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Minnesota River Creel Survey
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Highlights

- Estimated daytime angling effort on the Minnesota River during May–October 2022 was **91,463 hours**, which is comparable to annual open-water angling effort on other popular river (Red River, St. Louis River estuary, Mississippi River Pool 2) and lake fisheries (Big Stone Lake, Sauk River Chain of Lakes).
- Relative angling effort of **11.4 hours per acre** is indicative of moderate fishing pressure. In contrast, popular southern Minnesota lakes like Big Stone Lake (Big Stone County) and Green Lake (Kandiyohi County) experience slightly less effort per acre while smaller systems like Madison Lake (Blue Earth County) and the Sauk River Chain of Lakes (Stearns County) have significantly greater effort per acre.
- **Shore anglers contributed 55%** of angling effort on the Minnesota River, which is much greater than on most other fisheries.
- **50% of Minnesota River anglers targeted catfish**, followed by "no particular species" (27%), Walleye/Sauger (23%), Freshwater Drum (5%), and Common Carp (4%).
- **Channel Catfish**, **Freshwater Drum**, and **Walleye/Sauger** were 79% of the fish caught and 89% of the fish harvested.
- **Shovelnose Sturgeon** are the sixth most caught (1,245) fish species from the Minnesota River and became legal for anglers to target in 2015.
- Relative harvest was relatively low with **less than 0.60 Channel Catfish**, **Freshwater Drum, and Walleye/Sauger harvested per acre**.
- Anglers targeting specific species experienced moderate catch rates of **0.26 Channel Catfish**, **0.27 Walleye/Sauger**, and **0.04 Flathead Catfish** per hour.
- Although 39% of the anglers interviewed during the daytime were targeting Flathead Catfish, a significant amount of **Flathead Catfish angling effort, catch, and harvest occurs at night** and was not included in this creel survey.
- **Compared with the previous Minnesota River creel survey** conducted during 1998, more anglers are targeting Freshwater Drum and anglers are catching and harvesting relatively more Walleye and Freshwater Drum but harvesting relatively fewer Channel Catfish and Flathead Catfish.

Abstract

The Minnesota Department of Natural Resources (MNDNR) conducted the first creel survey of the Minnesota River fishery since 1998 during April 27th–October 31st, 2022. The creel survey was implemented similarly to the Red River of the North creel survey and consisted of a modified roving-access design for estimating angler effort, catch, and harvest along a 233-mile reach of river downstream of Granite Falls Dam. Effort, catch, and harvest estimates were assumed conservative because the survey design excluded shore anglers dispersed away from the 40 discrete access sites visited by creel clerks and excluded night angling effort. Creel clerks completed 309 creel shifts and interviewed nearly 1,200 individual anglers or groups of anglers. Total estimated angling effort was 91,463 hours, which is equivalent to 392.5 hour per river mile or approximately 11.4 hours per acre. Unlike most lake fisheries, 55% of total angling effort was by shore anglers. Estimated total catch was 45,452 fish; 79% of which were Channel Catfish *Ictalurus punctatus* (16,576), Freshwater Drum *Aplodinotus grunniens* (11,566), or Walleye *Sander vitreus* (7,570 combined with Sauger *Sander canadensis*). Similarly, the estimated total harvest of 12,701 fish was dominated by Freshwater Drum (4,719), Channel Catfish (3,759), and Walleye (2,859), but was less than 0.6 fish per acre for each individual species. Mean catch rates of anglers specifically targeting popular game fishes were 0.26 Channel Catfish per hour, 0.04 Flathead Catfish *Pylodictis olivaris* per hour, and 0.27 Walleye per hour. Overall, 50% of interviewed Minnesota River anglers were targeting catfish, 27% “no particular species”, 23% Walleye, 5% Freshwater Drum, and 4% Common Carp *Cyprinus carpio*. Compared with the previous Minnesota River creel survey, angling effort per river mile was relatively similar. However, catch rates, relative harvest, and targeted effort for Freshwater Drum was greater during 2022 while targeted effort for and relative harvest of Channel Catfish and Flathead Catfish was greater during 1998. As expected, the Minnesota River remains an important fishery for Channel Catfish, Flathead Catfish, and Walleye and has an emerging Freshwater Drum fishery. Despite having dispersed angling effort, the Minnesota River is among the most heavily fished waterbodies within the MNDNR’s southern region during the open-water season.

Introduction

The Minnesota River (M-055) is a relatively large and unique fishery in southern Minnesota that flows over 300 miles through five of the Minnesota Department of Natural Resources (MNDNR) fisheries management areas. The Minnesota River is not only one of the few Flathead Catfish *Pylodictis olivaris* fisheries within the state, but it has a reputation as a tremendous trophy-fishery. Additionally, the Minnesota River provides excellent angling opportunities for a diversity of unique species including Shovelnose Sturgeon *Scaphirhynchus platorynchus* and Freshwater Drum *Aplodinotus grunniens*. The Minnesota River fishery is also unique because it has greater shore angling opportunities than most lake fisheries and provides urban fishing opportunities within numerous towns and cities that it flows through. The unique angling experience provided by the Minnesota River is highlighted by certified weight records for Black Buffalo *Ictiobus niger*, Goldeye *Hiodon alosoides*, Mooneye *Hiodon tergisus*, River Carpsucker *Carpoides carpio*, and Shortnose Gar *Lepisosteus platosomus* being caught from its waters.

Fisheries management of the Minnesota River has generally focused on maintaining quality Channel Catfish *Ictalurus punctatus* and Flathead Catfish populations, monitoring the health of

the diverse fish community, and studying unique river species (e.g., Paddlefish *Polydon spathula*, Blue Sucker *Cycleptus elongatus*; MNDNR 2018). Fish stocking into the Minnesota River is limited to sparse stocking of Walleye *Sander vitreus* (various life stages) and annual stocking of 4,000 Lake Sturgeon *Acipenser fulvescens* fingerlings into Big Stone Lake (Minnesota River headwaters) as part of a reintroduction effort. With a few minor exceptions (e.g., continuous catch-and-release season for Largemouth Bass *Micropterus salmoides*, Sauger *Sander canadensis*, Smallmouth Bass *Micropterus dolomieu*, and Walleye downstream of the Mendota Bridge; use of cast-nets for gizzard shad *Dorosoma cepedeianum* with a permit), fishing regulations on the Minnesota River are the same as general Minnesota fishing regulations for inland waters.

An additional goal identified in the 2018–2022 Minnesota River fisheries management plan is monitoring angling use of the river. Previous assessment of angler use on the Minnesota River is limited to one creel survey conducted by the MNDNR along a 110-mile reach of river during 1998 (Chapman 2001). The 1998 creel survey revealed that the Minnesota River was predominantly a Channel Catfish, Flathead Catfish, and Walleye fishery, relative fishing effort was moderate, and over 30% of the fish caught were harvested. During the last 20 years there have been observable changes in angler behaviors and interests (e.g., greater catch-and-release ethic), but changes in the amount of angler effort, catch, and harvest are unknown. Therefore, a creel survey was planned for the 2022 open-water season on the Minnesota River with the goal of providing a contemporary estimate of annual angling effort, catch, and harvest and gaining a better understanding of Minnesota River angler demographics and preferences. The 2022 creel survey includes a larger portion of the river than the previous 1998 creel survey and uses methods most similar to the creel survey that is conducted periodically on the Red River of the North (Wendel 2016).

Study Area

The Minnesota River is a 7th–8th order river that flows approximately 320 miles from Big Stone Lake on the Minnesota–South Dakota Border to its confluence with the Mississippi River in St. Paul, MN. The Minnesota River is a low gradient, productive, and turbid warm water river that flows through the agriculturally dominated prairie region of southern Minnesota. Flow of the Minnesota River is altered by very few dams and the 240-mile reach downstream of Granite Falls Dam (river mile 240) is completely free flowing and home to a diverse fish community of over 80 species. In addition to over 50 boat ramps and canoe accesses, the Minnesota River is bordered by numerous public lands that are accessible by anglers including Aquatic Management Areas, State Parks, National Wildlife Refuges, and County and City Parks.

The 2022 creel survey was conducted on an approximately 233-mile reach of the Minnesota River from Granite Falls Dam in Granite Falls, MN downstream to river mile 7 near the Cedar Avenue Public Water Access in Burnsville, MN (Figure 1). The lower 7-miles of the Minnesota River were excluded from the study reach because differentiating angling effort that occurs within the Minnesota River or the Mississippi River becomes more difficult near the confluence. Anglers frequently fish backwaters within the Minnesota River floodplain, but this survey was primarily restricted to the main channel. The approximate bank-full surface area of the study reach is 8,000 acres (based on 2010 Farm Service Agency aerial imagery), although the surface area is very dynamic and is magnitudes larger during flood conditions.

Methods

Modified Roving-Access Design

Minnesota Department of Natural Resources fisheries staff commonly conduct roving-roving open-water creel surveys on small to medium-sized lake fisheries to estimate angling effort, catch, and harvest (e.g., Coahran 2021; Eder 2021). During roving-roving creel surveys, angling effort is estimated from instantaneous angler counts conducted by a creel clerk navigating a boat around ("roving") the waterbody or study area. Catch and harvest rates are estimated for these types of surveys from angler interviews conducted during fishing trips by a creel clerk roving amongst the anglers. Conducting roving-roving creel surveys from a boat is logistically challenging on large riverine systems like the Minnesota River because the view of anglers is obstructed by the sinuosity of the river channel, the study area is hundreds of miles long, angling effort is minimal within various remote reaches, and navigation obstacles often prevent safe boat passage. Therefore, alternative creel survey designs were considered for the 2022 Minnesota River creel survey.

Comparable to the Red River of the North creel survey design (Wendel 2016), a modified roving-access survey that used stratified random sampling and uniform selection probabilities was selected for estimating angler effort, catch, and harvest on the Minnesota River during 2022. Effort estimates were calculated from progressive instantaneous angler counts conducted at all discrete access sites within a study area and creel clerks traveled between the access sites with a vehicle rather than a boat. Catch and harvest rates were estimated from angler interviews also conducted at the discrete access sites, preferably after the completion of fishing trips. The daily counts of individual shore anglers were used to estimate shore angling effort and daily counts of empty watercraft trailers (and other watercraft carrying equipment such as canoe racks) rather than watercrafts themselves were used to estimate boat angling effort. Ideally, during access-based angler interviews all interviews are conducted after the completion of fishing trips (completed trip interviews) rather than during fishing trips (incomplete trip interviews). Incomplete trip interviews introduce potential "length-of-stay" biases because anglers are interviewed with a probability proportional to the length of their fishing trip and catch and harvest rates may be influenced by the length of fishing trips (Pollock et al. 1997). Additionally, incomplete trip interviews further introduce bias if catch and harvest rates change after the interview is conducted (McCormick et al. 2012). However, shore angling is particularly popular along the Minnesota River and a significantly greater number of shore angler interviews are obtained by conducting incomplete trip interviews. Therefore, catch and harvest rates were estimated from completed trip interviews along with incomplete trip interviews of shore anglers that had been fishing for at least 30 minutes (Hoenig et al. 1997).

A vast majority of shore angling along the Minnesota River occurs at discrete and publicly accessible access sites that can be surveyed by creel clerks. However, some shore angling does occur outside of discrete access sites (e.g., private property, along vast tracks of public land), and therefore, estimates of shore angling effort (and consequently catch and harvest) from this survey design are conservative. Additionally, the creel survey was limited to daylight hours and therefore knowingly underestimates total effort, catch, and harvest by excluding angling effort that occurs at night, which is common practice by Minnesota River catfish anglers.

Sampling Stratification

The study reach of the Minnesota River was divided into three 72- to 86-mile-long reaches (reach 1 or “upper river”, reach 2 or “middle river”, and reach 3 or “lower river”) and each reach was divided into two clusters (Figure 1). Each cluster contained six to eight survey stations for a total of 40 stations (Appendix A). Survey stations included all the public boat ramps and discrete shore fishing access sites throughout the study reach (excluding the Eckstein Public Access near New Ulm that was inaccessible due to road construction). Reaches and clusters were treated as independent strata for analyses and sampled with stratified random sampling and uniform selection probabilities. Survey stations within each cluster were also surveyed with equal probability, meaning creel clerks visited each station for an equal amount of time during a creel shift.

The creel survey began on April 27th, 2022 and ended on October 31st, 2022. Months were treated as independent strata for analyses and were defined based on creel clerk pay periods (Wednesday–Tuesday) rather than calendar dates. As such, May included April 27th–May 31st, June included June 1st–June 28th, July included June 29th–July 26th, August included July 27th–August 30th, September included August 31st–September 27th, and October included September 28th–October 31st. Many analyses were performed at a coarser scale of season rather than month, and seasons included spring (May and June), summer (July and August), and fall (September and October). Creel surveys were also stratified among day types of weekdays and weekends. Holidays were included in the weekend stratum but were not surveyed by creel clerks. Estimates of effort, catch, and harvest were also stratified among angler types (shore and boat).

For each creel shift, a non-overlapping morning or evening work shift was selected with stratified random sampling and uniform probabilities, but work shift was not treated as an independent stratum for analyses. The starting station, direction of travel (upstream or downstream), and instantaneous count time (at arrival or at departure) for each creel shift was randomly selected.

Creel Shifts

Each reach (two clusters) was assigned to one of three creel clerks. Creel clerks worked four creel shifts per pay period (Wednesday–Tuesday) within their reach, including all weekend days and two randomly selected weekdays. For each creel shift, the creel clerk was provided a detailed schedule indicating the cluster, work shift (morning or evening), starting station, direction of travel, instantaneous count time (at arrival or at departure), and the regimented schedule of arrival and departure times for each station. During a creel shift, the creel clerk drove a vehicle between stations (according to the regimented schedule) within the assigned cluster, spending an equal amount of time (20–50 minutes) at each station. While at each station, the creel clerk conducted an instantaneous count (at arrival or at departure) of all shore anglers and empty watercraft trailers within the defined station boundaries. During the remainder of the time at each station, the creel clerk interviewed anglers, attempting to maximize the number of completed trip interviews. When possible, creel clerks attempted to interview each individual shore angler, even if they were fishing as a group. Angler interviews included questions about the duration of the fishing trip, species sought, catch, harvest, and demographics (e.g., age, gender, zip code, avidity; Appendix B). Unique questions asked during

angler interviews included “How many days did you fish the Minnesota River during the last 12 months?”, “How many days did you fish anywhere during the last 12 months?”, and “What percent of your open water fishing effort is targeting catfish?”.

