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Evaluation of the Relative Growth and Survival of Assinica, Nipigon, and Iron River Strains of Brook Trout Stocked into Two Small Inland Lakes

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Abstract.–We stocked fall fingerling Assinica, Iron River, and Nipigon strain brook trout *Salvelinus fontinalis* into two Michigan lakes and estimated the survival and growth of each strain to age 4. Survival of the Assinica and Iron River strains from stocking to age 4 was similar in East Fish Lake. First-year survival of Nipigon strain brook trout in East Fish Lake was only 4% as compared to 24% for Assinica strain and 18% for Iron River strain. Survival of all three strains after age 1 was similar, averaging 52% per year through age 4. In Fuller Pond, Iron River strain brook trout survived better than the Assinica strain the first year but by age 4 numbers of both strains were similar. Nipigon strain survival, as estimated from electrofishing and netting catches, was very low in Fuller Pond. Both Assinica and Iron River strain fish were slightly larger than the Nipigon strain when they were stocked in fall 2004. One year later Assinica strain fish were larger than fish from either of the other strains. By two years after stocking the lengths and weights of Assinica and Nipigon strain brook trout were similar and both strains were larger than the Iron River strain. By the end of the study Iron River strain brook trout were substantially smaller than either of the other two strains. The Assinica brook trout strain appears to be the most suitable of the three strains tested for Michigan trout lake management.

The Michigan Department of Natural Resources (DNR) currently stocks a total of approximately 240,000 brook trout *Salvelinus fontinalis* into inland lakes and streams on an annual basis, primarily in Michigan's Upper Peninsula (DNR fish stocking records 2008). While hatchery-produced brook trout have been stocked for many years to augment wild populations in streams where natural recruitment is insufficient to maintain desirable fisheries, the stocking of approximately 75 inland lakes provides both put-grow-take brook trout fisheries and trophy angling opportunities. Michigan has historically reared many different strains of brook trout based upon availability of eggs and broodstock. Some strains have been reared and stocked for short periods of time to assess survival and growth of strains that had produced good angler fisheries in other states.

Currently two brook trout strains, Assinica and Iron River, are stocked by the DNR. The Assinica strain is generally regarded as being genetically adapted to perform well in lakes. The original broodstock were collected from Assinica Lake in Quebec, and Michigan developed its first Assinica strain broodstock from gametes obtained from the State of New York in the 1970s. Michigan has continued to rear and stock the Assinica strain for waters where a larger-sized fish is targeted for harvest and thus attributes of fast growth and greater-than-usual longevity are needed. This strain is primarily stocked into small inland lakes, although some streams are stocked with Assinica strain brook trout when managers desire fish that are relatively large at the time they are stocked. In past

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field tests conducted in Michigan inland lakes the Assinica strain exhibited faster growth and higher survival than domestic strains of brook trout (Gowing 1978). However, hybrid crosses of Assinica x Maine domestic-strain brook trout stocked into Michigan streams survived at very low rates and did not provide the angling opportunities that managers sought to create (Wagner et al. 1994).

The low survival and poor angler returns of several strains of hatchery-reared brook trout in streams (Assinica strain, Assinica x Maine domestic hybrids, and Owhi strain) led to the development of a broodstock derived from 1,400 wild young-of-year and yearling brook trout collected from Michigan's Iron River (Iron County) in 1994. Division staff hypothesized that a strain derived from an indigenous, stream-adapted wild trout population would have greater genetic diversity and be more adapted to survive in variable stream environments. Iron River strain brook trout are presently stocked primarily into streams located in the Upper Peninsula (U.P.) of Michigan, although some are also stocked into lakes. Eggs from the Nipigon strain of brook trout used in our study were obtained from the Red Cliff Hatchery in Wisconsin, which had developed the broodstock from eggs obtained from the Dorian Fish Culture Station in Ontario. The founding stock for the Nipigon strain held at Dorian was established from three wild spawn collections that took place in 1976–78 in West Bay of Lake Nipigon, Ontario (G. Durant, Ontario Ministry of Natural Resources, personal communication). This strain was reared by DNR and Lake Superior State University from 1998–2006. Although the Nipigon strain was stocked primarily in the Gratiot and Little Carp rivers in an attempt to increase populations of adfluvial (Coaster) brook trout that spawn in Lake Superior tributaries, some were also stocked to provide trophy fishing opportunities in small inland lakes.

We initiated this study in 2005 after fisheries managers expressed concerns about the performance (growth and survival) of progeny from the DNR's current brook trout broodstocks. Since the overall genetic diversity of the Assinica strain broodstock was low and the strain was quite susceptible to furunculosis infections in the hatchery, there was interest in exploring the development of an alternative strain for stocking into inland lakes. Accordingly, the longevity and large sizes attained by wild Nipigon brook trout in Ontario made this a logical strain to evaluate. Limited field evaluations of the Iron River strain, which suggested they grew very slowly after stocking, also prompted interest in a more quantitative evaluation of their field performance. Thus, our objective was to evaluate the relative growth and survival of Assinica, Nipigon, and Iron River strains of brook trout in two Michigan trout lakes.

