Green Bay Great Lakes Spotted Musky Management Plan 2012

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Green Bay Great Lakes Spotted Musky Management Plan
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by

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Background

The Wisconsin Department of Natural Resources (WDNR) in cooperation with several local musky clubs and the Musky Clubs Alliance of Wisconsin initiated a Great Lakes strain muskellunge reintroduction program in 1989 in the Green Bay waters of Lake Michigan. Muskellunge in southern Green Bay were decimated during the early to mid 1900s by habitat destruction, pollution, and over-exploitation. The need to re-establish a native inshore predator fish species has been identified in several planning efforts including the Lake Michigan Integrated Fisheries Management Plan and the Lower Green Bay Remedial Action Plan.

A three-phase plan was drafted by WDNR biologists to re-establish a self-sustaining population of muskellunge in Green Bay: (1) identify an appropriate egg source, obtain eggs, and successfully hatch, rear and stock fish, (2) establish an inland lake broodstock population, and (3) develop a self sustaining population in Green Bay. Phase 1 included the collection of gametes from the Indian Spread Chain in the lower peninsula of Michigan, a tributary system to Lake Huron. In cooperation with the Michigan DNR, gametes were collected and brought to the Wild Rose Fish Hatchery from 1989-1993. In 1996, additional spawn was collected from Lake St. Clair to increase the genetic diversity of the population. Fish health issues and funding delayed further feral muskellunge collections from 1997-2004. In 2005, WDNR pursued an agreement with Ontario Ministry of Natural Resources (OMNR) to collect gametes from Georgian Bay of Lake Huron. In 2007, WDNR signed a five year agreement with OMNR to collect gametes and raise those fish at Fleming College for eventual transfer to Wisconsin. Those efforts led to transfer and stocking events in 2009-2010.

Phase 2 was initiated with the stocking of muskellunge fingerlings into Long Lake in Waushara County, Wisconsin from 1989-1992. From 1995-2001, Long Lake was the main brood source for the reintroduction effort. In 2002 the WDNR discontinued the use of Long Lake as a broodstock lake. In April of 2009, three new inland lakes were stocked with muskellunge from Georgian Bay, Lake Huron, in order to establish brood populations.

Phase 3 began with the stocking of Great Lakes muskellunge in 1989 and subsequent stocking events through 2010. To date there has been no significant recruitment from natural reproduction of muskellunge documented in Green Bay or the Lower Fox River. However in 2008, two young of the year muskellunge were collected from the Lower Menominee River and in 2009 young of the year muskellunge were captured in both the Lower Menominee River and in Sawyer Harbor, Sturgeon Bay. Tissue samples have confirmed these individuals are genetically consistent with Great Lakes spotted muskellunge, confirming the first evidences of natural reproduction.

Current Status

Stocking

The first six years of the program (1989-94), hatchery production averaged 2,200 fingerling and yearling muskies and was based upon spawn collected directly from the Indian Spread Chain of Lakes in the State of Michigan. From 1995 to 2001, hatchery production averaged 2,875 muskies and was primarily from spawn collected from Long Lake, with the exception of 1996 when spawn was collected from Lake St. Clair, Michigan. From 2002 to 2006, spawn was collected from the Fox River and Long Lake and the annual hatchery production increased to an average of 20,324 muskellunge. Stocking increased as hatchery production increased (Figure 1). In 2005, the lower Fox River became the sole location for spawn collection for the reintroduction program. During the spring of 2007, the discovery of other species of fish infected with Viral Hemorrhagic Septicemia virus in Lake Michigan, Green Bay and the Fox River prevented any collection of gametes from those waters and no spawn was collected from 2007-2009. Muskellunge gamete collection and stocking was resumed in 2010 when WDNR staff used a remote Kewaunee County facility and an outlying pond to hatch and raise spawn collected from the Fox River. All parental fish that contributed gametes in 2010 tested negative for VHSv and so did a representative sample from the production lot before they were stocked out. Since 2005, stockings have occurred at a greater diversity of locations around Green Bay (Figure 2).

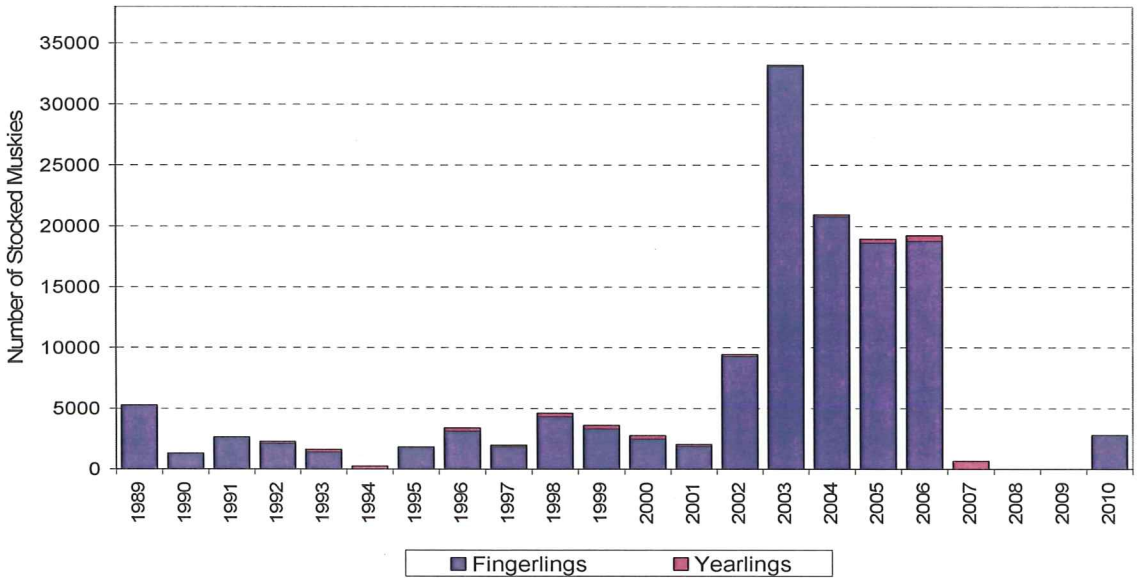

Figure 1. Stocking history of Great Lakes Spotted muskellunge in Green Bay from 1989 to present.

