STUDY **PERFORMANCE REPORT**

State: Michigan **Project No.:** F-53-R-13

Study No.: 469 **Title:** Investigations into causes of, and solutions for, recent declines in survival of trout stocked in Lake Huron

Period Covered: April 1, 1996 to March 31, 1997

Study Objective: (1) to explore methods of documenting the lacustrine early life history of stocked salmonids, with emphasis upon an understanding of factors influencing mortality during their first year at large; (2) to determine whether there are genetically based differences in early life history characteristics that affect return to the creel, by comparing performance of a lacustrine strain of brown trout with that of one of the standard domesticated strains; and (3) to define methods that can be employed to improve survival and extend average longevity of brown trout used for stocking, such that return to the creel in lakes can be improved to 10% of the number stocked.

Summary: Two strains of brown trout have been selected for study, Wild Rose and Seeforellen. The stocking phase of this evaluation was completed in 1995. Returns of the two strains continued to be monitored in 1996. Also in 1996, two study lots of Wild Rose brown trout were stocked: one lot was marked with a right ventral fin clip and stocked offshore in Thunder Bay, and a second lot was marked with a left ventral fin clip and stocked using conventional techniques from the beach. Creel census will be used to evaluate return to creel from the two groups. A replicate of the 1996 stockings is planned for 1997, but in 1997 the Seeforellen strain will be employed. The fish scheduled for 1997 were fin clipped in November 1996. Since 1991, stocking of Thunder Bay was delayed until the June peak in alewife density was reached to reduce losses to predation. Also, beginning in 1991, the selected study strains were introduced. The 1991-95 year classes of brown trout were much more successful than those of previous years. Estimated sport harvest of brown trout increased from 500 in 1991 to 2,369 in 1992 and 4,031 in 1993. Harvest declined in 1994, 1995, and 1996 to 3,498, 3,441, and 2,000 respectively. In Thunder Bay to date, Seeforellen strain has produced generally better return to creel and consistently higher yields than Wild Rose or Plymouth Rock. During the July 1996 Alpena Brown Trout Festival, the proportion of Seeforellen strain in randomly collected biological data was not significantly different than that of Wild Rose ($P>0.05$), but higher numbers of Seeforellen were entered in the tournament, probably due to their larger size. During July, 1996 age-2 and age-3 Seeforellen strain were significantly larger than Wild Rose ($P<0.05$). A similar study has been conducted on Lake Charlevoix since 1991. Creel census was conducted there from 1993-96 to assess the performance of three strains: Seeforellen, Wild Rose, Plymouth Rock. The catch rates (fish per 100 angler hours) were similar for Seeforellen and Wild Rose strains of the same age. However, in 1993 and 1994 catch rates of both Seeforellen and Wild Rose strains were at least 5 times those for Plymouth Rock strain of the same age. Paired Seeforellen and Wild Rose stocked in 1994 and 1995 survived poorly and fishing success for brown trout in Lake Charlevoix sharply declined in 1995 and 1996. Causes of the recent declines in brown trout catches at Thunder Bay and Lake Charlevoix have not been identified. In Thunder Bay, longevity, age at maturity, and gonadal-somatic indices were slightly higher for

Seeforellen than Wild Rose strain. Very few brown trout of either strain lived beyond age 3 at either study site. Conclusions of the first phase of the study are: 1) performance of Plymouth Rock strain was inferior to the other strains at both study sites; 2) although both Seeforellen and Wild Rose strains performed well, Seeforellen strain performed somewhat better than Wild Rose, usually reaching larger sizes and achieving greater longevity and return to creel.

Job 5. Title: <u>Determine return to creel of stocked trout.</u>

Findings: Stocking histories for the study period for Thunder Bay and Lake Charlevoix are given in Tables 1 and 2.

Thunder Bay.–From 1985 through 1990, an average of 100,000 yearling brown trout was stocked annually in Thunder Bay. But in 1991, the estimated harvest was only 500 brown trout (Study 427). This was the lowest estimated harvest since the creel census began. Clearly, the brown trout fishery had collapsed in Thunder Bay.

