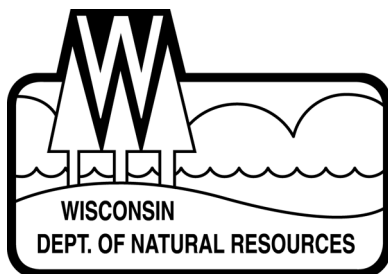


Comprehensive Fisheries Survey of Minocqua Chain, Oneida County Wisconsin during 2009.

Waterbody Identification Codes: Little Tomahawk 1543900, Mud 1544000,
Tomahawk 1542700, Mid 1542600, Minocqua 1542400, Kawaguesaga 1542300.



John Kubisiak
Senior Fisheries Biologist
Rhinelanders
March, 2010



Your purchase of fishing equipment
and motor boat fuel supports boating
access and Sport Fish Restoration.

Comprehensive Fisheries Survey of Minocqua Chain, Oneida County Wisconsin during 2009.

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March, 2010

EXECUTIVE SUMMARY

A comprehensive fisheries survey was conducted the Minocqua Chain during spring and fall, 2009. Largemouth bass (Tomahawk population estimate, PE = 3.5 adults per acre) and smallmouth bass (Tomahawk PE = 3.9 adults per acre), were the dominant gamefish, along with moderate numbers of walleye (combined PE = 1.7 adults per acre), muskellunge and northern pike. All game species showed good size and appeared to be in excellent condition. Panfish species were also abundant, with good size. We found moderate catches of black crappie, bluegill, pumpkinseed, rock bass and yellow perch, along with low numbers of black bullhead, bluegill x pumpkinseed hybrids and yellow bullhead. Non-game species in the catch include bowfin, cisco, golden shiner, grass pickerel and white sucker. I recommend managing Minocqua Chain for walleye, muskellunge, bass and panfish. Walleye are at moderate abundance except in Tomahawk, where walleye recruitment is suppressed by cisco and the fishery is supplemented by stocking. All three lakes have very good numbers of quality- and trophy-size walleye. A low-density muskellunge population with trophy size potential is also present. Bass are abundant with moderate size structure.

Lakes and location:

Minocqua Chain includes Little Tomahawk, Mud, Tomahawk, Mid, Minocqua and Kawaguesaga lakes. Four additional lakes are connected by navigable channels but are not generally named with the Minocqua Chain: A non-flowing constructed channel connects Tomahawk to Katherine Lake; a wetland channel in Kemps Bay connects Tomahawk and unnamed Lake 30-6; a constructed channel connects Minocqua to Jerome Lake; and a wetland channel connects Kawaguesaga with Baker Lake. Minocqua Chain is located in north-central Oneida County, with the village of Lake Tomahawk and City of Minocqua on its shores. The Chain is part of the Upper Wisconsin River watershed, and forms the headwaters of the Tomahawk River. Mud, Little Tomahawk and Mid are considered spring lakes (no inlets and flowing outlets), and the Chain is also fed by the Minocqua Thoroughfare. A dam on Kawaguesaga with 5 feet of head is owned and operated by Wisconsin Valley Improvement Company (WVIC) to help regulate flow in the Tomahawk River. The Minocqua Chain reservoir maximum elevation is 1585.05 ft MSL with a summer minimum of 1584.05 ft (June 1 – September 30) and a winter minimum elevation of 1582.72 ft (October 1 – May 31). The summer target elevation is 1584.55 ft MSL. (Dave Coon, WVIC, personal communication).

Physical/Chemical attributes (Andrews and Threinen 1966 except as noted):

Morphometry: area 5841 acres with maximum depth of 84 feet in Tomahawk (from lake maps; excluding the Tomahawk Thoroughfare).

Watershed: 89 square miles, including 602 acres of adjoining wetlands.

Lake type: drainage (except Little Tomahawk, Mud and Mid are spring lakes).

Basic water chemistry: Soft – weighted average alkalinity 43 mg/l, conductance 100 μ mhos.

Water clarity: Clear water of moderate transparency.

Littoral substrate: weighted average of 57% sand, 19%, gravel, 13% rubble, 10% muck with some boulders present.

Aquatic vegetation: moderate to abundant. Eurasian water milfoil is present.

Winterkill: Mid Lake experiences periodic winterkill.

Boat landings: Little Tomahawk has a roadside carry-in along Bird Lake Road. Tomahawk has paved ramps in Town of Lake Tomahawk on Coffen Lane (fee, parking lot has 21 trailer stalls and 28 additional vehicles) and at Indian Mounds State Forest Campground (State Park fee, 15 trailer stalls and 15 additional vehicles; launch may be shallow due to sand). There is a paved ramp on Tomahawk Thoroughfare at Thoroughfare Road (fee, 6 trailer stalls). Mid Lake has a gravel ramp at the end of Grundy Point Road (room for 2-3 trailers). Minocqua has a paved ramp at Brunswick Road on Stacks Bay (11 trailer stalls and 8 additional vehicles); gravel ramp at Cedar Street (fee, roadside parking); paved ramp at Chicago Street (fee, about 8 trailer stalls at the Minocqua city lot); paved ramp at Park Street (fee, 4 trailer stalls). Kawaguesaga has a paved ramp at Dam Road (5 trailer stalls).

Purpose of Survey: Assess status of game species and develop management recommendations.

Dates of fieldwork: Walleye netting, April 21 to May 1 2009. Muskellunge netting, April 27 to May 15. Electroshocking (entire shoreline): April 27 (Kawaguesaga walleye); April 28 (Minocqua walleye); May 3 (Tomahawk walleye); June 4 and 8 (Tomahawk bass). Cisco gillnetting in Tomahawk, September 10-11.

