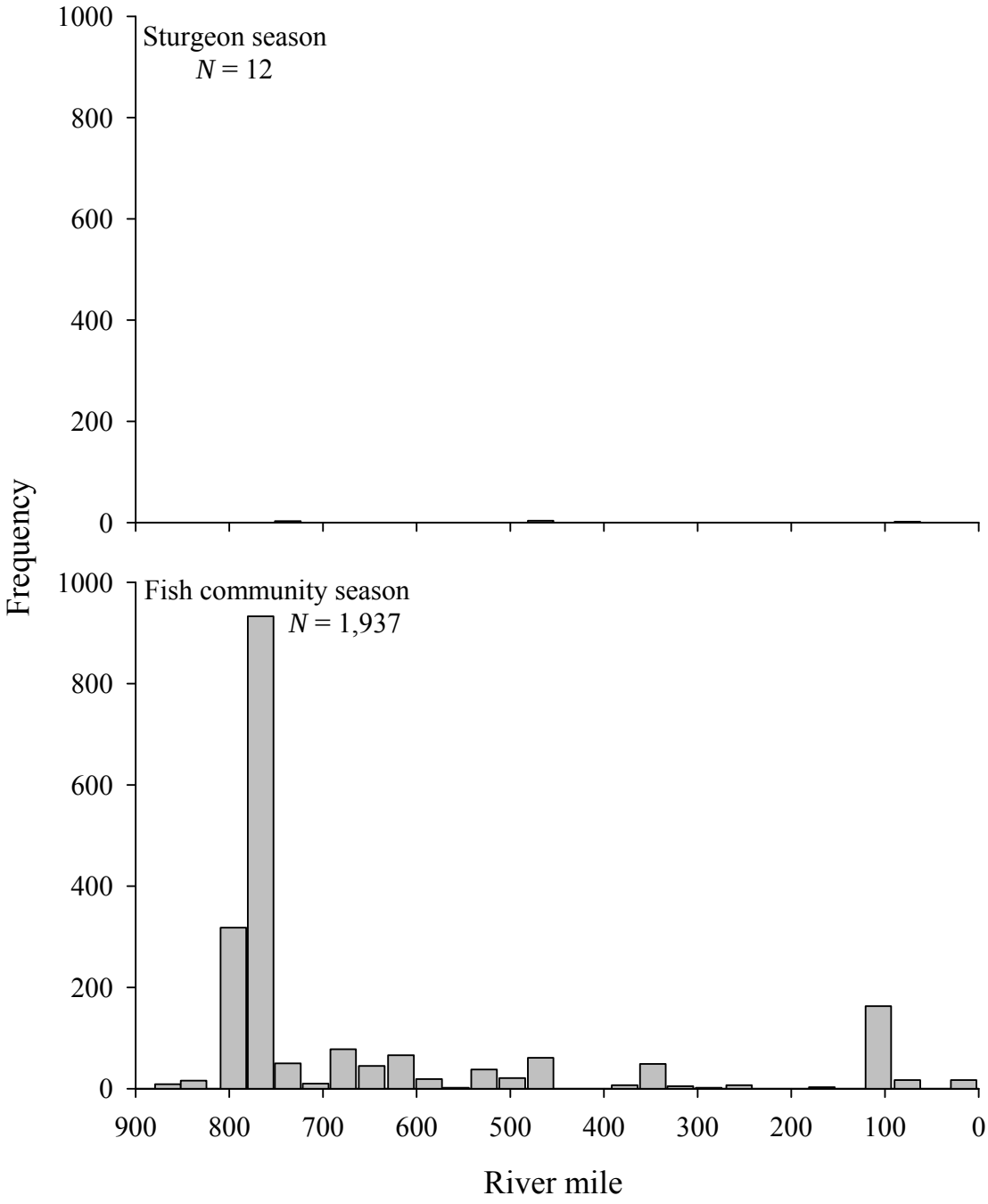


**Figure 34.** Seasonal catch by river mile (30-mile bins) of sand shiner in the lower basin of the Missouri River in the 2005 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

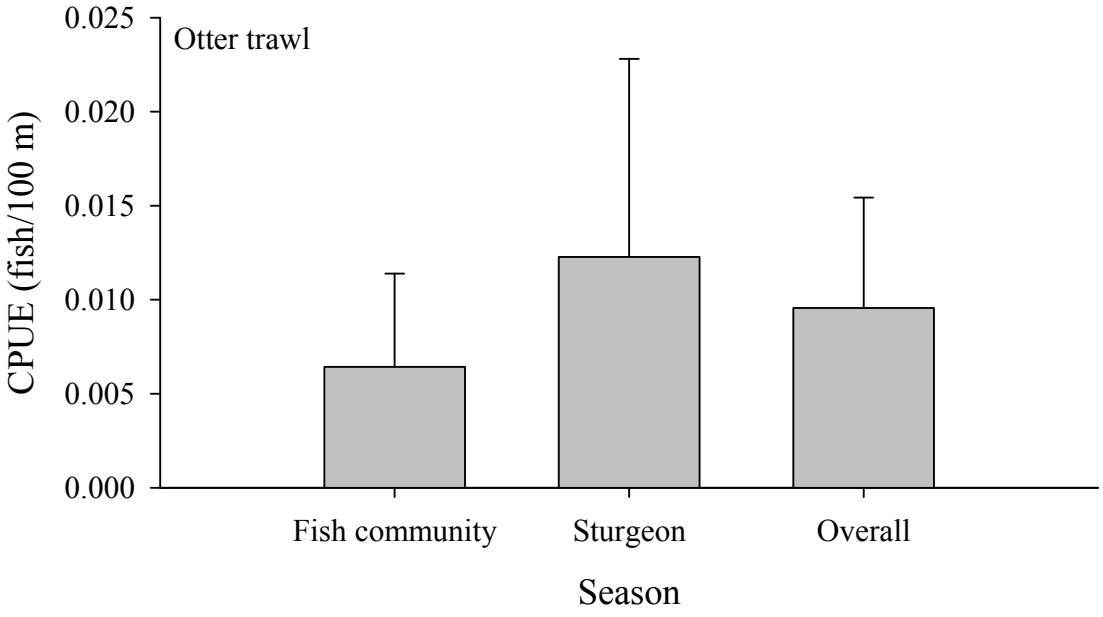


**Figure 35.** Mean seasonal catch per unit effort (± 2 SE) for sand shiner using otter trawls in the lower basin of the Missouri River in the 2005 sampling year.

