Smallmouth Bass and Muskellunge Fisheries in Three Northwestern Wisconsin Rivers

"Guide to the Future" Project Report, 2014

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and

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Photos courtesy of Hayward Fly Company:
https://www.facebook.com/HaywardFlyFishingCompany/photos_stream?ref=page_internal#!/HaywardFlyFishingCompany/photos_stream

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Acknowledgements

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Summary of Major Findings

- Predictable differences in catch rate among anglers with different skill levels were observed for both smallmouth bass and muskellunge. Understanding these differences is necessary to control against biased interpretation of catch rate date. Correction factors were developed and applied to control against biases created by spatial and temporal patterns in angler skill level.

- Angler catch rates of smallmouth bass on the Flambeau River were significantly higher than on the Namekagon or Chippewa rivers during the course of this project to date. This difference was largely driven by high catch rates of smallmouth bass <14 inches long.

- Anglers fishing these rivers with guides experienced catch rates for both muskellunge and smallmouth bass that were typically 2-3 times higher than the northern Wisconsin average for unguided anglers on lakes. However, 2014 was a relatively poor year for catch rate of both species. Guides believe that inconsistent flow rates and a truncated season reduced catch rates. This theory is at least partially supported by discharge data.

- Anglers targeting muskellunge encountered 2-3 muskellunge for every one caught.

- Northern pike were a common incidental catch in these rivers and have a similar catch rate to muskellunge.

- Walleye and largemouth bass were rarely caught on these guided trips and are not targeted specifically. This method of monitoring may not be effective for indexing their relative abundance.

- Overall catch rate for smallmouth bass was highest during peak summer months (July/August). There was no significant monthly trend in muskellunge catch rates due to high variability. However, when conditions allow for summer (June-August) muskellunge fishing, catch rate appears to be comparable if not higher than in fall when most muskellunge effort is typically expended.

- Increasing river discharge had a negative effect on smallmouth bass fishing on the Namekagon and Chippewa River. There were no significant relationships detected between discharge and smallmouth bass catch rate on the Flambeau or with muskellunge catch rate on any of the three rivers. However, whether statistically significant or not, all catch rates indicated a negative relationship with discharge which supports the hypothesis that fishing is compromised under high discharge. The discharge cutoff where fishing quality begins to diminish varies between the three rivers.

- Catch rate for smallmouth bass on the Namekagon River was higher when water was stable compared to when it was rising. In general, rising water appeared to have a negative effect on fishing quality for both smallmouth and muskellunge (with muskellunge in the Flambeau being the exception) but high variability in catch rates limited the statistical significance of results, particularly for muskellunge.

Introduction and Project Objectives

Medium and large rivers often hold exceptional and popular recreational sportfish populations. In northern Wisconsin rivers, smallmouth bass and muskellunge are the dominant sportfish, though northern pike and largemouth bass are present and walleye can be important seasonally. Due to a variety of factors including current, water clarity, structural complexity, and access, these 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 2014 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 the general public. In the third year of this project, we enlisted four guides from the Hayward Fly Fishing Company to collect data on the Flambeau, Chippewa, and Namekagon rivers (Price, Sawyer, Rusk, Washburn, and Burnett counties). In total, there have been 883 completed angler trips documented on these rivers in the first three years of this project. The data can be used to inform management decisions regarding fishing regulations, water level management, access, and fish passage.

General Methods

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. Because skill level for each angler was expected to vary, guides discreetly rated their clients as inexperienced beginners, average anglers, or experts. These classifications are used later to standardize and interpret data. Fly-fishing gear was used exclusively, and all flies had single barbless hooks (some muskellunge flies had a second, trailing single hook).

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 series of reports 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 but are known to WDNR personnel. Individual reaches were rarely fished on sequential days. Data collection began in late June during the 2012 pilot season, early May in 2013, and late May in 2014. Three rivers were fished enough to provide useful information for this report – the Flambeau (Figure 1, Price and Sawyer counties), Chippewa (Sawyer and Rusk counties), and Namekagon (Sawyer, Washburn, and Burnett counties).

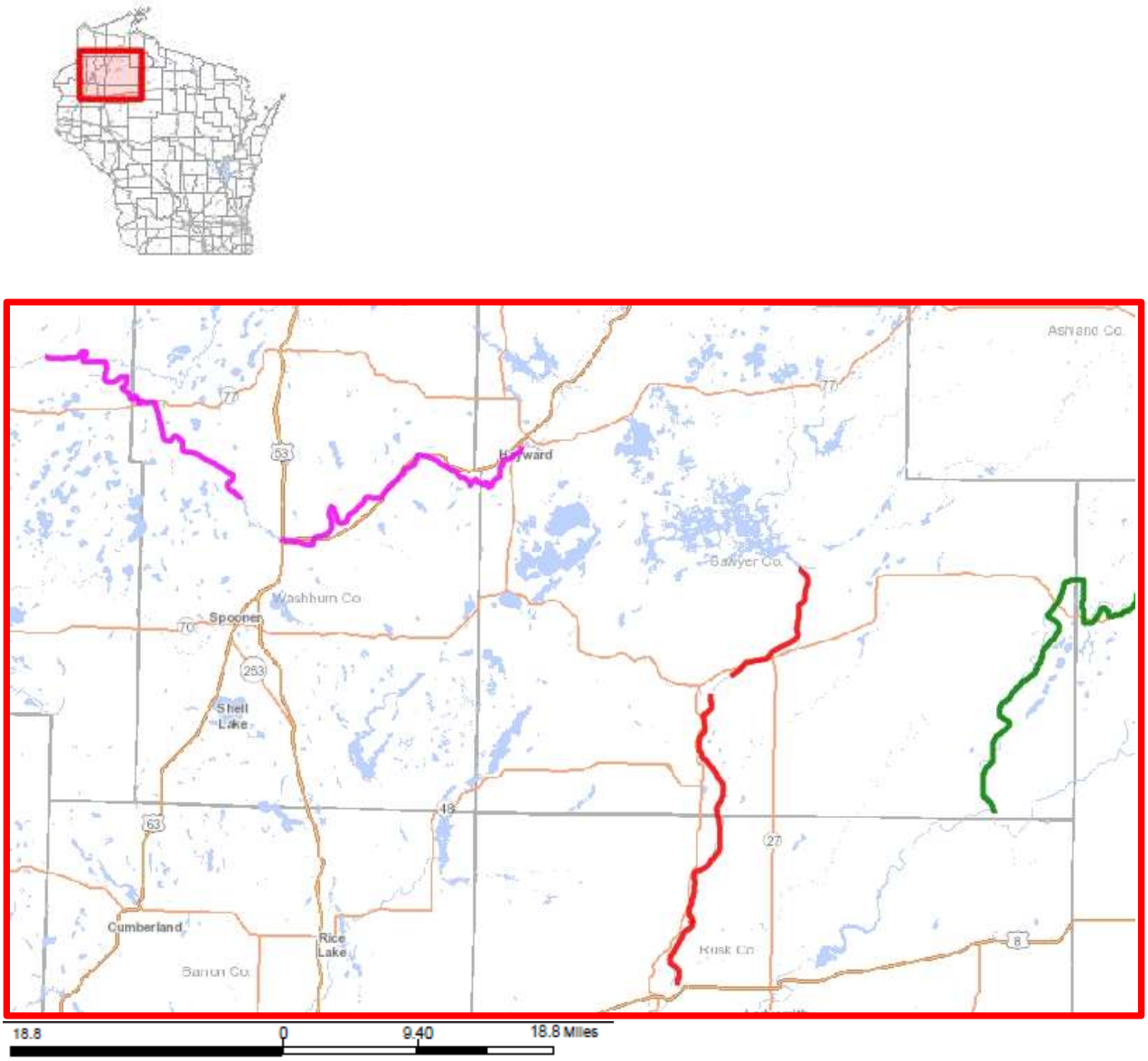


Figure 1. Area fished by guides on the Namekagon (purple), Chippewa (red), and Flambeau (green) rivers in 2012 and 2013.

Each captured fish was recorded on a labeled 12-key mechanical counter (MC-12 counters purchased at http://store.controlconceptsusa.com for $383.00 each) 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. Fish were not always measured but were often assigned to these bins by guides based on their ability to estimate length. Guides also recorded catches, but not sizes, of northern pike, walleye, and largemouth bass. Having two weather-resistant mechanical counters in each drift boat greatly facilitated data recording by guides who needed to remain focused on boat control, client safety, and client satisfaction (measuring and photographing fish) rather than spending time recording individual catches or encounters on paper data forms. Guides found it convenient to simply push

a button during moments of peak activity (especially in fast water or bad weather), then complete their data forms carefully after tallying results from the counters at the end of the trip.

"Encounters" with muskellunge were recorded whenever a fish followed but did not strike, struck and missed, or was lost after hooking but before landing. Such events are believed to contribute to the quality of fishing for trophy species like muskellunge even when no fish are actually caught. If there were multiple encounters with what was believed to be the same fish, only one encounter was recorded.

