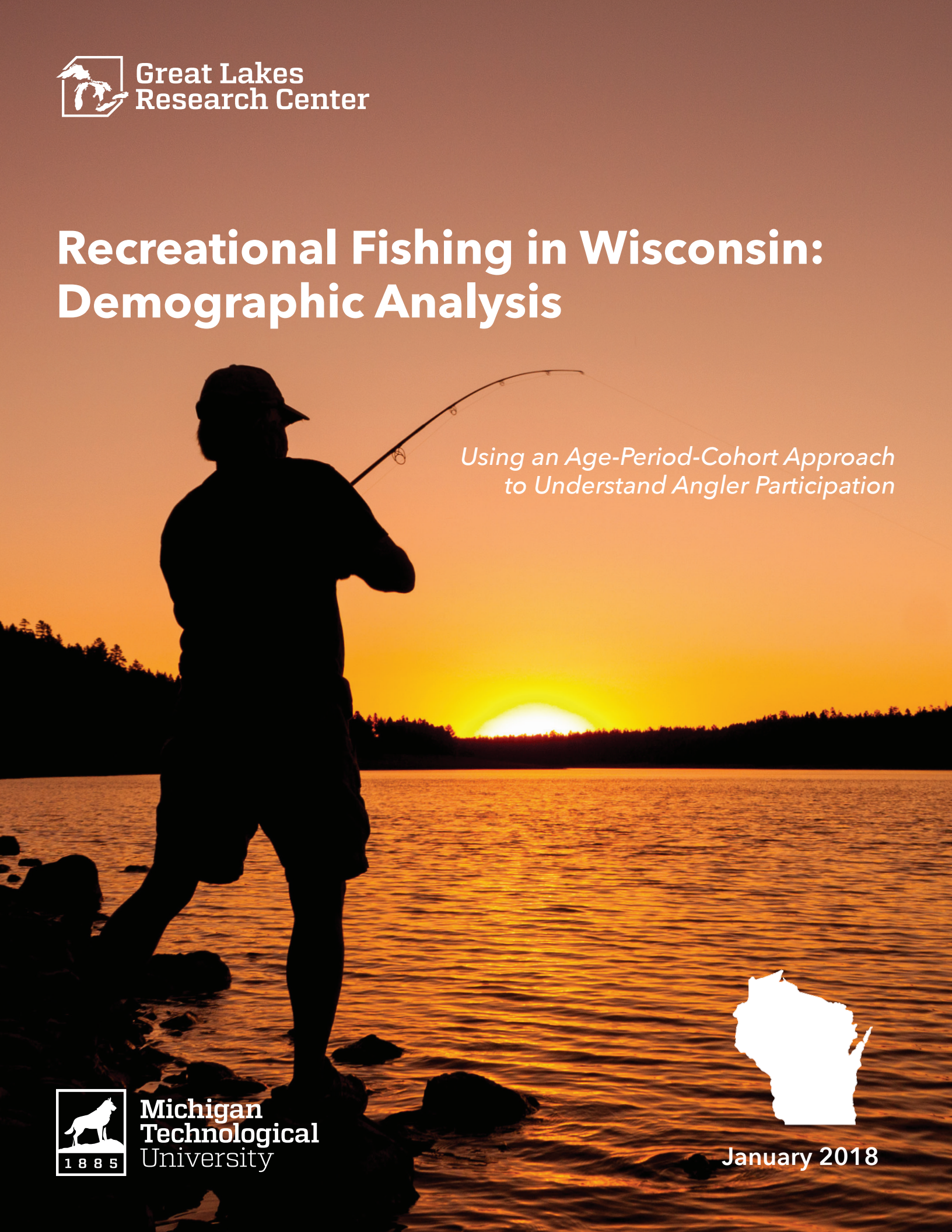
Great Lakes Research Center

Recreational Fishing in Wisconsin: Demographic Analysis

Using an Age-Period-Cohort Approach to Understand Angler Participation



Michigan Technological University

January 2018

Acknowledgements

This research was funded by the Great Lakes Fishery Commission, project ID 2015_WIN_44044 entitled "Angler Demographics: An Age-Period-Cohort Analysis." The Wisconsin Department of Natural Resources provided fishing license sales data. The content is solely the responsibility of the authors (Winkler/Burkett) and does not necessarily represent the official views of the Great Lakes Fishery Commission or the Wisconsin Department of Natural Resources.

Suggested Citation:

Erin M. Burkett and Richelle L. Winkler. 2017. *Recreational Fishing in Wisconsin: Using an Age-Period-Cohort approach to understand fishing participation*. Michigan Technological University. Houghton, MI, USA.

Erin Burkett, PhD student, Environmental and Energy Policy, Michigan Technological University
Richelle Winkler, Department of Social Sciences, Michigan Technological University

Executive Summary

The number of Wisconsin residents over age 16 who purchased a fishing license in the state of Wisconsin increased from 1,032,775 in 2000 to 1,091,303 in 2009 before dipping to 1,054,193 in 2014. In 2000, 24.8% of Wisconsin residents bought a fishing license.[1] This proportion declined to 22.9% in 2014. Male anglers make up the majority of Wisconsin's anglers (approximately 71% in 2014), but the number and proportion of female anglers has been increasing.

In order to understand change in Wisconsin's anglers over time, researchers at Michigan Technological University partnered with the Great Lakes Fishery Commission and the Wisconsin Department of Natural Resources to analyze demographic patterns in the fishing population and to use those results to project future numbers of anglers in Wisconsin. We used an Age-Period-Cohort regression model to analyze 15 years of Wisconsin resident fishing license sales data from 2000 to 2014. We specifically looked at differences by gender, age, and birth cohort among both total anglers and more specifically at Great Lakes salmon/trout anglers.

The results show that age, time period, and cohort effects all impact general fishing participation among males and females, with age and cohort effects having the greatest impact. In other words, both age-based and generational differences are important predictors of fishing participation. Among both males and females, people between age 25 and 45 were more likely to fish than those who were younger or older. Participation peaked around age 25 and dropped off markedly after age 65. Beyond the effects of age, generations born before 1970 showed an increased likelihood to fish in comparison to more recent generations, with cohorts born between 1957 and 1967 having the highest participation rates.

For Great Lakes salmon/trout anglers, estimates showed that recruitment into fishing was highest for male cohorts born between 1938-1948 and 1957-1967, and participation was low among cohorts born since 1980. Female cohort effects for Great Lakes salmon/trout anglers showed high participation among those born 1957-1970. Participation for males and females is greatest in the middle ages (25-55), and drops dramatically after about age 60 for females and age 65 for males. Controlling for age and cohort effects, there was little change in Great Lakes salmon/trout fishing participation rates between 2000 and 2013, but there was an increase in 2014.

These results inform projections of future anglers. Assuming patterns from the recent past continue, the number of in-state male anglers could decrease by approximately 69,000 by 2030 to fewer than 680,000 licensed anglers, down from approximately 748,000 in 2014. This decline would primarily be due to aging of the Baby Boom generation moving through the system. However, female anglers are projected to partially make up for this decline and increase slightly from approximately 307,000 in 2014 to 318,000 in 2030. The number of Great Lakes salmon/trout anglers is projected to either remain fairly stable at numbers similar to those in 2013 or to decrease somewhat over the next fifteen years. Finally, the age structure of anglers is projected to change such that there will be considerably more anglers at older ages (65 plus) in coming years.

[1] Excludes individuals exempt from state license requirements.

Introduction

Fishing is an important cultural activity in Wisconsin, with about 23% of the adult resident population purchasing a fishing license annually. Although the total number of Wisconsin resident anglers increased from 2000 to 2014, the rate of fishing participation decreased over this same time period. Fishing participation decline, coupled with similar and more dramatic declines in hunting license sales, has important implications for fish and wildlife management, conservation funding, restoration efforts, social relationships with nature, and social and cultural ways of life. For recruitment and retention efforts to be successful, it is vital that fish and wildlife planners, policymakers, and managers understand the nuanced social, cultural, and demographic issues behind participation shifts. Moreover, adaptations to fewer future anglers and different types of anglers (i.e. older anglers) may be necessary.

Researchers have explored several explanations for nationwide declines in fishing participation. A myriad of social, cultural, and economic changes throughout the 20th century typically earn the brunt of the blame—urbanization, population aging, increasing time demands from work and family, and new competing activities have all contributed to patterns of decline.[1,2,3,4]

This report focuses on understanding demographic drivers of fishing participation in the state of Wisconsin, particularly the effects of age and birth cohort, and how these vary by gender. In doing so, we use techniques that are well-known in demography including the age-period-cohort (APC) analytical approach. This approach is useful because we have access to administrative records on the full universe of anglers who purchase licenses, virtually eliminating the possibility of sampling or reporting error. The study cannot address the detailed causes of why people of different ages or birth cohorts may or may not fish, but it can describe the ways that age and birth cohort (by gender) impact angler participation over time. The APC approach is also useful for projecting future numbers of anglers.

This report is part of a larger project examining angler participation and demographic change among the upper Great Lakes states (Illinois, Indiana, Michigan, Minnesota, and Wisconsin) and particularly among anglers who fish the upper Great Lakes for salmon/trout. Here, we focus specifically on results among Wisconsin resident anglers with the following objectives:

1. Summarize annual participation rates of Wisconsin resident anglers and Great Lakes salmon/trout anglers from 2000-2014 (by age and sex).
2. Analyze the relative importance of age, period, and cohort effects on Wisconsin angler participation.
3. Generate population projections of the future number of Wisconsin anglers and Great Lakes salmon/trout anglers by age and sex.
4. Describe geographic differences in angler participation across Wisconsin at the county level.

Data and Methods

The primary data come from the fishing license sales records database for fishing licenses purchased between 2000 and 2014, provided by the Wisconsin Department of Natural Resources (DNR), absent any identifying information for confidentiality purposes. Licenses are coded by year of purchase, single year of age (based on date of birth), sex, county of residence, and type of license sold. Analysis was restricted to Wisconsin residents ages 16 and older. Because of a license structure rule that exempts people born prior to 1927 from license requirements, we removed all anglers born prior to 1927 from our analyses. Males and females were analyzed separately because prior research shows they have somewhat different pathways into recreation activities like fishing[5,6] and hunting,[7,8] and the effects of age, period, and cohort may also show gender differences that would be obscured by looking at the entire population.[9] We analyzed Great Lakes (GL) salmon/trout anglers separately from total anglers using the Great Lake Salmon/Trout Stamp sales records. Wisconsin requires anglers to purchase either a Great Lake Salmon/Trout Stamp or a 2-Day Great Lakes Fishing License (which includes the Great Lakes Salmon/Trout Stamp) in order to fish the Great Lakes or their tributaries up to the first barrier for salmon or trout. However, the Great Lake Salmon/Trout Stamp data from the Wisconsin DNR does not include 2-Day Great Lakes Fishing licenses issued by charter boat captains so these data are omitted from our analysis. This means that the approximately 1,000 to 1,500 individuals who purchase their 2-Day Great Lakes Fishing licenses from charters each year are not included in our estimates and analyses of GL salmon/trout anglers (Jennifer McDonough, personal communication, November 28, 2016). For all groups, age-specific participation

[2] Great Lakes salmon/trout anglers includes only Lake Michigan and Lake Superior waters of Wisconsin.

rates show the proportion of the in-state population that bought a fishing license in any particular year.