Methods

Study Lakes

East Fish Lake and Fuller Pond are located within the Hunt Creek Fisheries Research Area, Montmorency County, Michigan (Figure 1). East Fish Lake is 6.5 ha in area, with an average depth of 6 m and a maximum depth of 12 m. The lake stratifies thermally in summer and adequate dissolved oxygen levels for trout exist even in the deepest water throughout the year. A small creek and numerous springs contribute water to the lake, which drains to nearby Fuller Creek through a small (0.04 m^3/s outflow) lake level control structure. Fuller Pond, the headwaters of Fuller Creek, is a 6.1 ha flowage with an average depth of 0.5 m, a maximum depth of 2.1 m, and an outflow of approximately 0.08 m^3/s. It is formed by an earthen dike and lake level control structure built in the 1950s at the site of an old beaver dam. The coldwater inflow from a number of springs and a small creek that enters the pond creates a rather strong thermal stratification during hot weather. The surface water temperature may be 21 ^{o}C while the bottom waters in the old creek channel may be only 13 ^{o}C. Adequate dissolved oxygen exists for trout throughout the year at all depths. Waters of both East Fish Lake and Fuller Pond are moderately hard with total alkalinity of 140–175 mg/l and pH that fluctuates slightly around 8.0.

The fish community in the test lakes consists primarily of forage species including redbelly dace *Phoxinus eos*, Iowa darter *Etheostoma exile*, brook stickleback *Culaea inconstans,* fathead minnow *Pimephales promelas,* and central mudminnow *Umbra limi*. Small numbers of wild brook trout are naturally recruited from the small inlet tributaries. Both lakes are closed to public angling.

Stocking

All fish stocked for this study were reared at the Marquette State Fish Hatchery and transported to the stocking sites on the same truck. Fin clips were used to identify each strain; the right pelvic fins of Nipigon strain fish were clipped in the hatchery several weeks before they were transported to the stocking sites while Assinica and Iron River strain fish were given left pelvic and adipose fin clips, respectively, immediately before they were stocked. On October 4, 2004, 700 fall fingerling Assinica, Nipigon, and Iron River strain brook trout were stocked into East Fish Lake at a total stocking rate of 325 fish/ha. Due to an unexpected shortage of fish on the transport truck, numbers of brook trout stocked into Fuller Pond in 2004 were not equal. We stocked 386 Assinica, 500 Nipigon, and 417 Iron River strain brook trout into Fuller Pond at a total stocking rate of 215 fish/ha. A subsample of 100 fish of each strain was measured for total length (TL) and weight immediately before they were stocked. Mean total length of fingerlings planted in 2004 was 96 mm for Assinica and Iron River strain fish and 90 mm for the Nipigon strain. The Nipigon strain was significantly smaller than the other strains at the time they were stocked in 2004.

Although it was not known at the time, a significant number of predator-sized brown trout *Salmo trutta* were present in Fuller Pond in fall 2004 when fingerling brook trout were stocked. These fish were progeny of brown trout that escaped capture at the end of a previous experiment. Therefore, after additional brown trout were removed in the spring and summer of 2005 (see below), Fuller Pond was restocked with 500 fingerlings of each brook trout strain on September 14, 2005. A subsample of 100 fish of each strain was again measured for total length (TL) and weight immediately before they were stocked. The mean TL of fingerlings planted in 2005 was 102 mm for Assinica, 105 mm for Nipigon, and 73 mm for Iron River strain fish. Iron River strain fingerlings stocked in 2005 were significantly smaller than the other strains. No predatory fish were present in East Fish Lake so it was stocked only in 2004.

Sampling and Tagging

Spring (May) and fall (October or November) electrofishing surveys were conducted with a 240 V DC boat-mounted electrofisher in East Fish Lake and Fuller Pond each year from 2005 through 2007. Inclined screen fish traps (Wolf 1951) were also operated year-round on the outlet creeks of both East Fish Lake and Fuller Pond to capture brook trout that attempted to emigrate (most fish encountered in the traps were captured during the last two weeks of October and the first week of November after fish had matured). All trout captured during electrofishing surveys or in inclined screen traps during or after fall 2005 were measured to the nearest mm, weighed to the nearest g, examined for fin clips and tags, and released back into the lake. We began tagging brook trout in fall 2005 with standard 1.0 x 2.5 mm VI Alpha (VIA) tags (Northwest Marine Technology, Inc.) after they had grown large enough to accommodate tags inserted into the adipose eyelid tissue posterior to the eye. During subsequent surveys, all brook trout were examined for tags and a VIA tag was applied to fish that were not previously tagged, or which had lost a tag.

Survival

Mark-and-recapture population estimates were made in East Fish Lake each fall from 2005 through 2007. Fall marking runs were composed of a mix of trout collected by electrofishing or in the fish traps, while recapture runs consisted of trout collected during both the spring and fall of the subsequent year. We used the Chapman modification of the Petersen mark–recapture formula (Hayes et al. 2007) to compute population estimates, which in turn were used to calculate annual survival estimates for each brook trout strain of age x by dividing the fall populations of age (x + 1) present in a subsequent year by the density of age-x fish present in the previous year. Analysis of covariance (ANCOVA) was used to determine if instantaneous natural mortality rates were different among strains (α=0.05). Because mortality from age 0 to age 1 was clearly much higher for Nipigon strain than for either Assinica or Iron River strain brook trout (Table 1) we performed our ANCOVA using age-1 trout as a starting point.

