Fishery Management Plan

Pike Lake Chain of Lakes, Price County, Wisconsin

January 2015

Prepared by:

Jeff Scheirer, Fisheries Biologist at Park Falls
Wisconsin Department of Natural Resources

and

Dave Neuswanger, Fisheries Team Leader, Retired
Hayward Field Unit
Wisconsin Department of Natural Resources

FOREWORD AND ACKNOWLEDGMENTS

This is a long-term strategic plan that will guide our fishery management efforts on the Pike Lake Chain (Pike, Round, Turner, and Amik lakes) for many years to come. We believe our fishery management plans should be based upon a shared vision that is developed by combining broad-based survey information from statewide anglers with interactive input from local stakeholders. From those sources we determine user preferences in light of ecosystem capability. We believe the goals of a good plan must reflect the shared vision between users and managers; and measurable objectives must be set so we know whether selected strategies are succeeding or failing. We believe in making good tries and learning from failure. Part of that process involves amending strategic plans (like this document) when failure dictates that we either develop more realistic objectives or change our strategies to achieve realistic objectives. This plan should be updated as needed in the decades that follow.

We call this a "long-term strategic plan" because the goals and objectives are relatively timeless, and because we have neither the wisdom nor the authority to commit DNR or partner resources to a specific operational schedule of funding and action. Each year will bring its own fiscal constraints and operational priorities, so we must remain flexible in our implementation of proposed actions. Because there are so many complex and interrelated strategies, we have chosen to forego the lengthy process required to secure statewide DNR approval at this time. We will do our best to justify actions we believe necessary to realize our shared vision to DNR leaders and the general public as time and circumstances permit. We promise only to consult this plan annually as we allocate our time and resources to the many important projects before us.

We wish to acknowledge the contributions of past and present members of the many agency teams and citizen volunteers who collected and analyzed resource information from countless surveys and samples completed over the last 60+ years. Their dedication and perseverance enlightened our understanding of the fishery and its potential.

We also thank the Pike Lake Chain Lakes Association and Past-President Bill Avelallemant for promoting (via newsletter and signage) and hosting our local stakeholder visioning session at the Pike Lake Fire Station on July 21, 2012. Their support for this process and this plan has given us the energy and enthusiasm needed to pursue implementation and to expand this process to other area lakes.

We especially thank the 23 local stakeholders (21 riparian landowners and two area residents who fish the Chain frequently) who gave up a pleasant Saturday morning to help us develop the vision that forms the backbone of this plan. We are very pleased to incorporate their input at this appropriate stage in the planning process; and we look forward to their continued support for the actions we believe will be necessary to achieve the shared vision. We can settle for nothing less in an area where the quality of fishing means so much to our livelihoods and our quality of life.

—Jeff Scheirer and Dave Neuswanger

BACKGROUND

The Pike Lake Chain of Lakes is formed by the natural and navigable connections of Amik, Pike, Round, and Turner lakes. Spanning the border of Price and Vilas counties, the Chain is located in the headwaters of the South Fork Flambeau River just north of State Highway 70 about halfway between Fifield and Woodruff, Wisconsin (Figure 1). The Pike Lake Chain is centrally located within the Ceded Territory—22,400 square miles of northern Wisconsin that was ceded to the United States by the Lake Superior Chippewa Tribe in 1837 and 1842.

Figure 1. Location of Pike Lake Chain of Lakes in Price and Vilas counties, Wisconsin.

<u>Human Development and Public Access</u>

The earliest dam on the Pike Chain was built at the outlet of Round Lake in 1876 to store and release the volume behind a 7-foot head, facilitating transport of white pine logs to sawmills located 172 river miles downstream in Chippewa Falls and Eau Claire, Wisconsin. In 1995 the U.S. Forest Service, Price County Historical Society, and Friends of the Round Lake Logging Dam, in partnership, restored a non-functioning replica of the logging dam at its original site and installed interpretative displays to commemorate the region's logging history. Currently, the Forest Service owns and maintains the steel sheet pile dam constructed in 1971 immediately upstream of the replica. It functions as an overflow weir to maintain a recreational water level in the Chain about two feet above the natural condition. Though the Department has not formally ordered[1] specific water elevations for the Pike Lake Chain, WDNR approved the 1971

[1] WDNR regulates federally-owned dams in Wisconsin under a memorandum agreement (presently undergoing revision), which applies the State's authority in Chapter 31, Wisconsin Statutes.

construction plan to set the dam crest elevation at the average historical lake level. With a fixed crest elevation and no spillgates, the contemporary dam offers no capability to manipulate reservoir level and discharge. The Forest Service has completed several large-scale projects that successfully stabilized eroding banks and repaired sections of the damaged river channel, but the lingering ecological effects of damming and log driving are still evident in the South Fork Flambeau River nearly 140 years later, and the 2-foot vertical drop at the existing dam continues to disrupt fish movements and vital interactions in the aquatic community.

Analysis of satellite imagery reveals that land use in the 92 square mile watershed upstream from the dam is primarily surface water and wetlands (49.0%) and forest (48.3%) with relatively little residential development (2.2%) and virtually no agriculture (0.4%). Most development in the upper watershed occurs on water frontage; there are no cities or villages. About 12 square miles of the Lac du Flambeau Tribal Reservation occupies the extreme headwaters of the Upper South Fork Flambeau River watershed. The USDA Forest Service manages a large proportion of the watershed for timber production and recreation in the Chequamegon-Nicolet National Forest.

For centuries the Pike Lake Chain and its surroundings were the principal hunting, fishing, and gathering grounds for the Lac du Flambeau Band of Lake Superior Ojibwa. Early in the logging era, the Pike Lake Chain and the South Fork Flambeau River gained notoriety among European-American hunters and fishermen. After the white pine and hardwoods were harvested, the cut-over shorelands of the Pike Lake Chain drew attention from visitors seeking opportunity for outdoor recreation. The Pike Chain experienced two early waves of residential construction in the decades immediately before and after World War I. Several resorts originally built in that era continue to serve vacationers today. Ojibwa men from the nearby reservation became renowned as fishing guides for patrons of the early resorts. In 1911 – 1915 Otto Doering, vice president of Sears Roebuck Company, purchased the dam and nearly 3,000 acres surrounding Round Lake and developed an elaborate vacation retreat that served as the Doering family's summer residence into the 1960s. The USDA Forest Service purchased the Doering estate in 1968.[2]

By the 1960s nearly all the habitable shoreline was occupied. Since that period, larger dwellings have gradually replaced modest cabins and cottages. Pike Lake appears to have the highest number of seasonal and year-round houses, but the overall shoreline development on the Pike Chain is low to moderate compared with the high residential densities on shorelands of many clear-water lakes in neighboring watersheds. Public lands include 6.4 miles of federal frontage on Round and Amik lakes and Rice Creek. The state-owned islands and WDNR's 7-acre parcel on the east shore comprise the only public frontage on Pike Lake. Turner Lake has no public shorelands. Despite the moderate level of development, most of the Pike Chain's shorelands retain their natural appearance. A 2001 photographic evaluation[3] revealed that over 95% of 772 parcels on the Pike Lake Chain met the subjective criteria used to define the natural condition of shorelines and upland areas, (i.e. ≥ 50% native vegetation in the understory and ≥ 50% natural vegetation along a shoreline strip extending at least 15 feet landward). Observations made by Blue Water Science in 2010 and WDNR Fisheries Team in 2011 and 2012 indicate that natural shoreline aesthetics have remained mostly intact since the 2001 inventory. Educating property owners and enforcing shoreland ordinances should serve to protect and improve the function and quality of shoreland buffers in the future.

Because the fixed-crest dam maintains a near constant water level, most boaters have navigable access to the entire Chain via connecting channels from the two public boat landings on Round Lake and the carry-in access on Pike Lake's east shore (Figure 1). The rare exceptions are pontoons and other large craft whose

---

[2] *The Pike Lake Chain—A Collection of Historical Accounts and Photographs.* 2002. Berg J. L. and L. Stein.

[3] *Lake Management Plan for the Pike Lake Chain of Lakes Price and Vilas Counties, Wisconsin*. 2012. Prepared by Steve McComas, Blue Water Science, with significant contributions from the Pike Lake Chain of Lakes Association and Wisconsin Department of Natural Resources.

high profile may prevent them from passing under the bridge across the channel between Pike and Round lakes (locally known as the Thorofare), especially when spring runoff or storms temporarily raise the Chain's level. The USDA Forest Service maintains a concrete boat ramp, boarding pier, and toilets as part of its recreational complex on the west side of Round Lake where an annual vehicle admission sticker or a daily use fee is required. Boats may be launched free of charge at WDNR's shallow draft boat ramp on the opposite shore just north of the Thorofare Bridge and at WDNR's primitive carry-in landing on Pike Lake. Additional boat ramps and boat rental are available at several resorts. Statewide and municipal regulations limit boats to "slow – no wake" speed within 100 feet of shore and in all connecting channels, and a local ordinance prohibits boating near the rock in Pike Lake upon which ospreys traditionally nest. Boaters should exercise caution to avoid submerged hazards, both marked and unmarked, that are scattered throughout the Chain, especially near the two state-owned islands in Pike Lake. A 500-yard portage trail provides walk-in access from the north shore of Round Lake to 118-acre Tucker Lake through federal land managed for conservation and non-motorized recreation as the Tucker Lake Hemlocks State Natural Area.

Habitat Characteristics and Productivity

Among the four lakes in the Pike Chain, Round Lake has the greatest depth, the greatest volume, and the highest proportion of rocky lakebed material (Table 1). Pike and Round lakes have similar surface areas, but with more fine-particle substrates and twice the shoreline, Pike Lake is better suited for growth of aquatic plants in the near-shore zone. The silt and muck in shallow Amik Lake produce dense stands of aquatic vegetation, occasionally impeding navigation. Substrate, depth, and aquatic plant density in Turner Lake can be categorized as intermediate among the lakes in the Chain.

Table 1. Selected physical characteristics of lakes in the Pike Lake Chain.

	Surface Area (acres)	Shoreline (miles)	Maximum Depth (feet)	Average Depth (feet)	Percent < 3 feet deep	Substrate			
						Rubble	Gravel	Sand	Muck
Round	726	5.1	24	16	6%	1%	55%	42%	2%
Pike	806	10.9	17	11	6%	3%	27%	50%	20%
Turner	149	2.6	12	8	9%	x	x	xx	xx
Amik	224	5.2	8	5	11%			x	xxx
Combined	1905	23.8	24	12	7%				

Note: x, xx, and xxx reflect the increasing frequency of lake map symbols that depict each unquantified class.

Based on watershed characteristics and precipitation records, a run-off yield model predicted that the Pike Chain's three first-order tributaries (Tucker Creek and 2 unnamed streams) and three third-order tributaries (Foulds, Little Pine, and Squaw creeks) contribute to an annual median discharge of 59 cubic feet per second (cfs) from the Round Lake Dam. Seventy-five percent of simulated discharge values exceeded 40 cfs, and 25% exceeded 85 cfs in annual intervals. Because its water level is influenced by the dam, the entire length of Rice Creek is considered part of the Chain, not a tributary, and its surface area is included with Amik Lake's acreage.

Information on nutrient levels collected by citizen volunteers in summer 2001 – 2013 allows us to characterize the four lakes of the Pike Chain as moderately fertile and meso-eutrophic (Table 2). Water quality in Pike and Round lakes is quite similar. Moderately high phosphorus concentrations, averaging 30 and 31 micrograms per liter (µg/l) in June through August, support moderately high algae production in Pike and Round lakes, as indicated by mean summer chlorophyll a concentrations. Severe algae blooms occur occasionally in both lakes. Nitrogen-to-phosphorus ratios indicate that algae growth is limited by phosphorus. Summer water clarity, as measured by mean depth at which an 8-inch black-and-white Secchi disk disappears from view, is low compared with the regional average of 8.5 feet. Dissolved organic compounds draining from wetlands result in moderately high water color (60 to 100 platinum-cobalt units), and this tea-colored staining contributes to the low water clarity, which limits the depth to which rooted plants can growth. A one-time measure of alkalinity reveals that both lakes have soft water, and in single year samples, near neutral pH in spring increased slightly as summer progressed (7.1 → 7.8 in Pike Lake and 7.0 → 7.7 in Round Lake). Typically, pH increases gradually from spring to summer as acidic drainage from wetlands tapers and algae and aquatic plants in increasing abundance absorb more carbon dioxide by photosynthesis.

Summer thermal stratification in Pike Lake is weak and non-continuous due to its shallow depth. Occasional dissolved oxygen depletion has been observed near the lake bottom, and sediment phosphorus release, which occurs during anoxia, probably contributes to increased dissolved phosphorus concentrations in late summer of some years. Thermal stratification and dissolved oxygen depletion are more pronounced and frequent in Round Lake, the deepest lake in the Chain. Consequently, sediment phosphorus appears to contribute more toward late-summer and early-fall increases in lake phosphorus concentrations as the full volume of the lake "turns over" or mixes. Total phosphorus concentrations as high as 78 µg/l have been recorded in September.

While summer phosphorus levels were similar among the four lakes, chlorophyll a concentrations in Amik and Turner lakes were somewhat lower than their corresponding phosphorus concentrations would predict—an indication that a larger proportion of the phosphorus in these two lakes may be channeled toward aquatic plant growth, rather than algal production. Compared with Turner Lake, chlorophyll concentration in Amik Lake shows greater year to year variability. Although Amik Lake is shallowest and seemingly least prone to thermal stratification, oxygen depletion near the lakebed, coinciding with higher phosphorus and chlorophyll concentrations, has been observed in some years. Phosphorus released from sediment may be responsible for the higher-end chlorophyll concentrations that indicate severe algae blooms occur occasionally in Amik Lake. Based on observations, water color is probably moderate in Turner and Amik lakes most of the time.

Table 2. Water quality characteristics of the Pike Lake Chain monitored by citizen volunteers in summer 2001 – 2013 (columns 2 – 4) and others. Averages are in parentheses.

Lake	Total Phosphorus (µg/l)	Chlorophyll a (µg/l)	Secchi Depth (feet)	True Color (Pt-Co units)	Alkalinity (mg/l as $CaCO_3$)	Summer pH	N:P ratio
Pike	23 – 37 (30)	6 – 38 (15)	3 – 5 (4.1)	100	30	7.8	21 – 32 (26)
Round	23 – 45 (31)	4 – 46 (14)	2.5 – 5.8 (4.3)	60	21	7.7	23 – 27 (26)
Amik	16 – 58 (31)	2 – 46 (10)	2 – 8.5 (5.4)	--	--	--	--
Turner	18 – 37 (28)	4 – 24 (10)	3 – 7.8 (4.0)	--	--	--	--

Aquatic Community Overview

Our electronic records chronicle a diverse fish community in the Pike Lake Chain with 29 species and one hybrid (northern pike x muskellunge) represented among over 75,000 fish captured in fishery surveys dating back to 1959. Community composition was comparable with that found in headwater lakes and impoundments on regional river systems. Records of blue catfish and buffalo, excluded from this species count, were probably misidentified channel catfish and redhorses. Fish in the Pike Lake Chain with elevated protection under Wisconsin's Endangered Species Act include the greater redhorse (threatened) and lake sturgeon (special concern), though sampling since 1980 has documented a broad distribution of greater redhorse in the upper Chippewa River drainage. Sturgeon occasionally appear in contemporary surveys as very large, old individuals that probably entered the Chain before 1971 when the deteriorated condition of the former dam allowed fish to move between Round Lake and the South Fork Flambeau River. Now that the sheetpile dam has blocked fish movements again, it is doubtful that the Pike Lake Chain supports a viable lake sturgeon population in such apparently low abundance.

An August 2004 survey in two of the lakes found a "very good" diversity of native aquatic plants (43 species in Pike Lake and 38 species in Round Lake) and a "good" mix of emergent, floating leaf, and submergent plants. Emergent plants were more widespread in Pike Lake where an intermittent band was present around most of the shoreline. The rocky, sandy lakebed in the northern two-thirds of Round Lake had the fewest emergent and floating leaf aquatic plants, present only in scattered locations. Protected bays with muck substrate tended to support more plant species and higher plant densities compared to wave-scoured sites with coarser sand or gravel substrates. Aquatic plant densities were low to moderate at most locations. Frequently occurring aquatic plants in 2004 included bushy pondweed, flat-stem pondweed, and wild celery (also called eel-grass) in Pike Lake and bushy pondweed, leafy pondweed, clasping-leaf pondweed, and wild celery in Round Lake. Small stands of wild rice were found in a few scattered locations. Rice appears to be more common in the Squaw Creek embayment of Pike Lake and the Rice Creek arm of Amik Lake, where heavy grazing by wildlife may be controlling its abundance.

Point-intercept surveys completed by Blue Water Science in 2001 and 2010 reveal that the aquatic plant community in Pike and Round lakes was stable over that period with wild celery occurring in the highest frequency—59 and 81% in Pike Lake and 50 and 79% in Round Lake in those years, respectively. Naiads were the second most frequently occurring species in those lakes in both years. The number of floating-leaf and submergent species remained relatively unchanged in Pike Lake (17 and 19 in 2001 and 2010, respectively), but the species count in Round Lake increased from 10 to 15 in successive surveys. Coverage patterns were similar in both surveys with plants colonizing 14% of Round Lake and 19% of Pike Lake in 2010. Light penetration allowed and naiads to grow to a depth of 14 feet in Pike Lake, but plants were scarce at 7 feet and deeper. Rooted plants grew at a maximum depth of 8 feet in Round Lake.