Each guide recorded daily water temperature (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 was obtained from USGS gauges on the Namekagon River (Leonard School) and Chippewa River (Bishop's Bridge), and from a database maintained by Flambeau River Papers at their dam on the Flambeau River (accessed through DNR WAMS database). These gauges were determined to provide the most representative description of conditions that guides encountered on these rivers. Daily discharge (cubic feet per second) was recorded for each day of fishing using the noon measurement from the 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). This classification system was used to determine the effects of river discharge and changing water level conditions on catch rates between 2012 and 2014.

All 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. The 2014 version of this report primarily examines aggregate data from the first three years of this project to make general conclusions about differences in angling success between rivers, times of year, and in-stream conditions. However, data from individual years is also presented in some segments. As future years of data are added to this dataset it may become possible to examine trends in river populations through time. 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 were made using standard linear regression. Results of statistical tests were considered significant at P values less than 0.05 (less than a 5% chance of incorrectly concluding a tested difference was real).

Description of Angling Effort

In 2014, data were recorded from 309 anglers totaling 1,317 hours of smallmouth bass effort and 907 hours of muskellunge effort. In most years total fishing effort, particularly for muskellunge, is spread somewhat evenly among the Chippewa, Flambeau, and Namekagon Rivers. But because of high flow rates on the Chippewa and Flambeau Rivers in 2014, more fishing effort was directed toward the Namekagon River. In 2014, including only days without mitigating conditions, the Flambeau River was fished for 156 hours (81 smallmouth bass and 75 muskellunge), the Chippewa River was fished for 523 hours (336 smallmouth bass and 187 muskellunge), and the Namekagon River was fished for 1,545 hours (900 smallmouth bass and 645 muskellunge). Total amount of effort across all three rivers in the first three years of this project is 6,429 angling hours. Reaches fished by guides have been relatively constant throughout time and total 56 river-miles on the Namekagon, 39 on the Chippewa, and 37 on the Flambeau (Figure 1).

Between 2012 and 2014 only 7.6% of all guided trips were considered to be under conditions that mitigated fishing success based on the judgment of the guides. The most common factors thought to mitigate angling success were high/dark water and high water temperature in peak summer months.

Between 2012 and 2014 there were 209 individual anglers rated as beginners, 331 rated as average, and 280 rated as experts. Expert anglers were more interested in targeting muskellunge than average or beginning anglers. There were only minor differences in the guide-

rated skill level of anglers between the Chippewa and Flambeau River rivers over the course of this project (Figure 2). However, the Namekagon was a more popular destination for guides to take beginner or average anglers. A likely explanation for this pattern is that the Namekagon is closer to the guide's base of operations.

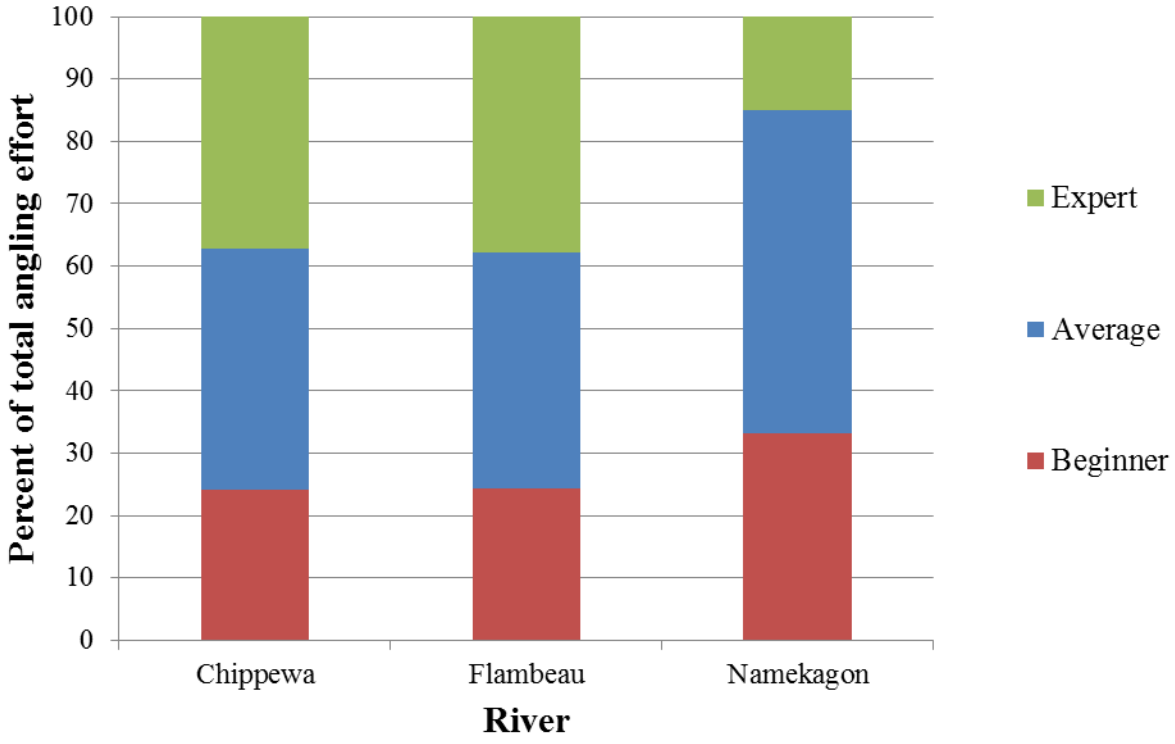


Figure 2. Guide-rated angler skill level, by river, from 2012-2014.

Effect of Angler Skill on Catch Rates

Angler skill level had a significant effect on catch rates of smallmouth bass (all sizes). As expected, the catch rate of experts ranked significantly higher than that of inexperienced beginners or average anglers ($P < 0.01$, Figure 3). Average anglers had significantly higher ranking catch rate than inexperienced beginners ($P < 0.01$).

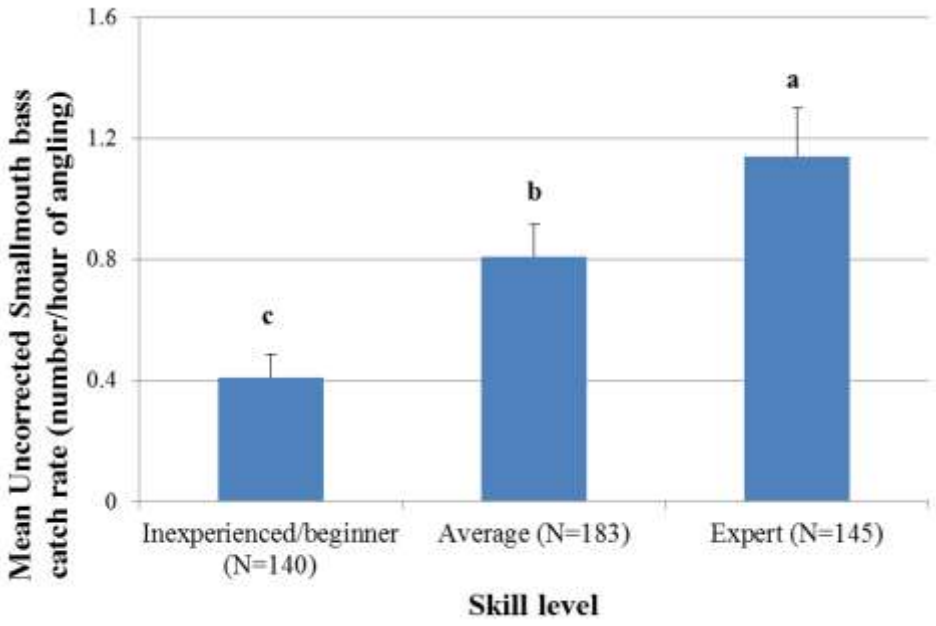


Figure 3. Mean catch rates of smallmouth bass targeted by guided anglers of different skill levels in three northwestern Wisconsin rivers between 2012 and 2014. Error bars represent 95% confidence intervals about the mean. Sample size (N) is shown in parenthesis. Significantly different groupings ($P < 0.05$ from K-W test) are denoted with different letters.

Angler skill level had a similar effect on catch rates of muskellunge (all sizes), with expert anglers exhibiting higher ranking catch rates than inexperienced beginners and average anglers ($P < 0.01$ for both comparisons, Figure 4). Average-rated anglers had catch rates that were not significantly different than inexperienced beginners ($P = 0.09$).

