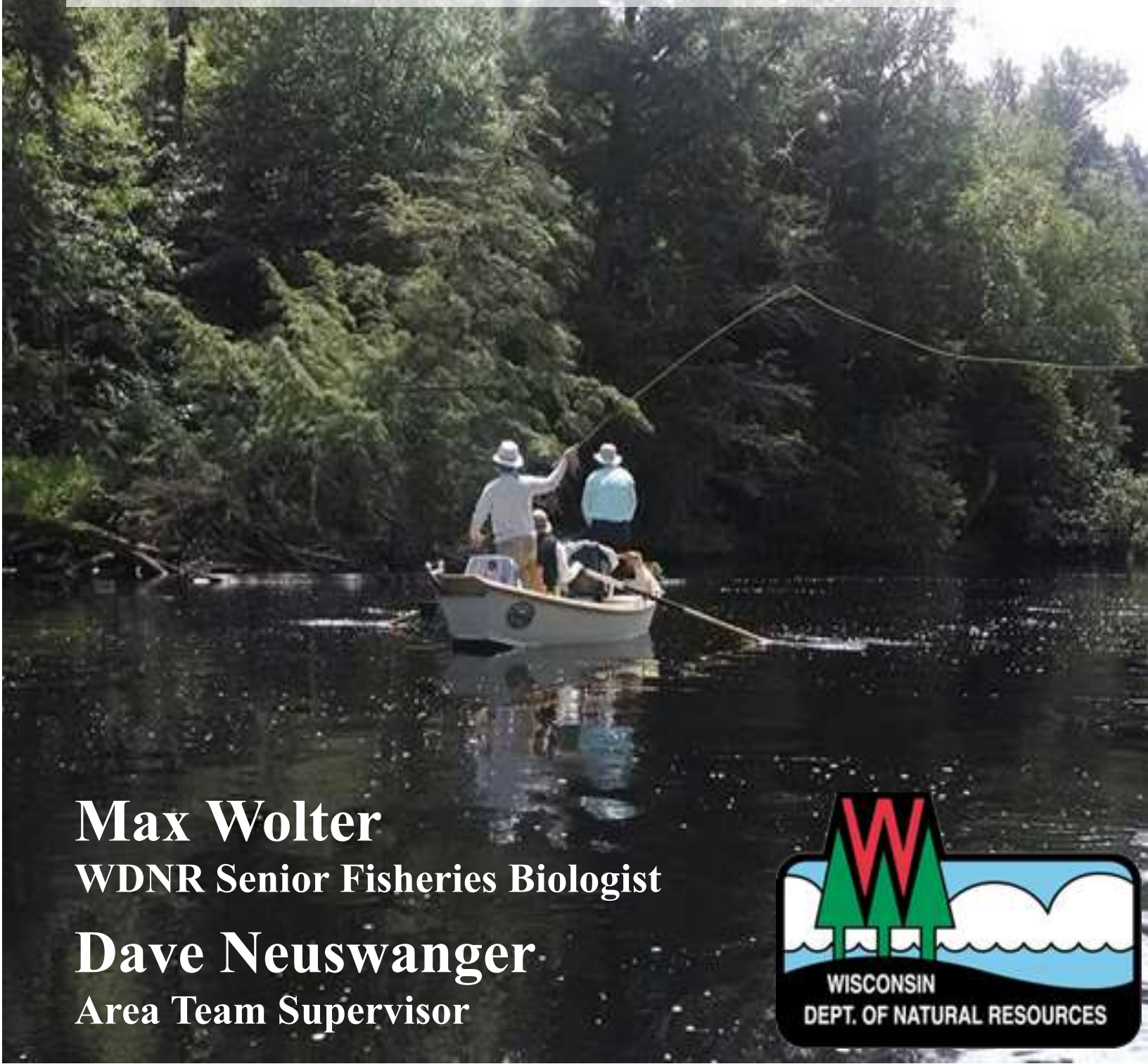
Smallmouth Bass and Muskellunge Fisheries in Northwestern Wisconsin Rivers:

A Guide to the Future Project

5-year report



Max Wolter
WDNR Senior Fisheries Biologist

Dave Neuswanger
Area Team Supervisor

WISCONSIN
DEPT. OF NATURAL RESOURCES

Foreword and Acknowledgments

The "Guide to the Future" project was initiated in 2012 to meet a data collection need for sportfish populations in some of the most popular rivers in northwest Wisconsin. Five years of partnership between the Wisconsin DNR and the Hayward Fly Fishing Company has generated 1,487 records of guided angler trips. The data from these guided trips has allowed for comparisons of catch rate for smallmouth bass, muskellunge, and other species among rivers, times of year, different river conditions, and more. Collection of this large volume of data would not be possible without the excellent participation of each of the individual guides working for the Hayward Fly Fishing Company including Wendy Williamson, Larry Mann, Stu Neville, Erik Huber, Brett Nelson, and Cory Andraschko. Rarely does science get to be as fun as this project has been.

Max Wolter

Table of Contents

Summary of Major Findings

- Angler skill accounts for a significant amount of variation in catch rates for both smallmouth bass and muskellunge. Accounting for skill with a correction factor allows for more meaningful comparisons of catch rate, particularly when sample size is limiting.
- Smallmouth bass catch rate (relative abundance) and size structure varied among rivers. Rivers with high catch rate demonstrated smaller size of fish caught, and vice versa.
- Muskellunge catch rate varied among rivers, but size differences among rivers were generally less pronounced. The Namekagon River emerged as a better river for catching larger muskellunge (>40”) than the Chippewa or Flambeau.
- Catch rates for smallmouth bass and muskellunge appeared relatively stable from one year to the next. Smallmouth catch rates were positively related to water temperature and were highest during peak summer (July). Muskellunge catch rates appeared higher in early summer and fall compared to mid-summer, though the relationship was not statistically significant.
- Spatial trends in catch rates for both species within rivers did not demonstrate consistent increases or decreases from upstream to downstream reaches.
- The amount of discharge on a river (cubic feet per second) generally had a negative impact on both smallmouth bass and muskellunge catch rates, though the relationship was typically not statistically significant.
- Catch rates for smallmouth bass were significantly higher under flat water conditions compared to rising water. There was an indication of a similar trend for muskellunge but it was not statistically significant.
- Northern pike catch rates were significantly higher on the Namekagon compared to the Flambeau with the Chippewa being intermediate. Incidental catch of other species like walleye and largemouth bass were rare.

Project Objectives and General Methods

Due to a variety of factors including current, water clarity, structural complexity, and access, river fish populations are often not easily (or representatively) sampled by traditional fisheries methods such as netting or electrofishing. On an experimental and voluntary basis from 2012 to 2016, the Wisconsin Department of Natural Resources (WDNR) enlisted a group of river fishing guides who completed hundreds of fishing trips on these rivers annually with their clients while targeting smallmouth bass and muskellunge using fly fishing gear. Records of the effort and catch from these fishing trips can provide important information on relative abundance and size structure of river populations of smallmouth bass and muskellunge in a manner that is efficient to the monitoring agency (WDNR) and informative to the guides, their clients, and other anglers.

WDNR personnel and guides met and developed the following protocol for data collection. For each trip, the guide recorded the catch for each client (typically two people) separately. There was no set schedule or locations that guides were asked to follow with their fishing activities. However, as a result of the use of logical access points, fishing trips were assigned to "reaches" within each river with set start and end points. Each captured fish was recorded on a labeled 12-key mechanical counter corresponding to the angler that caught the fish. Four sizes categories of smallmouth bass (7-11, 11-14, 14-17, and >17 inches) and muskellunge (20-30, 30-40, 40-50, and >50 inches) were recorded. Guides also recorded catches, but not sizes, of northern pike, walleye, and largemouth bass. "Encounters" with muskellunge were recorded whenever a fish followed but did not strike, struck and missed, or was lost after hooking but before landing.

Each guide recorded daily water temperature (degrees F), which was measured in a shaded portion of the river near noon. Guides also recorded "mitigating conditions" (inclement weather, challenging water level, off-color water, etc.) that they judged may have negatively impacted fishing success. Data on river discharge (cubic feet per second) was obtained for each day from nearby USGS or hydropower dam gauges. Short-term variation in discharge was calculated and expressed as the most recent 3-day change in discharge (noon discharge three days prior minus noon discharge on day of fishing). Based on this calculation, river conditions on each day of fishing were classified as either falling (≥15% *decrease* in discharge over 3-day period), stable (<15% change in discharge over 3 day period), or rising (≥15% *increase* in discharge over 3-day period).

Data were entered into an Excel database and analyzed using R software. Trips when guides noted "mitigating conditions", as described above, were excluded from all analyses unless specified otherwise. Similarly, only trips where at least four hours of targeted effort for a species were used for analyses of that species. A non-parametric Kruskal-Wallis test was used to make statistical comparisons of catch rates across classes of data (i.e. different rivers, months) because of non-normal shape of the catch rate data. When significant differences were found between classes, multiple comparison analysis was made using a Dunn Test with a Holm modification of the Bonferroni adjustment. Comparisons between catch rate and river discharge or temperature were made using standard linear regression. Results of statistical tests were considered significant at P values less than 0.05.

Study Area

There was no set schedule or locations that guides were asked to follow with their fishing activities. However, as a result of the use of logical access points, fishing trips were assigned to "reaches" within each river with set start and end points. In this report these are labeled with the river name (or abbreviation) and a number corresponding to the relative downstream location of the reach within that river (e.g., Chippewa 4 is downstream from Chippewa 3). To protect the proprietary information of these guides, the specific start and end points of each reach are not presented in this report. Individual reaches were rarely fished on sequential days. Three rivers were primarily fish by the guides– the Flambeau (Figure 1, Price and Sawyer counties), Chippewa (Sawyer and Rusk counties), and Namekagon (Sawyer, Washburn, and Burnett counties). However, data was also collected on the West Fork of the Chippewa River (Sawyer County) and the St. Croix River (Burnett County). Because of smaller sample size, these two rivers are not included in all analyses.