Age-Period-Cohort analysis is a statistical method that estimates the independent impacts of age, time period, and birth cohort on angler participation.[10] Age affects an individual's ability to participate in many kinds of outdoor recreation, including fishing. Individuals at different ages are more or less likely to fish based on life events, career, family, and, at later ages, physical ability.[11] True age effects, however, are complicated by the fact that they are easily confounded by changes over time and by differences among birth cohorts.[12] For example, other studies of fishing participation find that age is a significant factor predicting participation,[13] but without considering birth cohort, it is impossible to say whether participation is determined by current age or if participation is determined by being born during a certain era.

Period effects (time period) refer to social, environmental, policy, and economic changes that impact the conditions under which fishing takes place over time. These might be specific and discrete events (such as a dramatic reduction in stocking a popular target species) or incremental change over time (such as slow changes in species composition). Changes in rules and regulations, decreasing access to fishing areas, and changes in fish abundance are other examples that could lead to period effects in fishing participation.

Cohort effects refer to the impact of the environmental, social, and historical factors that shape the experiences and worldviews of those born in a particular year. Each birth cohort experiences significant events at the same point in the life course. Those experiences influence individuals' behavior throughout their lives and contribute to lasting social change as each successive generation replaces the previous one. A good example is cigarette smoking and its dramatically different participation rates by different generations of people born over the course of the twentieth century.

Resulting age-period-cohort estimates then provide key information to build **projections of future angler populations**. We used two demographic methods to generate projections of the future number of Wisconsin anglers and GL salmon/trout anglers by age and sex. The APC approach uses the age-period-cohort results to predict future participation rates. The cohort survival approach advances current anglers forward in time assuming average recruitment/retention by age each year. Both models generally assume that patterns observed in the recent past will continue into the future.

Lastly, this report includes **maps of fishing participation rates and changes over time for Wisconsin counties**. Reviewing geographic differences in angler participation is useful for hypothesizing about causes of change and for considering where to focus recruitment and retention efforts.

Angler Participation Rates

Figure 1 shows the changes between 2000 and 2014 in the number of anglers (ages 16 and older) in bars (along the left axis) and corresponding participation rates in a line (along the right axis). The total number of unique anglers peaked in 2009 at 1,091,303 anglers, then dropped to 1,031,880 in 2011 before rebounding again to 1,054,193 anglers in 2014. The number of male anglers generally declined over this period, while the number of female anglers generally increased. Participation rates declined from 2000 (24.8%) to 2014 (22.9%). GL salmon/trout anglers are shown in a blue bar at the bottom. They made up 14.3% of the total number of anglers in 2014 and their numbers increased somewhat from 135,755 in 2000 to 150,801 in 2014.

Figure 1. Wisconsin Resident Anglers and Fishing Participation Rates (2000-2014)

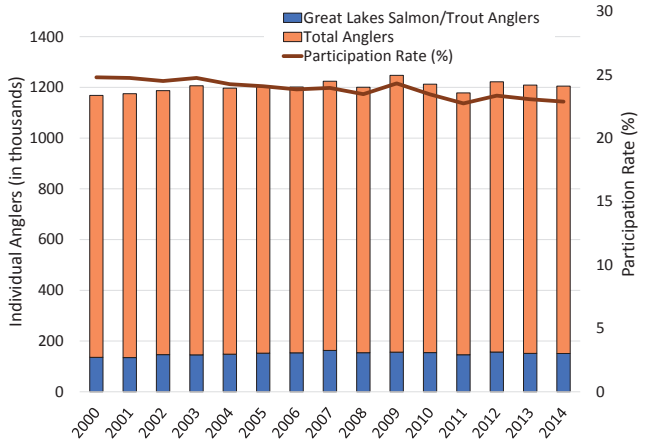


Figure 1 shows the number of individual Great Lakes salmon/trout anglers (in blue), the number of total anglers (in orange), and total fishing participation rate (the brown line) for Wisconsin residents from 2000-2014.

Data sources: Wisconsin Fishing License Database, provided by the Wisconsin Department of Natural Resources; U.S. Census 2000, U.S. Census 2010, and U.S. Census Bureau, Intercensal Estimates.

Figure 2A shows the age structure of Wisconsin anglers in 2014 transposed on top of the general age structure for Wisconsin's entire population in 2014, by sex. Among females, the orange bulge under age 60 indicates that female anglers are concentrated at younger ages. The hollow bars at ages

65 and above shows that despite the large number of elderly Wisconsin females in the total population, they are not well represented among anglers. Looking at males, angler age structure mimics that of the general population, except for underrepresentation of anglers under age 25.

Figure 2. Age Structure of Wisconsin Anglers vs. Total Population, by Sex (2014)

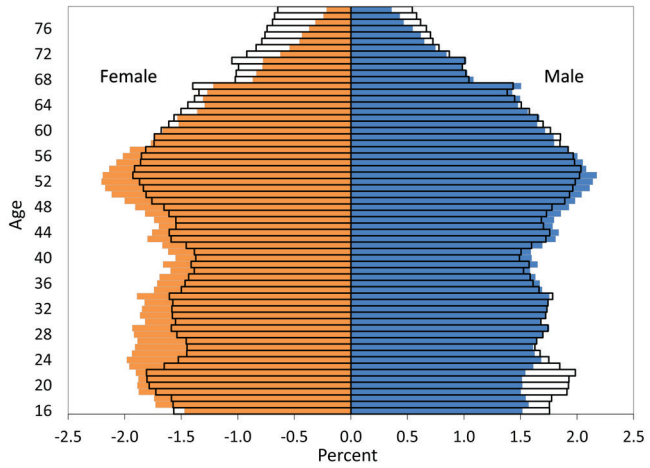


Figure 2 shows the age distribution of the total Wisconsin population (in hollow black bars) compared to the age distribution of Wisconsin anglers (orange and blue bars) in 2014. For each single year of age between 16 and 79, it shows the proportion of all anglers (or people in total) who are at that age.

Data sources: Wisconsin Fishing License Database, provided by the Wisconsin Department of Natural Resources; U.S. Census 2000, U.S. Census 2010, and U.S. Census Bureau, Intercensal Estimates.

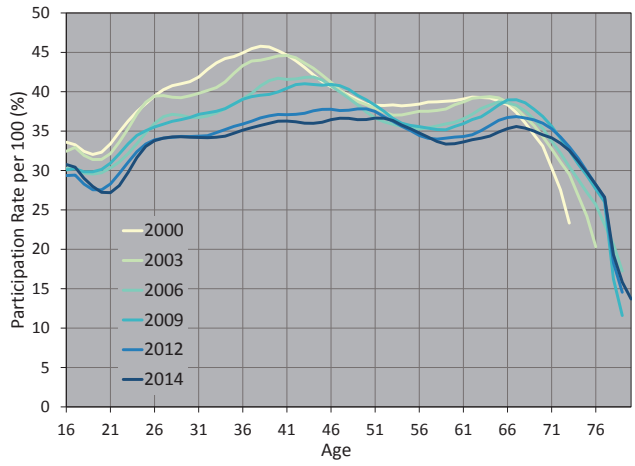
Figures 3A-3D show age-specific fishing participation rates for total male and female anglers and GL salmon/trout anglers for ages 16 and older. Note the scale is different for different groups. Lighter colors represent earlier time periods and become darker in more recent years. The rates are "smoothed" to account for the fact that birthdays fall at various times over the course of the year and don't match perfectly with the age reported by the U.S. Census Bureau (age on April 1 of each year), which may suffer from age heaping and other classification errors. Smoothing is a common demographic technique when dealing with rates by single year of age. Here, we report participation rates by age calculated from the reported data for that single year of age plus borrowing from participation at the ages directly before and after each single year of age.

In the figures, following any particular curve from left to right shows variation in participation across different ages. Among males, participation rates are fairly even by age (horizontally flat), except for lower participation in the late teens/early 20s and again for those over age 70. Reading the graph vertically shows a general decline over time in male participation across age groups with the exception of the oldest age groups (>70) where participation rates have increased over time. We can also see evidence of cohort effects in these charts, looking at peaks and valleys of participation and then following these as they advance in age (move to the right) over time. For instance, in 2000 the peak male participation rate (over 45%) was at age 38 (born around 1962), but this peak steadily moves to the right and diminishes over time as this birth cohort gets older. By 2014, peak participation is at age 52 (again the 1962 cohort) with about 36% participating.

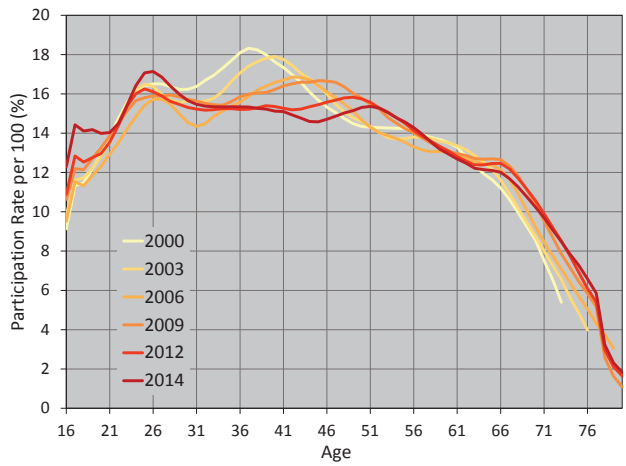
Female participation rates are much lower than male participation rates. Participation is generally higher for younger females, especially those under age 55, and drops off dramatically after age 66. Participation rates increased for women under age 30 and over age 65 between 2000 and 2014, but declined for women in their 30s and 40s. As with males, we see evidence of cohort effects with peak participation in 2000 at age 37 (over 18% of women fished). These same women were age 51 in 2014 and about 15% fished. With women, however, a new peak gradually emerged around age 25 as younger women increasingly participated.

Participation rates for GL salmon/trout anglers are much lower than total angler participation rates. For GL anglers, participation rates are highest for those age 25-70 for males and age 25-60 for females. There is little evidence of change over time in participation across ages. It appears that male and female cohorts born about 1960 had high participation rates over the time period 2000-2014. Looking at males, those who were age 32-40 in 2000 had among the highest participation rates. These same men were then age 46-54 in 2014 and were still participating at relatively high rates. Similarly for females, women born in 1964 were age 36 in 2000 and age 50 in 2014 and show the highest female participation rates.