In contrast to the stability observed in Pike and Round lakes, the 2001 and 2010 surveys documented shifts in plant community dominance in Amik and Turner lakes. Fern pondweed replaced coontail in Amik Lake and elodea replaced fern pondweed in Turner Lake as the most frequently occurring species. Over that period counts of submergent and floating-leaf species increased only slightly from 17 to 18 in Amik Lake and from 14 to 16 in Turner Lake. In 2010 aquatic plants grew to the 9-foot maximum depth of Amik Lake with colonies covering 97% of the 141-acre main basin. Coverage was generally robust near shore and scattered elsewhere. Plants consistently grew to 11 feet, colonizing 57% of Turner Lakes in 2010. Plant coverage in Amik and Turner lakes increased slightly from 2001to 2010. Chironomid larvae observed feeding on the leaves and stems of large-leaf pondweed (also known as musky weed or cabbage) may be responsible for a die-back that reduced the widespread coverage and nuisance density of musky weed noted in Amik Lake in 2000. Musky weed was "scattered" in 2001, suggesting that grazing insect larvae may be controlling the density of this important plant species, which offers shade, shelter, and foraging opportunity to fish and waterfowl. Cabbage in Amik Lake was described as "common" in 2010, suggesting an increase, but not to nuisance levels of abundance.

No exotic fish species have been documented yet in the Pike Lake Chain, but invasive Chinese mystery snails and purple loosestrife have been found in Pike and Round lakes, and the non-native rusty crayfish is known to occur in Pike and Turner lakes. Their scattered distribution and low population abundance does not appear to be upsetting the Chain's ecosystem functions, however. Eurasian water milfoil, curly-leaf pondweed, and zebra mussels have been documented in several Price County waters, but not in the Pike Lake Chain. Despite the presence of exotic species in nearby waters, the relatively minor impact of invasive species on native plant and animal communities in the Pike Chain may be attributed in part to the diligent efforts of volunteer participants in the "Clean Boats – Clean Waters" campaign, who inspect boats and trailers at landings and educate boaters about ways to slow the spread of aquatic invasive species. The Pike Lake Chain of Lakes Association recently investigated options to purchase and install a boat washing station at the federal landing on Round Lake.

In addition to continuing efforts aimed at preventing unwanted introductions, the physical and chemical characteristics of the water and sediments may curb the likelihood and severity of invasive species colonization in the Pike Lake Chain. Blue Water Science examined sediment properties (bulk density, organic content, iron-to-manganese ratio, and pH) and depth to predict that, if introduced into the Pike Chain, curlyleaf pondweed could produce light to moderate growth, but would not expand to nuisance density. In a similar comparison, low concentrations of nitrogen and organic matter in sediments projected low to moderate growth potential for Eurasian water milfoil if it were to become established. Eurasian milfoil may grow widely in other systems, but only a few isolated acres of Pike Lake near the mouth of Foulds Creek has substrate suitable to support heavy growth should that species be introduced. Fortunately, low dissolved calcium concentration in all four lakes would limit shell production, reducing the risk that zebra mussel would become established and limiting their growth potential if they do invade the Pike Lake Chain. Colonization by zebra mussels or other members of the filter-feeding dreissenid family would likely increase water clarity and thereby reduce the competitive advantages enjoyed by walleye under low light conditions. Major increases in water clarity in other North American waters with aggressive phosphorus abatement programs or zebra mussel invasions (e.g., the Kawartha Lakes Region of Ontario) have been associated with major declines in the survival of young walleye and ultimately a lower density of adults.

Historical Perspective on the Fishery

The Pike Lake Chain was a reliable source of food to nomadic peoples for thousands of years, and the fishery continues to provide sustenance and recreation to Native Americans and anglers today. The long history of protection and management activities signifies the importance of the fishery to a diverse group of stakeholders. In a 1950 report, the Wisconsin Conservation Department described efforts in 1947 – 1949 to remove 3,200 adult northern pike suspected as the cause for the deteriorating quality of muskellunge fishing. Some of Wisconsin's earliest estimates of walleye population density were derived from surveys completed on the Pike Lake Chain in the 1970s. A 1988 – 1989 telemetry study tracked habitat use, behavior, and spawning movements of adult walleye surgically implanted with radio transmitters. Over the last 25 – 30 years, the Great Lakes Indian Fish and Wildlife Commission and WDNR's Treaty Fisheries Assessment Team have continued to evaluate population density, tribal and angler harvest, and recruitment rates of walleye and muskellunge across the Ceded Territory. WDNR's county-assigned Fishery Management Team from Park Falls monitors the status of important sport fish populations in the Pike Lake Chain by netting and electrofishing surveys at 6-year frequency, and the Cooperative Fisheries Team funded by the U.S. Forest Service and WDNR completes fall electrofishing surveys in Turner Lake in alternate years.

WDNR archives show that fish stocking in the Pike Lake Chain began in 1933, though unauthorized stocking probably occurred earlier. A twenty-year gap in Pike Lake stocking records cause us to question whether we have a complete stocking history there prior to 1955. In 1933 – 1944 Amik, Round, and Turner lakes received 254,000 muskellunge fry, a handful of musky fingerlings (265), and millions of walleye fry, usually in batches of 125,000 – 750,000 planted annually. Nearly 225,000 northern pike fry were planted into Amik Lake in 1937 and 1938—our only record of pike introduced in the Chain. Amik Lake also received 8,000 largemouth bass fingerlings in 1942, and 3,500 more were stocked into Amik, Round, and Turner lakes in 1945. Fingerling walleyes were stocked in the 1940s and 1950s, but walleye stocking was suspended throughout the Chain in 1958. Muskellunge were stocked as small or large fingerlings annually (1959-1964, 1969-1973, 1978-1988) or biennially (1999-2013) in Pike, Round, and Turner lakes, usually at rates of 0.5 – 3 fingerlings per acre. Walleye stocking resumed at 25 or 50 small fingerlings per acre in 1989 and continued until 2002, even with evidence of strong year classes from natural reproduction in that period. In 1994 four hundred yearling walleyes (8 inches) were stocked into Amik, Turner, and Round lakes from a private hatchery. In a 1985 trial, fertilized muskellunge eggs were sandwiched between the interlocking bristle-like plastic fibers of two “welcome mats” stacked facing each other, bundled in layers of 4 – 6 pairs, and placed in Round Lake. A large proportion of dead eggs were found when the bundles were retrieved and examined later that spring. Muskellunge fry were experimentally reared through summer 1990 in Lower McKinnsey Slough, the downstream-most of three man-made ponds on a tributary to Round Lake. The experiment was repeated with walleye fry in 1991, but then discontinued after near zero return when the pond was drained in fall of both years. Other species seldom stocked into the Pike Chain include bluegill, yellow perch, black crappies, pumpkinseeds, and rainbow trout; we presume the 5-inch trout were hatchery surplus stocked as forage.

The most recent creel survey on the Pike Lake Chain (May 7, 2005 – Mach 5, 2006) documented light to moderate fishing pressure (26 hours/acre/year) compared with other lakes in Price County (38 hours/acre/year in 20 surveys) and in the Ceded Territory in northern Wisconsin (32 hours/acre/year in 510 surveys) from 1990 to 2013. Ice fishermen contributed nearly 12% of the estimated annual effort in 2005. The two smaller lakes in the Chain have typically received greater fishing pressure per acre than the larger lakes, and prior-year estimates suggest a declining trend in angling effort since 1991.

Table 3. Total angling effort (hours/acre/year) estimated in three year-long creel surveys on the Pike Lake Chain.

	Acres	1991	1998	2005
Amik Lake	224	55	51	40
Pike Lake	806	39	26	24
Round Lake	726	27	24	20
Turner Lake	149	78	54	52
Combined	1905	39	30	26

Though the Chippewa bands ceded their land in the northern third of Wisconsin to the United States over 175 years ago, they reserved their off-reservation rights to hunt, fish, and gather within the Ceded Territory. Today, fish populations in the Pike Lake Chain, particularly walleye and muskellunge, are jointly exploited by anglers and tribal spearers. To assure that no more than 35% of adult walleyes are harvested in any year, a sliding bag limit was established in 1989 that usually requires a reduction of the daily bag limit for walleye in Ceded Territory lakes, depending on the annual tribal declaration and harvest of walleye. The declared tribal intent to harvest is used in early spring to reduce sport fishing bag limits for walleye to 3, 2, 1, or 0 fish per day. If Native American spearers decide to relinquish a significant part of their reserved allocation of the safe walleye harvest once spring spearing harvest ceases, then sport fishing bag limits may be increased again in the open season. In recent years, bag limits have usually varied between 2 and 3 walleye per day in Pike, Round, and Turner lakes. Because tribal members have never declared their intent to harvest fish from Amik Lake, the statewide bag limit of 5 walleyes per day remains unchanged there. This “sliding bag limit” approach is under agency review as managers seek a more consistent and less confusing method to manage harvest while continuing to minimize risk of overexploitation. As a courtesy service to anglers, the Department posts the daily limits at public boat ramps as they change. On average, tribal spearers have taken 145, 163, and 40 walleyes from Pike, Round, and Turner lakes, respectively, in years when they had at least some success (Figure 2). By contrast, in 1991, 1998, and 2005 creel surveys, estimated angler harvest averaged 594, 757, and 232 walleyes from those lakes, respectively (Table 7). Tribal members harvested a total of 28 muskellunge from the Pike Chain since 1985 when the Lake Superior Bands of Chippewa Indians resumed exercising their hunting and fishing rights in Wisconsin (Figure 2).

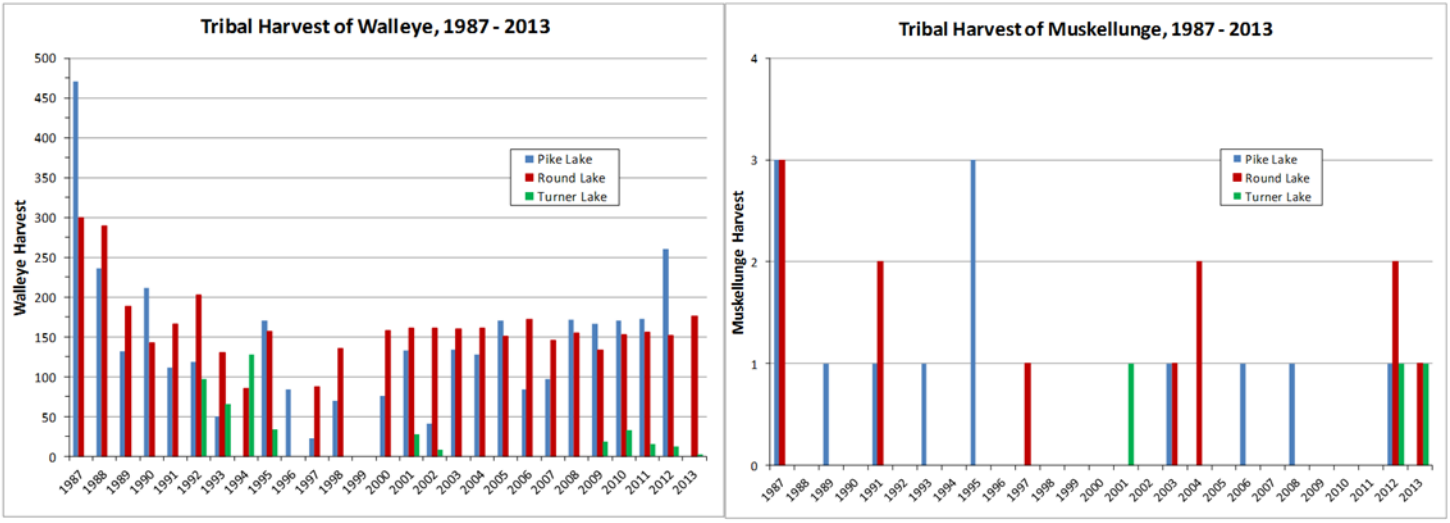


Figure 2. Tribal harvest of walleye and muskellunge in all waters of the Pike Lake Chain, 1987 – 2013.

Records indicate that various structures were placed in Pike Lake and Round Lake to supplement natural habitat or to attract fish and improve angler success. The 255 fish cribs installed from 1989 to 2003 had the traditional stacked log design—square in shape and filled with brush. Even with gravel covering more than half of the near-shore lakebed, cobble-size rock was placed on the ice in late winter 1992 to construct a walleye spawning reef on the windswept north shore of Round Lake, extending 25 feet from shore and 1,200 feet westward from the portage trail to Tucker Lake. A statistically insignificant increase in natural recruitment of walleye was associated with the rock reef after comparing several years of pre-project (14 fingerlings/acre; n = 5) and post-project (17 fingerlings/acre; n = 11) estimates from fall electrofishing surveys[4]. In 1988 WDNR placed 53 half log structures along the north and west shores of Round Lake to enhance spawning habitat for smallmouth bass. And in 1992 and 1993, forty whole trees were felled and anchored along Round Lake's shallow, sandy east shore to increase habitat complexity. We found no records of fish habitat structures placed into Turner and Amik lakes—probably because much of those lakes is too shallow to meet permit conditions that require a minimum of 5 feet of water over the top of the structures.

The Department granted permission for sponsors to hold four fishing tournaments on the Pike Lake Chain in 2013. The permits allowed competitors to fish in all four connected lakes of the Chain. The October musky contest was cancelled by the organizer. The two tournaments targeting muskellunge followed an "immediate release" format, as do most musky competitions. Successful anglers signal judges in roving boats to register their catch boatside, and the fish is released. Participants in the Pike Lake Chain Walleye Fest traditionally practice "catch-hold-and-release," transporting their catch by boat in live wells to a weigh-in station, then releasing the fish back into tournament waters after registration; 42 contestants vying for $580 in prizes registered and released 69 walleye in the two-day spring 2013 event. Most contests on the Chain are relatively lightly attended, usually attracting 25 – 30 boats with prize value usually less than $1,000 and rarely exceeding $3,000. In recent years, organizers of larger contests that once attracted 50 boats to the Pike Chain seem to be including more waterbodies in their traditional tournaments. The added waters should help to distribute tournament angling pressure and reduce the potential for congestion and user conflicts in peak summer recreation periods.

Analysis of skin-on and skin-off fillets from 67 walleyes collected from Pike, Round, and Turner lakes in 1986 – 2011 showed that mercury concentrations were comparable to those in most Wisconsin lakes, so

[4] Preliminary assessment of effects of rock habitat projects on walleye reproduction in 19 northern Wisconsin lakes—a summary of case histories to date. 2004. Compiled by Dave Neuswanger, Fisheries Team Leader, Wisconsin Department of Natural Resources, and Michael Bozek, Leader, Wisconsin Cooperative Fishery Research Unit.

anglers who eat fish from the Pike Lake Chain are advised to follow the general guidelines in *Choosing wisely 2014—A health guide for eating fish in Wisconsin.*[5] A few of the larger, older walleyes had mercury levels that exceeded the threshold we use when considering more stringent advice, so we plan to reevaluate fish flesh contaminants in the Pike Chain about every 10 years and update the consumption guidelines as necessary.

A 15-inch minimum length limit for walleye was enacted statewide in 1990. The following year walleye in the Pike Lake Chain and many regional waters were exempted from the statewide 15-inch minimum length limit under Chapter NR 20.35 Wisconsin Administrative Code, which authorizes the Department to apply and remove alternative size and bag limits to walleye and black bass populations in specific waters if it finds evidence that contaminant levels, growth rate, mortality rate, or exploitation rate do not meet one or more of the criteria specified in the same chapter. Walleye in the Pike Lake Chain qualified for exemption because males did not grow to 13 inches in 4 years. Unlike Chapter NR 20.20 fishing regulations enacted by the traditional rule-making process (influenced by polling the preferences of attendees at spring hearings of the Wisconsin Conservation Congress), size limit exemptions for these waters were summarily granted after publishing notice and offering opportunity for public comment and an informational meeting. The exemptions took effect in 1991 when they appeared in the annual ***Guide to Wisconsin Hook and Line Fishing Regulations*** pamphlet and signs were posted at public access sites. With one exception, average length of male walleyes at age 4 remained less than 13 inches in 1998 and 2005 surveys (Table 9). However, if future surveys reveal that exemption criteria are no longer met, the statewide minimum length limit for walleye must be reinstated as required under NR 20.35. Our proposal to modify harvest regulations in the Pike Lake Chain is described below as a strategy toward achieving stakeholder-influenced objectives for the walleye population.

Other changes to fishing rules affecting the Pike Lake Chain have included the increase in statewide minimum length limit for muskellunge from 34 to 40 inches, effective April 2012, and the spring 2014 elimination of the early catch-and-release-only season for largemouth bass in the Northern Bass Zone. Anglers on the Pike Chain may now keep up to five largemouth bass ≥ 14 inches per day throughout the open sportfishing season; however, the open season for smallmouth bass in the Northern Zone remains catch-and-release-only until the third Saturday of June each year. Motor trolling is allowed in all Price County waters since April 2011, but not in Vilas County. Consequently, motor trolling is permitted only in Pike, Round, and Turner lakes in the Pike Lake Chain. A proposal to allow one-line trolling in all Wisconsin waters where motor trolling previously was illegal is currently in review by the Governor's Office. The area around the Round Lake spawning reef was designated as a fish refuge in 1993, and fishing is currently prohibited within 100 feet of shore from April 1 until the opening date of the general fishing season each year. In a statewide review of refuges and special regulations aimed at simplifying fishing rules, the local WDNR Warden and Fishery Biologist recommended that this seasonal fish refuge should be eliminated, citing the widespread abundance of natural walleye spawning habitat in Round Lake and evidence that walleye spawning is not concentrated on the artificial reef. The Department's proposal to eliminate this and other unnecessary fish refuges throughout the State will be presented at the spring 2015 hearings of the Wisconsin Conservation Congress.

Though a declining population of lake sturgeon may still persist in the Pike Lake Chain, its lakes and tributaries are closed to sturgeon fishing. Current regulations allow anglers to harvest one lake sturgeon 60 inches or longer in the 4-week open season each fall in selected waters, including the South Fork Flambeau River downstream of the Round Lake Dam.

[5] WDNR Publication FH-824-2014.

A Vision for the Pike Lake Chain Fishery

On July 21, 2012 DNR representatives Jeff Scheirer and Dave Neuswanger met with 23 local stakeholders who were willing to volunteer their time to help develop a long-term vision for the fisheries of Pike, Round, Turner, and Amik lakes – the Pike Lake Chain. Objectives of the meeting were to prioritize species of interest, and then to identify for those species the relative importance of numbers versus size and catch versus harvest. Attention was then focused on identifying the desired conditions for species of greatest concern. Jeff Scheirer served as technical advisor to the group on what was possible. Little attention was given to methods for achieving goals and objectives (management strategies such as harvest regulations, fish stockings, and habitat preservation or enhancement). It was understood and generally agreed that professional fishery managers would select the most appropriate strategies once goals and objectives had been developed with help from local stakeholders and adjusted to incorporate what is known about statewide angler preference and the capacity of the Pike Lake Chain to produce what is desired.