BACKGROUND

Half-page spring netting records from Tomahawk during April and May of 1948, 53, 54, 56 and 57 appear to be from northern pike removals and spawning operations. A large number of similar records are from the Minocqua Thoroughfare or Tomahawk Thoroughfare during 1947-54 and 56. The records list species, size range and number of fish by date. A spawning record sheet for Minocqua Thoroughfare in 1952 contains a sketch of 2 net locations west of the Hwy 47 bridge, 2 locations around the railroad bridge and 2 locations on islands just east of the bridges. Northern pike were apparently being removed during these operations. The 1947 sheets (one from each thoroughfare) both have headings of "Northern Pike". A single-page memorandum dated April 18, 1956 in the Minocqua file deals with northern pike removal from the Minocqua Thoroughfare. It indicates that "various people in Minocqua" were concerned about northern pike removal, but agreed to allow it for a period of three years as long as pike growth rates were tracked for any changes. Presumably the removal of northern pike was intended to improve growth rates on the remaining fish, but no results are contained in the file.

Mid-June netting on Mid Lake during 1955, 56 and 59 found an average catch rate per net night (average respective length from 1955 and 56 in parentheses) of 1.1 walleye (20.0 and 18.9 inches), 1.3 largemouth bass (9.9 and 7.6 inches), 0.06 smallmouth bass (N/A and 11.8 inches), 1.9 northern pike (15.7 and 17.4 inches), 0.03 muskellunge (one fish, 28.5 inches), 7.5 crappies, 107 bluegill, 31 "sunfish" (likely pumpkinseed), 13 yellow perch, 1.4 rock bass, 5.1 bullheads and 0.53 suckers.

Seining with a 2000 foot shoreline seine was conducted in Minocqua and Tomahawk during 1959. The July 20 Minocqua catch included a 23.1-inch muskellunge and four 3.3-6.2 inch walleye, along with (in decreasing abundance) perch, rock bass, bluegill, "sunfish", and crappie. Electroshocking 1 mile for 6 hours (compared to a current target of 2 miles per hour) on July 27 resulted in observations of 2,800 walleye, 250 largemouth bass, 60 smallmouth bass, 23 northern pike and 6 muskellunge. Also listed were 3,500 yellow perch, 2,100 bluegill, 1,500 rock bass, 1,200 crappies, and abundant suckers and minnows. Tomahawk was seined on July 21, and estimated numbers of fish include 91 walleye, 154 smallmouth, 7 "sunfish", 1,012 bluegill and 1,138 yellow perch.

Tomahawk was stocked with yearling lake trout in 1962 (10,000), 1963 (10,000, 6-9 inches) and 1964 (8,000). Two nights of gill netting during July 14-15, 1964 did not find any lake trout, but

yielded 255 cisco (5.5 to 11.5 inches), 3 perch (3-4 inches) and 2 “muddlers” (likely mottled sculpin, 2.5 inches) (Radonski 1964). Electroshocking for lake trout in May 1965 only resulted in observations of walleye and suckers (Radonski 1965). Two lake trout were captured in a 1967-68 survey (McKnight and Theis 1968, below)

A survey using fyke nets, gill nets, seining and electrofishing was conducted on Tomahawk during May and September of 1967 and April of 1968 (McKnight and Theis 1968). A primary focus of the survey was a walleye assessment and mark-recapture population estimate (although not enough recaptures were obtained to complete the walleye population estimate). The spring walleye catch of 31.2 per net night was a little lower than the walleye catch during four years of spawning operations during mid-1950s of 33.4 to 46.5 per net night. Walleye reproduction was considered adequate and stocking was recommended only during years of spawn taking. “Plant-back” stocking into broodstock lakes was a standard practice at that time. Two lake trout (25 and 27 inches) were captured, but midsummer temperature and oxygen were judged to be marginal for trout. Experimental stocking of splake was recommended and 15,300 yearling splake were subsequently stocked in 1968. Their catch of 237 cisco had modes at 6.75 and 11 inches (2,250 feet of bottom-set gillnet had bar-measure mesh sizes of 0.75 and 1.25 inches).

Although spawning habitat in Tomahawk for muskellunge and northern pike is described as “good,” McKnight and Theis (1968) also suggest that “Periodic support stocking of muskellunge is recommended.” The report indicates that muskellunge and northern pike were spawned during most recent years in the Tomahawk Thoroughfare, and northern pike were removed at the same time, with removal numbers given for 1964-68. The report seems to question the usefulness of removing northern pike, but recommends continuing the program:

“III. Fish Removal

As part of the muskellunge management program, northern pike are being removed from the chain. This is to decrease competition between the species. Whether this program is as effective as intended is difficult to assess. Catch records (see V, “Past Management”) do not reveal the answer. There are considerable amounts of northern pike spawning areas where removal is not carried on. The result, therefore, may merely be the removal of a “harvestable surplus”. Since this removal program coincides with spawn-taking operations, however, continuation is recommended. Intensification of this effort might be considered.” (McKnight and Theis 1968)

A netting and shocking survey of Minocqua in 1973 to assess the walleye population found 24 walleye per net night with a good size distribution. The report indicates that little effort was spent on other species, but mentions large numbers of bluegill and small yellow perch and a good number of muskellunge measuring 18.0 to 47.5 inches (Wendt 1974).

A netting and shocking survey of Tomahawk was conducted in 1978 “with the main purpose of evaluating the present state of the walleye population and determining whether several years of walleye spawn-taking ... had an adverse impact on the walleye population.” (Serns 1979). The May fyke net catch was moderate, with 10.5 walleye, 0.02 largemouth bass, 1.2 northern pike and 0.3 muskellunge per net-night. Walleye fry had been stocked annually since 1971, along with fingerling stockings of 595 in 1973, 21,186 in 1974 and 40,000 in 1976. The report recommends continued fry stocking, along with 10 to 25 fingerlings per acre for a period of 9 years. Muskellunge stocking was also recommended. Serns (1979) commented “Based on the 1967-68 survey, splake were introduced, but they contributed little to the sport-fishery in subsequent years and no additional stocking of this species was done.”

A page of data and map from a May 18, 1983 electroshocking survey of 4.4 shoreline miles on Minocqua found 33.6 walleye, 3.6 largemouth, 1.1 muskellunge, 0.23 northern pike and 0.45 grass pickerel per mile. Notes in the margin indicate “Windy & light rain – poor night for shocking. Looks like a good bunch of black crappie 7-9 inches coming up.”