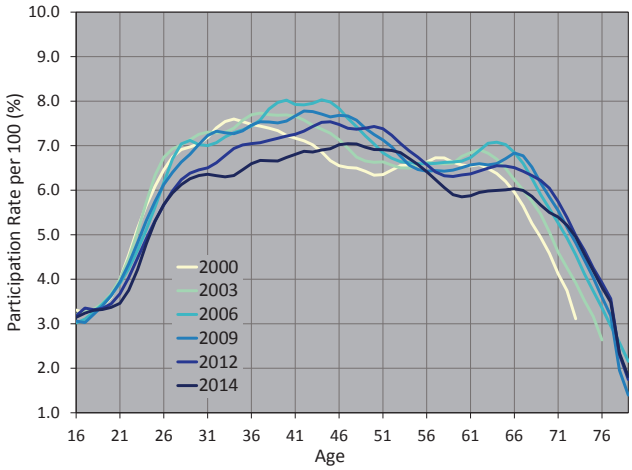
Figure 3. Wisconsin Angler Participation Rates by Age (2000-2014)



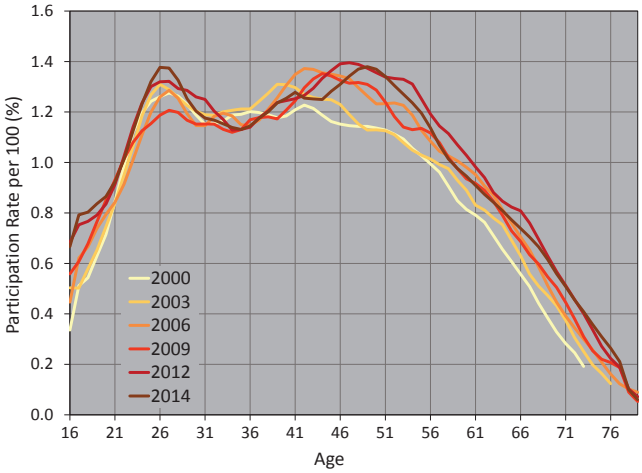
3A. Age-specific participation rates for total male anglers



3B. Age-specific participation rates for total female anglers



3C. Age-specific participation rates for male Great Lakes salmon/trout anglers



3D. Age-specific participation rates for female Great Lakes salmon/trout anglers

Figures 3A-3D show the proportion of Wisconsin residents who purchased a license to fish (3A & 3B) and the proportion of Wisconsin residents who purchased a Great Lake Salmon/Trout Stamp (3C & 3D) by age for a set of years between 2000 and 2014. Lighter colors represent earlier time periods and become darker in more recent years.

Data sources: Wisconsin Fishing License Database, provided by the Wisconsin Department of Natural Resources; U.S. Census 2000, U.S. Census 2010, and U.S. Census Bureau, Intercensal Estimates. Estimates of Lake Superior salmon/trout anglers were generated by the authors.

Estimating Age, Period, and Cohort Effects

This section reviews estimates of the independent effects of age, time period, and birth cohort on the likelihood of individuals to purchase a fishing license. To make these estimates, we fit a log linear regression model using Stata statistical software and an approach developed by Yang et al. (2008) that incorporates an "intrinsic estimator." Independent estimates of age, period, and cohort are complicated because they are perfect linear functions of one another: cohort = period - age. This is called the "identification problem" whereby common statistical and demographic models cannot uniquely identify the effects of age, period, and cohort.[14] The intrinsic estimator is a principal components regression estimator designed to circumvent the collinearity problem. Its purpose is to control for any two variables (age, period, or cohort) in order to accurately see the magnitude of the effect of the third, bypassing the problem of collinearity. The intrinsic estimator approach has been shown to produce unbiased, efficient, and asymptotically consistent estimates and to perform well in simulations.[15]

We assume that the data follow a Poisson distribution, modeling angler participation rates as the count of anglers at each age, sex, and year, divided by the total population of Wisconsin by age and sex in each year. Total population data are from the U.S. Census 2000 and 2010, and from U.S. Census Bureau population estimates for intercensal years. The process estimates the independent effects of age, period, and cohort, and shows the log likelihood of an individual to purchase a fishing license for any particular age, birth year, and annual time period.

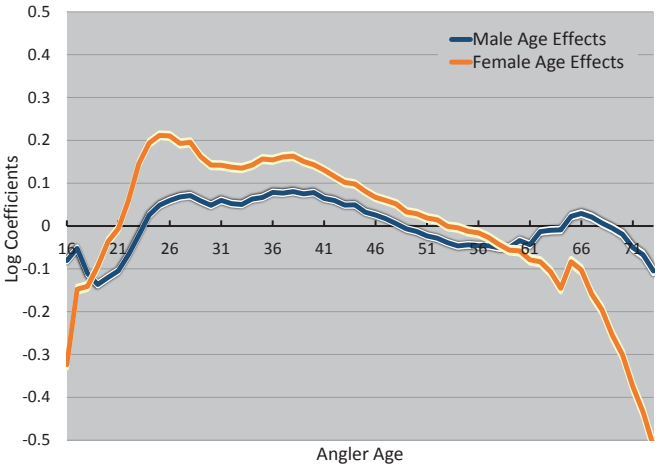
Results show that age and birth cohort have a substantial impact on fishing participation in Wisconsin, but period effects were less important. Figures 4A-4C illustrate the model results showing estimates of the independent impacts of age, period, and cohort on male and female total anglers. Figures 4D-4F show the estimates for male and female GL salmon/trout anglers. The Y-axis is a log likelihood coefficient, meaning that the bigger the difference from zero (positive or negative) a value is, the larger its effect on the likelihood of an individual to purchase a fishing license. Values above zero indicate an increased likelihood, while values below zero indicate a decreased likelihood. Note that likelihoods should be compared to other points on the same line (e.g. among males at different ages) rather than between groups (e.g. female to male). Lighter colored lines surrounding the primary ones indicate 95% confidence intervals associated with the estimates.

For both male and female anglers, participation rates peaked about age 25 and into the late 30s before gradually declining until age 65-66 when likelihood to participate drops off dramatically, especially among females. Time period has had relatively little impact on angler participation (in comparison to age and cohort) (see Figure 4B), but showed slight declines in participation among males between 2000 and 2014.

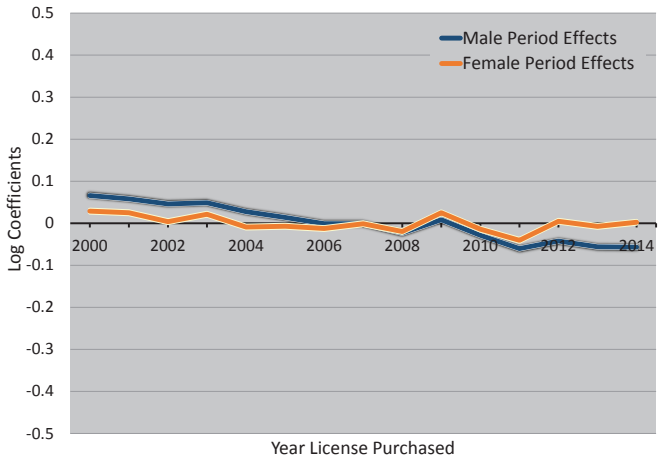
Cohort effects were also important (Figure 4C). Both males and females born between about 1937-1947 and 1957-1967 had an increased likelihood to fish compared to those born before 1937 or after 1970. To illustrate these impacts, it helps to convert the log likelihoods shown in the charts to probabilities and to play out some hypothetical examples. For example, if we hold age constant at 40 years and assume no changes over time, the difference between the predicted probability of a hypothetical cohort of men to fish varies by birth year. For every 100 hypothetical 40-year-old Wisconsin males born in 1950, 39 would purchase a fishing license in a given year. If a similar group was born in 1960 and exposed to the associated birth cohort effects, 42 of the 100 would purchase a fishing license. If the group were subject to the birth cohort effects of 1985, only 36.5 would fish.

Female cohort effects show a very similar pattern to males, except that among the most recent generations (born since 1993) there has been a renewed increase in participation. For females, the model predicts that for a hypothetical group of 30-year-old women born in 1950, 15.6% would fish in any given year. This compares to 30-year old women exposed to cohort effects from 1962 (peak cohort) where 17.5% would fish, and those exposed to 1985 cohort effects where 15.2% would fish.

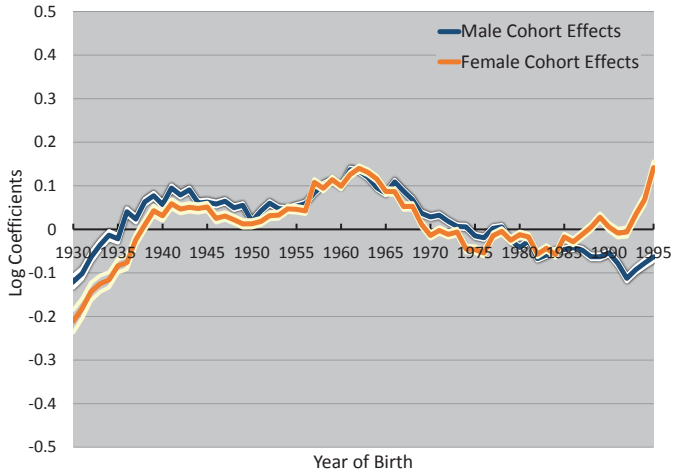
Figure 4: Age-Period-Cohort Estimates for Total Wisconsin Anglers (2000-2014)



4A: Age Effects, Total Anglers by Sex



4B: Period Effects, Total Anglers by Sex



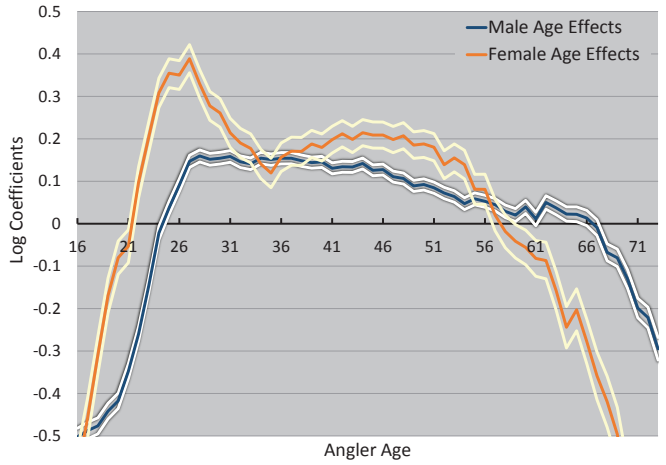
4C: Cohort Effects, Total Anglers by Sex

Figures 4A-4C show the age effects, period effects, and cohort effects for total male (blue lines) and total female (orange lines) Wisconsin resident anglers for ages 16-73.