Detailed results of the visioning session appear in Appendix A. In summary, local stakeholders in the Pike Lake Chain fishery felt that these lakes were similar enough in character and connected to such an extent that they should be managed as a unit, with uniform goals, objectives, and strategies throughout the Chain. Though some noteworthy differences exist among these lakes, DNR representatives agreed that managing them as a unit should be possible except from a standpoint of regulating the minor level of tribal harvest that occurs for walleye and muskellunge, which traditionally has been monitored and regulated on a lake-by-lake basis. Research on the Pike Lake Chain and other lake chains in northern Wisconsin has shown that adults of both species moved among the connected lakes. These movements, and the associated interactions that they imply, bolster our confidence in managing the Pike Lake Chain's fishery as a unit, with exceptions as necessary.

Similar to anglers statewide, local stakeholders were more interested in creating and sustaining good fishing for panfish, particularly black crappie, than for any other species. Local stakeholders generally preferred balance between numbers and sizes of panfish, though approximately a third of visioning session participants preferred larger size at the potential expense of numbers – perhaps reflecting a degree of dissatisfaction with the sizes of panfish currently available. For bluegills and to a lesser extent yellow perch, a majority of local stakeholders were willing to temper their harvest if necessary to achieve balanced populations or increase average size; but for black crappie they had a strong interest in management for maximum sustainable harvest.

Local stakeholders ranked walleye second only to black crappie among fish species of interest in the Pike Lake Chain. Visioning session participants were interested in maintaining a moderate density of walleye in a population balanced between numbers and size, provided that we seek to maintain or even increase a sustainable level of harvest. Nobody advocated for a "trophy" or "catch-and-release" fishery for walleye. An emphasis on walleye management is consistent with statewide angler priorities and with maintaining desirable panfish populations via predatory control, so efforts to achieve walleye population objectives will assume an important role in future management.

Muskellunge were of moderate to high importance to almost three-quarters of local stakeholders – ranking them as one of the most important fish species to manage in the Pike Lake Chain. Though a clear majority of visioning session participants valued size over number and expressed a preference for catch-and-release musky fishing, a solid third of all participants preferred a level of balance in size structure and harvest that would preclude management of muskellunge as a strictly "trophy" species.

Northern pike and smallmouth bass generated only a moderate degree of interest among local stakeholders, but negative feelings toward these species were rare. In contrast, few visioning session participants were interested in a largemouth bass fishery, and many had negative views of largemouth bass as a sport fish in the Pike Lake Chain. Only rock bass were viewed with less enthusiasm than largemouth bass.

By the time we had ranked the various species and developed goals and objectives for the three most important species, there was no time left to outline objectives for the species of lesser importance. Visioning session participants agreed that DNR representatives should develop goals and objectives for those species consistent with the preferences described in this summary and with maintaining a type of fish community that would favor the preferred species – black crappie, walleye, and muskellunge.

Overall, this was a very positive session in which everyone, including DNR representatives, learned a great deal. We are confident that we can develop strategies that reflect the preferences and desires of local stakeholders and other anglers who visit the area.

The Plan

Goals and objectives were developed for the highest-priority species – black crappie, walleye, and muskellunge – with significant input from stakeholders in the fishery. We agree these outcomes are desirable, measurable, and achievable. Unless otherwise noted, goals and objectives apply to all four lakes—Amik, Pike, Round, and Turner. Stakeholders were not consulted about management strategies. Recommended strategies represent a local consensus agreement between Plan authors regarding actions necessary to achieve the goals and objectives. For other fish species, plan authors chose goals and objectives that are deemed compatible with and even necessary to achieve objectives for the highest-priority species.

Surveys in 2011 and 2012 provide the most recent and useful assessments of population status for comparison with our objectives and development of appropriate strategies to achieve our goals for the fishery. Fyke netting in October yielded useful information on black crappies. Fyke nets set shortly after the spring thaw targeted walleye, muskellunge, northern pike, and yellow perch. Electrofishing surveys in late spring documented the abundance and size structure of smallmouth bass, largemouth bass, and bluegill populations.

Table 4. Effort directed toward capturing target species and range of average daily water temperatures recorded in recent fish population surveys. A "net-night" is the effort made by fishing one WDNR standard fyke net overnight for approximately one 24-hour period.

	Fyke netting October 5 – 9, 2011 57 – 62°F	Fyke netting April 9 – 17, 2012 46 – 53°F	Nighttime AC Electrofishing May 21 – 30, 2012 63 – 68°F			
			Gamefish		Panfish	
	Net-nights	Net-nights	Miles	Hours	Miles	Hours
Amik Lake	8	20	2.00	1.33	0.50	0.33
Pike Lake	12	24	4.00	2.20	1.00	0.77
Round Lake	12	24	4.00	2.20	1.00	0.60
Turner Lake	8	12	2.00	1.23	0.50	0.35
Combined	40	80	12	6.97	3.00	2.05

GOAL 1: **BLACK CRAPPIE:** A population of moderate density with a moderate proportion of preferred-size fish.

Objective 1.1: Currently we lack an agency-accepted standard method to assess the relative abundance of black crappie. Until such a method is developed, we will consider a late-spring or mid-fall fyke net capture rate of 10-15 black crappies 5 inches and longer per net-night to be indicative of the desired moderate density.

Objective 1.2: Of all black crappie 5 inches and longer captured by fyke netting in late spring or mid fall, 15-25% should be 10 inches or longer (RSD_{10} = 15-25%).

Black Crappie Status and Management Strategies (Local DNR Recommendations):

Similar to other measures of angler preferences in the Upper Chippewa River Basin and statewide, participants in the July 2012 visioning session ranked black crappies highest in relative importance among their fishing interests in the Pike Lake Chain. Past surveys typically focused on walleye and muskellunge, yielding little that would allow us to characterize trends in the crappie population. Survey effort in fall 2011 was directed specifically toward intercepting black crappies in fyke nets set in deeper water (usually 6 – 10 feet) as the fish move around shoreline points and prominences—a standard method of assessment in several states. Unlike spring netting and electrofishing samples that may be biased by larger, mature fish staging to spawn, we believe that crappies in fall fyke nets adequately represent population abundance and size structure.

Black Crappies in Fall 2011 Fyke Nets

Fall 2011	Net-nights	Number per net-night ≥ 5"	Preferred Size ≥ 10"	Memorable Size ≥ 12"
Amik	8	34	42%	2%
Pike	12	17	39%	3%
Round	12	2.0	46%	4%
Turner	8	19	41%	3%
Combined	40	16	41%	3%

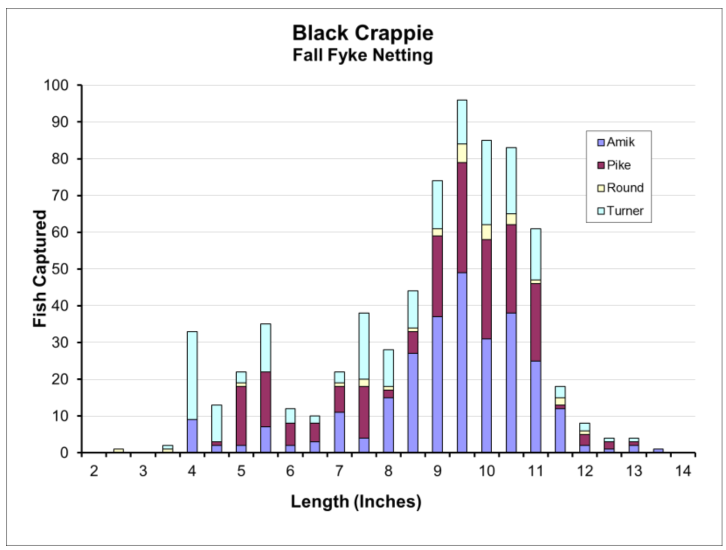
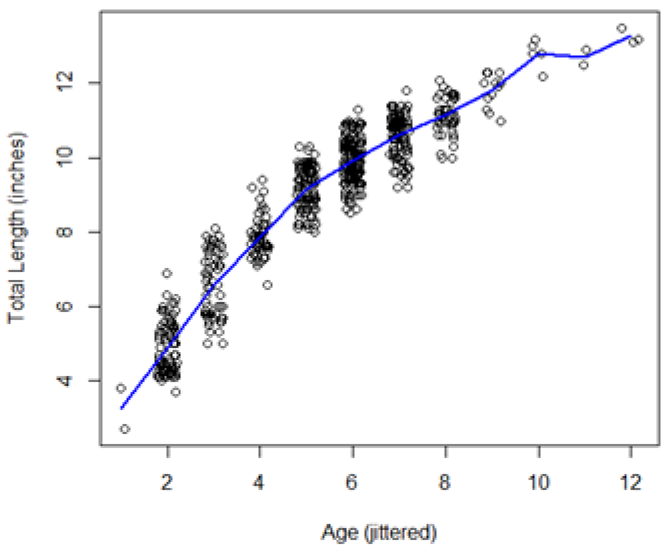


Figure 3. Capture rates and length distribution of black crappies captured in fyke nets, October 5-9, 2011.

Comparing fall fyke net capture rates of crappies ≥ 5 inches, relative abundance was highest in Amik Lake and lowest in Round Lake (Figure 3). Fyke nets in Pike and Turner lakes captured crappies at similar intermediate rates, and our overall measure of crappie abundance for the Chain as a whole slightly exceeded the range selected to represent the desired moderate population density (Objective 1.1). Proportions of preferred- and memorable-size crappies were similar among the four lakes, surpassing our goal to have 15 – 25% of the population at least 10 inches long (Objective 1.2).

Analysis of scales showed that crappies grew at an average rate in the Pike Lake Chain, attaining 9.9 inches in 6 years (Figure 4) compared with a regional average length of 10.1 inches at that age.

Crappies starting the year at 8.0 – 9.9 inches long gained on average 0.74 inch (range 0.33 – 2.02; n = 79) by the end of the growing season. In subsamples of crappies for which age was estimated, average length at age 5 and average increment were lowest in Amik Lake (8.4 and 0.59 inch), highest in Round Lake (9.7 and 0.89 inch), and intermediate in Pike (9.3 and 0.76 inch) and Turner (8.7 and 0.76 inch) lakes. Growth rates predictably mirrored the relative abundance of walleyes and crappies in the four lakes. Crappies grew fastest in Round Lake where abundant walleyes exerted greater predatory pressure to control crappie recruitment. In contrast, crappies grew slower than average in Amik Lake where the low-density walleye population, combined with other predators, was less effective in controlling crappie abundance.



Age	Mean	Count	SD
1	3.3	2	0.8
2	4.9	88	0.7
3	6.6	64	0.9
4	7.9	54	0.6
5	9.2	126	0.6
6	9.9	171	0.6
7	10.6	118	0.6
8	11.1	49	0.5
9	11.8	12	0.5
10	12.8	5	0.4
11	12.7	2	0.3
12	13.3	3	0.2

Figure 4. Average length at age of black crappies in the Pike Lake Chain. Ages were determined from scales subsampled by length category in all four lakes and assigned semi-randomly to all measured crappies by the age-length key.[6] SD = standard deviation.

The bulk of preferred-size crappies (80%) were six- and seven-year-old survivors of the strong 2005 and 2006 year classes. Our fall 2011 netting showed no signs of the sporadic recruitment that often characterizes crappie populations in fish communities dominated by walleyes. Several subsequent year classes were represented in lower abundance, assuring future angling opportunity for 2 – 3 years following our survey, though with a foreseeable decline in numbers as fewer young recruits will be available to replace the larger, older crappies that succumb to angling and natural mortality. Longer term projections would be unreliable because crappies are not fully vulnerable to fall fyke nets until age 3 and older, so our fyke netting capture rate of age-1 and age-2 crappies may or may not indicate significant year classes in the making. A catch curve plot of 694 crappies measured from fall 2011 fyke nets showed that 58% of crappies ages 6 – 12 die each year, though variable recruitment can affect mortality rates estimated by this method. We caution that crappie abundance may not persist at our objective level in the long term. Environmental variables and fish community interactions will almost

[6] Isermann, D. A. and C. T. Knight. 2005. A computer program for age-length keys incorporating age assignment to individual fish. *North American Journal of Fisheries Management*. 25:1153-1160.

[6] Ogle, D. H. FSA: Fisheries Stock Analysis. R package version 0.4.3.

certainly result in weak or missing year classes. Spring weather conditions, especially water temperature, have strong influence on egg and larval survival. We suspect that predation by walleye will occasionally affect crappie year class strength and their survival to adulthood, especially when young walleye are abundant in the Chain. The better-than-average recruitment and survival rates of black crappies in the 2005 and 2006 year classes may be associated with lower-than-average reproductive success of walleyes that has been documented several times in the Pike Lake Chain in the last decade.

In the 2005 – 2006 creel survey, crappie anglers on the Pike Lake Chain directed 2 to 4 times more of their effort and harvested 3 to 4 times more crappies per acre in Amik and Turner lakes than in the larger two lakes (Table 5). Average length of harvested crappies was similar among the four lakes, and anglers kept only half of the crappies they caught in the Chain (range 40 – 62%), reflecting a rate of voluntary release that seems unusually high among crappie anglers. Under moderate fishing pressure (last estimated at 6.1 directed angling hours per acre per year) and current harvest regulations that allow anglers to keep 25 panfish daily, there is some risk that black crappies in the Pike Lake Chain will exhibit a boom-and-bust cycle in population abundance as successful year classes grow to preferred size and anglers selectively harvest a high percentage of the largest adults in the population. However, harvest of crappies in recent years has not been excessive in the Pike Lake Chain (estimated at 7.2, 3.0, and 2.2 crappies per acre in 1991, 1998, and 2005 creel surveys, respectively), and we suspect that anglers rarely take their daily panfish limit. In light of anglers' strong preference to catch and keep crappies, and because we identified no problems related to angler harvest that are preventing crappies from attaining population goals currently, more restrictive harvest regulations are not recommended at this time. Nonetheless, in the long term, a reduced bag limit of 10 crappies daily could serve to moderate the expected fluctuations in crappie abundance and distribute the harvest more equitably among anglers and years.

Table 5. Projected angling effort directed toward black crappies, estimated catch and harvest, and average length of black crappies in the May 7, 2005 – March 5, 2006 creel survey on the Pike Lake Chain.

	Acres	Directed hours per acre	Catch per acre	Harvest per acre	Average Length (inches)
Amik	224	11.9	10.1	5.5	10.4
Pike	806	5.2	3.0	1.2	10.7
Round	726	3.7	2.6	1.6	11.0
Turner	149	14.6	11.8	4.9	10.9
Combined	1905	6.1	4.4	2.2	---

GOAL 2: WALLEYE: A population of moderate density with a moderate proportion of quality-size fish.

Objective 2.1 (revised by authors): 4 to 6 adult walleye per acre in Round Lake; 2 to 4 adults per acre in Pike and Turner lakes; and 1 to 3 adults per acre in Amik Lake in spring population estimates. Or, early spring fyke-netting capture rates that we someday determine to be statistically associated with these desired densities. (Adult walleye are defined by DNR as all fish over 15 inches long and all smaller fish for which gender can be determined in early spring.)

Objective 2.2: Of all walleye 10 inches and longer (stock size) captured by fyke netting in early spring, 20-40% should be 15 inches or longer (PSD = 20-40%).

Walleye Status and Management Strategies (Local DNR Recommendations):

Participants in the July 2012 fishery planning meeting collectively drafted a uniform goal for a walleye population of moderate density (4 – 6 adults per acre) throughout the entire Pike Lake Chain; however, since then a new method of habitat analysis has revealed differences among the four lakes that may limit the ability of walleyes to sustain such numbers in all of them. Because of special light-gathering tissues in their eyes, walleyes have a competitive advantage over their primary prey (yellow perch) and their sight-feeding predators under conditions of low light. Sawyer County Fishery Biologist Max Wolter adapted a model (originally developed by Lester et al.)[7] to predict the relative proportions of lakebed area that offer optimal optical conditions for walleye across a hypothetical range of light

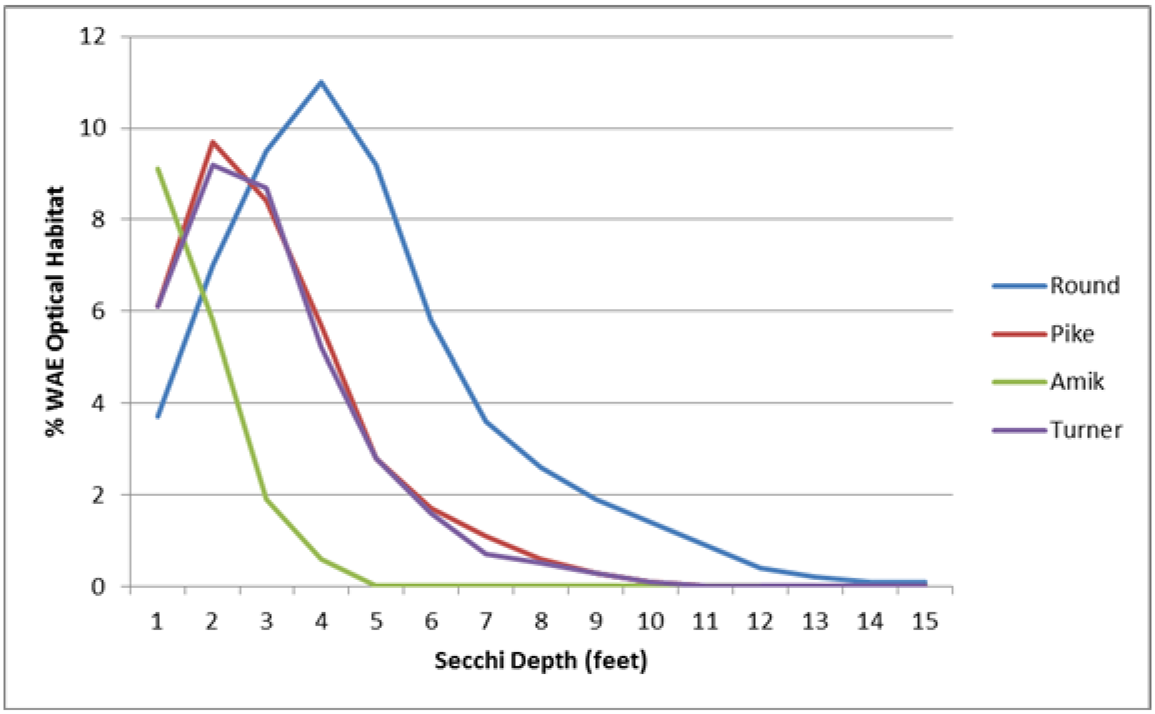


Figure 5. Simulated proportions of walleye optical habitat across a hypothetical range of Secchi depths in the four lakes of the Pike Lake Chain. Adapted from Lester, et al., 2004.

intensity, which is represented in Figure 5 as Secchi disk depth. The relative height and width of the resultant curves suggests that Round Lake is best suited for walleye because it has a relatively large proportion of lakebed suitable for habitation by walleye over a wide range of water clarity conditions. Amik Lake, on the other hand, is the shallowest and often clearest lake in the Chain. It therefore provides the least amount of suitable optical habitat for walleye, especially when Secchi disk depth exceeds 3 feet. Walleye optical habitat and its vulnerability to changes in water clarity were intermediate for Pike and Turner lakes. Theoretical projections of walleye optical habitat in the four lakes closely mirrored current status and historical trends in the Pike Chain's walleye sub-populations.