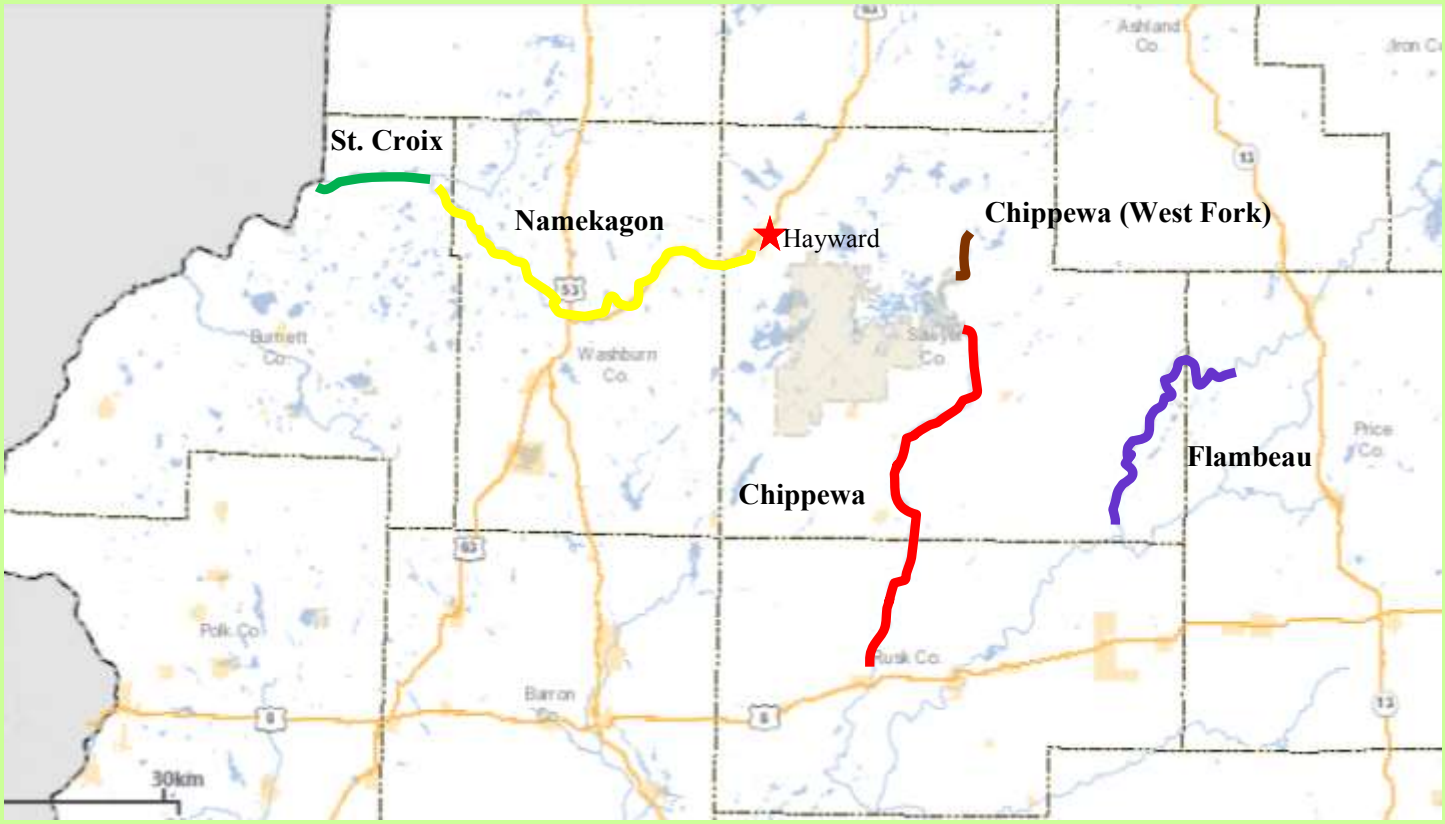


Figure 1. The sections of rivers fished by guides in the "Guide to the Future" fisheries data collection program. Each river is broken into multiple reaches that are fished for single-day float trips. Hayward, the home base for the guides, is denoted with a star.

Description of Angling Effort and Skill

Fishing effort for guides varied considerably among rivers, with the Namekagon River receiving the most total trips and hours of targeted effort for each species (Table 1). Most guided trips took place between June and October. October had the most overall trips (353) followed by July (278) and August (224). Trips in the summer (May-August) were more likely to target smallmouth bass while trips in the fall (September-November) are more likely to target muskellunge.

Table 1. Total number of angler trips and hours spent targeting muskellunge (musky) and smallmouth bass between 2012 and 2016 as a part of the Guide to the Future project.

River	Total trips	Hours targeting musky	Hours targeting smallmouth bass
Chippewa	315	1,035	1,194
Chippewa (West Fork)	70	161	295
Flambeau	155	677	493
Namekagon	851	2,086	3,987
St. Croix	94	481	189

It was known at the onset of this project that anglers fishing with guides would have wide variation in their skill, which would likely affect catch rate data. To account for this, we asked guides to discreetly assign a skill level rating to each client. Assignment of a skill level rating was done early in the trip and was based on casting ability and prior experience so rating would not be influenced by the day's catch. The three rating categories were inexperienced/beginner, average, or expert.

As expected, catch rates for both muskellunge and smallmouth (Figure 2) differed by angler skill level. To prevent this known source of variation from influencing other comparisons, we developed a correction factor to standardize catch rates. Multipliers were applied to catch rates in each skill level (Table 2).

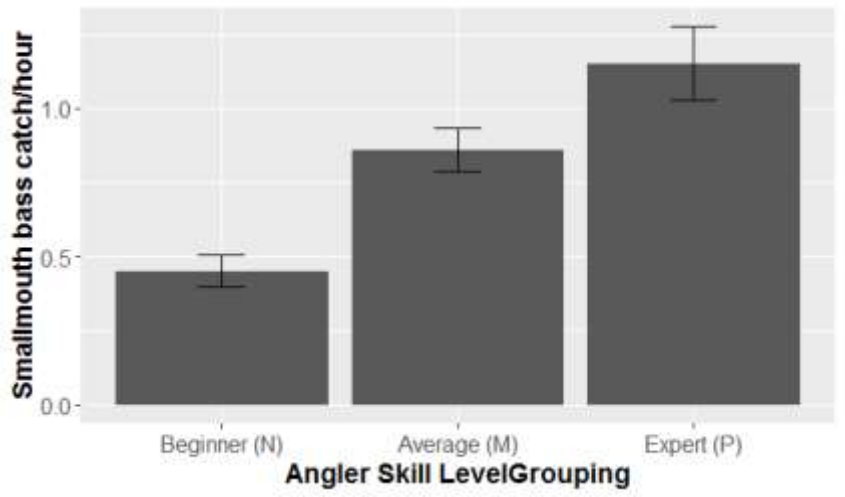
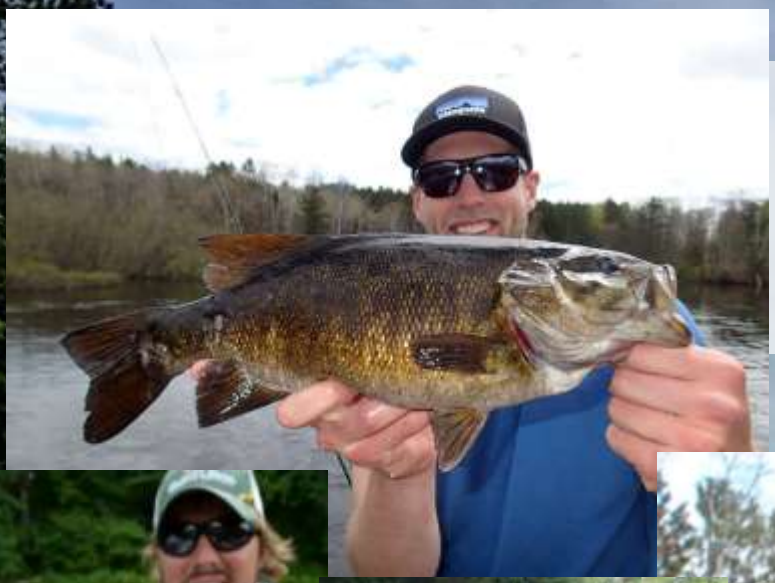


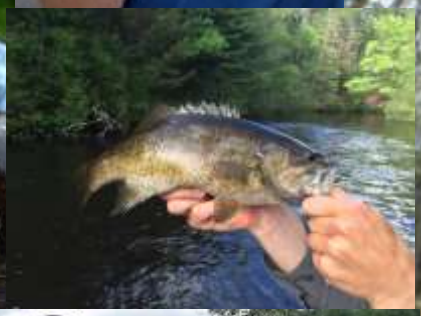
Figure 2. Catch rates (number of fish per hour of targeted angling effort) for smallmouth bass by anglers of different skill levels, shown with no correction factor applied. Error bars represent 95% confidence intervals. Skill levels were assigned by guides to account for the expected variation in catch due to individual anglers' fishing experience. Differences between the three skill levels were used to develop a correction factor to account for this variation when making other comparisons (i.e. catch rate among rivers).

Table 2. Correction factors applied to smallmouth bass and muskellunge catch rates.

	Beginner	Average	Expert
Smallmouth Bass	**2.0**	**1.0**	**0.75**
Muskellunge	**1.5**	**1.0**	**0.5**

SMALLMOUTH BASS ABUNDANCE AND SIZE





Smallmouth Bass Relative Abundance and Size

Smallmouth bass are well-suited for life in shallow rocky riverine habitats and as a result they are one of the most abundant sportfish in many northern Wisconsin rivers. Smallmouth bass are a popular target for anglers fishing either from shore or on float trips, yet little is known about the relative abundance of smallmouth in one river compared to the next or how size distribution compares among rivers. Data collected by guides demonstrated significantly different catch rates for smallmouth bass among five northwestern Wisconsin Rivers (Figure 3). Differences in catch rate are assumed to reflect differences in abundance.

