# DRAFT Wisconsin Muskellunge Brood Stock Management Plan

Muskellunge Standing Team
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## Background:

One major objective of muskellunge management in Wisconsin is to manage the species as a trophy. Another key objective is to protect naturally reproducing populations. Recently, concerns have been raised about the performance or stocked fisheries in Wisconsin. Some anglers believe that slow-growing populations of muskellunge are being used as egg sources for our hatchery system and that, as a result, fewer than expected trophy muskellunge are being caught by anglers fishing in Wisconsin waters. Further, many stocked lakes have not exhibited subsequent natural reproduction. Past spawning operations may have contributed to poor performance of stocked fish, although there is no conclusive evidence of this.

This plan is intended to improve the long term propagation of muskellunge in Wisconsin. While many of the fish handling and selection processes have generally been done in a sound manner, we have identified some areas for improvement based on genetic principles. In the short term, additional brood stock lakes will need to be identified. In the long term, these principles will improve the fitness of fish stocked into Wisconsin waters and ensure the species survival in our waters.

## Objectives:

This document addresses the following topics related to muskellunge brood stock management in Wisconsin:

- Best Management Practices for Spawning Operations (Chapter 1)
- Identification of Genetic Stock Structure of Muskellunge in Wisconsin (Chapter 2)
- Selection of Optimum Brood Sources (Chapter 3)

## Timeline:

Summer 2005 through 2007
Identification and selection of 10 self-sustained lakes for brood stock within each presumed Genetic Management Zone. Initially, we need to identify at least 3 interim self-sustained lakes for each facility (Winter 2005), which will be used over the next 3 years. Ultimately, 5 self-sustained lakes and 5 back-up lakes will be identified and used in a 5 year rotation for egg collection (Fall 2007).

Spring 2006
-Begin implementation of Best Management Practices for spawning operations (Chapter 1).
-Continue identification and selection of self-sustained brood stock lakes.

-Begin performance evaluation of Leech Lake versus Bone Lake (WI production fish) outside the native range of muskellunge (Chapter 3).

Spring 2007
-Preliminary determination of Genetic Management Zones (interim report from Dr. Brian Sloss and students).
-Begin field performance evaluations of candidate brood stock lakes (start with lakes well away from the preliminary GMZ boundaries).
-Selection of additional interim brood stock lakes.

Spring 2009
-Final determination of Genetic Management Zones (final report from Dr. Brian Sloss and students).
-Final selection of potential brood stock lakes based on genetic survey.

Fall 2009
-Conduct additional performance evaluations of potential brood stock lakes.

Fall 2012
-Review results of Leech Lake strain evaluation.

Winter 2015
-Final selection of optimum brood stock lakes.

Chapter 1

<u>Best Management Practices for Spawning Operations</u> (Excerpted from report titled: **FISH HANDLING/PROPAGATION OF MUSKELLUNGE ISSUES,** by BRIAN L. SLOSS, Wisconsin Cooperative Fisheries Research Unit, U.S.Geological Survey, College of Natural Resources, University of Wisconsin-Stevens Point, Stevens Point, WI, 2005)

Introduction

As we review the current status of the musky program, a few key elements stand out. First, the use of non-recruiting, supplementally stocked lakes as the sole sources of gametes for the program should be abandoned. This approach is prone to high risk of genetic impact on the propagated fish. In essence, this approach will result in a magnification of hatchery impacts experienced and in many cases unavoidable, within a supplementation program. Efforts should focus on identifying genetically 'healthy' and reproductively vigorous muskellunge populations that require no supplementation for consistent recruitment. Second, the selection of which fish to spawn needs refined and distinct guidelines for hatchery personnel should be outlined to allow for efficient gamete collections. Third, the number of fish selected for breeding each year will need to be increased. Efforts described later will focus on a strategy aimed at maximizing the effective number of breeders and overall effective population size across a putative muskellunge generation.