[7] Lester, Nigel P., A. J. Dextrase, R .S. Kushneriuk, M. R. Rawson, and P.A. Ryan. 2004. Light and Temperature: Key Factors Affecting Walleye Abundance and Production. *Transactions of the American Fisheries Society*. 133:588–605.

With few exceptions, estimated adult density was typically highest in Round Lake, lowest in Amik Lake, and intermediate in Pike and Turner lakes (Table 6). If we adopt the commonly accepted ecological principle that physical habitat is somehow related to productivity (i.e. a larger amount of suitable habitat will support a correspondingly greater biomass of organisms) or to fitness (i.e. more vs. less suitable habitat enhances the ability of individuals to replace themselves), then it seems prudent to adjust our expectations for walleye in the Pike Lake Chain to accommodate the predicted differences in optical habitat that this modeling exercise has identified among the four lakes. Walleye density in Amik Lake has never approached 4 – 6 adults per acre, and in light of these findings we doubt that it ever will. Seldom did we estimate walleye at objective density in Pike and Turner lakes. As stated in the Foreword to this Plan, our goals must be realistic in light of ecosystem capabilities. Revisions to Objective 2.1 represent the authors' shared opinion of attainable walleye densities that each lake can produce and sustain. Objective 2.2 remains unchanged.

Our decision to fine-tune the objectives for walleye density should not imply that each lake in the Chain harbors discrete populations with no mixing or interaction among individuals. To the contrary, we know from tracking mature adults implanted with radio transmitters and from recapturing differentially marked fish that walleye adults and to a lesser extent also juveniles move freely and sometimes quickly throughout the entire Chain. Such movements could confound estimates of population density, but low recapture rates of fish marked elsewhere in the Chain suggest that such movements are manageable and probably negligible within the short period of our surveys, especially if we assume that marked and unmarked fish rove among lakes at similar rates.

Walleyes in Early Spring 2012 Fyke Nets

	Number per net-night ≥ 10"	Quality Size ≥ 15"	Preferred Size ≥ 20"	Memorable Size ≥ 25"
Amik	1.2	87%	30%	4%
Pike	2.4	45%	10%	2%
Round	2.4	26%	10%	2%
Turner	2.8	82%	21%	0%
Combined	2.2	51%	15%	2%

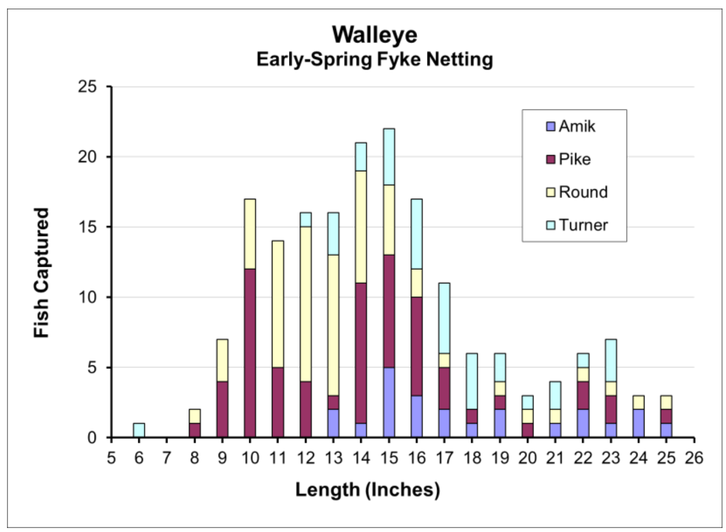


Figure 6. Capture rates and length distribution of walleyes captured in fyke nets, April 9 – 17, 2012.

Our most reliable estimates of adult walleye density in the Pike Lake Chain were completed in 1991, 1998, and 2005 following the standardized protocol developed by WDNR's Treaty Fisheries Assessment Team whose survey method employs early spring fyke netting and electrofishing to capture spawning adults. A comparison of those years reveals that walleye abundance had been generally within or slightly below the ranges selected to represent the desired moderate adult densities (Table 6). The notable exception was Turner Lake's extraordinarily high walleye density in 1991. Recent findings suggest that walleye population density has declined over the last decade, however. Estimates completed by the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) in 2012 were the lowest recorded in Pike and Round lakes, though mature females may be slightly underrepresented by GLIFWC's protocol that samples the spawning population by electrofishing only. Likewise, our capture rates of walleyes in 2012 fyke nets set to generally intercept early spring spawners (northern pike, walleye, yellow perch, and muskellunge) were considerably lower than those observed in earlier surveys when fyke nets were deployed specifically to maximize catch of spawning walleyes (Table 6).

Table 6. Estimated adult density, fyke net capture rate, and size structure indices of walleye captured by fyke netting, 1988 – 2012. PSD and RSD_{20} are proportions of all walleye ≥ 10 inches that were 15 and 20 inches or longer, respectively. Adult density goals and PSD goal are Objectives 2.1 and 2.2.

	Survey Year	Estimated adults/acre	Adult density goals	Net-nights	Number ≥ 10" per net-night	PSD (%)	PSD goal	RSD_{20} (%)
Amik	2012	--	1 – 3	20	1.2	87	20-40	30
	2005	0.9		16	2.6	64		25
	1998	0.4		16	2.4	62		30
	1991	1.5		28	3.5	37		8.2
Pike	2012	--	2 – 4	24	2.4	45	20-40	10
	2012	1.6*		*	*	16*		2.4*
	2005	2.9		30	17	31		9
	1998	2.4		30	15	27		9
	1991	3.9		59	18	24		4.6
	1988	6.7		69	10	17		1.3
Round	2012	--	4 – 6	24	2.4	26	20-40	10
	2012	2.3*		*	*	15		2.1
	2005	4.9		30	47	9		1.9
	1998	5.0		33	25	9		3.9
	1991	4.2		40	23	16		1.4
	1989	--		30	29	17		1.3
	1988	3.6		76	9.8	17		1.6
Turner	2012	--	2 – 4	12	2.8	82	20-40	21
	2005	1.7		12	8.2	77		37
	1998	2.5		20	6.4	68		36
	1991	12.5		21	17	54		14

*Estimated by Great Lakes Indian Fish and Wildlife Commission from fish captured by electrofishing only.

In 2005 walleyes received 8.7 hours of directed angling effort per acre, ranking just behind muskellunge as the second most sought after fish species in the Pike Lake Chain. Visioning session participants expressed their preference for maintaining or increasing sustainable levels of walleye harvest. Despite the attention that walleye receive from anglers who clearly want to keep at least some of their catch, we do not believe that the observed decline in walleye abundance is related to excessive harvest. Anglers and tribal spearers together harvested 28%, 9%, and 15% of the Pike Chain's adult walleye population in 1991, 1998, and 2005 estimates, respectively, never exceeding the 35% exploitation rate considered to be the safe limit on sustainable harvest in northern Wisconsin walleye populations (Table 7). In the most recent creel survey anglers released 75% of walleyes caught, even under liberal regulations that currently allow them to keep two or usually three and as many as five walleye of any size daily. We have no reason to believe that angling pressure or exploitation of walleye in the Pike Lake Chain has increased substantially since 2005. In fact, sporadic reports of mediocre angling success suggest that the downward trends in angler effort and walleye harvest observed from 1991 to 2005 have continued.

Table 7. Projected angling effort directed toward walleyes, estimated angler catch and harvest, and average length of angler-captured walleyes in creel surveys on the Pike Lake Chain in 1991, 1998, and 2005. Angling exploitation was estimated from the projected proportions of marked walleye recovered in the creel survey. Tribal exploitation was calculated as the percentage of the adult walleye population harvested by tribal spearers.

	Survey year	Directed angling hours/acre	Angler catch/acre	Angler harvest/acre	Angling exploitation (%)	Average length (inches)	Tribal harvest/acre	Tribal exploitation (%)
Amik	1991	12.8	2.3	1.1	66	16.0	0	0
	1998	6.8	0.5	0.3	88*	11.9	0	0
	2005	6.4	1.0	0.4	60	15.7	0	0
Pike	1991	14.6	2.9	1.6	26	14.3	0.1	3.5
	1998	9.3	2.0	0.5	2.3	12.9	0.1	3.8
	2005	8.7	1.1	0.1	17	14.3	0.2	7.4
Round	1991	11.4	2.7	1.3	24	13.2	0.2	5.4
	1998	10.3	4.1	0.9	5.4	12.5	0.2	3.7
	2005	8.2	3.2	0.9	5.5	12.7	0.2	4.3
Turner	1991	26.1	4.7	3.3	20	14.3	0	0
	1998	11.9	2.4	0.9	20	14.8	0	0
	2005	15.2	2.1	0.6	0.7	16.2	0	0
Combined	1991	13.7	2.6	1.4	25		0.2	3.3
	1998	9.6	2.7	0.7	5.4		0.1	3.4
	2005	8.7	2.0	0.5	10		0.2	5.1

*Calculated as projected angler harvest divided by adult population estimate because no marked walleye were recovered in the creel survey.

Information from fall electrofishing surveys designed to evaluate the reproductive success of walleye provides convincing evidence that the population can sustain itself without supplemental stocking. Most of the Pike Chain's walleye production occurs in Round Lake, which on average contributed 3½ – 23 times as many age-0 walleye as the other three lakes (Table 8). Capture rates of age-0 walleyes in Round Lake are consistently much higher than the average rate for lakes in the Ceded Territory classified as having self-sustaining walleye populations, whereas the same measures in Amik, Pike, and Turner lakes typically fall well below region-wide averages (Figure 7 and Table 8). Although survival through their first full growing season does not necessarily guarantee that young walleyes will "recruit" and contribute to the fishery, stocking walleye would be counter-productive and should be discouraged unless other factors affecting recruitment change significantly.

Because the Pike Lake Chain reliably produces natural walleye year classes, Pike and Round lakes will serve as two of 14 "reference lakes" in an evaluation now underway to learn why walleyes are struggling to reproduce successfully in many other northern Wisconsin lakes, and what we can do to help them recover. Foregoing stocking and monitoring natural reproductive success in the reference lakes will allow us to document the natural ups and downs of walleye recruitment throughout the region, so we can learn the extent to which any changes measured in lakes targeted for restoration are a result of natural fluctuations (e.g., weather patterns) versus our stocking efforts. Designation as a "reference lake" for this study will ensure that Pike and Round lakes are surveyed more frequently than they would have been surveyed otherwise, allowing us to keep a finger on the pulse and take remedial action in a few years should conditions take an unexpected turn for the worse.

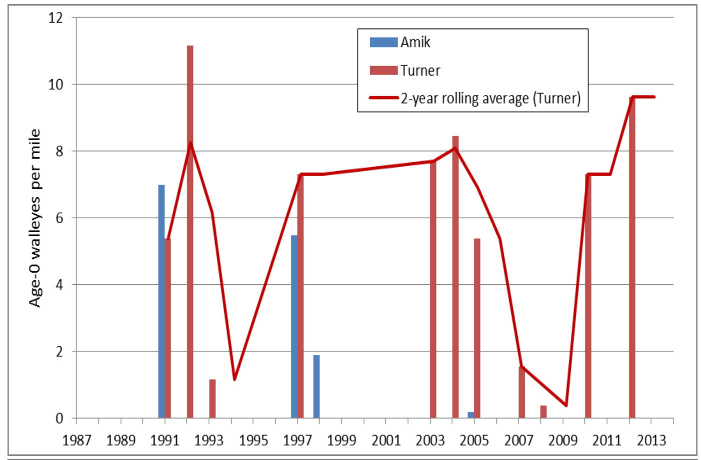


Figure 7. Electrofishing capture rates of age-0 walleye in Pike and Round lakes (left) and Amik and Turner lakes (right) fall 1987-2013. Replicate surveys in the same year were averaged.

Table 8. Mean electrofishing capture rates of age-0 walleyes in the Pike Lake Chain and Wisconsin's Ceded Territory in Fall 1985 - 2013 (long-term average) compared with Fall 2004 – 2013 (recent years). SD = standard deviation.

	Fall 1985 – 2013			Fall 2004 – 2013		
	Age-0 walleyes per mile		Survey Count	Age-0 walleyes per mile		Survey Count
	Mean	SD		Mean	SD	
Amik Lake	3.6	3.1	4	0.2	--	1
Pike Lake	23	29	23*	13	13	10
Round Lake	82	59	29*	86	63	14*
Turner Lake	5.9	3.6	11	5.4	3.8	6
Ceded Territory	33	48	3557	29	42	1257

*Includes replicate surveys. Round Lake: n=2 in 1993 and 1994; n=5 in 2005. Pike Lake: n=2 in 1993.

Walleye year class strength in Pike Lake was lower than Pike Lake's long term average in 7 of 10 surveys completed since 2004 (Figure 7). Similarly, Round Lake produced year classes near or below the regional average in 6 of those years. Coincidentally, the region experienced a prolonged drought with below-average precipitation in 11 of 13 years (1997 – 2009), but we do not know whether the sub-par walleye production can be attributed to weather patterns. High variability in year class strength is not uncommon in walleye populations, but several weak year classes produced in 2004 and 2007 – 2010 may help to explain why the 2012 estimates of adult walleye fell below our objectives for Pike and Round lakes. Fortunately, recent survey results show that better-than-average walleye production in 2011 and 2012 should help the adult population rebound on its own.

Proportional Stock Density (PSD), the percentage of walleye ≥ 10 inches that are ≥ 15 inches and our measure of population size structure, was generally within the objective range in Pike Lake, below Objective 2.2 in Round Lake, and above the desired bounds in Amik and Turner lakes (Table 6). We suspect that the differences in PSD values among the four lakes stem largely from their relative contribution of new recruits to the Chain's collective walleye population. Even though the mature walleye population is the target of early spring fyke netting surveys, high numbers of juveniles and subadults produced in Round Lake combined with adult emigrants that disperse to the other lakes would tend to mathematically deflate the PSD of Round Lake walleyes. Conversely, lower recruitment rates and adult immigration would inflate PSD values for walleye in Amik and Turner lakes. PSD of walleye in early spring 2012 fyke nets reflected a similar pattern among lakes, and the combined PSD for the Chain was 51%, though sample size was relatively small (n = 182) compared with surveys that estimated population density.

With few exceptions, walleyes in the Pike Chain grew slowly—both males and females failed to attain the regional average lengths at ages 4 – 7 in the most recent analyses of spines and scales (Table 9). Despite slower than average growth rates, the oldest known individuals in the Pike Chain survive long enough (≥ 15 years in several cases) for most males to attain quality size and for some females to surpass preferred size (≥ 20 inches) and approach trophy size (≥ 30 inches).

Table 9. Average lengths of male and female walleyes at ages 4 – 7, and the oldest fish in our subsamples. Horizontal arrows denote rare instances of parity with of regional averages.

Lake	Survey year	Sex	Age 4	Age 5	Age 6	Age 7	Length/age of oldest
Amik	2005	F	--	--	--	19.1	27.2 / 14
		M	13.5	15.5 ↔	15.0	16.0	16.0 / 7
Pike	2005	F	13.1	17.3 ↔	16.5	17.3	25.8 / 15
		M	12.1	13.7	14.2	14.9	17.2 / 11
Round	2005	F	--	15.4	14.5	15.9	28.7 / 18
		M	12.2	13.4	14.7	13.9	17.1 / 12
Turner	2005	F	--	13.7	16.5	18.5	26.3 / 15
		M	12.5	13.3	13.5	16.2	16.8 / 10
Ceded Territory	1990 - 2012	F	16.4	17.4	18.5	20.1	25.9 / 24
		M	14.1	15.4	16.2	17.2	23.5 / 21

Observed behavior and statewide preference polls suggest that anglers and tribal spearers would probably choose to harvest walleyes 14 – 18 inches long as the optimal sizes for sustenance, provided that the population offered a large enough proportion of those sizes. Tagging studies in Wisconsin and Minnesota showed that across all size categories, the highest proportions of both male and female walleyes harvested by angling and tribal spearing were 16 – 18 inches long.[8] The majority (52 and 82%, respectively) of walleye harvested by angling from Pike and Round lakes and measured in the 2005 – 2006 creel survey was less than 14 inches long. Only 10 of 65 walleye measured from Round Lake (15%) and 10 of 29 measured from Pike Lake (34%) were 14 – 15.9 inches long. None of the angler-harvested walleyes measured from either lake was 16 – 17.9 inches long. Walleyes harvested by tribal members in 2012 exhibited a similar length distribution (76 and 65% were < 14 inches; 18 and 20% were 14 – 15.9 inches; and 4 and 10% were 16 – 17.9 inches in Pike and Round lakes, respectively).