Population Assessments

Current assessment of the Green Bay muskellunge population includes spring fyke netting and fall electrofishing. Incidental muskellunge were captured from 1990 through 2003 while WDNR survey crews sampled walleye populations. In 2004 a targeted spring

effort to sample muskellunge began. Large diameter fyke nets are fished to target pre-spawn and spawning muskellunge in April and May. Fish are measured and total length, weight, sex, and fin clips are recorded. Fish are also given an individual alpha-numeric tag. In the past external Floy tags were used, but currently WDNR uses passive integrated transponder (PIT) tags to improve tag retention. Sampling effort varies from year to year and in some years the Menominee River, Peshtigo River, and the Sturgeon Bay areas have also been sampled.

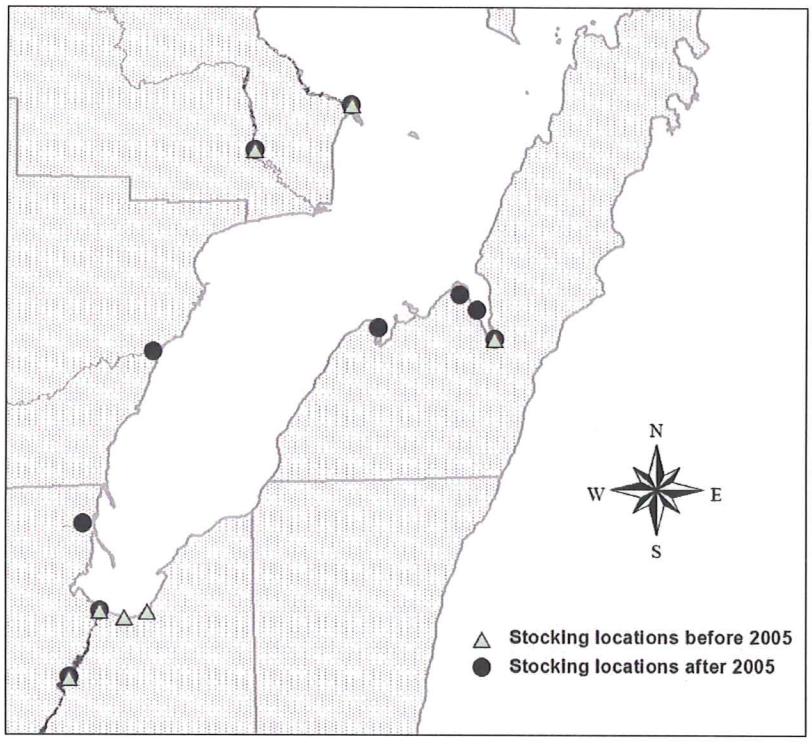

Figure 2. Stocking Locations of muskellunge on green bay from 1998-2010

The mean, median, and maximum length of muskellunge continues to increase as observed in Figure 3. As the population continues to mature, the fish continue to increase in size. This same pattern is visible when only female musky lengths are observed (Figure 4). However, there is more variability in the series because of small sample size in some of the years. In the near future average size may increase as an artifact of three missing year classes from discontinued stocking from 2007-2009 because of a lack of smaller fish.

Fall electrofishing assessments are conducted in September through November and target all game fish. The Lower Bay of Green Bay, Menominee River, Peshtigo River, Oconto River and Fox River are sampled. The catch rate on the Lower Fox increased from 2002 through 2008 as a result of increased stocking that occurred from 2003 through 2006 and as fish grew into larger sizes ages as they matured (Figure 5). The decline in CPE in 2009 for fish less than 17.5 inches in length is likely due to the lack of stocking in 2007-2009. The reason for the reduction in CPE for muskellunge greater than 30 inches is not clear although river water temperature may have affected our catch.

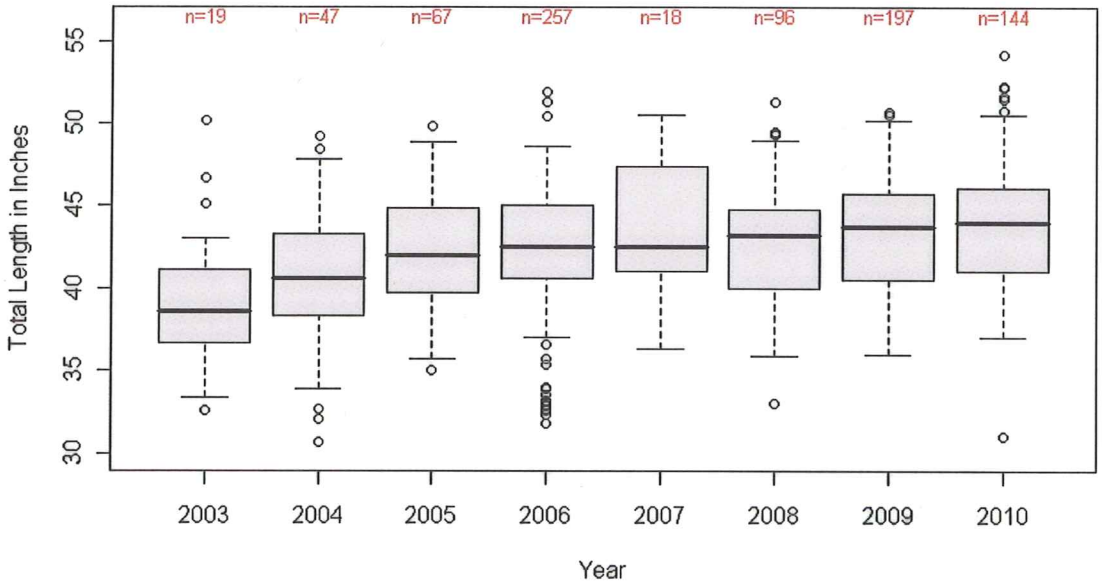

Figure 3. Length distribution of all spring fyke net samples from 2003 through 2010. Box plots show the length distribution of each spring sample. The thick black line indicates the median fish length (50 percentile), box limits show the upper and lower quartiles and the whiskers indicate 10^{th} and 90^{th} percentiles. The numbers above the box plot show the number of observations in each sample.