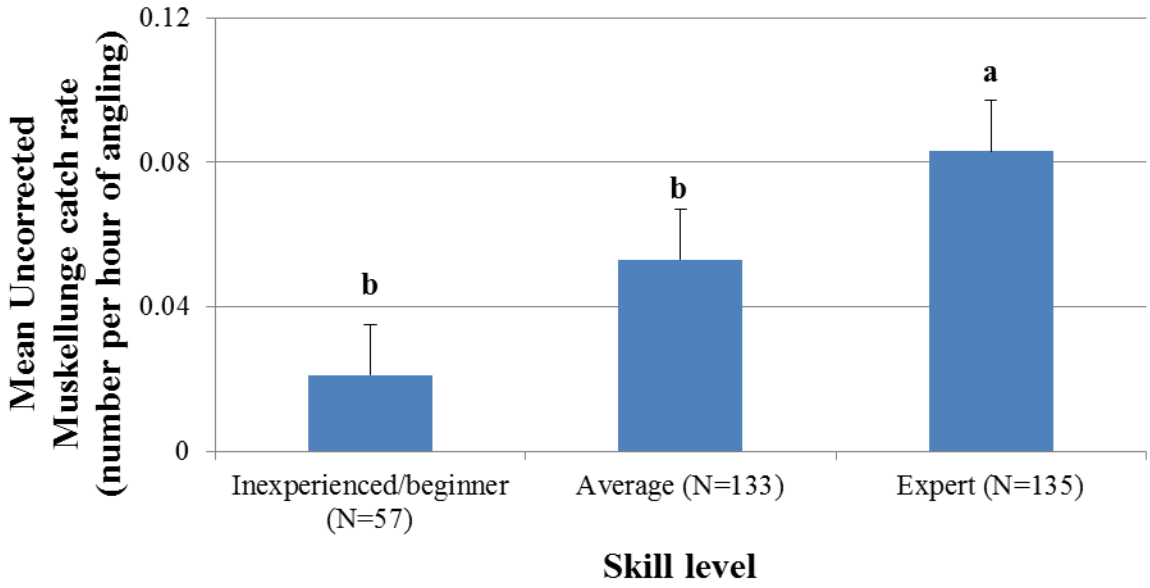
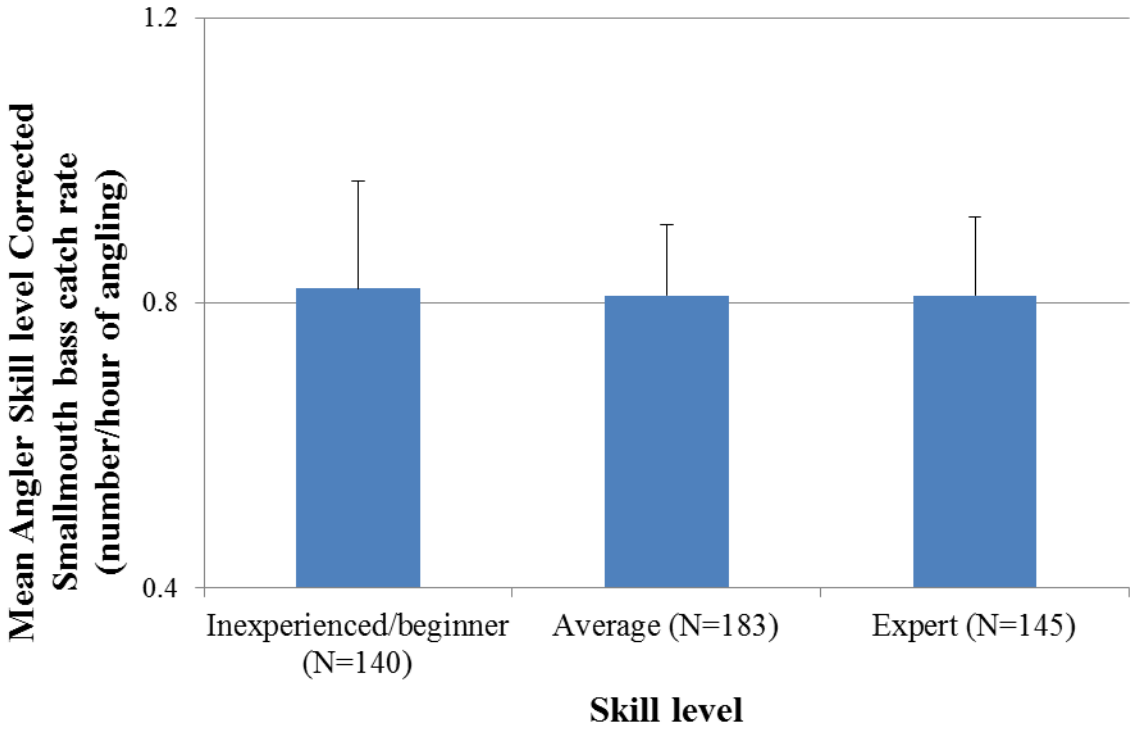


Figure 4. Mean catch rates of muskellunge targeted by guided anglers of different skill levels in three northwestern Wisconsin rivers between 2012 and 2014. Error bars represent 95% confidence intervals about the mean. Sample size (N) is shown in parenthesis. Significantly different groupings ($P < 0.05$ from K-W test) are denoted with different letters.

Development of a correction factor for angler skill level

A correction factor was developed to standardize for angler skill level in the catch rate data. This was deemed necessary after significant differences were observed in angler catch rates of both species across the three skill levels, and because uneven distribution of skill level among strata (i.e. river) existed. The correction factor was centered on the average angler group and involved applying a correction factor of 1.98 for smallmouth bass CPE (catch per effort) of beginners and 0.71 for smallmouth bass CPE of experts. For muskellunge data, CPE of beginners was corrected with a factor of 2.52 and CPE of experts was corrected with a factor of 0.64. Following correction, data can be interpreted as if all anglers on a given trip were of average angling experience which will allow more meaningful comparisons between strata that might otherwise have been biased by angler skill. Figures 5a and b show *corrected* smallmouth bass and muskellunge catch rates (respectively) by angler skill level.

a.



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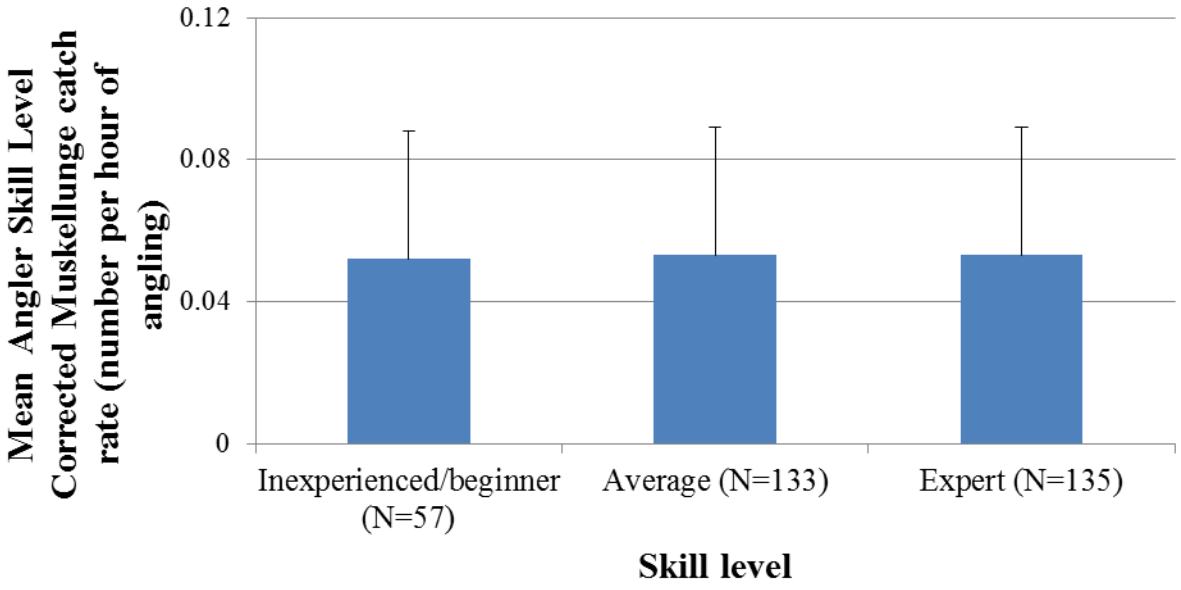


Figure 5a and b. Corrected catch rates across three classes of angler skill rating for smallmouth bass (a) and muskellunge (b) in three northwestern Wisconsin rivers between 2012 and 2014.

Relative Abundance and Size Structure of Smallmouth Bass

Smallmouth bass were the most frequently caught gamefish in most reaches fished by volunteer guides during this project. Average catch rate of smallmouth bass for guided fly fishers in these rivers is close to one fish per hour of angling, exceeding average angler catch rate of smallmouth bass on northern Wisconsin lakes (~one fish per three hours of directed effort).

We observed significant differences in catch rates of smallmouth bass among the Flambeau, Chippewa, and Namekagon rivers. Average catch rate of smallmouth bass was significantly higher in the Flambeau River than in the Chippewa and Namekagon rivers over the course of this project ($P < 0.01$, Table 1). This difference was largely the result of a particularly high catch rate of sublegal (<14 inches) smallmouth bass in the Flambeau. Smallmouth bass over 17 inches are caught at a significantly higher rate in the Namekagon and Chippewa rivers compared to the Flambeau where these fish are relatively rare (Table 1, Figure 6). Growth rate analysis of smallmouth bass in these rivers may shed further light on the observed size structure of angler caught bass and should be conducted in the future. Regardless, the results of this project have interesting implications for anglers looking to plan fishing trips for smallmouth bass in this area. The Flambeau River offers an "action" experience with high catch rates of mostly smaller fish, while the Namekagon and Chippewa offer better odds of catching larger fish but at a lower overall catch rate. These types of relationships are well understood among muskellunge fisheries, but have been less explored for smallmouth bass populations in rivers.

