Marks for rainbow trout[1]

by

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Abstract

One thousand 2-year-old rainbow trout (Salmo gairdneri) were divided into five differently marked lots of 200 trout (average length, 9.0 inches) and held together in a pond at the Thompson State Fish Hatchery to determine and compare survival, growth, and loss of marks. Trout in four lots were marked as follows: (1) No. 8 ring tag and left maxillary (bone) clip; (2) No. 10 ring tag and right maxillary clip; (3) No. 3 strap tag and adipose clip; and (4) right pectoral and right pelvic fin clips. A fifth lot, the control, was not marked. The maxillary and adipose clips were used to identify trout which had lost tags; these minor clips remained visible for the duration of the study and it was assumed that they did not affect survival and growth. The trout were counted, measured, and checked for lost marks at 6, 14, 18, and 24 months after marking. Trout that died between examinations were recorded. Condition factors of several groups of marked and unmarked fish from Lake Michigan were available for comparison from another study.

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[1] Investigations conducted, in part, under Dingell-Johnson projects F-18-R and F-27-R, Michigan.

In the hatchery, virtually all of the tags remained in place for at least 14 months and until a length of 14.5 inches was reached. At 18 and 24 months, when the trout had reached lengths of about 17 inches, 94 and 86% of the trout had retained their tags; most of the loss occurred among trout tagged with No. 3 and No. 8 tags. We judge that tag retention of trout released in a natural environment would not be less. In the hatchery, survival of tagged trout was not different from that of unmarked or fin-clipped fish. No inference can be made concerning survival of jaw-tagged fish released in the wild. Growth of trout in the hatchery was inhibited slightly by the tags. On the other hand, the condition factor of tagged trout recovered in Lake Michigan was not significantly different from that of similar groups of unmarked fish, although this observation must be qualified because of small sample size.

Our hatchery experiment showed that pelvic, pectoral, and adipose fin clips can be useful for field experiments since 96, 99, and 100% respectively, were easily recognized (one-half or less regenerated) at the end of 24 months. In the hatchery, fin-clipped fish survived as well as unmarked fish, but the effect of fin clips on survival in a natural environment is not known. The growth of fin-clipped fish in the hatchery and in Lake Michigan was not different from that of unmarked fish from the same environments.

In the hatchery, 95% of the maxillary bone clips were easily recognizable (one-half or less regenerated) after 24 months. This mark would be useful in field experiments conducted by trained observers.

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MARKS FOR RAINBOW TROUT[1]

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Stauffer (1955) and Hansen (1960) reported on the release of marked wild and hatchery rainbow trout (Salmo gairdneri) in tributaries of the Great Lakes. In Stauffer's study, 1- to 3-year-old wild fish (6-9 inches long) were either tagged with No. 3 tags or were fin-clipped while migrating downstream to Lake Michigan. Hansen marked 1- to 3-year-old hatchery fish (8-9 inches long) with No. 8 or No. 10 jaw tags and released them in or near the mouths of Great Lakes tributaries. In both instances, the trout were released in May or June and recaptured in a subsequent autumn or spring when 15-20 inches long.

To help evaluate the returns from these releases, jaw-tagged, fin-clipped, and unmarked rainbow trout were held in a hatchery pond for 2 years. During this time they were examined at intervals of about 6 months to compare growth, survival, and loss of marks, all of which are influenced by type of mark, lengths of fish at marking and recovery, and the elapsed time between marking and recovery. In our hatchery

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1 Investigations conducted, in part, under Dingell-Johnson projects F-18-R and F-27-R, Michigan.

2 Mr. Hansen has since resigned from the Department.

experiment these variables were essentially the same as in the reported field studies. Thus, the hatchery study should provide an indication of the reliability and effects of these marks.

Methods

One thousand 2-year-old hatchery-reared rainbow trout (average length, 9.0 inches) were randomly divided into five lots of 200 each in April 1957. They were anesthetized with M.S. 222, measured, weighed, marked (except a control lot), and put in a single pond at the State Fish Hatchery at Thompson, Michigan. The trout in four lots were marked as follows: (1) No. 8 ring tag and left maxillary (bone) clip, (2) No. 10 ring tag and right maxillary clip, (3) No. 3 strap tag and adipose fin clip, and (4) right pectoral and right pelvic fin clips.[3] The unmarked fifth lot served as a control. The tags and the pectoral and pelvic clips had been used in the field studies cited above.

The maxillary and adipose marks were used to identify trout which had lost their tags. It was assumed that the removal of the adipose fin and the extreme end of the maxillary bone would have no important effect on survival and growth. Partial support for this assumption was provided by Shetter (1952), who reported that the removal of the adipose fin had no significant effect on survival and growth of hatchery-reared fingerling lake trout (Salvelinus namaycush). In our experiment, practically all maxillary and adipose marks remained visible (Table 1).

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[3] The Monel metal jaw tags were purchased from the National Band and Tag Company, Newport, Kentucky.