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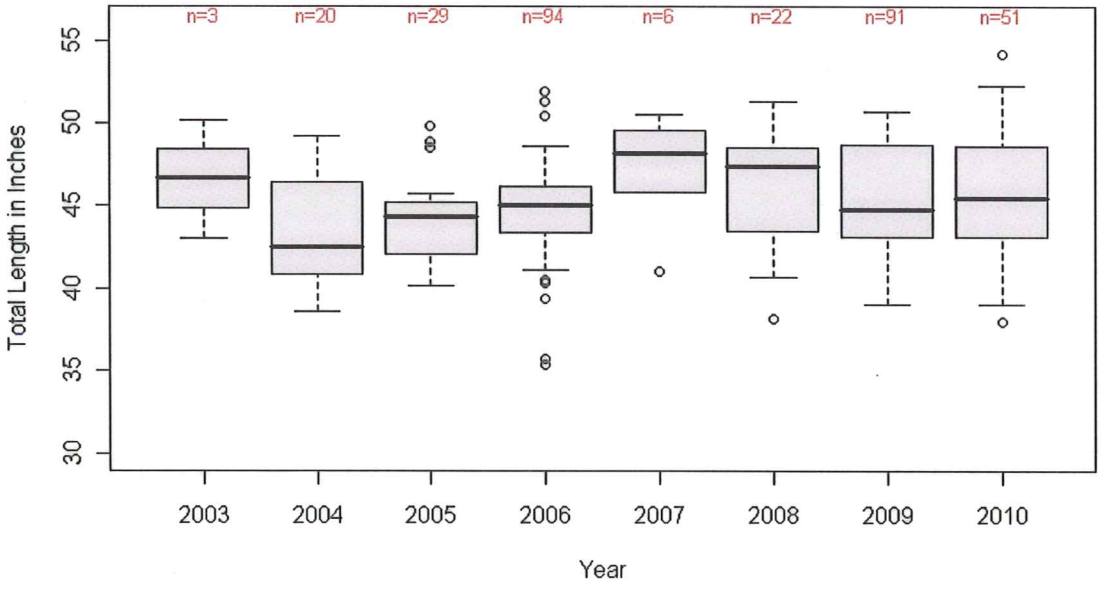

Figure 4. Length distributions of only female muskellunge from spring fyke nets samples.

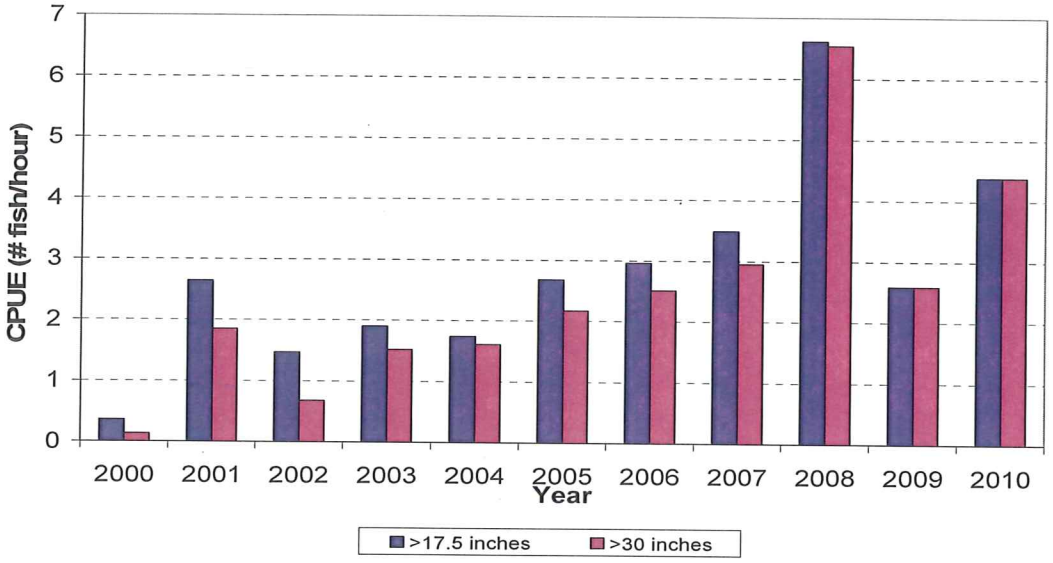

Figure 5. Fall electrofishing Catch per Unit of Effort (hours) for the Lower Fox River from 2000 through 2010.

Growth and Maturity

The growth rate of the Green Bay muskellunge population has been estimated using recaptures of known age fish and estimated for both males and females. Starting in 1991, stocked yearling fish were tagged with an individually numbered Floy tag. This tag allows biologists to know the exact age of the fish when the fish is recaptured. Through June of 2010, 319 individual known age fish have been recaptured. From that sample 119 observations of male length at age and 59 observations of female length at age have been used to describe fish growth using the von Bertalanffy Growth Model (Figure 6).