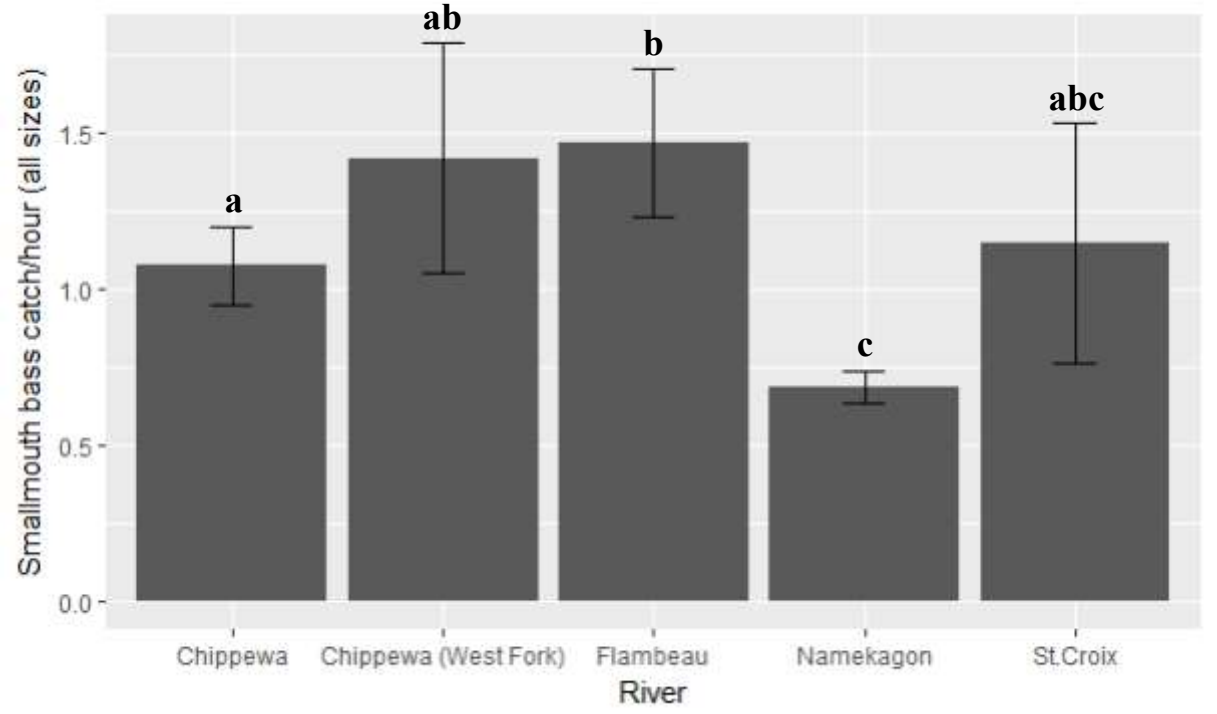


Figure 3. Skill level corrected catch rates (number of fish per hour of targeted angling effort) for smallmouth bass by river from 2012-2016. Error bars represent 95% confidence intervals. Statistically different groupings are denoted with letters.

Variation in overall catch rate of smallmouth bass among rivers is driven by variation within specific size classes. Comparing just the three rivers with the largest volume of data, the catch rates for smaller smallmouth bass was significantly higher on the Flambeau River than on the Chippewa or Namekagon (Table 3). However, catch rate for larger smallmouth bass (>17 inches) was significantly higher on the Namekagon River than the Chippewa or Flambeau. These three rivers offer differing fishing experiences. The Flambeau would be considered more of an action destination, with high overall catch rates but smaller fish, while the Namekagon is clearly more of a trophy opportunity with lower catch rates but higher catch of large smallmouth.

Table 3. Skill level corrected catch rates (number of fish per hour of targeted angling effort) of smallmouth bass by size class for three northwestern Wisconsin Rivers from 2012-2016. Statistically different groupings are denoted with letters.

Size Class	Chippewa	Flambeau	Namekagon
7-11 inches	0.38 (±0.07)[b]	0.70 (±0.16)[a]	0.10 (±0.02)[c]
11-14 inches	0.39 (±0.06)[a]	0.44 (±0.09)[a]	0.20 (0.02)[b]
14-17 inches	0.24 (±0.05)	0.30 (±0.08)	0.27 (±0.03)
>17 inches	0.07 (±0.02)[b]	0.03 (±0.02)[b]	0.11 (±0.02)[a]
All sizes	1.07 (±0.12)[b]	1.47 (±0.24)[a]	0.69 (±0.05)[c]

Smallmouth Bass Size Structure

Based on reported data from guides, size structure of smallmouth bass varied considerably among rivers. Catch in the Flambeau River was dominated by smaller bass, while catch in the Namekagon was predominantly larger fish, the Chippewa River catch was intermediate with the three smaller size classes represented fairly evenly in the catch (Figure 4). In the Flambeau, only 22% of smallmouth caught were over 14 inches, while on the Chippewa 33% were over 14 inches, and on the Namekagon 56% were over 14 inches. Interestingly, all three rivers have the same fishing regulations. It is not clear why the apparent difference in size structure among rivers exists. It appears, based on catch rate, that density of smallmouth bass is higher in the Flambeau River which may lead to slower, density-dependent growth. It is possible that prey availability differs among these three rivers independent of smallmouth bass density. Mortality may also play a role in structuring these smallmouth bass populations. If mortality of adult smallmouth bass is higher on one river compared to another it may result in differing size structure. Mortality could be due to environmental conditions, including overwintering habitat, or angler harvest, though harvest is believed to be minimal on all three rivers. A growth rate and age structure analysis would be beneficial to better understanding dynamics of these populations.

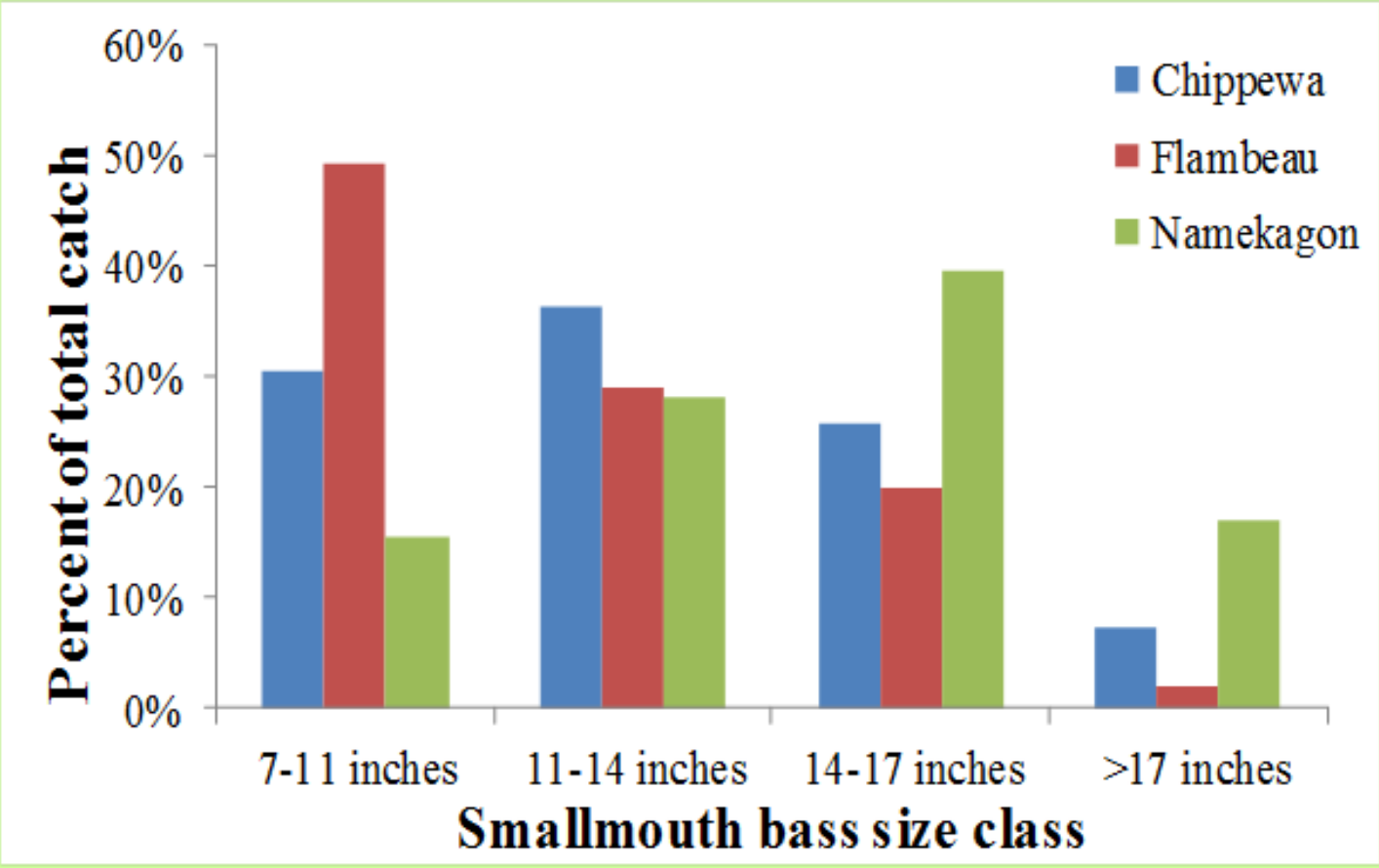


Figure 4. Smallmouth bass catch by size category for three rivers in northwestern Wisconsin fished by guides and their clients from 2012-2016.

MUSKELLUNGE ABUNDANCE AND SIZE

Muskellunge Relative Abundance and Size

Interpreting muskellunge catch rate data was made more difficult by the high degree of variation that inevitably exists when dealing with a species that occurs in low abundance and is challenging to catch. However, five seasons of data collection have provided enough data to start making statistical comparisons of muskellunge catch. Data collected by guides demonstrated significantly different catch rates for muskellunge among five northwestern Wisconsin Rivers (Figure 5). Differences in catch rate are assumed to reflect differences in abundance.

