

Muskellunge Management Update



Prepared by

Tim Simonson, WDNR
Bureau of Fisheries Management
101 S Webster Street, PO BOX 7921
Madison, WI 53707
(608) 266-5222
Timothy.Simonson@wisconsin.gov



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Muskellunge Management

PURPOSE

The purpose of this report is to provide muskellunge anglers with current information on Wisconsin's muskellunge fishery and associated management activities.

INTRODUCTION

Designated the state fish in 1955, muskellunge are found in lakes of all sizes and in large rivers, generally occupying areas with abundant submerged aquatic plants. The heart of the range is north central Wisconsin, although they are found in many other locations throughout the state; nearly 90% of muskellunge waters occur in the northern Wisconsin. Muskellunge are the largest predatory fish found in Wisconsin. They are sleek and powerful, known to feed on virtually every kind of fish, as well as aquatic birds and mammals. Because of their large size and predatory nature, muskellunge are usually present at low densities, with most waters generally containing less than 1 adult per acre. Long hours are often required to catch a muskellunge; however, most avid anglers are more than willing to invest the time required to encounter a muskellunge.

Muskellunge are managed as a trophy in Wisconsin. This means restricting the harvest through relatively high length limits and low daily bag limits to promote the occurrence of large fish in the population. Only hook and line fishing is allowed for muskellunge. Restrictions on trolling (originally developed to reduce muskellunge harvest) also exist in many waters throughout the state. Fishing regulations for muskellunge are varied, depending upon the growth potential of the population and public support for trophy length limits. The current statewide minimum length limit is 40", which applies to approximately 94% of all muskellunge waters (see **Fishing Regulations**, below, for a more details and exceptions). The daily bag limit for muskellunge is generally 1 on most waters statewide. The open season for muskellunge north of US Hwy. 10 (Northern Zone) is from the Saturday nearest Memorial Day to November 30. The open season south of US Hwy. 10 (Southern Zone) is from the first Saturday in May to December 31. A variety of fish refuges designed to protect vulnerable concentrations of spawning muskellunge exist throughout the state. Natural reproduction has always been relatively low, making stocking an important management strategy in some waters, especially for populations that are dependent on continued stocking.

The economic impact of muskellunge fishing in Wisconsin is substantial. A 2006 US Fish and Wildlife Service report estimated that 1.4 million anglers fishing in Wisconsin spent \$1.7 billion on fishing (fishing trips, equipment, etc.). We estimate that about 25% of anglers fish for muskellunge. So, about 5.3 million angler-days are spent fishing for muskellunge each year. A rough estimate of expenditures would be \$425 million spent directly on muskellunge fishing in Wisconsin. This does not include indirect economic impacts, such as wages and tax revenue.

RESOURCE BASE

Muskellunge occur in 667 lakes (588,822 acres) and 100 segments on 48 rivers (2,085 miles). Waters are subjectively divided into three classes based on the relative abundance of muskellunge and the quality of the fishery:

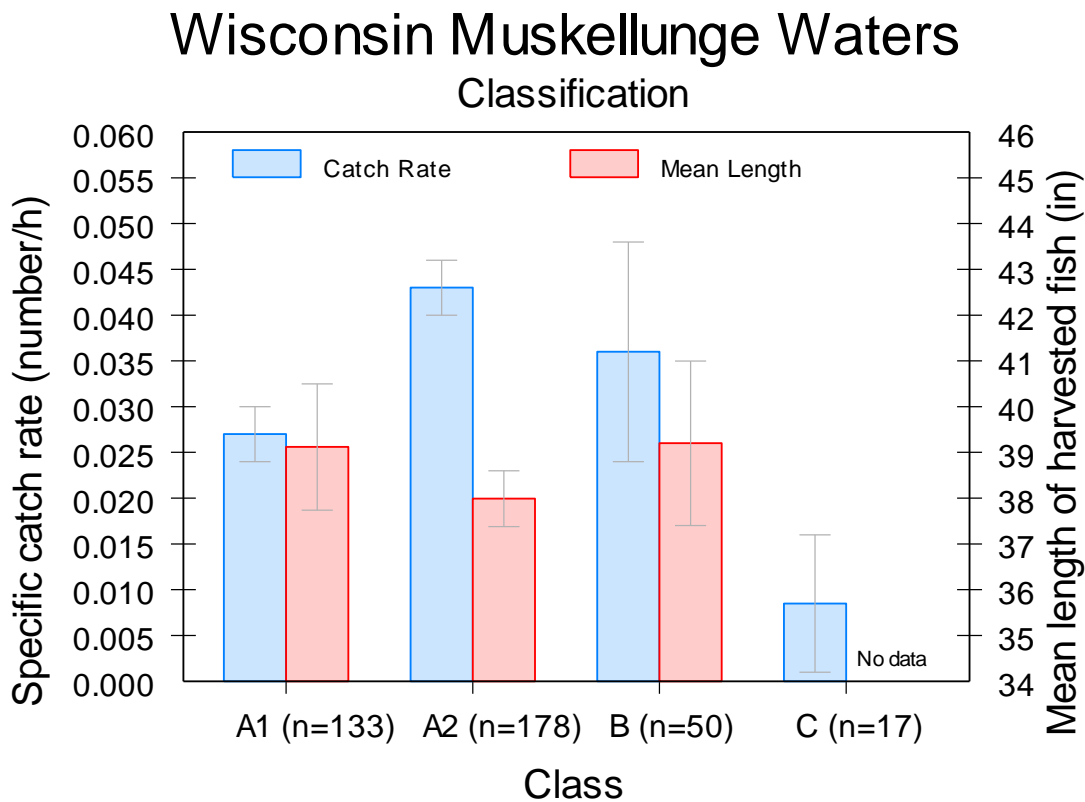
Class A waters are the premiere muskellunge waters considered by most to provide the best fishing (316 lakes; 325,087 acres).

Class A1 – “Trophy waters” (122 lakes; 254,838 acres)

Class A2 - “Action waters” (194 lakes; 70,249 acres)

Class B – Support intermediate populations that provide good fishing, but with generally lower catch rates than in Class A waters (227 lakes; 226,606 acres).

Class C – These waters have fishable muskellunge populations but they are generally not of major importance to the fishery (124 waters; 37,129 acres).



Muskellunge waters are further divided into four categories that described the reproductive status of the population:

Category 1. Sustained through natural reproduction; no stocking (302 lakes).

Category 2. Natural reproduction, but some stocking also occurs (188 lakes).

Category 3. Stocking is required to maintain the fishery (115 lakes).

Category 0. No know natural reproduction or stocking (62 lakes). Muskellunge are present due primarily to immigration from connected waters.