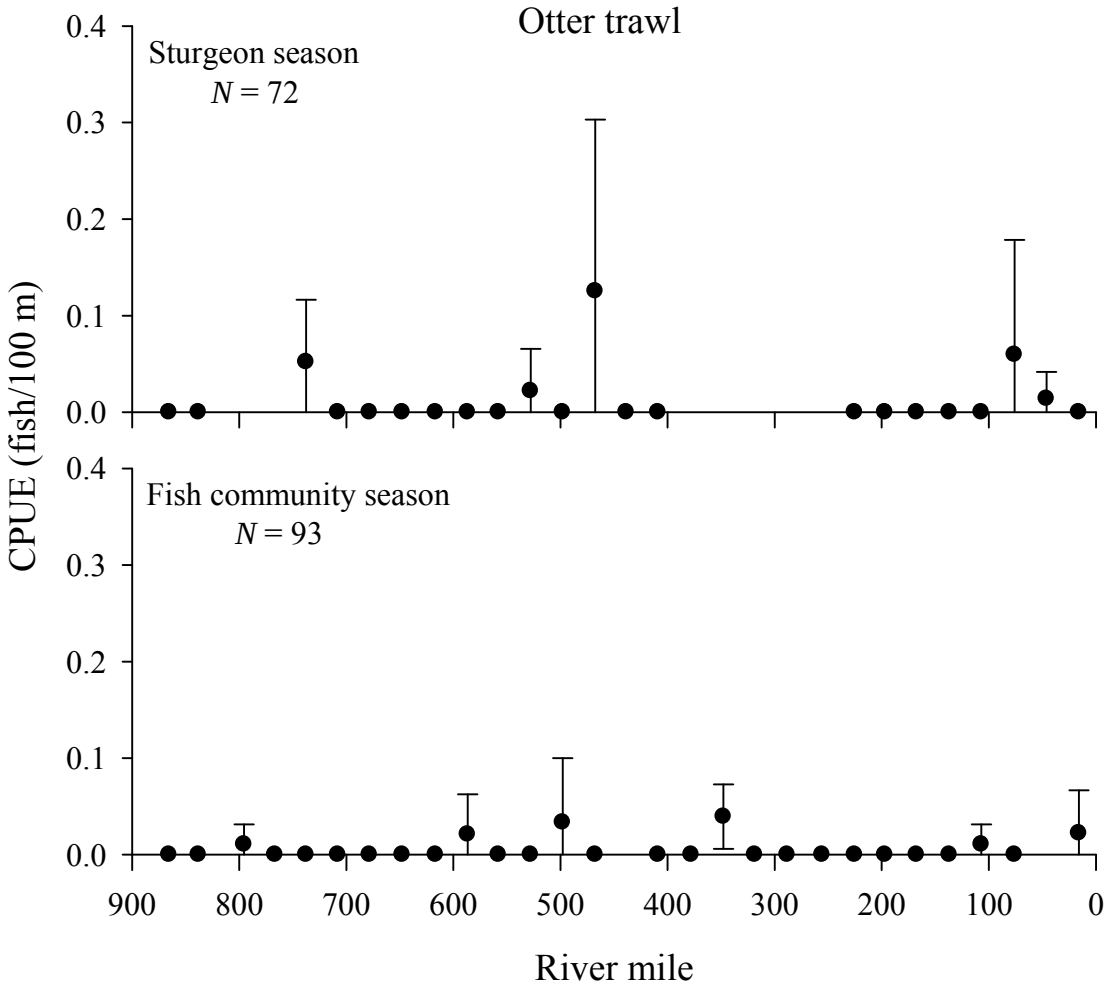


**Figure 36.** Mean catch per unit effort (± 2 SE) of sand shiner by river mile (30-mile bins) in the lower basin of the Missouri River during the sturgeon and fish community seasons in the 2005 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

**Table 19.** Total number of sand shiner 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 2005 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 |
| | | (0.9) | (22.9) | (1.6) | (0.3) | (0.6) | (62.6) | (3.5) | (3.9) | (3.3) | (0) | (0) | (0.3) | (0) | (0) |
| **Gill Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0) | (21.0) | (1.3) | (0) | (0) | (53.2) | (16.7) | (4.0) | (2.9) | (0) | (0) | (0.7) | (0) | (0) |
| **Otter Trawl** | 11 | 0 | 27.3 | 0 | 0 | 0 | 45.5 | 18.2 | 0 | 0 | 0 | 0 | 9.1 | 0 | 0 |
| | | (3.7) | (23.3) | (1.3) | (0.3) | (0) | (60.0) | (5.7) | (3.3) | (1.7) | (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 |
| | | (2.0) | (24.0) | (0.7) | (0.3) | (0.8) | (64.0) | (3.1) | (3.1) | (1.8) | (0) | (0) | (0) | (0.1) | (0) |
| **Mini-Fyke Net** | 1302 | 17.6 | 4.3 | 0.2 | 0 | 0 | 23.7 | 7.8 | 8.6 | 35.8 | 1.5 | 0 | 0.2 | 0.5 | 0 |
| | | (8.0) | (21.7) | (0.7) | (0.3) | (0) | (46.2) | (9.4) | (2.9) | (7.7) | (1.2 | (0) | (0.6) | (1.3) | (0) |
| **Otter Trawl** | 8 | 0 | 12.5 | 12.5 | 0 | 0 | 62.5 | 12.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (7.4) | (24.0) | (0.5) | (0) | (0.3) | (58.7) | (4.9) | (2.2) | (1.3) | (0) | (0) | (0.8) | (0) | (0) |

**Table 20.** Total number of sand shiner 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 2005 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 |
| | | (0.2) | (94.8) | (0) | (4.2) | (0.3) | (0.5) |
| **Gill Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0) | (50.0) | (0) | (4.2) | (45.3) | (0.5) |
| **Otter Trawl** | 11 | 0 | 100.0 | 0 | 0 | 0 | 0 |
| | | (0) | (97.6) | (0) | (2.4) | (0) | (0) |
| **Fish Community Season (Summer)** | | | | | | | |
| **1 Inch Trammel Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0.3) | (96.9) | (0) | (2.8) | (0) | (0) |
| **Mini-Fyke Net** | 1302 | 99.9 | 0.1 | 0 | 0 | 0 | 0 |
| | | (98.0) | (2.0) | (0) | (0) | (0) | (0) |
| **Otter Trawl** | 8 | 0 | 100.0 | 0 | 0 | 0 | 0 |
| | | (0) | (98.2) | (0) | (1.8) | (0) | (0) |