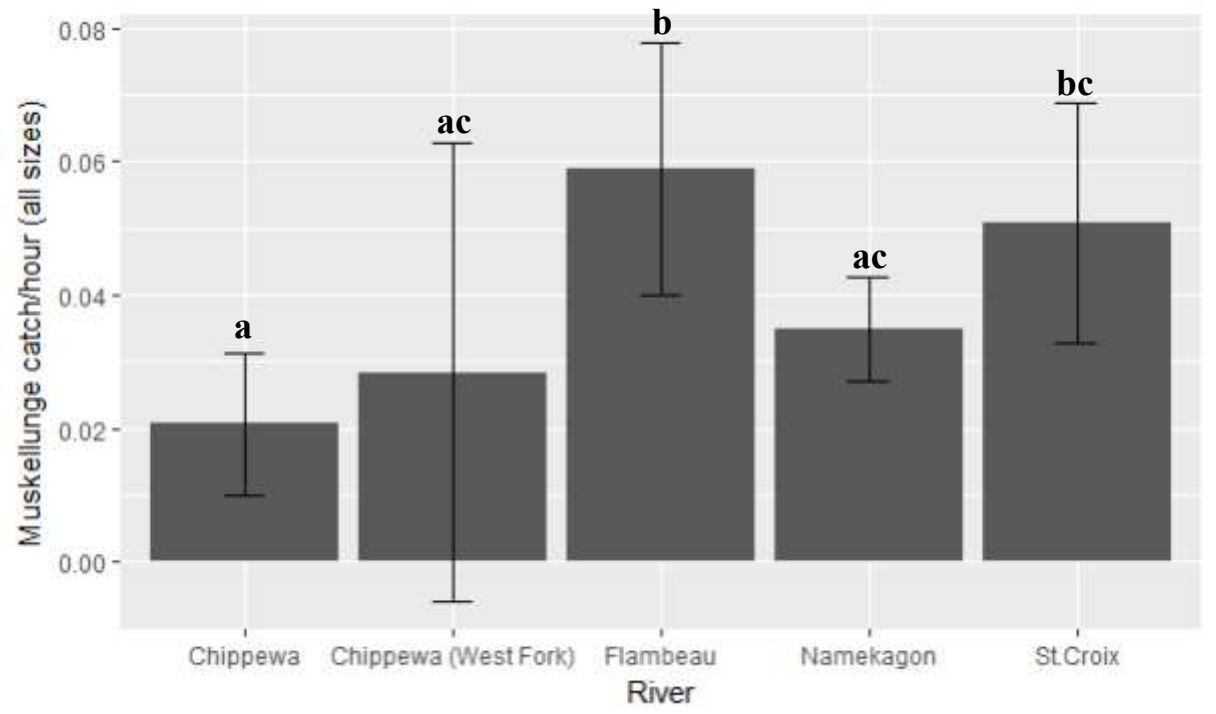


Figure 5. Skill level corrected catch rates (number of fish per hour of targeted angling effort) for muskellunge by river from 2012-2016. Error bars represent 95% confidence intervals. Statistically different groupings are denoted with letters.

Variation in overall catch rate of muskellunge among rivers was driven by variation within specific size classes. Comparing just the three rivers with the largest volume of data, the catch rates for smaller muskellunge (20-30 inches and 30-40 inches) were significantly higher on the Flambeau River than on the Chippewa or Namekagon (Table 4). However, catch rate for larger muskellunge (>40 inches) was significantly higher on the Namekagon River than the Chippewa or Flambeau. Catching a musky is rare under any circumstances, but the average catch rate of muskellunge by guided anglers as a part of this project (17.1 hours of fishing per musky) compare favorably to catch rates for anglers on lakes (~33 hours of angling per musky).

Table 4. Skill level corrected catch rates (number of fish per hour of targeted angling effort) of muskellunge by size class for three northwestern Wisconsin Rivers from 2012-2016. Statistically different groupings are denoted with letters.

Size Class	Chippewa	Flambeau	Namekagon
20-30 inches	0.008 (±0.006)^{b}	0.033 (±0.017)^{a}	0.013 (±0.005)^{b}
30-40 inches	0.011 (±0.008)^{b}	0.024 (±0.011)^{a}	0.013 (±0.005)^{b}
40-50 inches	0.002 (±0.003)^{b}	0.003 (±0.003)^{ab}	0.009 (±0.004)^{a}
>50 inches	0.000	0.000	0.001 (±0.001)
All sizes	0.021 (±0.011)^{b}	0.059 (±0.019)^{a}	0.035 (±0.008)^{b}

Muskellunge Size Structure

Based on reported data from guides, size structure of muskellunge varied slightly among rivers. Catch in all three rives is dominated by fish in the 20-40 inch range (Figure 6). The Namekagon River has demonstrated the best size potential evidenced by a larger percentage of the catch being over 40 inches and producing the only 50 inch muskellunge recorded by guides and their clients during the span of this project.

The relative infrequency of muskellunge over 40 inches being caught by guided anglers on these rivers is of interest. Many of the rivers fished as a part of this project are connected to impoundments which generally have larger fish than what was being caught in the rivers. The discrepancy in size structure between impoundments and rivers may be due to gear selectivity where fly fishing disproportionately targets the smaller sized muskellunge. But it may also be a result of habitat selection by larger fish, slower growth of fish inhabiting rivers, higher mortality of adult muskellunge in rivers, or other factors. More exploration into these trends is warranted.

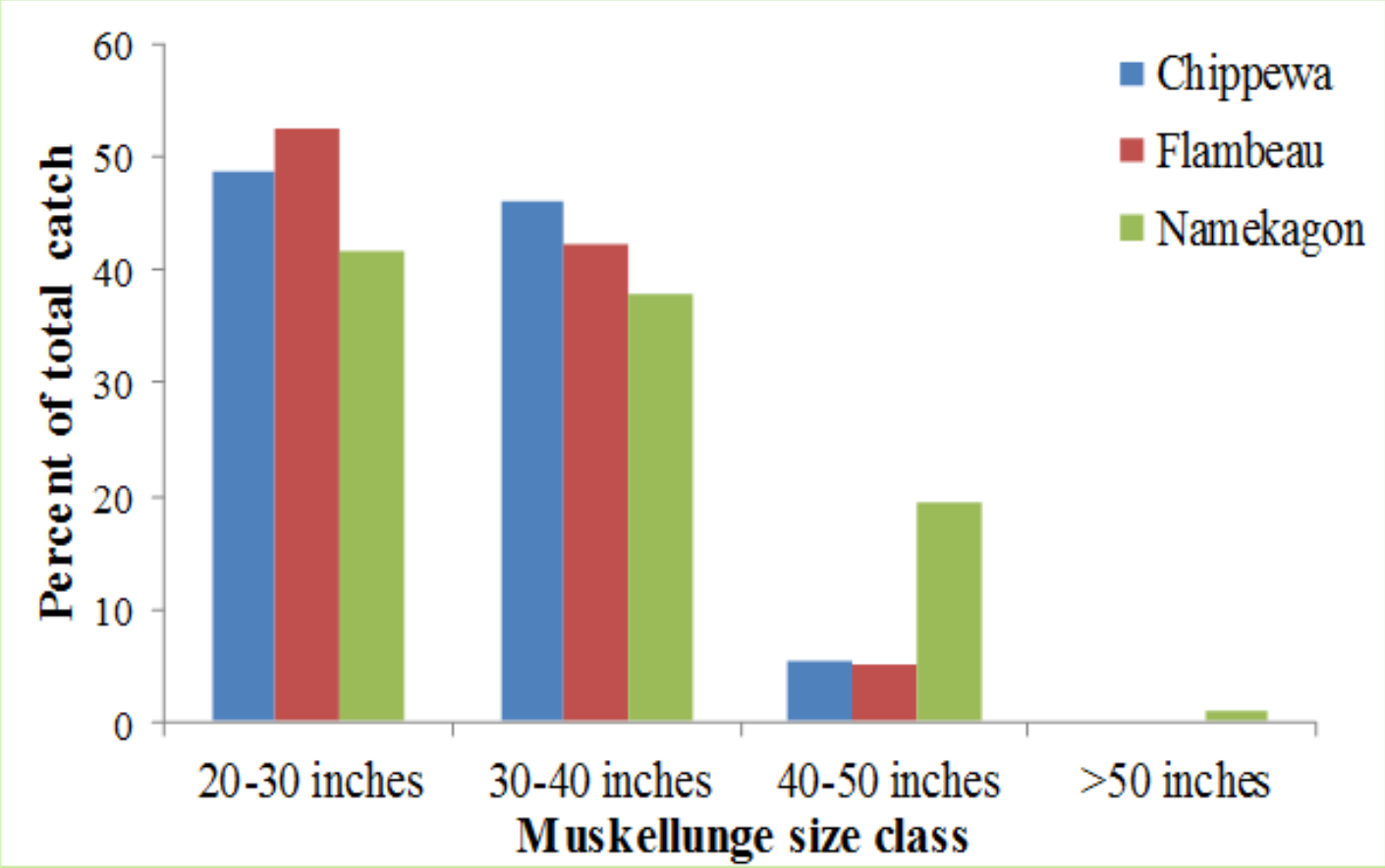


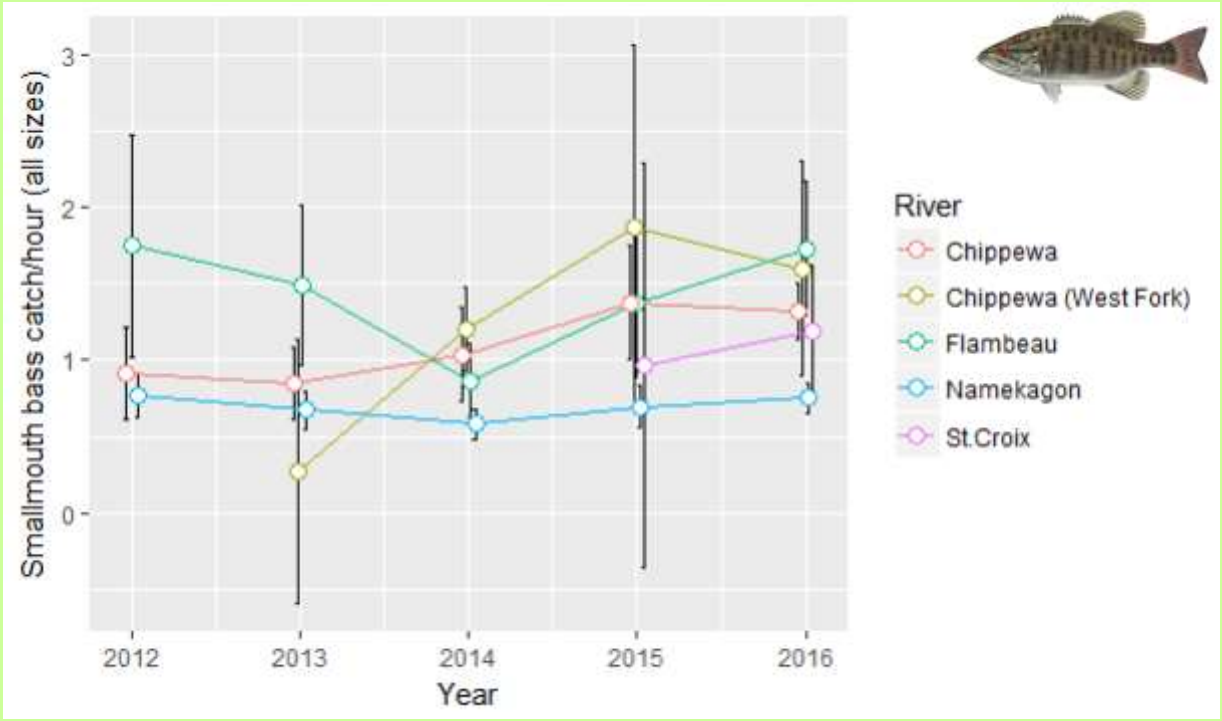
Figure 6. Muskellunge catch by size category for three rivers in northwestern Wisconsin fished by guides and their clients from 2012-2016.