Several surveys were conducted to assess the walleye population in Tomahawk with the onset of spearing by Chippewa tribal members. A 1986 survey estimated 3.7 adult walleyes per acre, while a survey the following year estimated 1.9 per acre. Walleye net catch was 13.2 in 1986 and 10.0 in 1987. A catch of 97 muskellunge ranging 11.5 to 44.0 inches was reported in 120 fyke net lifts (0.73 per net night) during April 16-23 1986 (Newman 1987). Muskellunge were marked with the same clip as walleye in the 1987 survey (Newman 1988), with a catch of 184 muskellunge ranging from 15.5 to 46.5 inches in 224 fyke net lifts (0.8 per net night); 7 were recaptures of previously-marked fish.

A spring, 1992 survey estimated the adult walleye populations (per acre) of Tomahawk = 2.5, Mid = 0.86, Minocqua = 5.6 and Kawaguesaga = 4.4. The area-weighted average across the four lakes = 3.4 per acre (or 3.5 if Mid Lake is excluded). A walleye survey in 1998 (excluding Mid Lake) found similar populations of Tomahawk = 2.5, Minocqua = 4.6 and Kawaguesaga = 5.2 per acre. The area-weighted average was again 3.4 per acre.

Great Lakes Indian Fish & Wildlife Commission (GLIFWC) estimated the combined Tomahawk and Little Tomahawk walleye populations in 2000, 2002 and 2004 at 1.4, 2.4 and 2.2 per acre, respectively.

A muskellunge survey on Tomahawk during 2005 and 2006 estimated a population of 339 fish 30 inches and larger, or 0.10 per acre (Kubisiak 2007).

Nine-month angler creel surveys were conducted during the open gamefish season, May through early March (excluding the low-effort month of November) of 1987-88, 1992-93, 1998-99 and 2009-10 (reported separately)

Most fall electroshocking surveys target juvenile walleyes, and in some cases other species are not handled. Fall surveys are also used as an index of muskellunge recruitment, but muskellunge catch rates are higher at colder water temperatures and faster boat speed than typical for walleye surveys. Current DNR standards during fall young-of-year (YOY) surveys are to collect juvenile gamefish, including walleye under 15 inches, bass under 14 inches and northern pike and muskellunge under 20 inches. Recent GLIFWC surveys recorded only walleyes. Fall YOY electroshocking surveys were conducted on Little Tomahawk (1991-96 and 2008), Tomahawk (1965, 78, 83, 85 and 86), Mid (1962, 92 and 2003) and Minocqua (1973 and 86). In 1987 and annually from 1990 to present, fall surveys were conducted by either DNR or GLIFWC on Tomahawk, Minocqua (except missed in 1992) and Kawaguesaga. Fall survey trends are discussed further in the walleye and muskellunge results, below.

A baseline survey was conducted on Tomahawk, Mid, Minocqua and Kawaguesaga in 2003, consisting of 35 mini-fyke net-nights targeting small and young-of-year fishes in August and electroshocking in September. All sizes of gamefish were targeted during electroshocking, and all species were picked up on 11, 0.5-mile stations. The catch included 25 species,

dominated by young-of-year bluegill and bluntnose minnow, along with good numbers of young largemouth and smallmouth bass.

METHODS

Eight standard fyke nets (¾-inch mesh, bar measure) were set on Kawaguesaga and ten nets on Minocqua on April 21, 2009. Tomahawk was set with 8 nets on April 25 and another 18 nets on April 26 (daily walleye net numbers on Tomahawk then fluctuated from 25 to 27). These nets targeted walleye. Net numbers were reduced by 2 on Kawaguesaga on April 25 and by two on Minocqua on April 28 and the remaining nets moved to muskellunge locations on April 27 (Kawaguesaga) and April 28 (Minocqua). The Tomahawk nets were reduced to 18 and moved to muskellunge locations on May 1. Two muskellunge nets set in Little Tomahawk for 9 nights are included with the Tomahawk results; two muskellunge nets were set in Mid on May 1. Nets were pulled on May 3 (Kawaguesaga and Mid), May 5 (Minocqua) and May 13-15 (Tomahawk, 6 pulled each day). Effort totaled 249 net nights targeting walleye and 350 net nights targeting muskellunge.

WDNR-standard alternating current electrofishing boats were used to collect gamefish, targeting walleye on April 27 (Kawaguesaga, 2 boats), April 28 (Minocqua, 3 boats) and May 3 (Tomahawk, 5 boats). Tomahawk received additional nights of electrofishing targeting bass on June 4 (2 boats) and June 8 (4 boats). One boat also targeted bass with hook-and-line on June 2 and June 5.

A seven-panel gillnet was set in 78 feet of water on Tomahawk during September 10-11 (about 24 hours), targeting cisco. Each panel was 10 feet wide and reached from surface to bottom. Mesh sizes were 19, 25, 32, 38, 51, 64 and 89 mm, bar measure.

Length or length category (nearest half-inch) was recorded for all gamefish. Adult gamefish were given a half-fin clip (half-clips provide an adequate mark and regenerate better than fully-removed fins) and juveniles were given a top-tail clip for use in mark-recapture population estimates. The clips were right ventral (Kawaguesaga), right pectoral (Minocqua), bottom caudal (Mid), left ventral (Tomahawk) and left pectoral (Little Tomahawk). Age structures (scales or spines) were removed from ten gamefish per species, per half-inch group for the three largest lakes.

RESULTS AND DISCUSSION

Walleye

During walleye netting, 938 walleye were captured on Kawaguesaga, 805 on Minocqua and 1,384 on Tomahawk for a total of 3,127 in 249 net-nights. This includes 487 recaptures and 5 juvenile fish (walleye of unknown sex shorter than 15 inches), at a rate of 13.9 walleye per net night (Table 1). The electrofishing recapture sample yielded 800 walleye (13.2 fish per mile), including 15 juveniles. An additional 307 walleye were handled during muskellunge netting.