After the stocking date was changed to Mid-June, and with introduction of the test strains, harvest increased in 1992 to 2,369 and rose again in 1993 to 4,031 fish. Harvest declined in 1994, 1995, and 1996 to 3,498, 3,441, and 2,000 respectively. Causes for the recent declines are unclear. In 1996, MDNR personnel measured a total of 343 creeled brown trout, including 208 Seeforellen, 77 Wild Rose strain and 58 unmarked fish. These data will be used to produce monthly harvest estimates, by strain, and strain specific estimates of yield for 1996.

Beginning in 1993, a concerted effort was made to collect a significant amount of biological data during a discrete time period for the purpose of comparing biological parameters of the test strains. The Alpena Brown Trout Festival, held annually during mid-July, was chosen as the best opportunity to collect this data because of the large number of fish available for measurement. The data collected included length, weight, fin clip, lamprey wounding rates, visceral fat index, stomach contents, sex, maturity, and, for aging purposes, scale samples. The ratio of age-3 Seeforellen strain in the Festival catch was significantly higher than the expected 50% when compared with Plymouth Rock strain in 1993 and with Wild Rose strain in 1994 ($P<0.01$), but was not significantly different from Wild Rose in 1995 or 1996 ($P>0.05$). The incidence of age-2 Seeforellen strain was also significantly ($P<0.01$) higher than that of Wild Rose in 1994 (Table 3), but not in 1995 or 1996. Of the fish actually entered in the tournament, Seeforellen was more heavily represented. The ratio of Seeforellen (right ventral clip) to Wild Rose and Plymouth Rock (left ventral clip) was significantly higher ($P<0.01$) than the expected 50% for 1993, 1994, and 1996 but not ($P>0.05$) for 1995 tournament entries (Table 4). Based on Festival biological data, age-3 Seeforellen strain trout were significantly larger in both length and weight (Table 5) than Wild Rose in all years ($P<0.05$), which may have caused them to be more likely to be entered in the tournament. Only two age-3 Plymouth Rock fish were observed and very few fish of any strain were as old as age 4. Thus, Seeforellen strain grew faster and exhibited somewhat greater longevity but, like the other strains, displayed low survival past age 3.

The principal item in both Seeforellen and Wild Rose brown trout stomachs during the festival was alewife, but a variety of other prey was also eaten (Table 6).

Lake Charlevoix.-Three genetic strains (Seeforellen, Plymouth Rock and Wild Rose) of marked (fin clipped) brown trout have been stocked in Lake Charlevoix since 1991 (Table 2). During

1996, a creel survey was conducted on Lake Charlevoix from May 1 through September 30 to determine the performance of these strains of brown trout.

The creel survey used on Lake Charlevoix was based on a stratified design using simple random sampling within strata. Strata included area fished by month, by weekday-weekend (holiday), and by mode of fishing. Catch and effort estimates were made for each stratum and then combined to give monthly and seasonal figures. Both weekend days and three randomly selected weekdays were sampled each week. The entire angling day from 8am to 1 hour past dusk was covered. This was accomplished by breaking each day into two 8-hour work shifts, then randomly selecting the actual shift to be worked.

Two types of data were collected for each area sampled: angler party interviews for catch rates and angler (or boat) counts for effort. An angler party was defined as one or more anglers who fished together. Angler parties were interviewed at the completion of their fishing trips at various boat launching ramps, marinas, and along the shoreline. Anglers were queried as to their mode of fishing (i.e., boat, shore, or pier/dock), where they fished, how long they fished, what they fished for, the numbers (by species) of fish they kept, and the number of fishing trips they made or intended to make that day. Additional data were collected on each angler in the party such as age and sex, zip code or county of residence, and the types of angling method used (casting, still fishing, trolling, etc.). These data were recorded on an angler interview form by the census clerk.

Fishing effort was determined through instantaneous counts of anglers or boats on the lake using air flights. Five flights were made each week at randomly selected starting times--one each weekend day, and one on each of three randomly selected week days. All effort counts were recorded on a count data form by the pilots.

A total of 1,809 Lake Charlevoix anglers were interviewed during 1996. Total estimated fishing effort for Lake Charlevoix was 79,788 angler hours or 18,509 trips (Table 7). Forty-two percent of all the fishing effort during the survey period occurred during the month of June. The total number of fish caught and kept was estimated at 22,682 and consisted of 16 species of fish. The most numerous species in the catch was yellow perch (14,495), followed by walleye (3,240), lake trout (2,656), smallmouth bass (856) and brown trout (692). The brown trout sport harvest was estimated by fin clip; 362 right ventral clips, 205 left ventral clips, and 125 no clip. Scale analysis indicated that all of the no-clip brown trout were of hatchery origin. These fish probably regenerated their clipped fins, or the fin clip was of poor quality when the fish were stocked. The estimated 125 unclipped browns were assigned to the other two genetic strains based on those strains proportion in the sport catch.