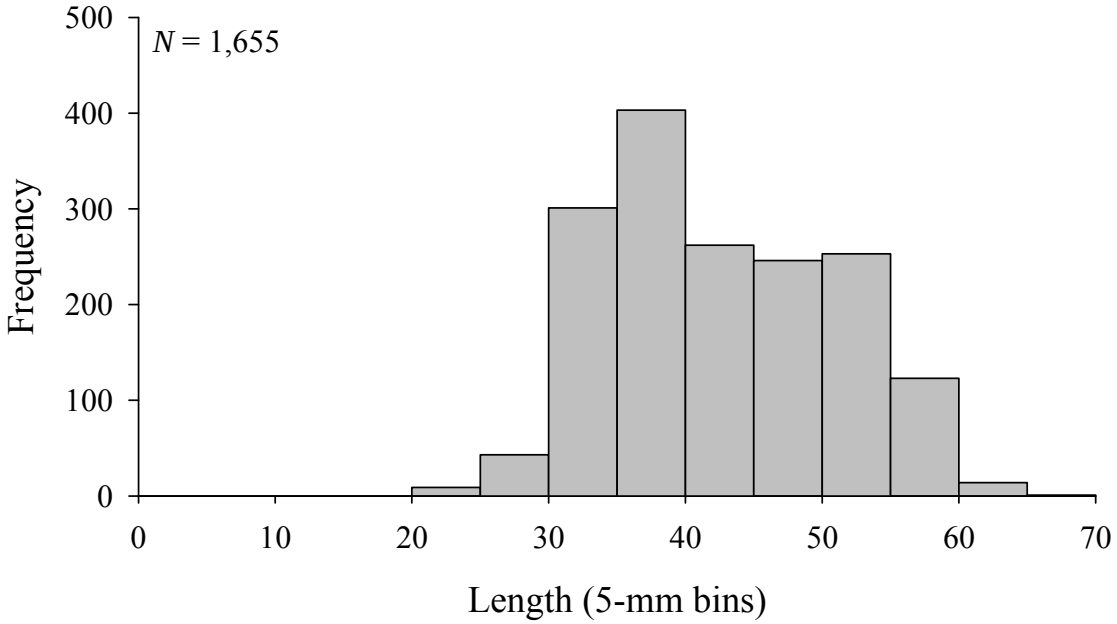


**Figure 37.** Length frequency distribution of sand shiner captured in the lower basin of the Missouri River during the 2005 sampling year using random and nonrandom sampling with standard and wild gears.

***Hybognathus* spp.**

During the 2005 sampling year in the lower Missouri River basin, no *Hybognathus* spp. were captured during the sturgeon season, while 491 were captured during the fish community season (Figure 38). During the fish community season there was a markedly larger catch of *Hybognathus* spp. near RM 470 in segment 9 (RM 368 – 596) than in all other segments, comprising 75% ($N$ = 367) of all *Hybognathus* spp. caught that season (Figure 38).

There were no *Hybognathus* spp. caught with standard gears that were deployed during both the sturgeon and fish community seasons (Figure 39 and Figure 40).

Random sampling with standard gears accounted for approximately 77% (376 fish) of the *Hybognathus* spp. catch during the fish community season (Table 21). Sampling with mini-fyke nets caught 100% of the *Hybognathus* spp. Most *Hybognathus* spp. were caught in main channel inside bend macrohabitats, where most of the total sampling effort occurred. All of the fish were caught from sand bar mesohabitats where 98% of the effort for that gear was expended (Table 22).

For all the *Hybognathus* spp. captured in the lower basin during the 2005 sampling year, lengths ranged from 20 to 90 mm, with an average of approximately 44 mm (Figure 41).

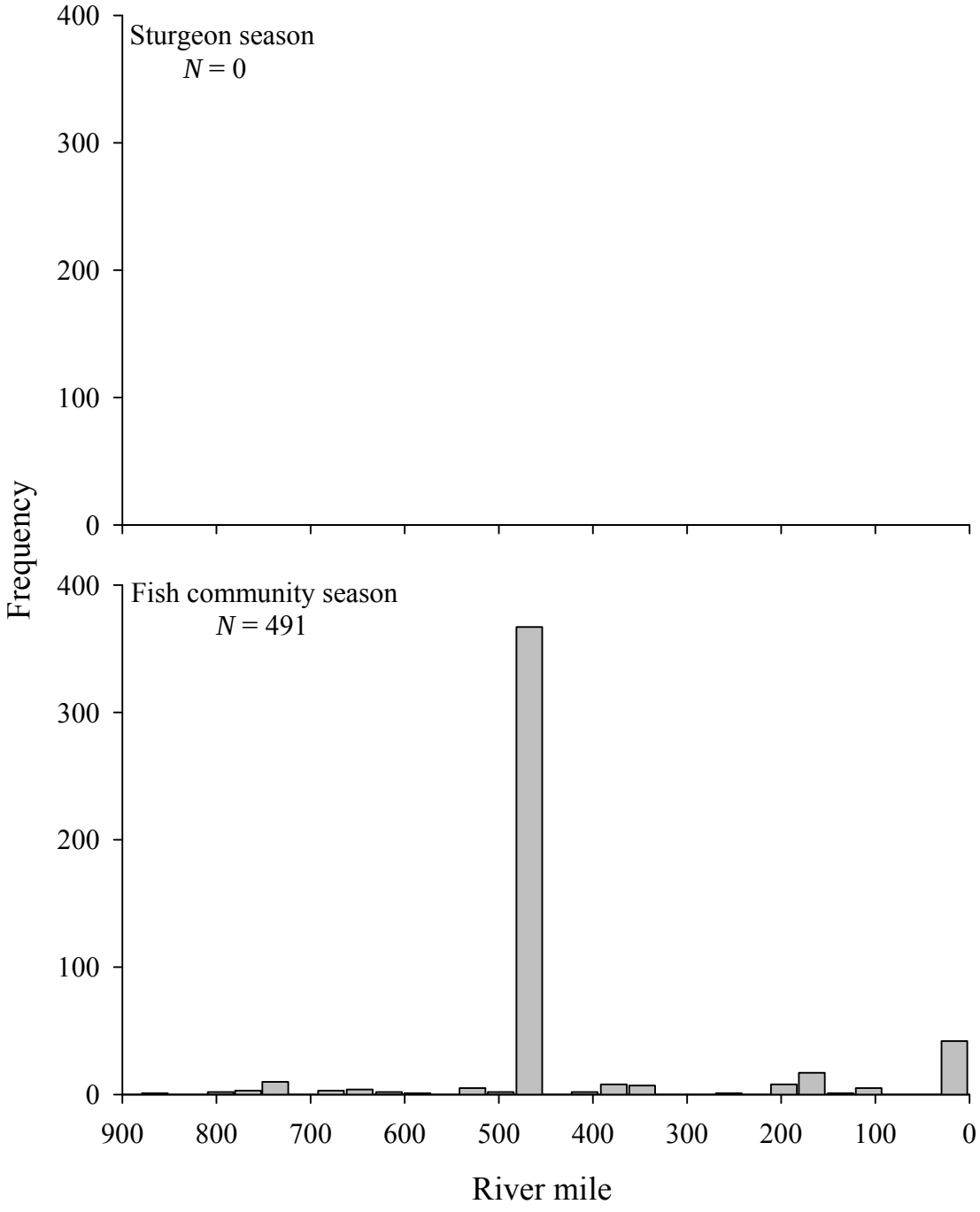


**Figure 38.** Seasonal catch by river mile (30-mile bins) of *Hybognathus* spp. in the lower basin of the Missouri River in the 2005 sampling year. Data obtained through random and nonrandom sampling with standard and wild gear types.