Until efforts to identify and test putative stock boundaries of muskellunge in Wisconsin waters is completed (see Chapter 2) a modification of the genetic management zones (GMZ) of Fields et al. 1997 should be employed and adhered to. The five muskellunge GMZ's within Wisconsin are Lake Superior watershed, Upper Mississippi watershed, Lower Mississippi watershed, Wisconsin River watershed, and Green Bay/Lake Michigan watershed. It is important to note that the data supporting these as distinct GMZ's fail to resolve the zones as distinct stocks. However, anecdotal data and trends in the data suggest these may be at a minimum a solid default approach. Many of the identified questions of the muskellunge team are clustered here to represent groups of answers to these questions. These guidelines should be followed as long as fish are stocked into waters with existing natural reproduction. Further, following these guidelines may improve the chances of stocked fish becoming naturalized in current non-natural reproduction lakes.

Recommendations

1. *Brood stock lakes should be self-sustained, not sustained through stocking. Plant-back of fry should be discontinued.*

Stocked populations should not be used as broodstock as long as a combination of NR lakes are available within the genetic management zone to meet production needs. Reliance on stocked lakes increases the probability of inbreeding and can/will result in a magnification of inadvertent selection (size, age at first spawning, run timing, etc.).

Selection of broodstock lakes should be based on various factors including those outlined by Miller and Kapuscinski (2003):

a. Genetic lineage

i. Is population a naturally occurring spawning population, a naturalized spawning population, or mostly/wholly reliant on stocking?
ii. To what extent are past stocking events known?
iii. Were past stockings across default GMZ boundaries?

b. Life history patterns
   i. Are potential source populations sympatric with pike?
   ii. Spawning habitat available similar to stocked lakes?
   iii. Other factors, e.g., riverene vesus lacustrine?

c. Ecology of source and receiving populations
   i. Food web
   ii. Competitors

2*. Ultimately, each GMZ should have 5 brood stock lakes (and 5 backup lakes) identified, and egg take should rotate among lakes each year. An odd number of brood stock lakes should be selected to ensure different sources of fish in alternate-year stocked lakes*.

My suggestion would be to develop at least 3-5 brood source lakes and keep the crosses within a single source. I base this suggestion on a couple of factors. If we rely highly on NR musky lakes only and only use a single source, we could potentially harm this source over an extended period of time by taking a significant proportion of its reproductive output. I feel this option would enable a satisfactory level of genetic diversity to be included in the program while not putting undue pressure on any one NR population. Further, the use of 3-5 is not a random choice. With many populations receiving fish in alternating years, the use of an odd number of source populations would result in all populations receiving progeny from all brood source populations over a 6 to 10 year period of time.

A consistent rotation should be developed and adhered to. If numbers are unavailable for a given year, move to the identified back up lake. If numbers are still low, curtail stocking for that year. In the event this is not an option, crosses should be limited to within populations only, no outcrossing.

This approach has the benefit of minimizing the impact on any given source NR population. This approach is not without challenges. The relevant information necessary to choose a brood source lake (see question 1) would increase the workload of hatchery and field personnel if a multiple source/rotation program were put into practice. It would also necessitate an increased load on fish health personnel. Nevertheless, it is my professional opinion that this approach represents an acceptable risk while providing benefits to the long-term muskellunge propagation program as a whole.

3. *When collecting eggs, use a nested stratified, random design across spawning season and fish size. It is an absolute* ***must*** *to avoid size, age, spawning time, sex ratio, weight, etc., discrimination in relation to selecting the individual fish for spawning. The most pressing of these issues in relation to muskellunge is time of spawning and size of fish. It is, however, permissible to avoid sick or deformed fish when selecting spawners*.

Choose 3-5 sample periods during the normal spawning season. An adaptive approach can be initially favored wherein over the near-future, the proportional collection of gametes will be consistent with the overall proportion of spawners in normal years. The initial efforts could concentrate on data we have on hand regarding the intensity of spawning through time. Within any given sampling effort, crews should attempt to randomly select fish in regards to length and weight. Care should be given to not spawn large fish just with large fish, small with small, etc. In this regard, the information I've reviewed suggests the state does a fair job of this. However, care should be taken to not simply collect until the quota is filled but to collect until the strata are represented. This approach will require monitoring and evaluation of the spawning grounds of NR lakes in order to consistently improve the accuracy of this design.