Since the number of fish stocked of each strain were not equal each year, catch rates were adjusted to a stocking rate of 50,000 fish per genetic strain. Catch rates during 1993-96 of the three strains of brown trout indicated that the Plymouth Rock strain made the least contribution to the Lake Charlevoix sport catch, while the Wild Rose and Seeforellen strains were better represented (Table 8). In general, the 1991 year class of Seeforellen and Wild Rose strains produced equally as well for fish in age groups 2 and 3. However, the catch rates of both of these genetic strains declined drastically for the 1993 and 1994 year classes (Table 8).

Limited creel surveys were conducted on Lake Charlevoix during 1993-95 where anglers were interviewed to determine their rate of catch. However, during those years no fishing pressure counts were made of boats or anglers to determine total angler effort. Estimates of the brown

trout catch by strain can made for these years (1993-95) assuming total fishing effort was similar to 1996 (80,000 angler hours) and utilizing the known catch rates (adjusted for a stocking rate of 50,000). The best fishery occurred during 1993 with an estimated catch of 4,044 brown trout (Table 9). After the 1993 season, the total catch of brown trout declined to 1,000 or less. It is conceivable that the 1993 brown trout catch exceeded 4,000 fish because more angler effort was probably expended on Lake Charlevoix that season due to the good success anglers experienced for browns. However, based on these conservative assumptions, the return to the creel of the 1991 year class of Wild Rose and Seeforellen brown trout ranged from 4.2% to 3.2%, respectively (Table 10). After the 1991 year class, the combined return for age 2 and 3 Wild Rose strain fish from the 1992 and 1993 year classes declined to 1.5% and 0.8%, respectively. Similarly, the combined return for age 2 and 3 Seeforellen from the 1993 year class was less than 0.4%.

The factor(s) affecting survival of Lake Charlevoix brown trout after the 1993 season (after the 1991 year class) are not known. The decline in survival could of been caused by predators, disease or escapement from the lake. Lake Charlevoix is connected to Lake Michigan via the Pine River Channel and Round Lake. A few brown trout with Lake Charlevoix fin clips were noted in the Lake Michigan creel survey during 1993-96. However, the overall numbers were small and in general the total brown trout catch (marked and unmarked) in Lake Michigan off Charlevoix ranged from a high of 287 fish in 1993 to a low of 11 fish during 1996. The Lake Michigan brown trout catch off the Charlevoix area had the same downward trend as Lake Charlevoix during the 1993-96 time period.

The abundance of two predators, walleye and double-crested cormorants, have increased over the past several years on Lake Charlevoix. The MDNR has been stocking walleye for several years and the estimated catch of 3,200 walleye during 1996 indicates that survival has been good for this species. In addition, the numbers of migrating double-crested cormorants have dramatically increased during the past three seasons. Prior to 1991-92, cormorants were rare in the Lake Charlevoix area. During May, 1994-96 large numbers (approximately 200-250) of migrating birds were observed on the lake for a period of 10 days to 2 weeks. A flock of these birds were observed actively feeding near the Ironton stocking site during 1994-95 after the brown trout were stocked. Cormorants have been known to feed heavily on newly stocked lake trout on Lake Ontario (Ross and Johnson 1994). Yearling stocked brown trout are of a similar average size to yearling lake trout.

Evaluation of whether either or both of these predators were the main cause for the decline in survival would be relatively easy without entering into a new research study. Stocking strategies could be manipulated over a series of years to keep the newly stocked fish away from cormorants and walleye. Most cormorants continue to migrate to the north and leave the lake by the end of the first week of June. Also, most walleyes tend to occupy water depths less than 20 feet deep during June. Therefore, if stocking were to be delayed until June and if the fish could be stocked off shore in water depths greater than 80 feet, managers may be able to increase survival and produce a return to the creel beyond the 3-4% range estimated for the 1991 year class of Seeforellen and Wild Rose strains of brown trout.