Creel clerks worked 10-hour days during May–August and 9-hour days during September and October. The length of “official” regimented creel survey shifts was affected by length of daylight and commute times and varied from 5.5 hours during October to 7.0 hours during June and July (Table 1). Creel clerks were asked to utilize any “extra” time at the beginning and end of their workday to obtain additional angler interviews within the assigned cluster. Angler interviews conducted during “extra” time were excluded from catch and harvest analyses since they deviated from the uniform probability sampling design, but they were valuable for increasing understanding of angler demographics and preferences and provided ancillary catch and harvest information.

Survey Cards

Along with the concurrent Red River creel survey (*in preparation*), survey cards were used to gain additional information from Minnesota River anglers. Two type of survey cards were provided to anglers, both of which included unique identifier codes that allowed linking of survey card responses with angler information recorded by creel clerks (Appendix C). During incomplete trip interviews anglers were given one type of survey card (“incomplete trip”) asking them to respond with their final catch and harvest information by completing an online Microsoft Forms survey (with a provided URL and QR code), leaving a voicemail, or emailing a photograph of the completed survey card form. The other type of survey card (“windshield”) was placed on the windshields of vehicles with empty watercraft trailers. Boaters were asked to respond with their trip information by completing a similar online Microsoft Forms survey or leaving a voicemail.

Analyses

All analyses were performed in R version 4.2.2 (R Foundation for Statistical Computing, Vienna). See Appendix D for detailed methods and equations.

Creel Survey Comparisons

Inferences about changes in the Minnesota River fishery and its anglers during the last 20+ years were made by comparing general outcomes of this creel survey with the general outcomes of the only prior creel survey conducted during 1998 (Chapman 2001). Additional context for the Minnesota River fishery was provided by comparing the creel survey results with recent creel results from other similar river fisheries (e.g., Red River of the North), lakes within MNDNR southern region (e.g., Big Stone Lake), and several of Minnesota’s large lakes (e.g., Leech Lake).

Results

Angler Surveys

Creel clerks completed 309 of the 312 scheduled creel shifts. Four or five creel shifts were typically conducted within each cluster, month, and day type strata, but the number of shifts per strata varied 3–6 (Table 1). Creel clerks successfully interviewed 1,278 individuals or groups, 1,178 of which were angling, representing 1,740 individual anglers (Table 2). Of the 1,178

angler interviews, 1,034 were of shore anglers, 136 were of motorized watercraft anglers, and 8 were of non-motorized watercraft anglers. The 1,034 shore angler interviews included 586 interviews of anglers that had been fishing for at least 30 minutes and that were conducted during official creel hours. Only 65 of the watercraft angler interviews were of completed trips and during official creel hours.

Creel clerks also provided 827 survey cards to anglers during incomplete trip interviews and placed 759 survey cards on windshield of vehicles with an empty watercraft trailer (Table 3). The survey card response rate was 13.5%; 10.3% for incomplete trip interview cards and 17.0% for windshield cards. Most survey card responses (79%) were completed using the Microsoft Forms online survey. Importantly, survey card responses (of boat anglers that indicated finishing their trip during official creel hours) were used to increase the number of completed trip boat angler interviews from 65 to 148. Completed trip boat angler surveys from the upper and middle reaches were combined to further bolster sample sizes. The number of angler interviews used to estimate catch and harvest rates within each reach and season strata varied from 41 to 134 for shore anglers and from 6 to 37 for boat anglers (Table 4).

The proportion of motorized watercrafts that were angling varied from (mean ± SE) 72.7 ± 14.1% during fall in the upper and middle reaches to 100.0 ± 0.0% during fall in the lower reach (Table 5). The proportion of non-motorized watercrafts that were angling was much lower and varied from 5.2 ± 2.9% during summer to 16.7 ± 9.0% during fall. The mean number of anglers (party size) fishing from boats varied from 1.6 ± 0.1 anglers during fall in the lower reach to 2.1 ± 0.1 anglers during spring in the upper and middle reaches (Table 6).

Effort

Total estimated angling effort during the creel survey (daylight hours from April 27th–October 31st, 2022) was 91,463 ± 4,880 hours, which is equivalent to approximately 11.4 hours per acre, 392.5 hours per river mile (rm), or 3.3 hours per river mile per day (Table 7). Angling effort within each cluster, month, and angler type strata varied from 0 ± 0 boat angler hours in cluster 1 during September to 5,026 ± 807 shore angler hours in cluster 1 during July (Table 8). Overall, shore angling effort (50,013 ± 3,253 hours) was greater than boat angling effort (41,451 ± 3,637 hours) with shore angling effort generally decreasing from upstream to downstream and boat angling effort increasing from upstream to downstream. Boat angling effort was greater during spring (18,120 ± 2,783 hours) and summer (17,777 ± 2,251 hours) than during fall (5,552 ± 644 hours). Shore angling effort was greatest during summer (23,828 ± 2,282 hours) and lowest during fall (10,980 ± 1,078 hours). Total angling effort was greatest in the lower reach (39,094 ± 3,531 hours), lowest in the middle reach (21,187 ± 1,942 hours), and intermediate in the upper reach (31,182 ± 2,752 hours). Similarly, angling effort per river mile was greatest in the lower reach (455 hours/rm), lowest in the middle reach (282 hours/rm), and intermediate in the upper reach (433 hours/rm).

Corresponding with effort estimates, four of the six most popular access sites for shore angling were within the upper reach and had mean instantaneous counts varying from 1.0 shore anglers at Vicksburg County Park and Upper Sioux Agency State Park to 4.5 shore anglers at Granite Falls Dam (Appendix E). The four most popular boat accesses were within the lower reach and included the Lyndale Public Access (mean count = 2.2 trailers), Cedar Avenue Public Access

(1.4 trailers), Shakopee Public Access (1.0 trailers), and Le Sueur Public Access (0.8 trailers; Appendix F).

Catch and Harvest

Minnesota River anglers caught an estimated 45,452 fish during the 2022 creel survey (Table 9; see Appendix G for SEs). Seventy-nine percent of the fish caught were Channel Catfish (16,576), Freshwater Drum (11,566 ± 971), or Walleye (7,570 combined with Sauger; Table 10; see Appendix H for SEs). Other species less frequently caught included Common Carp *Cyprinus carpio* (2,325), Flathead Catfish (1,409), and Shovelnose Sturgeon (1,245). Other species caught by anglers included bullhead *Ameiurus* Spp., buffalo *Ictiobus* Spp., crappie *Pomoxis* Spp., gar *Lepisosteus* Spp., Gizzard Shad, Goldeye, Largemouth Bass, Mooneye, Northern Pike *Esox lucius*, redhorse *Moxostoma* Spp., Silver Chub *Macrhybopsis storeriana*, Smallmouth Bass, suckers *Catostomid* Spp., sunfish *Lepomis* Spp., and White Bass *Morone chrysops*, but catches were considered negligible (i.e., less than 400 caught). Seasonal trends in catches were evident for some species. For instance, catches of Channel Catfish and Flathead Catfish were greatest during summer, intermediate during spring, and lowest during fall. Catches of Walleye were greater during spring than during summer or fall.

Minnesota River anglers harvested an estimated 12,701 fish during the 2022 creel survey (Table 11; see Appendix I for SEs). Like the catch composition, 89% of the fish harvested were Freshwater Drum (4,719), Channel Catfish (3,759), or Walleye (2,859; Table 12; see Appendix J for SEs). Other frequently harvested species included Common Carp (492) and Flathead Catfish (349). Freshwater drum were the most harvested species which equated to 20.3 fish/rm or 0.59 fish/acre (Table 13). In contrast, Flathead Catfish harvest was only 1.5 fish/rm or 0.04 fish/acre. For the five primarily harvested species, the percent of the fish caught that were harvested varied from 21% for Common Carp to 41% for Freshwater Drum. Harvest of all other species was considered negligible (i.e., less than 0.60 fish per rm). Interestingly, anglers in the upper reach harvested 44% of fish caught (7,641 fish harvested of 17,423 fish caught) whereas anglers in the middle and lower reaches only harvested 18% of fish caught. This general trend was true for Channel Catfish, Flathead Catfish, and Freshwater Drum. However, anglers in the lower reach harvested a greater number of Common Carp and Walleye than anglers in other reaches.

Mean lengths of harvested fish tended to be greater than mean lengths of released fish, except for Flathead Catfish (Table 14; Figures 3–5). For instance, the mean length of measured Channel Catfish that were harvested was 17.9 inches and the estimated mean length of Channel Catfish that were released was 13.2 inches. The estimated mean length of released Flathead Catfish was 29.4 inches while the mean length of harvested Flathead Catfish was 21.3 inches.

Catch and Harvest Rates

In general, shore anglers had greater catch rates than boat anglers in the upper and middle reaches with shore angler catch rates typically exceeding 0.40 fish/hour (Tables 15–16). Catch rates were more similar between shore anglers and boat anglers in the lower reach, with both shore and boat angler catch rates also typically exceeding 0.40 fish/hour. For species-specific catch rates, shore anglers catch rates of Channel Catfish were relatively high in the upper and middle reaches (0.19 ± 0.09–0.32 ± 0.15 fish/hour). Shore anglers were also relatively

successful at catching Freshwater Drum (0.11 ± 0.04–0.28 ± 0.13 fish/hour), except within the middle reach during spring. Species-specific boat anglers catch rates were generally low (less than 0.10 fish/hour), except for Channel Catfish catch rates during summer (0.14 ± 0.03–0.35 ± 0.02 fish/hour), Walleye catch rates during spring (0.15 ± 0.01–0.26 fish/hour), and Walleye catch rates during fall within the lower reach (0.23 ± 0.06 fish/hour). As expected for an apex predator, catch rates of Flathead Catfish were typically low (0.05 fish/hour or less) for both shore and boat anglers.

Anglers that indicated they were specifically targeting certain species were similarly successful at catching those species whether fishing from shore or boat (Table 17). Interestingly, catch rates of species being targeted by anglers did not exhibit strong seasonal patterns. Flathead Catfish anglers tended to be more successful during summer and fall than spring, but targeted catch rates never exceeded 0.05 fish/hour. Boat anglers targeting Walleyes during the fall were the most successful with a mean catch rate of 0.41 Walleye/hour. Mean weighted targeted catch rates were 0.26 Channel Catfish/hour, 0.04 Flathead Catfish/hour, and 0.27 Walleye/hour.

Species-specific harvest rates were almost always less than 1 fish harvested for every 10 hours of angling effort (Tables 15–16). The few exceptions include Channel Catfish harvest rates by shore anglers within the upper reach during spring (0.11 ± 0.08 fish/hour) and Freshwater Drum harvest rates by shore anglers within the upper reach during spring (0.22 ± 0.09 fish/hour) and summer (0.12 ± 0.03 fish/hour) and within the lower reach during fall (0.18 ± 0.13).

Angler Demographics and Preferences

Overall, 50% of all interviewed anglers were targeting catfish (Channel Catfish, Flathead Catfish, or both), 27% “no particular species”, 23% Walleye, 5% Freshwater Drum, 4% Common Carp, and all other species were targeted by less than 1% of interviewed anglers (Table 18). The percent of anglers targeting species differed among month, reach, and angler type. For instance, a greater percent of anglers targeted Channel Catfish and Flathead Catfish during July, August, and September than during May, June, and October. Fifty percent of anglers targeted Walleyes during October, 31% targeted Walleyes during May, and 25% or fewer targeted Walleyes during June–September.

Minnesota River anglers were primarily middle-aged (mean age of 34 years) males (83%). However, 16% of anglers were under the age of 16, 26% of anglers were 16–29 years old, and 9% of anglers were over the age of 60 (Table 19). The avidity of anglers that fish the Minnesota River was relatively evenly distributed from anglers that fished 5 or fewer days during the last year (21%) to anglers that fished 100 or more days during the last year (10%; Table 20). However, avidity to fishing the Minnesota River was much lower with 92% of anglers fishing the Minnesota River 25 or fewer days during the last year and 54% fishing the Minnesota River 5 or fewer days during the last year (Table 21). Yet, 25% of the anglers interviewed indicated that more than 75% of their days fished are on the Minnesota River (Table 22). The avidity to catfish angling was also relatively evenly distributed from anglers that never fish for catfish (29%) to anglers that fish for catfish more than 80% of the time (18%; Table 23).

Interviewed anglers provided reasons for releasing 722 of the fish that were caught and released. The primary reason anglers indicated that they released fish was that they enjoy practicing catch and release angling (57% of responses). Other common reasons included that

the species was undesirable for harvest (19%) or the fish was too small for harvest (15%). Less common reasons (≤ 2% each) included concerns about the safety of eating fish from the river, anglers that do not eat fish, fish that were illegal to harvest, fish that were too big, or other reasons.

Creel Survey Comparisons

Comparisons of relative angling effort, catch rates, relative harvest rates, and percent of anglers targeting specific species between the 2022 Minnesota River creel survey and other creel surveys are provided in Tables 24–26.

Discussion

Most Minnesota River anglers target Channel Catfish, Flathead Catfish, Walleye, or “anything that bites” and Minnesota River anglers predominantly catch Channel Catfish, Freshwater Drum, and Walleye. The number of anglers targeting Freshwater Drum and Common Carp is relatively small, but these fisheries are likely increasing in importance since the previous creel survey in 1998 (Chapman 2001). Along with what anglers are typically targeting and catching, the harvest is also dominated by Channel Catfish, Freshwater Drum, and Walleye. Interestingly, the catch, harvest, and effort directed towards other “game fish” species such a Northern Pike, Smallmouth Bass, and White Bass is extremely low. Similarly, the creel survey revealed that catch and harvest of most native “rough fishes” (e.g., Bowfin *Amia calva*, buffalo, bullhead, gar, Goldeye, redhorse, suckers) is negligible, likely because bowfishing is not popular along the Minnesota River due to its turbid waters. Despite being considered a species of conservation need and illegal to fish for as recently as 2015, Shovelnose Sturgeon were the sixth most caught species even though very few anglers (<1%) specifically target them.

