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COMPARATIVE GROWTH AND SURVIVAL POTENTIAL OF BROWN TROUT FROM FOUR WILD STOCKS AND ONE DOMESTIC STOCK[1]

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[1]Contribution from Dingell-Johnson Project F-35-R, Michigan.

ABSTRACT

Young-of-the-year wild brown trout from four streams and domestic brown trout from Oden Hatchery were stocked in four experimental lakes to determine their relative growth and survival after 2 years of residence in the lakes. Some differences in growth were found, suggesting that these were genetically different strains. Gilchrist Creek trout grew significantly more in length than other strains; however, their weight gain was not significantly greater than that for Pigeon River or Sturgeon River brown trout. The Pigeon River and Sturgeon River trout grew better than Au Sable River or domestic trout. No consistent difference in growth was found between Au Sable River and domestic trout.

A habitat or lake effect on brown trout growth was evident. All trout strains grew best in North Twin Lake and second best in Hemlock Lake. There was little difference in trout growth between South Twin Lake and Ford Lake.

The survival rates of the various wild brown trout strains were similar within lakes but differed among lakes. The survival rates of the hatchery strain of brown trout were only about half those of wild fish.

Study results suggest that the intensity of angler exploitation may alter the genetic potential for growth of wild trout populations. The slower growing Au Sable River trout are believed to be exploited more than Gilchrist Creek trout. However, the reduction in Au Sable brown trout growth which occurred since 1963 is mainly due to reduced fertility caused by reduced input of sewage.

INTRODUCTION

For a number of years some anglers and biologists have hypothesized that some of the growth differences observed among brown trout (Salmo trutta) populations are due to genetic differences in their growth potential as well as to the quality of the habitat in which they live. It has been further suggested that the genetic growth potential of trout has been degraded by the process of differential angler harvest of the faster growing fish of a cohort, thus leaving the slower growers to reproduce the stock. Controversy about these genetic growth hypotheses has magnified in Michigan in recent years because since 1960 the growth of brown trout in the famous Au Sable River has decreased. Favro et al. (1979 and 1980) used Au Sable River data on brown trout to demonstrate by modeling how such genetic degradation might occur.

Alexander et al. (1979) gave detailed background information on the Au Sable River brown trout population, growth, harvest, and fishing over time. Causes for decreased trout growth could not be determined for certain, but a number of possible reasons were advanced by the authors. The most probable explanation was a reduction in nutrient loading of the river. Additional background information on growth changes of Au Sable River brown trout and their probable causes can be found in Clark and Alexander (1984).

The primary purpose of this present study was to determine if wild brown trout populations in the Au Sable River, Pigeon River, Gilchrist Creek, and Sturgeon River differed in their growth potential. The null hypothesis was that growth would be similar for all these populations, indicating they are genetically similar. The secondary objective was to compare the growth and survival of Michigan's domestic hatchery-reared brown trout to that of wild brown trout.

METHODS

Young-of-the-year wild brown trout were collected with 220-volt DC electrofishing gear in October 1982 from the Au Sable River (Mainstream, T 26 N, R 2 W, Sec. 5), Pigeon River (T 32 N, R 1 W, Secs. 17 and 19), Sturgeon River (T 32 N, R 2 W, Secs. 15,and 21), and Gilchrist Creek (T 29 N, R 3 E, Sec. 27). Domestic brown trout were obtained from production stock being reared at the state fish hatchery at Oden, Michigan. Table 1 gives the average sizes and numbers of trout collected and planted in four experimental lakes in the Pigeon River Country State Forest, Otsego County, Michigan. No sorting or selection of trout to be transplanted was done. Thus, trout caught and transplanted were as close as possible to a random sample of the young-of-the-year cohorts. There likely was a constant bias for slightly higher than average size fish for all streams due to gear selection. Trout in the samples were measured and fin clipped for permanent identification, and then transported immediately to the experimental lakes. Stresses due to collection, holding, transporting, fin clipping, and planting were believed to be similar for each group and no mortalities occurred. The experimental lakes were closed to fishing and patrolled at random times to detect possible poachers.

Each of the four experimental lakes was planted with a total of 100 trout per acre, 25 from each of four sources. Each lake received trout from three wild stocks and one domestic stock. All lakes received domestic Au Sable River and Gilchrist Creek trout. Three lakes were planted with Pigeon River trout and the fourth lake (Hemlock Lake) received Sturgeon River trout.