Job 6. Title: <u>Assess age at maturity.</u>

Findings: One hypothesis in selection of Seeforellen brown trout for this study was that it would mature later and live longer than more domesticated strains. Fall sampling is biased toward

mature fish because few but mature fish are in shallow water where they can be easily netted. Sampling during the Alpena Brown Trout Festival in July offered an opportunity to collect a relatively unbiased sample with which to estimate maturity schedules. From these collections, there was indeed some indication that the maturation rate of Seeforellen strain was lower than Wild Rose at age 2, but all strains were nearly 100% mature at age 3 (Table 11). Few age-4 fish of any of the test strains have been identified in Thunder Bay.

Another hypothesis behind selection of the Seeforellen strain was that it's reputed longevity could be a result of lower energy expenditures during spawning. Weber (1988) determined spawning-associated mortality of the Michigan Harrietta strain brown trout was high in Thunder Bay. Wisconsin studies suggest total annual mortality of mature Wild Rose brown trout may exceed 85% (Wisconsin Department of Natural Resources, unpublished data). To evaluate this possibility, ovary weights were compared to somatic weights from Wild Rose and Seeforellen brown trout gill-netted during the fall, 1993-95. Visceral fat indices were also recorded from these ripe or nearly ripe fish. Male Seeforellen and Wild Rose brown trout were found to be spawning as early as age 1. Although Seeforellen spawners were significantly longer and heavier than Wild Rose strain at age 2 and age 3 ($P<0.05$), there was no significant difference ($P>0.05$) in apparent energy reserves, as measured by visceral fat index. For both age 2 and age 3 females, the gonadal-somatic index of Seeforellen strain was slightly below that of Wild Rose strain, but the difference was only weakly significant ($P=0.05$) at age 3, the estimates suffering from low sample sizes (Tables 12 and 13). Further sampling may have strengthened this data, however, shortage of staff (vacancy of Assistant Boat Captain position) precluded further fall sampling in 1996.

Job 7. Title: <u>Analyze data, prepare performance and final reports and technical publications.</u>

Findings: Completed as scheduled. The progress report was prepared. Graphics were prepared and presentations were made to various public interest groups and the Lake Huron Committee. A paper on the role of alewife abundance in brown trout survival in Thunder Bay was presented at the 39th Annual Conference of the International Association for Great Lakes Research.

Literature Cited:

Ross, R.M. and J.H. Johnson. 1994. Feeding ecology of double-crested cormorants in eastern Lake Ontario. Paper presented at 1994 joint annual meeting of American Wildlife Society and New York Chapter American Fisheries Society, January 26-28, Oswego, N.Y.

Weber, J. R. 1988. Return to the creel of brown trout stocked in the Great Lakes as yearlings and fall fingerlings. Pages 244-268 *in* Michigan Dingell-Johnson Annual Reports, Projects F-35-R-13 and F-53-R-4, Lansing.

Table 1.–Number of brown trout by strain stocked in Thunder Bay, 1990-96.

Year	Seeforellen	Wild Rose	Plymouth Rock	Total
1990	–	–	95,032	95,032
1991	59,288	–	58,914	118,202
1992	54,917	55,051	–	109,968
1993	56,133	57,000	–	113,133
1994	62,932	62,932	–	125,864
1995	58,098	56,390	–	114,488
1996[1]	–	89,832	–	89,832

[1] Shore vs. boat study: 42,268 stocked offshore, right ventral clip, 47,564 stocked from beach, left ventral clip.

Table 2.–Number of brown trout stocked by genetic strain in Lake Charlevoix, 1991-95.

	Stocking Year				
Strain	1991	1992	1993	1994	1995
Seeforellen	39,600	19,500		45,135	39,988
Plymouth Rock	39,800		39,992		
Wild Rose		46,400	33,786	45,100	39,980
Total	79,400	65,900	73,778	90,235	79,968

Table 3.–Number of brown trout by age group from biological data collected during the 1993-96 Alpena Brown Trout Festivals, by strain.