The ultimate goal is to avoid inadvertent selection of heritable traits (i.e., domestication) consistent with the goals laid out by Miller and Kapuscinski (2003). In addition, it is important not to use the same broodfish in successive years. Although the use of multiple brood lakes on a rotational basis will reduce the impacts of using the same breeders sequentially it is still recommended to avoid this if at all possible. To this end it is important to mark all fish being used as broodfish from each of the source populations. It is also preferred to take a small genetic sample (a fin clip would suffice) to allow for future evaluation of stocking efforts and efficiency. This would also allow more accurate measures of natural recruitment versus stocked fish in some of our unknown reproductive status systems.

This represents added effort on the part of the hatchery and field personnel responsible for gamete collections. I also recognize the added challenges to the rearing process in terms of having fish roughly the same size at the same time. However, the benefits, genetically, are necessary to ensure the propagation of diverse and healthy muskellunge populations. Time of spawning has been shown in many species to be heritable and thus, selectable by hatchery operations.

> 4*. Each facility should spawn 19 to 26 females (and 57 to 78 males) each year. Spawning should involve exactly 3 males per female, and families should be kept separate (don't spawn the males or the females with any other fish). Roughly the same number of eggs should be taken from each female. Efforts should be made to spawn the target of 26 females if at all possible. All spawned fish should be marked and sampled for genetic material.*

This is the critical issue in maintaining the diversity and viability of muskellunge populations affected by the propagation program in Wisconsin. The issues of minimum numbers and crossing strategies focus on the effective number of breeders in a given season ($N_b$) and the effective population size of the entire generation of muskellunge ($N_e$). With iteroparous fish such as muskellunge, the generation time can roughly be equated to the mean age of spawning fish. I have not been able to find an estimate on any of our populations currently being used for brood sources. Therefore, for the purpose of calculating $N_e$ I figured two prospective generation times for muskellunge, five years and seven years. In general with walleye, we find the mean age of spawners to be roughly equivalent to the age when these fish first reach reproductive age. This is important because estimates of $N_b$ can be summed to determined $N_e$.

The main challenge when determining numbers of broodfish for hatchery production lies in balancing the effort in collection, rearing, and overall production of a given number of individuals versus the increase in inbreeding and genetic drift (genetic sampling error) associated with the same number of individuals.

Despite the suggested use of multiple populations over time, the $N_e$ will be calculated on the basis of a single generation of hatchery productions (5 years and 7 years). Our goal here is to maintain the level of genetic diversity present in the source populations. In situations such as this, it important to preserve rare alleles. Rare alleles are alleles present in the population at a frequency of 5% or less. Long-term viability of populations relies on the preservation of this integral genetic variation. An effective population size of between 350 and 500 individuals/generation provides a 95-99% probability of retaining rare alleles over this timeframe. In order to achieve this $N_e$ the annual $N_b$ needs to average 70-100 individuals for the 5-year generation estimate and 50-71.5 individuals for the 7-year generation.

Currently, the $N_b$ with unequal sex ratios is:

$$N_b = 4N_f N_m / N_f + N_m$$

Where $N_f$ = number of females and $N_m$ = the number of males.

With this formula we can estimate the maximum $N_b$ of the two hatchery programs (Governor Thompson and Art Oehmcke).