Extremely low numbers of brook trout captured from Fuller Pond by electrofishing in May 2005 led us to conclude that piscivorous brown trout had eaten most of the planted brook trout. During spring 2005 we captured and removed 40 brown trout averaging 304 mm TL while attempting to sample brook trout. Therefore, we drew the pond down 1 m during summer 2005 and removed an additional 10 brown trout averaging 278 mm before restocking the pond with fingerling brook trout in September 2005. This brown trout removal effort was quite successful since only 16 additional brown trout were captured and removed during sampling conducted from 2006 through 2008. However, because this unanticipated problem required us to restock with brook trout we could not reliably calculate population or survival estimates for each cohort of brook trout stocked. Instead, we evaluated the relative survival of each strain in Fuller Pond by comparing total annual catches of each strain during sampling conducted between May 2005 and June 2008. Catches by strain were standardized to catches per 1,000 of each strain stocked to account for unequal stocking levels. Catches in fall 2005 were standardized based on numbers of trout stocked in fall 2004 while catches in 2006 and thereafter were standardized based on total numbers of trout stocked in 2004 and 2005 combined. We used Chi-square statistics (α=0.05) to compare standardized catches of each strain.

In 2008, we attempted to remove all trout remaining in both lakes by electrofishing and netting. Removal efforts in East Fish Lake ended after no trout were caught in 305 m of gill nets set for five consecutive days in early November. Fuller Pond was drawn down 1 m in May 2008 to make repairs to the dyke and the remaining open water was intensively electrofished to remove surviving trout. Trout could not escape the pond during the drawdown because waters were channeled through the fish trap located on the outlet. The numbers of brook trout removed from the two lakes in 2008 were used as a conservative estimate of the number of trout surviving to the end of the study.

Growth

Because lake bathymetry and trout diet composition were known to be quite different between East Fish Lake and Fuller Pond we analyzed growth rates separately for each lake (Alexander 1975a, 1975b). We used analysis of variance (ANOVA) to determine if the mean TL and weights of brook trout collected each spring and fall from 2005 through 2008 varied by strain and sampling period (α=0.05). We also compared the relative condition of the three brook trout strains within each lake by first calculating the slopes and intercepts of log-transformed length and weight data for the ordinary least-squares regression model

$$\mathrm{Log}_{10}(W) = \mathrm{a} + \mathrm{b}(\log_{10} L)$$

where W is total weight in g and L is the TL in mm. We made an initial assessment of differences in condition by determining if the 95% confidence intervals (CI) for the slopes and intercepts overlapped. If the CI's overlapped we next determined if the 95% confidence interval of the *difference* between slopes and intercepts for the strains included zero. If the confidence limits of the differences between the regression coefficients for the strains did not include zero we concluded that they were significantly different (Pope and Kruse 2007).

We computed daily growth rates for recaptured fish as mm/d and g/d for annual periods beginning each fall from 2005 through 2007. Differences in individual growth rates among strains within each lake were assessed using ANOVA and Tukey's Honestly Significant Difference (HSD) multiple comparison tests (α=0.05). All statistical analyses were performed using SPSS version 15 for Windows software (SPSS Inc. 2006**)**.

Results

Survival

Assinica and Iron River strain brook trout exhibited far higher overall survival than the Nipigon strain in East Fish Lake (Table 1, Figure 2). The Assinica strain survived 6 times better than the Nipigon strain and Iron River strain brook trout survived 4.5 times better than Nipigon strain fish for the first year after stocking. Annual survival and instantaneous natural mortality rates for age 1 and older trout were similar among strains (F=0.06, df=2, P>0.05, Figure 2). Average annual mortality of the three strains from age 1 to age 4, computed from the average instantaneous natural mortality rate, was 52%. The percentage of age-1 fish surviving to age 4 ranged from 12% for Nipigon strain brook trout up to 15% for Assinica strain brook trout. Because initial survival of the Nipigon strain was so low, only 3 of the 700 fish stocked into East Fish Lake survived to age 4 as compared to 25 Assinica strain (Table 1).

Chi-square tests showed that annual catches of brook trout in Fuller Pond varied significantly by strain each year from 2005 through 2008 (Table 2). The Nipigon strain brook trout exhibited very low survival compared to Assinica and Iron River strain fish. In 2005 we caught about 2.5 times more Iron River strain than Assinica strain trout but by the end of the study in spring 2008 numbers removed from the pond via drawdown and electrofishing were similar (Table 2).

Growth

Average length (F=2.32, df=12,459, P<0.01) and weight (F=4.25, df=12,459, P<0.001) of brook trout stocked into East Fish Lake varied significantly by strain and sampling period. Mean lengths and weights of Assinica and Iron River strain brook trout were similar at stocking in fall 2004 while Nipigon strain fish were about 6 mm shorter and 3 g lighter. Within a year after stocking into East Fish Lake, Assinica strain fish were longer and heavier than either of the other strains. Assinica strain remained longer and heavier than the Iron River strain at all subsequent sampling periods through fall 2008 when they were 4 years old. By the end of the study period the Assinica strain was an average of 39 mm longer and 285 g heavier than the Iron River strain in East Fish Lake. The Nipigon strain was substantially smaller than the Iron River strain one year after stocking but by fall 2006 their mean lengths and weights were similar to the Assinica strain and had surpassed the Iron River strain. Both Assinica and Nipigon strain brook trout were larger than Iron River strain fish at age 2 and age 3. The mean length of the small sample of Nipigon strain fish removed from East Fish Lake at the end of the study was comparable to the other strains (Figure 3).