The mark-recapture population estimates are 2,274 adult walleye (± 184 SD), or 3.4 per acre on Kawaguesaga; 2,764 (± 463) or 2.0 per acre on Minocqua and 4,321 (± 523) or 1.3 per acre on Tomahawk. For Kawaguesaga and Minocqua, this compares to predicted values of 3.4 and 3.3 per acre for 670 and 1,360-acre lakes supported by natural reproduction. The walleye population in Tomahawk is supported by stocking, and in past surveys the walleye fishery averaged 2.4 per acre, mid-way between the predicted populations in similar-sized stocked lakes (1.2 per acre) and naturally reproducing lakes (3.2 per acre). Taken together, the three lakes averaged 1.7 walleye per

acre in 2009. I consider around one walleye per acre a minimum value for a “fishable” population, where an angler has a reasonable chance of catching a walleye.

Walleye showed excellent size structure, with a 19.7-inch average adult length. Forty percent of adult walleye were 20 inches or larger, while 17% were at least 25 inches (Figure 1). Walleye growth rates were good, with male length-at-age ahead of the regional average through age 8, and about average at older ages. Female length-at age was average or a little behind. Both sexes showed incredible longevity. We captured good numbers of males out to age 15 and females to age 20 (Appendix A).

Despite the presence of good spawning gravel, natural recruitment by walleye in Tomahawk is low due to competition and predation on walleye fry by cisco. This results in low catch of YOY walleye in fall surveys (Figure 2). Hatchery walleye were marked with Oxytetracycline (OTC, an antibiotic that leaves a stain on bones) in 2001, 04, 06 and 08. The OTC-marked fish respectively contributed 80, 100, 93.5 and 67% of the fall YOY catch. However, after a high catch of 70.1 YOY per mile in 2000, fall catch averaged only 2.0 during subsequent stocked years and 0.6 during non-stocked years. Walleye stocking quotas were changed to large fingerlings beginning in 2010, due to the poor recent performance of small fingerlings.

In northern Wisconsin, fall catch of YOY walleye in lakes supported by natural reproduction averages 34 per mile of shoreline. Over the 20 years of fall surveys from 1990 through 2009, Minocqua and Kawaguesaga have not shown the high numbers of YOY walleye typical of many other naturally reproducing lakes (Figure 2). Nevertheless, recruitment produced above-average adult walleye densities on the two lakes with estimates that ranged from 4.4 to 5.6 per acre in 1992 and 1998. Seven consecutive years of low recruitment has had an impact. The current walleye populations in Tomahawk, Minocqua and Kawaguesaga are about half of historic values, although still within the range of normal fluctuation. Tomahawk requires supplemental stocking, but enough recruitment is trickling in to Minocqua and Kawaguesaga to maintain the populations until strong yearclasses return.

Figure 1. Length-frequency of adult walleye during 2009 in Minocqua Chain, Oneida County WI.

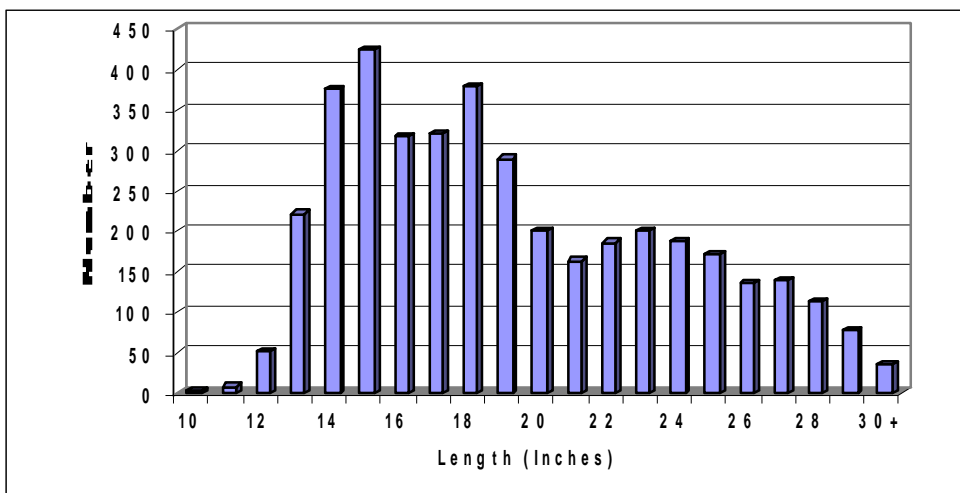
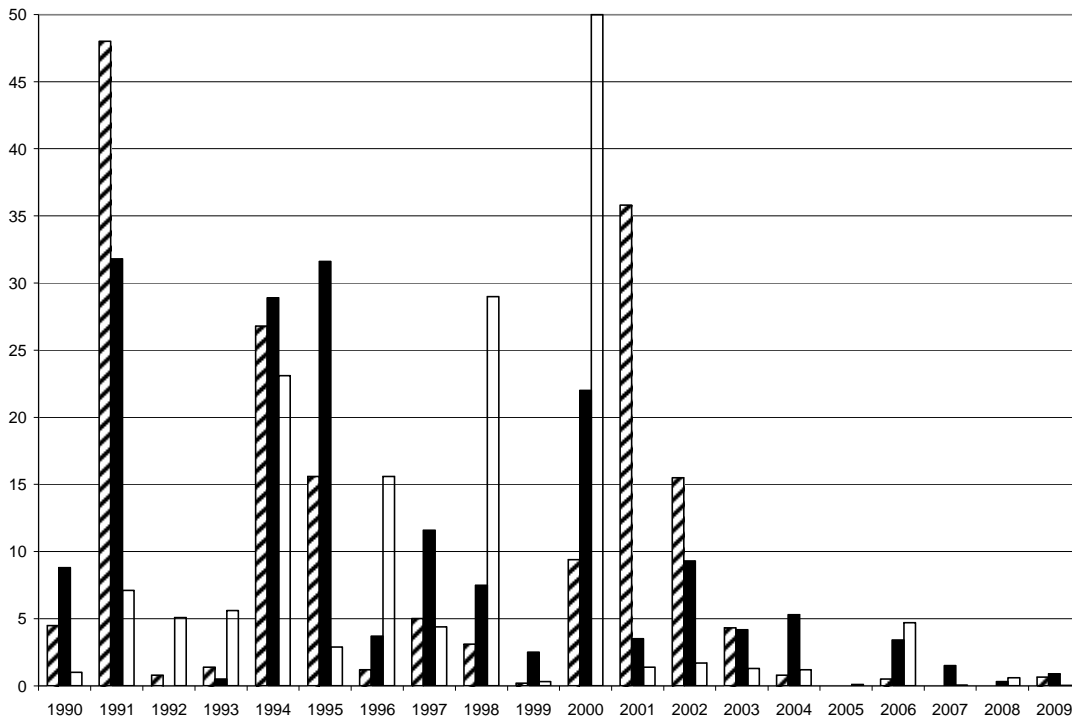