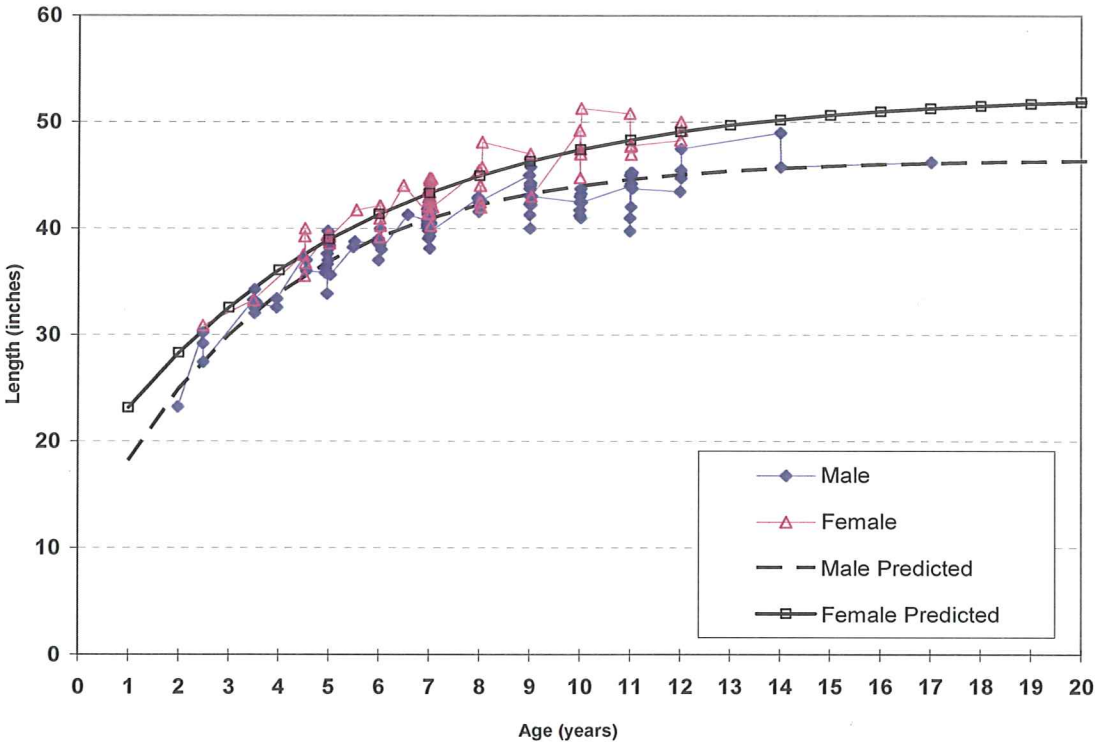

Figure 6. von Bertalanffy growth models for male and female muskellunge from recaptures of known age tagged fish through October 2010. Individual observations of length at age are represented by diamonds for female fish (n=59) and open triangles for male fish (n=119). The predicted average ultimate maximum size is 52.7 inches for female muskellunge and 46.5 for males.

These models are nonlinear regressions that predict the ultimate size of an average fish in the population and describe how fast the fish attain that ultimate size. Muskellunge in Green Bay grow relatively quickly compared to other muskellunge populations and the average ultimate size is predicted at 52.7 inches for females and 46.5 for male fish. As more known age fish are recaptured this model should become more accurate. Many large fish that were initially Floy tagged and later recaptured had lost their tag making age determination impossible. The current use of PIT tags should improve this situation and provide more known age observations of larger fish.

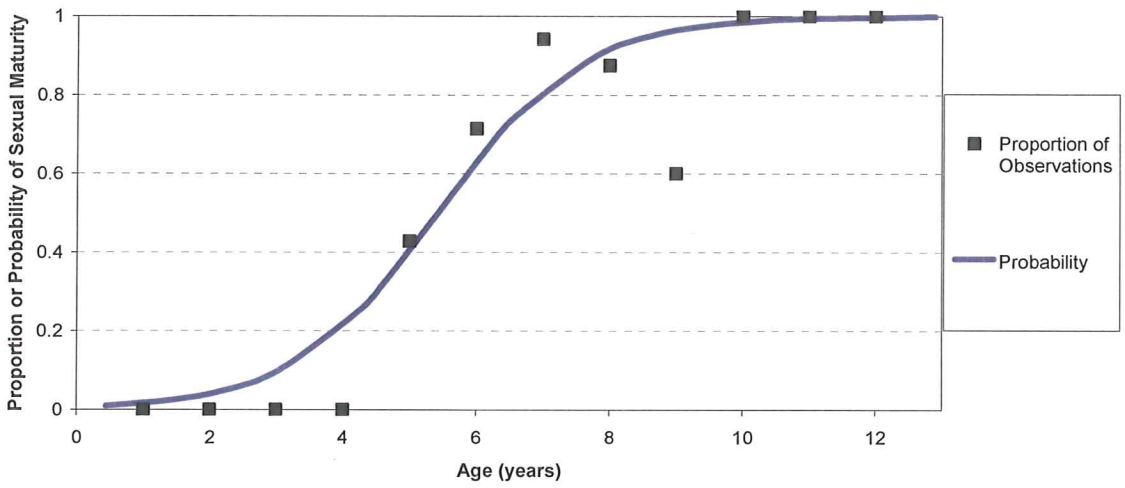

Figure 7. Proportion of sexually mature female fish at age from all spring samples, and non-linear regression estimating probability of sexual maturity. The probability of sexual maturity for female muskies exceeds 90% at 7.8 years of age.

Using the known age and if it expresses gametes at time of capture, allows determination of at what age the fish reach sexual maturity. Figure 7 shows the proportion of sexually mature known age fish in the spring samples, (immature and females only). Female fish begin to mature at age 5 and by age 8 above 90% are mature. A logistic regression predicts that the probability of an individual female fish being mature exceeds 90% at 7.8 years of age. Using the von Bertalanffy growth model and the maturity probability, a 45 inch female is likely 8 years old and has a probability of 90% that she is sexually mature. The probability of 99% maturity for females is attained at 10 years of age, approximately 47.4 inches. Male fish begin to mature at 4 years of age.

