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Performance of Leech Lake, Minnesota, Muskellunge in a Wisconsin Lake

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Abstract

Three stockings (1984, 1987, 1990) of 11- to 14-inch fingerling muskellunge originating from the Leech Lake, Minnesota population were made into Nancy Lake, Washburn County to assess survival, growth, and natural reproduction. Short-term survival was low ($\leq$ 20%) for two of the stockings. No survival estimate was made on the third stocking because of late stocking date (October 25). Growth rate of muskellunge in Nancy Lake was above average compared to Wisconsin growth rates. However, muskellunge in Nancy Lake tended to have a leaner body shape, as reflected by lower relative weight (W_r) indices, when compared to muskellunge populations in Wisconsin. Natural reproduction of muskellunge in Nancy Lake occurred in four of six years, though fall young-of-the-year densities were lower than average for self-sustaining muskellunge populations. Muskellunge performance in Nancy Lake was difficult to assess because no muskellunge were present prior to this introduction. Hence, there was no evidence to suggest that Leech Lake muskellunge would perform better than Wisconsin muskellunge in Wisconsin waters. Stockings such as this need to be carefully evaluated because of potential genetic risks posed by stock transfers among drainages.

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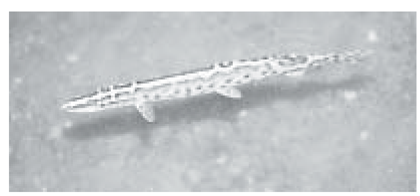

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Introduction

Declining levels of muskellunge (*Esox masquinongy)* reproduction are a concern in many midwestern waters (Dombeck et al. 1986). In Wisconsin, only an estimated 18% of muskellunge populations are considered self-sustaining (Wisconsin Department of Natural Resources 1996). Factors associated with declining reproduction include the invasion of muskellunge waters by northern pike *(Esox lucius)* (Oehmcke et al. 1974, Inskip and Magnuson 1983, Dombeck et al. 1986), and reproductive failures due to loss or modification of habitat (Dombeck et al. 1984).

In some waters, sympatric populations of muskellunge and northern pike occur. Dombeck et al. (1986) found little evidence of negative interactions between northern pike and muskellunge in the Upper Mississippi River basin. In Leech Lake, Minnesota (within the Upper Mississippi River basin) spatial separation occurs between the two species during spawning and their early life history (Strand 1986). Strand (1986) found muskellunge in Leech Lake to spawn offshore in water depths of 3-6 feet over dense beds of *Chara* spp. This type of habitat is not anoxic at the bottom-water interface. Typically, muskellunge spawn in shallow bays over a muck bottom covered with dead vegetation and other detritus at water depths less than 3 feet (Becker 1983). This habitat can limit egg survival because of dissolved oxygen depletion at the bottom-water interface (Dombeck et al. 1984).

An important tool for muskellunge management in Wisconsin includes stocking of cultured fish to supplement insufficient natural reproduction (Margenau 1996). Historically, hatcheries have selected brood sources for culture based on logistics and hatchery performance (i.e., progeny growth and survival), and more recently, survival and contribution to the fishery after release (Piper et al. 1982). However, such a selection process may not be best suited for the differing environmental conditions where cultured fish are stocked. Krueger et al. (1981) suggested that populations with environmental similarities may possess preadapted genotypes making them more desirable as brood sources. Hence, the reproductive traits of Leech Lake muskellunge may allow them to successfully co-exist with northern pike populations or survive where degraded shallow water substrate habitats occur. The objective of this study was to evaluate the survival, growth, and reproduction of muskellunge progeny from Leech Lake, Minnesota in a Wisconsin lake with a northern pike population. This information will be used to assess the management potential of stocking Leech Lake muskellunge in Wisconsin.

Methods

Leech Lake is a large (111,526-acre) impoundment in north-central Minnesota on the upper Mississippi River. Leech Lake has self-sustaining populations of muskellunge and northern pike. Nancy Lake, Washburn County, is a 772-acre soft water drainage lake with diverse habitat, such as rocky shoreline and shoal areas along with shallow bays (Figure 1). An intermittent outlet from Nancy Lake drains into the St. Croix River via the Totagatic River. Nancy Lake has a self-sustaining population of northern pike. No muskellunge were present in Nancy Lake prior to initiation of this study.