Table 1. Skill level corrected catch rates (fish per hour) of smallmouth bass, by size class, on three northwestern Wisconsin rivers between 2012 and 2014. Significantly different groupings ($P < 0.05$ from K-W tests) are denoted with different letters.

Smallmouth bass size class	River			P Value
	Chippewa	Flambeau	Namekagon	
7-11 inches	0.33 (±0.08)b	0.79 (±0.25)a	0.13 (±0.02)c	<0.01
11-14 inches	0.28 (±0.07)b	0.43 (±0.13)a	0.19 (±0.03)c	<0.01
14-17 inches	0.24 (±0.06)	0.29 (±0.10)	0.22 (±0.03)	0.51
17+ inches	0.09 (±0.03)a	0.03 (±0.02)b	0.10 (±0.02)a	<0.01
All sizes	**0.94 (±0.14)b**	**1.54 (±0.33)a**	**0.65 (±0.07)c**	**<0.01**

In the Namekagon, 52% of all smallmouth bass captured by anglers were ≥ 14 inches, while only 39% and 21% were of legal size in the Chippewa and Flambeau rivers, respectively. This pattern of larger fish in the Namekagon and smaller fish in the Flambeau has been consistent throughout the three year span of this project (see Figure 6 for size histograms). Growth rate analysis may reveal if the resulting poor size structure in the Flambeau is slow growth arising from competition for limited prey resources. If growth rates are similar among the three rivers an alternate explanation may be that there is some type of adult mortality limiting longevity of smallmouth in the Flambeau that does not occur in the other rivers. We hope to conduct a growth rate analysis within the next few years to compliment this catch rate data, provided that samples can be collected.

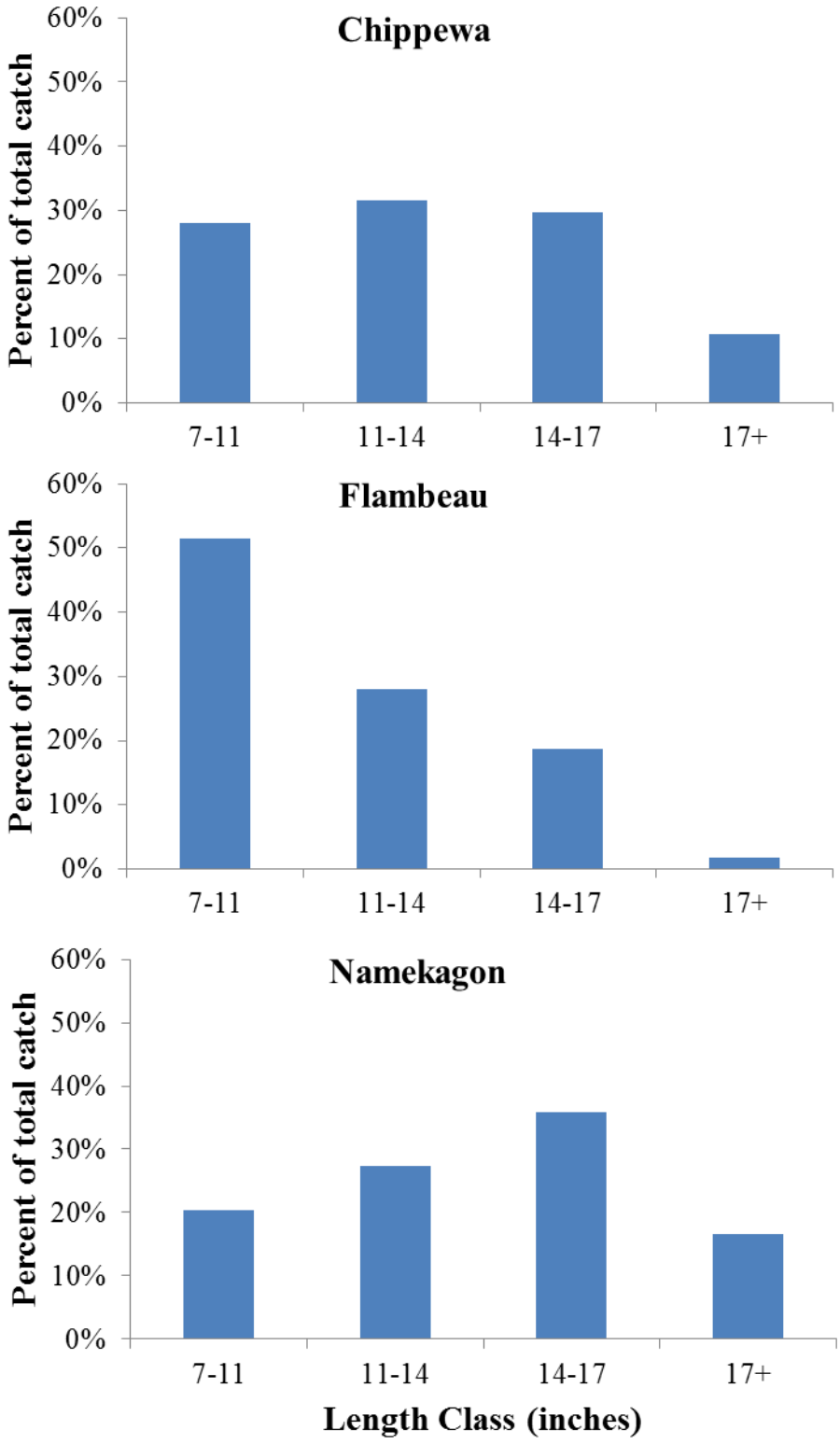


Figure 6. Relative size structure of smallmouth bass caught by guided fly fishing anglers in three northwestern Wisconsin rivers in between 2012 and 2014.

Relative Abundance and Size Structure of Muskellunge

Catch rate of muskellunge between 2012 and 2014 ranked significantly higher in the Flambeau River than in the Chippewa or Namekagon rivers ($P < 0.01$, Table 2). This difference was driven in part by high catch rates of muskellunge in the 20-30 inch size class in the Flambeau. There were no other significant differences in catch rate of specific size classes among rivers. Overall, muskellunge catch rate averaged 1 fish per 14 hours of angling during the course of this project, although that number has varied considerably by year. This overall catch rate for guided fly fisherman on these rivers compares very favorably to the Wisconsin statewide average for lakes (1 musky per 34 hours of angling effort) and to many Sawyer County lakes (Chippewa Flowage = 54 hours, Teal Lake = 24 hours, Spider Lake Chain = 13 hours).

Table 2. Angler skill level corrected catch rates (fish per hour) of muskellunge, by size class, on three northwestern Wisconsin rivers between 2012 and 2014. Significantly different groupings ($P < 0.05$ from K-W tests) are denoted with different letters.

Muskellunge	River			
Size class	Chippewa	Flambeau	Namekagon	P Value
20-30 inches	0.023 (±0.022)b	0.044 (±0.021)a	0.019 (±0.010)b	<0.01
30-40 inches	0.029 (±0.022)	0.029 (±0.015)	0.018 (±0.008)	0.27
40-50 inches	0.006 (±0.008)	0.003 (±0.003)	0.004 (±0.005)	0.85
50+ inches	0.000 (±0)	0.000 (±0)	0.001 (±0)	NA
All sizes	**0.058 (±0.033)b**	**0.075 (±0.024)a**	**0.041 (±0.014)b**	**<0.01**

Muskellunge between 20 and 40 inches long dominated the catch; and there was no major difference in size distribution among the three rivers (Figure 6). Each river produced several fish over 40 inches long. A 50 inch fish was caught in the Namekagon River in 2014.