Table 1. Fish catch per unit effort during a 2009 survey of Minocqua Chain, Oneida County WI. Netting catch rates are reported as number of fish per net night, while electrofishing catch rates are number of fish per mile of shoreline. Only gamefish were collected during shocking runs and the bass marking run only covered about half the shoreline.

species	walleye netting	muskellunge netting	walleye recapture shocking	bass marking shocking (Tomahawk)	bass recapture shocking (Tomahawk)
walleye	13.9	0.85	13.2		
largemouth bass	0.39	2.4	4.8	26.5	14.3
muskellunge	0.21	0.15	0.12		
northern pike	0.48	0.22	0.43		
smallmouth bass	0.40	0.91	1.7	31.0	10.8
black bullhead	0	0.0086			
black crappie	4.9	3.4			
bluegill	2.3	32.6			
hybrid bluegill x pumpkinseed	0.0040	0.47			
bowfin	0.22	0.66			
cisco	0.016	0.0057			
golden shiner	0	0.0086			
grass pickerel	0.040	0.21			
pumpkinseed	0.73	6.4			
rock bass	2.7	8.9			
white sucker	0.44	0.28			
yellow bullhead	0.50	2.0			
yellow perch	45.5	10.8			

Figure 2. Young-of-year walleye catch in Kawaguesaga (striped), Minocqua (solid) and Tomahawk (clear bars) during 1990 through 2009. Minocqua was not surveyed in 1992; the Tomahawk catch of 70.1 per mile in 2000 was truncated for scale.



Largemouth and Smallmouth Bass

The bass catch included 2,058 largemouth and 1,360 smallmouth bass during spring sampling, including recaptures of 112 largemouth and 40 smallmouth that were previously-marked, and 70 juvenile largemouth and 191 juvenile smallmouth smaller than 8 inches in length. Bass were not marked for a population estimate during shocking runs on Minocqua and Kawaguesaga. Mark-recapture population estimates were calculated for Tomahawk at 11,891 adult largemouth bass ($\pm 1,849$ SD), or 3.5 per acre and 13,082 adult smallmouth ($\pm 3,281$ SD) or 3.9 per acre.

Both species of bass had good numbers of fish up to 16 or 17 inches, with low numbers of larger fish (Figures 3 and 4). The longest largemouth bass were 19.9 inches from Mid and 19.8 inches from Kawaguesaga. Twenty-one percent of largemouth were 14 inches and larger. The longest smallmouth was 19.7 inches from Tomahawk and 12% were 14 inches or larger. Length-at-age of largemouth was at or slightly above the regional average, while smallmouth length-at-age was slightly below average (Appendix A).

Northern Pike

We captured 211 northern pike (including 11 recaptures of previously-marked fish and 1 immature fish less than 12 inches in length). Average size of northern pike was 23.5 inches and 30% of adult pike were 26 inches or larger while 9.9% were at least 30 inches (Figure 4). The largest northern pike was a 37.7-inch female from Kawaguesaga. Abundant northern pike have been shown to inhibit muskellunge recruitment, but the netting catch rates below 0.5 per net-night suggest a low-density population.

Figure 3. Length-frequency of largemouth bass during 2009 in Minocqua Chain, Oneida County WI.

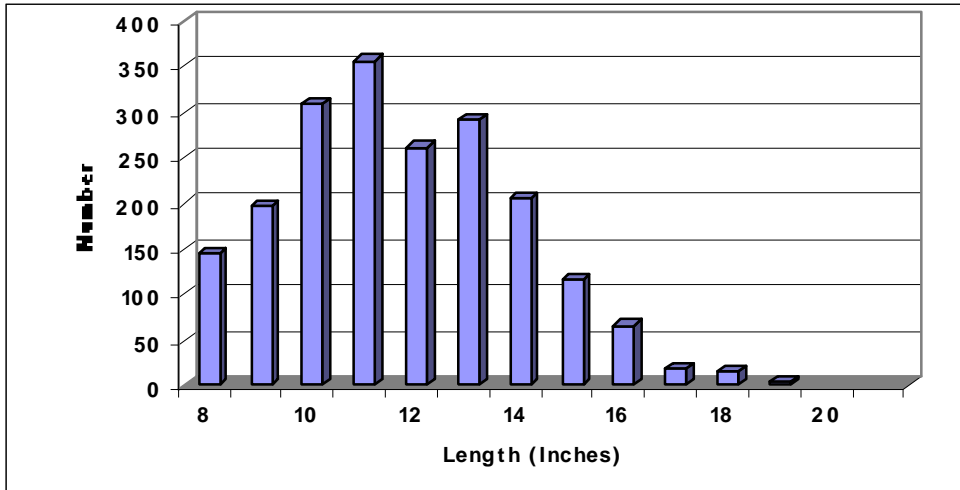


Figure 4. Length-frequency of smallmouth bass during 2009 in Minocqua Chain, Oneida County WI.