Muskellunge fingerlings were scheduled for stocking into Nancy Lake for three consecutive years beginning in 1984. However, because of difficulties with obtaining viable eggs from Leech Lake, the stocking schedule was modified. Fall fingerlings from Leech Lake were stocked in 1984. In 1987, stocked fingerlings were progeny of eggs collected from Wolf Lake. Wolf Lake was established (1982 and 1984 stockings) as a brood stock source of Leech Lake muskellunge by the Minnesota DNR to help facilitate egg collection. In addition, a small number of fingerlings (N=85) were stocked in 1987 from eggs collected from Leech Lake and reared at the Spooner Hatchery. In 1990, DNR research crews collected eggs from muskellunge in Nancy Lake from the original 1984 stocking. Muskellunge were stocked at 1.5-3.0 fingerlings/surface acre (Table 1). All stocked muskellunge were given a fin-clip prior to stocking.

Short-term survival of stocked fingerling muskellunge was determined by mark-recapture population estimates conducted 30-60 days following stocking (Darroch's maximum-likelihood estimator, Everhart and Youngs 1981). No survival estimate was made on the 1990 stocking because fish were held in ponds later than in previous years to increase fingerling size before stocking and hopefully improve survival (Table 1).

Beginning in 1989, adult muskellunge were sampled during spring with fyke nets. Initially, nets were set in numerous locations near different habitats. However, later netting concentrated on locations with the highest catch rates. All fish captured were inspected for a fin-clip to determine