Trout were allowed to grow for 2 years and their incremental growth gain during this time frame was used to judge their relative performance. In late October and early November of 1984, most surviving trout were netted from the lakes to assess growth and survival. The number of trout surviving in each lake was estimated from daily records of net catches by the DeLury method (DeLury 1947). All lakes were sampled with the same group of seven gill nets. Total area of netting was about 9,600 square feet and mesh sizes ranged from 2.5- to 3.5-inch stretched measure.

Growth increments in length and weight were analyzed statistically to determine if strains and lakes differed. Pooled variances, calculated from two-way analyses of variance, were used to calculate 95% confidence limits for average growth increments. Growth increments were judged significantly different if the confidence limits did not overlap.

RESULTS

Growth in length

Pooled data for all lakes indicated that the Gilchrist Creek stock had the greatest average length increment (Table 2). They grew 8.9 inches, as compared to 8.6 inches for Sturgeon River trout, 8.4 inches for Pigeon River trout, 8.1 inches for domestic trout, and 7.9 inches for Au Sable River trout. Growth of Gilchrist Creek trout was significantly greater than that of all other stocks. Sturgeon River trout grew significantly better than Pigeon River, Au Sable River, or domestic stocks. The Pigeon River stock had significantly greater growth than Au Sable River or domestic stocks. Finally, domestic trout had a small but significantly greater gain than Au Sable River trout.

The relative growth performances of the various stocks within each lake were usually consistent with the pooled data for all lakes (Table 2). In Ford Lake, Gilchrist Creek trout grew significantly faster than all other stocks, and the Pigeon River stock grew faster than domestic or Au Sable River fish. Domestic trout grew faster than Au Sable River fish. Thus, Ford Lake data are in complete agreement with the pooled data. In North Twin Lake, again, Gilchrist Creek fish grew significantly faster than all other stocks, and Pigeon River trout grew faster than domestic or Au Sable River fish. However, no significant difference was found between domestic and Au Sable River trout. In South Twin Lake, once again Gilchrist Creek trout grew significantly faster than other stocks and Pigeon River fish grew faster than domestic or Au Sable River fish. However, no significant difference was demonstrated between Au Sable River and domestic trout. In Hemlock Lake, also, Gilchrist Creek fish grew faster than the other stocks. This lake had Sturgeon River trout, rather than Pigeon River trout, and they too grew significantly faster than Au Sable River or domestic trout. There, Au Sable River fish grew significantly faster than domestic fish.

Trout growth differed significantly among lakes (Table 2). Note, however, that the growth of the stocks in relation to each other was quite consistent for all lakes. All stocks of trout grew best in North Twin Lake. Further, all stocks faired better in Hemlock Lake than in South Twin Lake or Ford Lake. Domestic trout and Au Sable River trout grew better in South Twin Lake than in Ford Lake, but no difference could be shown for Pigeon River or Gilchrist Creek stocks in South Twin Lake when compared to Ford Lake. These data demonstrate that environmental or food conditions, which influenced brown trout growth, varied between lakes. Thus, the trout stocks tested were exposed to an array of conditions.

Growth in weight

Growth in weight generally followed the pattern of growth in length. Pooled data for all lakes over the 2-year test showed the following average weight gains (g): Gilchrist Creek, 289; Sturgeon River, 286; Pigeon River, 283; domestic, 260; and Au Sable River, 257 (Table 3). Gilchrist Creek trout growth was significantly greater than that of Au Sable River or domestic trout. Gilchrist Creek trout average weight was not significantly different than that of Pigeon River and Sturgeon River trout. Gilchrist Creek trout growth in weight was not significantly different than that of Pigeon River and Sturgeon River trout. Pigeon River and Sturgeon River trout were heavier for their length (higher condition factor) than Gilchrist Creek fish. Trout from both the Pigeon River and the Sturgeon River showed significantly better growth than domestic or Au Sable River trout. No significant difference was found between domestic and Au Sable River stocks.

Again, differences in trout growth among the various lakes were evident in the weight gain data (Table 3). All trout stocks grew best in North Twin Lake, followed by Hemlock Lake, South Twin Lake, and Ford Lake.