Angling effort on the Minnesota River can be perceived as low because the effort is dispersed among dozens of access sites and hundreds of miles of river. Yet, the conservative estimate of over 90,000 hours of angling effort during the open-water season ranks the Minnesota River among the most fished waterbodies within southern Minnesota and likely one of the most fished waterbodies by shore anglers which contribute 55% of the effort. The Minnesota River is likely attractive to shore anglers because of numerous public access sites, its proximity to urban areas, and moderate-high catch rates for “anything that bites”. During the 2022 creel survey, shore anglers that were targeting “no particular species” had an average catch rate of 0.50 fish per hour, including reasonable catch rates of species desirable for harvest (e.g., 0.24 Freshwater Drum and 0.13 Channel Catfish per hour) and the chance at catching “trophy-sized” Flathead Catfish. The Minnesota River is undoubtedly an important recreational resource and fishery that attracts anglers from across the southern portion of the state, although most anglers that fish the Minnesota River live relatively close (≤ 30 miles; Appendix K).

Total angling effort was greater in the lower reach of the Minnesota River than the two upstream reaches. This is likely because the lower reach is near and within the Minneapolis-St. Paul metropolitan area. The lower reach also had the greatest amount of boat angling effort which is also likely influenced by proximity to the metropolitan area, but also likely reflective of the deeper depths and greater number of quality boat ramps within the reach compared with the upper and middle reaches. This was especially true during 2022 when low water conditions during late-summer and fall greatly reduced boat angling access upstream of St. Peter, MN.

Interestingly, anglers in the upper reach of the river were more interested in harvesting fish than in the middle and lower reaches, and they harvested significantly more Channel Catfish and Freshwater Drum. This trend was largely influenced by shore anglers fishing near Granite Falls (e.g., Granite Falls Dam, Memorial Park, Upper Sioux Agency State Park) that tended to be harvest oriented.

Compared with results from the 1998 Minnesota River creel survey, relative angling effort during 2022 was similar, but the fishery has shifted. Catch rates and relative harvest of Freshwater Drum and Walleye has increased while relative harvest of Channel Catfish and Flathead Catfish has decreased since 1998. A smaller proportion of anglers were targeting catfish during 2022 than 1998, but a greater proportion of anglers were targeting “no particular species” and Freshwater Drum during 2022. This is especially true when considering that 10% of anglers within the upper reach of the Minnesota River were targeting Freshwater Drum during 2022, which is the same reach of river that much of the 1998 creel survey was conducted on when only 1% of anglers were targeting Freshwater Drum.

Relative open-water angling effort is generally similar between the Minnesota River and several other riverine fisheries in Minnesota, including portions of the Mississippi River and the St. Louis River Estuary. However, relative angling effort has been significantly greater along certain reaches of the Mississippi River and less on the Red River. Targeted catch rates of Channel Catfish are relatively similar among most riverine fisheries, except non-targeted catch rates of Channel Catfish from the Red River exceed even targeted catch rates from all other rivers. Targeted catch rates of Walleyes (combined with Sauger) are more variable among rivers and years, with a moderate catch rate of 0.27 fish per hour on the Minnesota River during 2022. Relative harvest of Channel Catfish, Flathead Catfish, and Freshwater Drum is greater on the Minnesota River than from most other riverine fisheries, but relative harvest of Walleye (and Sauger) is intermediate. Compared with other lake fisheries in the MNDNR southern region, total open-water angling effort on the Minnesota River is high and most comparable to Big Stone Lake. However, relative angling effort per acre is relatively moderate on the Minnesota River and Big Stone Lake compared with some of the small but popular fisheries in southern Minnesota such as Cedar and Mazaska Lakes in Rice County. Not surprisingly, some of Minnesota’s popular large lakes (e.g., Leech Lake, Mille Lacs) have substantially greater open-water angling effort than fisheries like the Minnesota River, but relative angling effort per acre is typically lower on the large lakes. Catch rates and targeted catch rates of Walleyes are relatively intermediate on the Minnesota River compared with southern Minnesota lake fisheries but are quite a bit lower than on the larger lakes that are known for their quality Walleye fisheries. Relative harvest of Walleyes is also intermediate on the Minnesota River compared with southern Minnesota lake fisheries and several of the state’s large lakes.

Given the productivity of the Minnesota River, and comparison with other fisheries around the state, relative harvest of most fish species is unlikely having an undesirable impact on the populations. For instance, relative daytime harvest of Flathead Catfish was 0.04 fish per acre or 1.5 fish per river mile. This represents an estimated annual harvest of less than 1% of the population based on the Flathead Catfish density of 145 fish ≥ 20 inches per river mile estimated by Shroyer (2018). With that said, the “trophy” size-structure of the Flathead Catfish population is reliant on low annual mortality, and small increases in harvest could have

undesirable long-term impacts. Thus, continued monitoring of the Flathead Catfish fishery is important, and identifying a way to estimate night-angling effort and harvest is a priority.

Angler effort, catch, and harvest estimates from this creel survey are conservative for multiple reasons. First, some amount of shore angling effort occurs at locations other than the discrete public access sites that were visited by creel clerks and therefore not all shore angling effort was accounted for. Secondly, the creel survey was limited to daylight hours and therefore knowingly excluded effort, catch, and harvest by night anglers, which are commonly targeting Flathead Catfish and likely have greater success than daytime anglers. Lastly, flood conditions during late-May and early-June and low water levels during late-August through October provided less than ideal conditions for Minnesota River anglers and likely resulted in less angler effort, catch, and harvest than during a more typical year. Low water conditions during the latter part of the creel survey likely had the greatest impact on boat anglers within the upper two reaches of the river where few boat ramps remained usable and boat navigation was extremely challenging.

During the 2022 creel survey, creel clerks asked anglers questions about their angling avidity and interest in catfishing. These questions were asked in hopes of evaluating the influence of angling avidity and angling specialization on angling success (e.g., Are anglers that fish more frequently better at catching fish and are anglers that primarily fish for catfish better at catching catfish?). Unfortunately, the number of angler interviews completed were insufficient for performing robust evaluations.

Design of the 2022 Minnesota River creel survey was generally effective, and the implementation of several novel ideas helped improve the survey. For instance, the use of online surveys and survey cards placed on windshields of vehicles with empty trailers proved extremely valuable for augmenting completed trip boat angler interviews. Survey cards handed to anglers during incomplete trip interviews did provide additional useful information about Minnesota River anglers but may not have been worth the extra effort and cost given the relatively low response rate of around 10%. Therefore, future Minnesota River creel surveys should primarily utilize “windshield” survey cards. However, creel clerks were frequently unable to complete angler interviews because of language barrier issues and creating “incomplete trip” survey cards in different languages might be an effective approach for increasing participation in the angler surveys. Lastly, novel methods for estimating angling effort, catch, and harvest by night anglers should be considered for future creel surveys.

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Figures

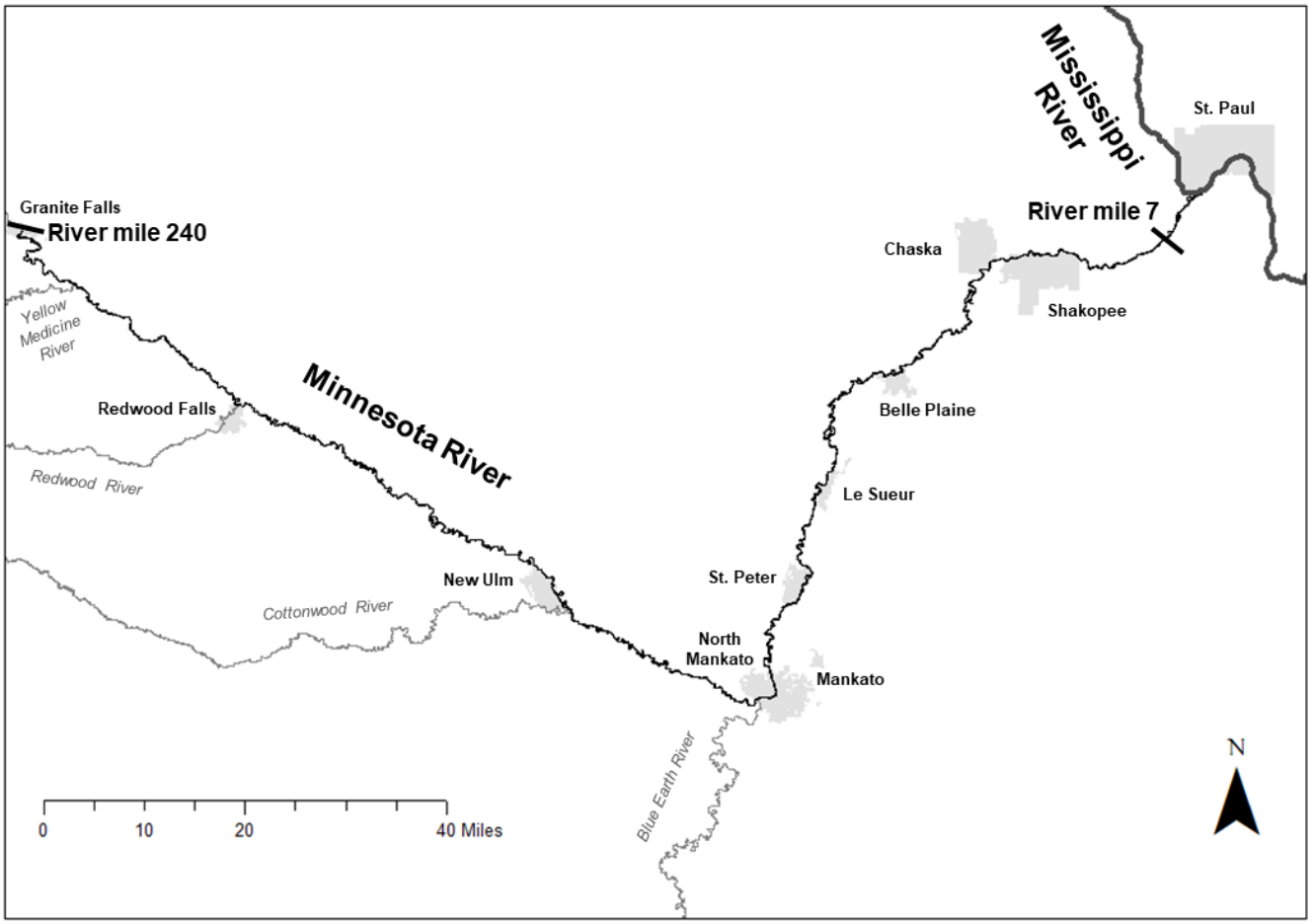

Figure 1. The reach of the Minnesota River (river mile 7 to river mile 240) included in the 2022 creel survey. Larger tributaries and select cities are displayed for reference.

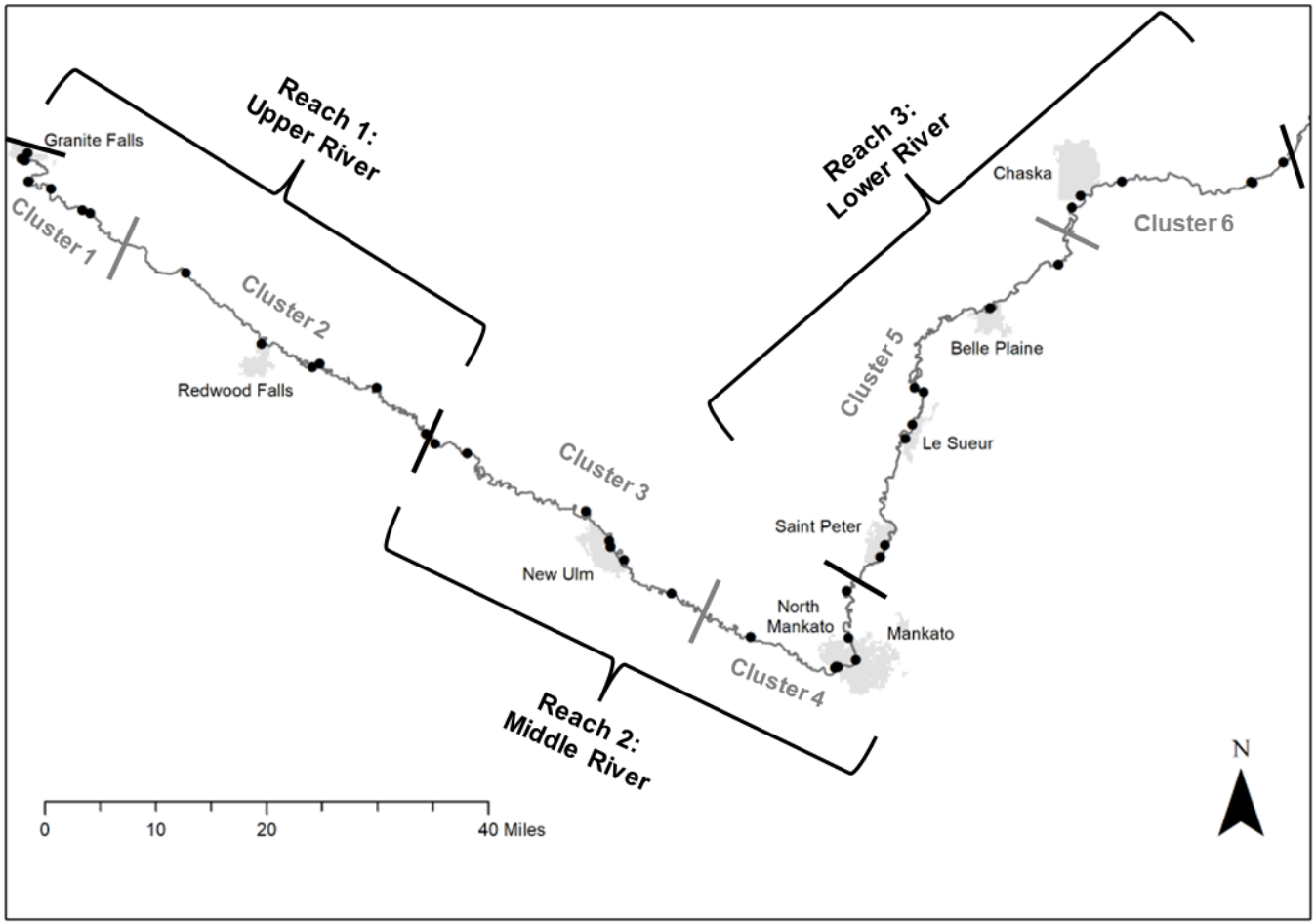

Figure 2. The Minnesota River was stratified into three study reaches and six clusters for the 2022 creel survey. Black circles represent discrete survey stations.