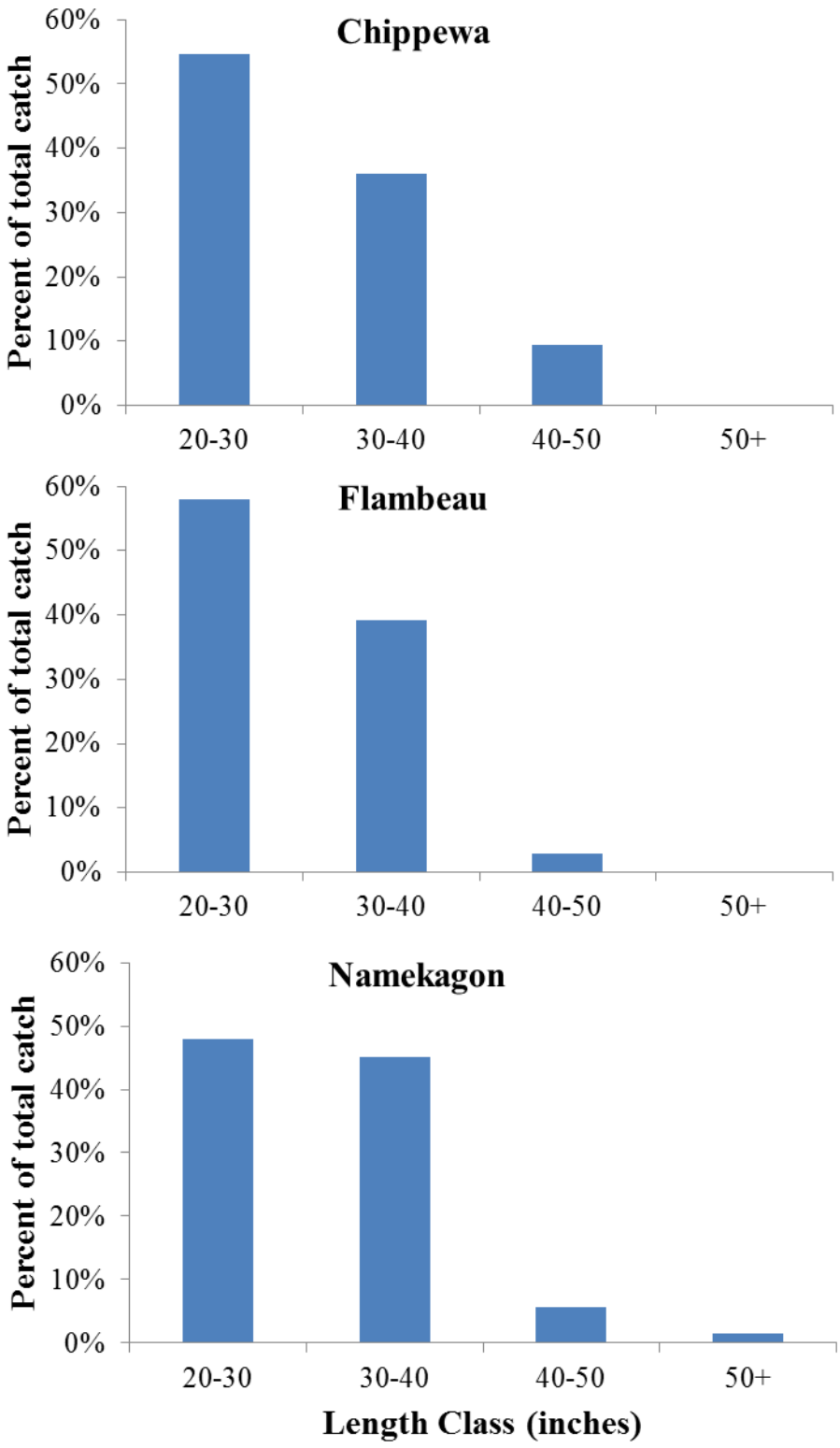


Figure 7. Relative size structure of muskellunge caught by guided fly fishing anglers in three northwestern Wisconsin rivers between 2012 and 2014.

Muskellunge Encounters vs. Muskellunge Catch

Guides recorded encounters with muskellunge that did not result in fish being landed. "Encounters" were defined as follows, strikes, and fish hooked but lost before they could be fully subdued and intentionally released. Stratifying results by angler skill level allowed us to quantify an element of musky fishing quality and proficiency that typically goes undocumented. On average, two to three muskellunge were encountered for every fish caught (see "Capture frequency" column in Table 3). Applying this ratio to the average catch rate of one fish every 14 hours, guided anglers who targeted muskellunge were encountering (and sometimes catching) a fish roughly every 5 hours on these rivers.

In 2014 capture frequencies among the three skill levels followed a predictable pattern with experts landing a higher percentage of encountered fish than average or beginner anglers. Overall capture frequency has stayed relatively consistent during the three years of this project with around 30% of all encounters resulting in a catch.

Table 3. Summary of muskellunge catches and encounters among anglers with different skill levels in three northwestern Wisconsin rivers between 2012 and 2014. Capture frequency = fish caught / total encounters + fish caught x 100.

Year	Skill level	Fish caught	Fish encountered but not caught	Total encounters + fish caught	Capture frequency
2012	Inexperienced	2	7	9	22%
	Average	4	28	32	13%
	Expert	15	44	59	25%
	Not assigned	49	124	173	28%
	Total/Average	**70**	**203**	**273**	**26%**
2013	Inexperienced	5	6	11	45%
	Average	23	60	83	28%
	Expert	44	61	105	42%
	Total/Average	**72**	**127**	**199**	**36%**
2014	Inexperienced	3	19	22	14%
	Average	16	35	51	31%
	Expert	19	34	53	36%
	Total/Average	**38**	**88**	**126**	**30%**

Relative Abundance and Distribution of Other Species

Only 9 walleyes and 29 largemouth bass have been caught by guided anglers during the 6,429 total hours of angling documented in this project. This is a very low catch rate even for incidental/non-target species. This probably reflects relatively low abundance of these species, but it does not preclude the possibility of high seasonal use of these rivers by walleyes during their early-spring spawning migrations upstream from various flowages (before these guided angling trips typically begin each spring). It is also possible that the methods used by anglers in this project are not particularly effective for these species. This would not be surprising since effort is specifically targeted at smallmouth bass and muskellunge which have different behavior than these other species. Our general conclusion based on the extremely low capture rates of these species is that this method of monitoring is probably not useful for generating any catch/per/effort statistics, but may only be tentatively useful for determining presence of these species in different reaches.

Table 4. Total angling hours and total catch of walleye and largemouth bass on three northwestern Wisconsin rivers between 2012 and 2014 by guided fly fishing anglers.

River	Total angling hours	Walleye caught	Largemouth bass caught
Chippewa	1928	1	0
Flambeau	966	1	2
Namekagon	3535	7	27

Northern pike were captured in the Namekagon River at a rate that was almost double that of the Chippewa or Flambeau rivers, but this difference was not statistically significant due to high variability ($P = 0.12$, Figure 7). In general, catch rates for northern pike were similar to that of muskellunge. Monitoring pike over a long time scale will be important as the climate warms. Predictive models suggest that within a few decades northern Wisconsin rivers, such as the ones fished in this project, will be too warm for northern pike to inhabit.

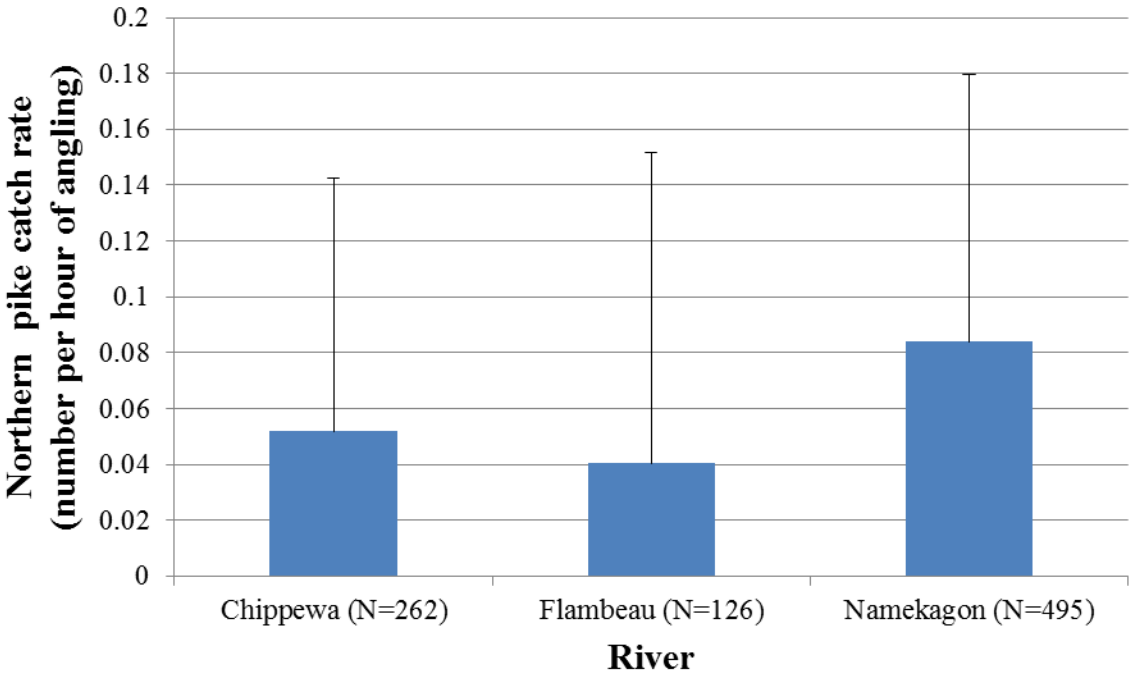


Figure 8. Incidental catch rate of northern pike by guided anglers in three northwestern Wisconsin rivers between 2012 and 2014. Error bars represent 95% confidence intervals about the mean. Sample size (N angler trips) is shown in parenthesis.

Effects of Season and River Discharge on Catch Rates

Average monthly catch rate of smallmouth bass ranked highest in July during the course of this project (Figure 9). In general, monthly catch rates mirror summer temperatures with the highest catch rates during the warmest months. Surprisingly, catch rates of smallmouth bass in May and June are consistently lower than other months, despite the presumed increase in sight-fishing vulnerability of male smallmouth bass on nests during those months. Catch rates drop off in September compared peak summer. There is increasing evidence that in mid-September smallmouth bass in these rivers move to the nearest flowage or deep hole where they will overwinter, making them largely inaccessible to anglers focusing on the rivers with fly fishing gear.