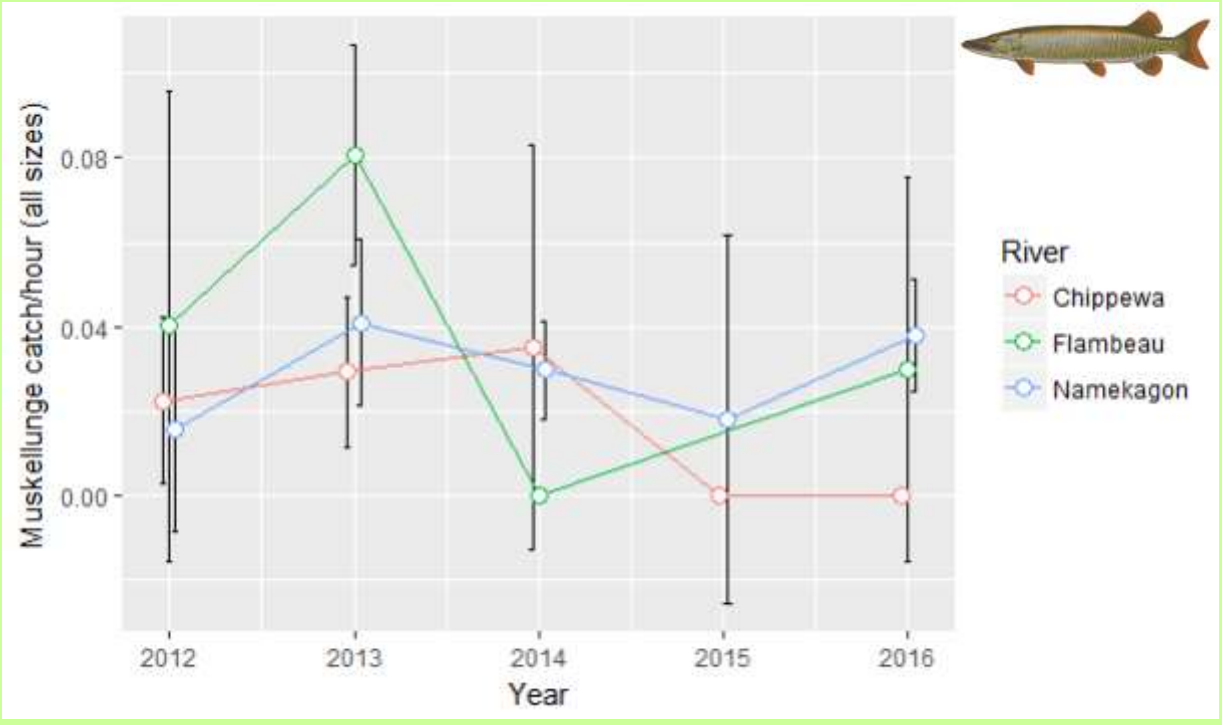
TEMPORAL TRENDS IN CATCH RATES

Catch By Year

Clear trends in catch rate by year within individual rivers were not always evident for either species. Catch rate for smallmouth bass on the Namekagon has been remarkably consistent across time. Catch rate for smallmouth bass on the Flambeau River demonstrated the greatest oscillation (Figure 7). Year-to-year data for muskellunge catch rate on the St. Croix and West Fork Chippewa rivers was limiting and therefor those rivers were excluded from that analysis. Other rivers demonstrated relatively consistent catch rates for muskellunge, with some evidence of declining catch rate for the Chippewa River. Once again, catch rate data for muskellunge was marked by a high degree of variability.

Figure 7. Smallmouth bass (top panel) and muskellunge (bottom panel) skill level corrected catch rates in three rivers in northwestern Wisconsin fished by guides and their clients from 2012-2016. Error bars represent 95% confidence intervals.





Catch By Month

Catch rates by month showed interesting patterns for both smallmouth bass and muskellunge, though differences were not always statistically significant. For smallmouth, catch rate was higher in July than in the cooler months of June and September (Figure 8). Guides have anecdotally reported poor success targeting smallmouth in these rivers after September, and as a result very little smallmouth bass data exists for those months. Catch rates for muskellunge showed an inverse pattern to smallmouth, with generally higher catch in cooler months (early summer and fall), though there were not statistically significant differences among months. It should be noted that muskellunge catch data from summer months is more limited since guides are typically targeting smallmouth bass at that time. Trips targeting muskellunge in December have been rare, but successful.

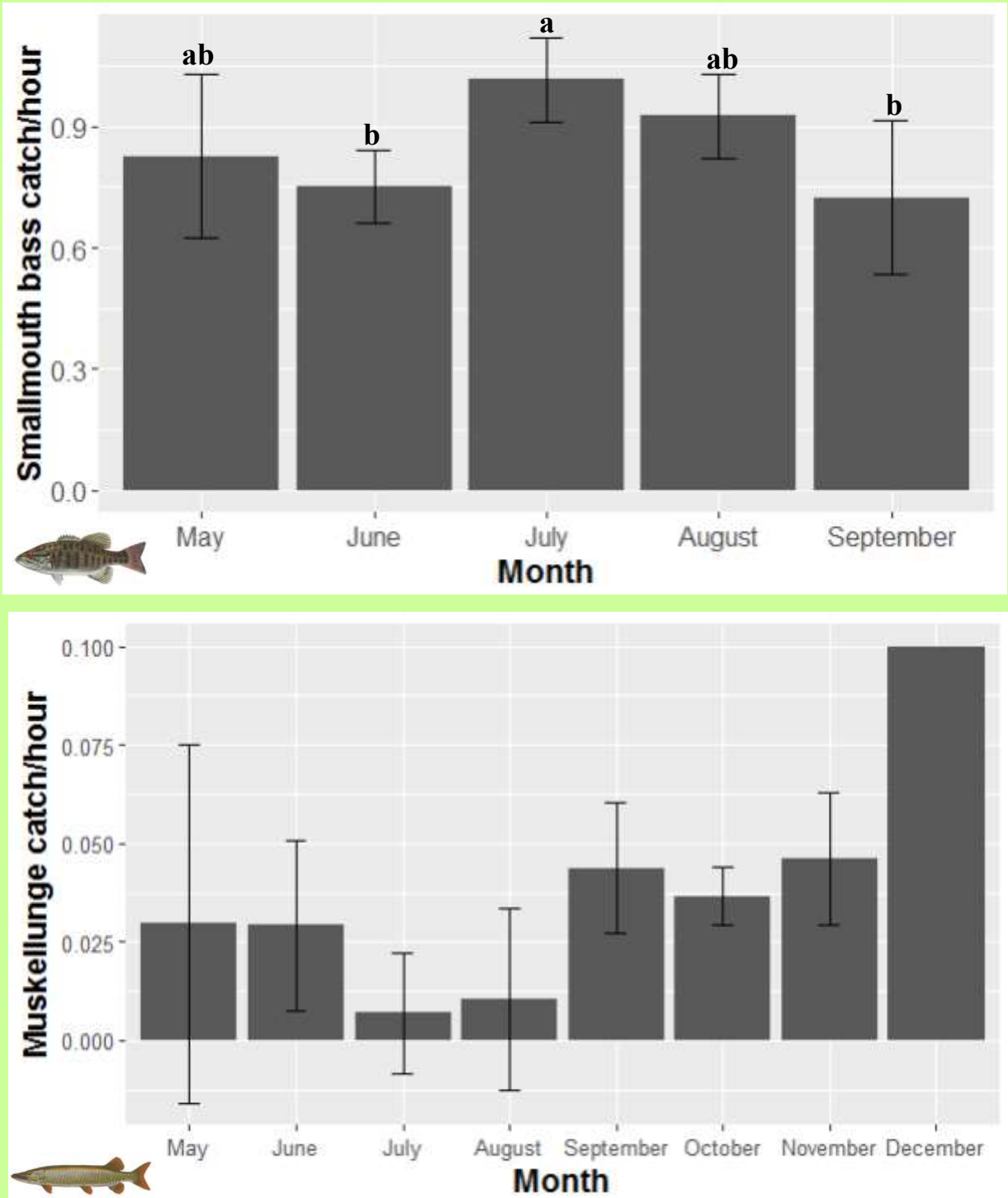
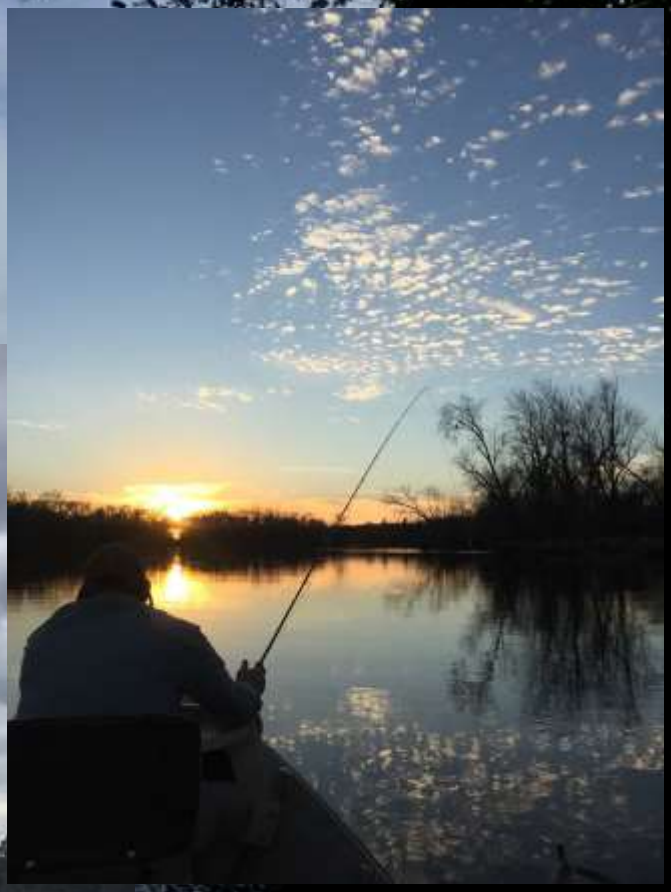


Figure 8. Smallmouth bass (top panel) and muskellunge (bottom panel) skill level corrected catch rates by month in three rivers in northwestern Wisconsin fished by guides and their clients from 2012-2016. Error bars represent 95% confidence intervals. Letters represent statistically significant groupings.