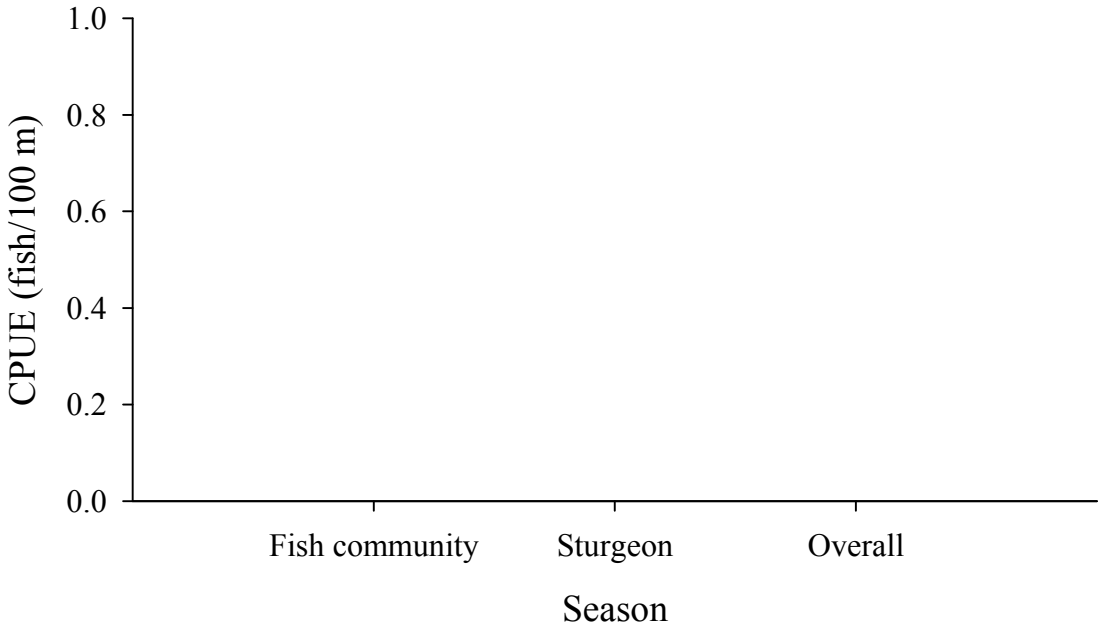


**Figure 39.** Mean seasonal catch per unit effort (± 2 SE) for *Hybognathus* spp. using otter trawls in the lower basin of the Missouri River in the 2005 sampling year.

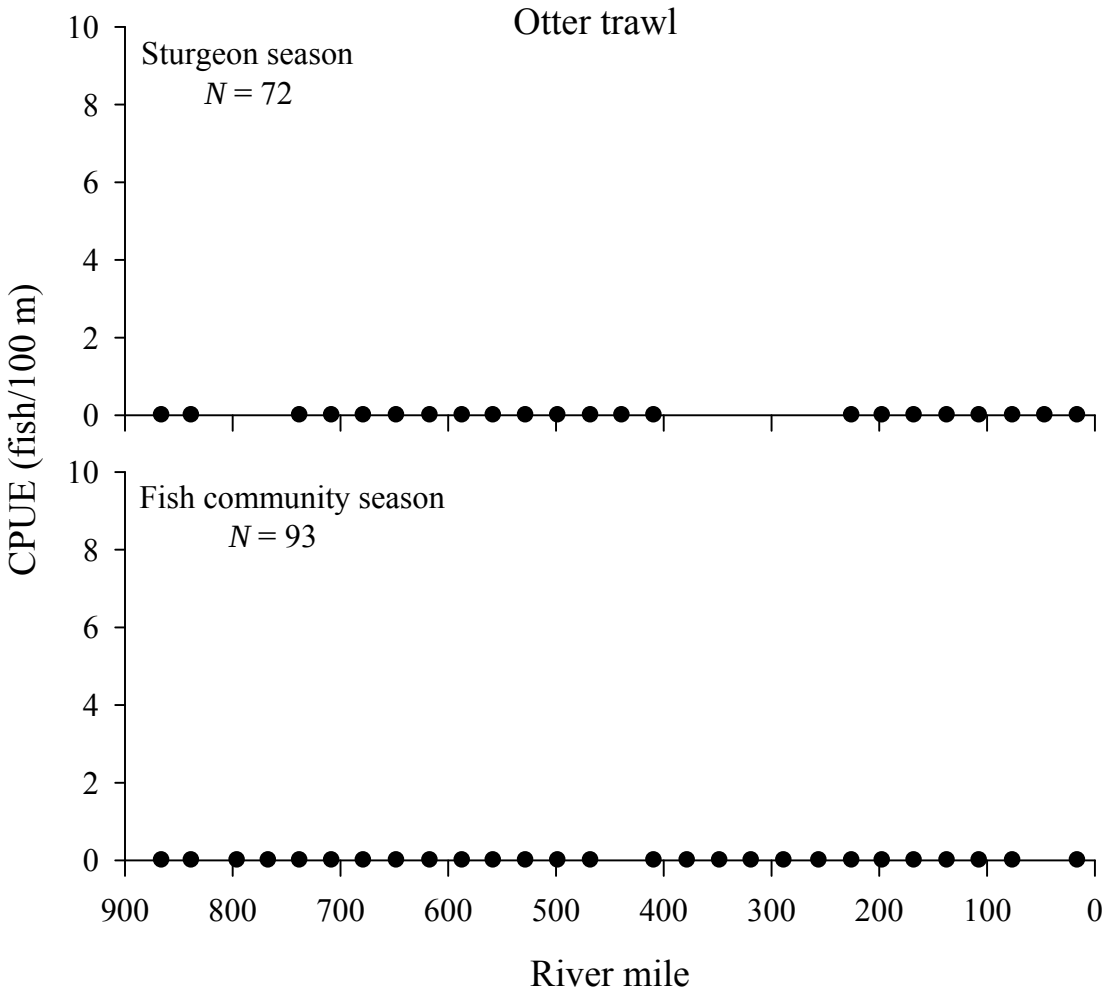


**Figure 40.** Mean catch per unit effort (± 2 SE) of *Hybognathus* spp. by river mile (30-mile bins) in the lower basin of the Missouri River during the sturgeon and fish community seasons in the 2005 sampling year. Data obtained through random sampling using otter trawls. Sample size denotes the number of bends sampled.