Green Bay Muskellunge Fishery

Muskellunge fishing in Green Bay is continuing to grow in popularity and the fishery is managed for trophy potential because of the excellent size structure and growth potential of the fish. The fishery emerged in 2005 and fishing pressure tripled from 2005 to 2007 as estimated by the Lake Michigan Creel Survey (Figure 8). In 2007 the directed fishing effort for muskellunge during the open water season was just under 40,000 hours. This number is an underestimation because the creel survey is not conducted in November when a significant portion of the effort for muskellunge is fished.

As total effort declined in 2008 and 2009 fishing effort became more distributed around the bay with increased effort observed in the Oconto, Marinette and Door county waters of Green Bay. Spring effort is concentrated as anglers target post spawn muskies when the general muskellunge season opens the Saturday of Memorial day weekend or on the Michigan/Wisconsin Boundary waters the season opens several weeks earlier. During the summer there is little targeted musky fishing as fishing effort is spread through out the bay. In the fall as the muskies begin to feed heavily on gizzard shad and whitefish in

the rivers anglers again focus their attention on muskies as over 60% of the annual effort occurs in the months of September and October.

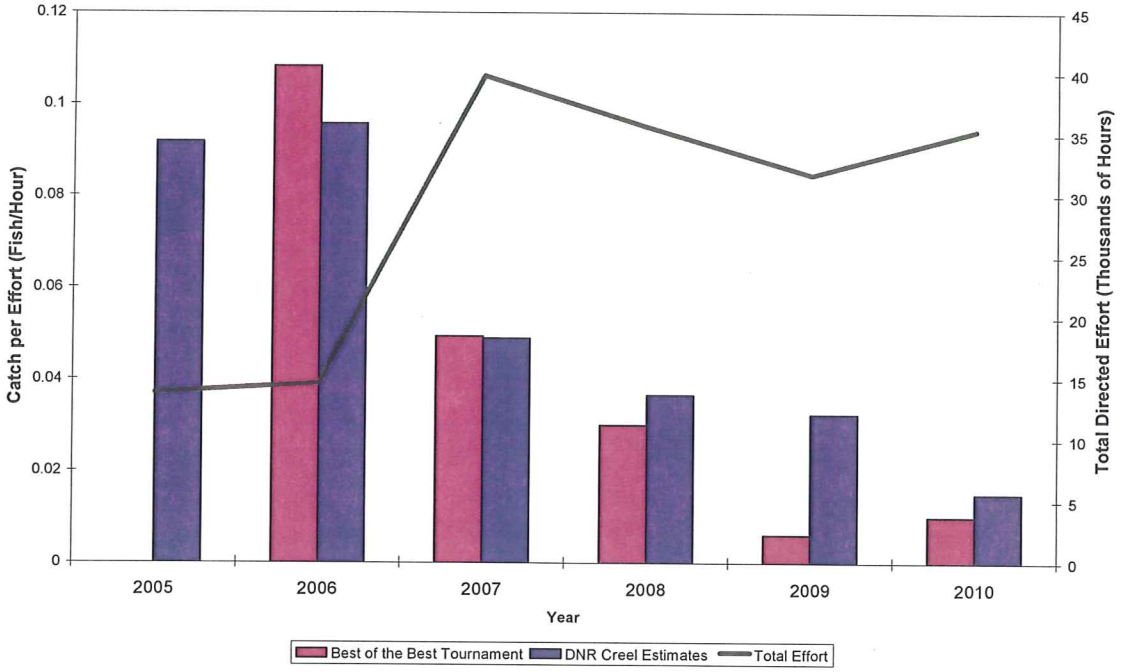

Figure 8. The total directed angling effort for Green Bay Muskellunge from 2005 until 2010, excluding the month of November.

In 2010, the Lake Michigan creel survey estimated a total of 35,342 hours of directed effort for muskellunge on Green Bay and the lower Fox River from March 15th through October 31st (Figure 8). Although the 2010 total effort estimate increased over the 2009 total, catch per effort continued to decline. The creel estimated catch rate has decreased since 2006 reaching its lowest level of 0.015 fish/hour in 2010 (Figure 8). In comparison, statewide directed muskellunge catch rates average 0.039 fish/hour (25.6 hours/fish) for naturally reproduced populations, and 0.020 fish/hour (50 hours/fish) for populations maintained by stocking. This could be explained by several possibilities; as the fishery becomes more popular less experienced anglers are participating and their catch rates are poorer than experienced anglers and guides, the fish are responding to the increase in pressure and their catchability is decreasing to the recreational fishery, anglers are fishing areas that hold fewer fish to get away from the crowds, annual mortality (natural and fishing) and the lack of stocking has reduced the number of fish available to anglers, or annual variability in weather and forage base has affected the recreational anglers success. In 2010 the creel survey estimated that anglers caught 541 musky but harvest was estimated at zero.

Figure 8 also shows the catch rates from a Muskies Inc. tournament that has been held annually on the lower part of the Bay and the Fox River in mid-October since 2006. This tournament is only conducted over 2 days but during the most active period of

muskellunge angling. The similarity in values of the tournament census data, and the creel estimates gives good confidence in the creel survey estimates.

Anglers were concerned that in 2007 muskellunge were being overharvested, especially large females. The Lake Michigan Creel Survey did estimate that there was some harvest in 2007, but none were estimated to have been in 2008 through 2010 (Figure 9). The Lake Michigan Creel Survey is a statistically designed survey that uses effort counts and angler interviews to estimate harvest. Since the harvest of muskellunge is rare, harvest is not well estimated by the survey and has large confidence limits around that estimation. Although the creel survey indicates that anglers catch and harvest muskellunge, there is little confidence in the estimate because harvest of a muskellunge is a rare event. Extending the creel survey through November, a month with high fishing effort could improve harvest and catch estimates.

