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**EVALUATION OF MADISON, DONALDSON
AND KAMLOOPS STRAINS OF RAINBOW TROUT**

Salmo gairdneri IN LAKE SUPERIOR

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EVALUATION OF MADISON, DONALDSON AND
KAMLOOPS STRAINS OF RAINBOW TROUT (Salmo
gairdneri) IN LAKE SUPERIOR 1/

By

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ABSTRACT

Kamloops, Madison and Donaldson strains of rainbow trout were stocked in fall 1972 and spring 1973 in the French River estuary of Lake Superior. Recoveries of stocked strains after one or more years of lake growth were made by anglers and by a trap in the French River. Returns were highest by weight for fall stocked Donaldson (2.4 pounds per pound stocked) and by number for spring stocked Kamloops (79 fish per 1000 planted). Madison strain had the highest initial vulnerability with 26% recovered within 3 months of stocking. Length-weight functions for Kamloops and Donaldson strains were not significantly different. Madison strain were significantly lighter at a given length than the other strains.

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INTRODUCTION

Traditionally, sport fishing for rainbow trout along Minnesota's North Shore has been in the streams during the spring and fall spawning migrations (Hassinger, Hale and Woods 1974). In recent years, an increasing open water and ice fishery has developed for rainbow trout in Lake Superior although the success of the fishermen remains quite low (Hassinger, 1978).

Kamloops, Donaldson and Madison strains of rainbow trout are available for stocking in Minnesota. A study was undertaken in 1972 to evaluate the three strains for relative survival, growth and contribution to the sport fishery in Lake Superior.

The Kamloops rainbow is presently found in Lake Pend Oreille, Idaho; Lake Tahoe, California; and several large lakes in British Columbia where they are reported to grow to a large size (Scott and Crossman, 1973).

The Donaldson rainbow is a strain developed through 40 years of selective breeding by Dr. Lauren Donaldson at the University of Washington. His goal was to develop a strain of rainbow that would grow faster and larger than the native rainbow and withstand greater fluctuations in water temperature (Woods, 1971).

The Madison rainbow has been the primary rainbow raised by Minnesota hatcheries and is the mainstay of a successful stocking program in inland lakes. It has shown satisfactory growth and return to the creel (Micklus and Johnson, 1965).

Wales and Borgeson (1961) compared Kamloops strain rainbows to a wild strain of steelhead and a domestic California strain and found that return to the angler was greatest for the Kamloops. Cordone and Frantz (1968), Cordone and Nicola (1970), and Rawstron (1972) all reported

Kamloops strain to be superior to or to have the best potential of various strains they tested. Hansen and Stauffer (1971) compared Michigan domestic and two other strains of steelhead trout when stocked in the Great Lakes according to various plans and found no consistent differences in returns among these strains.

METHODS

During fall 1972 and spring 1973, the French River estuary received a total of 88,649 fin-clipped rainbows of the three strains in five separate stockings (Table 1). In addition, 440 Donaldson strain, 921 Kamloops strain, and 633 Madison strain were identified with numbered Floy ^{2/} tags and stocked during June, 1973 in French River. Recoveries of the stocked rainbow trout were made by creel census, test netting, and captures in the weir and trap in French River during the years 1973 to 1979.

Creel census during the summer months was carried out by two full time clerks sampling 21 major landings and shore fishing areas between Duluth and Hovland. Creel census methods were according to Schupp (1964). The North Shore was divided into two sampling sections. From 1973 through 1976 a systematic sampling scheme was used for scheduling. From 1977 through 1979 probability sampling was incorporated into the census (Fleener, 1971) with information from the 1976 census used to calculate probabilities for scheduling the 1977 census. The census effort was reduced to one clerk for three months in the fall with efforts during the late fall and winter months limited to instantaneous counts and angler interviews in the vicinity of French River. Census clerks obtained information on the number of hours fished, catch by species, and length, weight

^{2/} Mention of brand name does not constitute endorsement by the Minnesota Department of Natural Resources.

and scale samples from each fish.