Not surprisingly, the length distribution of harvested walleyes appears to closely resemble the size structure of the population. Given the choice, with no minimum length limit on walleyes, anglers and tribal members by nature tend to selectively harvest the largest walleyes available within the desirable

[8] Myers, R. A., M. W. Smith, J. M. Hoenig, N. Kmiecik, M. A. Luerhing, M. T. Drake, P. J. Schmalz, and G. G. Sass. 2014. Size- and sex-specific capture and harvest selectivity of walleyes from tagging studies. *Transactions of the American Fisheries Society*. 143:438–450.

size range. Redirecting some of the harvest toward the plentiful walleye < 14 inches could serve to reduce their abundance, decrease intra-specific competition, improve growth rate, and increase the proportion of quality-size walleye ≥ 15 inches long. As our primary strategy to attain and maintain walleye population size structure at the objective level (20 – 40% at least 15 inches), in late 2013 we submitted a fishing rule-change proposal that would allow Pike Lake Chain anglers to continue keeping walleye of any length, but restrict harvest to no more than one fish daily longer than 14 inches. If the proposal is approved through all levels of internal and external review, the new rule would become effective in April 2016. WDNR cannot unilaterally impose additional restrictions on tribal harvest in Wisconsin's Ceded Territory. However, by sharing this Fishery Management Plan with tribal governing boards and resource management teams, we will formally convey our recommendation that tribal spearers cooperate in assuring an adequate supply of edible-size walleyes by also focusing some of their harvest on the abundant 11- to 14-inch fish.

GOAL 3: **MUSKELLUNGE:** A muskellunge population of moderate density with a moderate proportion of legal-size fish and a measurable presence of trophy-size fish.

Objective 3.1: 0.2 to 0.3 adult muskellunge per acre in population estimates, or early spring fyke-netting capture rates that we someday determine to be statistically associated with the desired density. (Adult muskellunge are defined by DNR as all fish over 30 inches long and all smaller fish whose gender can be determined, either by expressing gametes or by examining dimorphic characteristics of the vent.)

Objective 3.2: Of all muskellunge 20 inches and longer captured by fyke netting in early spring, 20-30% should be 40 inches or longer (RSD_{40} = 20-30%) and 1-2% should be of "trophy size" 50 inches or longer (RSD_{50} = 1-2%).

Muskellunge Status and Management Strategies (Local DNR Recommendations):

Muskellunge ranked as the third most important species of angling interest to those who voted in the July 2012 fishery planning session (Appendix A). Muskellunge received 8.8 hours of directed angling effort per acre in the 2005 (Table 10), narrowly eclipsing walleye as the most sought after sport fish in the Pike Lake Chain. In that season musky anglers generally exerted twice as much fishing pressure on Amik and Turner lakes as they did on Pike and Round lakes. In 2005 the Chain received only 57 and 62% of the musky fishing pressure estimated in 1991 and 1998, respectively, trending opposite to the statewide increase in musky fishing popularity over the same period. In 2005 Pike Chain anglers fished 20 hours for each muskellunge caught in Pike, Round, and Turner lakes and 14 hours per muskellunge caught in Amik Lake. Specific catch rates for muskellunge in the Pike Lake Chain were higher than the statewide average of 23 hours per fish in Class A2 musky waters—those known for providing consistent angling action and also having potential to produce some larger fish.

Muskellunge captured in spring 2005 and 2006 fyke nets yielded estimates of adult density in Pike and Round lakes, but we captured too few to evaluate population density in Amik and Turner lakes. Our approximation of 0.25 muskellunge ≥ 20 inches per acre in Round Lake ($C.I._{95\%}$ = 0.13 – 0.37) was central within the range selected to represent the desired moderate population density (Objective 3.2). In 2005 estimated density of muskellunge ≥ 20 inches in Pike Lake (0.14 per acre) was below the objective range, even after we account for our uncertainty in the estimate ($C.I._{95\%}$ = 0.08 – 0.21). Though catch per unit of fyke netting effort does not necessarily correlate with estimated adult density, similar capture rates of muskellunge ≥ 20 inches in early spring 2005, 2006, and 2012 suggest that population abundance has remained relatively stable over that period (Figure 8). The Chain's combined capture rate of 0.6 muskellunge ≥ 20 inches per net-night in spring 2012 ranked near the 40th percentile among Class A2 musky waters.

Most measures of musky population size structure fell short of the targets in Objective 3.2 (Figure 8). Muskellunge in Pike Lake slightly exceeded our expectations with a third longer than legal size (40 inches) in spring 2012 fyke nets, and 6 of 13 muskellunge (46%) in spring 2005 fyke nets were 40 inches or longer in Amik Lake. The largest muskellunge captured in contemporary surveys was in the just over 46 inches long—less than 4 inches short of trophy size. Nonetheless, we believe our objectives for population size structure, while ambitious, are attainable.

We suspect that the Pike Lake Chain harbors larger muskellunge and perhaps higher proportions of legal- and memorable-size fish (≥ 42 inches) than our surveys revealed, but we lack data to substantiate these claims. Creel surveys are infrequent, and in their interviews creel clerks rarely see harvested muskellunge and seldom encounter successful musky anglers in time to measure their fish before release. Organizers chose not to report optional information on the lengths of muskellunge that competitive anglers registered in permitted fishing tournaments on the Pike Lake Chain. <u>Issuing tournament permits with a requirement to report lengths of muskellunge registered in contests would provide valuable length data at no cost.</u> <u>Initiating a volunteer angler diary program, administered by the Lake Association, could also provide useful information to help us characterize muskellunge population status</u>, such as encounter rates (fish that follow or strike a bait or lure, but are not landed), catch rates (fish successfully landed and released), harvest rates (fish landed and kept), estimated lengths of muskies encountered, and measured lengths of muskies landed.

We did not evaluate growth rate of muskellunge because without the ability to compare lengths of uniquely identifiable fish over time, all other reliable methods of age estimation from bony structures require lethal sampling that would be unacceptable to musky anglers and counterproductive to achieving our objectives. Consequently, we do not have specific information to determine whether males and females grow fast enough and live long enough to produce the desired shares of legal- and trophy-size muskellunge in the Pike Lake Chain. However, we can infer that these waters have potential to produce muskellunge of memorable and possibly even trophy size. Growth potential in musky populations depends largely on lake size—larger lakes tend to grow larger muskellunge. This relationship predicts that lakes 2,000 acres and larger typically support musky populations that are more likely to produce individuals that will eventually reach or even exceed 50 inches long[9]. The Pike Lake Chain nearly qualifies for this lake size category with a combined surface area of 1,905 acres, and yellow perch, white suckers, and redhorses in this highly productive, riverine lake system should provide sufficient forage to maintain satisfactory growth in the Chain's muskellunge population.

Addition of new recruits to the muskellunge population comes from a combination of natural reproduction and stocking, though we do not know the relative contribution of these sources. WDNR crews documented evidence of natural reproduction in Round and Turner lakes when they captured four young muskellunge (8.4 – 10.7 inches) in electrofishing surveys in fall 2000 and spring and fall 2005. The timing of these surveys relative to the date of the previous stocking event allows us to conclude that the fingerlings and yearlings at those sizes were produced naturally. Supplemental stocking of muskellunge occurred at a consistent rate of 0.5 large fingerling per acre in alternate (odd-numbered)

[9] Simonson, Tim. 2012. *Muskellunge Management Update*. WDNR Publication FH-508-2012.

years in Pike, Round, and Turner lakes since 2001, except in 2007 and 2013 when stocking rates were reduced by 33% and 50%, respectively, due to production shortfalls. The average size of stocked muskellunge has increased from about 8 fingerlings per pound in the 1980s when statewide production and stocking rates were substantially higher to 3 per pound in 2010. The average length of musky fingerlings stocked into the Pike Lake Chain was 11 or 12 inches in 6 of 7 stocking events since 2001. Fish stocked at larger sizes generally survive better than those stocked at smaller sizes.

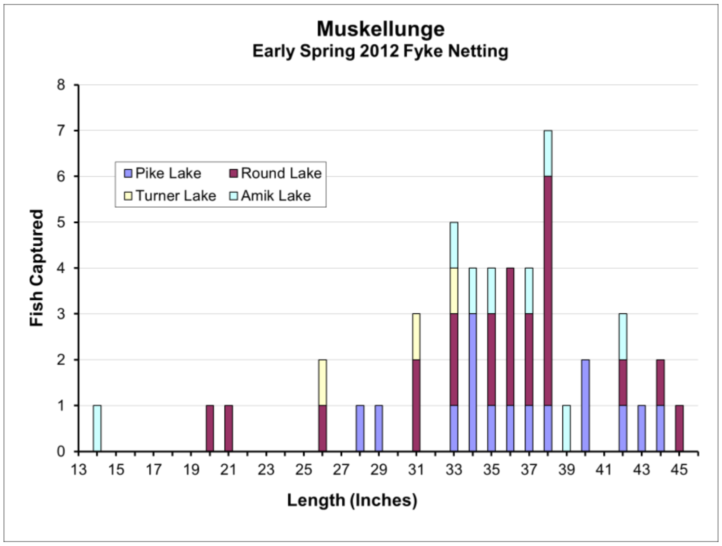
Harvest of muskellunge from the Pike Lake Chain is very low. Anglers kept none of the muskies they caught in the 1998 and 2005 creel surveys, and our projections of 0.15 and 0.07 muskellunge per acre harvested from Amik and Round lakes in the 1991 creel survey were likely inflated by small sample sizes and our calculation method. Tribal members took only 28 muskellunge in total since 1987, an average of about one per year from the entire Chain (Figure 2). Two revised angling regulations that took effect in 2012 should serve to reduce fishing mortality rates even further in muskellunge populations statewide. The minimum length limit on muskellunge increased from 34 to 40 inches, affording protection to most males for their entire lives, and anglers must now use a quick-strike rig or a non-offset circle hook to fish with a baitfish 8 inches or longer. The latter is intended to increase post-release survival of muskellunge captured with live bait and hooked in the mouth compared with a traditional angling method, which utilized a large single hook and required the muskellunge to swallow the baitfish prior to hook set, often resulting in delayed death from internal trauma and infection (83% mortality after one year in controlled trials)[10]. In light of the strong catch-and-release ethic shared by musky anglers in general and the very low angler and tribal harvest of muskellunge documented in the Pike Lake Chain, we believe that fishing mortality will have a negligible influence on our ability to achieve objectives for muskellunge abundance and size structure. Consistent with stakeholders' interest in balance between catch-and-release and sustainable harvest in the fishery, additional restrictions on muskellunge harvest do not appear to be necessary or desirable at this time.

As a result of new statewide fishing regulations and stocking muskellunge fingerlings at larger sizes, we can expect increased survival of both young and adult muskellunge. If harvest remains as low as we currently believe it is, then perhaps our most effective strategy toward improving population size structure is to examine recruitment rates more closely, especially our contribution from stocking, since evaluation of natural recruitment in low-density muskellunge populations is difficult. It is generally accepted that lower stocking rates and lower adult densities often produce larger muskellunge, especially in large lakes.[9] Beginning in 2015 we propose to maintain the current alternate-year stocking frequency, but reduce muskellunge stocking rates from 0.5 to 0.25 large fingerling per acre. We also plan to evaluate survival of naturally produced age-0 fingerlings and stocked age-1 yearlings by monitoring fin clips on hatchery-reared muskellunge captured in fall electrofishing surveys scheduled annually to document the natural fluctuations in walleye recruitment in Pike and Round lakes (two of 14 "reference lakes" without treatment in an evaluation of stocking large walleye fingerlings at various rates under the Wisconsin Walleye Initiative). Because 2013 stocking rates were cut by half, expected progress toward Objective 3.2 resulting from increased growth at lower density may become somewhat detectable in adult muskellunge captured in our early spring 2018 fyke netting survey. If WDNR's Treaty Fishery Assessment Team aligns its schedule for walleye and muskellunge population estimates with our baseline lakes monitoring schedule, as planned, then another estimate of adult muskellunge density from fyke net surveys in spring 2018 and 2019 could help us find appropriate balance between the desired adult density and the desired size structure and help us determine whether adjustments to Objective 3.1 and 3.2 are necessary.

[10] Margenau, Terry L., 2007. Effects of angling with a single-hook and live bait on muskellunge survival. *Environmental Biology of Fishes*. 79:155–162.

Muskellunge in Early Spring 2012 Fyke Nets

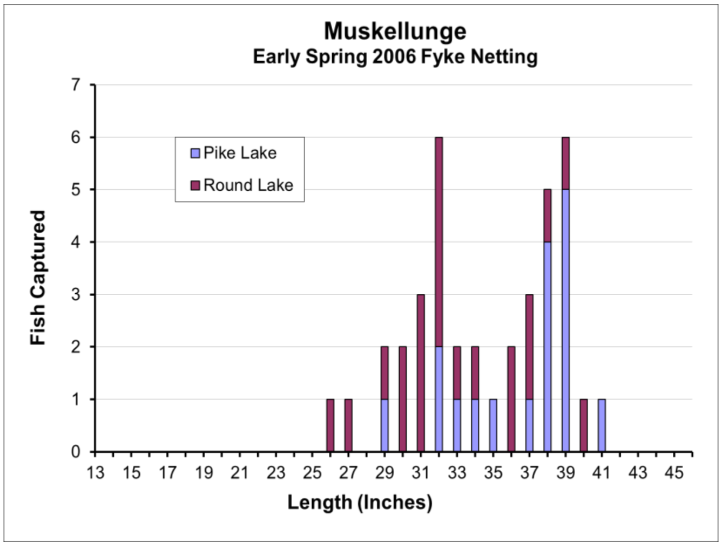
	Number per net-night ≥ 20"	Quality Size ≥ 30"	Preferred Size ≥ 38"	Legal Size ≥ 40"
Pike	0.6	87%	40%	33%
Round	0.9	86%	36%	14%
Turner	0.3	67%	0%	0%
Amik	0.4	100%	43%	14%
Chain	0.6	87%	36%	19%



Muskellunge in Early Spring 2006 Fyke Nets*

	Number per net-night ≥ 20"	Quality Size ≥ 30"	Preferred Size ≥ 38"	Legal Size ≥ 40"
Pike	0.6	94%	59%	6%
Round	0.7	86%	14%	5%
Both	0.7	89%	34%	5%

*Includes fish marked in 2005.



Muskellunge in Early Spring 2005 Fyke Nets

	Number per net-night ≥ 20"	Quality Size ≥ 30"	Preferred Size ≥ 38"	Legal Size ≥ 40"
Pike	0.4	93%	27%	15%
Round	0.5*	86%	28%	10%
Turner	0.3	93%	21%	0%
Amik	0.3	100%	62%	46%
Chain	0.3	91%	31%	14%

*Excludes 38 muskellunge captured in an unknown number of fyke net-nights (April 21 – May 1, 2005) that are represented in the indices and chart.

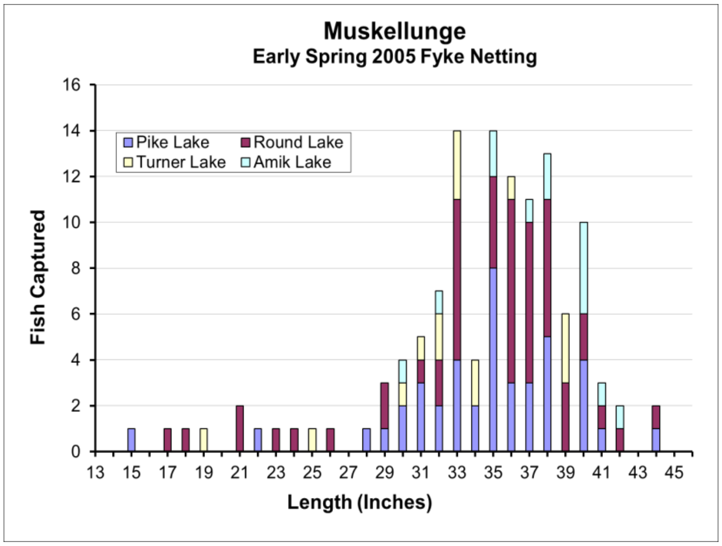


Figure 8. Capture rates and size structure indices of muskellunge in early spring 2005, 2006, and 2012 fyke nets.

Table 10. Projected angling effort directed toward muskellunge; estimated angler catch and harvest per acre in creel surveys in 1991, 1998, and 2005; and tribal harvest in those years.

	Survey year	Directed angling hours/acre	Angler catch/acre	Angler harvest/acre	Tribal harvest (count)
Amik	1991	25.5	1.1	0.1	0
	1998	30.1	1.7	0	0
	2005	14.5	1.0	0	0
Pike	1991	13.4	0.8	0	1
	1998	10.4	0.5	0	0
	2005	7.7	0.4	0	0
Round	1991	12.5	0.7	0.1	2
	1998	11.4	0.5	0	0
	2005	6.8	0.3	0	0
Turner	1991	25.0	2.9	0	0
	1998	24.1	1.1	0	0
	2005	16.3	0.8	0	0
Combined	1991	15.4	1.0	0	3
	1998	14.2	0.7	0	0
	2005	8.8	0.5	0	0

GOAL 4: **BLUEGILL:** A population of moderate density with a low to moderate proportion of preferred-size fish.

Objective 4.1: Currently we lack an agency-accepted standard method to assess the relative abundance of bluegill. Until we have reliable data upon which to base an objective, we will consider a late spring electrofishing capture rate of 50-100 bluegill 3 inches and longer per hour to be somewhat indicative of the desired moderate density.

Objective 4.2: Of all bluegill 3 inches and longer (stock size) captured by electrofishing while bluegill are spawning, 5-10% should be 8 inches or longer (RSD_8 = 5-10%).