**Table 21.** 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 2005 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 |
| | | (0.9) | (22.9) | (1.6) | (0.3) | (0.6) | (62.6) | (3.5) | (3.9) | (3.3) | (0) | (0) | (0.3) | (0) | (0) |
| **Gill Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0) | (21.0) | (1.3) | (0) | (0) | (53.2) | (16.7) | (4.0) | (2.9) | (0) | (0) | (0.7) | (0) | (0) |
| **Otter Trawl** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (3.7) | (23.3) | (1.3) | (0.3) | (0) | (60.0) | (5.7) | (3.3) | (1.7) | (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 |
| | | (2.0) | (24.0) | (0.7) | (0.3) | (0.8) | (64.0) | (3.1) | (3.1) | (1.8) | (0) | (0) | (0) | (0.1) | (0) |
| **Mini-Fyke Net** | 376 | 0 | 12.8 | 0 | 0 | 0 | 84.0 | 2.1 | 0.3 | 0.8 | 0 | 0 | 0 | 0 | 0 |
| | | (8.0) | (21.7) | (0.7) | (0.3) | (0) | (46.2) | (9.4) | (2.9) | (7.7) | (1.2 | (0) | (0.6) | (1.3) | (0) |
| **Otter Trawl** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (7.4) | (24.0) | (0.5) | (0) | (0.3) | (58.7) | (4.9) | (2.2) | (1.3) | (0) | (0) | (0.8) | (0) | (0) |

**Table 22.** 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 2005 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 |
| | | (0.2) | (94.8) | (0) | (4.2) | (0.3) | (0.5) |
| **Gill Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0) | (50.0) | (0) | (4.2) | (45.3) | (0.5) |
| **Otter Trawl** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0) | (97.6) | (0) | (2.4) | (0) | (0) |
| **Fish Community Season (Summer)** | | | | | | | |
| **1 Inch Trammel Net** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0.3) | (96.9) | (0) | (2.8) | (0) | (0) |
| **Mini-Fyke Net** | 376 | 100.0 | 0 | 0 | 0 | 0 | 0 |
| | | (98.0) | (2.0) | (0) | (0) | (0) | (0) |
| **Otter Trawl** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | (0) | (98.2) | (0) | (1.8) | (0) | (0) |

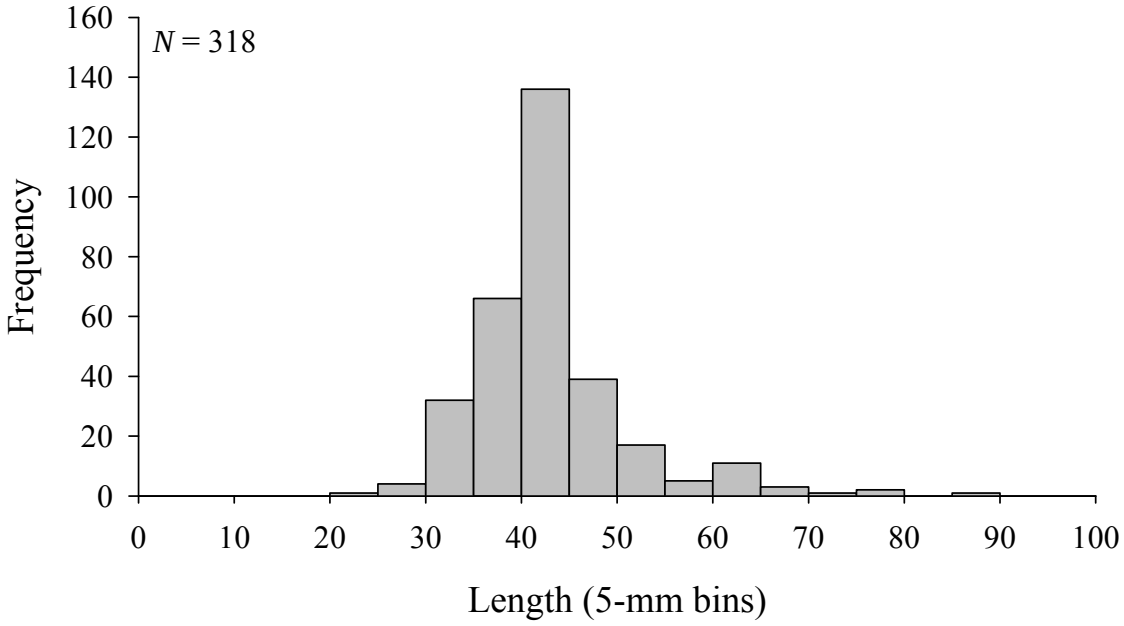


**Figure 41.** Length frequency distribution of *Hybognathus* spp. captured in the lower basin of the Missouri River during the 2005 sampling year using random and nonrandom sampling with standard and wild gears.

# Discussion

***Pallid Sturgeon***

Pallid sturgeon from eight year classes (i.e., 1992, 1997, 1998, 1999, 2001, 2002, 2003, 2004) have been released in the lower basin of the Missouri River since 1994 (Appendices C and D). From 1994 - 2005, 36,308 juvenile pallid sturgeon and an additional 37,954 fingerlings were released into the lower basin.

One hundred eighteen pallid sturgeon were sampled during the 2005 sampling season in the lower basin of the Missouri River. Seventy-six pallid sturgeon were sampled using standard gears while forty-two were sampled with wild gears (green dyed gill and trammel nets $N = 33$, wild gill and trammel nets $N = 9$). Only 58 of the 76 pallid sturgeon sampled using standard gear types were sampled randomly. However, thirty-three of the individuals sampled with wild gear types were sampled with trammel and gill nets of identical dimensions to the standard nets but were dyed green. Thus, the majority of pallid sturgeon sampled in the lower basin of the Missouri River in 2005 were sampled using one-inch trammel nets ($N = 45$; includes green dyed trammel nets) followed by gill nets ($N = 30$; includes green dyed gill nets), standard otter trawl ($N = 27$), and other wild gear types ($N = 16$). Therefore, with respect to which gears sampled the most pallid sturgeon in 2005, the random sampling data for standard gear types (Tables 3 – 6) may be misleading as they depict otter trawls as sampling the greatest number of pallid sturgeon, followed by trammel nets then gill nets.

Although no major differences are prevalent within the relative abundance data for pallid sturgeon, a few idiosyncrasies exist that are worth discussing. Mean CPUE from trammel net sampling was greater during the fish community season than during the sturgeon season for hatchery-reared pallid sturgeon. However, an opposite trend was observed for wild pallid sturgeon (Figure 3). This difference may be a function of the low sample size observed for wild pallid sturgeon. It is unlikely that major shifts in intra-annual 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. Geographic distribution analysis did not yield any interesting results as mean CPUE for all observations fell well within 2 SE of other observations. Although, no pallid sturgeon were reported to be sampled with standard trammel nets above RM 600 during the sturgeon season, whereas four were sampled above that location during the fish community season (Figure 4), this figure excludes green dyed trammel nets which are now considered to be standard trammel nets. Thus, CPUE above RM 600 is much greater than what is displayed in this report. No general trends are obvious in geographic distribution from otter trawl data.