SPATIAL TRENDS IN CATCH RATES



Smallmouth Bass Catch By River Reach

Smallmouth bass catch rate across different reaches within the same river did not reveal many consistent patterns (Figure 9). For example, there was no evidence that smallmouth bass catch rate consistently increased or decreased from upstream reaches to downstream reaches. Catch rates on the Chippewa River were significantly lower at Chip3 compared to Chip1 and Chip5, but no other trends were present. Catch rates on the Flambeau and Namekagon were statistically similar across all reaches. Given that few differences in catch rate were observed, one can conclude that smallmouth bass fishing quality is generally similar along the entire stretch of each river fished by guides as a part of this project. It also indicates that there are few major habitat issues (dams, impaired discharge, etc.) that limit smallmouth bass populations in particular reaches.

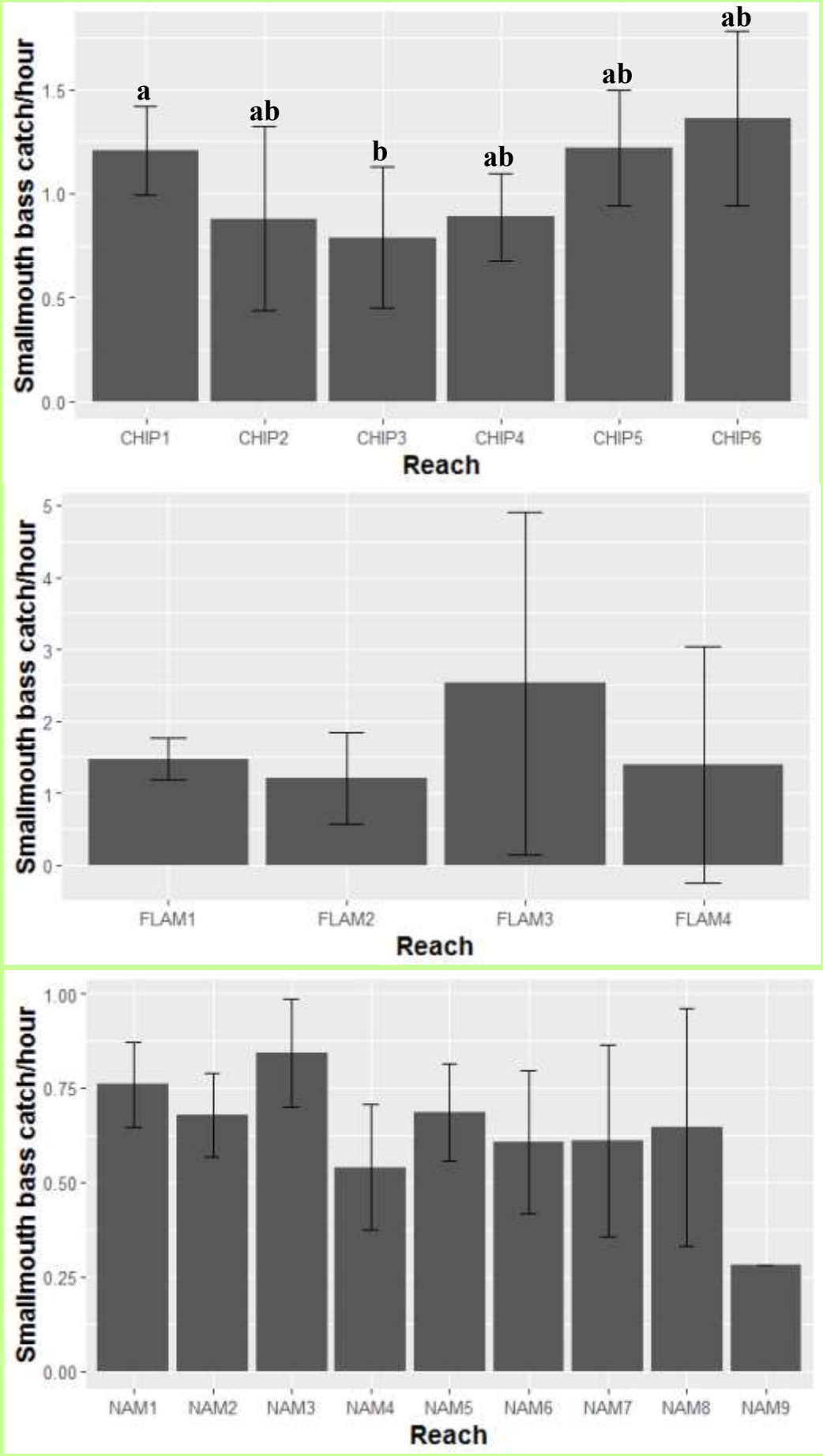


Figure 9. Smallmouth bass skill level corrected catch rates by reach in three rivers (top=Chippewa, middle=Flambeau, bottom=Namekagon) in northwestern Wisconsin fished by guides and their clients from 2012-2016. Error bars represent 95% confidence intervals. Letters represent statistically significant groupings. Reaches are arranged from upstream to downstream (i.e. CHIP1 is upstream of CHIP2 and so on).

Muskellunge Catch By River Reach

Muskellunge catch rate by river reach similarly did not reveal statistically significant patterns (Figure 10). However, several notable trends are present. Almost no muskellunge are caught on the Namekagon River upstream from Namekagon4. Muskellunge are known to inhabit these upper reaches and it is not clear why this pattern exists

As with other analyses in this report, the comparison of muskellunge catch by river reach was limited by high variation (see wide error bars in Figure 10) and was exacerbated by low sample size for some reaches. Perhaps the inclusion of more data from future years of fishing will allow for better comparisons of muskellunge catch within rivers.

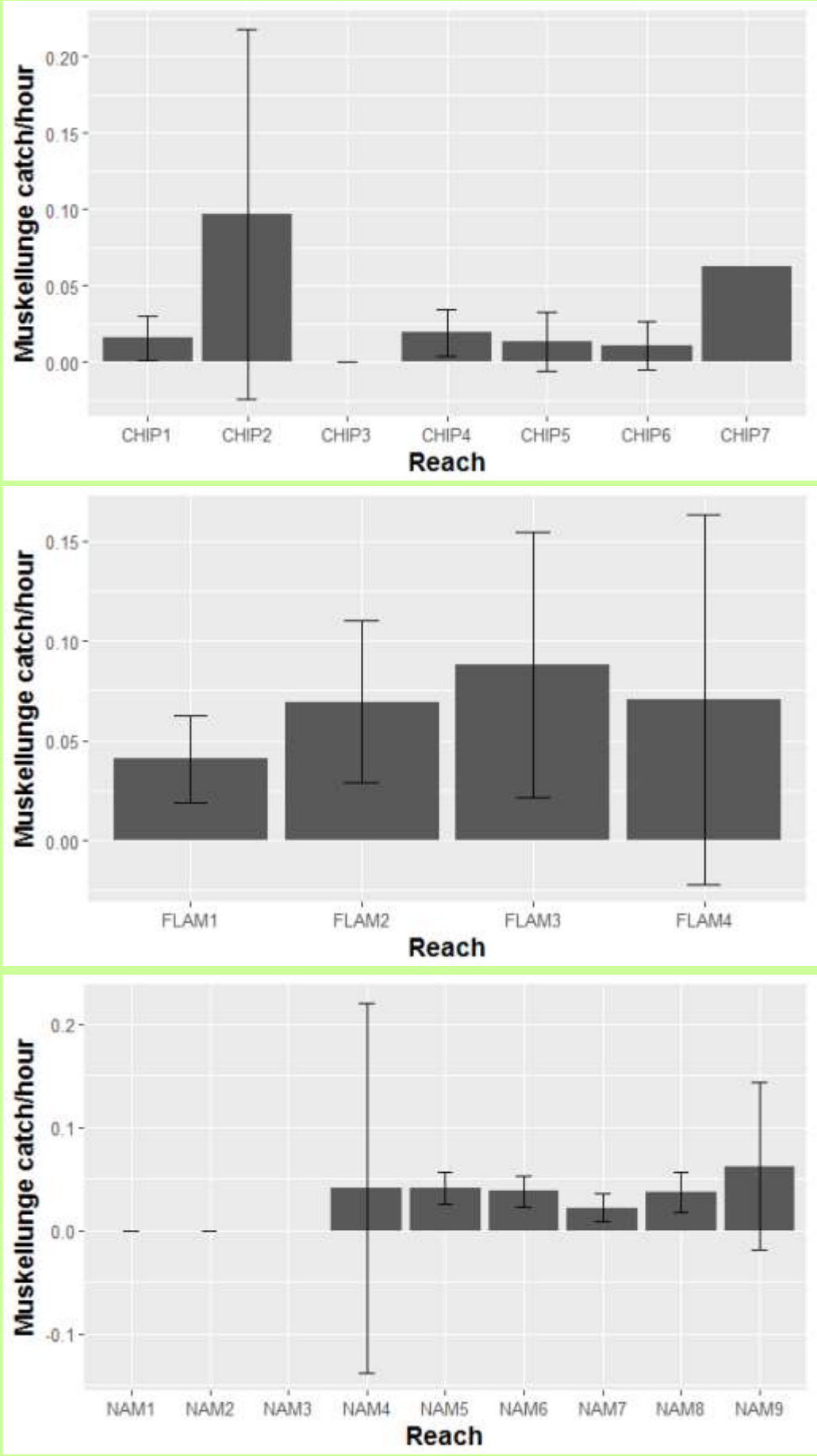
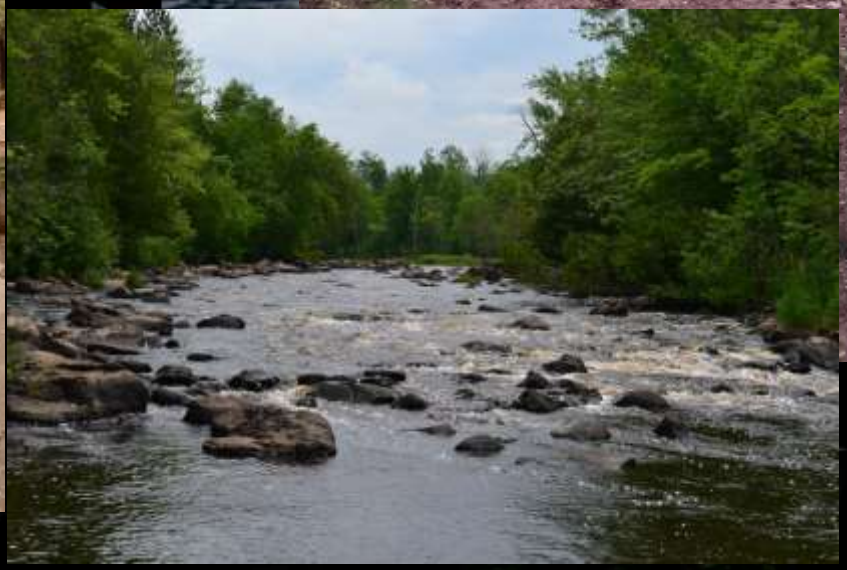