PROGRAM GOALS AND OBJECTIVES

I. Protect and enhance Wisconsin's naturally reproducing (category 1) populations.

- A. Identify self-sustained muskellunge populations. Develop an index of natural reproduction and quantitative criteria to define "self-sustained" populations.
- B. Identify and protect existing spawning and nursery habitat. Develop a volunteer monitoring program for spawning habitat delineation within category 1 and 2 lakes. Use the Nohner (2010) model to identify potential spawning grounds.
- C. Protect the genetic integrity of self-sustained muskellunge populations.
- D. Protect adult muskellunge from harvest to full maturity.

II. Manage muskellunge for a variety of unique fishing opportunities (including trophy, quality action, and harvest) within balanced aquatic communities.

- A. Trophy Fisheries - Manage Class A1 waters to increase the catch of 45" and larger muskellunge, with some fish 50" and larger.
- B. Action Fisheries - Manage Class A2 waters for a catch rate of 1 muskellunge (any size) per 25 hours of muskellunge angling.
- C. Improve Existing Fisheries - Rehabilitate former muskellunge waters that have experienced substantial declines in the muskellunge population; improve class B and C fisheries.

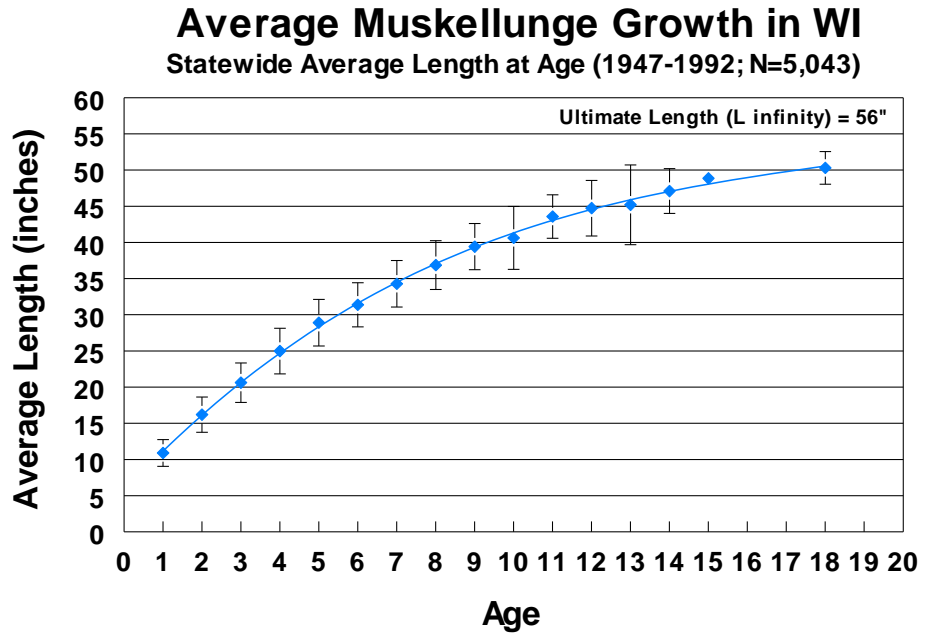
III. Improve the information available for muskellunge populations and educational efforts to inform anglers about the status and management of muskellunge fisheries.

- A. Monitoring - Assess muskellunge abundance, size-structure and relative abundance of the associated fish community. Conduct mail surveys every 10 years to track angler attitudes and to evaluate program goals. Pilot an Angler Diary program for possible broad-scale coverage. Maintain Class and Category designations.
- B. Evaluation – Assess muskellunge regulations; evaluate muskellunge stocking to determine relative contribution of stocked fish in Category 2 waters and stocking success in category 3 waters.
- C. Education - Provide information and technical assistance to our partners, anglers, and lakeshore property owners. Continue to emphasize the value of catch and release. Clarify the role that muskellunge play within aquatic ecosystems, including interactions with other species.

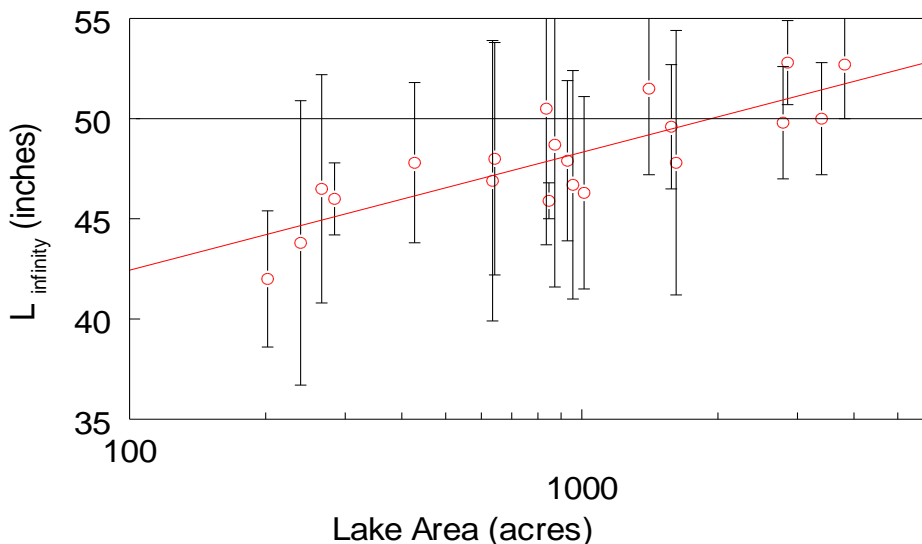
BACKGROUND FISHERY INFORMATION

Muskellunge Growth – The annual growth of muskellunge in Wisconsin is shown below. On average, musky are about 11 inches long after their first year of life, reach 34” in year 7, reach 40” in year 9, and reach 50 inches by age 17. Typically, females grow faster than males. Overall, the average “ultimate length” (a measure of biological potential) attainable by muskellunge populations in Wisconsin is about 56”.