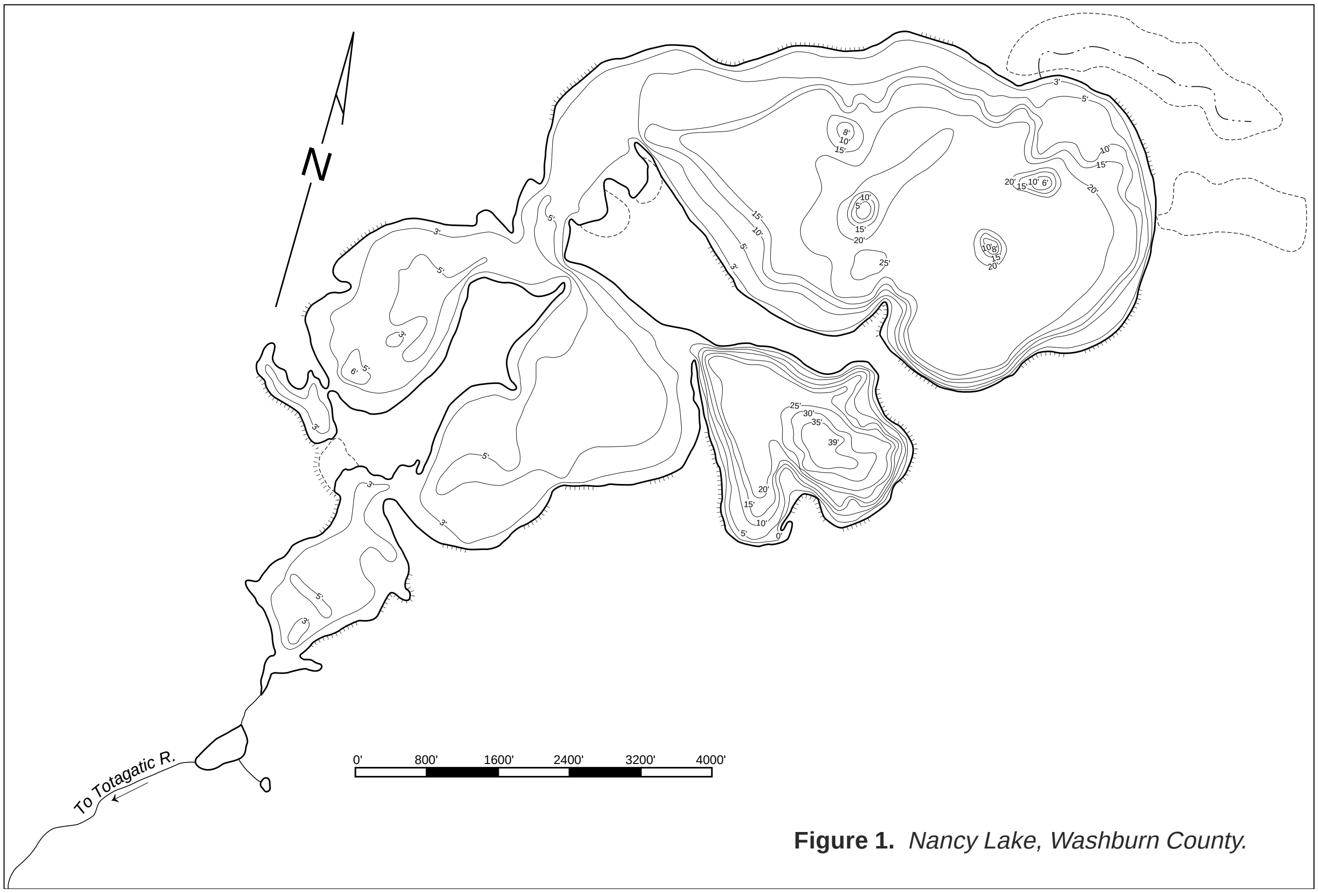

Figure 1. *Nancy Lake, Washburn County.*

Muskellunge natural reproduction occurred in four of six years sampled (1989-1994) in Nancy Lake; however, catch rates of young-of-the-year were lower than average for self-sustaining muskellunge populations in Wisconsin.

year class, sexed by the presence of gametes or by visual characteristics of the urogenital pore (Lebeau and Pageau 1989), measured, weighed, and released. No attempts were made to determine spawning locations selected by muskellunge.

Growth rates were determined using empirical length and weight-at-age data from the three stocked year classes captured during fyke net sampling. Linear growth and weight at age were compared to a growth standard developed by Casselman and Crossman (1986). This index compares growth rates in a given lake to an established length and weight standard. Growth indices are reported as a percent compared to the growth standard. We also used relative weight (W_r) as an indicator of condition of muskellunge (Neumann and Willis 1994).

Monitoring of muskellunge natural reproduction was initiated in 1989, when muskellunge from the first stocking were 5 years old. Annually, from 1989 through 1994, an AC electrofishing boat was used to sample shoreline areas. Sampling was conducted in fall when water temperatures neared 50° F, which was generally mid- to late October. Young-of-the-year (YOY) catch was quantified by catch per hour and mile of electroshocking.

Results and Discussion

Short-term Survival

Short-term survival of stocked fingerling muskellunge in Nancy Lake was low. Only an estimated 20.0% of 1,187 11.7-inch fingerlings stocked in 1984 were surviving 44 days following stocking (Table 2). Survival of the 1987 stocking was less; 10.8% of 1,581 11.4-inch fingerlings were surviving 41 days after stocking (Table 2). The third stocking of 13.9-inch fingerlings was late in the year (October 25, 1990), hence no survival estimate was possible before ice formation.

Short-term survival rates were within the range previously reported for large fingerling stockings in Wisconsin, but were below the average survival rates of 38.7% and 37.7% reported by Hanson et al. (1986) and Margenau (1992). Primary factors associated with low post-stocking survival of esocids have been stress (Miles et al. 1974, Mather et al. 1986, Mather and Wahl 1989) and predation (Stein et al. 1981, Carline et al. 1986, Wahl and Stein 1989, Margenau 1992). The fingerlings from the first

Table 1. *Muskellunge fingerlings stocked into Nancy Lake, Washburn County. Standard deviation for length and weight are in parentheses.*

Stocking Date	Number Stocked	Fin-clip[a]	Stocking Rate (No./ac)	Mean Length (in)	Mean Weight (g)
9/20/84[b]	1,187	RV	1.5	11.7 (0.72)	116 (25.2)
9/11/87[c]	1,581	LV	2.0	11.4 (0.91)	115 (33.0)
10/25/90[d]	2,294	RV	3.0	13.9 (0.72)	232 (39.2)

[a] RV=Right Ventral (Pelvic), LV=Left Ventral (Pelvic).
[b] Egg source Leech Lake, Minnesota.
[c] Egg source Wolf Lake, Minnesota (Leech Lake brood lake). Number stocked includes 85 fingerlings reared at the Spooner Hatchery from eggs collected from Leech Lake.
[d] Egg source Nancy Lake.

Table 2. *Short-term survival of muskellunge fingerlings in Nancy Lake, Washburn County.*

Stocking Date	Number Stocked	Days at Large	Population Estimate	95 % C.I.	Observed Survival (%)
9/20/84	1,187	44	238	203-272	20.0
9/11/87	1,581	41	170	143-197	10.8
10/25/90	2,294	NO ESTIMATE MADE			

two stockings into Nancy Lake were reared in Minnesota and transported to the Spooner Hatchery (1984) or Nancy Lake directly (1987) for stocking, hence experienced a longer transport than is typical in Wisconsin. However, Miles et al. (1974) found that the initial harvesting of muskellunge from ponds created the greatest amount of physiological stress and these symptoms persisted for several days. Additional transport times may not have had an extreme effect on survival. It is more likely that the low survival resulted from predation. Hanson and Margenau (1992) found northern pike and great blue heron (*Ardea herodias)* common in habitats occupied by stocked muskellunge in Nancy Lake. Such habitat overlap with common predators may have resulted in below-average short-term survival.