Bluegill Status and Management Strategies (Local DNR Recommendations):

Time limitations kept participants from establishing performance standards for the Pike Lake Chain's bluegill population during the July 2012 visioning session. However, recognizing the high importance of the species to anglers locally and statewide, we incorporated into this Plan the same goals and objectives that local stakeholders helped to define for bluegills in the *2008 Fishery Management Plan for the Phillips Chain of Lakes*, our guidance for a nearby impoundment with similar physical and ecological characteristics.

Information on bluegills in the Pike Lake Chain was sometimes recorded in earlier surveys that primarily targeted walleyes and other gamefish, but we are reluctant to use electrofishing and fyke netting capture rates as indicators of historical trends in bluegill abundance due to our discovery that corresponding catch and effort were not always recorded properly in past surveys when panfish were sub-sampled in only a portion of total survey effort. Nonetheless, a cursory examination of bluegill lengths from past surveys can provide insight about growth potential, (i.e. the sizes that the population is capable of producing in this system). Our database included only two records of memorable-size bluegills (≥10 inches): one 10.6-inch fish from Pike Lake captured by electrofishing in May 2012 and one 10.1 inches long from Turner Lake in May 1969 fyke nets. Bluegills 8.5 – 9.4 inches long were never again as common anywhere in the Chain as they were in late May 1969 and early July 1980 fyke nets in Amik and Turner Lakes.

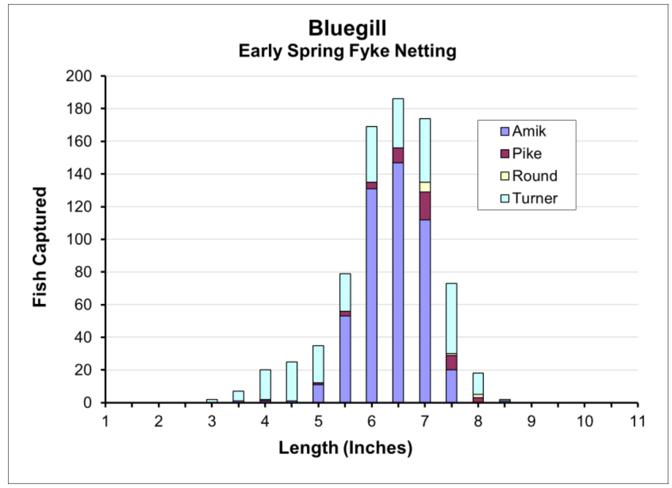
Our late spring 2012 electrofishing surveys revealed that bluegill population status varied substantially among lakes in the Chain. Comparing electrofishing capture rates of bluegill ≥ 3 inches, population abundance was highest in Amik Lake, moderately high in Pike and Turner lakes, and lowest in Round Lake (Figure 9); and all capture rates were outside the objective range (4.1) selected to represent the desired moderate density. Electrofishing also showed that only bluegills in Round Lake met our standard for population size structure in Objective 4.2, though sample size was low (n = 21). Early spring 2012 fyke nets portrayed similar patterns of bluegill population abundance and size structure throughout the Chain, but fyke nets captured preferred-size bluegills in Pike and Turner lakes that went undetected (or nearly so) in our electrofishing surveys.

The dissimilarities that we saw in bluegill abundance and size across the Chain closely reflect the distinctions that we noted in the walleye sub-populations and the availability of suitable walleye optical habitat in each lake. Round Lake has enough optical habitat to produce enough walleye to exert enough predatory control on bluegill recruitment, resulting in a low-density bluegill population that meets or exceeds our expectation for preferred-size fish. In stark contrast but not surprisingly, Amik Lake with the lowest predicted amount of walleye optical habitat and the lowest walleye density, had the highest bluegill abundance among the four lakes with low proportions of keeper- and preferred-size bluegills. In Turner and Pike lakes, the relationship among bluegill, walleye, and walleye optical habitat lies somewhere intermediate between the extremes observed in Round and Amik lakes. If these predator-prey interactions are ultimately limited by the availability of physical habitat, as we suspect, then our size objectives for the bluegill population may be unattainable in Amik Lake and possibly in the other lakes as well. It is unlikely that stocking walleye in Amik Lake would serve as an effective remedy to control recruitment to and improve the size structure of its bluegill population because stocked walleye would probably seek more favorable optical conditions elsewhere in the Chain.

Others in the fish community failed to deliver enough predatory pressure to maintain bluegill recruitment at a relatively low level so that survivors can experience low food competition and grow well throughout their life. Largemouth bass, northern pike, and muskellunge at low to moderate densities were incapable of controlling bluegill abundance in Amik and Turner lakes, probably because these predators become less effective at capturing prey when aquatic vegetation is dense. Predation by adult yellow perch on age-0 bluegill in winter can help to keep bluegill recruitment under control. However, perch could take on an opposing influence on bluegill abundance, if walleyes shift their feeding attention away from the less-favored, circular body shape of bluegills and instead eat more young perch that offer the cylindrical body shape that walleyes prefer. Round Lake had both the lowest perch abundance and the highest proportions of keeper- and preferred-size bluegills in our spring 2012 surveys (Figure 9 and Figure 10), suggesting that walleyes hold the major role in limiting bluegill abundance there. In the other three lakes with fewer walleyes, management strategies to increase the number of perch ≥ 6 inches (including reduction of muskellunge that prefer a diet of larger perch) may help to regulate recruitment and improve size structure of the bluegill population.

Bluegill captured by Early Spring Fyke Netting

	Number per net-night ≥ 3"	Quality Size ≥ 6"	Keeper Size ≥ 7"	Preferred Size ≥ 8"
Amik	47	86%	28%	0.2%
Pike	2.0	89%	62%	6%
Round	0.4	100%	100%	22%
Turner	21	63%	38%	5%
Combined	16	79%	34%	3%



Bluegill captured by Late Spring 2012 Electrofishing

	Number per mile ≥ 3"	Number per hour ≥ 3"	Quality Size ≥ 6"	Keeper Size ≥ 7"	Preferred Size ≥ 8"
Amik	244	366	61%	15%	0%
Pike	99	129	68%	11%	1%
Round	21	35	86%	33%	10%
Turner	164	234	26%	6%	0%
Combined	108	158	56%	13%	0.9%

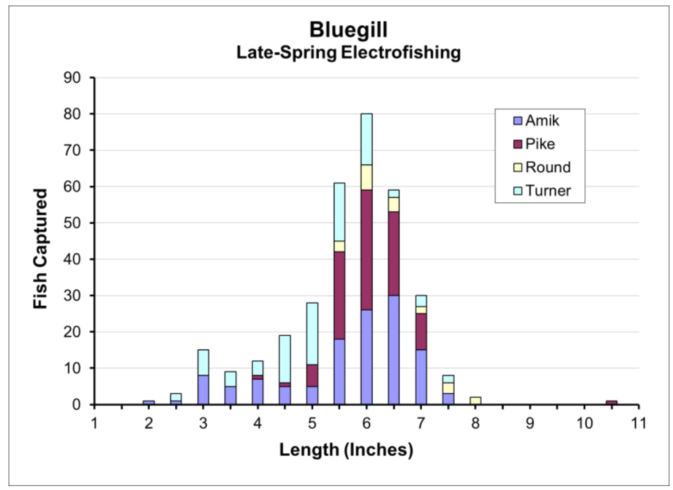


Figure 9. Capture rates and size structure indices of bluegills captured by late spring 2012 electrofishing and early spring 2012 fyke netting.

Compounding the problems that stem from insufficient predation to curb bluegill recruitment, size-selective fishing can also diminish proportions of keeper- and preferred-size fish when anglers harvest the largest bluegills. Aside from its obvious effect on the population's length distribution, size-selective harvest results in the preferential removal of large parental male bluegills. We did not analyze growth patterns in bluegills from the Pike Lake Chain. However, studies have shown that large parental males influence reproductive behavior, growth rates, and size structure in bluegill populations through social mechanisms.[11] Consistent harvest of large parental males reduces the growth potential of parental males by lowering their age at sexual maturation, causing them to invest more of their life-long energy budget in reproduction, rather than growth. This has a cascading effect on bluegill size structure. In the absence of large parental males, smaller parental males mature at younger age and smaller size. Spawning and nesting success of smaller males often increases, but their earlier maturation and their earlier behavioral investment in reproduction further slows their growth rate, worsening the population's overall size structure. Regulations that greatly restrict harvest of large bluegills could eventually improve bluegill size, provided that enough large parental males are still alive to exert their self-regulating, social influence on male bluegill reproduction. However, if heavy exploitation has already

[11] Jennings, Martin J., J. E. Claussen, And D. P. Philipp, 1997. Effect of Population Size Structure on Reproductive Investment of Male Bluegill. *North American Journal of Fisheries Management*. 17:516-524.

eliminated large parental males, either recently or decades ago, and their age at maturity and growth potential are now appreciably reduced, we are not certain whether any strategy could serve to restore satisfactory growth and achieve our objective for bluegill size structure.

In the 2005 – 2006 fishing season anglers harvested an estimated 4,259 bluegills (2.2 per acre) from the Pike Lake Chain. Average length of harvested bluegills was 7.2 – 7.6 inches in the four lakes. Anglers kept 36% of bluegills caught in Round Lake, but only 7% of their catch in Amik Lake. Across the entire Chain, bluegill anglers kept 22% of bluegills caught in 2005, about half the proportion kept in 1998 (43%). Though bluegill harvest is not considered to be excessive, a reduced bag limit might help to distribute harvest more equitably among anglers over longer periods. Unless greatly reduced, however, it is unlikely that more restrictive bag limits alone will work to increase the percentages of bluegill 8 inches and longer because even under moderate fishing pressure directed towards bluegill (4.7 hours/acre in 2005) anglers will continue to selectively take the largest individuals from the population.

Earlier in 2014 we recommended that the Pike Lake Chain should be included in the subset of waters statewide where the Department plans to differentially apply harvest regulations in a structured manner to evaluate which regulations are most effective in maximizing the potential of those lake systems to produce high-quality angling opportunity for panfish. Specifically, we recommended a daily bag limit of 10 bluegills, 10 black crappies, and 10 yellow perch in an aggregate bag limit of 25 panfish daily in the Pike Lake Chain. If our recommendation, currently in review, is internally approved and publically supported, the change would become effective in April 2016. Over time we would employ our baseline lakes monitoring protocols to evaluate panfish populations in all experimental waters for any responses to the special harvest regulations and continually move towards using those most effective in achieving our objectives.

GOAL 5: **YELLOW PERCH:** A population of moderate density with enough large, mature females to produce strong cohorts of young in years with favorable weather conditions, thus maximizing food prey availability for higher-priority fish species.

Objective 5.1: It is difficult to accurately assess perch abundance by using traditional survey methods, but we will examine the utility of early spring fyke netting data. As methods are developed for assessing perch abundance, we will update this objective with appropriate parameter values.

Objective 5.2: Of all yellow perch 5 inches and longer captured by fyke nets in early spring, 10 – 20% should be 8 inches or longer (PSD = 10 – 20%) and 1 – 2% should be 10 inches or longer.

Yellow Perch Status and Management Strategies:

The yellow perch population is an essential component of the fish community, but perch held relatively low angling importance in the Pike Lake Chain. Over 90% of visioning session participants had medium or low interest in perch fishing, and the resulting relative importance score (58%) ranked perch fifth among nine species of sport fishing interest identified in July 2012 (Appendix A). Anglers' low regard for yellow perch is also evident in the fishing effort put forth to catch them. Perch never received more than 10% of the directed fishing pressure anywhere on the Chain in the 1991, 1998, and 2005 creel surveys, and in 1991 Pike Lake Chain anglers directed less than 3% of their effort toward perch.

The low interest in perch fishing on the Pike Lake Chain is undoubtedly related to the population's poor size structure. Early spring 2012 fyke nets captured very few perch and only one was longer than 8 inches (Figure 10). Only 11 of 1,424 perch measured in surveys since 1963 were 10 inches or longer. In 2005 anglers kept 20% of the projected yellow perch catch, harvesting the largest individuals at a rate of 0.43 perch per acre, but the average length of 65 perch measured in the creel (8.8 inches; range 6.5 – 11.8) was far short of preferred size (≥ 10 inches).

Yellow Perch in Early Spring 2012 Fyke Nets

	Number per net-night ≥ 5"	Quality Size ≥ 8"	Preferred Size ≥ 10"
Amik Lake	0.7	0%	0%
Pike Lake	0.8	0%	0%
Round Lake	0.1	0%	0%
Turner Lake	1.5	6%	0%
Combined	0.6	2%	0%

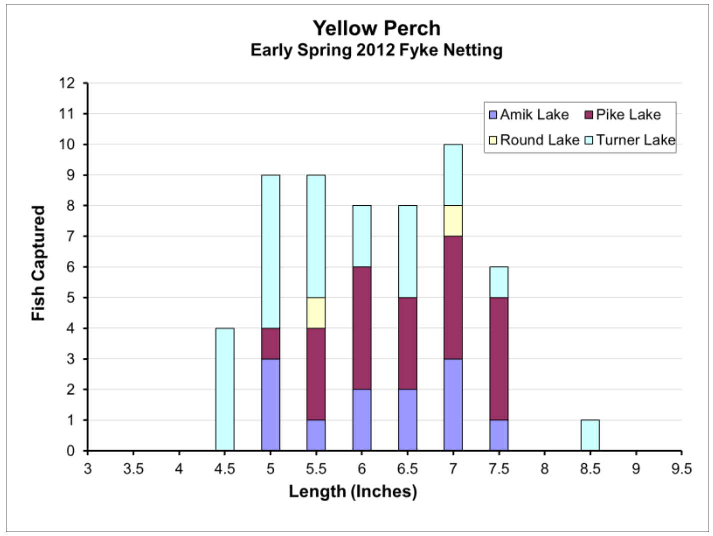


Figure 10. Capture rates and size structure indices of yellow perch in early spring 2012 fyke nets.

Anglers may occasionally take a few perch that were fortunate enough to evade predators and grow to keeper-size ≥ 9 inches, but traditional management options, including reduced daily bag limits and minimum length limits, probably will not improve the population's size structure. Most would be disappointed if we attempted to set an 8-inch maximum length limit on yellow perch, but that may be the only regulatory tactic that would lead to the desired changes in the perch population and fish community overall.

An alternative goal, drafted by the authors, focuses instead on the supporting role of yellow perch as forage for the fish community. Perch of all sizes should continue to serve as the fundamental food of sport fish with higher importance to Pike Chain anglers. Stronger and more consistent year classes of yellow perch should help to reduce cannibalism among young walleyes and increase their survival and growth rates, in turn moderating the wide variations in walleye reproductive success. Efforts to increase perch fecundity and year-class production should also serve to improve growth rates in the walleye, pike, muskellunge, and largemouth bass populations, each of which prefer to eat tube-shaped perch over platter-shaped sunfishes and crappies, even when the latter are more plentiful than the former. With higher priority placed on perch as fish food and less emphasis on perch as food for anglers, finding the optimal balance between size and number is less important than it would be if we strived to achieve angling-oriented objectives.

Many studies have demonstrated that stocking perch and other native fish as forage for the purpose of restructuring the fish community is unnecessary and ineffective. By contrast, strategies aimed toward increasing the availability and suitability of forage already in the lake, such as enhancing habitat and controlling predator density, offer much better prospects for achieving goals for the fishery. For instance, replacing the submerged woody structure that landowners commonly remove to enhance conditions for recreation in the near-shore zone could provide additional high-quality substrate for yellow perch to drape their long strands of adhesive eggs, thus improving water circulation and hatching success. The Pike Chain of Lakes Association could seek regulatory approval and funding to install whole trees from an upland source, preferably hardwoods with branches intact, as fish habitat in water deep enough to attenuate the ultra-violet light that can damage perch eggs. With high concentrations of dissolved and suspended organic material, 2 – 4 feet should be sufficient. In November 2014 the Department initiated "Healthy Lakes," a statewide grant program to partially fund small-scale projects that employ eligible "best practices" that improve fish habitat, integrate native shoreland plantings, divert and clean runoff, and promote natural beauty. Tree-drops projects (trees installed individually) and "fish sticks" projects (installed in clusters of 3 – 5 trees) would qualify for 75% reimbursement capped at $1,000 for each best practice completed. Related strategies to control muskellunge, northern pike, and largemouth bass abundance would reduce predatory pressure on perch, lessening the demand and increasing the supply of food available to structure the fish community.

GOAL 6: **NORTHERN PIKE:** A population of very low density that minimizes predation upon young muskellunge but allows angling diversity and sustains a winter fishery, with a low proportion of preferred-size fish.

Objective 6.1: Less than 1 adult northern pike per acre in spring population estimates, or early spring fyke-netting capture rates that we someday determine to be statistically associated with the desired density.

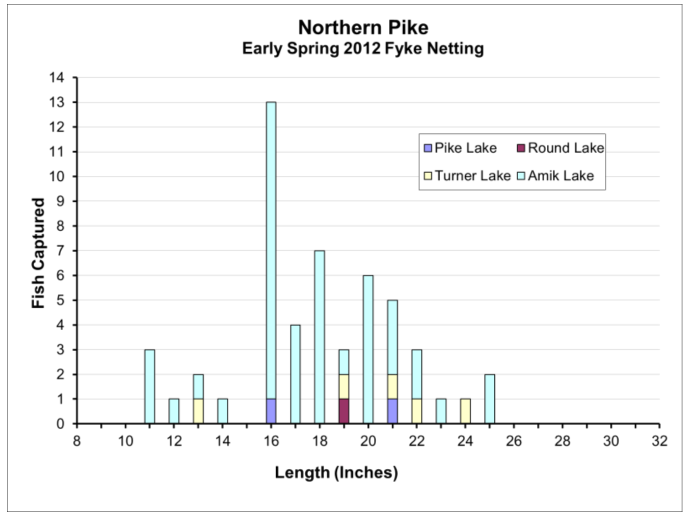
Objective 6.2: Of all northern pike 14 inches and longer captured by fyke netting in early spring, 5 – 10% should be 28 inches or longer (RSD_{28} = 5 – 10%).