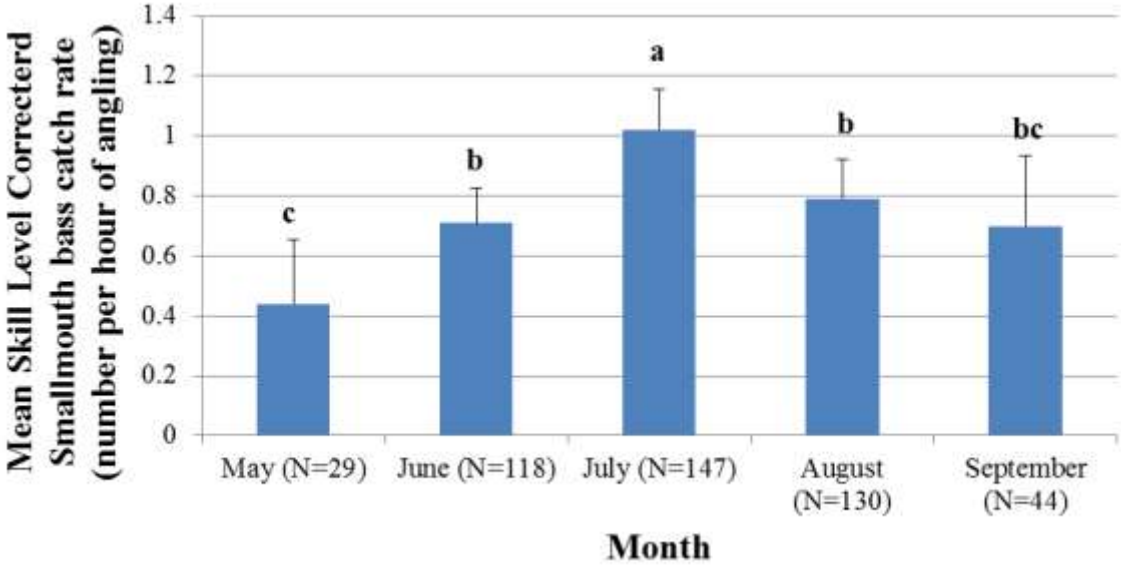


Figure 9. Corrected catch rates of smallmouth bass targeted by guided anglers, by month, in three northwestern Wisconsin rivers between 2012 and 2014. Error bars represent 95% confidence intervals about the mean. Sample size (N angler trips) is shown in parenthesis. Significantly different groupings ($P < 0.05$ from K-W tests) are denoted with different letters.

Monthly catch rate of muskellunge did not vary significantly, but low sample size (particularly in summer months when guides avoided targeting muskellunge during periods of high water temperature) and high variability in catch rate limited our ability to test differences (Figure 10). It was our expectation that muskellunge catch rates would be highest in the fall (September-November) when most of the targeted musky fishing effort occurrred, but that pattern has yet to manifest itself. Instead, the limted data for summer muskellunge fishing (when conditions allow) show indications of a higher catch rate. We will need more summertime musky fishing data in the future in order to determine if there are truly no significant seasonal differences in guided angler catch rates. However, collection of that data is dependant on favorable water temperatures througout the open water period which is rare.

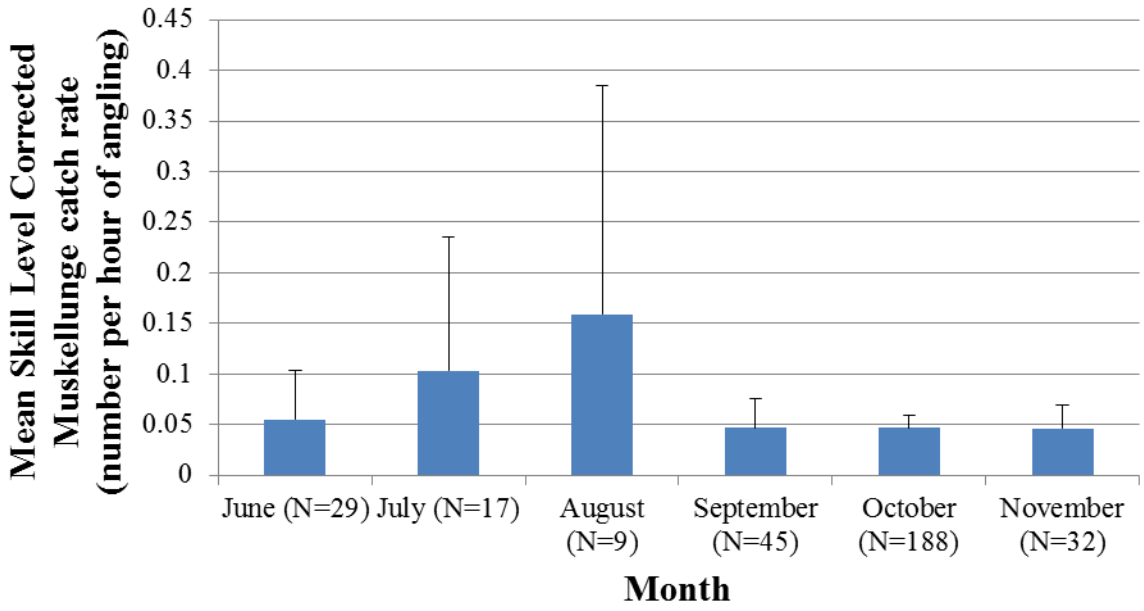


Figure 10. Corrected catch rates of muskellunge targeted by guided anglers, by month, in three northwestern Wisconsin rivers between 2012 and 2014. Error bars represent 95% confidence intervals about the mean. Sample size (N angler trips) is shown in parenthesis.

Catch rates and discharge

Water level conditions can vary greatly on these river systems from one day to the next. This variation is commonly thought to have a significant influence on fishing success by influencing both fish behavior, gear effectiveness, and general navigation. With three cumulative years of data collection on these three rivers we were able to make some comparisons of fishing quality (measured as skill level corrected catch-per-effort of all sizes of smallmouth bass and muskellunge separately) across different water level and discharge conditions. This analysis specifically *included* trips when guides noted that water level conditions had the potential to mitigate angling success. This was done to capture the full range of water level conditions experienced by guides.

Smallmouth bass catch rate in the Chippewa River was negatively related to river discharge ($P < 0.01$, Figure 11). There was no significant relationship between muskellunge

catch rate and river discharge ($P = 0.72$). In general, angling success for both smallmouth bass and muskellunge on the Chippewa River was better when discharge was less than 1,000 cfs.

There was no relationship between river discharge and catch rate of smallmouth bass or muskellunge on the Flambeau River ($P = 0.08$ and 0.72 respectively). Catch rate for both species remained relatively consistent across a wide range of observed discharges (400-1,600 cfs) although there was some evidence for decreasing quality of smallmouth bass fishing at extreme high discharge.

Smallmouth bass catch rate in the Namekagon River was negatively related to river discharge ($P = 0.01$, Figure 11). In general, smallmouth bass catch rate was highest between 100 and 200 cfs (measured at the Leonard School Bridge which is roughly 15 miles upstream from the area fished by guides) and declined considerably at flows exceeding 300 cfs. There was no statistically significant relationship between discharge and catch rates of muskellunge ($P = 0.22$) although the general trend was negative.

We are aware that guides avoid fishing these rivers on days with extreme discharge, primarily for safety reasons. But there also appears to be support for that decision from a fishing quality standpoint. It is not difficult to imagine how high, turbid water would reduce angling success for sight-feeding smallmouth bass and muskellunge in fast moving water. Each river seems to have a certain level of discharge, beyond which, fishing quality begins to deteriorate. The specific amount of discharge is of course unique to each river since they have inherently different baseline discharge. Understanding the relationship between fishing success and river discharge to the greatest possible extent will aid managers asked to make recommendations about specific flow regimes. Anglers can use this information and real-time discharge data (http://waterdata.usgs.gov/wi/nwis/rt) to plan trips at times when fishing success may be optimized, or at least not impaired, by river conditions.