Mean length (F=5.14, df=12,518, P<0.001) and weight (F=8.83, df=12,519, P<0.001) of brook trout in Fuller Pond also varied significantly by strain and sampling period. Both Assinica and Iron River strain fish were slightly larger than the Nipigon strain when they were stocked in fall 2004 and they maintained their lead at six months after stocking. One year after stocking, the Assinica strain fish were longer and heavier than either of the other strains while Iron River strain brook trout were larger than Nipigon strain. However, lengths of both Assinica and Nipigon strains collected from fall 2006 through spring 2008 were similar to each other and longer than Iron River strain fish. Mean weights of both Assinica and Nipigon strains collected from spring 2007 through spring 2008 were also higher than for the Iron River strain (Figure 4).

Weight–length relationships initially varied to some extent among each of the three strains but by the time fish had grown to about 225 mm the weight–length regression lines had converged. In East Fish Lake the slope of the regression line for Nipigon strain brook trout was higher than for Iron River or Assinica strain fish; the slope for Iron River strain fish was higher than for Assinica strain brook trout. Relative differences in slopes among strains in Fuller Pond were similar to those in East Fish Lake except that there was no difference in weight–length relations between the Nipigon and Iron River strains. Intercepts in both lakes were lowest for Nipigon strain, intermediate for Iron River strain, and highest for Assinica strain brook trout (Table 3). Thus, as fish of all strains attained sizes of 225–500 mm TL their weights became similar, regardless of strain.

Individual Growth Rates

There were no significant differences in individual daily growth rates (mm/d) among brook trout strains tagged from East Fish Lake ($F=0.97$, $df=2{,}127$, $P>0.05$). In East Fish Lake, individual daily growth rates (g/d) were significantly higher for Assinica strain brook trout compared to Iron River strain fish (Tukey's HSD $P<0.01$) across all years of study. Individual growth rate differences among strains in Fuller Pond followed a similar pattern to that observed in East Fish Lake. Although there were no significant differences in daily growth (mm/d), individuals of the Assinica strain gained weight (g/d) significantly faster than Iron River strain fish (Tukey's HSD $P<0.01$) (Table 4). Because very few individual Nipigon strain brook trout were captured and tagged from either lake, statistical power to detect any difference in their growth rates from that of other strains was very low.

Discussion

In this study, the Assinica strain brook trout exhibited overall superior survival and growth compared to the Iron River and Nipigon strains. Our findings mirror those of previous evaluations conducted in small Michigan lakes in the 1970s and 1980s that also indicated the Assinica strain survived well and grew well relative to other strains studied (Gowing 1978; Gowing 1986; Alexander et al. 1991). Although survival of all strains was similar from age 1 to age 4, very low survival of age-0 Nipigon strain fish was observed in both East Fish Lake and Fuller Pond.

We have no explanation for high post-stocking mortality of the Nipigon strain. Fisheries health and quality assessments performed at the hatchery indicated that all strains were healthy at stocking. The Nipigon strain was subjected to less handling stress at the stocking sites than the Iron River or Assinica strains because Nipigon strain fish were clipped at the hatchery several weeks earlier. By contrast, Iron River and Assinica brook trout strains were lightly anaesthetized and fin clipped at the stocking sites. East Fish Lake contained no piscivorous fish and although Fuller Pond was initially found to contain a substantial population of predator-sized brown trout, most of these fish were removed in summer 2005. Dissolved oxygen and temperature conditions in both pristine study waters are well-suited for trout survival as has been demonstrated by many trout studies conducted in these waters since the 1950s.

Survival of all three strains after age 1 in our study (52%) is roughly comparable to brook trout survival rates of 59% to 66% reported in previous studies in East Fish Lake, Fuller Pond, and other small Michigan Lakes (Gowing 1986; Alexander et al. 1991). High mortality of Nipigon strain brook trout caused by a disease contracted after stocking may have occurred, but because we did not observe dead or distressed fish post-stocking disease testing was not performed. Although furunculosis was not present in stocked fish it is ubiquitous in Michigan waters and has been implicated in high post-stocking mortality of Canadian strains of brook trout in Michigan and New York (Webster and Flick 1981; Alexander et al. 1991).

The Iron River strain survived as well as Assinica strain brook trout in East Fish Lake, but their slower growth rate makes them less desirable for put-grow-take fisheries in lakes. Higher catches of Iron River strain brook trout from Fuller Pond in 2005 after exposure to predation by brown trout may indicate that they were more adept than Assinica strain fish at predator avoidance. Bassett (2000) found that survival of the Iron River strain was clearly superior to that of Assinica strain fish when both were stocked to supplement stream brook trout fisheries in Michigan's U.P. A previous study of Assinica-Maine domestic hybrids stocked into U.P. streams (Wagner et al. 1994) found that less than 4% survived to be caught by anglers, and provided some of the impetus to develop the Iron River strain for the purpose of stream stocking.

Assinica strain brook trout grew faster than either Iron River or Nipigon strain fish during the first year or more after stocking and therefore appear well suited for stocking into lakes where rapid initial growth is desired. Rapid early growth of Assinica strain brook trout has been previously observed in both field (Gowing 1986) and laboratory experiments (Sutton et al. 2002). Sutton et al. (2002) found that fingerling Assinica strain fish grew significantly faster than either Nipigon or Iron River strain brook trout during 150-d hatchery trials. In the present study, all strains were of roughly similar size at stocking but within two years Iron River strain brook trout were smaller than Assinica and Nipigon strain fish in both lakes. By age 4, Iron River strain brook trout weighed 237 g less than Assinica strain brook trout in Fuller Pond and 285 g less in East Fish Lake.