Survival

From 52 to 60% of all wild brown trout stocks survived the 2-year test (Table 1). Thus, annual survival was about 75%, which is excellent. In contrast, survival of domestic stock brown trout was about half that of wild fish. Fish from the domestic stock survived as well as wild fish only in North Twin Lake, where all trout grew best. Survival of the three wild stocks of trout did not vary significantly. However, 2-year survival of wild trout appeared to differ among lakes: Hemlock Lake—80%; North Twin Lake—64%; South Twin Lake—48%; and Ford Lake—40%.

DISCUSSION

I conclude that the Gilchrist Creek trout stock was superior in growth potential to the other stocks tested. Pigeon River and Sturgeon River trout may not be different but they were both better than Au Sable River or domestic trout. There was little difference in overall performance between Au Sable River and domestic trout.

The data demonstrated that there was a habitat (lake) effect on growth rate of brown trout. All stocks grew best in North Twin Lake, second best in Hemlock Lake, and poorest in South Twin Lake and Ford Lake. The relative growth ranking of the various trout strains was consistent over all four lakes.

A number of possible explanations can be offered for the varying growth potential of these wild brown trout stocks. First, the hypothesis that growth potential has been altered by angler exploitation of faster growing fish is supported to the extent that growth rates measured in this study seem to be inversely correlated with trout harvest rates. I believe that the Au Sable River brown trout stock has been cropped the most intensively through the years, Pigeon River and Sturgeon River stocks somewhat less, and the Gilchrist Creek stock the least. Various creel census surveys on the Au Sable River and Pigeon River, conducted by the Michigan Department of Natural Resources since the 1950's, have determined that fishing pressure is greater on the Au Sable River. The Sturgeon River is similar to the Pigeon River in terms of accessibility and fishing reputation. No creel census surveys have been conducted on Gilchrist Creek but fishing pressure is believed to be relatively low because of its brushy character, limited access, and reputation.

A second possible reason for differing growth potentials in these wild brown trout stocks is that they may not have been "seeded" with the same strain. The early history of brown trout planting in Michigan can be partially reconstructed from the account by Westerman (1961). Brown trout were introduced to the Au Sable River in 1891. Apparently watersheds to the north—including the Pigeon River, Sturgeon River, and Gilchrist Creek (Thunder Bay River system)—were first planted shortly thereafter, because by 1894 brown trout were being planted extensively throughout the Lower Peninsula, and even in the Upper Peninsula. These fish were progeny of the first brown trout broodstock developed at the Paris Hatchery. Apparently this broodstock was a composite of brown trout of both German and Scottish origin. But even though these early introductions of brown trout to Michigan streams may have been of common genetic background, we do not know the genetic background of all subsequent plantings. Thus, the gene pools of wild Michigan brown trout cannot be fully traced.

A third explanation is that natural selection (other than angling) has taken place within these relatively isolated brown trout populations over time causing their genetic growth potential to diverge. That is, in some streams natural mortality may favor either fast growers or slow growers. This is difficult to rationalize because predacious fish and birds typically select the smaller trout of a cohort as prey (Alexander 1977).

A fourth possible explanation for the differences in growth potential among wild brown trout is that Gilchrist Creek trout adapted to a lake environment better for some unknown reason.

Finally, a fifth possible explanation is that young-of-the-year trout had experienced selection for growth before I collected them. Possibly in Gilchrist Creek the smaller, slower growers, had already been eliminated by more intensive competition than trout experienced in the other donor streams.

I cannot determine from this study why the growth potential varied among the wild stocks tested. However, the results suggest that genetic degradation was not the major factor responsible for the rapid deterioration of brown trout growth in the Au Sable River between the 1960's and 1970's. The average size of 3-year-old brown trout declined 2.4 inches during this 10-year period. By comparison, there was only a 1 inch difference in growth potential between trout from the Au Sable River and Gilchrist Creek. This difference in growth potential may have required almost 100 years of differential fishing to develop (from original stocking)—a rate of only 0.1 inch in 10 years. However, this would follow only if angler exploitation had no effect on the Gilchrist Creek stock over time.

Survival of wild brown trout was about 75% per annum in this study. In view of the extremely good survival, I believe illegal cropping of trout was a negligible source of bias in assessment of trout growth. Only seven illegal anglers were observed during the study and none had any fish in possession when apprehended. Four of the violators were juveniles.

The wild strains of brown trout experienced similar survival rates in the lakes, suggesting that all adjusted equally well to their new habitats. This further demonstrates that all stocks were in good physical condition when planted in the lakes.