	1993				1994				1995					1996				
	Age 2	Age 3	Age4	Total	Age 2	Age 3	Age 4	Total	Age 2	Age 3	Age 4	Age 5	Total	Age 2	Age 3	Age 4	Age 5	Total
Seeforellen	26	12[1]	–	38	61[1]	47[1]	–	108	36	25	7	1	69	29	7	0	0	36
Wild rose	27	–	–	27	38[1]	9[1]	–	47	50	26	1	0	77	18	5	0	0	23
Plymouth Rock	–	2[1]	–	2	–	–	–	0	–	–	–	0	0	–	–	–	–	–
Unclipped	3	1	–	4	23	2	1	26	45	6	1	0	52	5	0	0	0	5

[1] Ratio of test strains (binomial test) significantly different from 0.50 ($P<0.01$): numbers stocked were essentially the same for each paired comparison (Table 1).

Table 4.–Number of each strain weighed-in during Alpena Brown Trout Festival 1993-96.

Strain	1993	1994	1995	1996
Seeforellen	203[1]	89[1]	59	93[1]
Wild Rose or Plymouth Rock	113[1]	56[1]	70	50[1]
Unknown	218	146	235	69
Total	534	291	364	212

[1] Ratio of Seeforellen to Wild Rose/Plymouth Rock significantly different (binomial test) 0.50 ($P<0.01$).

Table 5.–Comparison of lengths and weights of brown trout by year, strain, and age from Alpena Brown Trout festival, mid-July, 1993-96.

Strain	1993		1994		1995			1996	
	Age 2	Age 3	Age 2	Age 3	Age 2	Age 3	Age 4	Age 2	Age 3
Seeforellen									
Length (mm)	518	670	528	690[1]	519[1]	701[1]	721	532[1]	711[1]
Standard deviation	42	49	46	59	46	51	41	35	47
Weight (kg)	2.01	4.93	2.11	5.07[1]	2.06	5.42[1]	5.50	2.33	5.85[1]
Standard deviation	0.60	1.23	0.71	1.21	0.60	1.00	0.81	0.49	1.57
Number	26	12	61	46	37	25	7	29	7
Wild Rose									
Length (mm)	521	–	513	628[1]	500[1]	615[1]	665	504[1]	586[1]
Standard deviation	36	–	47	36	26	52	–	22	39
Weight (kg)	2.22	–	2.15	3.79[1]	2.04	3.78[1]	4.31	2.16	3.51[1]
Standard deviation	1.04	–	0.79	0.67	0.39	0.97	–	0.31	0.85
Number	27	–	37	9	50	26	1		
Plymouth Rock									
Length (mm)	–	605	–	–	–	–	–	–	–
Standard deviation	–	17.7	–	–	–	–	–	–	–
Weight (kg)	–	3.76	–	–	–	–	–	–	–
Standard deviation	–	0.23	–	–	–	–	–	–	–
Number	0	2	0	0	0	0	0	0	0

[1] Significant difference (t test: $P<0.05$) between Wild Rose and Seeforellen.

Table 6.–Stomach contents of brown trout examined during brown trout festivals of 1993-96, Thunder Bay, Lake Huron.

Strain	Age	Number of prey items observed									
		No. examined	No. void stomachs	Unidentified fish	Crayfish	Alewife	Smelt	9-Spine stickleback	Sculpin	Lake whitefish	Trout perch
Seeforellen	2	150	55	66	0	85	8	12	2	1	0
	3	96	38	30	0	72	2	3	2	0	0
Wild rose	2	128	45	47	2	85	5	10	2	0	4
	3	39	18	18	0	22	3	1	0	0	1

Table 7.–Estimated catch per hour, number caught, and effort (angler hours, trips, and days) for Lake Charlevoix, by all modes of sportfishing, 1996. Two standard errors in parentheses.