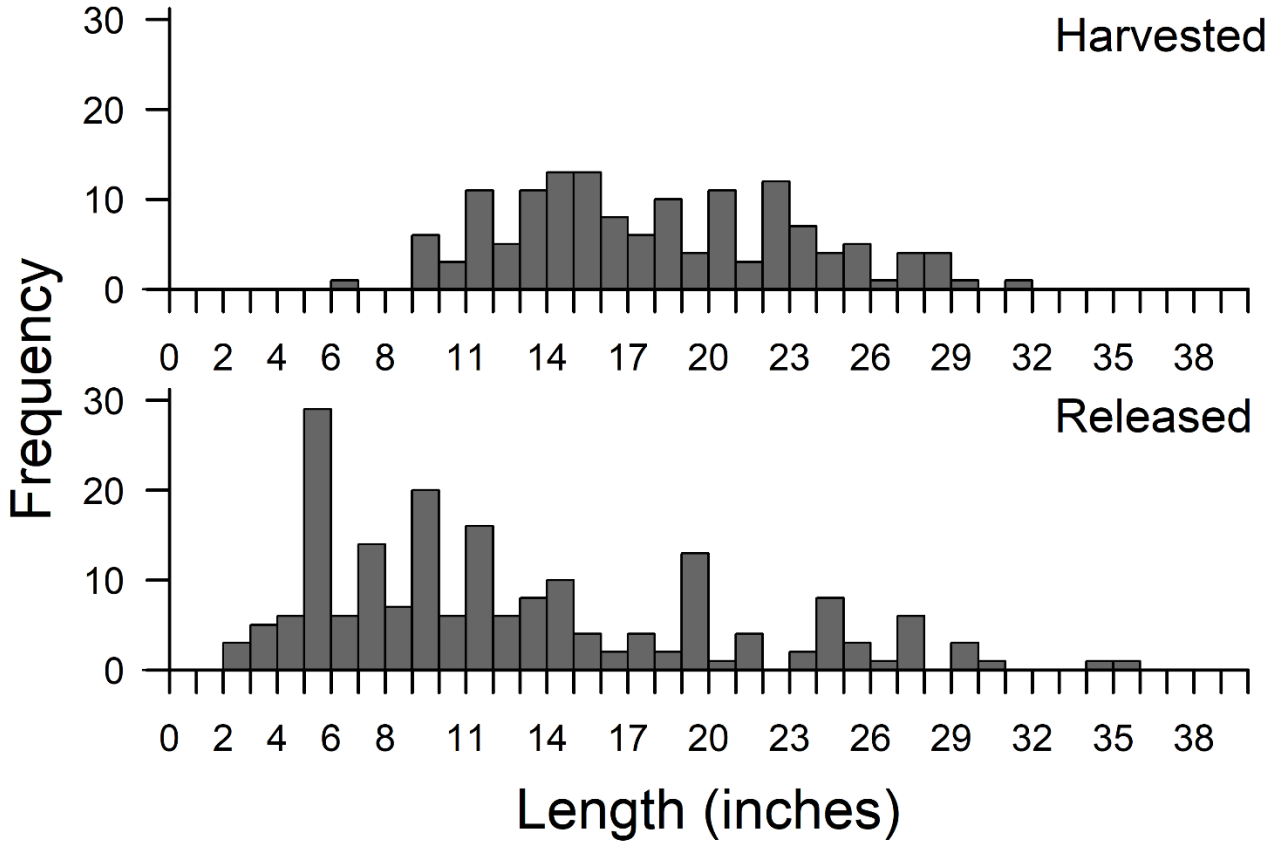

Figure 3. Length frequency histogram of harvested Channel Catfish measured by creel clerks and released Channel Catfish (lengths estimated by anglers).

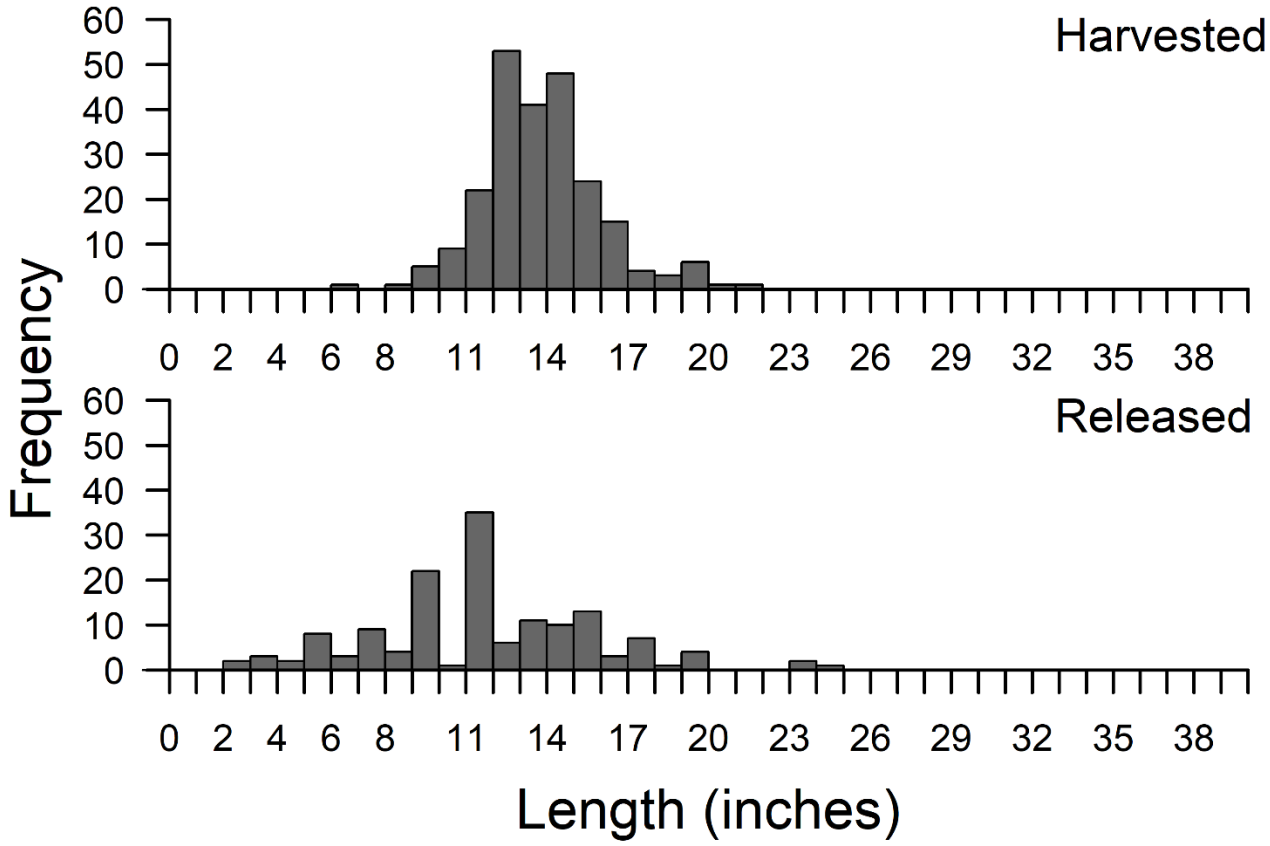

Figure 4. Length frequency histogram of harvested Freshwater Drum measured by creel clerks and released Freshwater Drum (lengths estimated by anglers).

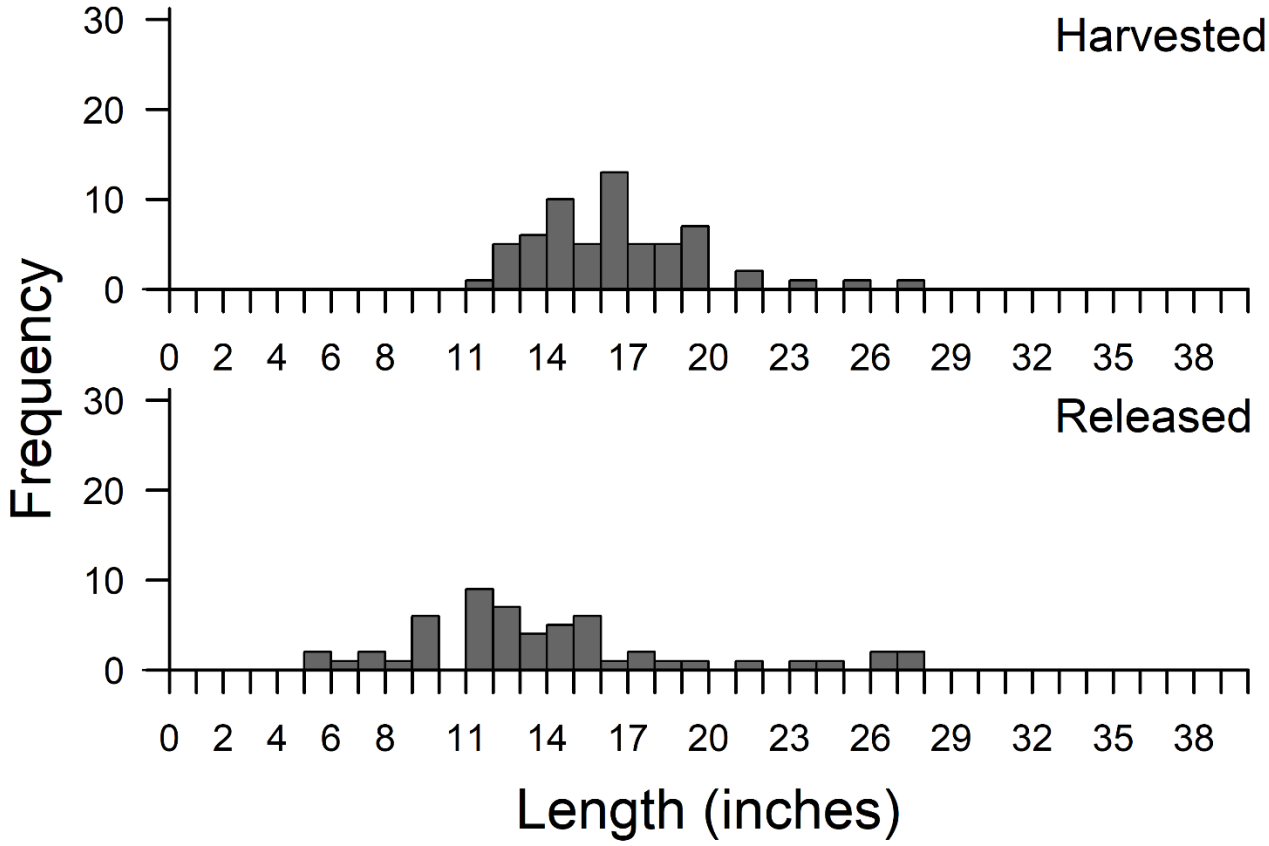

Figure 5. Length frequency histogram of harvested Walleye measured by creel clerks and released Walleye (lengths estimated by anglers).

Tables

Table 1. Creel shifts by month and the number of days sampled within each month, cluster, and day type stratum. The weekend stratum includes holidays. During June and July, the morning creel shift started a half hour later and the evening creel shift ended a half hour earlier for clusters 1 and 2.

		Creel shifts				Days sampled by cluster					
Month	Daylight hours	Morning	Evening	Day type	Days in stratum	1	2	3	4	5	6
May (4/24–5/31)	15	7:30–14:00	14:00–20:30	Weekday	24	4	5	5	4	4	5
				Weekend	11	5	5	4	5	5	5
June (6/1–6/28)	16	7:00–14:00	14:00–21:00	Weekday	20	4	4	4	4	4	4
				Weekend	8	3	4	3	4	3	4
July (6/29–7/26)	15.5	7:00–14:00	14:00–21:00	Weekday	19	4	3	3	4	3	3
				Weekend	9	4	4	4	4	4	4
August (7/27–8/30)	14	7:30–14:00	14:00–20:30	Weekday	25	5	5	5	5	5	5
				Weekend	10	5	5	5	5	5	5
September (8/31–9/27)	12.5	7:30–13:30	13:30–19:30	Weekday	19	3	4	3	4	4	4
				Weekend	9	4	4	4	4	4	4
October (9/28–10/31)	11	7:30–13:00	13:00–18:30	Weekday	24	5	5	6	4	4	5
				Weekend	10	5	5	5	5	4	5

Table 2. The number of interviews conducted by creel clerks and the number of anglers represented for each interview type.

Type	Accepted interviews	Anglers represented
Not fishing	109	NA
Shore anglers	1,034	1,460
Motorized watercraft anglers	136	270
Non-motorized watercraft anglers	8	10
All anglers	1,178	1,740

Table 3. Survey card response rates and response types.

				Response type		
Survey card type	n	Responses	Response rate (%)	Online survey	Voicemail	Email
Incomplete interview	827	85	10.3	53	14	18
Windshield	759	129	17.0	116	13	NA
Combined	1586	214	13.5	169	27	18

Table 4. Total interviews completed by creel clerks and the number of shore angler and watercraft angler surveys used to estimate catch (C) and harvest (H) for each reach of the Minnesota River. Total interviews completed includes interviews conducted outside of the official creel hours, interviews of non-anglers, interviews of shore anglers fishing for less than 30 minutes, and incomplete trip interviews of watercraft anglers. The low number of completed trip watercraft interviews were supplemented with survey card responses from watercraft anglers.

Reach	Spring	Summer	Fall
Total interviews completed			
1	177	190	84
2	129	221	88
3	121	76	92
Shore interviews used for C&H estimates			
1	51	134	47
2	46	80	47
3	74	41	66
Watercraft interviews used for C&H estimates			
1–2	26	30	6
3	35	37	14

Table 5. Proportion of motorized and non-motorized (e.g., canoes, kayaks) watercrafts that were angling among Minnesota River reaches and seasons. Proportion angling was calculated as the number of interviewed watercrafts that were angling divided by the total number of watercrafts interviewed.

	Spring			Summer			Fall		
Reach	Proportion angling	SE	n	Proportion angling	SE	n	Proportion angling	SE	n
Motorized watercrafts									
1–2	93.0	3.8	43	81.0	6.1	42	72.7	14.1	11
3	90.5	6.6	21	78.1	7.4	32	100.0	0.0	10
Non-motorized watercrafts									
1–3	11.1	7.6	18	5.2	2.9	58	16.7	9.0	18

Table 6. Mean number of anglers (party size) fishing from watercrafts (motorized and non-motorized combined) among Minnesota River reaches and seasons. Mean party size was estimated using all boat angler interviews and survey card responses.