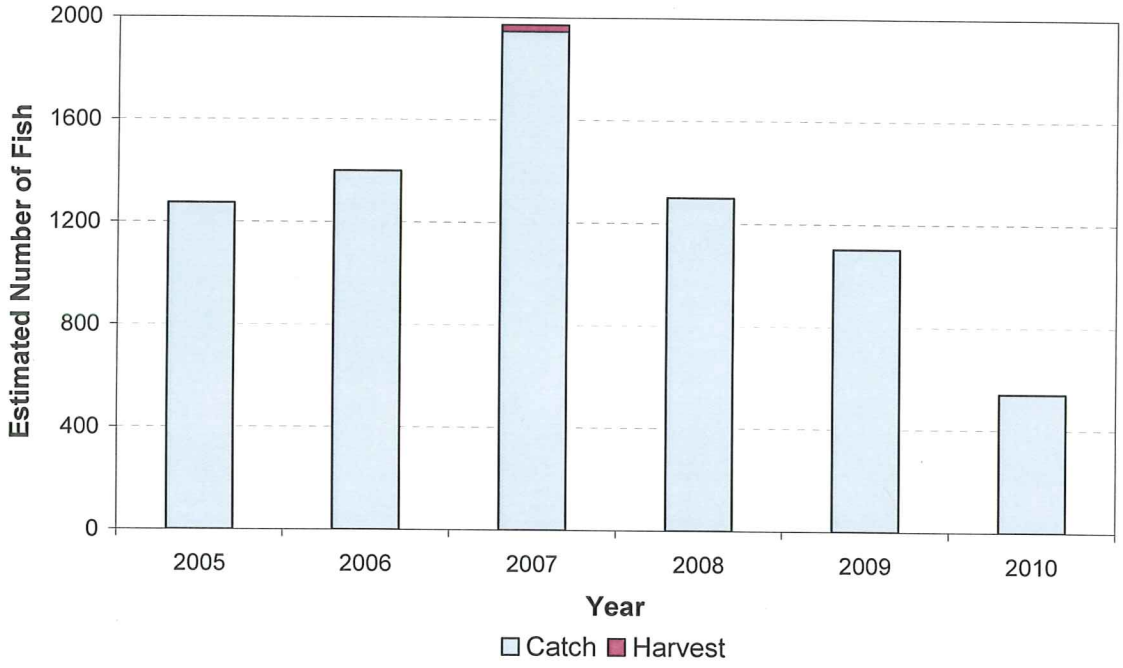

Figure 9. Estimates of muskellunge catch and harvest from Green Bay from 2005 until 2010. In 2007 it was estimated 26 fish were harvested.

The current regulations for muskellunge on Green Bay include; a closed season from November 30 through the Saturday closest to Memorial Day, a 50 inch minimum length limit and a one fish daily bag limit. The biological goals of these regulations are intended to protect muskellunge during the pre-spawn and spawning period by restricting angling, and to prevent harvest of fish before they are sexually mature and can contribute their spawning potential multiple times through their life to sustain the population. The social aspects of these regulations are to maintain the fishery as an open water sport fishery, and to increase the size structure of the population to provide a trophy opportunity.

Research

There are two current areas of research that are helping to further the Green Bay Great Lakes Spotted Muskellunge reintroduction; a study to increase our understanding of musky spawning behavior in Green Bay and work to identify and understand the genetic diversity of the population. In 2009 WDNR and University of Michigan were awarded a Great Lakes Fish and Wildlife Restoration Act Grant to study the Spawning site selection and natural recruitment of the re-established GB muskellunge population. The study aims to answer three important questions about the re-introduced population. Where do the introduced muskellunge spawn, and do those locations have specific habitat qualities? Are those locations that they are choosing able to support natural recruitment? And if some locations are able to support natural recruitment and some are not, do those locations have qualitatively different habitat characteristics or fish communities? By answering these questions the department will be able to better manage the population of fish by improving stocking practices and habitat improvements and protection.

The other area of research is to delineate the genetic make up of the re-established population and to understand how the current genetic diversity of the population may affect the success of the reintroduction. The current population of muskies in Green Bay has been trans-located from two other areas of the Great Lakes region by moving spawn collected from a limited number of adults. It is unclear exactly how many parental fish were used in the four years eggs were collected from the Indian River Chain and the one year eggs came from Lake St. Clair. To increase the likelihood of a successful reintroduction, it is critical the re-established population have sufficient genetic diversity to adapt to local stressors including; diseases, climate, and habitat changes. Current research in cooperation with the Wisconsin USGS Fisheries Coop Unit at UW-Stevens Point is looking at the current level of genetic diversity in the Green Bay population and comparing that to the richness and diversity of the original source populations as well as other Great Lakes spotted muskellunge populations.

Green Bay Spotted Muskellunge Planning Public Meeting

On February 17, 2010 WDNR Fisheries Staff held a meeting to solicit input from stakeholders on future management of Green Bay muskellunge fishery. The meeting was held at the Green Bay Yacht club and well attended by local anglers. A written survey was completed by the 36 non-DNR participants and 28 anglers reported that they primarily fish Green Bay for muskellunge. The 8 other participants reported fishing primarily for walleye, smallmouth bass, yellow perch, or brown trout. Two of these anglers also reported never having fished for muskellunge. The survey also asked participants to identify what they like about the Green Bay muskellunge fishery and what specific concerns that had. The most common answer provided for "something you like" was the potential for a very large or "Trophy" muskellunge. This answer was given by 30 of the 38 participants. The most common concern or dislike that participants gave was overharvest, but this was very close to stocking limitations. The top answers for each question are listed in Table 1.

Table 1. Most common answers provided by participants of the February 17th meeting to the questions: "What to you like about the Green Bay muskellunge fishery?" and "What is one thing that concerns you about the GB muskellunge fishery?"