Species	Total catch per hour	Month					
		May	Jun	Jul	Aug	Sep	Season
Coho salmon	0.0001	0	0	0	0	11	11
	(0.0002)	(0)	(0)	(0)	(0)	(22)	(22)
Chinook salmon	0.0022	0	13	0	18	145	176
	(0.0017)	(0)	(19)	(0)	(37)	(127)	(134)
Rainbow trout	0.0006	8	32	0	0	6	46
	(0.0006)	(17)	(41)	(0)	(0)	(13)	(46)
Brown trout (NC)[1]	0.0016	72	53	0	0	0	125
	(0.0017)	(100)	(81)	(0)	(0)	(0)	(129)
Brown trout (LV)[1]	0.0026	80	125	0	0	0	205
	(0.0015)	(83)	(81)	(0)	(0)	(0)	(116)
Brown trout (RV)[1]	0.0045	262	95	5	0	0	362
	(0.0033)	(247)	(75)	(10)	(0)	(0)	(258)
Brook trout	0.0001	0	9	0	0	0	9
	(0.0002)	(0)	(18)	(0)	(0)	(0)	(18)
Lake trout	0.0333	472	1,309	284	377	214	2,656
	(0.0112)	(310)	(598)	(189)	(308)	(264)	(809)
Northern pike	0.0024	4	3	104	84	0	195
	(0.0031)	(8)	(7)	(182)	(169)	(0)	(249)
White sucker	0.0004	31	0	0	0	0	31
	(0.0006)	(48)	(0)	(0)	(0)	(0)	(48)
Channel catfish	0.0004	0	25	3	0	0	28
	(0.0005)	(0)	(36)	(7)	(0)	(0)	(37)
Rockbass	0.0029	0	48	79	104	0	231
	(0.0028)	(0)	(68)	(142)	(160)	(0)	(224)
Bluegill	0.0001	0	4	0	0	0	4
	(0.0002)	(0)	(9)	(0)	(0)	(0)	(9)
Smallmouth bass	0.0107	54	462	121	213	6	856
	(0.0052)	(70)	(316)	(95)	(207)	(9)	(396)
Yellow perch	0.1817	12,796	47	790	666	196	14,495
	(0.0808)	(5,876)	(62)	(1,418)	(659)	(360)	(6,091)
Walleye	0.0406	17	1,383	832	740	268	3,240
	(0.0144)	(29)	(863)	(395)	(353)	(254)	(1,044)
Freshwater drum	0.0001	0	0	8	0	0	8
	(0.0002)	(0)	(0)	(16)	(0)	(0)	(16)
Burbot	0.0001	0	0	4	0	0	4
	(0.0002)	(0)	(0)	(9)	(0)	(0)	(9)

Table 7.–Continued:

	Total catch per hour	Month					
		May	Jun	Jul	Aug	Sep	Season
Total	0.2843 (0.0887)	13,796 (5,891)	3,608 (1,111)	2,230 (1,505)	2,202 (867)	846 (530)	22,682 (6,264)
Angler hours		16,303 (5,910)	33,490 (9,025)	9,166 (1,944)	16,205 (3,387)	4,624 (1,770)	79,788 (11,609)
Angler trips		4,249 (1,553)	6,579 (1,794)	2,374 (522)	4,218 (1,006)	1,089 (426)	18,509 (2,664)
Angler days		4,234 (1,547)	6,113 (1,679)	2,345 (518)	4,132 (987)	1,089 (426)	17,913 (2,576)

[1] NC= no fin clip, LV= left ventral fin clip and RV= right ventral fin clip.

Table 8.–Catch rates (fish per 100 angler hours) of three strains of brown trout stocked into Lake Charlevoix by year class and age during 1993-96. Catch rates were adjusted for a stocking rate of 50,000 fish of each strain.

Strain	Age	Year class				
		1990	1991	1992	1993	1994
Seeforellen	2		2.163	–	0.110	0.555
	3	0.462	0.569	–	0.036	
	4	0.088	0.109	–		
	5		0.039	–		
Wild Rose	2	–	2.230	1.766	0.268	0.140
	3	–	0.763	0.525	0.195	
	4	–	0.092	0.039		
Plymouth Rock	2		–	0.225	–	–
	3	0.200	–	0.177	–	–
	4	0.017	–	0.078	–	–

Table 9.–Estimated catch of brown trout by strain and year for Lake Charlevoix. Assumes stocking rate of 50,000 fish per strain and fishing effort of 80,000 angler hours per year.

	Year			
Strain	1993	1994	1995	1996
Seeforellen	2,100	115	175	504
Wild Rose	1,784	610	708	299
Plymouth Rock	160	14	142	62
Total catch	4,044	739	1,025	865

Table 10.–Estimated catch at age and return of three strains of brown trout stocked into Lake Charlevoix during 1993-96.