Northern Pike Status and Management Strategies (Local DNR Recommendations):

We did not have enough time at the July 2012 meeting to draft specific goals and objectives that described participants' lukewarm interest in northern pike fishing. Votes were almost evenly split between those expressing high or medium interest (55%) and those with little or no interest (45%) in northern pike, probably because of the population's lackluster size structure. Even if pike are not very popular among Pike Lake Chain anglers, managing the pike population will be essential to our success in achieving goals for more important sport fish populations, especially muskellunge and yellow perch. To establish a management direction, the authors adapted the goals and objectives for northern pike in the *2007 Fishery Management Plan for Chippewa Flowage in Sawyer County*, which documents angler preferences and a fish community similar to those we found in the Pike Lake Chain.

Northern Pike in Early Spring 2012 Fyke Nets

	Number per net-night ≥ 14"	Quality Size ≥ 21”	Preferred Size ≥ 28"
Pike	0.1	50%	0%
Round	0.0	0%	0%
Turner	0.3	75%	0%
Amik	2.0	21%	0%
Combined	0.6	26%	0%



Northern Pike in Early Spring 2005 Fyke Nets

	Number per net-night ≥ 14"	Quality Size ≥ 21”	Preferred Size ≥ 28"
Pike Lake	1.7	36%	4%
Round Lake	2.9*	38%	2%
Turner Lake	0.4	36%	0%
Amik Lake	2.8	42%	3%
Combined	1.7	38%	3%

*Excludes 36 northern pike captured in an unknown number of fyke net-nights (April 21 – May 1, 2005) that are represented in the indices and chart.

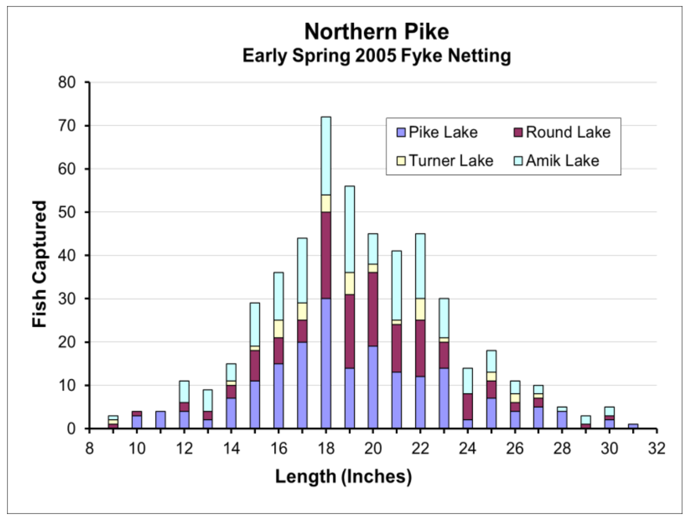


Figure 11. Capture rates and size structure indices of northern pike in early spring 2005 and 2012 fyke nets.

Unless spawning adults were concentrated in tributaries where they would be invulnerable to our gear, the low capture rates of northern pike ≥ 14 inches in early spring 2005 and 2012 fyke nets seem to represent the very low abundance described in Objective 6.1 (Figure 11). None of our recent samples had the desired proportion (5 – 10%) of preferred-size pike, however. In fact, of the combined 1,991 pike ≥ 14 inches measured and electronically recorded in numerous surveys since 1959, only 2% were 28 inches or longer and only 14 individuals (0.7%) were ≥ 30 inches long. We are not certain why the Chain’s pike population has so few large fish, especially when pike abundance and angler harvest[12] are so low. Perhaps competition for yellow perch, the preferred food of both pike and muskies, favors the growth of muskellunge, which fortunately have greater angling importance in these four lakes anyway. We suspect that muskellunge are eating most perch before they reach 8 or 9 inches and leaving few items of prey that would constitute a bioenergetically efficient ration for large pike. Having more juvenile white suckers and redhorse could temper the competition between muskies and pike for large perch, but if largemouth bass abundance increases we can expect few white suckers will survive to age-1. A shortage or lack of suitable summer habitat conditions (temperature < 79°F; dissolved oxygen concentration > 3 mg/l) for optimal growth of northern pike could also offer a plausible explanation for the pike population’s unsatisfactory

[12] Anglers harvested an estimated 0.4, 0.1, and 0.2 northern pike per acre from the Pike Lake Chain in 1991, 1998, and 2005, respectively, and they kept 40, 9, and 12% of the pike caught in those years.

size structure[13]. When wind-driven mixing subsides and the water column becomes thermally-stratified, feeding, metabolism, and growth rates can decrease as pike are forced to inhabit a narrowing range of depth between oxygen-deficient bottom water and warming surface water. As noted above, the likelihood, stability, and duration of thermal stratification varies widely among the four lakes, so we do not know how severely this summer habitat squeeze might affect the pike population in the Chain. Competition for food and environmentally-driven limitations on physical habitat, in combination, may preclude us from achieving even our conservative objective (6.2) for northern pike size distribution.

Despite the scarcity of preferred-size fish, the northern pike population in the Pike Lake Chain does provide fishing opportunity for a species that is relatively easy to catch, even for novice anglers. We encourage anglers to harvest and utilize northern pike under current regulations (5 daily bag limit; no minimum length limit) to control their abundance and to minimize predation on young muskellunge. Directing harvest toward pike 18 – 22 inches long may help to improve the population's size structure. Special fishing regulations are not warranted here because they would confer greater importance than the species deserves, but the Pike Lake Chain of Lakes Association could promote voluntary implementation of this strategy.

GOAL 7: SMALLMOUTH BASS: A population of low to moderate density with a high proportion of preferred-size fish and a moderate proportion of memorable-size fish.

> **Objective 7.1:** Electrofishing capture rates for 7-inch and longer smallmouth bass of 10 – 20 per hour in bass spawning grounds during the bass spawning season.
>
> **Objective 7.2:** Of all smallmouth bass 7 inches and longer captured by electrofishing during the bass spawning season, 50-70% should be 14 inches or longer (RSD_{14} = 50-70%) and 10-20% should be 17 inches or longer (RSD_{17} = 10-20%).

Smallmouth Bass Status and Management Strategies (Local DNR Recommendations):

Late spring 2012 electrofishing captured smallmouth bass at rates lower than Objective 7.1 which describes the desired low to moderate population density. Capture rates in the Pike Lake Chain were similar to those recorded in 2014 in nearby Solberg Lake and the Phillips Chain of Lakes where electrofishing catch rates decreased 38% and 62% since late spring 2008. The relative abundance of smallmouth bass mirrored the differences in habitat characteristics among the four lakes in the Pike Lake Chain. With the highest combined percentage of rocky substrate to support crayfish, the favorite food of smallmouth bass, Round Lake harbored the most and the largest smallmouth bass (Figure 12 and Table 1). Shallow, sandy, weedy Amik Lake is better suited for largemouth bass, and it is unlikely that the smallmouth bass population there will ever attain our goals. Smallmouth bass abundance in Pike and Turner lakes was intermediate between these two extremes.

---

[13] Headrick, M. R. and R. F. Carline. 1993. Restricted Summer Habitat and Growth of Northern Pike in Two Southern Ohio Impoundments. *Transactions of the American Fisheries Society*. 122:228-236.

Smallmouth Bass captured by Late Spring 2012 Electrofishing

	Number per mile ≥ 7"	Number per hour ≥ 7"	Quality Size ≥ 11"	Preferred Size ≥ 14"	Memorable Size ≥ 17"
Amik	0	0	--	--	--
Pike	1.5	2.7	83%	50%	0%
Round	2.0	3.6	88%	50%	13%
Turner	1.0	1.6	0%	0%	0%
Combined	1.3	2.3	75%	44%	6%

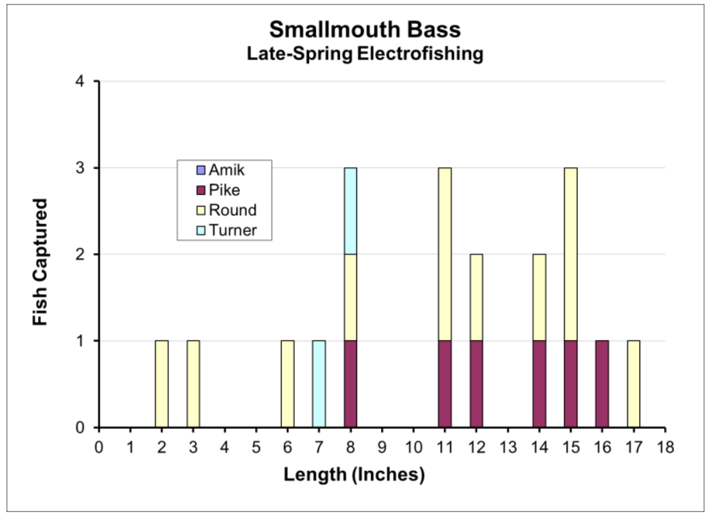


Figure 12. Capture rates and size structure indices of smallmouth bass captured by late spring electrofishing.

Though small samples limit our confidence in assessing population size structure, smallmouth bass in Round and Pike lakes barely met our expectations for preferred-size fish, and only Round Lake had the desired share of memorable-size smallmouth bass (Objective 7.2). Ages estimated from scales suggest that smallmouth bass in the Pike Chain reach 8.5 inches in three years (n = 2) and 11.2 inches in 4 years (n = 3), 0.7 inch below and 0.1 inch above the regional average length at those ages. In very low abundance the population's growth rate and size distribution appear to be satisfactory.

Creel surveys in 1991, 1998, and 2005 confirm the low interest in smallmouth bass fishing that stakeholders voiced in July 2012. Smallmouth bass received only 0.3 – 2.4% of the directed fishing pressure in those years. Estimated harvest was zero in 2005 and negligible in 1998 and 1991 (0.01 and 0.04 bass/acre, respectively). Consistent with statewide angling behavior, Pike Chain anglers released 82 – 100% of their catch, projected as 0.22, 0.24, and 0.55 bass/acre in 1991, 1998, and 2005. With a strong catch-and-release ethic among bass anglers, harvest regulations more restrictive than those currently in place (catch-and-release-only in May and early June, minimum length = 14 inches, daily bag limit = 5) are not likely to increase abundance or alter the size structure of the smallmouth bass population.

Smallmouth bass and their nesting sites are often closely associated with rubble/gravel substrate and submerged rocky and woody structure that provides adjacent and overhead cover. Usually we assume a positive relationship between physical habitat and productivity, (i.e. increasing the amount of suitable habitat should increase recruitment, survival, or growth rates to produce more fish or larger fish). We do not believe that physical habitat or spawning stock density is limiting the smallmouth bass population in Round, Pike, and Turner lakes. Instead, recruitment often depends on the success of only a few nest-building, brood-guarding males each year. Using family-specific DNA fingerprints, Gross and Kapuscinski (1997) found that only 5.4% of all spawning male smallmouth bass in Lake Opeongo, Ontario produced 54.7% of the fingerlings captured in fall, suggesting that even a smaller fraction of the spawning fish may actually produce a given year-class of adults.[14] A very high percentage of smallmouth bass dies shortly after hatching, and year class strength is governed by subtle changes in survival rates at two early phases of development: the swim-up fry stage (influenced by environmental conditions—mainly water temperature and wind) and the late fingerling stage (influenced by the size attained in the first growing season and the energy reserves available for overwinter survival). Consequently, the productivity of smallmouth bass populations is extremely vulnerable to both natural and man-made impacts.

[14] Gross, M. L. and A. R. Kapuscinski. 1997. Reproductive success of smallmouth bass estimated and evaluated from family-specific DNA fingerprints. *Ecology*. 78(5):1424-1430.

Our inability to distinguish between successful and unsuccessful males or to influence climatic conditions underscores the need to protect all spawning males from human activities that might affect the nest-building, spawning, and brood-guarding phases. In northern Wisconsin fishing regulations permit catch-and-release angling for smallmouth bass, but prohibit their harvest from the first Saturday in May until the third Saturday in June, the period when the bulk of smallmouth spawning activity occurs throughout the region. In controlled tests mortality rates at least 48 hours following release were 11% for smallmouth bass caught on a single hook baited with a minnow, 0% for those hooked on a spinner with a treble hook, and 4% for those not hooked.[15] To maintain or increase current levels of smallmouth bass abundance anglers are encouraged to use artificial baits with one or more treble hooks and to carefully release their catch to minimize hooking mortality, especially at higher water temperatures.

Spawning male smallmouth bass, especially experienced males, exhibit strong nest site fidelity from year to year. Approximately 81% re-nested within 200 meters of their previous year's nest site, while the remainder nested 200 – 1,200 meters from their previous nest site.[16] This behavioral pattern of repeated use draws attention to the higher importance of protecting traditional nesting sites versus attempting to create new or better habitat. Enforcement of state and municipal ordinances that regulate boat speed near shore, dredging, grading and other shoreline development activities, vegetative clearing, and herbicide/fertilizer application coupled with “best practices” that maintain or restore littoral and riparian zones in a natural condition offer the most promising tools for protecting smallmouth bass spawning habitat.

Though we cannot predict a resulting increase in smallmouth bass abundance or biomass, replacing the submerged woody habitat that landowners commonly remove along developed shorelands by installing half-logs (logs sawn longitudinally, weighted, and elevated about 1 – 1½ feet above the lakebed) and whole trees from an upland source (placed individually as “tree-drops” or in clusters as “fish sticks”) may increase available cover and angling success for adult and sub-adult smallmouth bass without compromising our objectives, provided that Pike Chain anglers continue to practice catch-and-release for smallmouth as most bass anglers do statewide. The strategy to supplement in-lake woody material for yellow perch would serve these purposes as well.

GOAL 8: **LARGEMOUTH BASS:** A population of low density that minimizes predation upon young walleye but provides some angling diversity, with a moderate proportion of fish at least 18 inches long.

Objective 8.1: Electrofishing capture rates for 8-inch and longer largemouth bass of 10-20 per hour (5-10 per mile) during the bass spawning season (low end of range for Round and Pike lakes, high end of range for Amik and Turner lakes).

Objective 8.2: Of all largemouth bass 8 inches and longer captured by electrofishing during the bass spawning season, 30-40% should be legal size (RSD_{14} = 30-40%) and 5-10% should be 18 inches or longer (RSD_{18} = 5-10%).

---

[15] Clapp, D. F. and R. D. Clark, Jr. 1989. Hooking mortality of smallmouth bass caught on live minnows and artificial spinners. *North American Journal of Fisheries Management*. 9:81-85.

[16] Ridgway, M. S., J. A. MacLean, and J. C. MacLeod. 1991. Nest-site fidelity in a centrarchid fish, the smallmouth bass (Micropterus dolomieui). *Canadian Journal of Zoology*. 69:3103-3105.

Largemouth Bass Status and Management Strategies (Local DNR Recommendations):

Electrofishing capture rates showed largemouth bass abundance near the upper end of the desired range in Amik and Turner lakes where the Chain's shallowest basins, densest stands of aquatic plants, and highest water clarity favor growth and survival of largemouth bass over walleye. We are not concerned that largemouth bass abundance is below the Chain-wide objective in Round and Pike lakes because their habitat and water quality conditions are better suited for walleye and because walleyes had greater angling importance than largemouth bass (Appendix A). Largemouth bass generally received only 2 – 3% of the directed fishing pressure on the Pike Chain, slightly higher than the share directed toward smallmouth bass (1 – 2%), but far less than the proportion that walleyes typically receive.

Largemouth Bass captured by Late Spring 2012 Electrofishing

	Number per mile ≥ 8"	Number per hour ≥ 8"	Legal Size ≥ 14″	Preferred Size ≥ 15"	Objective Size ≥ 18″
Amik	9.0	14	28%	11%	0%
Pike	1.5	2.7	33%	17%	17%
Round	1.0	1.8	75%	50%	0%
Turner	10	16	15%	0%	0%
Combined	4.0	6.9	27%	10%	2%

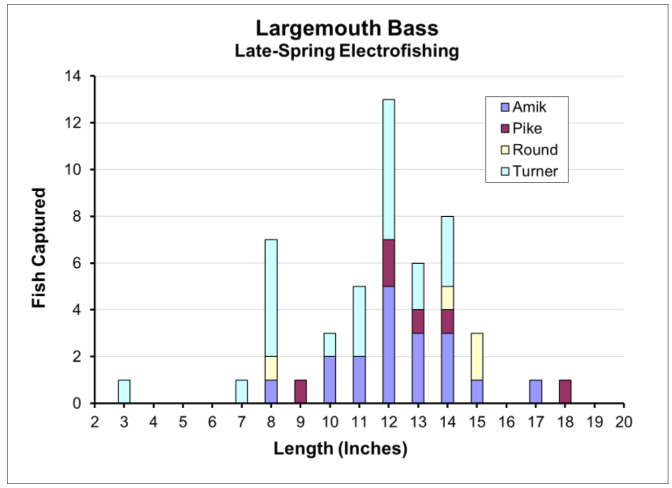


Figure 13. Capture rates and size structure indices of largemouth bass captured by late spring 2012 electrofishing.

Our spring 2012 electrofishing samples were probably too small to adequately represent largemouth bass size structure, but records from a small catch-and-release bass fishing tournaments provide additional insight about the population's largest individuals. In July 2012 eight contestants fished five hours (40 angler-hours) and registered 12 largemouth bass, including two 17.7 and 18.1 inches long. Of seven largemouth bass caught in 39 angler-hours in their June 2009 contest, two were 17.8 and 18.1 inches. In three informal tournaments held in summer 2010 – 2014, participants caught and released 26 largemouths in 79 angling hours combined, but none was longer than 16 inches. At low population density, largemouth bass maintain a nearly-average growth rate that should produce the desired proportion of fish ≥ 18 inches. Back-calculated lengths at age-5 averaged 11.5, 12.7, and 12.2 inches in Amik (range 10.7 – 12.6; n = 5), Pike (range 12.0 – 13.6; n = 3), and Turner (range 11.4 – 12.5; n = 5) lakes, respectively, compared to the regional average (12.7 inches) at that age.