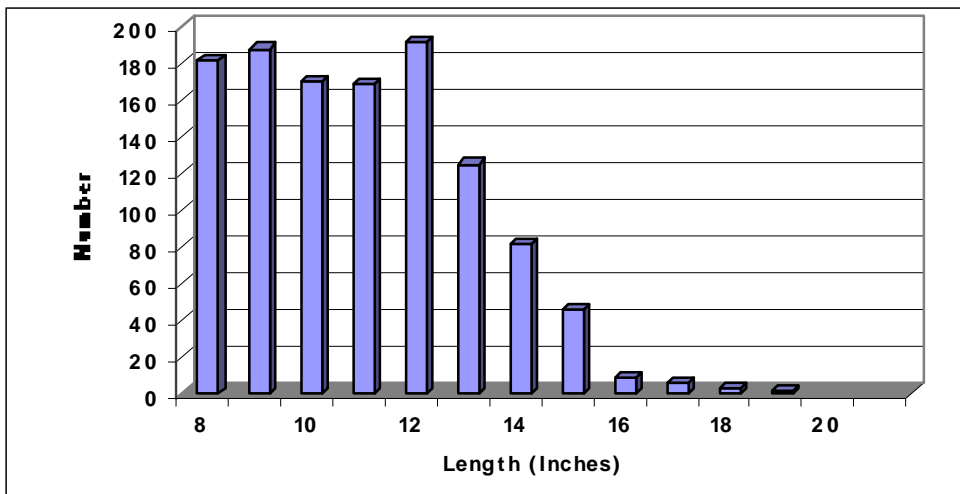
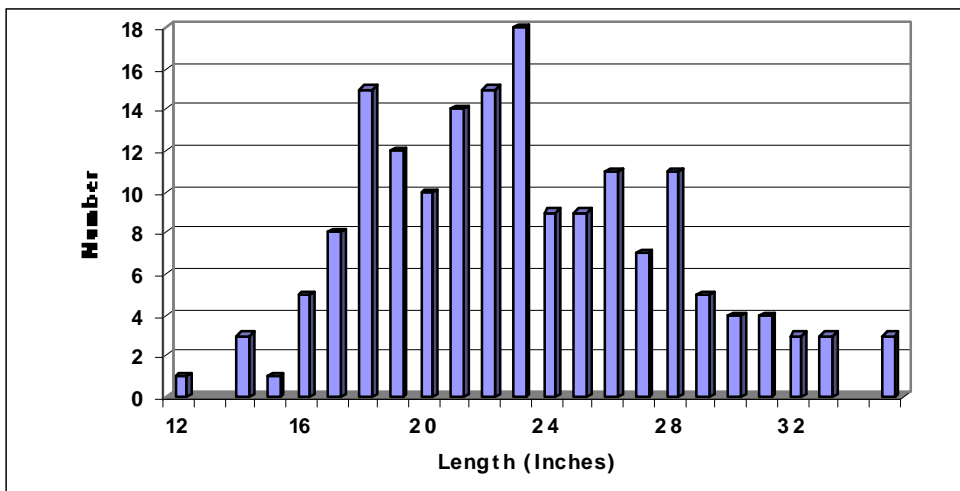


Figure 5. Length-frequency of adult northern pike during 2009 in Minocqua Chain, Oneida County WI.



Muskellunge

One hundred and six muskellunge were captured during the survey, including three recaptures of previously-marked fish and one juvenile smaller than 30 inches in length. Muskellunge ranged from 23.0 to 50.5 inches in length, with 57% at least 40 inches in length and 15% at least 45 inches (Figure 5). The largest fish was a 50.5 inch, 35.1 pound female from Tomahawk, aged at 18 from a scale. Scale ages tend to underestimate the age of older muskellunge, but accurate age structures like otoliths and cleithral bones require the fish to be sacrificed (Crossman and Casselman 2000). One 40.5-inch male muskellunge that died in the net was aged at 19 from a cleithrum.

Large fingerling muskellunge were stocked in Minocqua Chain as recently as 2001 (Table 2). The contribution of natural reproduction is difficult to assign prior to 2001 because of consecutive years of muskellunge stocking. Thus, the contribution of stocked fish to relatively strong yearclasses (based on catch in fall surveys) in 1989, 90 and 91 is unknown. No muskellunge were stocked during another strong yearclass in 1993. In 2009, any fish less than age 8 can be assumed to have recruited from natural reproduction. However, only 9 of 30 male, 4 of 62 female and 2 of 3 unknown-gender muskellunge were assigned age 8 or younger (Appendix A), suggesting low recruitment from natural reproduction. In addition, length-frequency modes at 38 and 41 inches (Figure 6) correspond to modes at 33 and 35 inches in 2005-06 (Kubisiak 2007), suggesting that the existing fish are growing longer over time but few young fish are coming in. The recapture portion of the muskellunge population estimate scheduled for spring, 2010 will give one more opportunity to look at muskellunge size structure and recruitment dynamics. If the 2010 results confirm that recruitment is lagging, then muskellunge stocking should be resumed.

Trophy muskellunge potential is discussed by Kubisiak (2007). Some additional large fish were documented during 2009. On July 1, 2009 I received a photograph of a large muskellunge reported to be 51-52 inches in length, recently caught and kept from Minocqua Chain; LAX Taxidermy plans to save a cleithrum. The Tomahawk creel clerk saw photographs of a 50+ inch muskellunge caught and released on August 14, and he measured a 49.1-inch muskellunge with 21.5-inch girth, caught and released on August 25. On September 8, the same clerk helped an angler release a 44-inch fish, he found a dead 43-inch muskellunge that appeared to have been badly hooked on Tomahawk and a partly decomposed mid-30's fish on Little Tomahawk.

Figure 6. Length-frequency of adult muskellunge during 2009 in Minocqua Chain, Oneida County WI.