	Spring			Summer			Fall		
Reach	Mean party size	SE	n	Mean party size	SE	n	Mean party size	SE	n
1–2	2.1	0.1	61	1.8	0.1	63	1.7	0.2	15
3	2.0	0.2	48	1.9	0.1	52	1.6	0.1	21

Table 7. Mean angler effort (SE) by season, reach, and angler type.

	Spring			Summer			Fall			Total		
Reach	Shore	Boat	Total	Shore	Boat	Total	Shore	Boat	Total	Shore	Boat	Total
1	6,858 (1,478)	2,615 (560)	9,473 (1,581)	14,397 (2,024)	2,634 (565)	17,032 (2,102)	3,902 (750)	775 (312)	4,677 (812)	25,157 (2,616)	6,025 (855)	31,182 (2,752)
2	3,761 (978)	3,927 (1,143)	7,688 (1,504)	6,570 (880)	3,076 (518)	9,646 (1,021)	3,366 (662)	487 (163)	3,853 (682)	13,697 (1,473)	7,490 (1,265)	21,187 (1,942)
3	4,586 (1,035)	11,578 (2,475)	16,164 (2,683)	2,861 (579)	12,067 (2,117)	14,928 (2,194)	3,712 (402)	4,290 (539)	8,002 (672)	11,159 (1,252)	27,935 (3,301)	39,094 (3,531)
Total	15,205 (2,052)	18,120 (2,783)	33,325 (3,458)	23,828 (2,282)	17,777 (2,251)	41,606 (3,206)	10,980 (1,078)	5,552 (644)	16,532 (1,255)	50,013 (3,253)	41,451 (3,637)	91,463 (4,880)

Table 8. Mean angler effort (SE) by month, cluster, and angler type.

	May		June		July		August		September		October	
Cluster	Shore	Boat	Shore	Boat	Shore	Boat	Shore	Boat	Shore	Boat	Shore	Boat
1	3,687 (1,191)	202 (132)	2,155 (774)	84 (84)	5,026 (807)	329 (183)	4,718 (1,272)	272 (131)	1,357 (580)	0 (0)	1,030 (184)	167 (144)
2	552 (346)	949 (504)	464 (215)	1,380 (188)	2,722 (929)	1,167 (432)	1,932 (982)	865 (288)	1,022 (380)	497 (270)	493 (219)	111 (60)
3	619 (395)	1,235 (653)	869 (527)	818 (317)	1,910 (456)	1,110 (346)	1,442 (542)	482 (150)	810 (156)	158 (38)	374 (146)	62 (59)
4	1,137 (640)	1,111 (875)	1,136 (335)	763 (119)	1,496 (324)	789 (190)	1,772 (410)	695 (300)	1,038 (284)	206 (141)	1,144 (558)	62 (39)
5	807 (176)	1,258 (524)	960 (406)	3,241 (728)	447 (276)	2,504 (1,120)	910 (402)	1,335 (361)	281 (169)	602 (184)	913 (239)	248 (90)
6	1,731 (850)	2,696 (933)	1,088 (393)	4,383 (2,110)	650 (165)	3,841 (1,107)	854 (264)	4,387 (1,368)	569 (173)	2,362 (464)	1,949 (213)	1,079 (181)
Total	8,533 (1,690)	7,452 (1,615)	6,672 (1,164)	10,669 (2,267)	12,250 (1,389)	9,741 (1,690)	11,578 (1,810)	8,037 (1,487)	5,077 (803)	3,824 (587)	5,903 (719)	1,728 (265)

Table 9. Estimated total catch among angler type (shore or boat), seasons, and Minnesota River reaches.

	Spring			Summer			Fall			Combined
Reach	Shore	Boat	Total	Shore	Boat	Total	Shore	Boat	Total	Total
1	7,108	1,023	8,131	6,561	708	7,269	1,938	85	2,023	17,423
2	1,561	1,536	3,098	3,881	826	4,707	1,988	53	2,041	9,846
3	1,369	4,812	6,182	1,151	6,014	7,165	2,556	2,280	4,837	18,183
1–3	10,039	7,372	17,411	11,593	7,548	19,141	6,482	2,419	8,900	45,452

Table 10. Estimated catches by species among angler type (shore or boat), seasons, and Minnesota River reaches.

	Spring			Summer			Fall			Combined
Reach	Shore	Boat	Total	Shore	Boat	Total	Shore	Boat	Total	Total
Channel Catfish										
1	1,737	161	1,898	2,724	382	3,106	749	13	762	5,765
2	790	241	1,031	1,539	446	1,985	1,077	8	1,085	4,101
3	302	1,001	1,303	429	4,179	4,608	313	485	798	6,709
1–3	2,829	1,402	4,231	4,692	5,007	9,699	2,139	506	2,645	16,576
Common Carp										
1	457	0	457	206	0	206	171	0	171	834
2	45	0	45	164	0	164	131	0	131	340
3	232	405	637	31	44	75	439	0	439	1,150
1–3	735	405	1,140	400	44	445	740	0	740	2,325
Flathead Catfish										
1	231	18	248	192	124	316	33	46	79	644
2	0	27	27	299	145	445	0	29	29	500
3	40	0	40	11	133	144	32	49	81	265
1–3	271	45	315	503	402	905	65	123	188	1,409
Freshwater Drum										
1	2,277	113	2,390	2,624	74	2,698	525	26	551	5,639
2	249	170	419	956	86	1,043	454	16	471	1,932
3	523	691	1,214	380	730	1,110	1,040	631	1,671	3,994
1–3	3,049	974	4,023	3,960	890	4,851	2,019	673	2,693	11,566
Shovelnose Sturgeon										
1	90	36	125	0	9	9	0	0	0	134
2	210	54	263	82	10	93	248	0	248	604
3	181	0	181	0	88	88	237	0	237	507
1–3	481	89	570	82	108	190	485	0	485	1,245
Walleye & Sauger										
1	972	678	1,650	170	47	218	287	0	287	2,155
2	173	1,018	1,191	494	55	549	18	0	18	1,758
3	0	1,763	1,763	108	420	528	396	970	1,366	3,657
1–3	1,145	3,459	4,604	772	523	1,294	701	970	1,671	7,570

Table 11. Estimated total harvest by angler type (shore or boat), season, and Minnesota River reach.

	Spring			Summer			Fall			Combined
Reach	Shore	Boat	Total	Shore	Boat	Total	Shore	Boat	Total	Total
1	3,090	375	3,465	3,619	133	3,752	424	0	424	7,641
2	364	563	927	470	156	626	233	0	233	1,786
3	155	1,048	1,204	104	663	767	1,013	291	1,304	3,275
1–3	3,610	1,986	5,596	4,193	952	5,145	1,669	291	1,961	12,701

Table 12. Estimated harvest by species among angler type (shore or boat), seasons, and Minnesota River reaches.

	Spring			Summer			Fall			Combined
Reach	Shore	Boat	Total	Shore	Boat	Total	Shore	Boat	Total	Total
Channel Catfish										
1	754	24	778	1,444	80	1,524	69	0	69	2,371
2	286	36	321	167	93	260	123	0	123	705
3	11	24	35	0	619	619	29	0	29	683
1–3	1,050	83	1,134	1,611	792	2,404	222	0	222	3,759
Common Carp										
1	9	0	9	48	0	48	8	0	8	65
2	0	0	0	86	0	86	32	0	32	119
3	0	238	238	0	22	22	48	0	48	309
1–3	9	238	247	135	22	157	88	0	88	492
Flathead Catfish										
1	231	12	242	0	15	15	33	0	33	290
2	0	18	18	0	17	17	0	0	0	35
3	23	0	23	0	0	0	0	0	0	23
1–3	253	30	283	0	32	32	33	0	33	349
Freshwater Drum										
1	1,510	107	1,617	1,774	0	1,774	170	0	170	2,562
2	56	161	217	0	0	0	0	0	0	217
3	96	95	191	90	0	90	659	0	659	940
1–3	1,662	363	2,025	1,864	0	1,864	829	0	829	4,719
Shovelnose Sturgeon										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
1–3	0	0	0	0	0	0	0	0	0	0
Walleye & Sauger										
1	411	226	637	161	38	200	130	0	130	967
2	23	339	362	217	45	261	18	0	18	642
3	0	667	667	13	22	36	257	291	548	1,251
1–3	434	1,233	1,666	391	106	497	405	291	696	2,859

Table 13. Relative catch and harvest per river mile and per acre.

	Per mile		Per acre	
	Catch	Harvest	Catch	Harvest
Channel Catfish	71.1	16.1	2.1	0.5
Common Carp	10.0	2.1	0.3	0.1
Flathead Catfish	6.0	1.5	0.2	0.0
Freshwater Drum	49.6	20.3	1.4	0.6
Shovelnose Sturgeon	5.3	0.0	0.2	0.0
Walleye & Sauger	32.5	12.3	0.9	0.4

Table 14. Mean lengths of harvested fish measured by creel clerks and mean lengths of released fish estimated by interviewed anglers.

	Mean length (inches)	
Species	Released	Harvested
Channel Catfish	13.2	17.9
Common Carp	21.9	23.5
Flathead Catfish	29.4	21.3
Freshwater Drum	12.1	13.8
Walleye	14.5	16.6

Table 15. Mean shore angler catch rates (catch per hour; CPH) and harvest rates (harvest per hour; HPH) among seasons and Minnesota River reaches.

	CPH									HPH					
	Spring			Summer			Fall			Spring		Summer		Fall	
Reach	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	Mean	SE	Mean	SE
All species															
1	1.04	0.17	51	0.46	0.06	134	0.50	0.12	47	0.45	0.13	0.25	0.05	0.11	0.05
2	0.42	0.11	46	0.59	0.11	80	0.57	0.16	47	0.10	0.05	0.07	0.03	0.05	0.03
3	0.30	0.07	75	0.40	0.09	41	0.69	0.18	66	0.03	0.02	0.04	0.03	0.27	0.13
Channel Catfish															
1	0.25	0.10	51	0.19	0.03	134	0.19	0.09	47	0.11	0.08	0.10	0.03	0.02	0.01
2	0.21	0.07	46	0.23	0.06	80	0.32	0.15	47	0.08	0.05	0.03	0.02	0.04	0.03
3	0.07	0.03	75	0.15	0.04	41	0.08	0.03	66	0.00	0.00	0.00	0.00	0.01	0.01
Common Carp															
1	0.07	0.04	51	0.01	0.01	134	0.04	0.03	47	0.00	0.00	0.00	0.00	0.00	0.00
2	0.01	0.01	46	0.02	0.02	80	0.04	0.02	47	0.00	0.00	0.01	0.01	0.01	0.01
3	0.05	0.03	75	0.01	0.01	41	0.12	0.10	66	0.00	0.00	0.00	0.00	0.01	0.01
Flathead Catfish															
1	0.03	0.03	51	0.01	0.01	134	0.01	0.01	47	0.03	0.03	0.00	0.00	0.01	0.01
2	0.00	0.00	46	0.05	0.03	80	0.00	0.00	47	0.00	0.00	0.00	0.00	0.00	0.00
3	0.01	0.01	75	0.00	0.00	41	0.01	0.01	66	0.01	0.01	0.00	0.00	0.00	0.00
Freshwater Drum															
1	0.33	0.09	51	0.18	0.04	134	0.13	0.05	47	0.22	0.09	0.12	0.03	0.04	0.03
2	0.07	0.04	46	0.15	0.05	80	0.13	0.06	47	0.01	0.01	0.00	0.00	0.00	0.00
3	0.11	0.04	75	0.13	0.04	41	0.28	0.13	66	0.02	0.01	0.03	0.03	0.18	0.13
Shovelnose Sturgeon															
1	0.01	0.01	51	0.00	0.00	134	0.00	0.00	47	0.00	0.00	0.00	0.00	0.00	0.00
2	0.06	0.04	46	0.01	0.01	80	0.07	0.03	47	0.00	0.00	0.00	0.00	0.00	0.00
3	0.04	0.02	75	0.00	0.00	41	0.06	0.04	66	0.00	0.00	0.00	0.00	0.00	0.00
Walleye & Sauger															
1	0.14	0.06	51	0.01	0.01	134	0.07	0.04	47	0.06	0.03	0.01	0.01	0.03	0.03
2	0.05	0.03	46	0.08	0.04	80	0.01	0.01	47	0.01	0.01	0.03	0.02	0.01	0.01
3	0.00	0.00	75	0.04	0.02	41	0.11	0.04	66	0.00	0.00	0.00	0.00	0.07	0.03

Table 16. Mean boat angler catch rates (catch per hour; CPH) and harvest rates (harvest per hour; HPH) among seasons and Minnesota River reaches.

	CPH									HPH					
	Spring			Summer			Fall			Spring		Summer		Fall	
Reach	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	Mean	SE	Mean	SE
All species															
1–2	0.39	–	26	0.27	0.06	30	0.11	0.09	6	0.14	0.03	0.05	–	0.00	–
3	0.42	0.04	35	0.50	0.07	37	0.53	–	14	0.09	–	0.05	0.01	0.07	0.02
Channel Catfish															
1–2	0.06	0.01	26	0.14	0.03	30	0.02	0.01	6	0.01	0.00	0.03	–	0.00	–
3	0.09	0.01	35	0.35	0.02	37	0.11	–	14	0.00	–	0.05	0.01	0.00	–
Common Carp															
1–2	0.00	–	26	0.00	–	30	0.00	–	6	0.00	–	0.00	–	0.00	–
3	0.03	–	35	0.00	–	37	0.00	–	14	0.02	–	0.00	0.00	0.00	–
Flathead Catfish															
1–2	0.01	0.00	26	0.05	0.01	30	0.06	0.04	6	0.00	0.00	0.01	0.00	0.00	–
3	0.00	–	35	0.01	0.00	37	0.01	0.00	14	0.00	–	0.00	–	0.00	–
Freshwater Drum															
1–2	0.04	0.01	26	0.03	0.01	30	0.03	0.03	6	0.04	0.01	0.00	–	0.00	–
3	0.06	0.01	35	0.06	0.01	37	0.15	0.01	14	0.01	0.00	0.00	–	0.00	–
Shovelnose Sturgeon															
1–2	0.01	0.00	26	0.00	0.00	30	0.00	–	6	0.00	–	0.00	–	0.00	–
3	0.00	–	35	0.01	0.00	37	0.00	–	14	0.00	–	0.00	–	0.00	–
Walleye & Sauger															
1–2	0.26	–	26	0.02	–	30	0.00	–	6	0.09	0.01	0.01	–	0.00	–
3	0.15	0.01	35	0.03	–	37	0.23	0.06	14	0.06	0.00	0.00	–	0.07	0.02

Table 17. Catch rates of targeted species by angler type and season.