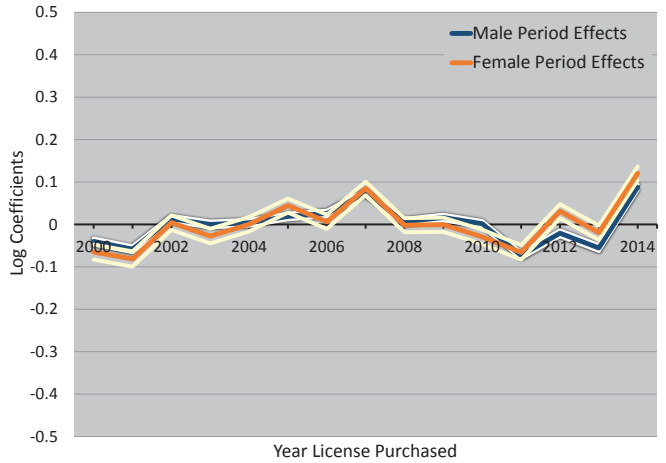
The Baby Boomer effect we observed for female anglers may be due to female residents fishing with their spouses. About one-third of female Wisconsin anglers are licensed to fish under a spousal license as the secondary license holder, and of these, most are Baby Boomers. In 2000, for example, 36% of licensed female anglers were secondary spousal license holders, and most of these women (63%) were born between 1945 and 1965 (Baby Boom years). In 2014, approximately 33% of female anglers were licensed as a secondary spousal license holder, and 45% of these anglers were born between 1945 and 1965. Females who are primary license holders mostly come from more recent cohorts, with 40% born since 1980.

Turning to GL salmon/trout anglers, both age and birth cohort have a substantial impact on fishing participation for females and males. Period effects were weak and showed a slight incline over the time period, peaking in 2014. Male participation peaked at age 28 and declined markedly after age 66. Female participation was highest in the mid-to-late twenties and dropped dramatically after age 58. Male cohorts born prior to 1980 (and especially those born 1935-1947 and 1956-1978) show an increased likelihood to participate. Male cohorts born since 1980 showed a reduced likelihood to participate in comparison to other generations. Because of the relatively small number of female GL salmon/trout anglers, there is less certainty of clear cohort patterns. The model predicts that for a hypothetical group of 30-year-old Wisconsinites born in 1950, 2.5% of them will fish for GL salmon/trout in any given year. This is in comparison to the probability of 30-year-olds born in 1965 which is predicted at 2.7%, and to 30-year-olds born in 1985, predicted at 2.3%.

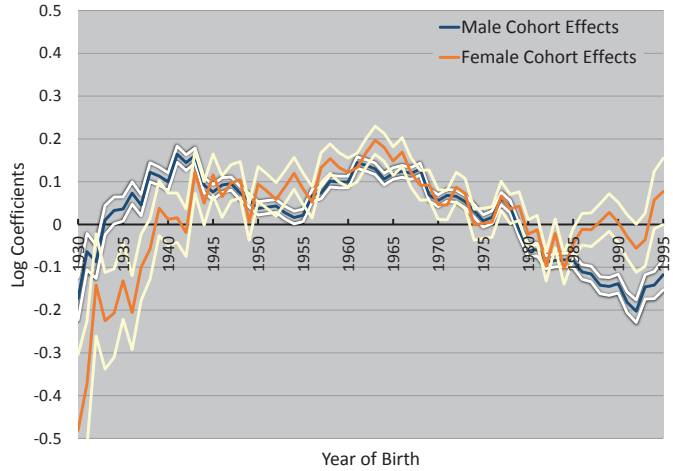
Figure 5: Age-Period-Cohort Estimates for Wisconsin Great Lakes Salmon/Trout Anglers (2000-2014)



5A: Age Effects, Great Lakes Salmon/Trout Anglers



5B: Period Effects, Great Lakes Salmon/Trout Anglers



5C: Cohort Effects, Great Lakes Salmon/Trout Anglers

Figures 5A-5C show the age effects, period effects, and cohort effects for male (blue lines) and female (orange lines) Wisconsin resident Great Lakes salmon/trout anglers for ages 16-73.

Projecting Future Anglers

We used the results of the age-period-cohort analysis described above to project future angler populations employing two different technical approaches. Both models assume that the general patterns of the recent past will continue into the future. One approach (APC model) directly uses the age-period-cohort estimates described above to estimate the proportion of future Wisconsinites who will purchase a fishing license. Then, these rates (by age and sex) are multiplied by the total projected population for the State of Wisconsin (from State Age-Sex Population Projections by Single Years, 2010-2025, vintage 2013, Demographic Services Center, State of Wisconsin and then extended to 2030 with informal projections provided by the Applied Population Laboratory, University of Wisconsin-Madison). The APC projection model is a fairly novel approach (better described in Winkler and Warnke 2013[16]) that has proven accurate in projecting Wisconsin deer hunters over the last ten years.

The other approach (Cohort Survival model) begins with the number of anglers observed in 2014 and ages them forward over time, applying a "survival ratio" that accounts for the average annual loss or recruitment/retention of anglers at different ages over time. Cohort survival models are commonly used by demographers and are well known to produce reliable population projections. Using both the APC model and the Cohort Survival model acts as a way of checking our work, and comparing a new model (APC) with a well-established one (Cohort Survival).

Results

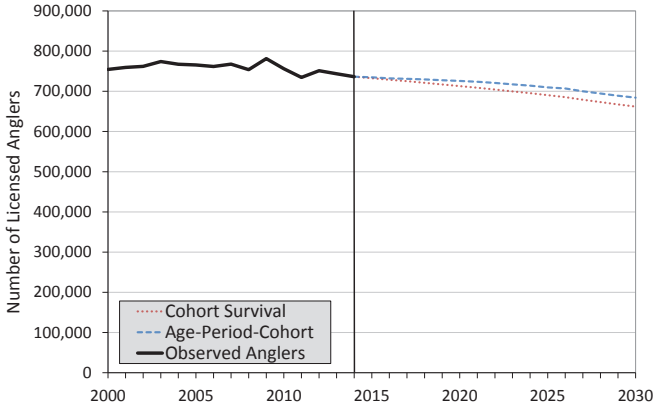
Both the APC and the Cohort Survival models represent a "business-as-usual" approach to recruitment and retention and assume that the general social, environmental, and economic patterns experienced between 2000 and 2014 will continue into the future. These projections are expected to be fairly accurate if socioeconomic and environmental conditions and policies, programs, and outreach efforts remain about the same over the next twenty years. Both models generally assume that current and recent patterns of angler participation by age, period, and cohort will continue into the future.

The results of the two models are very similar among total anglers, showing continued decline among male anglers and a stable number of female anglers. Table 1 (Appendix A) and Figures 6A-6C summarize

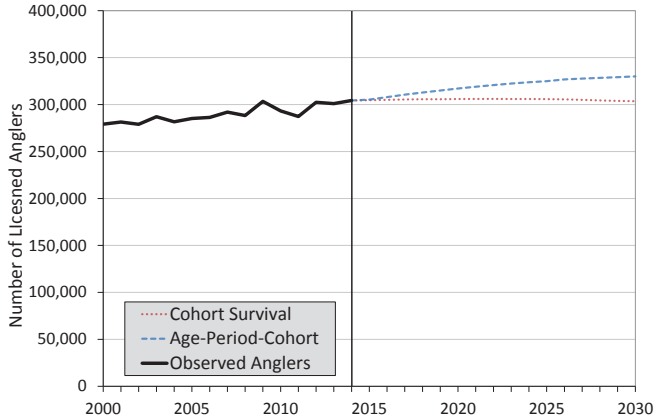
the projections for total males, total females, and combined (both sexes) GL salmon/trout anglers annually through 2030. The models project a decline to approximately 678,000 male anglers by 2030, down from 747,511 in 2014. Recent growth in the number of female anglers is projected to continue in the coming years. The two different models project somewhat different futures for the number of GL salmon/trout anglers. The APC model projects GL anglers to remain stable at 2013 numbers into the future, while the Cohort Survival model projects moderately decreasing numbers. This difference between the two models is primarily due to the fact that the Cohort Survival model is most impacted by the observed number of anglers in 2014 (most recent year of data included), which was a slightly lower year for GL salmon/trout stamp sales, and so it is less optimistic.

Beyond changes in the number of future anglers, the models also predict changes to the age structure of the fishing population. Figures 7A-7C compare the observed age structure of fishing license purchasers in 2014 with projected age structures in 2030. Most noticeable on the male chart is that the large peak of anglers aged 48-60 years in 2014 will be dramatically reduced and older by 2030. Among females, the 2014 age structure was similar to males, with the most female anglers ages 50 to 60 and aging into their 60s and 70s by 2030. At the same time, the number of female anglers in their twenties and thirties is projected to grow. Looking at GL salmon/trout anglers, in 2014 the most represented ages were 45-60. This peak is projected to age by 2030 such that the age structure of anglers will be fairly uniform between ages 25 and 70 in 2030.

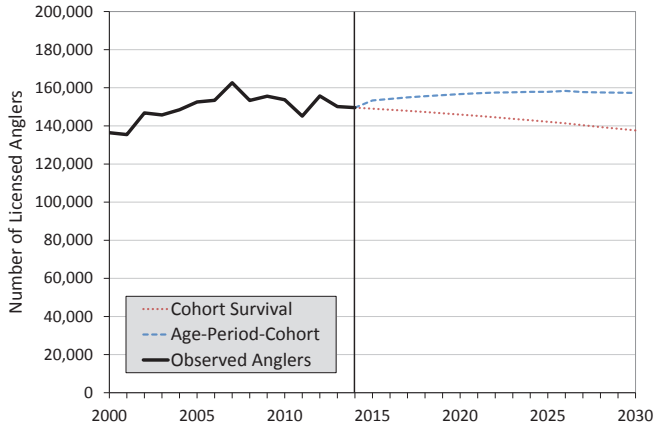
Figure 6: Modeling Future Anglers



6A: Projected Wisconsin Resident Male Anglers, 2000-2030, Ages 16-79

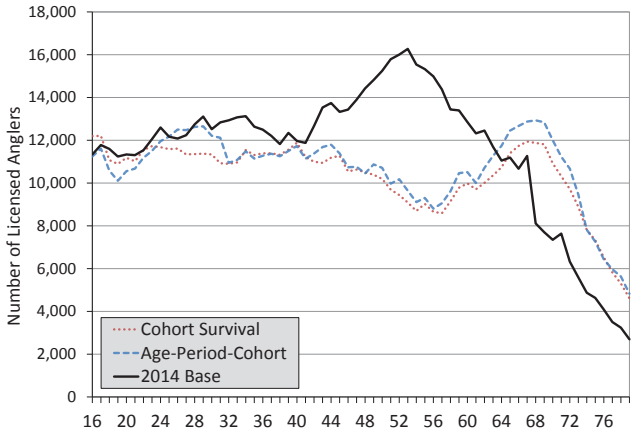


6B: Projected Wisconsin Resident Female Angers, 2000-2030, Ages 16-79

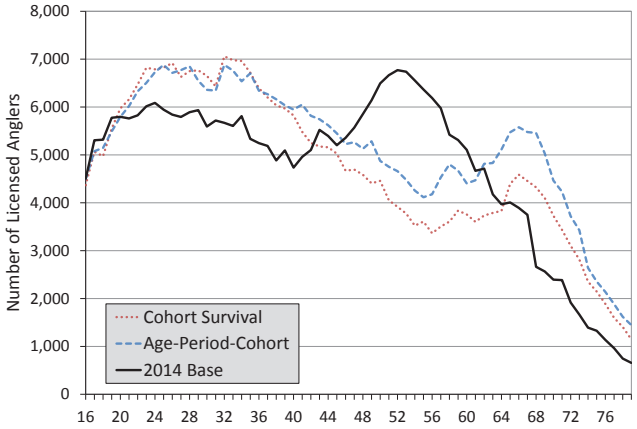


6C: Projected Wisconsin Resident Great Lakes Salmon/Trout Anglers, 2000-2030, Ages 16-79