Figure 10. Muskellunge skill level corrected catch rates by reach in three rivers (top=Chippewa, middle=Flambeau, bottom=Namekagon) in northwestern Wisconsin fished by guides and their clients from 2012-2016. Error bars represent 95% confidence intervals. Letters represent statistically significant groupings. Reaches are arranged from upstream to downstream (i.e. CHIP1 is upstream of CHIP2 and so on).

INFLUENCE OF ENVIRONMENTAL CONDITIONS ON CATCH RATES



Catch Rates and River Discharge

The guides who participated in this project consider river discharge to have a considerable impact on fishing success. We conducted a regression analysis to compare catch rates for smallmouth bass and muskellunge with discharge. This analysis included days with mitigating conditions to capture fishing under extreme discharge. A separate model was constructed for each species x river combination. Generally speaking, catch rates for both smallmouth bass and muskellunge demonstrated a negative trend with increasing discharge. However, in all but one case (smallmouth bass in the Flambeau River) the trend was not statistically significant (Figure 11). Future data collection may allow us to better describe this relationship. Similarly, more data may allow for exploration of quadratic or nonlinear relationships, which may effectively allow for determination of "ideal" discharge conditions for catching each species.

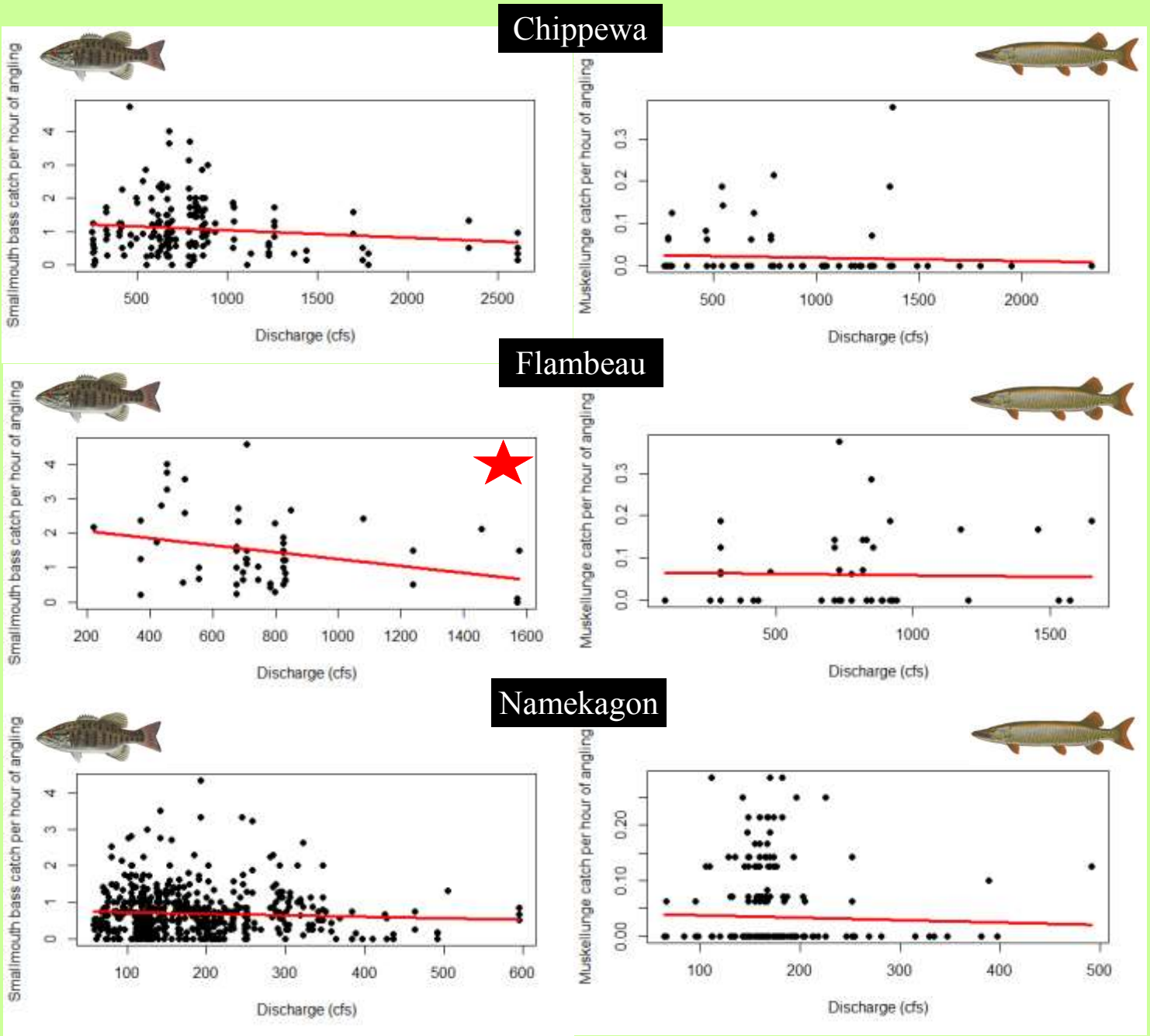


Figure 11. Comparison of skill level corrected catch rates for smallmouth bass (left column) and muskellunge (right columns) with river discharge (cubic feet per second) on the day of fishing for guided anglers on three northwestern Wisconsin rivers from 2012-2016. A red star in a panel demotes a statistically significant relationship ($P<0.05$).

Catch Rates and River Level Changes

Changing river conditions prior to a day of fishing is also considered to be an important factor determining fishing success. We compared catch rates for smallmouth bass and muskellunge from all rivers under three different conditions: falling water level (>15% drop in discharge over 3 days), flat water level (<15% change in discharge over 3 days), and rising water level (>15% increase in discharge over 3 days). Catch rates for smallmouth were significantly higher under flat water conditions compared to rising water (Figure 12). A similar pattern appears to be present for muskellunge, though it was not statistically significant.

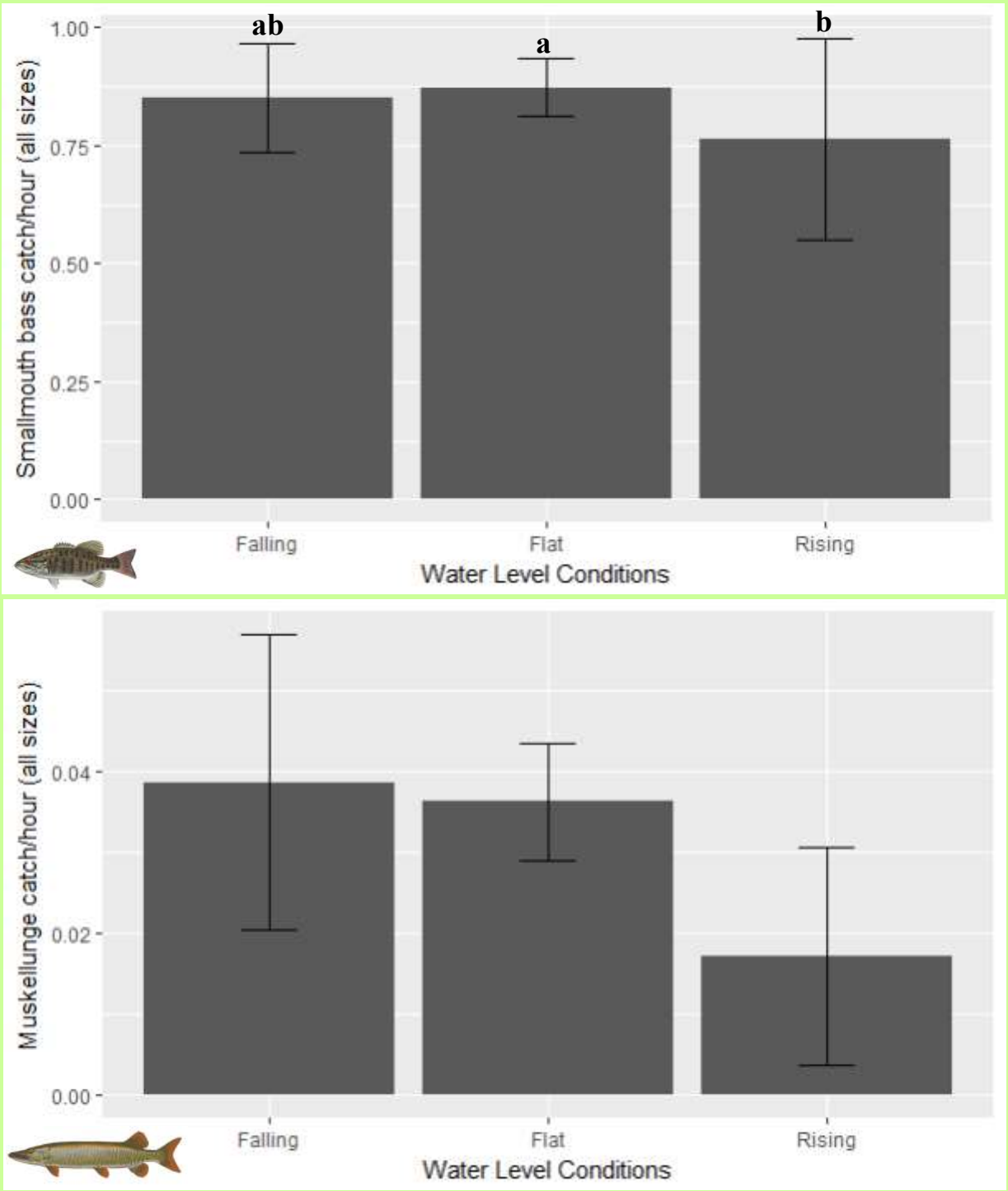


Figure 12. Skill level corrected catch rates of smallmouth bass (top panel) and muskellunge (bottom panel) under three different river conditions. Data was collected by in northwestern Wisconsin fished by guides and their clients from 2012-2016. Error bars represent 95% confidence intervals. Letters represent statistically significant groupings.