Thompson (assume 3 males/cross): $N_b = 4(18)(54)/18+54 = 54$ individuals/year

$$N_{e\text{-}5yr/gen} = 5 \times (N_b) = 270$$
$$N_{e\text{-}7yr/gen} = 7 \times (N_b) = 378$$

Oehmcke (assume 3 males/cross): $N_b = 4(8)(24)/8+24 = 24$ individuals/year

$$N_{e\text{-}5yr/gen} = 5 \times (N_b) = 120$$
$$N_{e\text{-}7yr/gen} = 7 \times (N_b) = 168$$

Both current strategies fail to reach the target range of 350-500 over a 5-year generation interval. However, the Thompson hatchery does make the minimum size if a 7-year generation is assumed. Additionally, factors influencing the reproductive variance among individuals adversely affect the final $N_e$ measure. For example, if males suffer even a small percentage of infertility and/or differential success when milt is combined (i.e., sperm competition), it effectively reduces the numbers of males we can consider as contributors of genetic material.

Let's assume a low degree of male infertility coupled with a random (poisson distributed) probability of fertilization among the males combined to fertilize a female. Let's assume these combine to effectively make every one male used equivalent to ¾ of a male. This is not an unreasonable estimate as the same factors in salmonid studies have effectively reduced male contribution to as low as 0.60 that of a given female. Therefore, if we use three males to fertilize every female, we effectively are using 1 female and 2.25 males. Taking this into account in our equations would lower the $N_b$ and $N_e$ estimates of both systems. For the 5-year generation, Thompson $N_b$ = 49.8 and $N_e$ = 249.2 and Oehmcke $N_b$ = 22.2 and $N_e$ = 110.8. For the 7-year generation, the $N_e$ estimates become 348 and 155.4 for Thompson and Oehmcke, respectively.

Ideally, we would cross in a 1:1 ratio with no mixing of gametes to eliminate the variability of fertilization and the possibility of male infertility. However, given the low milt production of muskellunge, it appears necessary to combine milt for fertilization. Nevertheless, the combination of eggs should be avoided throughout the propagation program. This introduces a level of variability that is unnecessary and will result in lowered effective size production compared to theoretical maximum numbers. Given that males are more numerous when collecting gametes, I would suggest the following approach: 1 female: 3 males. This should allow adequate milt for fertilization of all eggs. I use these numbers not entirely from a genetics perspective but the fact that both current hatchery protocols experience ~ 80% fertilization with this current approach suggesting a low variability among female family size.

Efforts should begin immediately to find a way to eliminate the combination of milt to maintain this 1:3 cross ratio. One approach that has been discussed is the use of sperm extenders. If and when this is possible, the approach should still be 1 female to 3 males. However, the approach should result in the eggs of a single female being divided equally (or as close as possible) into three batches and fertilized independently by the milt of a single male. Further, the males should only be used to fertilize a single female. As with other suggestions, all broodfish should be marked and sampled for genetic analysis. We can then begin efforts to investigate sperm viability and/or other factors related to mixing of milt. It is not unreasonable that this approach could result in the present method (combining milt) being cleared of potential detrimental effects and thus becoming the long-term standard protocol.

Using the logic we used earlier to estimate the effective number of males (0.75/male), each individual cross (1 female and 3 males or 4 fish total) would have a $N_b = 2.77$. Therefore, to reach our minimum target goal of 70/year (5-year generation), we would need 26 females/year. This gives us an $N_b = 72$ and a final $N_e = 360$. Given this number is only 8 more females than are used currently by the Governor Thompson hatchery, this should be an attainable goal without greatly increasing the man-hours and rearing space. This does represent slightly more than a three-fold increase in the number of females necessary for the Oehmcke hatchery. Hopefully, this would be possible out of the potential brood lakes. An alternative strategy could be a partial factorial crossing scheme. However, this would require a large effort in crossing design and in-field manipulations. The easier route would most likely be increasing the number of females sampled. Similar estimates for the 7-year generation would result in a minimum target goal of 19 females/year.

Taking this number of females will result in an excess of eggs under the current fecundity and egg-take scheme. My suggestion would be to raise less eggs/female to reach the production quota. Efforts should be made to produce roughly the same number of fry/female. Therefore, I am suggesting a minimum number of females used in any given year be 19 females with exactly 3 males/female being used. The males should only be used on a single female, no mixed crosses of males to multiple females. I would like to reiterate that no mixing of eggs should occur. Efforts should be made to make the target minimum 26 females to provide a more conservative approach toward generation time (5 years) and provide for $N_e$ in excess of 350 individuals.