Daily growth data from tagged brook trout, particularly daily growth in weight, further supports our finding of relatively slow growth of Iron River strain fish compared to the Assinica strain. All but one point estimate of annual growth increments for Assinica strain brook trout (g/d) were higher than those for Iron River strain fish in both lakes (Table 4). Slow growth of Iron River strain brook trout was evident from both our daily growth increment data derived from individuals and from our mean size-at-age data computed from the total sample of each strain collected each season (tagged and untagged fish combined). These data support the hypothesis that growth of the Iron River strain was indeed slow, and not the result of inverse size-dependent mortality of strain cohorts.

The present study was initiated, in part, due to concerns that low levels of genetic diversity in the Assinica strain might be reducing their fitness for management purposes. Low fitness of populations and individuals is often associated with inbreeding and low levels of heterozygosity (Kapuscinski and Miller 2007). In the context of management of put-grow-take or trophy fisheries in Michigan inland lakes, important fitness traits are fast growth and high survival rates. Growth of Assinica strain brook trout in the present study was much faster in East Fish Lake and Fuller Pond than during a previous evaluation of Assinica strain fish in the same lakes conducted from 1982 to 1987 (Alexander et al. 1991). Survival after age 1 was similar between the studies (52% in our study compared to 59% in the 1980s study).

Our data also allowed us to evaluate the growth of Iron River strain brook trout in the wild to test fisheries managers' hypothesis that these fish are a slow-growing strain, and to evaluate the Nipigon strain to determine if it might provide an alternative to Assinica strain brook trout for inland lake stockings. We found that Iron River strain brook trout did grow significantly slower than either the Assinica or Nipigon strains, and the very low survival of Nipigon strain fish from age 0 to age 1 in both study lakes suggests that fall fingerlings would not provide a good alternative to the Assinica strain. However, given that their survival after age 1 was similar to the other strains, yearling Nipigon strain brook trout stocked into inland lakes might provide an alternative to Assinica strain yearlings.

Management Implications

Our study findings indicate that the Assinica strain brook trout broodstock presently held at the Marquette State Fish Hatchery produce fingerlings that are much better suited for put-grow-take or trophy fisheries in inland lakes than the Iron River or Nipigon strains. Iron River strain fish grew much more slowly than Assinica or Nipigon strain brook trout and do not appear to provide a good alternative strain for lake stocking. Very low post-stocking survival of Nipigon strain fall fingerlings suggests that this life stage is not a reliable alternative to the Assinica strain for stocking in inland lakes. The Assinica strain brook trout stocked for our study were surplus from a group of fish being reared for future broodstock and were used because they were very similar in size to the production Nipigon and Iron River strain fingerlings in our experiment. Fingerling Assinica strain brook trout in production lots destined to be stocked into public waters are fed higher rations to take advantage of their high growth potential in the hatchery and are typically about 50 mm larger than the fish we tested. We would expect that these production-sized fish would grow to sizes attractive to anglers faster than the smaller Assinica strain fingerlings we tested.

Acknowledgments

We thank Tom Adams who assisted with the field work and data summarization for the project. Jan VanAmBerg reviewed the manuscript. Funding for this project was provided by the Michigan Department of Natural Resources through Federal Aid in Sport Fish Restoration, Project F-80-R, Study 230515.