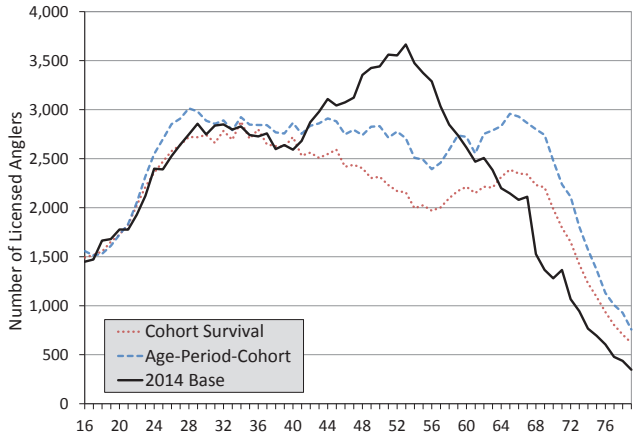
Figure 7: Modeling Age Structure of Future Anglers



7A: Age Structure of Wisconsin Resident Male Anglers in 2030, Ages 16-79



7B: Age Structure of Wisconsin Resident Female Anglers in 2030, Ages 16-79



7C: Age Structure of Wisconsin Resident Great Lakes Salmon/Trout Anglers in 2030, Males and Females, Ages 16-79

Figures 7A-7C show the predicted age structure of male (7A), female (7B), and combined male/female Great Lakes salmon/trout (7C) anglers in 2030. Two model outputs are shown in red and blue.

Figure 8: Wisconsin Angler Projections Summary

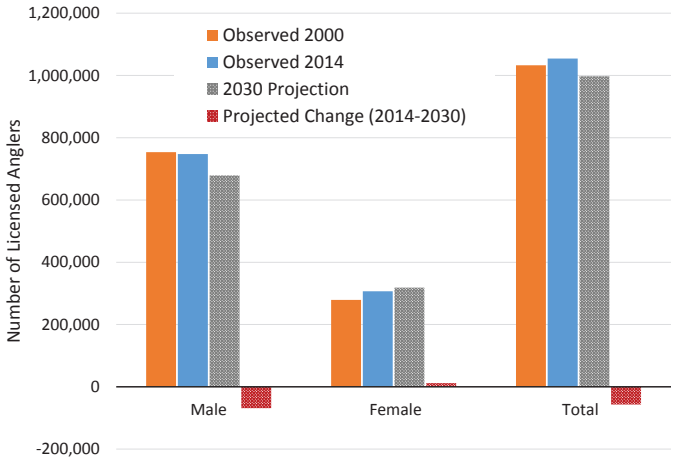


Figure 8: Wisconsin Resident Angler Projections Summary

Figure 8 shows the number of observed Wisconsin resident anglers in 2000 (shown in orange) and 2014 (shown in blue), the number of projected anglers in 2030 (shown in gray), and the projected change in the angler population from 2014 to 2030 (shown in red), by sex.

Data sources: Wisconsin Fishing License Database, provided by the Wisconsin Department of Natural Resources; projections generated by the authors.

Figure 8 summarizes and compares the results of the total angler projection models to provide a synthesized glimpse into projected changes in the number of Wisconsin resident anglers, if age- and cohort-specific patterns from the recent past continue for the next 20 years. The chart compares the 2014 observed fishing population to the projected fishing population in 2030 showing an average projection from the two models. The total number of anglers is projected to decline by about 57,000 between 2014 and 2030. Of the approximately 997,000 anglers that might be expected in 2030, about 318,000 of them (32%) should be expected to be women. This is an increase from 2014 when females made up about 29% of the fishing population.

Geographic Patterns

To examine differences in angler participation rates across different regions of the state, we used the license sales database on anglers' residence and total population data from the U.S. Census Bureau to calculate and map fishing participation rates and change in participation rates over time for each Wisconsin county using ArcGIS. We generated a series of maps designed to showcase spatial variations in angler participation (see Appendix B). They show patterns based on where anglers live, rather than where they fish.

All participation rate values reported are per 100 Wisconsin residents (percentages). Rates tend to be higher in northern Wisconsin, especially in counties with an abundance of inland lakes and a strong lake culture. In 2014, the highest male fishing participation rates occurred in Washburn County (76%), Vilas (66%), and Price and Lincoln Counties (58%). Menominee County (11%), which falls into tribal jurisdiction where members are not required to purchase a fishing license and so would not be included in the numerator, and Milwaukee County (15%) showed the lowest overall male participation rates. Note that while participation rates are lower in more urban areas, the greatest number of anglers still reside in more urban areas. For instance, Milwaukee County was home to the greatest number of anglers (n=69,253 male anglers) in 2014, compared to only 6,847 in Washburn County.

We determined change in county participation rates from 2000 to 2014 by calculating the difference in the proportion of residents age 16-79 who purchased a fishing license in 2014 compared to 2000. Change is reported as the simple difference in participation rate in 2014 compared to 2000 (percent participating in 2014 minus percent participating in 2000).

Male fishing participation generally decreased from 2000 to 2014, with more dramatic declines for males in counties with some of the highest participation rates in 2000. In Adams County, male participation declined from 73% in 2000 to 50% in 2014 (a decrease of approximately 23%). Do note, however, that Adams is a special case where a new prison was built during this time period which increased the denominator (total population) but would not have changed the numerator. Waushara County (-15%) and Vilas County (-15%) also experienced considerable decline from 2000 to 2014. All three counties have large numbers of cottages (second homes) and may be experiencing a change in culture as increasing numbers of urban retirees (who may be less likely to fish than longer term residents) permanently move to their cottage home and change the local population make up.

Female fishing participation was highest in Washburn County (39%) and Vilas County (32%) and lowest in Kenosha County (7%), Milwaukee County (5%), and Menominee County (4%). Female fishing participation increased slightly from 2000 to 2014 in just over one third of counties, especially in Buffalo County (increase of 4%) and Kewaunee County (increase of 3%), but generally the increases were under a 2% change. Vilas County (-6%) had the greatest decline in female fishing participation.

As expected, participation in Great Lakes salmon/trout fishing is greatest in counties near Lake Michigan or Lake Superior with the highest participation rates (for combined males and females) in 2014 in Ashland County (7%), Kewaunee County (7%), Bayfield County (5%), Door County (5%), and Iron County (5%). Participation rates changed very little from 2000 to 2014, with the biggest decreases occurring in Bayfield (-0.8%) and Forest (-0.4%) counties. Great Lakes salmon/trout fishing participation increased the most in Ashland (1.1%), Manitowoc (0.9%), and Iron (0.8%) counties.

Limitations

The key limiting factor in this analysis is that only fifteen years of license sales data are available, meaning we do not have data on the participation rates of generations born before the 1990s when they were young. Further complicating the analysis is that cohorts born prior to 1927 are not required to purchase a fishing license in the state of Wisconsin, and so must be eliminated from this study. Excluding these older generations weakens the strength of the APC estimates and the models' ability to estimate old age participation. Despite this, we are confident in our general results because they are corroborated by alternative data sources and by alternative methods. For instance, data from the National Survey of Fishing, Hunting, and Wildlife Associated Recreation on age-specific angler participation from 1980, 1985, 1991, 1996, 2001, and 2006 suggest that fishing participation rates vary by cohort in a similar pattern to what is shown here.

Second, as with any projection of future populations, assumptions about future social conditions must be made. Here, we specifically make assumptions about future time period effects and new incoming cohort effects for generations not yet old enough to be required to purchase a fishing license or even born. We base these assumptions on the recent past and the newest cohorts.

Finally, another potential factor that has yet to be explored in depth is that of race and ethnicity. While approximately 80% of anglers nationwide are Caucasian/White,[17] the proportion of people of color in Wisconsin is growing, particularly among younger generations. This shift in the demographic make-up of the state's population will likely have significant impacts on demands for outdoor recreational opportunities, including fishing. It is possible that the age and generational differences described here are related to generational differences in the race/ethnic structure of the Wisconsin population. Data on race and ethnicity are not collected in the license sales process, so we cannot exactly measure the impact of race/ethnic shifts on cohort effects.

Implications for Fisheries Management

Three key points emerge from this study: 1) The male fishing population in Wisconsin is likely to decline over the next two decades, 2) Females will make up an increasing proportion of anglers, and 3) The angler population will grow older with a growing share over age 65. Most state fisheries and wildlife management agencies in the U.S. are grappling with the issue of declining hunting and fishing participation. Societal changes throughout the 21st century have altered the social context under which most citizens live, consequently leading to decreasing participation in fishing and hunting. The Baby Boom generation is both large in number and has participated at high rates. As this group continues to age and is eventually replaced by newer cohorts, management agencies must adapt to these changes.

Along with similar evidence from other states,[18,19] the findings presented here indicate that while participation patterns do vary by state, age and cohort effects on hunting and fishing participation are generally operating in similar ways across the Upper Midwest and the broader nation. Cohort effects and projected participation declines are more severe among hunters than among anglers, but the general patterns are broad and will be difficult to change. Agencies will require better understanding of differences in the mix of environmental, fisheries/wildlife, social, and food-related values between different generations of stakeholders.

Our projections indicate that Wisconsin's future fishing population will likely be smaller, older, and more gender balanced. This means that future fishing stakeholders may have different abilities, values, interests, and expectations than the past and present fishing population.[20] We encourage agencies to use projections such as ours to explicitly plan how to meet conservation goals and to engage diverse fishing and non-fishing publics in the face of these changes.