Presently, largemouth bass are not compromising our ability to attain the fishery that most people want in the Pike Lake Chain. However, if electrofishing capture rates of largemouth bass in Pike and Round lakes approach or exceed Objective 8.1, then we should consider strategies to decrease largemouth bass density, including liberalized harvest regulations, in order to minimize predation and competition that we suspect may suppress walleye recruitment rates when largemouth bass populations surpass that threshold level of abundance. Anglers almost always released 100% of the projected largemouth bass catch in 1991, 1998, and 2005 creel surveys, except in Round Lake where they kept nearly half in 1991 and 2005. With a strong catch-and-release ethic among bass anglers nationwide, many anglers will be reluctant to keep largemouth bass should the need arise to achieve our goals for walleye and largemouth bass populations. Consequently, our success will rely heavily upon first removing the size limit that currently protects largemouth bass from harvest in their first 6 – 8 years until they grow to 14 inches minimum (WDNR's role), and then upon actively encouraging anglers to selectively harvest and utilize intermediate-size largemouth bass 9 – 12 inches long (lake association's role). Relaxed regulations in effect since 2014 eliminated the early catch-and-release only season for largemouth bass, now allowing anglers to keep fish that some believe are tastier if taken at lower water temperature when the harvest season opens in early May.

GOAL 9: **BIODIVERSITY:** A diverse native fish community that fluctuates in species composition but generally experiences no net loss of native fish species and provides adequate forage for sport fish populations.

Objective 9.1: No net loss of native fish or other native aquatic species in the lakes or their connecting channels; and no catastrophic losses to disease or poor water quality that could lead to fish community imbalance and failure to achieve important sport fishing objectives.

Objective 9.2: Adequate forage, as reflected by satisfactory growth rates and condition factors of sport fish populations managed under Goals 1-8.

General Ecosystem Management Strategies (Local DNR Recommendations):

To maintain native aquatic plant and animal communities that are best adapted to inhabit these waters, the Pike Lake Chain of Lakes Association should continue to discourage introduction of invasive species via their newsletter, appropriate posters or signs at resorts and public access areas, and their active participation in the "Clean Boats – Clean Waters" campaign. Anglers and boaters should carefully follow the laws and guidelines established to control the spread of exotic, infectious, and invasive species beyond the waters where they already occur. By responsibly obtaining and handling live bait and removing water, mud, and aquatic plants from boats and trailers before leaving the landing of any lake, people who enjoy the Pike Lake Chain can fulfill their pivotal role in preventing unwanted introductions.

Blue Water Science reported that soils near the Pike Lake Chain are among the most acidic (pH 5.5) and their available phosphorus concentration (138 pounds/acre) ranks among the highest of Wisconsin soils.[17] Runoff carrying phosphorus from the soils of the 92-mile^2 watershed is the primary source of the limiting nutrient for algal production in the Pike Chain. Phosphorus export rates estimated by WDNR[18] and Blue Water Science[17] were near the statewide average rate (0.11 pounds/acre/year) released from Wisconsin's undeveloped woodland and wetland areas. In addition to surface inputs, phosphorus in the sediment contributes substantially when it dissolves under anoxic conditions that occasionally occur in summer and possibly in winter. With no point source discharges and very low potential for non-point source pollution in this pristine watershed, the influx of nutrients to the Chain is largely driven by natural geochemical processes, rather than human activities. Unless we someday see extensive and poorly-planned development in the watershed, we predict that water clarity, walleye optical habitat, and fish community composition will continue to trend with environmental variables as they appear to now.

Nonetheless, support for good shoreland management would serve to prevent high nutrient levels from increasing further to a point where nuisance algae blooms occur more frequently. Diligence in maintaining wild shorelines and wide buffer strips between managed lawns and the lake will help to slow runoff,

[17] *Lake Management Plan for the Pike Lake Chain of Lakes Price and Vilas Counties, Wisconsin*. 2003. Prepared by Steve McComas, Blue Water Science, with significant contributions from the Pike Lake Chain of Lakes Association and Wisconsin Department of Natural Resources.

[18] *South Fork Flambeau River Tributary Monitoring Report, 2010-2011*. Prepared by Craig Roesler, Water Quality Biologist. Wisconsin Department of Natural Resources.

intercept fine-particle transport, and assimilate nutrients before they reach the lake. Minimizing near-shore silt deposition and input of phosphorus and nitrogen from lawns or faulty septic systems will in turn minimize growth of filamentous algae and dense aquatic plants and the ultimate decay of those plants that depletes oxygen and kills fish in winter. Wild shorelines can exist on well-managed private properties as well as public lands. But, the more shoreland that can be maintained or restored in a natural state, the greater the likelihood that the complex energy-to-biomass transformations will happen where and as they should.

A diverse and stable forage base comprised of suitable-size prey is vital to maintain sport fish populations with acceptable growth rate and size structure. Descriptive or quantitative information on suckers, redhorses, and minnows was recorded now and then in netting and electrofishing surveys, but gross inconsistency in sampling methods renders that data of little value for interpreting status and trends in the forage community. Because we will probably never have sufficient resources to properly characterize and manage forage populations individually, we opt instead to focus on achieving optimal habitat conditions and predator densities as a more generalized strategy toward Objective 9.2. Our specific recommendations for modifying predator abundance are outlined in several sections of this Plan. Maintaining healthy native plant communities will be important in facilitating and regulating the recruitment and production of young bluegill, yellow perch, crayfish, and other organisms consumed by predatory sport fish. We refer readers to the Aquatic Community Overview section of this plan to review the current status of aquatic plant communities. Likewise, retaining and replacing the coarse woody materials, which landowners commonly remove from the productive near-shore zone, would help to increase habitat diversity and complexity and bolster productivity for the broad range of organisms that rely on submerged woody structure for energy, substrate, and cover.

Finally, a restoration strategy aimed at reconnecting the lake and river ecosystems should mimic natural conditions, restore the historic distribution of native fish and freshwater mussel populations, and promote balanced predator-prey interactions. Since 1876, the Round Lake Dam in various designs and states of repair has largely fragmented physical habitat, segregated plant and animal communities, and impeded both passive and willful movements of aquatic organisms between the Chain of Lakes and the South Fork Flambeau River. Resource agency personnel have observed schools of suckers and redhorse congregated at the base of the weir in spring, but only a few could overcome the velocity and elevation to successfully swim or jump upstream. Throughout summer 1995 the construction crew watched an adult sturgeon repeatedly fail to ascend the weir as they built the replica logging dam. We encourage federal, state, and tribal resource agencies and their citizen partners to investigate the feasibility of reestablishing two-way fish passage at this low-head dam as a lasting way to integrate the lake and riverine communities, assure responsible management of water levels and discharge, and afford return opportunity to fish escaped or entrained from the Chain. Although many factors must be thoroughly examined before any action is taken, a cursory look suggests that favorable site conditions, including federal dam and land ownership, the small difference between headwater and tailwater elevations, and the absence of invasive fish species and hydroelectric generation, would allow construction of a simple fishway, designed as nature-like bypass channel around the weir or a channel-width ramp to the weir crest, at relatively low cost, compared with highly-engineered fishways that must overcome taller obstacles, selectively pass only desirable species, or allocate flow among competing uses.

The South Fork Flambeau River is designated as an Outstanding Resource Water under Chapter NR 102, Wisconsin Administrative Code, which confers the most rigorous protection against degradation of its high quality water resources. Additionally, the South Fork is a candidate stream for inclusion under the national Wild and Scenic Rivers Act. If we take practical measures to apply what we know, protect and enjoy what we have, and carefully restore what we and others before us have disturbed, we can collectively advocate for the healthiest possible ecosystem and strengthen our assurance that the Pike Lake Chain will remain a special place for our children's children.

Pike Lake Chain Fishery Management Plan
January 2015
Summary of Local WDNR Strategies & Recommendations
(Proposed roles for partners are <u>underlined</u>.)

Black Crappie:

- A reduced bag limit of 10 crappies in an aggregate daily bag limit of 25 panfish could serve to moderate the expected fluctuations in crappie abundance, increase the proportion of crappies ≥ 10 inches, and distribute the harvest more equitably among anglers and years. A packaged fishing rule-change proposal to evaluate various harvest restrictions in about 100 selected lakes, including the Pike Lake Chain, will be before the Wisconsin Conservation Congress in April 2015.

Walleye:

- Stocking walleye would be counter-productive and should be discouraged unless other factors affecting recruitment change significantly.
- To achieve and maintain our objective for walleye population size structure (20 – 40% ≥ 15 inches) a fishing rule proposal before the Wisconsin Conservation Congress in spring 2015 would allow Pike Lake Chain anglers to continue to keep walleye of any length, but restrict harvest to no more than one fish daily longer than 14 inches.

Muskellunge:

- Additional restrictions on muskellunge harvest do not appear to be necessary or desirable at this time.
- Beginning in 2015 we will maintain the current alternate-year stocking frequency, but reduce muskellunge stocking rates from 0.5 to 0.25 large fingerling per acre.
- Beginning in 2015 we will evaluate survival of naturally produced age-0 fingerlings and stocked age-1 yearlings by monitoring fin clips on hatchery-reared muskellunge captured in fall electrofishing surveys scheduled annually to document the natural fluctuations in walleye recruitment in Pike and Round lakes.
- Another estimate of adult muskellunge density from fyke net surveys in spring 2018 and 2019 could help us find appropriate balance between the desired adult density and the desired size structure and help us determine whether adjustments to our stocking strategy or Objectives 3.1 and 3.2 are necessary.
- Issuing fishing tournament permits with a requirement to report lengths of muskellunge registered in contests would provide valuable length data at no cost.
- <u>Initiating a volunteer angler diary program, administered by the Lake Association, could also provide useful information to help us characterize muskellunge population status.</u>

Bluegill:

- A proposed fishing rule change that would allow anglers to keep a daily bag limit of 10 bluegills, 10 black crappies, and 10 yellow perch in an aggregate bag limit of 25 panfish daily as a strategy to increase the average length of panfish in the Pike Lake Chain and about 100 selected lakes statewide will be presented to the Wisconsin Conservation Congress in April 2015.

- Strategies to increase the number of perch ≥ 6 inches (including reduction of muskellunge and northern pike that prefer a diet of larger perch) may help to regulate recruitment and improve size structure of the bluegill population.

Yellow Perch:

- Perch of all sizes should continue to serve as the fundamental food of sport fish with higher importance to Pike Chain anglers.

- Strategies to control or decrease muskellunge, northern pike, and largemouth bass abundance would reduce predatory pressure on perch, lessening the demand and increasing the supply of food that walleyes and muskellunge prefer to eat.

- Replacing the submerged woody structure that landowners commonly remove from the near-shore zone could provide additional high-quality spawning substrate for adhesive perch eggs to improve hatching success. The Pike Lake Chain of Lakes Association could seek regulatory approval and funding to install whole trees from an upland source as fish habitat.

- While presently not available as a fishing regulation that WDNR could apply and enforce, the Pike Lake Chain of Lakes Association could promote a voluntary 8-inch maximum length limit on yellow perch as a strategy to increase perch fecundity.

Northern Pike:

- Encouraging anglers to harvest and eat northern pike under Northern Zone fishing regulations could reduce predation of age-0 muskellunge produced in-lake, possibly enough to sustain the desired adult muskellunge population by natural recruitment without stocking.

- Directing angling harvest toward northern pike 18 – 22 inches long may help to improve the pike population's size structure. The Pike Lake Chain of Lakes Association could promote voluntary implementation of this strategy without a formal change to enforceable fishing regulations.

Smallmouth Bass:

- To maintain or increase current levels of smallmouth bass abundance anglers are encouraged to use artificial baits with one or more treble hooks and to carefully release their catch in order to minimize hooking mortality, especially at higher water temperatures.

- Enforcing and abiding state and municipal ordinances that regulate boat speed near shore, dredging, grading and other shoreline development activities, vegetative clearing, and herbicide/fertilizer application coupled with "best practices" that maintain or restore littoral and riparian zones in a natural condition offer the most promising tools for protecting smallmouth bass spawning habitat.

- Installing half-logs and whole trees may increase available cover and angling success for adult and sub-adult smallmouth bass without compromising our objectives, provided that Pike Chain anglers continue to practice catch-and-release. The strategy to supplement in-lake woody material for yellow perch would also serve these purposes.

Largemouth Bass:

- If largemouth bass abundance increases to a level that we believe may suppress walleye recruitment by predation and food competition, then a contingency to remove the 14-inch minimum length limit on largemouth bass coupled with actively encouraging anglers to selectively harvest and utilize intermediate-size largemouth bass 9 – 12 inches long may jointly serve to keep walleye dominant in the fish community.

General Ecosystem Management:

- Anglers and boaters should carefully follow the laws and guidelines established to control the spread of exotic, infectious, and invasive species.

- Introduction of invasive species should be discouraged by the Pike Lake Chain Lakes Association via their newsletter and appropriate signs at resorts and public access areas. Volunteers are encouraged to continue their diligent participation in the "Clean Boats – Clean Waters" campaign.

- Support for good shoreland management would serve to prevent high nutrient levels from increasing further to a point where nuisance algae blooms become commonplace.

- Educating property owners and enforcing shoreland ordinances should serve to protect and improve the function and quality of shoreland buffers in the future.

- Resource agencies should evaluate the feasibility of reestablishing two-way fish passage at the Round Lake Dam to integrate the lake and riverine communities, assure responsible management of water levels and discharge, and afford return opportunity to escaped and entrained fish.

- New and modified strategies that optimize habitat conditions and predator densities should result in a diverse and stable forage base with enough suitable-size prey to maintain sport fish populations at our benchmarks for size and abundance. Specifically,
    - maintaining healthy native plant communities,
    - replacing the submerged woody material near shore,
    - reconnecting river and lake ecosystems,
    - decreased stocking rate for muskellunge, and
    - encouraging angler harvest of northern pike.

APPENDIX A

Results of Visioning Session for Stakeholders in the Fishery of the Pike Lake Chain in Price County, Wisconsin

Date: July 21, 2012
Time: 9:00 a.m. to 1:00 p.m.
Place: Pike Lake Fire Station
Facilitator: Dave Neuswanger, Fisheries Supervisor, Hayward Field Unit, WDNR
Technical Advisor: Jeff Scheirer, Senior Fisheries Biologist, Price/Rusk/Taylor counties, WDNR
Profile of 23 Participants (more than one affiliation possible per person):

Lakeside Landowners – 21; Area Anglers – 2; No Fishing Guides or Business Owners

Table A1. Levels of sport fishing interest among visioning session participants in Pike Lake Chain fish species nominated for consideration.

Fish Species Nominated	Level of Participant Fishing Interest			
	High	Medium	Low	None
Black Crappie	19	2	0	0
Walleye	17	5	0	0
Muskellunge	10	7	6	0
Bluegill and Sunfish	4	13	4	0
Yellow Perch	2	12	8	0
Northern Pike	4	8	7	3
Smallmouth Bass	0	9	12	2
Largemouth Bass	0	4	8	9
Rock Bass	0	1	12	8

Table A2. Preferences for numbers versus size and catch versus harvest among visioning session participants for fish species perceived to be most important in Pike Lake Chain.

Important Fish Species	Preference for Numbers versus Size			Preference for Catch-and-Release versus Harvest		
	Emphasis on Number over Size	Prefer Balance	Emphasis on Size over Number	Emphasis on Catch and Release	Prefer Balance	Emphasis on Maximum Sustainable Harvest
Black Crappie	0	17	6	0	3	19
Walleye	0	19	4	0	15	8
Muskellunge	0	8	12	15	8	0
Bluegill	0	16	6	1	13	7
Yellow Perch	0	16	6	2	11	9

APPENDIX B

Common and scientific names of species and taxa referenced (listed alphabetically by common name)

Common Name	Scientific Name
Black bass (in Wisconsin: smallmouth bass and largemouth bass)	*Micropterus dolomieui, Micropterus salmoides.*
Black crappie	*Pomoxis nigromaculatus*
Blue catfish	*Ictalurus furcatus*
Bluegill	*Lepomis macrochirus*
Buffalos	*Ictiobus sp.*
Bushy pondweed	*Najas flexilis*
Channel catfish	*Ictalurus punctatus*
Chinese mystery snail	*Cipangopaludina chinensis malleata*
Chironomids (midges)	Family: Chironomidae
Clasping-leaf pondweed	*Potmogeton richardsonii*
Coontail	*Ceratophyllum demersum*
Crayfish	*Cambarus sp., Orconectes sp., and Procambarus sp.*
Curly-leaf pondweed	*Potamogeton crispus*
Dreissenids (freshwater mussels)	Family: Dreissenidae
Elodea	*Elodea canadensis*
Eurasian water milfoil	*Myriophyllum spicatum*
Fern pondweed	*Potamogeton robbinsii*
Flat-stem pondweed	*Potamogeton zosteriformis*
Greater redhorse	*Moxostoma valenciennesi*
Lake sturgeon	*Acipenser fulvescens*
Large-leaf pondweed (also called musky weed or cabbage)	*Potamogeton amplifolius*
Largemouth bass	*Micropterus salmoides*
Leafy pondweed	*Potamogeton foliosus*
Muskellunge	*Esox masquinongy*
Muskgrasses	*Chara sp.*
Naiads	*Najas sp.*
Northern pike	*Esox lucius*
Osprey	*Pandion haliaetus*
Panfish (in Wisconsin: bluegill, pumpkinseed, black crappie, white crappie, yellow perch, green sunfish, warmouth, orangespotted sunfish)	*Lepomis sp., Perca flavescens, and Pomoxis sp.*
Pumpkinseed	*Lepomis gibbosus*
Purple loosestrife	*Lythrum salicaria*
Rainbow trout	*Oncorhynchus mykiss*
Redhorses	*Moxostoma sp.*
Rock bass	*Ambloplites rupestris*

APPENDIX B

Common and scientific names of species and taxa referenced (listed alphabetically by common name)

Common Name	Scientific Name
Rusty crayfish	*Orconectes rusticus*
Smallmouth bass	*Micropterus dolomieu*
Walleye	*Sander vitreus*
White pine	*Pinus strobus*
White sucker	*Catostomus commersonii*
Wild celery (also called eel-grass)	*Vallisneria americana*
Wild rice	*Zizania palustris*
Yellow perch	*Perca flavescens*
Zebra mussel	*Dreissena polymorpha*