Catch Rates and Water Temperature

Water temperature is an important factor determining many aspects of fish behavior. Guides participating in this project collect daily water temperature data on-site at noon in a shaded area. We compared catch rates for smallmouth bass and muskellunge with water temperature across all rivers (Figure 13). Smallmouth bass demonstrated a significant positive relationship between water temperature and catch rate. This result matches the observed higher catch rates in peak summer months. There was no statistically significant trend between muskellunge catch rate and temperature, but there was an indication of higher catch between 50-70F.

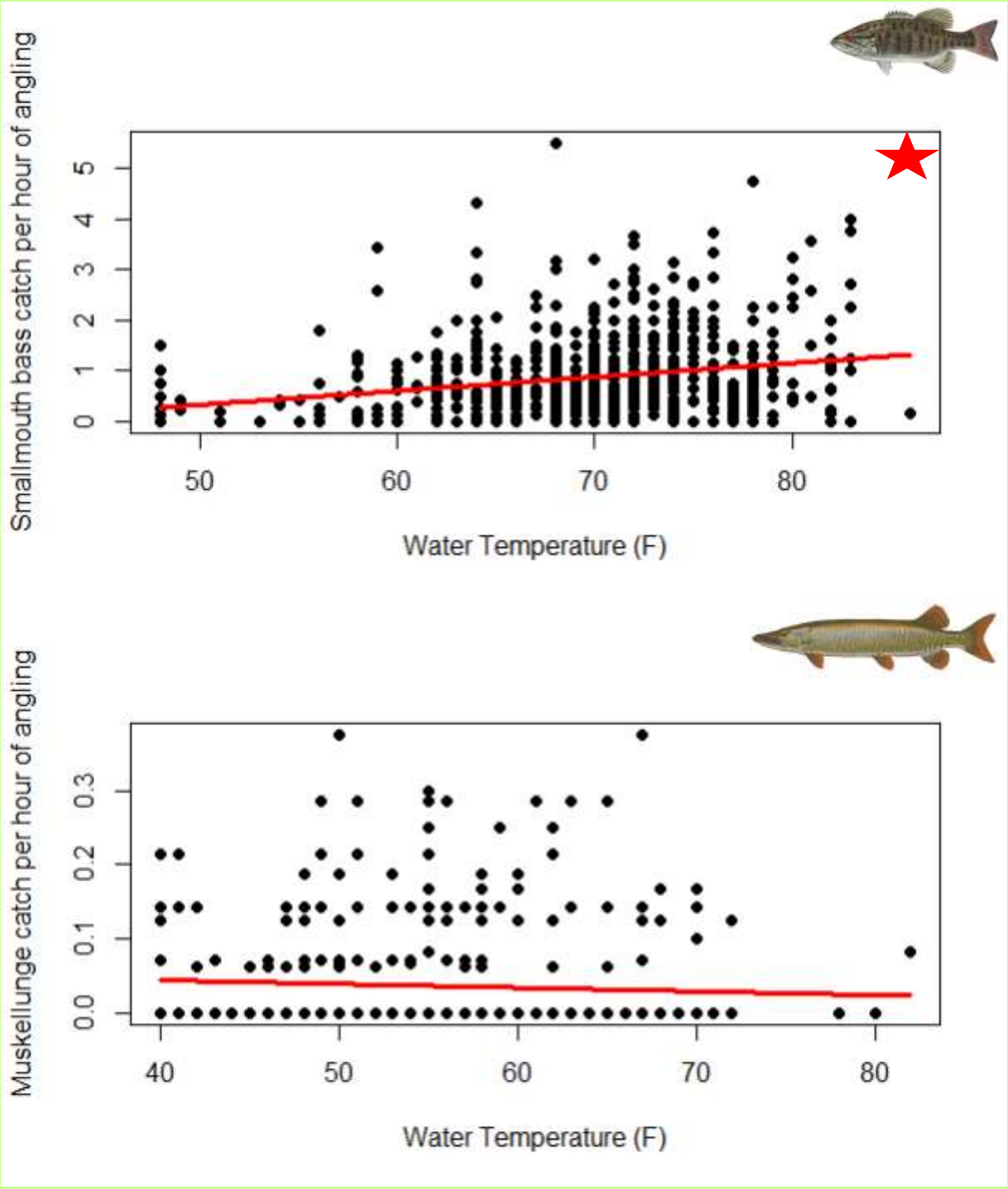


Figure 13. Comparison of skill level corrected catch rates for smallmouth bass (top panel) and muskellunge (bottom panel) with water temperature on the day of fishing for guided anglers on three northwestern Wisconsin rivers from 2012-2016. A red star in a panel demotes a statistically significant relationship (P<0.05).

CATCH RATES FOR OTHER SPECIES

Catch Rate of Northern Pike and Other Species

While smallmouth bass and muskellunge were the target species for all trips included in this project, other predator species were caught incidentally. Guides recorded all incidental catch which provided at least a limited amount of information on northern pike, walleye, and largemouth bass populations. Catch rates for northern pike were significantly higher on the Namekagon River in comparison to the Flambeau River, with the Chippewa River being intermediate (Figure 14). Overall, incidental catch rate of northern pike was similar to that of targeted catch rate for muskellunge. Northern pike density appears to be relatively low in these rivers in comparison to lakes in the area. Incidental catch of walleye and largemouth bass was rare. Only 22 walleye were caught in 1,486 angler days of fishing. Walleye are believed to be more common in these rivers than the low catch would indicate. As a result, we believe that fly fishing guide data may not be a representative way to sample walleye populations in rivers. Only 34 largemouth bass were captured incidentally as a part of this project. Based on their similarities to smallmouth bass we feel more confident that the low catch of largemouth bass is, in fact, representative of the populations in these rivers. Largemouth bass likely occur at a very low density in these fast, rocky rivers. Largemouth bass are generally considered to be better suited for lake environments.

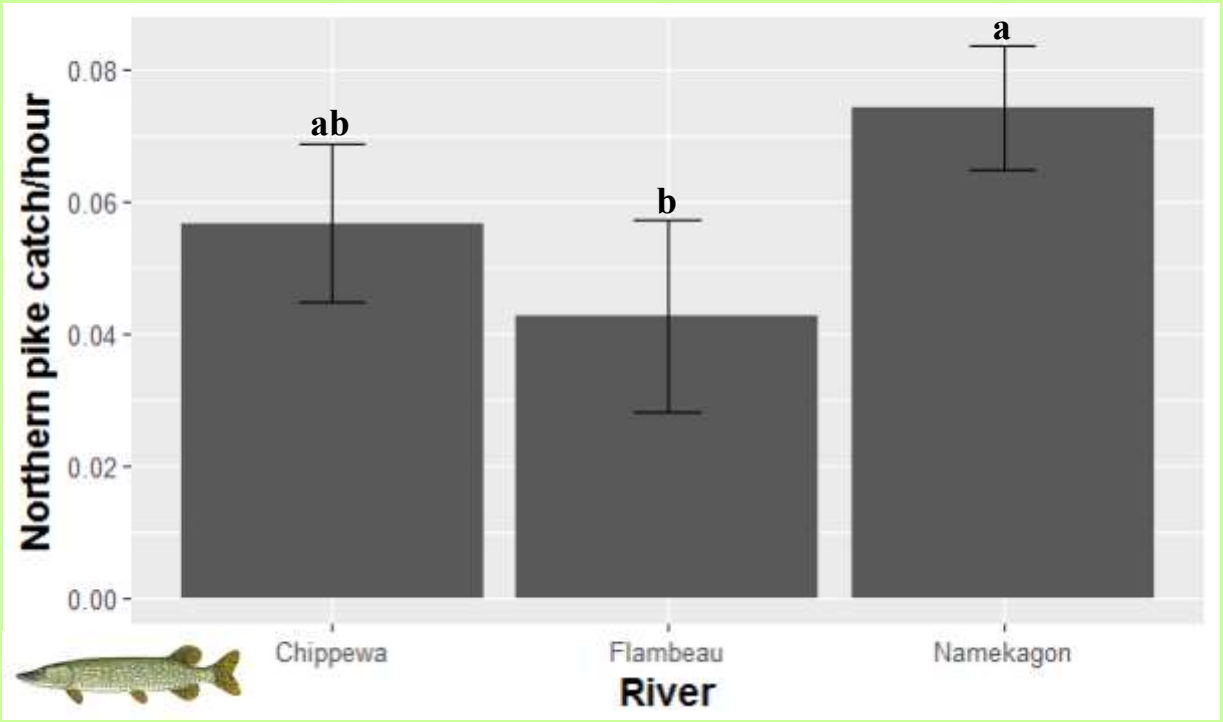


Figure 14. Northern pike incidental catch rates (number per hour of total angling) in three rivers in northwestern Wisconsin fished by guides and their clients from 2012-2016. Error bars represent 95% confidence intervals.