Sources Cited

[1]Aiken, R. 2010. *Trends in fishing and hunting 1991–2006: A focus on fishing and hunting by species*. Report 2006-8. U.S. Fish and Wildlife Service.

[2]Arlinghaus, R., & Mehner, T. (2004). "A management-orientated comparative analysis of urban and rural anglers living in a metropolis (Berlin, Germany)." *Environmental Management* 33(3):331-344.

[3]Manfredo, M. J. and H. C. Zinn. 1996. "Population change and its implications for wildlife management in the new west: A case study of Colorado." *Human Dimensions of Wildlife* 1:62–74.

[4]Responsive Management. 2003. *Factors related to hunting and fishing participation among the nation's youth*. Harrisonburg, VA.

[5]Fedler, A. J. and R. B. Ditton. 2001. "Dropping out and dropping in: a study of factors for changing recreational fishing participation." *North American Journal of Fisheries Management* 21(2):283-292.

[6]Floyd, M. F., L. Nicholas, I. Lee, J. H. Lee, and D. Scott. 2006. "Social stratification in recreational fishing participation: Research and policy implications." *Leisure Sciences* 28(4):351-368.

[7]Stedman, R. and T. Heberlein. 2001. "Hunting and rural socialization: Contingent effects of the rural setting on hunting participation." *Rural Sociology* 66(4):599-617.

[8]Heberlein, T., B. Serup, and G. Ericsson. 2008. "Female hunting participation in North America and Europe." *Human Dimensions of Wildlife* 13(6): 443–458.

[9]Winkler, R. and K. Warnke. 2013. "The future of hunting: An age-period-cohort analysis of deer hunter decline." *Population and Environment* 34(4): 460-480.

[10]Yang, Y., W. J. Fu, S. Schulhofer-Wohl, and K.C. Land. 2008. "The intrinsic estimator for age-period-cohort analysis: What it is and how to use it." *American Journal of Sociology* 113:1697-1736.

[11]Fedler, A. J. and R. B. Ditton. 2001. "Dropping out and dropping in: a study of factors for changing recreational fishing participation." *North American Journal of Fisheries Management* 21(2):283-292.

[12]Yang, Y., W. J. Fu, S. Schulhofer-Wohl, and K.C. Land. 2008. "The intrinsic estimator for age-period-cohort analysis: What it is and how to use it." *American Journal of Sociology* 113: 1697-1736.

[13]Floyd, M. F., L. Nicholas, I. Lee, J. H. Lee, and D. Scott. 2006. "Social stratification in recreational fishing participation: Research and policy implications." *Leisure Sciences* 28(4):351-368.

[14]Mason, K.O., W.H. Mason, H.H. Winsborough, and K. Poole. 1973. "Some methodological issues in cohort analysis of archival data." *American Sociological Review* 38:242-58.

[15]Yang, Y., W. J. Fu, S. Schulhofer-Wohl, and K.C. Land. 2008. "The intrinsic estimator for age-period-cohort analysis: What it is and how to use it." *American Journal of Sociology* 113:1697-1736.

[16]Winkler, R. and K. Warnke. 2013. "The future of hunting: An age-period-cohort analysis of deer hunter decline." P*opulation and Environment* 34(4): 460-480.

[17]Recreational Boating and Fishing Foundation. 2015. *2015 Special Report on Fishing*.

[18]Winkler, R. and K. Warnke. 2013. "The future of hunting: An age-period-cohort analysis of deer hunter decline." *Population and Environment* 34(4): 460-480.

[19]Chase, L. 2012. "Nonresident license purchasing patterns and an aging customer base: A demonstration study of six states." Presented at the Pathways to Success Conference: Integrating Human Dimensions into Fisheries and Wildlife Management. September 25, Breckenridge, CO.

[20]Connelly, N. A., S. Keeler, and B. A. Knuth. 2013. "Understanding Angler Preferences for Species and Water Bodies: Importance for New York's Future Fisheries Management." *Human Dimensions of Wildlife* 18(5):386-402.

Appendix A

Table 1: Wisconsin Resident Angler Projection Results

Wisconsin Male Resident Angler Projections

Year	Observed	Age-Period-Cohort Projection	Cohort Survival Projection
2000	746,246		
2001	750,960		
2002	753,024		
2003	765,015		
2004	758,124		
2005	756,358		
2006	752,907		
2007	758,632		
2008	745,258		
2009	772,308		
2010	747,171		
2011	726,339		
2012	741,996		
2013	734,698		
2014	736,372		
2015		734,779	733,467
2016		732,169	730,621
2017		731,220	727,829
2018		729,545	724,656
2019		727,614	721,302
2020		725,960	718,180
2021		723,675	714,699
2022		720,916	711,067
2023		717,493	707,069
2024		713,999	703,288
2025		709,794	699,057
2026		707,122	694,729
2027		700,030	688,864
2028		694,411	683,345
2029		689,088	678,074
2030		684,272	673,154

Wisconsin Female Resident Angler Projections

Year	Observed	Age-Period-Cohort Projection	Cohort Survival Projection
2000	277,848		
2001	280,146		
2002	277,722		
2003	285,785		
2004	280,370		
2005	283,814		
2006	285,035		
2007	290,483		
2008	286,859		
2009	301,926		
2010	291,799		
2011	285,846		
2012	300,746		
2013	299,366		
2014	304,297		
2015		305,334	304,909
2016		308,004	305,526
2017		310,526	306,131
2018		312,855	306,610
2019		314,929	306,957
2020		317,093	307,410
2021		319,036	307,698
2022		320,787	307,919
2023		322,369	308,104
2024		323,800	308,254
2025		324,957	308,281
2026		326,856	308,265
2027		327,668	307,870
2028		328,376	307,443
2029		329,183	307,127
2030		330,024	306,857

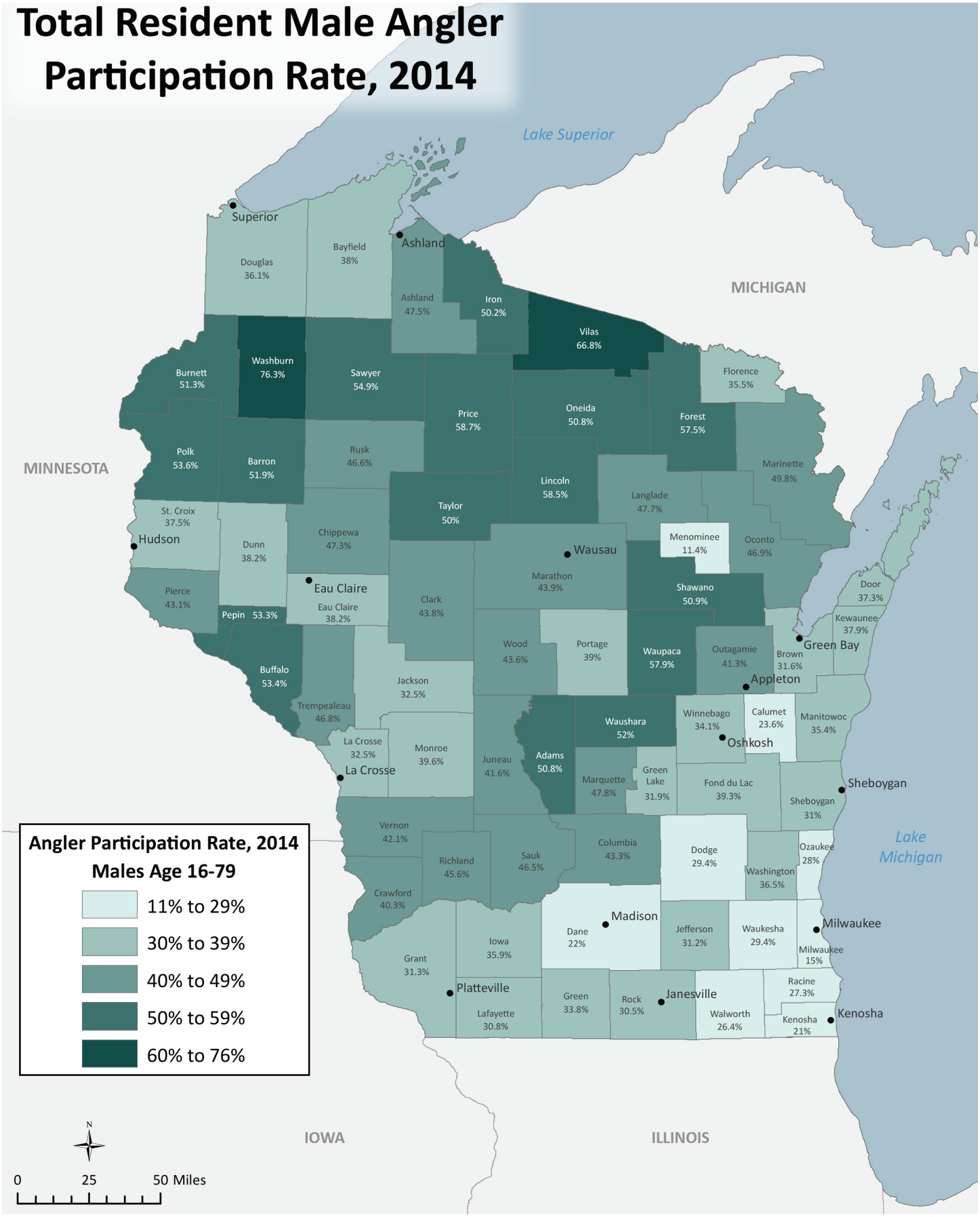
Wisconsin GL Salmon/Trout Angler Projections

Year	Observed	Age-Period-Cohort Projection	Cohort Survival Projection
2000	81,837		
2001	81,237		
2002	88,426		
2003	87,885		
2004	89,345		
2005	91,852		
2006	92,522		
2007	98,115		
2008	91,745		
2009	92,810		
2010	91,546		
2011	85,555		
2012	90,842		
2013	87,559		
2014	101,110		
2015		92,008	102,147
2016		92,445	103,144
2017		92,862	104,110
2018		93,189	104,987
2019		93,475	105,824
2020		93,772	106,632
2021		93,984	107,346
2022		94,137	108,018
2023		94,184	108,560
2024		94,242	109,123
2025		94,229	109,636
2026		94,467	110,065
2027		94,053	110,317
2028		93,884	110,565
2029		93,750	110,796
2030		93,628	111,018

Table 1 shows observed and projected numbers of Wisconsin resident male, female, and combined total anglers for ages 16 and up. Data sources: Wisconsin Fishing License Database, provided by the Wisconsin Department of Natural Resources; Projections generated by the authors.