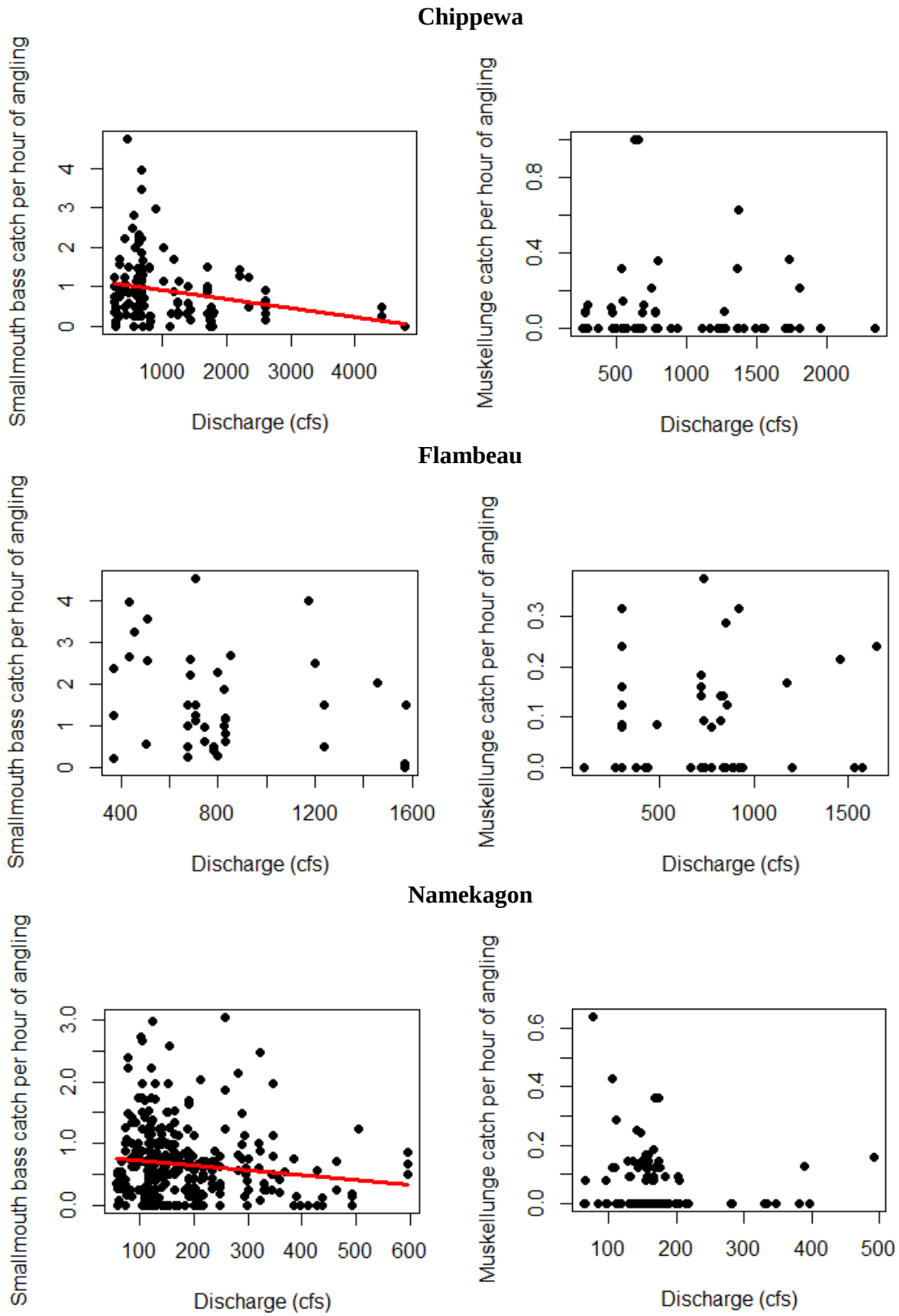
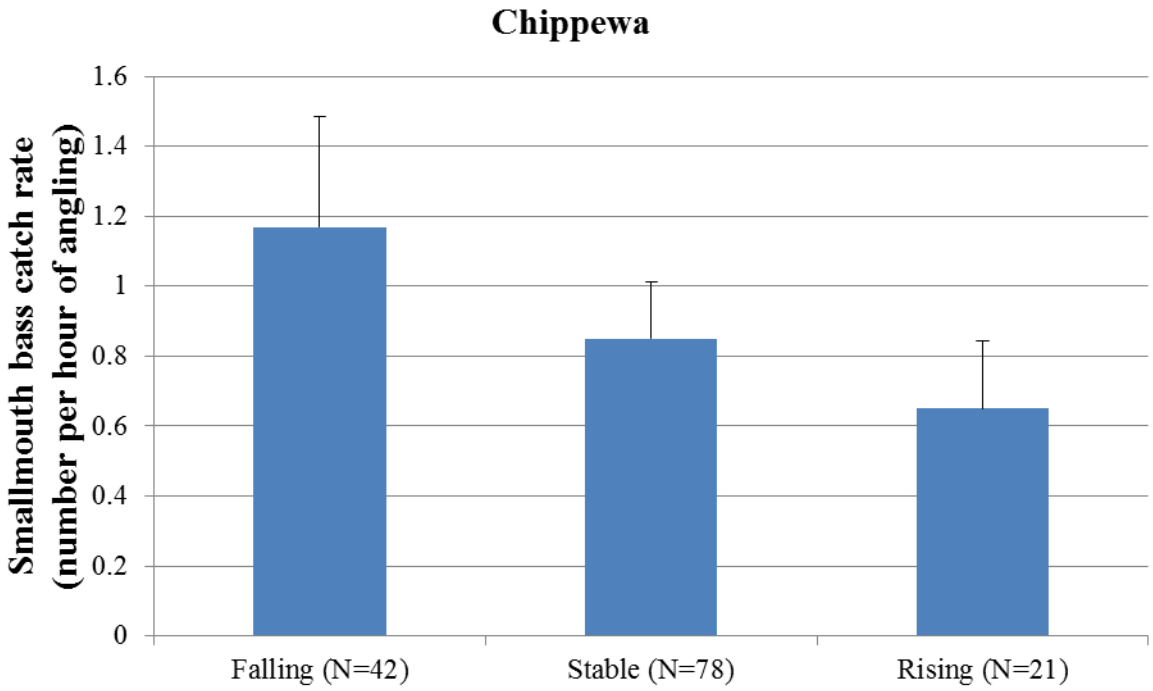


Figure 11. Skill level corrected catch rates of smallmouth bass (left panes) and muskellunge (right panes) across varying levels of river discharge in three northwestern Wisconsin rivers in 2012 and 2013 (combined). A red line indicates a significant trend ($P < 0.05$).

Changing water levels

There were no statistically significant differences in corrected smallmouth bass catch rate between rising, falling, or stable water level conditions within the Chippewa or Flambeau rivers individually (P = 0.13 and 0.80 respectively, Figure 12). In the Namekagon River, however, smallmouth bass catch rates were significantly higher during stable water conditions than when water level was rising (note: while mean values were similar between falling and stable water levels, the variability surrounding catch rates for falling water level prevented a significant difference from rising). Guided trips during rising water levels were relatively rare in all three rivers, which limited this analysis to some extent. In general, participating guides seemed to avoid rising water levels when possible and while not always statistically significant, there is some evidence suggesting lower catch rates for smallmouth under these conditions.