*5. Ensure that all families contribute to the fish being stocked into any given water body in any given year.*

A final factor that has been raised in initial reviews of this document is the rearing and stocking of muskellunge. Currently, several ponds are used to rear muskellunge with all production from a subset of females going into a given pond. When stocking time arrives, a given population generally receives stocked fish from a single pond or only a few ponds. This raises a new set of concerns as the target goal of $N_e$ = 350-500 will never be achieved despite the correct broodstock sampling strategy, spawning strategy, and lake choices. Given this scenario, further effort will be required to fine tune this genetic guideline for muskellunge propagation. My initial reaction was to suggest all stocking be from a combination of ponds. Alternatively, all ponds could be pooled into a single, larger rearing pond/lake. However, application issues, especially cannibalism of younger/smaller fish by older/larger fish, make the pooling of all families unfeasible. From a genetics perspective, it is important to ensure that all families contribute to the fish being stocked into any given water body in any given year. The more deviation from this occurring the more the $N_b$ of the receiving water body's is negatively impacted. This strengthens the need to more accurately identify and, more importantly, quantify what constitutes a naturally recruiting muskellunge population. Avoiding stocking into these waters would minimize the long-term impact of low $N_b$ hatchery issues on NR waters. New guidelines could be developed and, perhaps, modified approaches to ensure non-NR waters are stocked according to a genetically viable and sustainable approach within the boundaries of hatchery production logistics.

> *6. Brood stock lakes should be protected from selective angling harvest by establishing high minimum length limits?*

To ensure consistent, adequate numbers of spawning adults, higher minimum lengths limits will be proposed for all brood stock lakes (ultimately, 10 lakes). The committee will work out the details (specific size limit) by February 2006 and as the list of brood stock lakes is developed, companion rule change proposals will be submitted for each lake that is not already protected with the appropriate regulation. We anticipate the first proposals will be presented at the 2007 Spring Fish and Wildlife Rules Hearings.

## Conclusion

The guidelines suggested herein are just that, guidelines. In many cases the correct data and or experiments have not been conducted to more accurately pinpoint the correct approach. Further, year to year variation may result in some of the suggested targets being unattainable. In that case, effort should focus on coming as close as possible to the target. The suggested numbers of fish to spawn and the rotation of lakes will allow some room for failure to meet target goals without increasing the risks to an intolerable level. Nevertheless, it is my opinion that these guidelines represent the best scenario to ensure the propagation of muskellunge in Wisconsin is producing a quality product representative of native, naturally-recruiting muskellunge populations.

A few final thoughts on the propagation program for muskellunge. In my review and preparation of this document, a few key items stood out to me.

1. The first is we currently have no quantitative index of natural reproduction and subsequently, no effective means of objectively identifying self-sustained populations. As these are two specifically identified items of importance in the Muskellunge Management

Update (Simonson 2004), future efforts and attention need to be paid to resolving these evaluation questions.

2. The goal of stocking muskellunge into specific Wisconsin waters is poorly defined compared to other state, regional, and national stocking programs being implemented throughout the country. Generally speaking, management actions such as supplementally stocking a recruiting population are usually accompanied by a specific objective statement and evaluation/monitoring program to measure the success of the stocking. Further, it is alarming when a population is showing 'inadequate' recruitment, especially if the population was formerly a strong recruiting population. In these cases, stocking could result in a direct violation of Program Goal I.B. (protection of genetic integrity) while Program Goal I.A. 'Identify and protect existing spawning and nursery habitat', may help ameliorate the cause of the decline.

3. Private hatcheries and private interest stocking of muskellunge in Wisconsin should be monitored very closely. Private hatcheries should be required to meet similar effective population size limits and provide pedigree information for all broodstock prior to allowing release of these fish into Wisconsin waters. It is not uncommon for private hatcheries to use the appropriate number of broodfish thus appearing to be consistent with the genetic goals outlined earlier. What is seldom known is the ultimate source of these broodfish and the number of founder fish used to establish this source. This is another reason why all waters stocked in the state should be treated as a potential source for future generations.