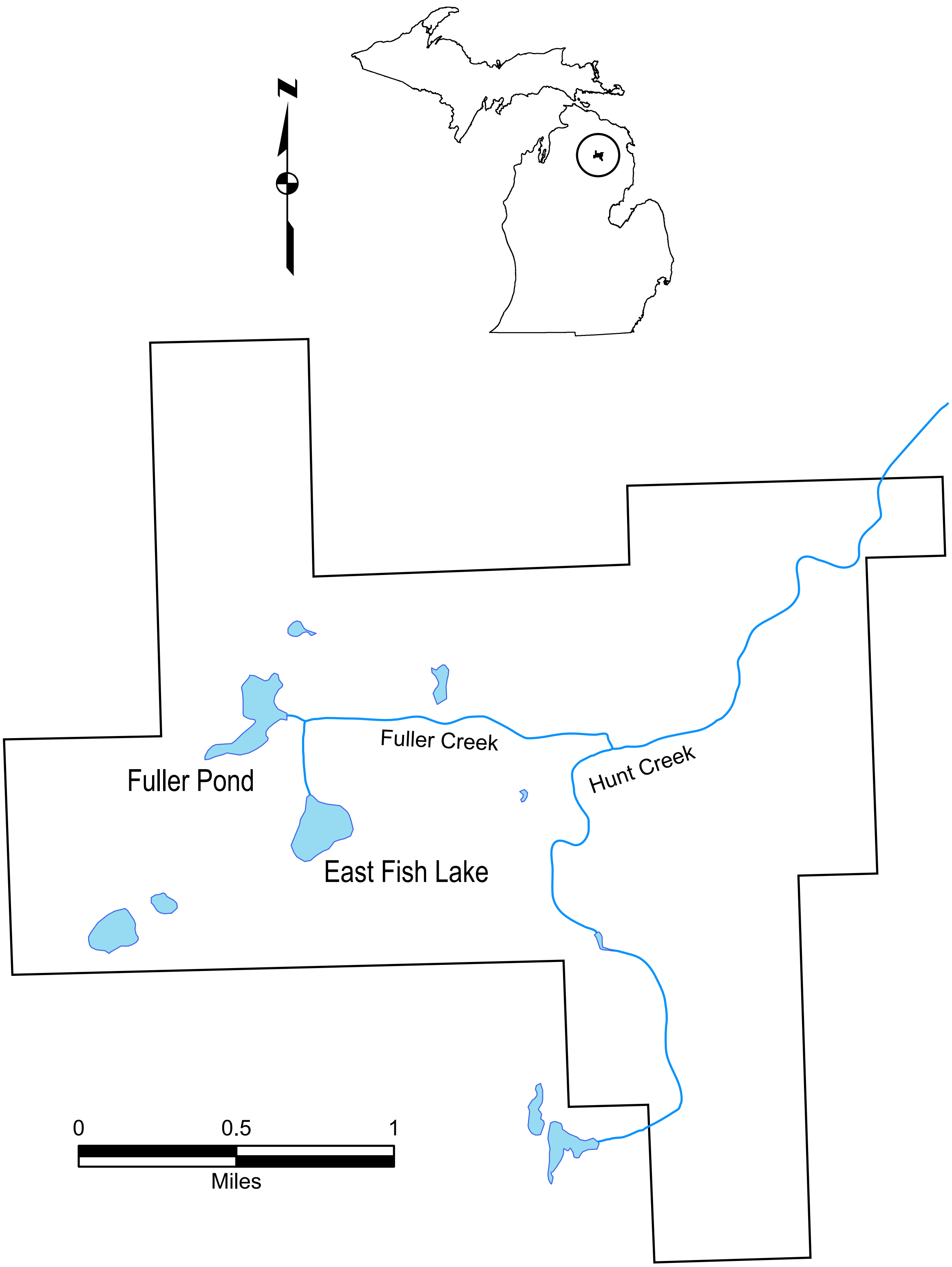

Figure 1.–Location of East Fish Lake and Fuller Pond within the border of the Hunt Creek Fisheries Research Area, Montmorency County, Michigan.

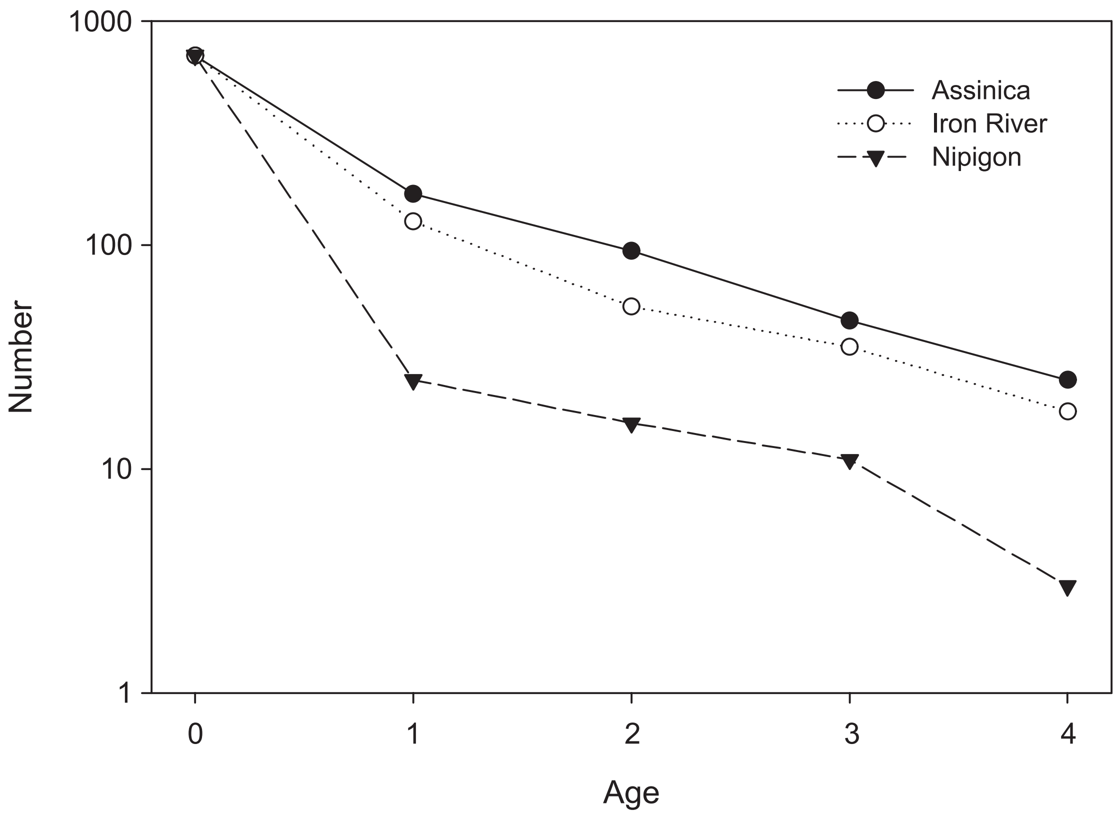

Figure 2.–Survivorship curves from population estimates of Assinica, Iron River, and Nipigon strains brook trout in East Fish Lake by age. Note that the y-axis is shown in log scale.