	Targeting CPH											
	Spring			Summer			Fall			Combined		
Angler Type	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n
Channel Catfish												
Shore	0.24	0.06	66	0.28	0.05	108	0.36	0.12	60	0.29	0.04	234
Boat	0.13	–	17	0.28	0.03	39	0.13	–	6	0.23	0.02	62
Flathead Catfish												
Shore	0.01	0.01	67	0.04	0.03	102	0.02	0.02	41	0.03	0.01	210
Boat	0.00	0.00	11	0.04	0.01	36	0.05	0.03	6	0.04	0.01	53
Walleye												
Shore	0.23	0.10	26	0.27	0.10	32	0.17	0.05	62	0.21	0.04	120
Boat	0.29	–	42	0.31	0.09	13	0.41	0.16	10	0.30	–	65

Table 18. Percent of anglers targeting specific species by angler type, Minnesota River reach, month, and combined.

		Angler type		Reach			Month					
Species	Combined	Boat	Shore	1	2	3	May	June	July	Aug.	Sept.	Oct.
Catfish	50	–	–	–	–	–	–	–	–	–	–	–
Channel Catfish	43	50	40	37	49	42	42	37	49	45	46	26
Flathead Catfish	39	51	36	41	42	33	30	40	48	43	49	10
No particular species	27	6	33	37	20	18	26	26	29	28	23	26
Walleye	23	37	19	13	31	29	31	25	10	18	25	50
Freshwater Drum	5	2	6	10	2	0	8	4	5	6	3	5
Common Carp	4	4	4	3	5	6	9	3	4	2	3	5

Table 19. Minnesota River angler ages by age-group.

Age-group	Percent of anglers
<16	3
16–29	26
30–39	23
40–49	16
50–59	9
60–69	6
>60	3

Table 20. Angling avidity of Minnesota River anglers based on the number of days fished during the previous year.

Days fished	Percent
0–5	21
6–25	29
26–50	21
51–100	17
101–200	9
>200	3

Table 21. Minnesota River angling avidity based on the number of days fished on the Minnesota River during the previous year.

Days fished Minnesota River	Percent
0–5	54
6–25	28
26–50	10
51–100	6
101–200	2
>200	0

Table 22. Proportion of fishing trips that Minnesota River anglers take to the Minnesota River.

Percent fished Minnesota River	Percent
0–10	24
11–25	17
26–50	23
51–75	11
>75	25

Table 23. Percent of fishing trips that Minnesota River anglers target catfish.

Catfishing trip percent	Percent
0	29
1–20	23
21–50	17
51–80	13
>80	18

Table 24. Comparison of results between two Minnesota River creel surveys (Chapman 2001) and the 2015 Red River of the North creel survey (Wendel 2016).

	Minnesota River		Red River
	1998 Creel Survey	2022 Creel Survey	2015 Creel Survey
		Survey details	
Study reach	110 miles	233 miles	400 miles
Duration	May–July, Sept.–Oct.	May–Oct.	May–Sept.
		Angler effort	
Total angler effort	49,311 hours	91,463 hours	88,860 hours
Relative effort	448 hours/mile	393 hours/mile	222 hours/mile
Shore angling	77%	55%	47%
		Species targeted	
Catfish	72%	50%	67%
Channel Catfish	63%	43%	67%
Flathead Catfish	57%	39%	NA
Freshwater Drum	1%	5%	<1%
No particular species	15%	27%	20%
Walleye/Sauger	24%	23%	12%
		Catch rates	
Channel Catfish	0.15/hour	0.18/hour	0.44/hour
Flathead Catfish	0.03/hour	0.02/hour	NA
Freshwater Drum	0.07/hour	0.13/hour	0.03/hour
Walleye/Sauger	0.03/hour	0.08/hour	0.08/hour
		Harvest	
Channel Catfish relative harvest	25.0/mile	16.1/mile	17.2/mile
Flathead Catfish relative harvest	6.0/mile	1.5/mile	NA
Freshwater Drum relative harvest	7.8/mile	20.3/mile	1.3/mile
Walleye/Sauger relative harvest	8.1/mile	12.3/mile	4.2/mile
Percent of caught fish harvested	31%	28%	18%

Table 25. Comparison of creel survey results between the Minnesota River and several other riverine fisheries in Minnesota (Gorton 1997; Altena 2008; Meerbeek 2008; Varian and Hendrickson 2016).

	Minnesota River	St. Louis River Estuary	Mississippi River Pool 2	Mississippi River Pool 2	Mississippi River (St. Cloud to Coon Rapids)	Mississippi River Pool 4 (including Lake Pepin)	Mississippi River Pool 4 (including Lake Pepin)
Survey details							
Creel survey year	2022	2015	1996	1997	2007	2006	2007
Duration	May–Oct.	May–Sept.	April–Oct.	April–Oct.	May–Sept.	Open water	Open water
Acres	8,000	11,500	10,524	10,524	4,922	39,255	39,255
Angler effort							
Total angler effort (hours)	91,463	118,849	94,699	66,926	118,469	571,048	502,884
Relative effort (hours/acre)	11.4	10.3	9.0	6.4	24.1	14.5	12.8
Catch rate (catch/hour)							
Channel Catfish	0.18	0.04	0.07	0.07	0.06	0.03	0.03
Flathead Catfish	0.02	NA	<0.01	<0.01	NA	<0.01	<0.01
Freshwater Drum	0.13	NA	0.12	0.11	NA	0.20	0.17
Walleye/Sauger	0.08	0.26	0.18	0.23	0.01	0.48	0.38
Targeted catch rate (catch/hour)							
Channel Catfish	0.26	0.26	0.21	0.13	0.29	0.10	0.30
Walleye/Sauger	0.27	0.33	0.30	0.56	0.05	–	–
Relative harvest (harvest/acre)							
Channel Catfish	0.47	0.04	0.08	0.06	0.44	0.11	0.04
Flathead Catfish	0.04	NA	<0.01	<0.01	NA	<0.01	<0.01
Freshwater Drum	0.59	NA	0.13	0.07	NA	0.11	0.04
Walleye/Sauger	0.36	0.81	0.00	0.00	0.20	1.82	1.39

Table 26. Comparison of creel survey results between the Minnesota River, several lake fisheries within MNDNR southern region (Anderson 2017; Coahran 2017; Eder 2017; Stevens 2020), and three of the states "large lakes" (Pederson and Schultz 2020; Heinrich 2021; Kennedy 2022).

Lake (county)	Year	Duration	Acres	Total angler effort (hours)	Relative effort (hours/acre)	Walleye catch/hour	Targeted Walleye catch/hour	Walleye harvest/acre
Minnesota River								
Minnesota River	2022	May–Oct.	8,000	91,463	11.4	0.08	0.3	0.36
MNDNR Southern Region Lakes								
Big Stone (Big Stone)	2016	May–Oct.	12,610	106,812	8.5	0.11	0.4	0.29
Cedar (Rice)	2016	May–Oct.	804	29,926	37.2	0.00	<0.1	0.05
Green (Kandiyohi)	2015	May–Sept.	5,406	35,499	6.6	0.16	0.3	0.68
Madison (Blue Earth)	2019	May–Oct.	1,446	48,867	33.8	0.08	0.2	1.24
Mazaska (Rice)	2016	May–Oct.	685	28,316	41.3	0.11	0.3	0.30
Stella (Meeker)	2019	May–Sept.	599	6,116	10.2	0.03	0.1	0.15
Washington (Meeker)	2019	May–Sept.	2,438	9,929	4.1	0.00	<0.01	0.01
MNDNR Large Lakes								
Leech Lake (Cass)	2019	May–Sept.	112,000	864,001	7.7	0.20	–	0.74
Mille Lacs (Aitkin)	2020	May–Oct.	132,516	739,692	5.6	0.54	0.9	0.00
Upper Red Lake (Beltrami)	2021	May–Sept.	48,000	130,817	2.7	0.58	0.6	0.75

Appendix A. Map of Minnesota River survey stations

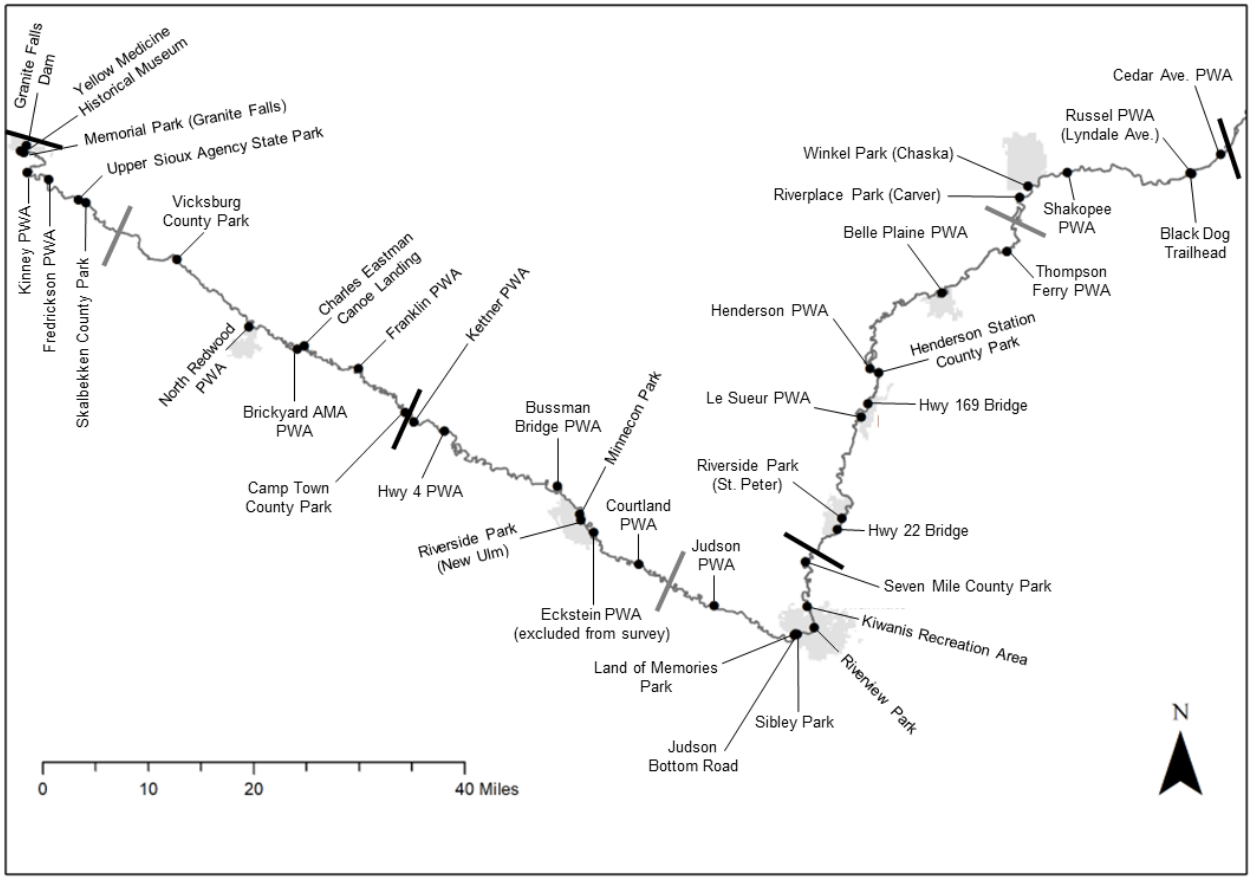

Figure 6. Map of discrete survey stations visited by creel clerks during the 2022 Minnesota River creel survey. Black and gray bars represent the boundaries of study reaches and clusters. The Eckstein Public Water Access (PWA) station was excluded from the creel survey because of road construction preventing access.

Appendix B. Creel clerk interview form and script

Creel clerks were instructed to generally follow the below instructions and script when conducting angler interviews and filling out the "interview form" (Figure 7) during the 2022 Minnesota River creel survey:

*Before the interview starts, fill out the following fields: Interview #, Date, Cluster, Site, Clerk Initials, Interview Time, Angler Type, Trip Status (if obvious), and Fishing (if obvious). **If Fishing = NO, end interview*

Approach an individual shore angler or boating party and start the interview with a friendly introduction, such as:

"Hello, my name is _____ and I work for the Minnesota Department of Natural Resources. We are conducting a survey of Minnesota River anglers and I am wondering if I can ask you some questions?"

Fill out Refused Interview; *if* Refused Interview = YES*, end the interview and thank the interviewee for their time.*

If Trip Status *and/or* Fishing *are not obvious, then start the interview by asking:*

1a. **"Are you fishing today?"** *and fill out* Fishing *field. **If* Fishing = NO*, end the interview*

1b. **"Are you finished fishing for the day?"** *and fill out* Trip Status *field*

1. "**Did you start this fishing trip today?**" *and fill out* Start Date *field*

2. "**What time did you start fishing?**" *and fill out* Start Time *field*

3. "Have you been previously interviewed while fishing the MN River?" *and fill out* Prev. Interviewed

4. "**What fish species were you primarily targeting during this fishing trip?**" *and fill out* Targeting *fields*

(Ask follow-up questions to specify, but species groups or "anything that bites" responses are acceptable)

5. "**May I ask how old you are and what your zip code is?**" *and fill out* Gender*,* Age*, and* Zip *fields*

(For boating parties, ask this for everyone in the group)

6. "**How many days did you fish the Minnesota River during the last 12 months?**" *and record*

7. "**How many days did you fish anywhere during the last 12 months?**" *and record*

8. "**What percent of your open water fishing effort is targeting catfish?**" *and record*

9. "Did you *(for shore anglers)* **or your group** *(for boating parties)* **keep any fish?**

If YES*, proceed to #10. If* NO*, proceed to #11.*

10. "**May I look at and measure the fish you're keeping?**"

If YES*, identify and measure each fish, and fill out the* Species, Kept, *and* Length *fields*

If NO*, ask* **"How many and what species did you keep?"** *and fill out the* Species, Kept, *and* Count *fields*

11. "**Did you** *(for shore anglers)* **or your group** *(for boating parties)* **catch and release any other fish?**"

If YES*, proceed to #12. If* NO*, proceed to #14.*

12. "**How many and what species did you release?**" *and fill out the* Species, Kept, *and* Count *fields*

If time allows, also ask **"How big were the fish you released?"** *and record* Length*s*

13. *For each species caught ask "***Why did you choose to release the fish?**" *and fill out the* Reason *field*

14. *if* Trip Status = Incomplete or Starting*, provide the angler with a* **survey card** *and tell them* ***"*We'd greatly appreciate it if you'd complete a follow up interview online, by email, or by phone*".***

Answer any questions they may have and record the code *in the* Card Code *field.*

15. *End the interview courteously, such as* ***"*Thank you for your time, your participation is greatly appreciated. Please let me know if you have any questions or concerns and have a great day."**

#	Date	Cluster	Site	Clerk	*Interview Time* (24h)	Type
	/ /2022	1–6		initials	:	

**Italicized sections (interview time, trip status, & catch data) NEED to be updated when changing from an incomplete or starting trip status to a completed trip status.*

Shore
Motorboat
Non-motorized

Completed / Incomplete / Starting	*Trip Status*	Fishing	***STOP** here if Fishing = No*	Refused Interview	***STOP** here if Refused = Yes*	Start Date	Start Time (24h)	Previously Interviewed
		Y/N		Y/N		/ /2022	:	Y/N

Species Targeted (ranked)			**WAE** = Walleye **CCF** = Channel Catfish **FCF** = Flathead Catfish **WHB** = White Bass **CAP** = Carp **NOP** = Pike **FRD** = Drum **NPS** = no particular species **Spell out all others**
1.	2.	3.	4.