Test netting was conducted at various depths and locations in the vicinity of French River using 250' experimental (variable mesh) gill nets. Spawning escapement was determined by monitoring the weir and trap at French River. The trap was checked once a day with captured fish checked for clips, weighed, measured and scale samples taken as needed.

Body conformation (relative plumpness) was compared by calculating length-weight equations and then testing for significant differences. Donaldson returns from the 1972-73 stockings were not sufficient to make a reliable length-weight calculation, therefore, 11 Donaldsons from the 1975 stocking were included in the calculation. The length and weight data for each strain was converted to natural logarithms and the general equation of the curvilinear length-weight function: $\text{weight} = a (\text{length})^b$ became $\log_e \text{weight} = \log_e a + b (\log_e \text{length})$, where $a = y$ intercept and $b = \text{slope}$. With the functions now in linear form, the null hypothesis ($b_1 - b_2 = 0$ or both sample slopes are estimates of a common population slope) was tested for significance for each possible pair of strains using Student's "t" (Steel and Torrie, 1960).

Differences between calculated mean lengths were also tested for significance using Student's "t."

FINDINGS

Initial Harvest

Vulnerability to angling shortly after stocking varied considerably between stocking dates and strains stocked (Table 2). Recoveries during the summer season (3 months) of fish stocked the previous fall were 0.1% for Kamloops and 2.4% for Donaldson. Recoveries during the summer of fish stocked in May were 3.9% for Kamloops, 1.7% for Donaldson and 25.7% for

Madison.

Returns during the first summer of the Floy tagged strains stocked in June 1973 indicated an exploitation rate of 10% for Kamloops and Madison and a 6% rate for Donaldson (Table 3). These returns are considered minimal since tag returns were voluntary.

Subsequent Harvest

After the fish dispersed in fall 1973, there were no more tag returns that year. The creel census sampled no clipped fish in 1974 in the Minnesota fishery, but one tag was recovered from Wisconsin waters. Tag recoveries in later years (Table 4) indicated that at least some of the fish moved great distances after stocking. One tag was recovered at Madeline Island, Wisconsin in 1974 and one at Sable River, Michigan in 1976. Although few rainbows were taken during the summer months, tag returns indicated wide dispersal of all strains.

Angler recoveries after one or more years in the lake as determined by creel census were highest from the Kamloops strain (Table 5). Anglers recovered 2.9% of the Kamloops and 4.6% of the Donaldsons stocked in fall 1972. Angler recovery rates for spring 1973 stockings were 6.2% for Kamloops, 1.4% for Donaldsons and 1.6% for Madisons.

The greatest number of returns for all strains occurred after 2 and 3 summers growth in the lake when fish moved inshore and became vulnerable to anglers during the fall and winter months. Examination of these fish indicated some to be mature and these fish entered North Shore streams for spawning shortly after ice out in the spring. This behavior resulted in the high catch of Kamloops from both plants in spring 1976.

Trap Recoveries of Spawning Fish

Recoveries in the weir and trap at French River indicated Kamloops returned in the greatest numbers (Table 6). Adult fish returned after 3

summers in the lake with trap recoveries the highest in fall 1975 and spring 1976. Fall stocked Kamloops were recovered at a rate of 0.6% and spring stocked Kamloops were recovered at a rate of 1.7%. For the Donaldson strain, returns were 0.3% from the fall stocking and 0.6% from the spring stocking. Madison strain were stocked only in spring 1973 and returned at a rate of 0.6%. Kamloops demonstrated the greatest longevity with 53 fish taken in the trap in spring 1978 after 5 summers in the lake. Only one Madison strain and no Donaldson strain were taken after 5 summers (Table 6).

Overall Recovery

No stocked rainbows were recovered in gillnets. Combined angler and trap recovery indicated that by number, Kamloops showed the best return with 79 recovered per 1000 stocked. Fall stocked Donaldsons had the best recovery by weight, 2.4 pounds per pound stocked. Fall stocked Kamloops and Donaldsons were recovered at a greater rate by weight than were those from any of the spring stockings (Table 7).