It is apparent that inside bend macrohabitats are frequented by pallid sturgeon as 66% of the randomly sampled pallid surgeon were sampled within this macrohabitat type and the percentage of pallid sturgeon captured within inside bends was greater than the percent of effort allocated to inside bends for most gear types (Tables 3 and 5). Outside bend, secondary channel, and braided channel macrohabitat types also had greater percentages of fish sampled than effort for at least one gear. However, relatively little effort was put into sampling these macrohabitats. Thus, outside bend, secondary channel, and braided channel macrohabitats may be important to pallid sturgeon; however, further investigation is warranted.

Little information regarding pallid sturgeon habitat associations on the mesohabitat scale can be deduced as the vast majority of sampling occurred in channel border habitats (Tables 4 and 6). Thus, it is difficult to make inferences regarding mesohabitat use of pallid sturgeon. However, congruent with effort, 88% of randomly sampled pallid sturgeon were captured in channel border mesohabitats.

Length was recorded for all 118 pallid sturgeon sampled in the lower basin in 2005. Little difference exists between random versus random and nonrandom sampling length frequency distributions (Figure 6). 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. Further, these length frequency data

must be interpreted cautiously due to the size selectivity of different gear types. The 2005 pallid sturgeon length frequency distribution for the lower basin yields little information as it likely misrepresents the true size structure of the population (Neumann and Allen 2007); however, it will be useful in the future for making comparisons between basins and monitoring for change among years.

***Shovelnose Sturgeon***

During the 2005 sampling season 14,493 shovelnose sturgeon were sampled in the lower basin of the Missouri River. Of those, 12,498 were sampled with standard gears, while 1995 were sampled using wild gears. Only 9785 of the 12,498 shovelnose sturgeon sampled using standard gear types were sampled randomly. The majority of randomly sampled shovelnose sturgeon were captured with gill nets ($N$ = 4856), followed by trammel nets ($N$ = 3083), and otter trawls ($N$ = 1845).

Consistent with findings for pallid sturgeon, shovelnose sturgeon mean CPUE from trammel net sampling was greater during the fish community season than during the sturgeon season. Conversely, mean CPUE from otter trawl sampling was similar between seasons for shovelnose sturgeon (Figure 8). Interestingly, effort for trammel net and otter trawl sampling within and between seasons was similar among habitat types. Thus, the difference in trends between trammel net and otter trawl CPUE is likely not associated with seasonal differences in habitat use on the macro- or mesohabitat level. Possible explanations for the observed difference in seasonal trends between trammel net and otter trawl CPUE may relate to seasonally variable fish depth use, microhabitat use, and gear-specific efficiency at various depths or microhabitats. Although trammel net CPUE was generally greater during the fish community season than sturgeon season, no seasonal trends are apparent in geographic distribution (Figure 9). Geographic distribution obtained through otter trawl sampling also yields no obvious trends. In general, CPUE increased from upstream to downstream, particularly during the sturgeon season (Figure 10); however, small effect sizes among 30-mile reaches and high variability within 30-mile reaches make this interpretation questionable.

Capture percentages of pallid sturgeon were consistent with effort percentages for all macrohabitat types where a reasonable percent of the total effort was put forth (Table 7).

This suggests that shovelnose sturgeon regularly use channel crossover, inside bend, outside bend, and side channel macrohabitats throughout the year. Whether shovelnose sturgeon utilize the remaining macrohabitat types in the lower basin of the Missouri River remains largely unknown as little sampling has been conducted in these areas. As with macrohabitat, capture percentages were consistent with effort percentages for mesohabitat types where a reasonable percent of the total effort was put forth (Table 8). However, only 25% of the shovelnose sturgeon sampled with gill nets were captured in border mesohabitats where 50% of the effort was allocated. Conversely, 68% of shovelnose sturgeon were sampled in pool habitats where 45% of the effort was allocated. This difference may be attributed to shovelnose sturgeon using pool habitat more than channel border habitat; however, an equally likely explanation is that gill nets sample more efficiently in pool than channel border mesohabitats.

Length was recorded for 14,472 shovelnose sturgeon sampled in the lower basin in 2005. Little difference exists between random versus random and nonrandom sampling length frequency distributions (Figure 11). This suggests that there was no length bias associated with nonrandom sampling. Further, these length frequency data must be interpreted cautiously due to the size selectivity of different gear types. The 2005 shovelnose sturgeon length frequency distribution for the lower basin yields little information as it likely misrepresents the true size structure of the population (Neumann and Allen 2007); however, it will be useful in the future for making comparisons between basins and monitoring for change among years.

***Sturgeon Chub***

The otter trawl was the most effective method for sampling sturgeon chub in the lower basin of the Missouri River in 2005. Sampling with otter trawls accounted for all but one of the 210 sturgeon chub sampled in the lower basin in 2005. Otter trawl mean CPUE for sturgeon chub was greater in the sturgeon season than in the fish community season (Figure 13). The amount of effort allocated to each macro- and mesohabitat type was similar between seasons; thus, seasonal habitat use likely does not explain the difference in relative abundance. As with shovelnose sturgeon, it is possible that the seasonal difference observed in relative abundance is associated with seasonally variable

fish depth use, microhabitat use, and gear specific efficiency at various depths or microhabitats. It is also possible that a greater proportion of sturgeon chub move to habitat types not sampled with otter trawls during the fish community season. Relative abundance from RM 392 – 513 was markedly greater during the sturgeon season than the fish community season (Figure 14). Catch per unit effort during the sturgeon season in the aforementioned reach was much greater than the rest of the geographic distribution in either season. A general trend of increasing CPUE with decreasing river mile was observed during the fish community season. However, the effect sizes are small. Overall, sturgeon chub CPUE was much less than that of the other two target Missouri River *Macrhybopsis* species.

Sturgeon chub catches were congruent with the amount of effort put into each macro- and mesohabitat type (Tables 9 and 10). It is clear that sturgeon chub utilize channel crossover and inside bend habitats. However, more effort is needed within all 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 all but one individual was sampled in channel border mesohabitat.

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 otter trawls sampled all but 4 of the 210 individuals in the distribution and the small mesh size (6 mm) of otter trawls greatly reduce mesh size bias for all but the smallest of individuals. As with all the species sampled, the length frequency distribution of sturgeon chub for the lower basin in 2005 has little utility. The greatest utility of the length frequency distribution for sturgeon chub will be in making comparisons between basins and monitoring for change among years.