I would like to thank the muskellunge species team for their review and suggested revisions of an earlier draft of this document. I would specifically like to thank Bruce Underwood and Gary Lindenberger for their assistance and openness in helping me understand the current work being done and helping me develop this suggested plan. Discussions with Dr. Martin Jennings, Tim Simonson, and Scott Stewart have helped me become more familiar with the history, present status, and importance of muskellunge propagation in Wisconsin. I would also like to thank all the private/public interests who have taken a supportive role in the muskellunge propagation program and the continued improvement of muskellunge propagation in Wisconsin. In particular, the comments of Tom Penniston, Secretary Capital City Chapter of Muskies, Inc. and a former State Hatchery Scientist for the Arkansas Game and Fish.

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Chapter 2

Identification of Genetic Stock Structure of Muskellunge in Wisconsin

This study will be funded through ISS and conducted by Dr. Brian Sloss, Wisconsin Cooperative Fisheries Research Unit, University of Wisconsin – Stevens Point. The study will take place over 4 years with 2 successive graduate students. The first student will survey 30-40 populations (many from existing tissue samples) and will make a preliminary determination of stock boundaries. The second student will focus on refining the stock boundaries by sampling 30-40 additional populations around the preliminary stock boundaries. Final determination of stock boundaries should be made by spring 2009.

Shortcut to Identification and Delineation of Muskellunge Stock Structure in Wisconsin and Neighboring Watersheds.pdf.lnk

Chapter 3

Selection of Optimum Brood Sources

Once stock boundaries are identified and Genetic Management Zones are delineated, performance evaluations of potential brood stock lakes within Wisconsin will be conducted. These should be self-sustained lakes. Paired stocking evaluations will be conducted starting in 2007. These evaluations should focus on lakes well away from the preliminary GMZ boundaries. Additional evaluations will be conducted once final GMZs are identified, starting in spring 2010. Initial results will be evaluated in 2012 and final selection of brood stock lakes should be completed by 2015.

In addition, in the near-term, fish from Leech Lake, Minnesota will be tested in paired evaluations with WI production muskellunge starting in spring 2006. Evaluations will include 10 lakes, 7 lakes representative of St. Croix Basin muskellunge waters (Field evaluation of muskellunge strains in the St. Croix Basin , below) and 3 stocked waters to the south, all outside the native range of muskellunge in Wisconsin. The 3 stocked waters include Lake Wissota, Chippewa County; Lake Monona, Dane County; and Lake Delavan, Walworth County. Any surplus Leech Lake fish will be stocked in Petenwell Flowage. All fish will be fin clipped (Left ventral = Leech Lake; right ventral=Bone Lake) but no rigorous evaluation will be conducted on Petenwell Flowage. On the 3 evaluation lakes, a portion of each strain will be PIT tagged to evaluate growth of individual fish. Protocol for evaluation of these waters will follow the St. Croix Basin evaluation (below) as closely as possible. Funding for this portion of the evaluation will be provided through FHAV.

| | | | Number Stocked | | |
|---|---|---|---|---|---|
| Lake | County | Acres | LL strain | WI strain | Years Stocked |
| Lake Wissota | Chippewa | 6300 | 2500 | 2500 | 06,07,08,09 |
| Lake Monona | Dane | 3274 | 985 | 985 | 06,07,08,09 |
| Lake Delavan | Walworth | 2072 | 1250 | 1250 | 06,07,08,09 |
| Petenwell Flowage | Adams/Juneau | | | | 06,07,08,09 |

**Proposal to Evaluate MN Strain Muskie in Lake Monona (Scot Stewart)**

Lake Monona in Dane County has been stocked with predominantly true musky since 1991. The Oregon Musky Busters have purchased some hybrid muskies to supplement the stocking of trues. A population estimate conducted in 2003 and 2004 estimated the population of fish to be 0.56 fish per acre.