Strain	Year class	Age		Catch	Percent return
Seeforellen	1990	3		648	1.3
		4		28	0.1
			Total	676	1.4
	1991	2		1,451	2.9
		3		87	0.2
		4		50	0.1
		5		16	<0.1
			Total	1,604	3.2
	1993	2		125	0.3
		3		33	<0.1
			Total	158	0.3
	1994	2		455	0.9
Wild Rose	1991	2		1,784	3.6
		3		226	0.5
		4		91	0.2
			Total	2,101	4.2
	1992	2		384	0.8
		3		358	0.7
		4		25	<0.1
			Total	767	1.5
	1993	2		258	0.5
		3		168	0.3
			Total	426	0.9
	1994	2		106	0.2
Plymouth Rock	1990	3		160	0.3
		4		1	<0.1
			Total	161	0.3
	1992	2		13	<0.1
		3		142	0.3
		4		62	0.1
			Total	217	0.4

Table 11.–Maturity rates for three strains of brown trout (sexes combined) in July during Alpena Brown Trout Festival, Thunder Bay, Lake Huron.

Age/maturity	Seeforellen	Wild Rose	Plymouth Rock
	1993 festival		
Age 2			
Number immature	8	3	–
Number mature	18	23	–
Percent mature	69.2	88.5	–
Age 3			
Number immature	1	–	0
Number mature	10	–	2
Percent mature	90.9	–	100.0
	1994 festival		
Age 2			
Number immature	15	6	–
Number mature	46	32	–
Percent mature	61.0	84.2	–
Age 3			
Number immature	1	0	–
Number mature	46	9	–
Percent mature	97.9	100	–
	1995 festival		
Age 2			
Number immature	12	6	–
Number mature	23	44	–
Percent mature	66	88	–
Age 3			
Number immature	1	1	–
Number mature	23	25	–
Percent mature	96	96	–
Age 4			
Number immature	0	0	–
Number mature	8	1	–
Percent mature	100	100.0	–
	1996 festival		
Age 2			
Number immature	11	4	–
Number mature	18	14	–
Percent mature	62	78	–
Age 3			
Number immature	0	0	–
Number mature	7	5	–
Percent mature	100	100	–

Table 12 –Lengths, weights and visceral fat index for male brown trout, by strain, sampled during fall surveys of Thunder Bay, Lake Huron, 1993-95.

	Seeforellen				Wild Rose			Plymouth Rock
	Age 1	Age 2	Age 3	Age 4	Age 1	Age 2	Age 3	Age 3
Number mature	19	56	15	1	2	27	2	0
Number immature	0	1	0	0	0	1	0	0
Mean total length (mm)	376	583[1]	726	711	440	548[1]	636	–
Standard deviation	52	78	40	–	105	40	39	–
Mean weight (kg)	0.73	2.70[1]	5.11	5.16	1.46	234[1]	3.71	–
Standard deviation	0.32	1.10	1.05	–	1.1	0.52	1.10	–
Visceral fat index	2.3	1.2	1.3	0.0	1.0	1.6	1.5	–
Standard deviation	1.4	1.1	0.9	–	1.4	1.0	2.1	–

[1] Significant difference between strains within age group (t test, $P<0.05$).

Table 13.–Lengths, weights, visceral fat and gonadal somatic indices for female brown trout, by strain, sampled during fall surveys of Thunder Bay, Lake Huron, 1993-95.

	Seeforellen				Wild Rose				Plymouth Rock
	Age 1	Age 2	Age 3	Age 4	Age 1	Age 2	Age 3	Age 4	Age 3
Number mature	0	51	26	1	2	49	11	1	1
Number immature	0	0	0	0	2	1	0	0	
Mean total length (mm)	–	583[1]	682[1]	736	441	529[1]	631[1]	690	546
Standard deviation	–	52	49	–	150	29	34	–	–
Mean weight (kg)	–	2.74[1]	4.58[1]	7.0	1.6	2.05[1]	3.45[1]	5.2	1.42
Standard deviation	–	0.95	1.02	–	1.54	0.36	0.54	–	–
Visceral fat index	–	1.3	0.8	1.0	2.0	1.1	0.7	2.0	1
Standard deviation	–	0.8	0.6	–	1.4	0.9	0.6	–	–
Gonadal somatic index	–	20.5	23.1[1]	26.1	30.6	22.6	35.7[1]	25.6	na
Standard deviation	–	4.8	6.5	–	7.9	7.6	15.7	–	–
Number		47	24		2	45	8	1	0

[1] Significant difference within age group between strains, ($P<0.05$).

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Date: March 31, 1997