Likes	Dislikes/concerns
Large size/Trophy potential	Overharvest
Close to home	Stocking limitations
Numbers of fish	VHS virus
Fishing experience on big Water	Fishing pressure
	Poor fish handling and release

The results of the survey were used at that meeting to guide a discussion about the future direction of the fishery. A short discussion of what is a "Trophy" occurred and it was determined that "Trophy" is a very subjective term and identifying objective criteria to describe the population would be preferable. Some of the participants were also very vocal about supporting the 54 inch minimum length limit that has previously been proposed through the Wisconsin Conservation Congress. DNR fisheries staff identified the concerns of participants as growth overfishing (harvest is reducing the mean size of fish in the population) and not recruitment overfishing (harvest is impacting the ability of the population to reproduce and sustain itself). Fisheries staff attempted to explain that fisheries biologists manage for entire populations rather than for individual fish and that population statistics are objective criteria that are used to evaluate the fishery and should not be used to predict the life history of a single fish.

The second part of the discussion at that meeting was spent identifying common goals or preferred outcomes for the fishery and re-establishment. Fisheries staff facilitated a discussion and elucidated ideas from the participants of what outcomes were realistic, important and achievable. Together five goals were identified during the discussion and agreed upon by consensus. Specific tactics to achieve the goals were not discussed.

1: Sustain the sport fishery and trophy potential of fishery.
2: Re-establish a naturally reproducing population.
3: Re-establish a viable population with sufficient genetic diversity.
4: Educate anglers on safe handling and compliance with regulations.
5: Restore/rehabilitate native habitats in Green Bay to support ecosystem functions.

On evening of December 2, 2010 a public meeting was held at the Brown county Library to collect public comments on the draft Green Bay Great Lakes Spotted Muskellunge Plan. Comments were collected that night and to give the public additional opportunity to comment on the draft plan, the public comment period was extended to February 2011. Thirty-seven comments on the plan were received with two (5.4%) for the plan as written, three (8.1%) did not indicate their position and thirty-two (86.5%) were opposed to the plan. Although many anglers supported most of the document, they strongly opposed the continuation of the 50" size limit. Of those that opposed the 50" size limit, most suggested either a 54" minimum size (43.9%) or catch and release only with a ten

year sunset (51.2%). Although more anglers supported the catch and release restriction in public comments, it is likely many of the anglers only supported this option because they believed that the 54" size limit was off the table.

Management Plan

Goal 1: Sustain the sport fishery and trophy potential of fishery

Objective 1.1 Angler catch rate of 0.04 fish per angler hour of directed effort as estimated by the Lake Michigan Creel Survey (30 hours of directed fishing/catch)

Objective 1.2 Maintain a high size structure with a RSD-46 of 20 and a RSD-50 of 5 or a RSD-54 of 2 (depending on the size minimum) measured during spring fyke netting

Strategies: maintain stocking until sufficient natural reproduction is occurring to sustain the abundance of the population. Maintain restrictive harvest regulations to maintain/achieve size structure.

Goal 2: Re-establish a naturally reproducing population(s)

Objective 2.1 PE 0.2 adult muskellunge per acre in the Lower Bay/Fox River management area (Figure 7, south of a line from little tail point to Brown County line)

Objective 2.2 PE of 0.1 adult muskellunge per acre in the West Shore management area (Figure 7, Pensuakee River to Menominee River)

Objective 2.3 PE of 0.1 adult muskellunge per acre in Door county management area (Figure 7, Little Sturgeon to Sister Bay)

Objective 2.5 Fall electrofishing catch rates of 1 YOY muskellunge per mile.

Strategies: Maintain population abundance through stocking and restrictive harvest regulations until population is self sustaining. Move stocking locations to areas that are more likely to support natural reproduction. Use conclusions and recommendations from GLFWRA study to select future stocking locations. Use closed season to prevent fishing during pre- and active spawning.

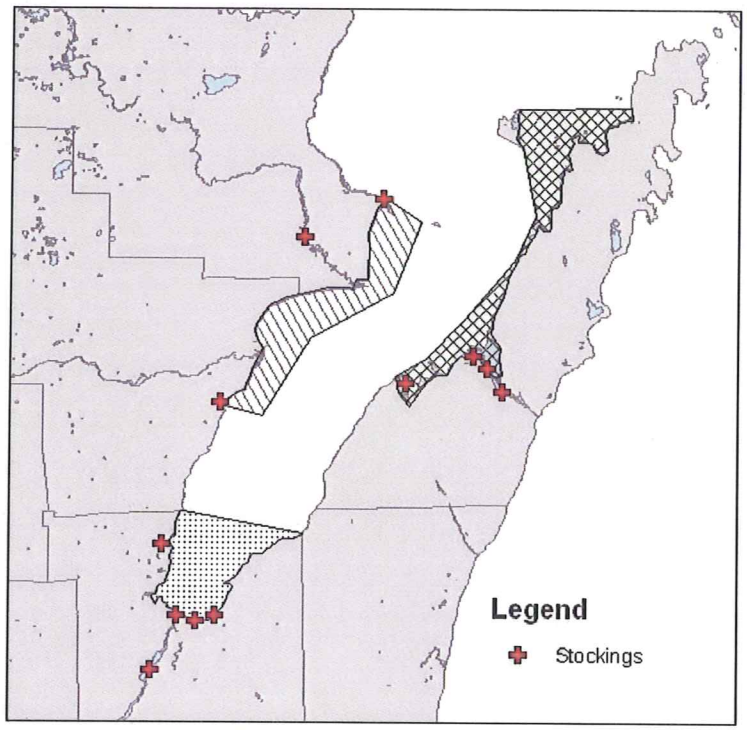

Figure 3. Green Bay waters of Lake Michigan showing the three proposed management zones for GLS muskellunge re-establishment. The Lower Bay/Fox River Zone are waters south of a line drawn from the Oconto/Brown County Line to the Kewaunee/Brown County line and upstream to the De Pere Dam on the Fox River (45,000 acres). The West Shore Zone is the near shore waters from the Mouth of the Pensuakee River to the Michigan-Wisconsin border including the Menominee River (60,000 acres). The Door county Zone is the near shore waters from Henderson Point to Sister Bay and out to Chambers Island (60,000 acres). Crosses indicate locations of past musky stockings.