The survival of domestic trout in North Twin Lake was as high as wild fish. This suggests that all domestic trout were in good condition at planting and that the poorer survival and growth of domestic trout in the other three lakes was due to poorer food supplies and greater competition. In a Michigan trout stream, Alexander and Peterson (1981) also found that survival of hatchery brown trout was only about half that of wild brown trout.

Ford Lake trout had the poorest survival. This lake has the shallowest water and the highest summer water temperatures. Trout in shallower habitats typically have lower survival (Gowing 1978, 1984). Mammalian and avian predators are mostly responsible for trout losses in these waters (Alexander 1977, 1979a).

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Table 1. Number and average length of five brown trout strains planted in four experimental lakes in October 1982, number of trout recovered in gill nets and estimated population in October 1984, and survival for 1982–84.

	Planting data			Recovery data		
Experimental lake and area	Strain	Number	Length (inches)	Number netted	Estimated population	Percent survival
Ford Lake						
10.2 acres	Gilchrist Cr.	255	3.55	82	94	37
	Pigeon R.	255	4.18	105	120	47
	Domestic	255	3.90	38	45	18
	Au Sable R.	255	4.02	84	91	36
North Twin Lake						
4.8 acres	Gilchrist Cr.	120	3.55	64	78	65
	Pigeon R.	120	4.18	60	64	53
	Domestic	120	3.90	67	73	61
	Au Sable R.	120	4.02	67	89	74
South Twin Lake						
3.9 acres	Gilchrist Cr.	99	3.55	36	37	37
	Pigeon R.	99	4.18	55	56	57
	Domestic	99	3.90	19	19	19
	Au Sable R.	99	4.02	49	50	50
Hemlock Lake						
5.9 acres	Gilchrist Cr.	150	3.55	87	115	77
	Sturgeon R.	150	3.87	106	134	89
	Domestic	150	3.90	39	45	30
	Au Sable R.	150	4.02	97	110	73
All lakes						
	Gilchrist Cr.	624	3.55	269	324	52
	Sturgeon R.	150	3.87	106	134	89
	Pigeon R.	474	4.18	220	240	51
	Domestic	624	3.90	163	182	29
	Au Sable R.	624	4.02	297	340	54

Table 2. Average incremental gain in inches (±2 standard errors) for five strains of brown trout in four experimental lakes, October 1982 to October 1984.

Strain	Lake: Ford	Lake: North Twin	Lake: South Twin	Lake: Hemlock	All lakes
Gilchrist Cr.	8.537 ±0.062	9.499 ±0.062	8.635 ±0.063	9.056 ±0.062	8.947 ±0.061
Sturgeon R.	— —	— —	— —	8.569 ±0.077	8.569 ±0.077
Pigeon R.	8.040 ±0.064	9.330 ±0.064	8.122 ±0.064	— —	8.412 ±0.064
Domestic	7.534 ±0.054	8.476 ±0.053	7.747 ±0.055	8.008 ±0.053	8.060 ±0.052
Au Sable R.	7.407 ±0.061	8.487 ±0.061	7.671 ±0.061	8.174 ±0.061	7.945 ±0.060
All strains	7.982 ±0.051	8.950 ±0.051	8.119 ±0.051	8.458 ±0.051	8.388 ±0.051

Table 3. Average incremental gain in grams (±2 standard errors) for five strains of brown trout in four experimental lakes, October 1982 to October 1984.

	Lake				
Strain	Ford	North Twin	South Twin	Hemlock	All lakes
Gilchrist Cr.	259.94 ±3.30	323.28 ±3.32	264.43 ±3.37	306.99 ±3.30	289.30 ±3.25
Sturgeon R.	— —	— —	— —	286.62 ±3.29	286.62 ±3.29
Pigeon R.	255.77 ±3.30	341.82 ±3.33	272.61 ±3.33	— —	283.45 ±3.25
Domestic	215.23 ±3.37	289.54 ±3.32	233.52 ±3.49	266.84 ±3.37	260.26 ±3.25
Au Sable R.	216.92 ±3.30	286.77 ±3.32	235.36 ±3.34	283.18 ±3.30	257.36 ±3.25
All strains	240.33 ±3.25	309.48 ±3.25	255.06 ±3.25	288.22 ±3.25	274.39 ±3.25

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