Table 1. --Percentage of maxillary bone and fin regeneration on rainbow trout in a hatchery pond at the end of four intervals

Type of clip	Months after marking	Number examined[1]	Percentage of regeneration				
			0	25	50	75	100
Left maxillary	6	159	94	1	2	1	2
(No. 8 ring tag)	14	144	85	3	8	2	2
	18	118	92	3	1	1	3
	24	85	87	1	6	3	3
Right maxillary	6	177	85	4	6	1	4
(No. 10 ring tag)	14	160	84	5	4	4	3
	18	128	93	1	2	2	2
	24	92	95	1	0	1	3
Adipose	6	179	91	7	1	0	1
(No. 3 strap tag)	14	160	92	7	0	0	1
	18	118	99	0	0	0	1
	24	80	100	0	0	0	0
Right pectoral[2]	6	164	85	12	3	0	0
	14	145	86	10	3	1	0
	18	132	88	7	4	1	0
	24	117	90	5	4	1	0
Right pelvic[2]	6	164	65	16	13	5	1
	14	145	64	19	13	2	2
	18	132	70	9	14	6	1
	24	117	69	9	18	2	2

[1] The number examined are the survivors in the pond with tags or a pectoral or pelvic fin clip. Mortality and lost tags account for the decline in numbers from the original 200 marked trout in each lot.

[2] Both fin clips were on the same lot of fish.

Thus, these marks were quite satisfactory for identifying trout that had lost their tags.

Longnose pliers were used to apply the tags in the form of a ring around the mandible. The No. 8 ring tag (.94 x .14 x .02 inch) and the No. 10 ring tag (1.16 x .20 x .02 inch) were bent into a circle and the ends abutted or slightly overlapped. The No. 3 strap tag (1.5 x .16 x .02 inch) was bent into a rectangular shape and the ends were locked together with a "tongue and eye" joint. The fins were clipped off at their base with scissors. The maxillary mark was made by removing 1/8 to 3/16 inch of the posterior end of the maxillary bone with bone-cutting forceps.

Between April 1957 and June 1958, the trout were held in a pond 50 x 25 x 3 feet outside the fence at the hatchery. In July 1958, the trout were moved to a pond (90 x 25 x 3 feet) inside the fence at the hatchery to protect them from poachers. Both ponds received their water supply from Williams Creek, whose average summer temperature was 56 F. The fish were fed heavily in the hope that they would grow as fast as rainbow trout in the Great Lakes. Predatory birds or mammals were not excluded from the ponds. Appreciable numbers of piscivorous birds (great blue heron, seagull, merganser, American bittern, and kingfisher) were killed at the hatchery but some predation doubtless occurred.

After the ponds were stocked we examined the fish at intervals of 6 (October 24, 1957), 14 (June 2, 1958), 18 (October 21, 1958), and 24 (April 16, 1959) months. At each examination, all of the fish were

anesthetized, identified as to lot, measured, and weighed. Tag loss, fin regeneration (recorded as 0, 25, 50, 75, or 100%), and erosion of the mandible by the tag were recorded. Fish which died between examinations were frozen and examined later.

Two complications arose during the study. First, about 30 alien rainbow trout appeared in the experimental pond between the June 1958 and October 1958 examinations. The presence of these alien trout was detected in October, when a bimodal length-frequency distribution for unmarked trout appeared. When the experimental fish were transferred to the pond inside the fence in July, alien trout must have been present in the pond. Because we could not accurately separate the non-experimental trout from experimental fish, the unmarked control trout were useful only for a comparison of survival and growth during the first year. The second complication was our inability to determine if missing fish had escaped or had been killed and removed by natural predators or poachers. Fish whose fate was in question included: 49 trout from the No. 8 jaw-tagged lot, 56 from the No. 10 jaw-tagged lot, 46 from the No. 3 jaw-tagged lot, 43 from the fin-clipped lot, and at least 43 from the unmarked lot. These trout were not included in any analysis.

A life history study of rainbow trout in the Black River, Mackinac County, provided additional growth data in the form of condition factors for marked and unmarked rainbow trout from Lake Michigan.

Retention of marks

Retention of jaw tags is associated with time and increase in size of the jaw after marking (Smith, 1957; Webster, 1962). With the passage of time, the tag presumably erodes the jaw and eventually the tag may be lost. Erosion is no doubt accelerated by growth of the jaw (Corson, 1959), so we have evaluated retention of jaw tags in relation to fish size and time.

Tag retention was very good for 14 months after tagging, but was appreciably poorer at 18 and 24 months (Table 2). At 6 and 14 months, when the trout averaged 13.8 and 14.5 inches long, tags were ratained equally well by fish in the three tagged lots. At 18 months, when the trout averaged 17.2 inches long, differences in tag retention were apparent (chi-square = 13.0). Further testing demonstrated that the retention of No. 10 tags was better than that for No. 8 tags (chi-square = 8.0) and No. 3 tags (chi-square = 11.8). There was no difference between retention of No. 8 and No. 3 tags. At 24 months, when the trout averaged 17.4 inches long, No. 10 tags were retained better than No. 3 tags (chi-square = 9.3). There were no other differences.