Angler Data

Gender (M/F/O)	Age	Zip

***REMINDER:** Interview shore anglers individually. Interview boat anglers as a group.*

***REMINDER:** Write additional angler data, catch data, and comments on the back of this form if more space is needed.*

Catch Data

Species	Kept (Y/N)	Length (mm)	Count	Reason
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

C= catch-and-release **S**= too small **B**= too big **I**= illegal **L**= limit full
U= undesirable **D**= don't eat fish **H**= fish aren't safe/healthy to eat **O**= other

Questions

How many days did you fish the MN River during the last 12 months?	
How many days did you fish anywhere during the last 12 months?	
What percent of your open water fishing effort is targeting catfish? (**A** = 0%, **B** = 1-20%, **C** = 20-50%, **D** = 50-80%, **E** = >80%)	

Provide survey card if Trip Status = Incomplete or Starting

Survey Card	Card Code
Y/N	

Figure 7. Image of the survey forms filled out by creel clerks during angler interviews.

Appendix C. Example survey cards

2022 Minnesota River Angler Survey

DEPARTMENT OF NATURAL RESOURCES

The Minnesota Department of Natural Resources is seeking your participation in a survey about your recent trip on the Minnesota River.

Unique code:

MRXXXX

There are two ways to participate in the survey.

1. Take an online survey available at https://forms.office.com/g/u88Jj8vXLe or with the QR code (at the bottom right).

2. Call 1-XXX-XXX-XXXX and leave a voicemail with the following information.
   A. Your name, phone number, and zip code (if willing to share)
   B. The unique code (provided above)
   C. The number of people fishing from the watercraft
   D. The date and time the fishing trip started
   E. How many hours you fished
   F. What species was primarily being targeted
   G. How many and what species were caught
   H. How many and what species were harvested

Thank you! Send questions or concerns to MNRCreel.dnr@state.mn.us

Figure 8. Image of the one-sided survey card placed on vehicle windshields with empty watercraft trailers during the 2022 Minnesota River creel survey.

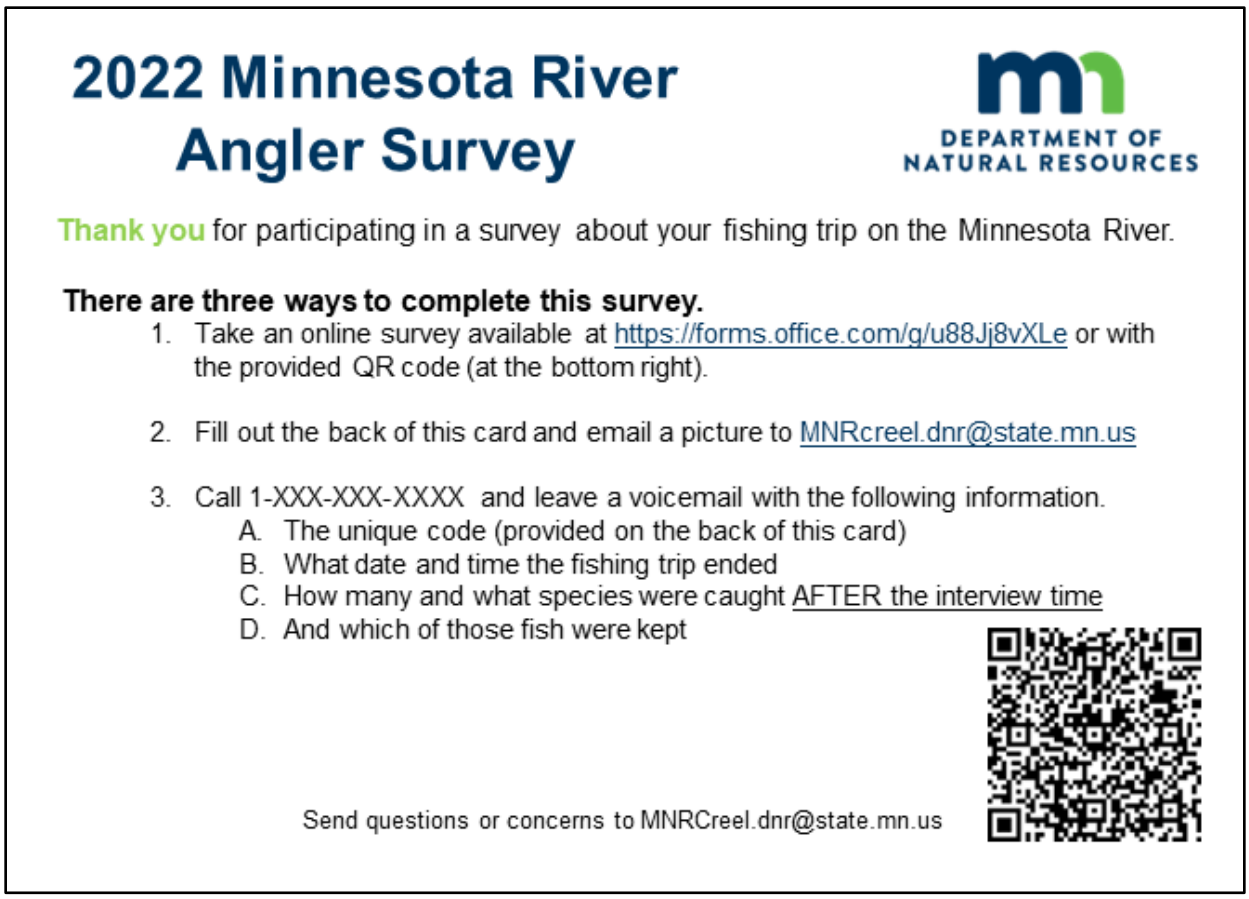

Figure 9. Image of the front side of survey cards provided to Minnesota River anglers during incomplete trip interviews.

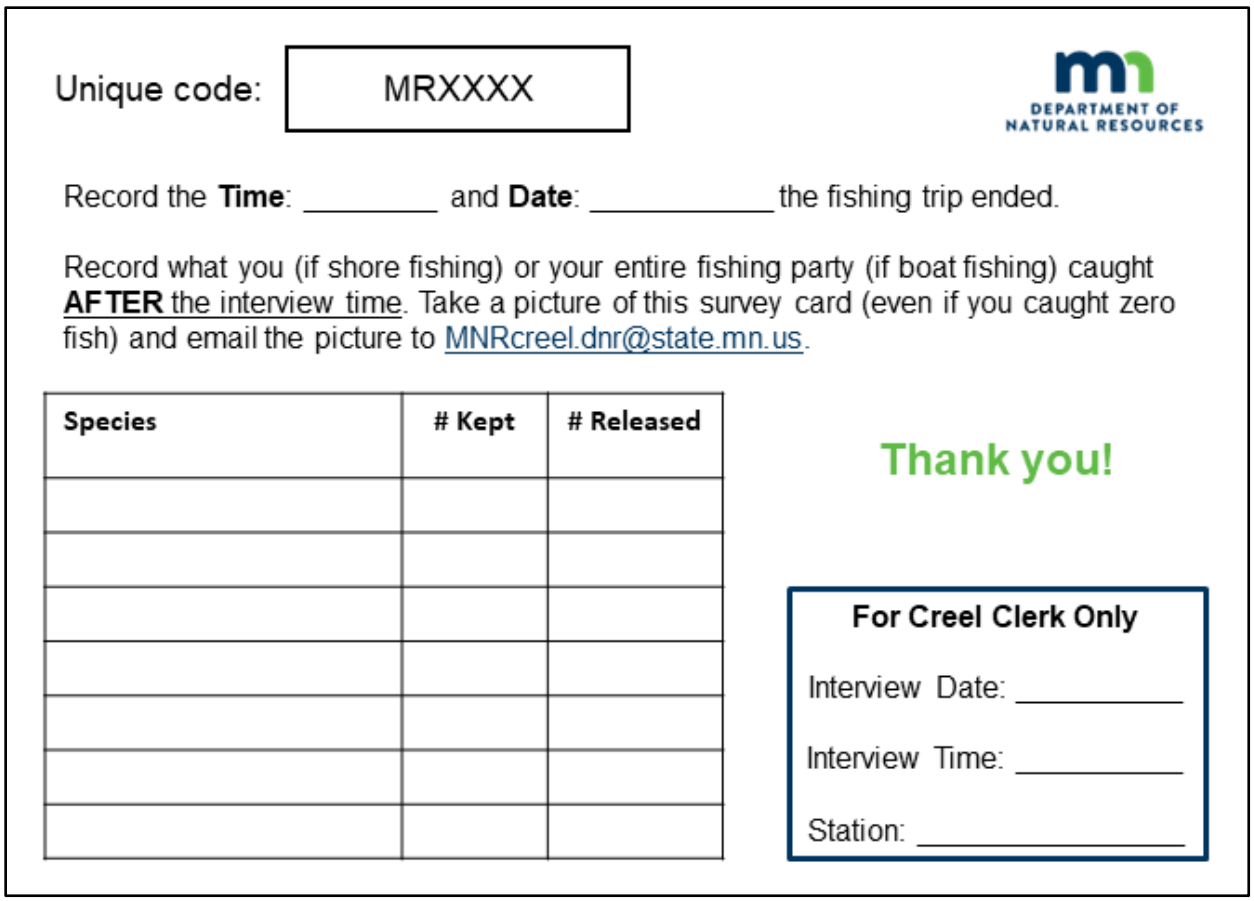

Figure 10. Image of the back side of survey cards provided to Minnesota River anglers during incomplete trip interviews.

Appendix D: Analysis methods and equations

Effort

Shore angling effort was estimated separately for each cluster, month, and day type stratum as the product of the mean daily shore angler count (equation 1), the number of days within the stratum (e.g., 11 weekend or holiday days within May), and the daylight hours within a fishing day for the stratum (e.g., 16 daylight hours during June).

(1) $\bar{a} = \frac{\sum a_i}{n}$

Where:

$\bar{a} =$ mean daily angler count

$a_i =$ daily angler count during creel shift i

$n =$ number of creel shifts in the stratum

Boat angling effort was estimated similarly, except the estimate was based on the mean daily count of empty trailers (and empty canoe racks, etc.) and the mean daily count was first multiplied by the mean proportion of watercrafts that were fishing (equation 2) and the mean party size (i.e., mean number of anglers per fishing watercraft; equation 3).

(2) $F = \frac{w_{fishing}}{w_{interviewed}}$

Where:

$F =$ proportion of watercrafts fishing

$w_{fishing} =$ number of watercrafts interviewed that were fishing

$w_{interviewed} =$ number of all watercrafts interviewed

(3) $\bar{p} = \frac{\sum p_i}{n}$

Where:

$\bar{p} =$ mean party size

$p_i =$ number of anglers in interviewed watercraft i

$n =$ number of fishing watercrafts interviewed in the stratum

The mean proportion of watercrafts that were fishing was estimated separately for motorized watercrafts (upper and middle river reaches were combined) and non-motorized watercrafts (all reaches were combined) based on creel clerk interviews conducted during each season. Mean party size was estimated for each season and reach (although upper and middle reaches were combined) from all interviews of motorized and non-motorized watercrafts combined (including surveys conducted outside “official” creel hours and survey card responses). Angling effort estimated by reach, season, and angler type was calculated by summing effort estimates of individual strata. For example, total angling effort during the spring season was calculated by

summing shore angling effort and boat angling effort estimates from each reach during the months of May and June.

Catch and Harvest

Catch and harvest estimates were calculated by multiplying the mean catch rate or harvest rate of a stratum by the estimated angling effort for the stratum. Mean catch and harvest rates were estimated from the catch, harvest, trip length, and party size reported during each angler interview within a stratum (equation 4).

(4) $CPUE_i = \frac{C_i}{p_i \times t_i}$

Where:

$CPUE_i =$ catch per unit effort or harvest per unit effort (HPUE) of interviewed angler(s) i

$c_i =$ number of fish caught or harvested (h) by interviewed angler(s) i

$p_i =$ party size of interviewed angler(s) i

$t_i =$ the fishing trip length of the interviewed angler(s) i

Mean catch and harvest rates by shore anglers were calculated from incomplete trip (≥ 30 minutes) and completed trip interviews combined using the means of ratios estimator (Jones et al. 1995; Hoenig et al. 1997; Pollock et al. 1997; Wendel 2016; equation 5).

(5) $\overline{CPUE_s} = \frac{\sum CPUE_i}{n}$

Where:

$\overline{CPUE_s} =$ mean shore angler catch per unit effort or harvest per unit effort (HPUE)

$CPUE_i =$ catch per unit effort or harvest per unit effort (HPUE)of interviewed shore angler(s) i

$n =$ numer of shore angler interviews

Mean catch and harvest rates by boat anglers were calculated from completed trip interviews using the ratio of means estimator (Jones et al. 1995; Pollock et al. 1997; equation 6). Survey card responses from boat anglers were included in these analyses to augment small sample sizes within each stratum.