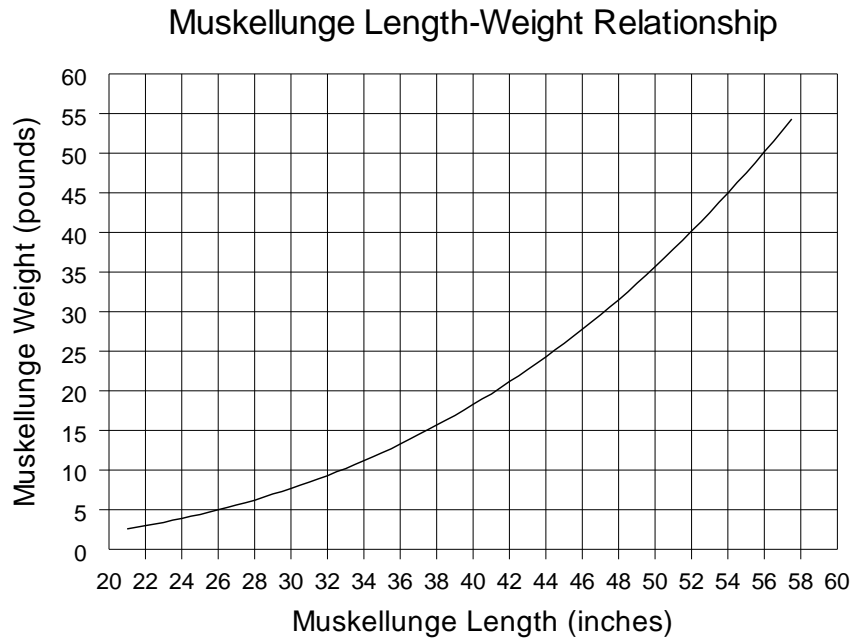
While the overall, statewide “ultimate length” is 56”, not all waters have the same potential. The ultimate length depends largely on the size of the lake; larger lakes tend to grow larger muskellunge. Lake size (acres) explains nearly 70% of the observed variability in ultimate length among lakes (see figure, below). This relationship predicts that lakes 2,000 acres and larger typically support populations more likely to produce fish that will, on average, reach or exceed 50 inches. This relationship also predicts that lakes down to 100 acres (and lower) are biologically capable of producing 40” or larger fish, except on a few, high density, very slow-growing populations, typically found in smaller lakes.



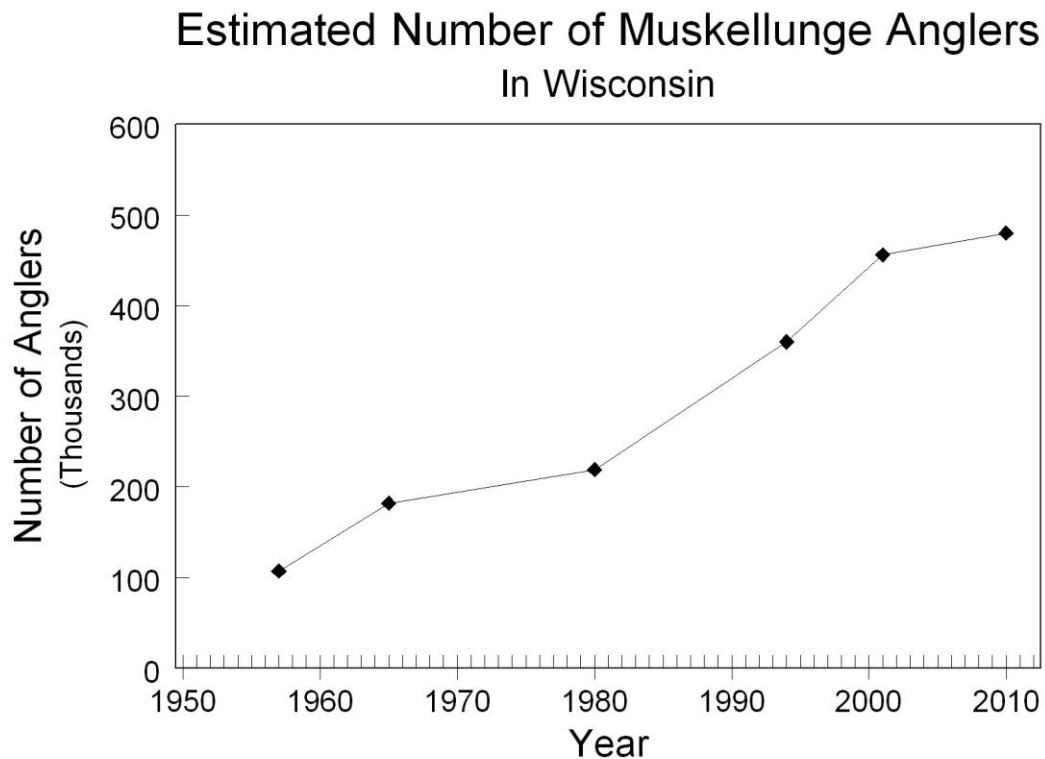
Mean Ultimate Length (L_{∞} - 99% CI) as a function of Lake Size for Muskellunge in 20 NE WI Lakes ($r^2=0.67$)



The average weight attained by Wisconsin muskellunge of varying lengths is shown below. On average, muskellunge reach 10 pounds at about 33 inches in length, 20 pounds at about 41 inches, 30 pounds at about 47 inches, and 40 pounds at about 52 inches. Again, this relationship will vary among populations and at different times of the year.

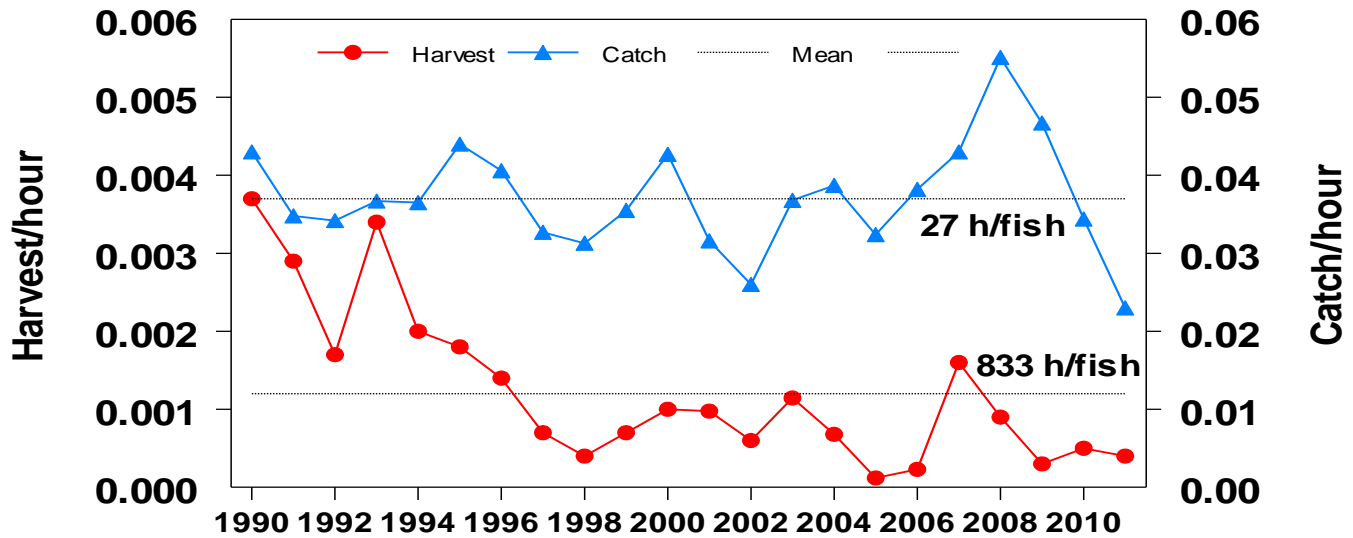


Fishing Effort. Muskellunge fishing has increased in popularity. Participation rates continue to grow. In 2010, an estimated 480,000 anglers pursued muskellunge in Wisconsin, a number that has increased steadily over the years.