Growth

Growth of the three strains during their lake life was rapid and compared favorably to domestic rainbow trout strains and wild steelhead stocked in other waters of the Great Lakes (Hansen and Stauffer, 1971).

Growth comparison was difficult because returns were scattered over a long period of time. However, a substantial number returned to the trap at French River in spring 1977. After 4 summers in the lake, 96 Kamloops averaged 24.4 inches in length and 7 pounds in weight, 5 Donaldsons averaged 23.8 inches in length and 7.6 pounds in weight, and 4 Madisons averaged 22.0 inches in length and 5.0 pounds in weight.

During the last two weeks of October 1975, 153 Kamloops and 30 Madison strain were captured in the trap. Tests for significant length difference between the two and between spring stocked Kamloops and fall stocked Kamloops were conducted using Students "t." The average length of the Kamloops in October was not significantly different ($t = .839$, $P .05$) from that of the Madison nor was there any significant difference in average length ($t = .19$, $P .05$) between the spring and fall stocked Kamloops. Very few Donaldsons were recovered in the trap during the seven years of the study, so a reliable comparison with the other strains was not possible.

Length-Weight Relationship

The slopes of the length-weight relationships of the Donaldson and Madison strains were found to be significantly different ($t = 9.88$, $P = .01$) indicating that the Donaldson rainbow was almost always heavier than the Madison at a given length. The difference between the slopes of Donaldson and Kamloops strains was not significant ($t = .20$, $P = .05$) indicating that a Donaldson and a Kamloops of equal length would weigh about the same. Regressed curves of best fit for each strain's length weight functions are shown in Figure 1.

DISCUSSION

Because stocked rainbow trout have the potential to reach a large size in Lake Superior, it is desirable to stock a strain with a low initial vulnerability so that large numbers are not removed by anglers before lake growth begins. Harvest during the summer was extremely high for spring stocked Madisons (25.7%) because they remained near the stocking site for several months. Initial recoveries of Donaldson and Kamloops strain were generally low although the Floy tagged

fish stocked in June 1973 were recovered at a higher rate (6% and 10% respectively). Anglers evidently learned of these stockings and fishing pressure was intense.

Donaldsons stocked in fall 1972 had the highest recovery rate by weight (2.4 lbs. per pound stocked), but the rate may be misleading because relatively few fish were stocked and one large fish could have unduly biased the recovery rate. Donaldsons stocked in spring 1973 had the lowest recovery rate by weight.

Kamloops stocked in spring 1973 had the highest recovery rate by number, but of the rainbow stocked in fall 1972, Donaldsons returned at a higher rate by number than Kamloops. The spring 1973 stocking of Kamloops was the largest of any during the study. A large percentage of these were ripe in December 1975 and returned to the vicinity of the French River where they attracted heavy fishing pressure. They could not negotiate the stream because of low water and most waited until the following spring to spawn and thus were concentrated and available to anglers all winter. These fish entered most of the North Shore streams immediately after ice out in spring 1976, providing an earlier stream fishery than the native steelhead. Higher than normal fishing pressure resulting from the heavy stocking and the long exposure to angling no doubt would account for the high percent return.

Additional stockings of Kamloops and Donaldsons have been made since 1973 using progeny from the original stockings. However, they have not produced the spectacular fishery of 1975 and 1976. The stockings have been small and scattered, and the fish have not been clipped. If the fish do not concentrate for spawning in the fall, the reason may be that conditions along the North Shore are more conducive to spring

spawning and the fish are reverting to the typical rainbow pattern of spring spawning. To maintain the desirable fall spawning pattern, captive broodstock would be necessary.