Goal 3: Establish a viable population with sufficient genetic diversity.

Objective 3.1 Increase the number of founding individuals to >50

Objective 3.2 Establish an allelic richness and diversity equal to or greater than the source populations.

Strategies: Import additional fish from other Great Lakes populations, use best hatchery practices to ensure genetic diversity of hatchery products.

Goal 4: Reduce hooking and handling mortalities and increase compliance with regulations.

Objective 4.1 Achieve 100% compliance with fishing regulations.

Objective 4.2 Reduce handling mortalities to less than 5%.

Strategies: Perform outreach activities to teach handling and improve compliance with regulations. Maintain and improve signage at access points.

Goal 5: Restore/rehabilitate habitat in Green Bay to support ecosystem functions.

Objective 5.1 Improve and enhance aquatic habitat in order to achieve Goal 2.

Strategies: Identify habitat limitations on musky life history strategies and design and implement habitat improvement/restoration projects to overcome deficiencies. Further research may be warranted on spawning and rearing habitat, and interactions with fish/aquatic community (exotics). Cooperate with internal (WDNR Wildlife and Watershed Bureaus) and external partnerships (USEPA, UWGB, USFWS), to improve and restore water quality and ecosystem functions of Greater Green Bay ecosystem.

Management recommendations

1. Continue stocking to maintain recruitment of fish into the population. Although several naturally reproduced musky were captured in the two northern management zones since 2008, the fishery bay wide is still maintained by stocking. The Department should continue to use the Lower Fox River to collect gametes until the inland brood lake populations become available. Enough gametes should be collected annually from the Fox River to be raised at the Besadny Facility with a goal to stock 3,000 fall fingerling Great Lakes musky into Green Bay and the Fox River. This total would approximate the average annual fingerling stocking total from 1989 through 2001. Once the inland brood lake populations become sexually mature then they should be the sole source for productions unless they are unable to provide the required number of eggs to meet the stocking quotas. Stocking of the inland brood lake progeny should continue even if significant natural reproduction is documented to improve the genetic diversity of the population. Monitoring of the genetic diversity of hatchery product should be performed to assess the allelic diversity. Stocking locations with habitat more likely to support natural reproduction should be chosen to encourage natural reproduction. Additional locations in the Door County Management zone should be stocked to increase the abundance of muskellunge in the northern portion of that zone, specifically Sister Bay and Fish Creek areas.

2. Maintain a restrictive minimum size limit to protect the Green Bay population of Great Lakes Muskellunge. The current minimum size limit for musky in Green Bay is 50 inches. Most of the collected data suggests that this size minimum is sufficient to protect these fish to first spawning. However, some recent data such as declining CPE and some questions regarding the accuracy of harvest estimates since the creel survey ends in October before the end of the muskellunge fishing season would to indicate that a larger minimum size limit may be needed to adequately protect these fish. In additional there is strong support from local musky clubs to increase the minimum size limit to 54" based on public comments received about this plan. A rule proposal to increase the minimum size limit to 54" has been submitted to be voted on at the 2013 Conservation Congress Spring Hearings.

3. Work with the State of Michigan to delay the opening of the muskellunge fishing season on the Boundary waters of the Lower Menominee River to prevent the disruption of spawning fish. The spawning study in 2010 showed that 60-80% of the female fish with radio transmitters implanted spawned after the opening of the Michigan fishing season on May 15th. By having the opening date of the season different than the rest of the Green Bay system it likely concentrates angler effort for the limited time before the Green Bay opener the Saturday of Memorial Day weekend. This increased fishing effort and very conspicuous spawning behavior of muskellunge in shallow water is in conflict with the goal of trying to encourage natural reproduction, by disrupting spawning by legitimate angling or snagging. WDNR has approached the Michigan DNRE and is working to make the opening date on the Lower Menominee River consistent with the rest of Wisconsin waters of Green Bay.

4. Improve the knowledge of the fishery by implementing a harvest reporting requirement and extending the creel survey through November. Although there is a well established Lake Michigan creel survey that estimates effort and catch well during the time period it is conducted. Harvest is a rare enough event that it is poorly estimated by the creel survey. A reporting requirement for all harvested muskellunge for the Green Bay population would greatly improve the understanding of the amount and effect harvest has on this population. The extension of the creel through November would give a more accurate estimate of the fishing effort and catch since the most popular months to fish for muskellunge are October and November.

5. Continue cooperation with internal and external partners to protect and enhance aquatic habitats to encourage natural reproduction of muskellunge. Efforts to improve water quality in the Fox River such as the WDNR and EPA Total Maximum Daily Loads program that sets limits on phosphorus and suspended solids, will lead to the use of best management practices in municipal storm water management, agriculture runoff, and industrial discharges in the Fox River watershed and continue to improve the water quality of the River and the Lower Bay. Habitat improvement projects that will restore or rehabilitate the critical habitat for muskellunge that has been damaged or eliminated during the last century should be undertaken. The Cat Island Chain re-creation is a project undertaken by the Army Corps of Engineers in order to utilize the dredged materials from maintaining the shipping channel. The dredged sediment will be used to recreate the barrier islands that once protected Pete's Lake. This project should have enormous environmental benefits by rehabilitating the deep water vegetation community. Thereby benefiting fish like muskellunge that need vegetation to hide in during their juvenile period.