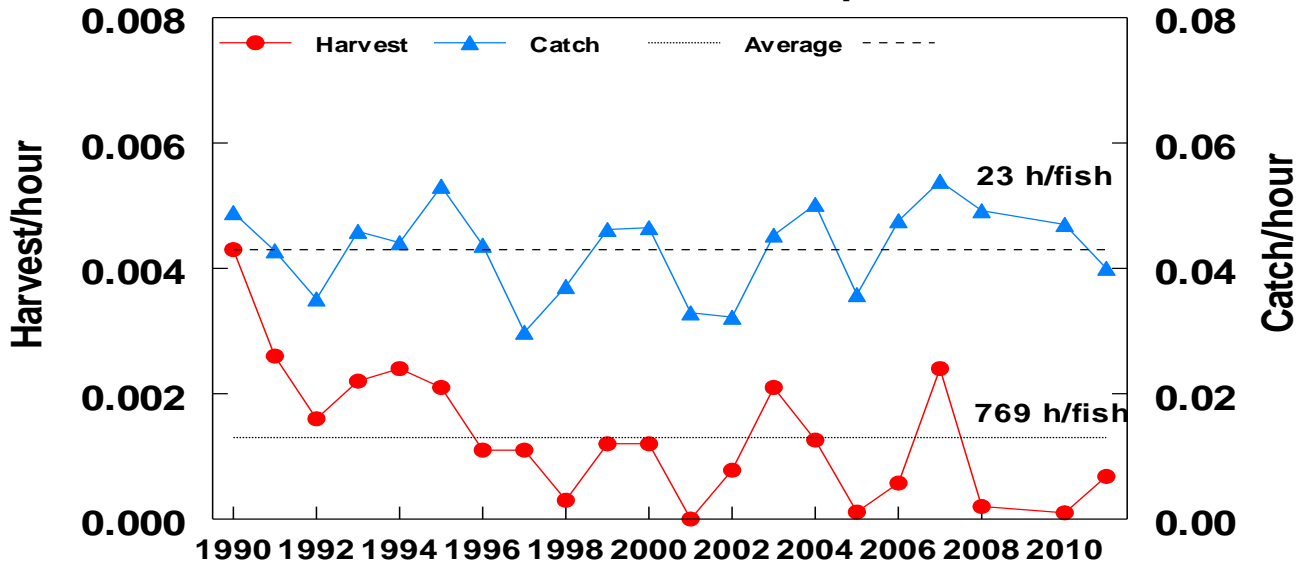
Catch and Harvest. The catch rate for muskellunge on all Class A and B waters averages about 0.037 fish/hour (27 hours spent fishing per muskellunge caught), while the harvest rate averages about 0.0012 fish/hour (833 hours per muskellunge harvested).

Angler Catch and Harvest Rates All Class A and B Waters - 1990-present

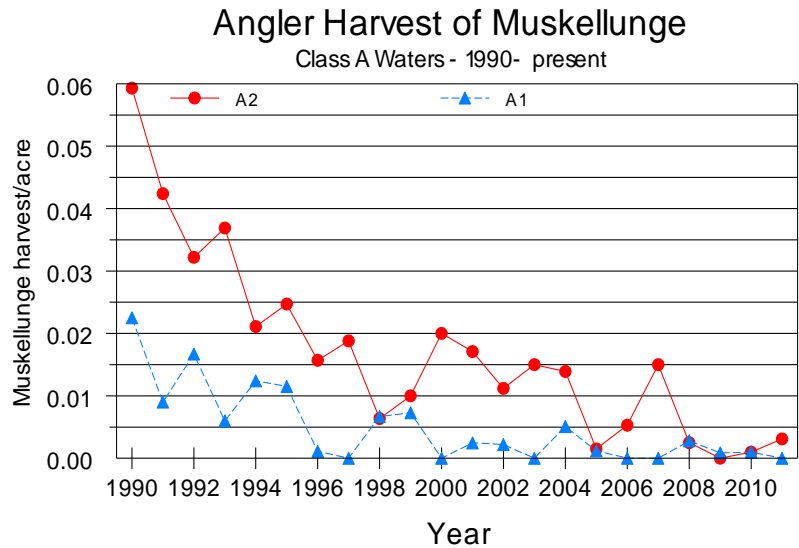


The catch rate on Class A2 (“action”) lakes averages about 0.043 fish/hour (23 hours/muskellunge; see Figure below). The estimated harvest rate on Class A2 lakes averages about 0.0013 fish/hour (769 hours per harvested fish).