### *Sicklefin Chub*

Similar to sturgeon chub, the otter trawl was the most effective method for sampling sicklefin chub in the lower basin of the Missouri River in 2005. All but 24 of the 1414 individuals sampled were captured with otter trawls. Interestingly, seasonal relative

abundance for sicklefin chub had a different trend than that of sturgeon chub. Catch per unit effort was similar between seasons for sicklefin chub, whereas CPUE was greater during the sturgeon season than the fish community season for sturgeon chub. The similar seasonal relative abundance of sicklefin chub may be indicative of little behavioral or selective change throughout the year in sicklefin chub. Similarly, geographic distribution of sicklefin chub was similar among seasons with a general trend of very few fish sampled above RM 500 and increasing CPUE with decreasing river mile. However, as with most of the targeted Missouri River species, small effect sizes necessitate caution in the interpretation of these trends.

Sicklefin chub catches were consistent with the amount of effort put into each macro- and mesohabitat type (Tables 11 and 12). As with sturgeon chub, it is clear that sicklefin chub are utilizing channel crossover and inside bend macrohabitats as well as channel border mesohabitats. Further, 19 individuals were captured with mini-fyke nets and all were sampled in sandbar mesohabitat. More effort is needed within all other meso- and macrohabitats to determine if they are utilized by sicklefin chub.

Length frequency distribution data came from sampling with standard otter trawls for all but 21 of the 1305 sicklefin chub that were measured in 2005. As with all the species sampled, the length frequency distribution of sicklefin chub for the lower basin in 2005 has little utility. The greatest utility of the length frequency distribution for sturgeon chub will be in making comparisons between basins and monitoring for change among years.

***Speckled Chub***

Congruent with the other targeted Missouri River *Macrhybopsis* species, the otter trawl was the most effective gear for sampling speckled chub in 2005. Otter trawls sampled 1217 of the 1535 speckled chub captured in the lower basin of the Missouri River. Although CPUE was much greater for speckled chub than sturgeon chub, the same trend in seasonal relative abundance was observed between these species. Mean CPUE was slightly greater in the sturgeon season than in the fish community season for speckled chub (Figure 21). Interestingly, geographic distribution was also very similar for sturgeon chub and speckled chub (Figures 14 and 22). The greatest CPUE for

speckled chub was observed during the sturgeon season from RM 392 – 513. However, the highest CPUE during the fish community season was observed downstream of that location at RM 183 – 240 and RM 60 – 122 (Figure 22).

The preponderance of speckled chub were sampled from inside bend macrohabitats where the majority of effort was focused. Channel crossover and small connected side channel macrohabitats also appear to be important speckled chub habitat as the percentage of capture exceeded the percentage of effort for both otter trawl and mini-fyke net sampling in those habitats. It is difficult to make inferences regarding all 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 otter trawl and mini-fyke net; thus, no inferences can be made regarding speckled chub habitat associations in these mesohabitats.

Length frequency distribution data came from sampling with standard otter trawls for 1090 of the 1297 speckled chub that were measured in 2005. Mini-fyke nets and bag seines accounted for the remaining 207 speckled chub lengths. Interestingly, very few sturgeon chub or sicklefin chub were sampled with these two gears, suggesting that speckled chub utilize shallow water habitat more than the other two target Missouri River *Macrhybopsis* species. The length frequency distribution for speckled chub will be useful for future monitoring for change in speckled chub population structure among years.

***Blue Sucker***

Trammel nets and gill nets were the most effective gears for sampling blue sucker in the lower basin of the Missouri River in 2005. Overall, trammel nets captured 48% of the 1833 blue suckers sampled in 2005 ($N$ = 646 for standard trammel nets, $N$ = 237 for 2.5-inch trammel nets). Gill nets captures comprised 39% (N = 720) of the total catch followed by otter trawl captures at 10% ($N$ = 192). Other wild gear types sampled the remaining 3%.

Catch per unit effort of blue sucker was greater during the fish community season than in the sturgeon season for both trammel net and otter trawl sampling (Figure 25). During both seasons mean CPUE was greater in the upper reaches of the lower basin (i.e., above RM 400) than below that location (Figures 26 and 27). However, mean CPUE for the fish community season was generally greater than the sturgeon season for the aforementioned upper reaches. Possible explanations for the differences observed in relative abundance may be related to the efficiency of gears during different seasons or blue sucker may utilize the less sampled habitats more during the sturgeon season.

Inside bends appear to be an important macrohabitat for blue sucker as the percentage of blue suckers captured in inside bends was generally greater than the proportion of effort but into inside bends for all gear types and during both seasons (Table 15). Channel crossovers are likely important blue sucker habitat as well, as the percent of catch and effort were similar across gear types. Outside bends may be less used by blue sucker as the percentage of capture was generally less than the percentage of effort within outside bends. It is difficult to make inferences regarding all other macrohabitat types as little to no effort was administered in these areas. 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 16). Conversely, gill net data suggests that channel borders were less important mesohabitat, as 19% of the catch came from 50% 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 sucker as 78% of the blue sucker gill net catch came from pool mesohabitat while only 45% of the effort was allocated to these areas.

Little difference exists between random versus random and nonrandom sampling length frequency distributions for blue sucker (Figure 28). 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, very few fish less than 50 cm were captured in 2005. It is possible that the

sampling gears used in this study are not efficient at sampling smaller blue suckers or that juvenile blue suckers rear in tributaries to the Missouri River outside the sampling areas. Again, these length frequency data must be interpreted cautiously due to the size selectivity of different gear types. The 2005 blue sucker length frequency distribution for the lower basin yields little information as it likely misrepresents the true size structure of the population (Neumann and Allen 2007); however, it will be useful in the future for making comparisons between basins and monitoring for change among years.

***Sauger***

Gill nets were the most effective gear for sampling saugers in the lower basin of the Missouri River. Gill nets (standard and green dyed) captured 41% ($N$ = 151) of the 368 saugers sampled in 2005. Trammel nets (standard and green dyed) were the next most effective gear capturing 20% ($N$ = 74), followed by standard otter trawls at 16% ($N$ = 59), and standard mini-fyke nets at 5% ($N$ = 19). All other wild gear types combined captured the remaining 18% ($N$ = 65).

Mean CPUE for saugers was greater during the fish community season than during the sturgeon season for both trammel net and otter trawl sampling (Figure 30). Although there was a general trend of increased CPUE across the lower basin during the fish community season, this difference was most pronounced above RM 450 (Figures 31 and 32). Possible explanations for the differences observed in relative abundance may be related to the efficiency of gears during different seasons or saugers may utilize the less sampled habitats more during the sturgeon season.

Channel crossover and outside bend habitat appear to be important macrohabitat for saugers as the percentage of capture within these areas generally exceeded the percentage of effort for most gear types across both seasons. Inside bends may be less important as the percent of saugers captured was generally lower than effort in these areas. Not enough effort was exerted in other macrohabitat types to make inferences on sauger associations in these areas. Channel border, sandbar, and pool mesohabitats are all utilized by saugers. As with blue sucker, gill net catches in channel border areas contradict catches from all other gear types. However, gill nets do demonstrate that saugers are using pool mesohabitats. Similarly, mini-fyke nets demonstrate that saugers

are using sandbar mesohabitat. Not enough effort was exerted in the remaining mesohabitats to make inferences regarding sauger habitat associations.