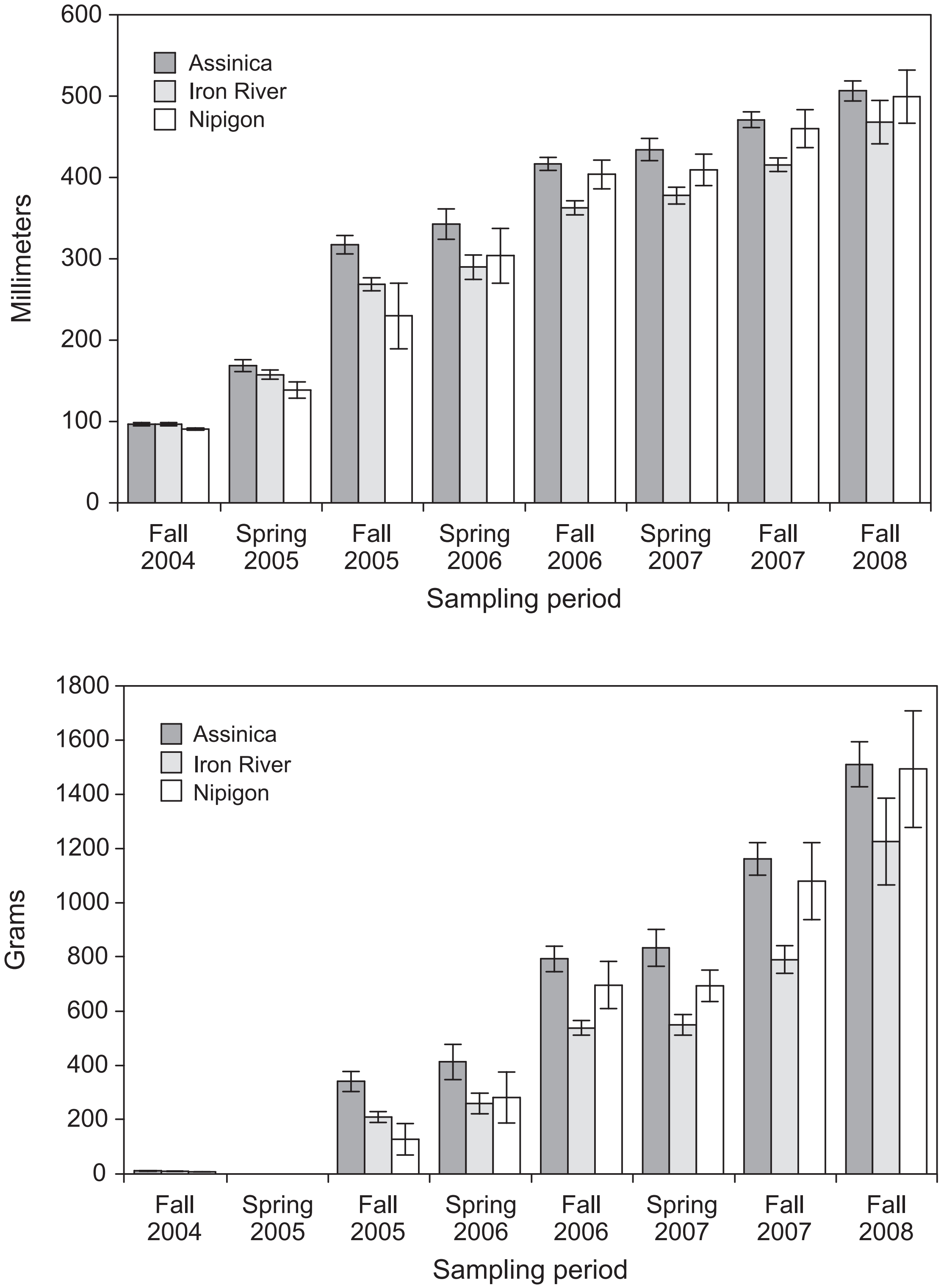

Figure 3.–Mean total length (top panel) and total weight (bottom panel) for three strains of brook trout in East Fish Lake from stocking in fall 2004 through fall 2008. The thin vertical lines depict ± 2 SE of the mean.