Growth

Linear growth of Nancy Lake muskellunge was faster than average growth rates reported for Wisconsin muskellunge (Wisconsin Department of Natural Resources 1985, Figure 2). Growth in Nancy Lake was also faster initially than muskellunge in Leech Lake (Younk, unpublished data), but lengths were similar by age 10 (Figure 2). Nancy Lake muskellunge exceeded the growth standard for length, averaging 104%. Younk and Strand (1992) also found that Mississippi River (Leech Lake) muskellunge stocked into several Minnesota waters exceeded the growth standard, with indices of 106% and 106.3%.

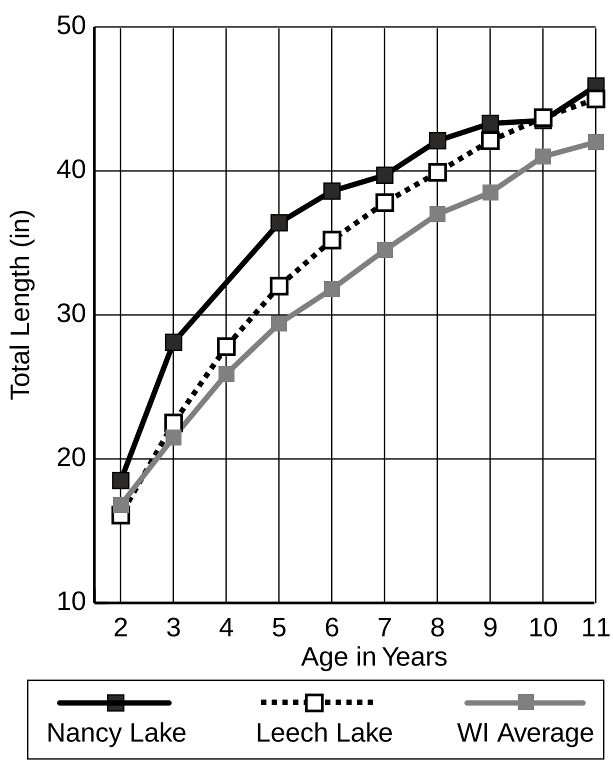

Figure 2. *Growth of Nancy Lake muskellunge (all years combined N = 106) compared to average Wisconsin muskellunge growth rates (Wisconsin Department of Natural Resources 1985) and Leech Lake, Minnesota muskellunge (Younk, unpublished data).*

Growth differences between Nancy Lake muskellunge and Wisconsin muskellunge were likely underestimated. The growth rates reported for Wisconsin muskellunge were largely derived from interpretation of scales. Scale interpretation is suspect for accurate age determination of muskellunge due to resorption or erosion on the scale edge (Casselman 1990). Johnson (1971) and Casselman (1983) felt accurate age determinations using scales were unlikely for fish over age 10. Fitzgerald et al. (1997) found interpreters assessed correct age on < 50% of known-age muskellunge ages 3-10, and were most likely to underage fish. Hence, growth for Wisconsin muskellunge is likely slower than reported here.

Muskellunge from Leech Lake reportedly have a less robust body shape (leaner) than muskellunge from other populations (Younk and Strand 1992). When compared to the growth standard for weight, Nancy Lake muskellunge exceeded the standard at 110.6%. However, W_r, an index of condition, for muskellunge 42-50 inches in Nancy Lake was 86 (N = 16). Mean W_r for similar size groups of muskellunge from eight Wisconsin lakes reported by Neumann and Willis (1994) was 102 (range 89-122). These results suggest Nancy Lake muskellunge attained greater lengths at age than Wisconsin muskellunge and this greater length was reflected in heavier fish at a given age. However, W_r values compare fish of similar length and do not take age into account. Hence, when compared to other Wisconsin muskellunge populations, Nancy Lake muskellunge of similar length weighed less.

Hanson (1986) found a positive relationship between adult catostomid density and muskellunge growth. Observations of the adult white sucker (*Catostomus commersoni)* population in Nancy Lake during spring fyke netting suggested density was high. Abundance of a preferred food item may have been responsible for the fast growth of muskellunge in Nancy Lake.

Muskellunge in Nancy Lake experienced good growth rates but had a more slender body shape compared to other Wisconsin populations.