Angler Catch and Harvest Rates Class A2 Waters - 1990-present

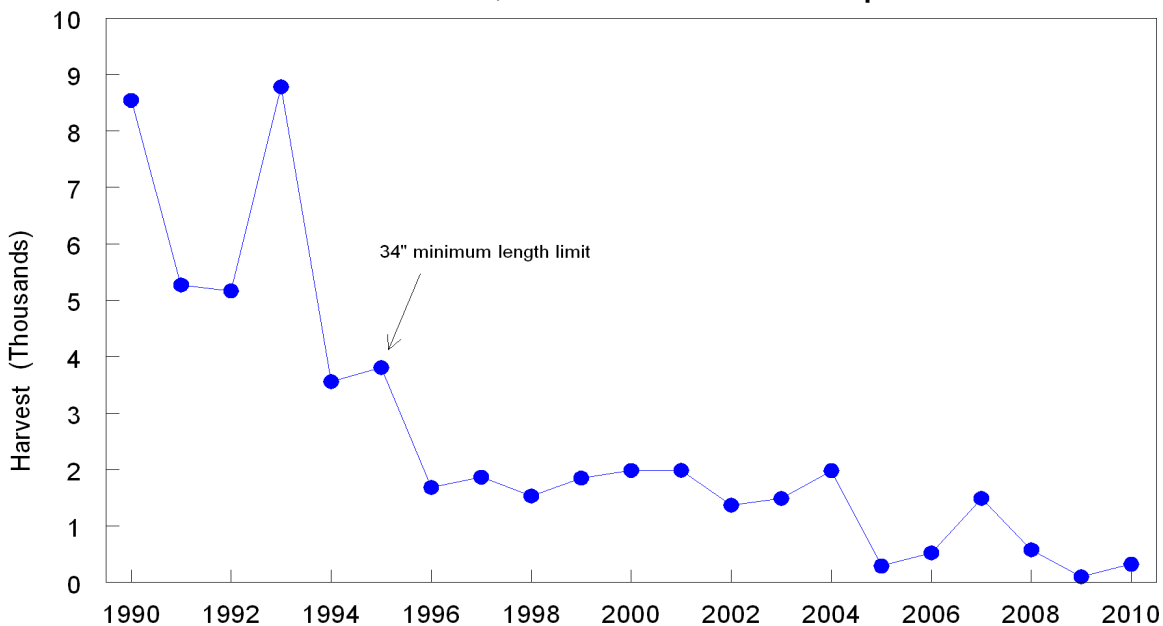


Overall, angler harvest of muskellunge has declined in Class A waters over the last several years. This decrease in harvest is more evident in Class A2 waters, where harvest had typically been higher than in Class A1 waters. Harvest in the early 1980s was estimated at 0.20 muskellunge/acre (Hanson 1986), which is about three times the harvest observed in the early 1990s, and over 20 times the harvest observed in the late 1990s. Total harvest in 2010 was estimated as 0.001 muskellunge/acre (about 1 fish per 1000 acres) in both Class A1 and Class A2 lakes.



Projected Harvest of Muskellunge. The total estimated number of muskellunge harvested from **Class A** waters has declined since 1990, from 8,541 to about 218 fish in 2011. From 1990 to 2011, the average length of muskellunge harvested (all musky waters) was 38.5 inches (553 fish measured). For comparison, the projected harvest from Class A waters in the early 1980's was 38,318 fish statewide (based on comparable creel survey data from Hanson 1986).

**Projected Angler Harvest of Muskellunge in WI,
from Class A waters, based on access point interviews**



Summaries of creel surveys conducted in northern Wisconsin are available on the web at: http://infotrek.er.usgs.gov/doc/wdnr_biology/treaty/StateMapHotspotsTreatyCreel.htm.

Periodic mail surveys of license holders are also conducted to estimate total catch and harvest of fish in Wisconsin. Total muskellunge harvest during 1957 for all waters was estimated as 47,700 (Threinen and Walker 1958). Estimates of harvest from the mid-1960s were considerably higher (from 94,000 to 110,000). More recent surveys suggest that total catch has remained relatively constant, from 296,300 in 2000 to 223,100 in 2006. However, estimates of total harvest have declined from 37,000 in 2000 to 12,500 in 2006.

Number of muskellunge anglers and projected annual harvest of muskellunge based on mail surveys.

Year	Musky anglers	Harvest	Source
1957	94,782	47,700	Threinen and Walker 1958
1964	114,000	110,000	Churchill 1968
1965	150,000	110,000	Churchill 1968
1966	157,000	94,000	Churchill 1968
1967	--	92,000	Churchill 1968
1975	212,000	66,700	WDNR 1979
1994	360,000		WDNR 1995
2000		37,010	McClanahan
2001	456,000*		USFWS 2003
2006		12,493	Weigel, unpublished
2006	421,200*		USFWS 2008
2010	480,000		Isermann et al. 2012

*Northern pike and muskellunge not separated.

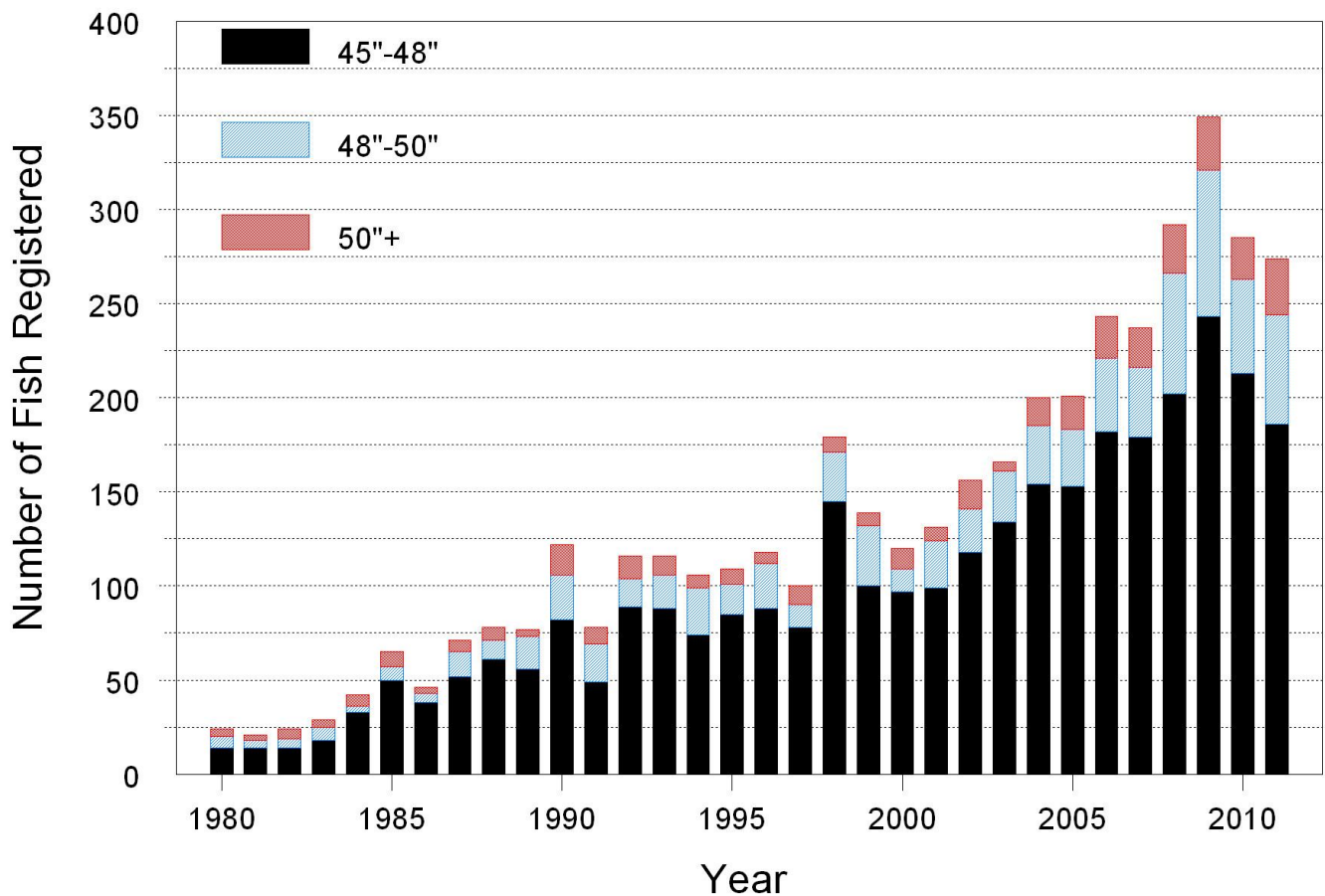
There are inherent biases associated with each method used to estimate catch and/or harvest, so they rarely result in similar estimates, and they are difficult to compare. As long as the bias is consistent through time, the estimates from any one method are useful for evaluating trends.