The Madison Lakes have been on a sampling rotation since 1987, so each lake is comprehensively sampled every four or five years. This rotation is altered slightly when we desire to investigate further, such as the two-year muskie population estimate for Monona.

Beginning in 2006, we propose to stock Monona on an annual basis with 1,965 large fingerling musky. This rate was the average stocking rate that resulted in the 2003 population of fish. We wish to stock the lake with half Wisconsin strain fish and half Minnesota strain fish. Fish will be differentially fin-clipped to identify strain. Further, we desire to insert as many PIT tags into the fish as we can afford (we currently have 1,131 tags on hand). We will use half of our tags in each strain of fish.

On each sampling rotation we will be able to conduct a population estimate on the fish and collect age and growth data. In addition we can collect some data continuously during our briefer annual surveys and by using angler diaries provided to select anglers that catch a large number of fish each year.

**Proposal to Evaluate MN strain Muskie in Delavan Lake (Doug Welch)**

Delavan Lake was chemically rehabilitated in 1989. True muskie have been stocked since 1990.

Beginning in 2006, we propose to annually stock 2,486 large fingerling musky. The stocking rate would be 1.2 per acre (.6/acre of MN strain, and .6/acre of WI strain). This rate is close to the per lake cap of 2500. Each strain will be marked with identifying finclips. Equal numbers of each strain will also be PIT tagged.

We will sample every 4 to 5 years to estimate population size and collect age and growth data. Some data will also be collected during our annual spring walleye egg taking (fyke nets) and our fall electrofishing.

**Field evaluation of muskellunge strains in the St. Croix Basin** (Contributed by Dr. Martin Jennings, Research Scientist, Spooner)

**Issue statement**: The appropriate source of muskellunge for propagation and stocking into non-native muskellunge waters in Wisconsin has been debated recently. Part of WDNR response to stakeholder concerns is to conduct a research evaluation of Leech Lake and Chippewa Basin strain performance in the St. Croix Basin. The statewide Muskellunge Management Committee has reviewed and approved a draft study design. FH Board review and approval of study design is requested.

**Background**

Wisconsin DNR's Muskellunge propagation and stocking program relies on wild broodstock netted in Wisconsin waters. Broodstock for production at the Governor Tommy G. Thompson Hatchery (GTH) in Spooner are typically netted in Bone Lake, Polk Co. WI, and historically from Lac Court Orielles in Sawyer County. Bone Lake muskellunge originated from hatchery-produced progeny of LCO broodstock.

Stocking records indicate that LCO was stocked with muskellunge produced from Spider Lake and Mud-Callahan Lake (both located in the upper Chippewa River basin in Sawyer County, Wisconsin) broodstock. Evidence from past research suggested that genetic as well as environmental differences in factors contributing to growth occur among these populations. Concerns recently raised by some members of the public include the possible impact of stocking into LCO on the LCO muskellunge population's growth potential, and the resulting impact on the growth potential of Bone Lake muskellunge and their progeny, which are widely stocked within the state.

Leech Lake, MN has been suggested as an alternative source of fish for propagation and stocking in Wisconsin waters. Although no controlled experiments comparing growth of Leech Lake musky to Wisconsin populations have been completed, the occurrence of large (>50") muskellunge in Leech Lake and lakes stocked with fish of Leech Lake origin indicates that these fish provide the potential for a trophy fishery under appropriate conditions. What has not been determined is how Wisconsin hatchery produced fish compare to Leech L. fish in performance characteristics important to muskellunge anglers, in Wisconsin waters. Differences in limnological characteristics of lakes, new introductions versus established populations, angling pressure, or fish community all make comparisons among waters difficult to interpret.