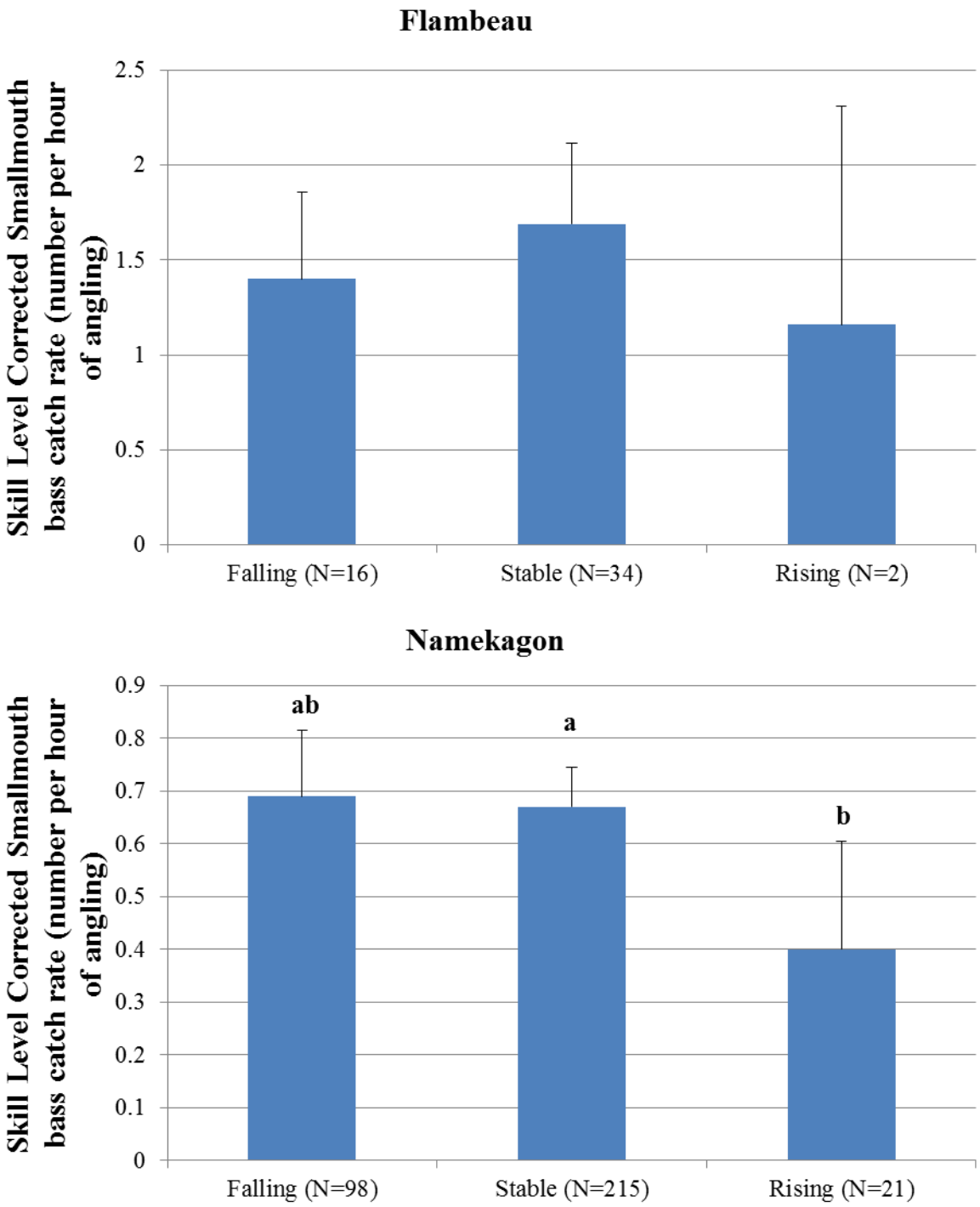
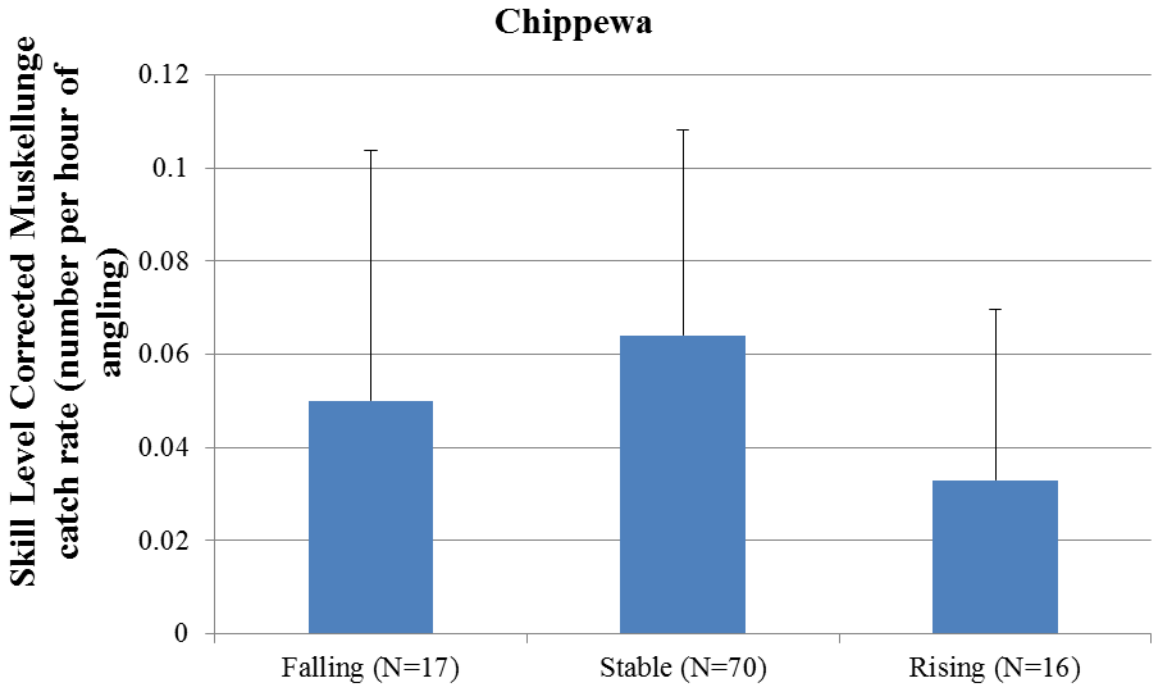


Figure 12. Comparisons of skill level corrected angler catch rates of smallmouth bass on three northwestern Wisconsin Rivers under different water level conditions between 2012 and 2014. Error bars represent 95% confidence intervals about the mean. Sample size (N guided trip days) is shown in parenthesis. Significantly different groupings ($P < 0.05$ from K-W test) are denoted with different letters

Comparisons of muskellunge catch rates under different water level conditions within each river are still somewhat limited by small sample size and high variability. As such, no significant differences in catch rate were observed between falling, stable, or rising water levels in any of the three rivers. In the Chippewa and Namekagon stable water level generally provided the best catch rates (not significant) with rising water level showing indications of lower catch rate. The pattern on the Flambeau River differed in that the highest catch rate observed was during rising water level conditions (not significant). The relationship between catch rate and in-water conditions seems to be different on the Flambeau in comparison to the other two rivers (see figures 11 and 13). The reason for the different response is not evident at this time but may be linked to water level management. The Flambeau has six major dams with a variety of functions in, and upstream, of the area fished by guides while the Chippewa has only two and the Namekagon has one.



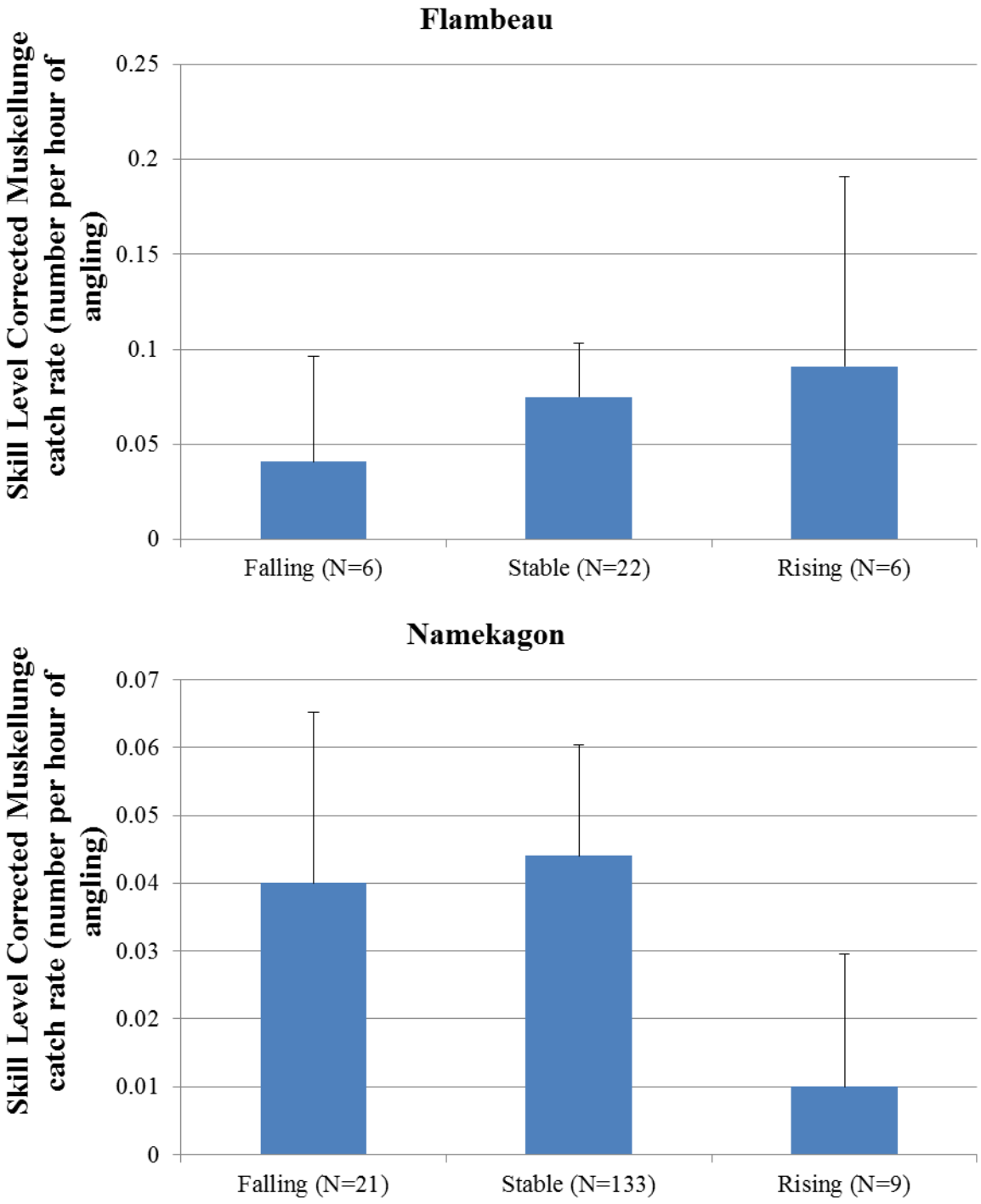


Figure 13. Comparisons of angler catch rates of muskellunge on three northwestern Wisconsin rivers under different water level conditions between 2012 and 2014. Error bars represent 95% confidence intervals about the mean. Sample size (N guided trip days) is shown in parenthesis.