A 1999 mail survey aimed at muskellunge anglers found that about 35% of licensed anglers specifically fished for muskellunge at some point in time over a 3 year recall period (Margenau, unpublished data). That survey only included counties in northern Wisconsin. More recently, a statewide mail survey of anglers found that 32% of resident anglers and 39% of non-resident anglers fished for muskellunge during 2010 (Isermann et al. 2012).

Consumption Advisory – Since 2002, muskellunge have been included in the statewide consumption advice for mercury. Nursing women, women who intend to have children, and children under 15 years of age are advised not to eat muskellunge. The mercury level for muskellunge 40” and larger averaged just over 1 ug/g of mercury, a level considered unsafe for children and women intending to have children. All men (and women not intending to have children) are advised to eat no more than 1 meal per month (and no more than 6 meals per year from Green Bay and the lower Fox River).

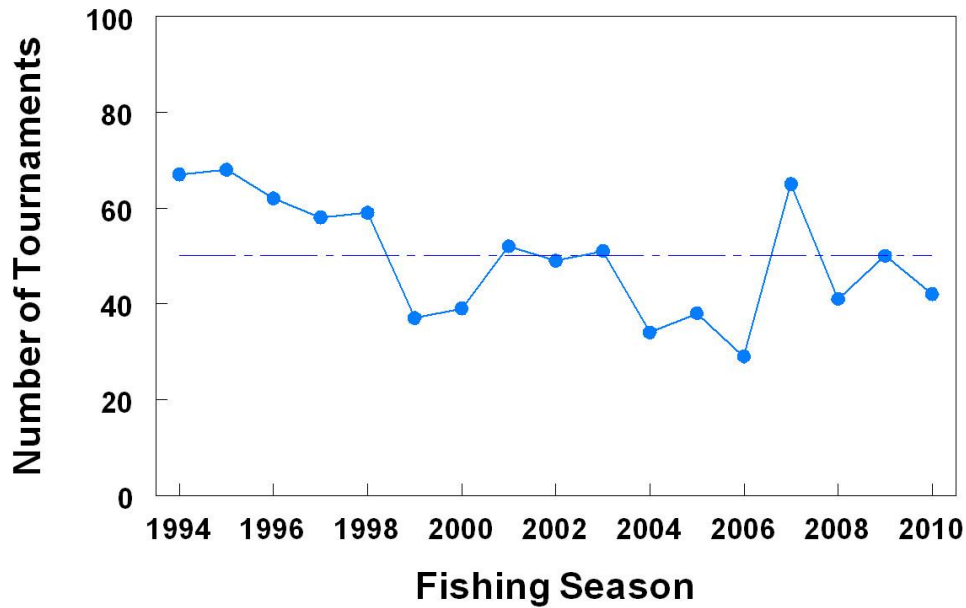
Catch of trophy muskellunge. We use data from Muskies, Inc., to evaluate trends in the catches of “trophy” muskellunge in Wisconsin. We compile the number of trophy muskellunge (45” and larger) reported from Wisconsin waters annually from 1980 to present. The number of 45”+ muskellunge reported to Muskies, Inc., has steadily increased. Over the last few years, the number has increased substantially. The contribution of fish from outlying waters (Lakes Michigan and Superior) increased from 2% in 2004 to 24% in 2009. Tracking this index provides a yardstick with which to measure changes in the catch of trophy muskellunge.

45"+ Muskellunge Registered from Wisconsin Waters by Muskies Inc., members, 1980 to present



Muskellunge Fishing Tournaments. The number of permitted muskellunge fishing tournaments has averaged about 50 per year since 1994 (the first full year of the mandatory permit system). The number of permitted tournaments generally declined from 1994 to 2001, but has remained relatively constant since then.

Permitted Muskellunge Fishing Tournaments in Wisconsin



MANAGEMENT ACTIVITIES

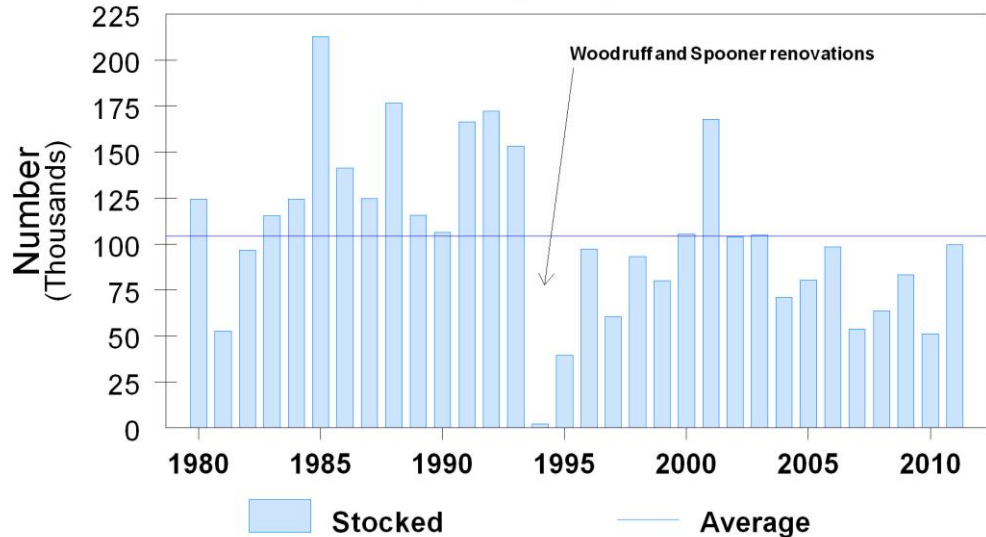
Stocking. Currently, stocking is a prescribed management activity on about 180 muskellunge waters. The typical strategy is to stock large (11"+) fingerlings at a rate of 0.5 per acre in alternate years to supplement natural reproduction.

About half the lakes are stocked in odd years and half in even years, to even out demand on the hatchery system and to allow evaluation of natural reproduction during non-stocking years.

As more is learned about natural levels of reproduction in muskellunge populations, larger fish (with greater survival) are produced by our hatcheries, and more anglers practice catch and release, we rely less on stocking in

certain waters with the ability to sustain themselves through natural reproduction. Lower stocking rates, and lower densities of adult muskellunge, are also usually compatible with producing larger fish for anglers.