Appendix B

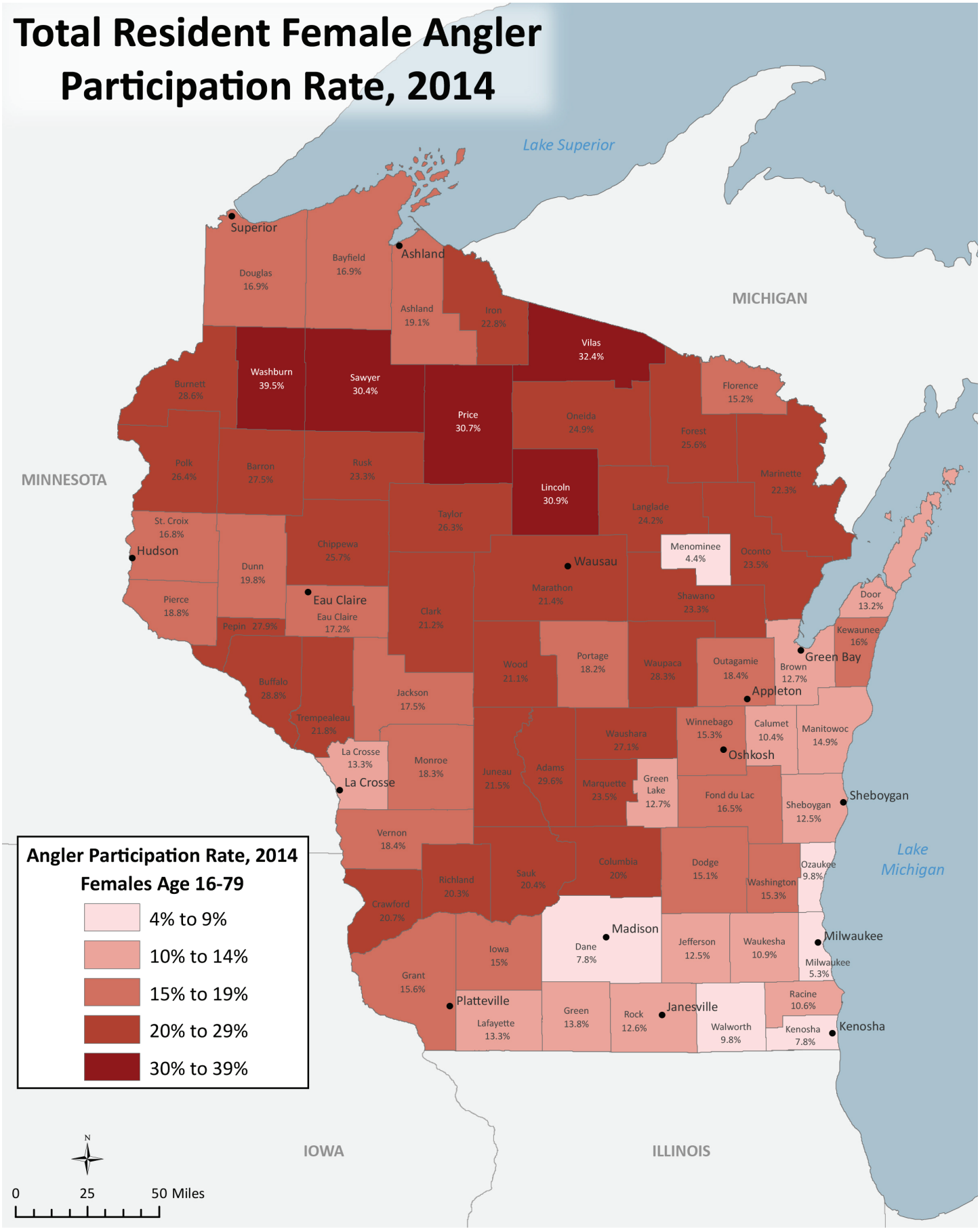
Total Resident Male Angler Participation Rate, 2014



Authors: Data analysis by Richelle Winkler and Erin Burkett, Michigan Technological University. Cartography by Roz Klaas, Applied Population Lab, UW- Madison
Sources: Rates constructed by dividing Wisconsin DNR resident license sales data by total population age 16-79 from US Census Bureau
Project supported by the Great Lakes Fishery Commission. Project ID - 2015 WIN 44044

Great Lakes Research Center
Michigan Technological University

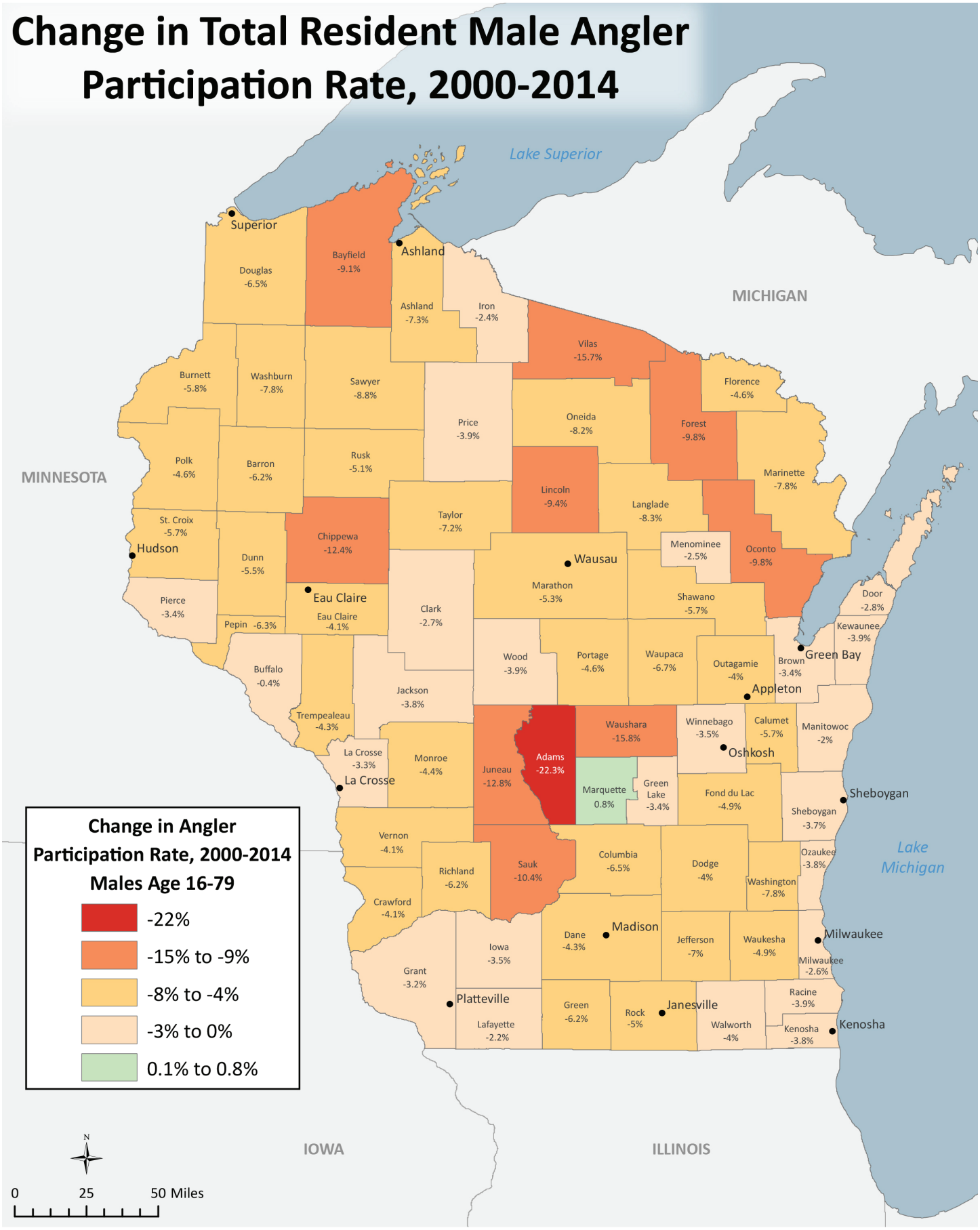
Total Resident Female Angler Participation Rate, 2014



Authors: Data analysis by Richelle Winkler and Erin Burkett, Michigan Technological University. Cartography by Roz Klaas, Applied Population Lab, UW- Madison
Sources: Rates constructed by dividing Wisconsin DNR resident license sales data by total population age 16-79 from US Census Bureau
Project supported by the Great Lakes Fishery Commission. Project ID - 2015 WIN 44044

Great Lakes Research Center
Michigan Technological University

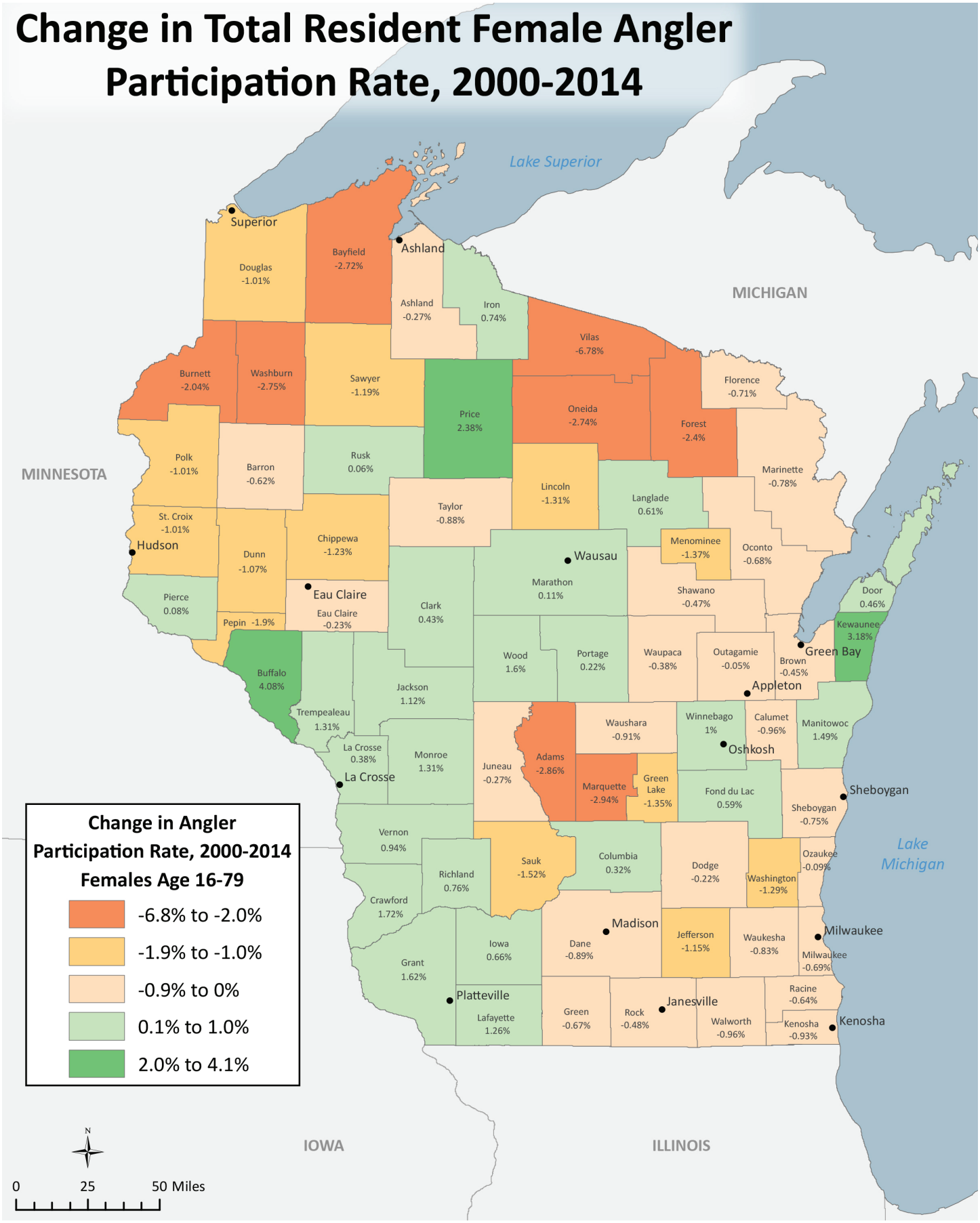
Change in Total Resident Male Angler Participation Rate, 2000-2014