Little difference exists between random versus random and nonrandom sampling length frequency distributions for saugers (Figure 33), 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 bimodal length frequency distribution for saugers can be explained by gear type. The first mode (< 200 mm) is comprised exclusively of saugers sampled with bag seines, mini-fyke nets, and otter trawls, whereas the preponderance of the second mode (≥ 200 mm) is observations obtained through sampling with gill nets and trammel nets (Figure 42). Each gear type has its 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.

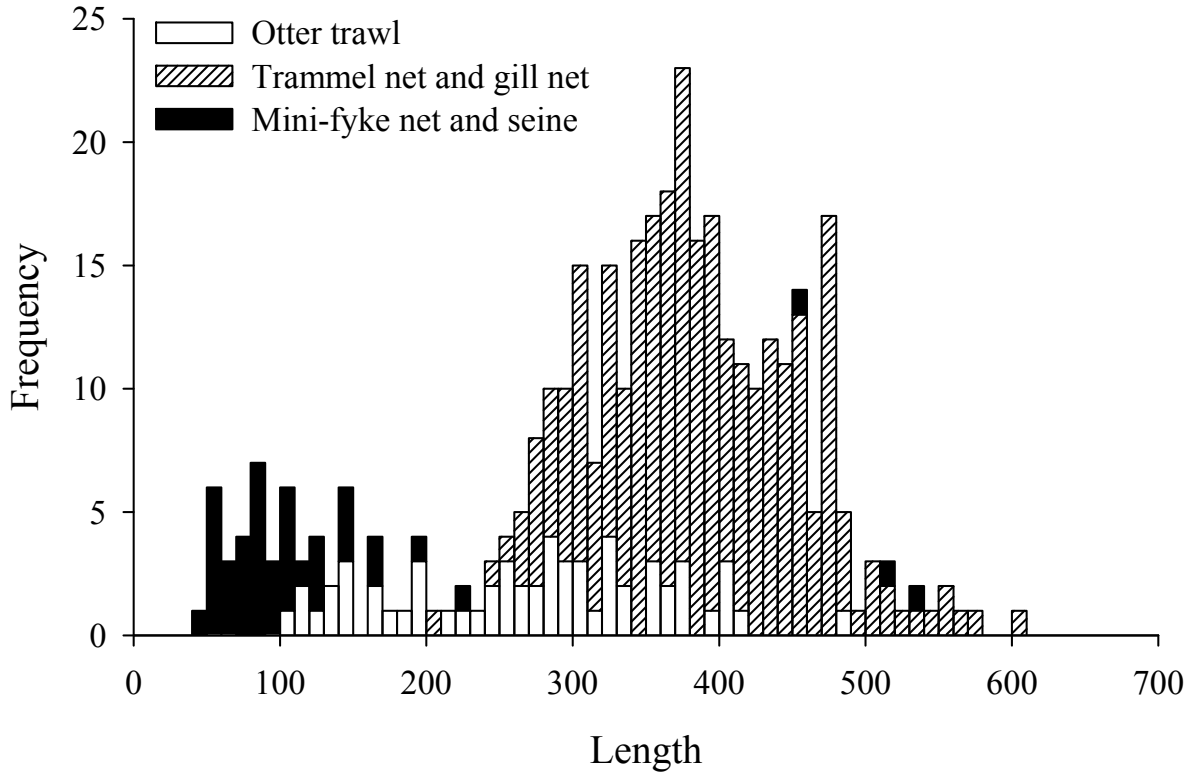


**Figure 42.** Length frequency distribution by gear type of saugers captured with otter trawl, trammel net, gill net, mini-fyke net, and bag seines in the lower basin of the Missouri River during the 2005 sampling year using random and nonrandom sampling.

***Sand Shiner***

Mini-fyke nets were the most effective gear for sampling sand shiner in the lower basin of the Missouri River in 2005. Mini-fyke nets captured 67% (N = 1302) of the 1949 individuals sampled during that year. Bag seines captured 32% (N = 627), while otter trawls sampled the remaining 1% (N = 20).

Only 19 individuals were randomly sampled with otter trawls in 2005; thus, the relative abundance analysis has little utility. However, mean CPUE was greater during the sturgeon season than during the fish community season. Further, no general trends were apparent in sand shiner geographic distribution.

Mini-fyke net sampling provides the only useful information regarding sand shiner habitat associations as very few individuals were sampled using other gear types. Based on mini-fyke net sampling, secondary channels and braided channels appear to be important sand shiner habitats as the percent of individuals captured in these macrohabitats were greater than the percent of effort exerted. Further, although inside bends received the greatest percentage of mini-fyke net effort, relatively few individuals were captured there. Sampling with mini-fyke nets in channel crossover macrohabitats also resulted in relatively low catches. Sandbars were the only mesohabitat sampled with enough effort to evaluate. Thus, nearly 100% of the mini-fyke net catch came from sandbar mesohabitat. Although the mini-fyke net sampling data provides insights into which habitats are used by sand shiner, it should not be assumed that the other habitat types are not important to sand shiners as mini-fyke nets may be inefficient in sampling these areas.

Length frequency distribution data came from sampling with standard mini-fyke nets for 1026 of the 1655 speckled chub that were measured in 2005. Bag seines accounted for 609 and standard otter trawls accounted for the remaining 20 sand shiner lengths. The length frequency distribution for sand shiners will be useful for future monitoring for change in population structure among years.

***Hybognathus spp.***

Mini-fyke nets were the most effective gear for sampling *Hybognathus* spp. in the lower basin of the Missouri River in 2005. Mini-fyke nets captured 376 of the 491 *Hybognathus* spp. sampled, while bag seines captured the remaining 115 fish. However, the majority ($N = 297$) of all *Hybognathus* spp. sampled in 2005 came from two deployments. Based solely on the limited catch observed from mini-fyke net sampling, it appears that inside bend macrohabitats and sandbar mesohabitats are used by *Hybognathus* spp. Mini-fyke nets sampled 208 *Hybognathus* spp. that were used in the length frequency distribution, while bag seines captured 110. The length frequency distribution for *Hybognathus* spp. will be useful for future monitoring for change in population structure among years. *Hybognathus* spp. should be monitored carefully as it appears that very few remain in the lower basin of the Missouri River.

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# 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 Randall Dam (RM 880) downstream to the headwaters of Lewis and Clark Lake (RM 825) from 1992 – 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 |

**Appendix D.** 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 – 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 |

**Appendix E.** 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 E.** (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 E.** (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 E.** (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 E.** (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 E.** (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 |
| | 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 E.** (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 |