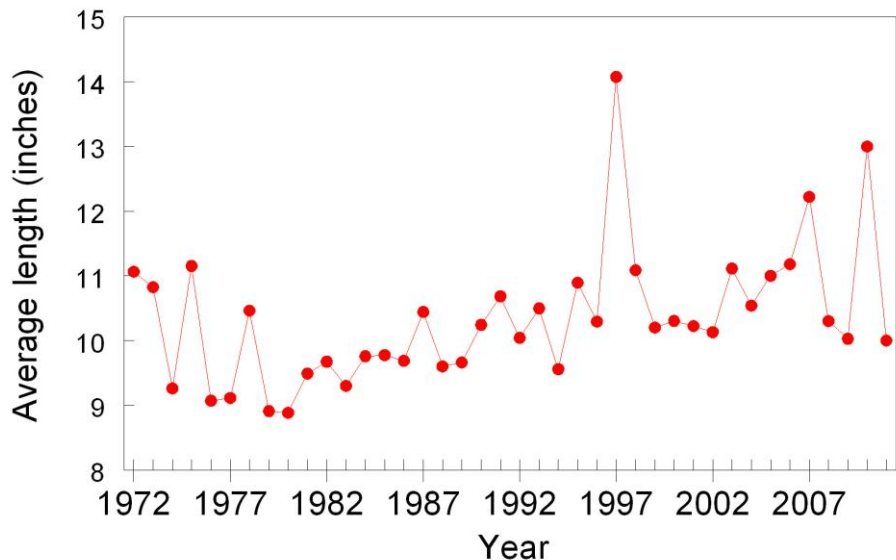
Inland Muskellunge Stocking
(Large Fingerlings 7-13")



The average size of stocked muskellunge has been higher in recent years. Typically, when fewer fish are produced in the hatcheries, they tend to be larger. Larger muskellunge have a greater chance of surviving than smaller stocked muskellunge. In 2010, the stocked fish averaged about 3 to the pound, whereas in the early 1980s, they averaged about 8 to the pound.

We implemented a comprehensive muskellunge stocking framework during 2001, primarily to determine the relative contribution of stocked fish in Category 2

Average Size of Stocked Muskellunge
Fingerlings (1972 - present)



waters and to evaluate stocking success in Category 3 waters. The evaluation consists of assessing the long-term stocking goals for 220 stocked lakes by sampling them through our monitoring program over a 10-year period.

Summary of waters with various stocking rates under the current muskellunge stocking plan.

Reproductive status	Stocking rate (number/acre)				
	0	0.5	1	2	Total
Category 1	0*	0	0	0	14*
Category 2	29	42	38	9	118
Category 3	0	27	35	18	80
Category 0	0	0	1	7	8
Total	29*	69	74	34	220

* 14 additional waters have been reclassified as Category 1 waters and would have been removed from the stocking quotas regardless of the development of this framework. Intensive evaluations will be continued on these reclassified waters to ensure that natural reproduction is sufficient to sustain these populations.

We completed a [Brood Stock Management Plan](#) in 2005 which guides many of our spawning operations of wild brood stocks and hatchery practices based on the best available genetic principles of fish culture.

On our stocking page, summaries of all [muskellunge stocking](#) events since 1972 are available. Once you are on that page, click on the county of interest.

Fishing Regulations. One important program goal is to manage muskellunge as a "trophy". What constitutes a trophy varies from angler to angler, based on their personal feelings, and from water to water, based on the biological potential of the population. Our general strategy is to manage muskellunge waters based on biological potential and the desires of anglers. Within the scientific community, relatively high length limits are generally accepted as the primary tool used to manage for trophy muskellunge fisheries. Only hook and line fishing is allowed for muskellunge. Restrictions on trolling (originally developed to reduce muskellunge harvest) also exist in many waters throughout the state. Fishing regulations for muskellunge vary among waters, depending upon the growth potential of the population and public support for a higher length limits. The current statewide minimum length limit is 40", which applies to approximately 94% of all muskellunge waters. There are 21 waters (3%) with high density, slower growing populations that are managed with lower minimum length limits (28" or "no minimum"). Twenty waters (3%) are managed with higher minimum length limits (45", 50" or Catch and release only). Additional waters proposed for the higher (50" minimum) length limit must 1) provide biological documentation of the potential for the population to meet the proposed length limit, and 2) must be supported through the public hearing process. The musky team also believes that a handful of exceptional muskellunge fisheries with the realistic capability to produce record-class fish, could be managed with a larger minimum length limit (e.g., 54"), provided there is substantial public support for this type of regulation.

The daily bag limit for muskellunge is 1 on all waters statewide except Yellowstone Lake, Lafayette County, where the daily bag limit is 0, and Escanaba Lake, Vilas County, where there is no daily bag limit. The open season for muskellunge north of US Hwy. 10 (Northern Zone) is from the Saturday nearest Memorial Day to November 30, except on Escanaba Lake, Vilas County, which has a continuous open season with no size limit or daily bag limit. The open season south of US Hwy. 10 (Southern Zone) is from the first Saturday in May to December 31.

Current framework for management of Wisconsin's 767 muskellunge waters (as of April, 2012).

Musky Population Status	Minimum length limit	Number of waters	% of Musky waters
High density, slow growing populations, few fish exceed 34"	28"	21*	3%
Moderate density, moderate growth populations; most fish able to exceed 40"	40"	726	94%
Trophy potential, based on growth rates and/or historic information	45"/50"	20**	3%

*Includes Escanaba Lake (no minimum); **Includes waters with a 45" (7 waters), a 50" (12 waters), and catch-and-release only (1 water).

The [current fishing regulations](#) for all Wisconsin waters are available here.

A selected history of muskellunge fishing regulations is provided below:

- 1889 - The first closed season established for muskellunge, from Feb 1 to May 1;
- 1903 - First muskellunge size limit set at 4 pounds "in the round";
- 1910 - First fishing license (nonresident males > 18 years of age, \$1);
- 1917 - First musky bag limit set at 2/day, with a 24" minimum length limit;
- 1933 - Resident "rod and reel" license established (18+ years old. \$1 – thru 1958);
- 1925 - Bag limit reduced to 1/day and minimum length limit increased to 30";
- 1949 - Musky season closed earlier in fall (November 1);
- 1964 - Open season extended through November 30;
- 1983 - Minimum length limit increased to 32";
- 1984 - Musky season opener delayed until Memorial Day weekend north of US Hwy 10;
- 1995 - Minimum length increased to 34";
- 2009 - Open season in southern zone extended to December 31;
- 2012 - Minimum length limit increased to 40".

Habitat Management - According to a study in Ontario, 94% of all lake life is born, raised and fed within 30 feet of the shoreline. Fallen trees and aquatic plants provide great habitat and protect the shore from wind and waves. A checklist of guidelines, intended for lakeshore property owners interested in voluntarily improving habitat for muskellunge on their shorelines, is available here (<http://dnr.wi.gov/fish/musky/documents/LakeRestorationTechniques.pdf>). It includes specific activities that can be completed on the property owner's shore and broader lake-wide activities that can benefit muskellunge. We have also developed a procedure for volunteers to survey and document muskellunge spawning habitat (<http://dnr.wi.gov/fish/musky/documents/Muskellungespawninglocations.pdf>).