Of the rainbows stocked in 1972 and 1973, the growth rate of Kamloops and Donaldsons appeared to be similar based on limited observations. Madisons were substantially smaller by weight at the same age. However, returns of Donaldsons and Kamloops strains stocked in 1975 indicate that Donaldsons may have a better growth rate than Kamloops. The mean length of 67 Donaldsons in spring 1978 (age III) was 23.9 inches as compared to a mean length of 23.1 inches for III + Kamloops in October after an additional summer's growth.

The "circus atmosphere" created by the concentration of large numbers of trophy rainbows is objectionable to some anglers. However, few recoveries are made during the summer open water fishery and the inshore fishery is necessary for maximum harvest.

Concerns over the possibility of the introduced strains mating with naturalized steelhead and changing their genetic integrity appear unfounded. The introduced strains spawned earlier and in lower reaches of the stream than the steelhead.

RECOMMENDATIONS

Kamloops and Donaldson strains appear to be the best choices of the strains tested. If a high rate of return by weight is desired, Donaldsons are probably the best strain to stock. If a high numerical return is important and a slightly smaller average size is acceptable, Kamloops appear to be a better choice. However, numerical returns in this study were difficult to assess because Kamloops stockings were much larger than Donaldson stockings and thus attracted a disproportionate amount

of fishing pressure. If stockings of Madisons and Donaldsons had been as large as those of Kamloops, perhaps fish would have been more concentrated and attracted more angling pressure, thus improving their rates of return.

Both strains are capable of producing a quality fishery with either spring or fall stocked fish. In terms of efficiency, fall stocked fish produce the best return per pound of fish stocked. More study is needed to determine with certainty which strain would produce the best numerical return if variables like stocking rate and fishing pressure were equal.

Consideration should be given to distributing sufficient quantities of imprintable fish in a number of streams to disperse fishing pressure and yet achieve maximum utilization of the fish.

Most rainbow trout strains spawn in spring. However, the progeny of captive Donaldson and Kamloops strain broodstock spawn in late fall or early winter. Returns of stocked fish should be continually monitored to determine reversion to characteristic spring spawning habits. Maintenance of hatchery broodstock may be necessary to ensure the fall spawning behavior that results in the successful late fall and winter fishery.

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Table 1. Initial stockings of three strains of rainbow trout made in French River estuary of Lake Superior - 1972 and 1973.

<u>Fall 1972</u>				
<u>Strain</u>	<u>Number</u>	<u>Rate</u>	<u>Pounds</u>	<u>Clip</u>
Donaldson	2,000	8/lb.	250	Adipose, Left Rear
Kamloops	25,000	8/lb.	3,125	Adipose, Right Rear
<u>Spring 1973</u>				
Donaldson	3,972	2.4/lb.	1,667	Both Front
Kamloops	37,688	3.0/lb.	12,900	Both Rear
Madison	19,989	3.0/lb.	6,667	Left Front

Table 2. Estimated initial angler recoveries of the marked strains of rainbow trout stocked in Lake Superior - 1972 and 1973.

<u>Fall Stocked (1972)</u>			<u>Spring Stocked (1973)</u>		
	Kamloops	Donaldson	Kamloops	Donaldson	Madison
No. Stocked	25,000	2,000	37,688	3,972	19,989
1973 (catch)	27	72	1,459	60	5,138
% Recovered	.001	.024	.039	.017	.257

Table 3. Initial tag recoveries of 3 marked strains of rainbow trout in Lake Superior - 1973.

	Tags implanted	Tags returned	Percent harvested
Kamloops	921	94	.102
Donaldson	440	26	.059
Madison	633	62	.100

Table 4. Recoveries of tagged rainbow trout in Lake Superior after initial harvest.

Date	Location	Strain	Method
May 11, 1974	Madeline Island, Wisc.	Madison	Angling
Oct. 6, 1975	Knife River, Mn.	Kamloops	Angling
Oct. 31, 1975	French River, Mn.	Madison	Trap
Nov. 10, 1975	French River, Mn.	Madison	Trap
April 27, 1976	Sable River, Mi.	Kamloops	Angling
Nov. 1977	Knife River, Mn.	Madison	Angling
May 5, 1978	Lester River, Mn.	Madison	Angling

Table 5. Estimated angler recoveries of the marked strains of rainbow Trout after one or more years of lake growth in Lake Superior.