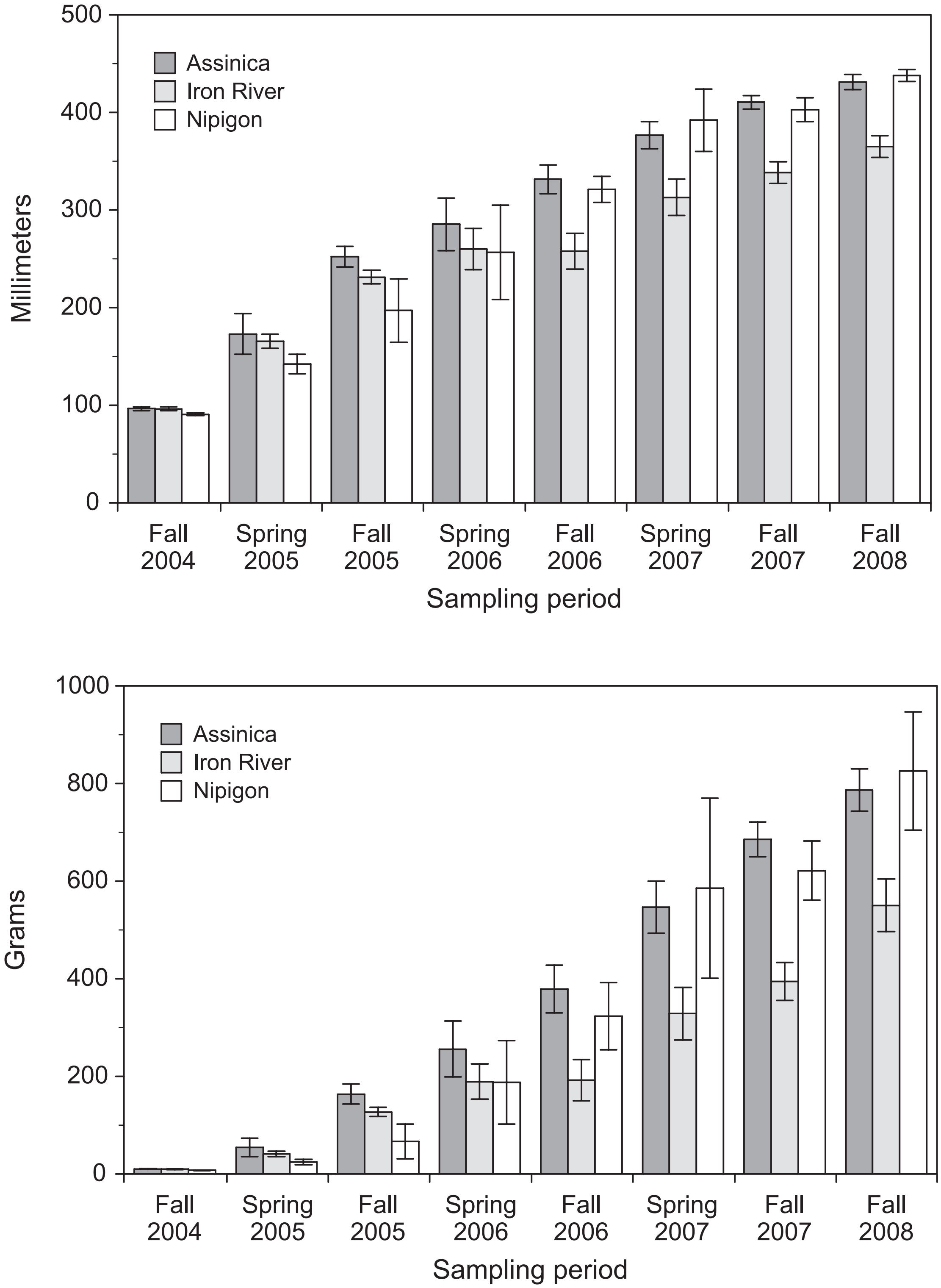

Figure 4.–Mean total length (top panel) and total weight (bottom panel) for three strains of brook trout in Fuller Pond from first stocking in fall 2004 through fall 2008. The thin vertical lines depict ±2 SE of the mean.

Table 1.–Fall population and annual survival estimates of three strains of brook trout in East Fish Lake from stocking in fall 2004 through final sampling in 2008. Confidence limits have been omitted for clarity.

		Population estimate			Percent survival to next year		
		Strain			Strain		
Date	Age	Assinica	Iron River	Nipigon	Assinica	Iron River	Nipigon
Fall 2004	0	700	700	700	24	18	4
Fall 2005	1	169	127	25	56	42	64
Fall 2006	2	94	53	16	49	66	69
Fall 2007	3	46	35	11	54	51	27
Fall 2008	4	25	18	3			

Table 2.–Chi-square test statistics from comparison of relative catches of three strains of brook trout (per 1,000 of each strain stocked) in Fuller Pond from second stocking in fall 2005 through final sampling in 2008. Chi-square tests assumed equal catches among strains.

	Catch by strain			Test statistic		
Year	Assinica	Iron River	Nipigon	χ^2	df	*P*
2005	111	273	22	239.3	2	<0.01
2006	88	81	13	56.6	2	<0.01
2007	95	64	6	74.2	2	<0.01
2008	34	25	4	22.6	2	<0.01

Table 3.–Confidence intervals (95%) for the slopes and intercepts of the weight–length relationships for three strains of brook trout in two experimental lakes. The form of the least-squares regression model is $\text{Log}_{10}(W) = a + b(\log_{10}L)$ where W is total weight and L is total length.

Lake	Strain	Slope (b)	Intercept (a)
East Fish Lake	Assinica	2.997 – 3.023	(-5.030) – (-4.967)
	Iron River	3.059 – 3.088	(-5.189) – (-5.125)
	Nipigon	3.096 – 3.131	(-5.309) – (-5.233)
Fuller Pond	Assinica	2.927 – 2.956	(-4.898) – (-4.833)
	Iron River	3.001 – 3.039	(-5.103) – (-5.019)
	Nipigon	3.019 – 3.073	(-5.194) – (-5.084)

Table 4.–Mean daily individual growth increments from fall of one year to the next (±1 SE) for Assinica, Iron River, and Nipigon strains of brook trout stocked into East Fish Lake and Fuller Pond.

		Brook trout strain								
		Assinica			Iron River			Nipigon		
Lake	Period	N	mm/d	g/d	N	mm/d	g/d	N	mm/d	g/d
East Fish Lake	2005-06	23	0.22 (0.02)	1.09 (0.08)	25	0.23 (0.01)	0.88 (0.04)	3	0.23 (0.03)	0.80 (0.12)
	2006-07	31	0.14 (0.01)	0.97 (0.07)	24	0.13 (0.01)	0.66 (0.07)	6	0.15 (0.02)	1.01 (0.12)
	2007-08	23	0.10 (0.01)	1.01 (0.08)	12	0.10 (0.01)	0.98 (0.12)	4	0.12 (0.01)	1.20 (0.18)
Fuller Pond	2005-06	10	0.29 (0.02)	0.95 (0.06)	18	0.24 (0.04)	0.66 (0.13)	0	– (–)	– (–)
	2006-07	22	0.19 (0.02)	0.88 (0.09)	14	0.18 (0.03)	0.51 (0.09)	2	0.19 (0.05)	0.75 (0.11)

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