Monitoring - There are three elements of our muskellunge monitoring strategy. First, we conduct angler surveys, with periodic mail surveys (about every 10 years) and annual creel surveys, which involves angler interviews at boat landings (about 20 lakes each year). Second, we have a statewide fisheries assessment program, where we conduct spring netting surveys for adults and fall electrofishing surveys (including young-of-year recruitment estimates) on every muskellunge lake in the state (with public access) on a periodic basis. Third, several of the larger, more important musky

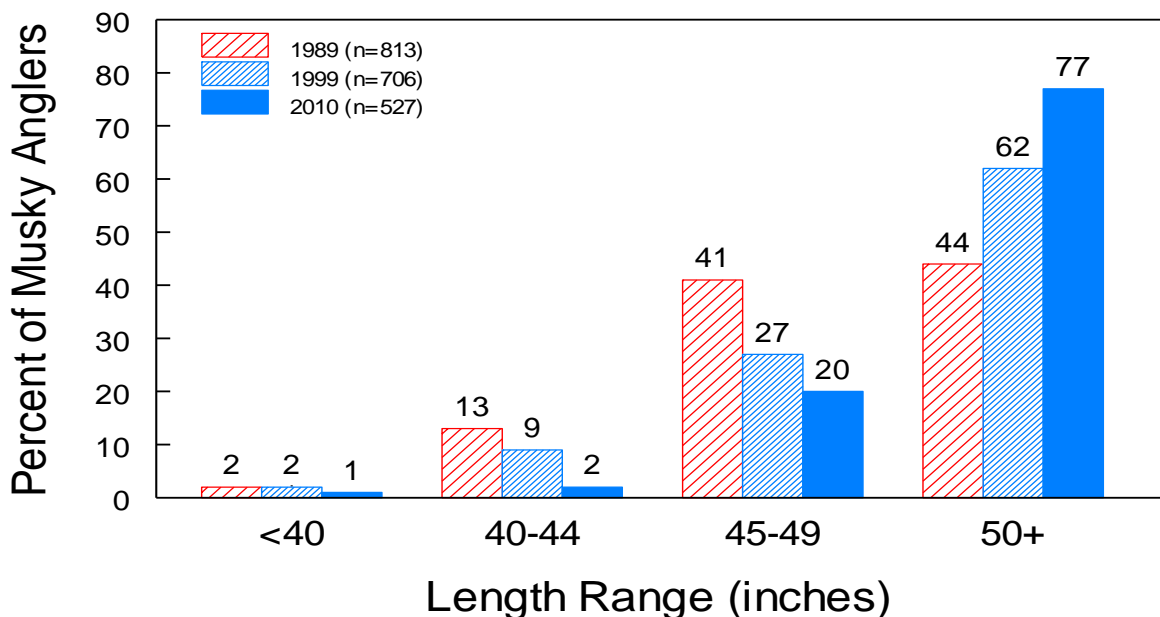
lakes are sampled on a more frequent basis, and we complete adult population estimates every few years. This information is used to evaluate size limits, stocking practices and to track changes in muskellunge populations through time.

Information and Education. [Muskellunge](#) Web pages were established to improve communication with anglers in Wisconsin. These Web pages contain a variety of musky fishing resources. For example, the University of Wisconsin-Stevens Point is conducting a variety of projects related to muskellunge genetics stocks across the native range of the species in Wisconsin. The goal is to examine genetic differences among the major drainage basins of the state. An update of ongoing genetic research is available on the [musky genetics page](#).

Also, see [musky related news releases](#) on our Musky Web Site for updates on many ongoing research projects.

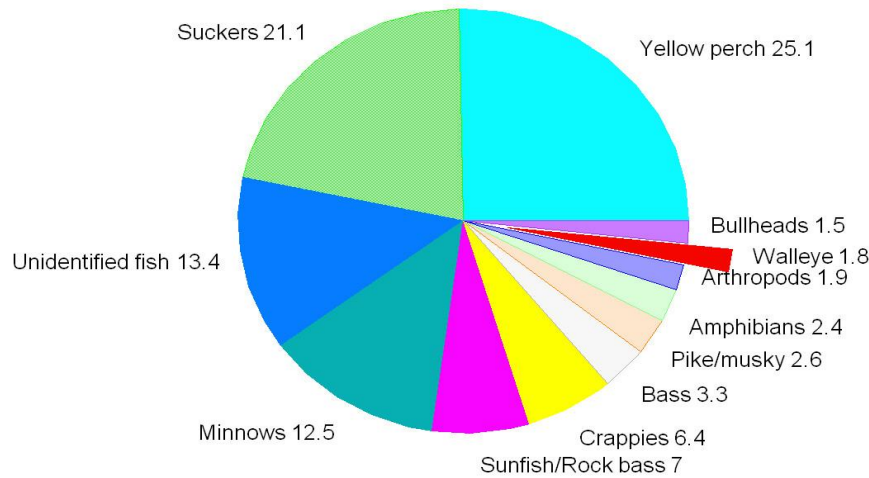
A [musky angler mail survey](#) was conducted during 2010-2011 by researchers from the University of Wisconsin – Stevens Point. The survey essentially repeated the 1989 and 1999 surveys conducted by Research Scientist Terry Margenau, and provides updated information and trends in musky angler opinions. Results from previous surveys are published were published by Margenau and Petchenik (2004).

What is a "Trophy" Muskellunge?



Muskellunge Diet and Community Interactions - Bozek et al. (1999) examined the food habitats of Wisconsin muskellunge. Thirty-four muskellunge lakes were sampled over a 4-year period, with 1,092 muskellunge (8 to 46 inches in length) examined. Fish comprised 98% of the diet. Yellow perch (30%) and white sucker (8.4%) were the major prey items; minnows and panfish were also important. Bass and walleye were relatively unimportant. Only 6 walleye (0.9% of the diet items; 0.5% of muskellunge sampled) and 17 bass (2.9% of the diet items; 1.6% of muskellunge sampled) were found in all the samples.

Relative Importance of Various Prey Items 1,092 muskellunge stomachs, 1991-1994 (717 empty)



Bozek et al. 1999. Diets of muskellunge in northern Wisconsin lakes.
North American Journal of Fisheries Management 19:258-270.

In order to further evaluate the interactions between muskellunge and walleye, we compared the density of adult walleyes in lakes with and without muskellunge over the last 20 years. The average density of walleyes tends to be higher in lakes with muskellunge (versus those without), most likely due to the similarities in habitat requirements between the two species.

Walleye Density in Northern WI Lakes with and without Muskellunge (1990-2009)