Wisconsin DNR's muskellunge management program has several objectives, such as providing a range of angling opportunities, including trophy fisheries, and conserving the biological resource, including native genetic diversity. Muskellunge fisheries exist in waters with native, self-sustaining populations, in waters with populations that reproduce but are supplemented with stocking, and in waters with introduced populations maintained exclusively with stocking. In this last group, where no native genetic resources are at risk from stock transfers, we can conduct evaluations of performance comparing fish from different sources. The St. Croix River basin in northwestern Wisconsin contains no native muskellunge populations but has lakes with muskie fisheries established and maintained by stocking. Because the species occurs in these waters and would not constitute a new introduction, and no native genetic resources would be put at risk with new introductions, the St. Croix Basin provides an appropriate setting for conducting evaluations of alternative muskellunge sources. Such an evaluation potentially provides empirical evidence necessary to make informed decision regarding investments in propagation system changes.

**Objective**

Compare performance of Leech L. and Wisconsin muskellunge in Wisconsin waters of the St. Croix River Basin.

**Approach**

Performance of Leech Lake and Wisconsin broodstock progeny will be compared in Wisconsin waters of the St. Croix Basin. Wisconsin broodstock will come from Bone Lake, Polk County, or lake designated as brood lake under the evolving broodstock management plan. All fish will be reared, harvested, and transported under similar conditions at the GTH in Spooner. Identical treatment of the fish minimizes differences in size or condition at stocking, which could influence survival and early growth results. Stocking will be paired, with equal numbers of fish from each source stocked in the same lake during the same year. This eliminates confounding effects of weather or fish community changes that could affect comparisons of fish stocked in different years. Total stocking from the two sources will be done at the standard stocking density of one fish per acre. Fish will be differentiated with PIT tags, which provide a unique binary code identifying individuals. Thus, any fish collected in the future will be of known age and source.

Stocking will occur in alternate years, which is the standard practice for WDNR muskellunge management. Each study lake will receive two experimental stockings. Lakes will be staggered in the design, so that some lakes are stocked in years 1 and 3, the remaining lakes in years 2 and 4.

The evaluation phase for growth results will begin when the fish are approximately age 5, and vulnerable to sampling with spring fyke nets. Netting will involve both research and fish management crews. Where sufficient numbers of fish are sampled, population estimates will be calculated to evaluate differences in abundance (survival) between the two sources. Growth differences will be inferred by comparing length at age and condition factors with ANOVA. The study will follow a randomized block design, with lakes as blocks. The model will use study lakes as representatives of the larger population of muskellunge lakes in the St. Croix Basin. Thus, the objective is not to tabulate results on a lake by lake basis for individual lake management, but to infer results as they apply generally across the basin. The model will evaluate length at age as a function of source (genetic background) and lake. The simplicity of the model is necessary because of the typically low sample size inherent in muskellunge field studies, and the lack of power to evaluate more complex models.

Study lakes were selected in consultation with St. Croix Basin Fisheries Management staff, and approved by the statewide muskellunge management committee. Selection of study lakes considered several criteria, including representing a range of muskellunge fisheries (Class A, B, and C waters) and using lakes currently managed for muskellunge, so that the study is truly representative of lakes managed for muskellunge in the basin. We attempted to minimize disruption to existing management plans or competition with existing quotas. Seepage lakes were preferred to minimize movements of fish into and out of the system during the study. New introductions were not considered, primarily to eliminate delays in implementation.

| Lake | County | Acres | Class | Year Stocked |
|---|---|---|---|---|
| Shell | Washburn | 2580 | A1 | 07, 09 |
| Deer | Polk | 807 | A2 | 06, 08 |
| Matthews | Washburn | 263 | B | 07, 09 |
| Sand | Barron | 322 | B | 06, 08 |
| Twenty-Six | Burnett | 263 | B | 07, 09 |
| Benoit | Burnett | 279 | C | 07, 09 |
| Des Moines | Burnett | 229 | C | 06, 08 |

**Schedule**

2005-lake selection, securing sources of LL fish, test tagging procedures (retention, mortality).
2006-09-production and stocking
2011-adult sampling begins.
2012-initiate annual review of results by muskellunge management committee for purpose of applying results to propagation and stocking policy.

**Funding**

Funding would be provided through the SFR allocation to WDNR FH Research, and is currently budgeted pending FH Board approval.