Natural Reproduction

Leech Lake muskellunge reproduced in Nancy Lake. Young-of-the-year muskellunge were collected in four of the six years sampled (Table 3). Muskellunge fingerlings were typically found in areas of bulrushes (*Scirpus* spp.) or deadfalls. This was similar to habitats of stocked fingerlings from Wisconsin (Hanson and Margenau 1992). Mean catch per effort from 1989 through 1994 was 0.38 YOY/hour and 0.17 YOY/mile. These catch rates were less than mean rates of 1.47 YOY/hour and 0.72 YOY/mile reported from ten self-sustaining muskellunge populations in Wisconsin (Margenau and AveLallement 1993). However, the catch rates reported by Margenau and AveLallement were variable and ranged from 0-5.99 YOY/hour and 0-3.33 YOY/mile.

Table 3. *Relative abundance of naturally reproduced fall young-of-the-year muskellunge in Nancy Lake, Washburn County.*

		Mean		Electroshocking		Catch Per Effort	
Year	Catch	Length (in)	SD length	Hours	Distance (miles)	YOY/hr	YOY/mile
1989	0	-	-	5.0	13.2	0.00	0.00
1990	2	10.3	1.20	7.8	15.2	0.26	0.13
1991	0	-	-	5.2	9.5	0.00	0.00
1992	2	9.4	0.49	6.4	13.0	0.31	0.15
1993	4	9.9	0.45	3.0	7.2	1.33	0.56
1994	1	10.4	-	2.5	5.0	0.40	0.20

Summary and Implications for Management

The purpose of stocking muskellunge from Leech Lake into a Wisconsin lake was to determine if Leech Lake muskellunge could survive and successfully reproduce in a lake inhabited by northern pike. The secondary objective was to evaluate growth rates of Leech Lake muskellunge in Nancy Lake. Results from this study suggest that stocked Leech Lake fingerlings had below-average survival. Surviving muskellunge fingerlings exhibited above-average linear growth in Nancy Lake. However, body condition, reflected by W_r, was lower than several Wisconsin muskellunge populations for fish of lengths considered trophies (> 40 inches) by sport anglers (Margenau et al. 1994). Nancy Lake muskellunge reproduced in four of six years when sampling was conducted. Relative density of YOY muskellunge in fall was below average for self-sustaining populations in Wisconsin, but still within the reported range.

A comparison of reproduction and growth of Leech Lake versus Wisconsin muskellunge in Nancy Lake is difficult. Because no muskellunge were present in Nancy Lake prior to this study, it is unknown how muskellunge from a Wisconsin population would have performed. It is possible that a similar introduction using progeny from a Wisconsin population could also have experienced low post-stocking survival, good growth rates, and reproductive success similar to that observed with Leech Lake muskellunge. In addition, we did not document habitat selection by spawning muskellunge in Nancy Lake, so it is unknown whether or not muskellunge selected areas similar to those in Leech Lake (Strand 1986) or were isolated from northern pike in other ways, if at all. Dombeck et al. (1986) suggested spatial isolation, afforded by larger lakes or lakes that are environmentally diverse, was necessary for natural populations of the two species to coexist. Such conditions may have been met in Nancy Lake, allowing muskellunge from Leech Lake or Wisconsin populations to successfully reproduce. With regard to growth, the catostomid population in Nancy Lake was relatively unexploited before the introduction of muskellunge in 1984. Perhaps the introduction of Wisconsin muskellunge would also have resulted in above average growth.

The concept of stock transfer of muskellunge to cope with the invasion of northern pike or to alleviate failing recruitment generates some policy questions on stocking muskellunge and other fish species in Wisconsin. The study in Nancy Lake utilized a population of muskellunge possessing genotypes that were adapted for coexistence with northern pike presumably via spawning behavior in Leech Lake. Krueger et al. (1981) suggested use of preadapted genotypes to enhance the success of rehabilitation programs. However, they also note that a biologist's and a fish's perception of environmental similarities may be different. Transfer of fish across major drainage boundaries could serve to break down spatial isolating mechanisms that have allowed local populations to become genetically tailored for the environment they inhabit (Philipp et al. 1993). While no muskellunge were previously present in Nancy Lake, an intermittent outlet connected with the St. Croix River Basin creates the potential for escapement into this system. The mixing of muskellunge from Nancy Lake with adjacent populations and a reduction in fitness resulting from outbreeding depression is possible (Philipp et al. 1993). Because of the potential negative consequences of introgression with native stocks, transfers such as the one accomplished in Nancy Lake should be closely scrutinized and should likely be discouraged in the future.

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