Authors: Data analysis by Richelle Winkler and Erin Burkett, Michigan Technological University. Cartography by Roz Klaas, Applied Population Lab, UW- Madison
Sources: Rates constructed by dividing Wisconsin DNR resident license sales data by total population age 16-79 from US Census Bureau
Project supported by the Great Lakes Fishery Commission. Project ID - 2015 WIN 44044

Great Lakes Research Center
Michigan Technological University

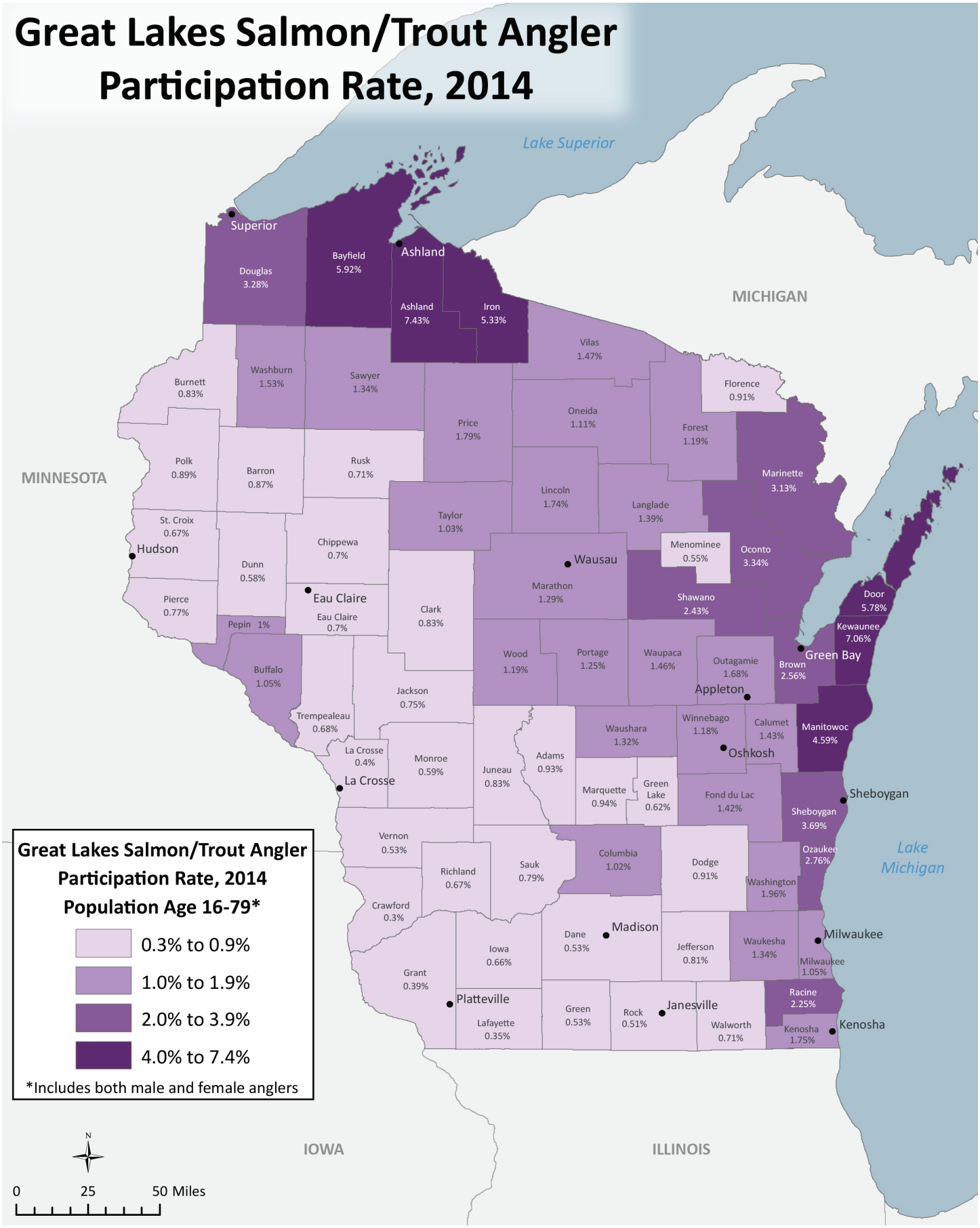
Change in Total Resident Female Angler Participation Rate, 2000-2014



Authors: Data analysis by Richelle Winkler and Erin Burkett, Michigan Technological University. Cartography by Roz Klaas, Applied Population Lab, UW- Madison
Sources: Rates constructed by dividing Wisconsin DNR resident license sales data by total population age 16-79 from US Census Bureau
Project supported by the Great Lakes Fishery Commission. Project ID - 2015 WIN 44044

Great Lakes Research Center
Michigan Technological University

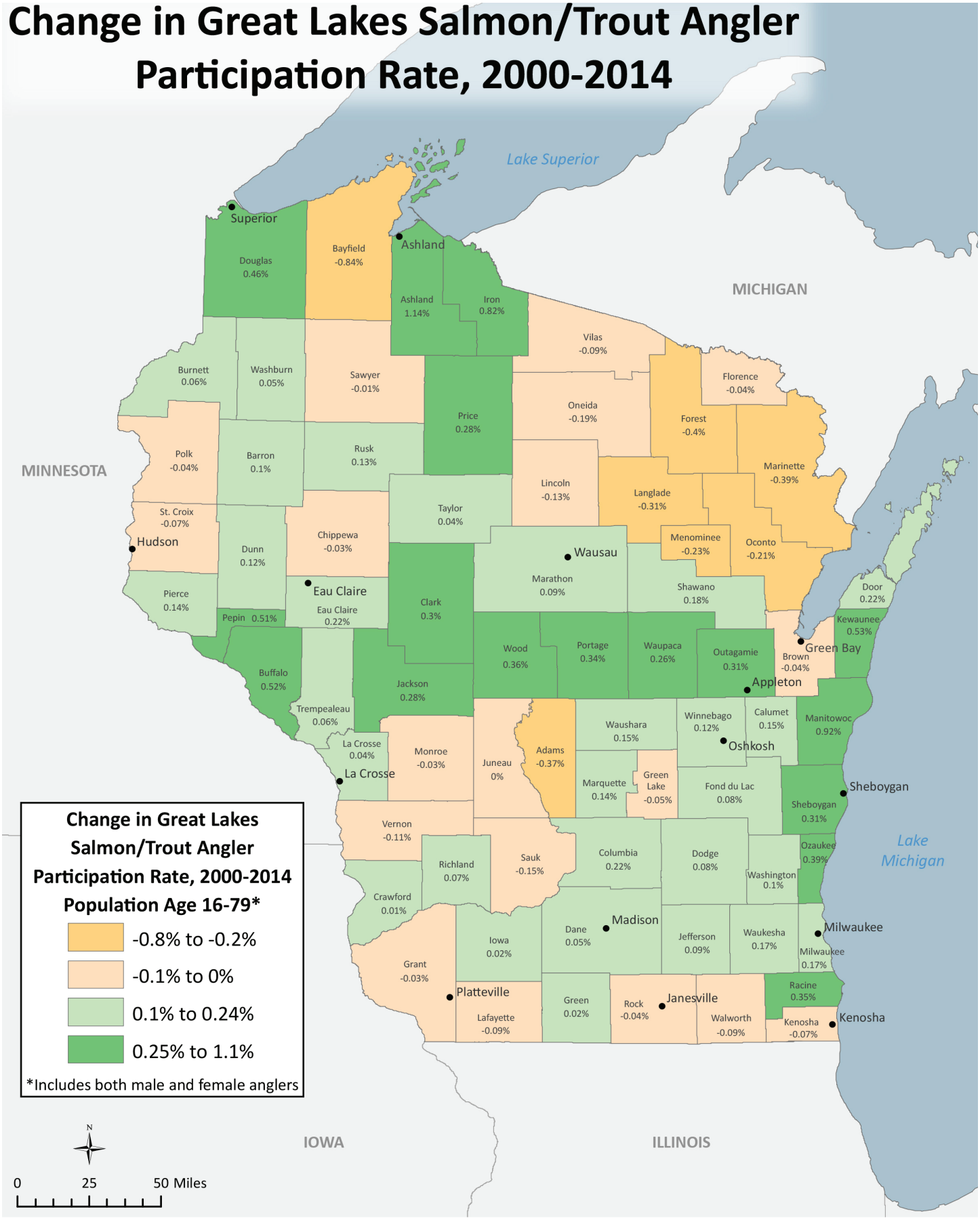
Great Lakes Salmon/Trout Angler Participation Rate, 2014



Authors: Data analysis by Richelle Winkler and Erin Burkett, Michigan Technological University. Cartography by Roz Klaas, Applied Population Lab, UW- Madison
Sources: Rates constructed by dividing Wisconsin DNR resident license sales data by total population age 16-79 from US Census Bureau
Project supported by the Great Lakes Fishery Commission. Project ID - 2015 WIN 44044

Great Lakes Research Center
Michigan Technological University

Change in Great Lakes Salmon/Trout Angler Participation Rate, 2000-2014



Authors: Data analysis by Richelle Winkler and Erin Burkett, Michigan Technological University. Cartography by Roz Klaas, Applied Population Lab, UW- Madison
Sources: Rates constructed by dividing Wisconsin DNR resident license sales data by total population age 16-79 from US Census Bureau
Project supported by the Great Lakes Fishery Commission. Project ID - 2015 WIN 44044

Great Lakes Research Center
Michigan Technological University