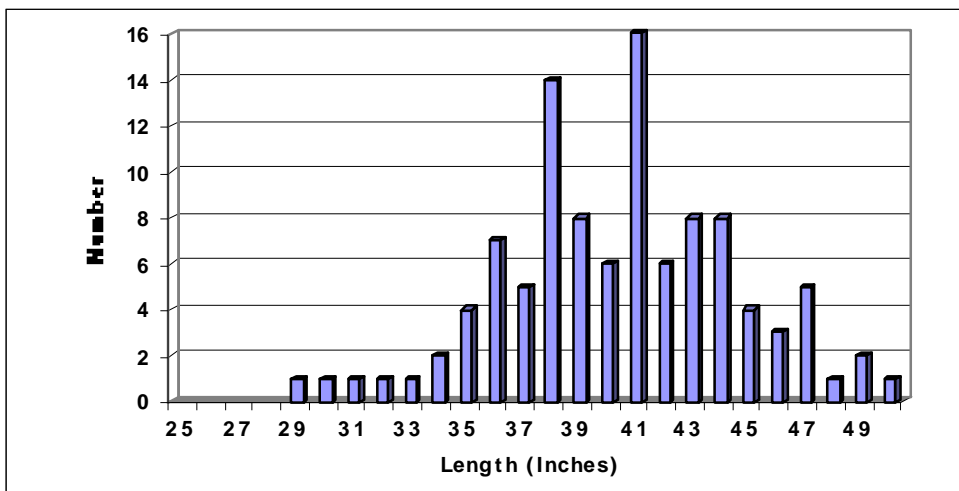


Table 2. Fish stocking record during 1995 through 2009 in Minocqua Chain, Oneida County WI.

Year	Lake	Species	Size	Number	Comments
1995	Tomahawk	walleye	fry	2,500,000	
1995	Tomahawk	muskellunge	fry	225,000	
1995	Tomahawk	walleye	small fingerling	85,902	
1996	Tomahawk	walleye	fry	1,000,000	
1996	Tomahawk	muskellunge	fry	82,400	
1996	Tomahawk	walleye	small fingerling (1.5 inch)	100,000	
1996	Minocqua	walleye	fry (0.3 inch)	500,000	
1996	Kawaguesaga	muskellunge	large fingerling (10 inch)	670	
1997	Tomahawk	walleye	fry	3,000,000	
1997	Tomahawk	muskellunge	fry	334,000	
1997	Tomahawk	muskellunge	large fingerling	1,500	
1997	Mid	muskellunge	fry	25,000	
1997	Minocqua	walleye	fry	2,000,000	
1997	Minocqua	muskellunge	large fingerling	680	
1997	Kawaguesaga	muskellunge	fry	100,000	
1998	Tomahawk	walleye	fry	5,300,000	
1998	Tomahawk	muskellunge	fry	56,750	
1998	Tomahawk	walleye	small fingerling (1.3 inch)	339,206	
1998	Minocqua	muskellunge	fry	79,900	Thoroughfare
1998	Kawaguesaga	muskellunge	large fingerling (12 inch)	670	
1999	Tomahawk	walleye	fry	4,700,000	
1999	Tomahawk	muskellunge	large fingerling (12.1 inch)	1,000	
1999	Minocqua	muskellunge	fry	121,500	Thoroughfare
1999	Minocqua	muskellunge	large fingerling	680	
2000	Tomahawk	walleye	fry (0.3 inch)	6,500,000	
2000	Tomahawk	muskellunge	fry (0.5 inch)	42,100	
2000	Tomahawk	walleye	small fgl. (1.7 & 2.3 inch)	311,889	
2000	Tomahawk	walleye	fingerling (4-6 inch)	1,500	private funds
2000	Minocqua	walleye	fry (0.5 inch)	3,000,000	
2000	Minocqua	muskellunge	fry (0.3 inch)	85,050	
2000	Kawaguesaga	muskellunge	large fingerling (10.9 inch)	670	
2001	Tomahawk	walleye	small fingerling (1.3 inch)	330,000	marked with Oxytetracycline
2001	Tomahawk	walleye	large fingerling (8 inch)	800	private funds
2001	Tomahawk	muskellunge	large fingerling (12.0 inch)	850	
2001	Minocqua	muskellunge	large fingerling (12 inch)	700	private funds
2004	Tomahawk	walleye	small fingerling (1.3 inch)	169,676	marked with Oxytetracycline
2006	Tomahawk	walleye	small fingerling (1.7 inch)	118,700	marked with Oxytetracycline
2007	Tomahawk	walleye	fry (0.3 inch)	1,660,000	
2008	Tomahawk	walleye	small fingerling (1.6 inch)	118,404	marked with Oxytetracycline

Cisco

The gillnet captured 370 cisco, 1 smallmouth bass, 1 black crappie and 1 bluegill. Forty-four percent of the cisco were 3.3 to 4.0 inches in length and were captured in the 19 mm mesh. Modes in length that likely correspond to yearclasses were also present at 6.75 and 9.75 inches (Figure 7). The largest cisco was 13.8 inches. Cisco inhibit walleye recruitment by preying on or competing with the fry, but they are also an important forage fish for large walleye and muskellunge. The

heaviest catch of cisco was 30 to 40 feet below the surface, near the thermocline. However, some cisco were scattered through the upper water column and a few cisco that may have been chasing minnows were captured within a foot of the surface. We noted schools of small minnows holding near the net at the surface, and minnows were regurgitated by several cisco.

Figure 7. Length-frequency of cisco during September 10-11, 2009 gillnetting in Tomahawk Lake, Oneida County WI.

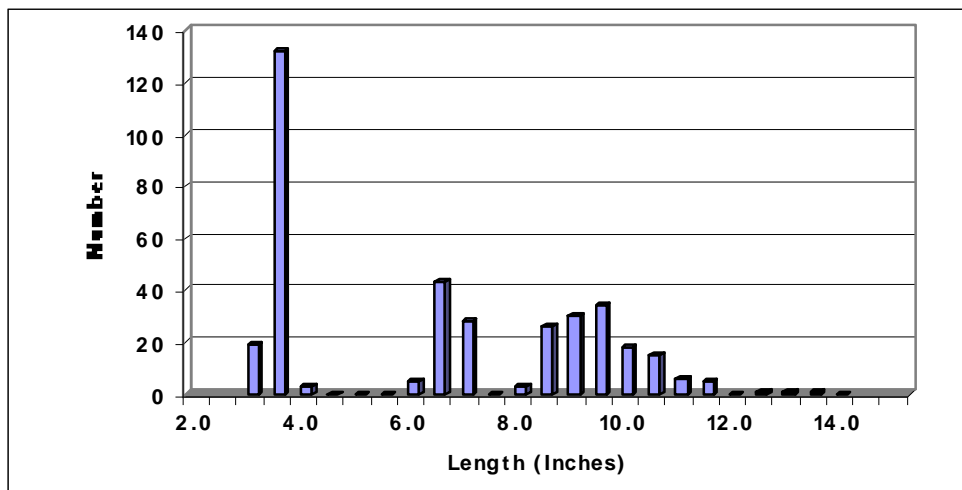


Table 3. Temperature and dissolved oxygen profile of Tomahawk Lake, Oneida County WI on September 10, 2009.