<u>Rainbow Trout Strains</u>						
Year	<u>Fall Stocked (1972)</u>		<u>Spring Stocked (1973)</u>			Total
	<u>K 1/</u>	<u>D 2/</u>	<u>K</u>	<u>D</u>	<u>M 3/</u>	
<u>1975</u>						
Winter	36	-	93	-	21	150
Spring	22	-	55	-	13	90
Summer	79	4	204	6	70	363
Fall	43	2	114	3	38	200
<u>1976</u>						
Winter	137	9	355	11	121	633
Spring	280	50	1300	35	40	1705
Summer	-	-	-	-	-	-
Fall	43	11	75	-	-	129
<u>1977</u>						
Winter	59	16	105	-	-	180
Spring	-	-	-	-	-	-
Summer	-	-	-	-	-	-
Fall	4	-	4	-	4	12
<u>1978</u>						
Winter	20	-	40	-	20	80
Spring	-	-	-	-	-	-
Summer	-	-	-	-	-	-
Fall	-	-	-	-	-	-
<u>1979</u>						
Winter	-	-	-	-	-	-
Spring	-	-	-	-	-	-
Summer	-	-	-	-	-	-
Fall	-	-	-	-	-	-
Total	723	92	2345	55	327	3542
Percent Recovered	2.9	4.6	6.2	1.4	1.6	4.0

1/ Kamloops

2/ Donaldson

3/ Madison

Table 6. Recoveries of three strains of rainbow trout in weir and trap at French River.

<u>Rainbow Trout Streams</u>						
Year	<u>Fall Stocked (1972)</u>		<u>Spring Stocked (1973)</u>			Total
	K 1/	D 2/	K	D	M 3/	
<u>1973</u>						
Fall	2	-	7	5	51	65
<u>1974</u>						
Spring	2	-	2	1	13	18
Fall	2	-	1	-	1	4
<u>1975</u>						
Spring	-	-	14	-	-	14
Fall	40	2	105	3	36	186
<u>1976</u>						
Spring	83	3	387	8	12	493
Fall	1	-	2	-	-	3
<u>1977</u>						
Spring	8	-	88	5	4	105
Fall	1	-	2	-	1	4
<u>1978</u>						
Spring	6	-	53	-	1	60
Fall	-	-	-	-	-	-
Total	145	5	661	22	119	952
Percent Recovered	0.6	0.3	1.7	0.6	0.6	1.0

1/ Kamloops

2/ Donaldson

3/ Madison

Table 7. Recoveries of three strains of rainbow trout in No.'s per 1000 stocked and pounds per pound stocked for years 1974 to 1979.

<u>Numbers per 1000 stocked</u>					
	<u>Fall Stocked (1972)</u>		<u>Spring Stocked (1973)</u>		
	<u>K</u>	<u>D</u>	<u>K</u>	<u>D</u>	<u>M</u>
Angler catch	29	46	62	14	16
Spawning escapement	<u>6</u>	<u>3</u>	<u>17</u>	<u>6</u>	<u>6</u>
Total	35	49	79	20	22

<u>Pounds per pound stocked</u>					
	<u>Fall Stocked (1972)</u>		<u>Spring Stocked (1973)</u>		
	<u>K</u>	<u>D</u>	<u>K</u>	<u>D</u>	<u>M</u>
Angler catch	1.1	2.3	.9	.2	.6
Spawning escapement	<u>.2</u>	<u>.1</u>	<u>.1</u>	<u>.1</u>	<u>.1</u>
Total	1.3	2.4	1.0	.3	.7

FIGURE 1. LENGTH - WEIGHT
RELATIONSHIP OF THREE STRAINS
OF RAINBOW TROUT IN LAKE
SUPERIOR