(6) $\overline{CPUE_b} = \sum c_i \Big/ \sum (p_i \times t_i)$

Where:

$\overline{CPUE_b} =$ mean boat angler catch per unit effort or harvest per unit effort (HPUE)

$c_i =$ number of fish caught or harvested (h) by interviewed boat angler(s) i

$p_i =$ party size of interviewed boat angler(s) i

$t_i =$ the fishing trip length of interviewed boat angler(s) i

Variance of the ratio of means estimator was calculated as suggested by Rasmussen et al. (1998; equation 7). The standard error of the ratio of means estimator was calculated as the square root of the variance.

(7) $var(\overline{CPUE_b}) = \frac{1}{n}\overline{CPUE_b}^2 \left[\frac{var(c)}{\bar{c}^2} + \frac{var(m)}{\bar{m}^2} - \frac{2cov(c,m)}{\bar{m}\bar{h}}\right]$

Where:

$n =$ number boat angler interviews

$c =$ boat angler catch or harvest (h)

$m =$ boat angler effort

$cov(c, m) =$ the covariance between catch and harvest

Catch and harvest was estimated for individual species, but results were not reported for species with negligible total catch (< 400). Additionally, given the difficulty of distinguishing Walleye and Sauger and their frequency of hybridization, Sauger was included with Walleye for analyses. Targeted catch rates of species were calculated similarly, but only using interview data for anglers that indicated they were targeting the specific species.

Angler Demographics and Preferences

Angler demographics were unexpected to significantly differ spatially and temporally within clusters and therefore all angler interviews, including survey card responses, were used to describe angler demographics and preferences. However, interviews of anglers that had been previously interviewed by a creel clerk were excluded from most analyses. Angler gender and age were not provided on survey card responses and therefore were only analyzed from data collected from creel clerk interviews of anglers. The proportion of anglers that were targeting specific species was calculated with equation 8 using all angler interviews. Anglers were only considered targeting “no particular species” if they did not indicate they were targeting any other species.

(8) $TARGET_z = \frac{\sum p_{i,z}}{\sum p_i}$

Where:

$TARGET_z =$ proportion of anglers targeting species z

$p_{i,z} =$ party size of interviewed angler(s) i targeting species z

$p_i =$ party size of interviewed angler(s) i

Standard Error

Standard error was calculated and reported as a general measure of variability and reliability of estimates. In many instances standard errors were incalculable due to small sample sizes or estimates of zero. Standard error of an estimate was calculated using equation 9.

(9) $SE_x = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n(n-1)}}$

When estimates were summed (e.g., shore angling effort + boat angling effort), the sum of standard errors was calculated using equation 10.

(10) $SE_{x+y} = \sqrt{SE_x^2 + SE_y^2}$

And, when estimates were multiplied (e.g., mean trailer count × mean party size), the standard error of products was calculated using equation 11.

(11) $SE_{xy} = \sqrt{\left(\bar{x}^2 \times SE_y^2\right) + \left(\bar{y}^2 \times SE_x^2\right) + \left(SE_y^2 \times SE_x^2\right)}$

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Appendix E. Shore angler accesses ranked by popularity

Table 27. Mean instantaneous count of shore anglers at Minnesota River survey stations.

Station name	Cluster	Mean count
Granite Falls Dam	1	4.47
Black Dog Park	6	1.75
Riverside Park StP	5	1.20
Yellow Medicine Museum	1	1.12
USA State Park	1	1.00
Vicksburg Park	2	1.00
Sibley Park	4	0.94
Cedar Ave Access	6	0.93
Seven Mile Park	4	0.88
Hwy 4 Access	3	0.78
Kiwanis Park	4	0.77
Memorial Park GF	1	0.71
Camp Town Park	2	0.65
Skalbekken Park	1	0.65
Riverside Park NU	3	0.61
Land of Memories Park	4	0.54
North Redwood Access	2	0.49
Minnecon Park	3	0.49
Franklin Access	2	0.48
Judson Bottom Rd	4	0.45
Chaska Access	6	0.42
Kinney Access	1	0.41
Courtland Access	3	0.37
Fredrickson Access	1	0.34
Bussman Bridge Access	3	0.29
Hwy 169 Bridge	5	0.27
Jordan Access	5	0.27
Belle Plaine Access	5	0.20
Morton Canoe Access	2	0.19
Kettner Access	3	0.18
Lyndale Access	6	0.17
Brickyard AMA Access	2	0.15
Le Sueur Access	5	0.12
Shakopee Access	6	0.11
Henderson Access	5	0.08
Riverview Park NM	4	0.08
Hwy 22 Bridge	5	0.06
Judson Access	4	0.06
Carver Access	6	0.04
Henderson Station Park	5	0.02

Appendix F. Boat accesses ranked by popularity

Table 28. Mean instantaneous count of empty watercraft trailers at Minnesota River survey stations.

Station name	Cluster	Mean count
Lyndale Access	6	2.21
Cedar Ave Access	6	1.44
Shakopee Access	6	1.00
Le Sueur Access	5	0.76
Judson Access	4	0.70
Franklin Access	2	0.63
Carver Access	6	0.52
Belle Plaine Access	5	0.45
Jordan Access	5	0.45
Henderson Access	5	0.39
Chaska Access	6	0.38
Bussman Bridge Access	3	0.37
Riverside Park StP	5	0.37
Land of Memories Park	4	0.37
North Redwood Access	2	0.36
Minnecon Park	3	0.27
Brickyard AMA Access	2	0.23
Riverside Park NU	3	0.18
Fredrickson Access	1	0.14
Hwy 4 Access	3	0.12
Kettner Access	3	0.10
Kinney Access	1	0.10
Seven Mile Park	4	0.10
Memorial Park GF	1	0.08
Camp Town Park	2	0.06
Vicksburg Park	2	0.06
Skalbekken Park	1	0.02
Black Dog Park	6	0.00
Courtland Access	3	0.00
Granite Falls Dam	1	0.00
Henderson Station Park	5	0.00
Hwy 169 Bridge	5	0.00
Hwy 22 Bridge	5	0.00
Judson Bottom Rd	4	0.00
Kiwanis Park	4	0.00
Morton Canoe Access	2	0.00
Riverview Park NM	4	0.00
Sibley Park	4	0.00
USA State Park	1	0.00
Yellow Medicine Museum	1	0.00

Appendix G. Standard errors of total harvest estimates

Table 29. Standard errors of total harvest estimates among angler type (shore or boat), seasons, and Minnesota River reaches.

	Spring			Summer			Fall			Combined
Reach	Shore	Boat	Total	Shore	Boat	Total	Shore	Boat	Total	Total
1	892	92	897	630	–	–	140	–	–	–
2	145	174	226	130	–	–	84	–	–	–
3	54	–	–	48	124	132	325	71	332	–
1–3	905	–	–	645	–	–	363	–	–	–

Appendix H. Standard errors of species harvest estimates

Table 30. Standard errors of estimated harvest by species among angler type (shore or boat), seasons, and Minnesota River reaches.

	Spring			Summer			Fall			Combined
Reach	Shore	Boat	Total	Shore	Boat	Total	Shore	Boat	Total	Total
Channel Catfish										
1	397	8	397	289	–	–	34	–	–	–
2	129	14	130	79	–	–	65	–	–	–
3	7	–	–	0	117	117	18	–	–	–
1–3	418	–	–	300	–	–	76	–	–	–
Common Carp										
1	6	–	–	20	–	–	4	–	–	–
2	0	–	–	46	–	–	19	–	–	–
3	0	–	–	0	4	4	15	–	–	–
1–3	6	–	–	51	–	–	25	–	–	–
Flathead Catfish										
1	162	7	162	0	5	5	20	–	–	–
2	0	10	10	0	5	5	0	–	–	–
3	14	–	–	0	–	–	0	–	–	–
1–3	162	–	–	0	–	–	20	–	–	–
Freshwater Drum										
1	508	25	508	369	–	–	75	–	–	–
2	35	48	59	0	–	–	0	–	–	–
3	43	22	48	46	–	–	304	–	–	–
1–3	510	59	514	372	–	–	313	–	–	–
Shovelnose Sturgeon										
1	0	–	–	0	–	–	0	–	–	–
2	0	–	–	0	–	–	0	–	–	–
3	0	–	–	0	–	–	0	–	–	–
1–3	0	–	–	0	–	–	0	–	–	–
Walleye & Sauger										
1	171	50	178	92	–	–	62	–	–	–
2	14	100	101	81	–	–	11	–	–	–
3	0	146	146	8	–	–	76	71	104	–
1–3	172	183	251	122	–	–	99	–	–	–

Appendix I. Standard errors of total catch estimates

Table 31. Standard errors of total catch estimates among angler type (shore or boat), seasons, and Minnesota River reaches.

	Spring			Summer			Fall			Combined
Reach	Shore	Boat	Total	Shore	Boat	Total	Shore	Boat	Total	Total
1	1,728	–	–	1,021	177	1,037	458	65	462	–
2	470	–	–	641	168	662	496	34	497	–
3	362	1,060	1,121	270	1,153	1,184	496	–	–	–
1–3	1,827	–	–	1,235	1,178	1,702	837	–	–	–

Appendix J. Standard errors of species catch estimates

Table 32. Standard errors of estimated catches by species among angler type (shore or boat), seasons, and Minnesota River reaches.

	Spring			Summer			Fall			Combined
Reach	Shore	Boat	Total	Shore	Boat	Total	Shore	Boat	Total	Total
Channel Catfish										
1	585	37	586	469	92	478	252	10	252	797
2	261	72	271	287	87	300	359	5	359	541
3	105	221	245	112	746	755	73	–	–	–
1–3	649	236	690	561	757	942	445	–		–
Common Carp										
1	219	–	–	68	–	–	70	–	–	–
2	22	–	–	59	–	–	49	–	–	–
3	103	–	–	14	–	–	235	–	–	–
1–3	243	–	–	91	–	–	250	–	–	–
Flathead Catfish										
1	162	9	162	65	35	74	20	30	36	182
2	0	13	13	124	34	129	0	16	16	131
3	19	–	–	7	27	28	20	7	21	–
1–3	163	–	–	141	56	151	28	35	45	–
Freshwater Drum										
1	642	26	642	482	20	482	153	24	155	818
2	105	51	117	225	19	226	139	13	140	290
3	154	163	224	99	144	175	320	83	330	436
1–3	668	173	690	541	146	561	381	88	391	971
Shovelnose Sturgeon										
1	46	8	47	0	2	2	0	–	–	–
2	105	16	106	44	2	44	80	–	–	–
3	71	–	–	0	29	29	105	–	–	–
1–3	135	–	–	44	29	53	132	–	–	–
Walleye & Sauger										
1	332	–	–	92	–	–	96	–	–	–
2	86	–	–	143	–	–	11	–	–	–
3	0	380	380	35	–	–	93	195	216	–
1–3	343	–	–	174	–	–	134	–	–	–

Appendix K. Minnesota River anglershed analyses

Methods

Angler zip codes obtained during creel clerk interviews (and survey card responses from boat anglers) were used to estimate the Minnesota River anglershed (the spatiotemporal draw of anglers to a waterbody). Only ZIP codes from Minnesota, Iowa, and South Dakota were included for analyses since only 2% of interviewed anglers were from a variety of other states (e.g., Ohio, Texas, Wisconsin). Anglershed analyses were performed in R version 4.2.2 (R Foundation for Statistical Computing, Vienna). Coordinates of centroids associated with most ZIP codes were obtained from the "zipcodeR" package in R (Rozzi 2021) and the "adehabitatHR" package in R (Calenge 2006) was used to calculate kernel-densities and delineate anglersheds. Similar methods as Ruskamp (2018) were used to calculate the "primary", "median", and "total" anglersheds for the entire survey portion of the Minnesota River and each of the three sub-reaches (upper river, middle river, and lower river; Figure 2). The 25% utilization distribution contour was interpreted as the "primary" anglershed which reflects the densest area of angler participation in the fishery. The 50% utilization distribution contour was interpreted as the "median" anglershed which reflects the area of approximately half the angler participation. Lastly, the 90% utilization distribution contour was interpreted as the "total" anglershed and reflects the area where most Minnesota River anglers reside.

Results and Discussion

As expected, a vast majority of participation in the Minnesota River fishery is by anglers that reside within southern Minnesota, including the Minneapolis-St. Paul metropolitan area, and generally within 90 miles of the river (Figure 11). However, anglers from as far south as northwest Iowa and as far north as St. Cloud, Minnesota are within the total Minnesota River anglershed. The median anglershed of the Minnesota River is roughly a 30-mile perimeter around the study reach of the river. The greatest density of angler participation comes from an area surrounding the cities of Mankato, New Ulm, and St. Peter and from the southwestern region of the Minneapolis-St. Paul metropolitan area. The total anglershed for the upper reach of the Minnesota River is rather large, and extends south into northwest Iowa, north of St. Cloud, and east including the entire Minneapolis-St. Paul metropolitan area (Figure 12). The greatest density of anglers fishing this reach of the river are from the nearby Granite Falls area, as well from southwestern Minnesota and northwestern Iowa. The greatest density of anglers that fish the middle reach of the Minnesota River reside near Mankato and New Ulm (Figure 13). However, the total anglershed for the middle reach includes a large portion of south-central Minnesota and much of the Minneapolis-St. Paul metropolitan area. The lower reach of the Minnesota River has the smallest anglershed with the greatest density of anglers residing in the southwest region of the Minneapolis-St. Paul metropolitan area and extending southwest towards Mankato (Figure 14). The anglershed analyses reveal an interesting trend that anglers that live closer to downstream reaches of the Minnesota River are important participants in the upstream fisheries, but anglers that live closer to upstream reaches contribute relatively little to the angling participation in the downstream reaches. For instance, the Minneapolis-St. Paul metropolitan area is within the anglersheds for the upper and middle reaches, but the Granite Falls area is not within the anglershed of the middle and lower reaches, and even the New Ulm area (upstream of Mankato) is not within the anglershed for the lower reach.

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Figures

Figure 11. The primary (P; solid black contour), median (M; dark gray contour), and total anglersheds (T; light gray contour) for the surveyed portion of the Minnesota River during 2022.

Figure 12. The primary (P; solid black contour), median (M; dark gray contour), and total anglersheds (T; light gray contour) for the upper reach of the Minnesota River during 2022.

Figure 13. The primary (P; solid black contour), median (M; dark gray contour), and total anglersheds (T; light gray contour) for the middle reach of the Minnesota River during 2022.

Figure 14. The primary (P; solid black contour), median (M; dark gray contour), and total anglersheds (T; light gray contour) for the lower reach of the Minnesota River during 2022.