Depth below surface (feet)	Dissolved Oxygen (mg/l)	Temperature (°C)	Temperature (°F)
0 (Surface)	8.2	22.2	72.0
5	8.3	21.8	71.2
10	8.3	21.5	70.7
15	8.7	20.3	68.5
20	8.5	19.5	67.1
25	8.0	19.1	66.4
30	7.3	18.7	65.7
35	5.9	18.0	64.4
40	1.6	13.9	57.0
45	1.3	12.3	54.1
50	1.1	11.3	52.3
55	1.0	10.9	51.6
60	0.8	10.6	51.1
65	0.8	10.3	50.5
70	0.7	10.0	50.0
75	0.5	9.7	49.5
78 (bottom)			

Panfish

Minocqua Chain has many well-vegetated bays and shorelines and supports good populations of panfish. This survey did not target panfish, but we found a high catch of yellow perch during walleye netting, good bluegill numbers during muskellunge netting and moderate numbers of rock bass and black crappie (Table 1).

MANAGEMENT RECOMMENDATIONS

Minocqua Chain supports a diverse fishery. Smallmouth and largemouth bass were the dominant gamefish. Abundance of walleye was moderate and muskellunge was low, but both species showed excellent numbers of quality- and trophy-size fish. Northern pike were also low density. Yellow perch and bluegill dominated the panfish catch, while rock bass and black crappie were moderate in abundance. Low numbers of black bullhead, bluegill x pumpkinseed hybrids, pumpkinseed and yellow bullhead were also present. Forage and non-game species include bowfin, cisco, golden shiner, grass pickerel and white sucker. Minocqua Chain is best managed for walleye, muskellunge, bass and panfish. Supplemental stocking of walleye is recommended on Tomahawk, where cisco inhibit natural reproduction. Muskellunge stocking may also be necessary, pending results of the recapture portion of a muskellunge population estimate in spring, 2010.

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APPENDIX A FISH AGE RESULTS

The aged subsamples were applied against the full length-frequency to eliminate bias from a non-random subsample of age structures.

Table A.1. Male walleye length at age in Minocqua Chain, Oneida County Wisconsin during 2009.

Age	Number of fish	avg. length	Northern WI avg.
2	6	12.4	11.3
3	40	13.7	11.9
4	17	14.6	13.3
5	32	15.1	14.2
6	23	16.0	15.6
7	31	17.0	16.6
8	21	18.3	17.6
9	14	18.3	18.7
10	12	19.2	19.2
11	11	19.6	19.4
12	9	19.7	20.0
13	5	20.1	
14	9	21.2	
15	2	21.3	

Table A.2. Female walleye length at age in Minocqua Chain, Oneida County Wisconsin during 2009.

Age	Number of fish	avg. length	Northern WI avg.
3	1	12.8	13.3
4	9	15.4	15.0
5	26	16.4	16.2
6	24	17.7	17.8
7	30	18.9	19.6
8	36	19.8	21.0
9	21	20.8	22.5
10	27	22.1	23.5
11	37	23.3	24.7
12	25	23.6	25.4
13	24	24.5	26.5
14	37	25.4	27.4
15	30	27.3	27.7
16	20	27.8	
17	11	28.0	
18	12	28.6	
19	7	29.1	
20	5	29.6	

Table A.3. Largemouth bass length at age in Minocqua Chain, Oneida County Wisconsin during 2009.

Age	Number of fish	avg. length	Northern WI avg.
2	11	6.1	6.6
3	40	9.3	8.9
4	57	11.2	10.5
5	40	12.7	12.1
6	48	13.7	13.6
7	51	15.0	14.9
8	21	15.7	15.8
9	8	17.0	16.2
10	11	17.6	17.1
11	6	18.7	17.8
13	1	19.8	18.3

Table A.4. Smallmouth bass length at age in Minocqua Chain, Oneida County Wisconsin during 2009.

Age	Number of fish	avg. length	Northern WI avg.
2	4	7.4	6.9
3	25	9.1	9.3
4	32	11.1	11.8
5	39	13.0	13.5
6	14	14.2	15.2
7	11	15.4	16.1
8	4	15.5	17.1
9	1	18.3	17.7
10	1	18.7	18.3

Table A.5. Male muskellunge length at age in Minocqua Chain, Oneida County Wisconsin during 2009.

Age	Number of fish	avg. length	Northern WI avg.
4	2	30.3	27.3
5	1	30.2	29.2
6			31.5
7	3	34.7	33.3
8	3	35.5	34.4
9	2	36.1	35.8
10	5	37.0	37.3
11	7	38.4	37.9
12	4	38.3	39.0
13			38.9
14	1	37.2	43.5
15	1	41.0	39.0
19	1	40.5	

Table A.6. Female muskellunge length at age in Minocqua Chain, Oneida County Wisconsin during 2009.

Age	Number of fish	avg. length	Northern WI avg.
5	1	32.6	31.9
6			33.7
7	1	36.5	35.8
8	2	38.3	38.1
9	8	40.5	39.5
10	14	41.0	41.0
11	11	42.5	43.2
12	6	42.2	43.7
13	7	44.0	44.3
14	6	46.7	
15	1	47.0	
16	2	47.4	
17	1	47.4	
18	1	50.5	
19			
20	1	49.3	