The cause of 28% of the tag loss was unknown but 72% of this loss resulted from mandibles breaking at the tag. Observations of many recently broken mandibles and the entanglement of tags in nets during examinations suggested that activity in the nets was the immediate cause of at least some jaw breakage. However, the primary cause of tag loss probably was erosion and resultant weakening of the jaw by the tags. Tag

Table 2.--Retention of three types of tags by rainbow trout in a hatchery pond at the end of four intervals after tagging

Type of tag	Months after tagging	Number examined[1]	Percentage with tags
No. 8 ring	6	160	99
	14	148	97
	18	130	91
	24	100	85
No. 10 ring	6	179	99
	14	162	99
	18	129	99
	24	97	95
No. 3 strap	6	181	99
	14	163	98
	18	134	88
	24	101	79

[1] Only live fish were examined. Mortality accounts for declining numbers.

loss was high for fish with No. 3 or No. 8 tags where erosion was relatively severe, but low for fish marked with No. 10 tags which caused relatively little erosion (Table 3). The relatively large inside diameter of the No. 10 tag (.336 inch) presumably reduced erosion and tag loss by allowing more nearly normal growth of the mandible than did the No. 8 tag (.274 inch) or the No. 3 tag (short axis, .188 inch). The greater width of the No. 10 tag may also have contributed to better tag retention.

The combined right pectoral and right pelvic fin mark (Table 1) was always identifiable. At the end of 24 months, 99% of the right pectoral and 96% of the right pelvic marks were recognizable (one-half or less of the fin regenerated).

Survival

Survival of all five lots was compared at 6 and 14 months and, for the four lots of marked trout, at 18 and 24 months (Table 4). A chi-square test revealed no significant differences among survival rates of the lots at any examination.

Growth

Jaw tags inhibited growth by a small but significant amount, but fin clips did not (Table 5). An analysis of variance showed significant differences ($p =< 0.05$) in average lengths among the lots each time they were measured after the starting date. A test of all comparisons among means (Snedecor, 1956, p. 251) was used to find these differences. At

Table 3.--Percentage of tagged rainbow trout in a hatchery pond with varying degrees of erosion of the mandible at the end of four intervals after tagging[1]

Type of tag	Months after tagging	Degree of erosion and percentage		
		None[2]	Moderate[3]	Severe[4]
No. 8 ring	6	8	56	36
	14	29	57	14
	18	27	58	15
	24	14	65	21
No. 10 ring	6	36	52	12
	14	68	31	1
	18	48	40	12
	24	14	79	7
No. 3 strap	6	4	40	56
	14	17	41	42
	18	13	52	35
	24	4	60	36

[1] The numbers of fish examined are the same as in Table 1, except at 6 months when only 25 of each lot were examined.

[2] Erosion less than 1/8 of the normal diameter of jaw.

[3] Erosion 1/8 to 1/2 of normal diameter of jaw.

[4] Erosion greater than 1/2 of normal diameter of jaw.

Table 4. --Percentage survival of five lots of marked and unmarked rainbow trout in a hatchery pond at four intervals after stocking

Type of mark	Months after stocking	Number examined[1]	Percentage surviving
No. 8 ring tag	6	172	92
	14	161	89
	18	140	84
	24	124	69
No. 10 ring tag	6	184	96
	14	173	92
	18	149	86
	24	138	67
No. 3 strap tag	6	191	94
	14	183	87
	18	147	80
	24	127	63
Right pectoral and pelvic fin clip	6	173	95
	14	167	87
	18	158	84
	24	157	75
Unmarked control	6	172	97
	14	157	94
	18	-	-
	24	-	-

[1] Fish which lost tags were not included in the table. Mortality included known-dead trout, except fish which died at examination.

Table 5.--Average total length (inches) of four lots of marked rainbow trout and an unmarked control lot in a hatchery pond at four intervals after stocking[1]

Type of mark	Months after stocking				
	0	6	14	18	24
No. 8 ring tag	9.0	13.9	14.5	17.3	17.4
No. 10 ring tag	9.0	13.7	14.5	17.2	17.4
No. 3 strap tag	9.1	13.8	14.5	17.2	17.5
Right pectoral and pelvic fin clip	9.1	14.2	14.8	17.7	17.9
Unmarked control	9.0	14.1	15.0	-	-

[1] The number examined in each lot was 200 at installation; for 6, 14, 18, and 24 months, the numbers examined are the same as in Table 1.

6 months, the only significant difference detected was the greater average length of trout marked with fin clips over those with No. 10 tags. Differences were most evident at 14 months when the average length of the unmarked lot was significantly greater than the average lengths of the three tagged lots. At 18 months, the average length of fin-clipped fish was significantly greater than trout tagged with No. 3 and No. 10 tags. At 24 months, differences were present among the four lots, but they were too small to be significant. However, the mean lengths of the tagged fish continued to be smaller than for the fin-clipped trout.

An analysis of average weights among the five experimental lots gave similar results.

Value of marks for field use

Jaw tags. --The three kinds of tags can be expected to remain in place on rainbow trout released in a natural environment for at least 14 months and/or until a length of 14.5 inches is reached. There is a possibility of tag loss for trout recaptured after a longer period of release and/or at a larger size, particularly when No. 3 or No. 8 tags are used. It is probable, however, that tag loss in the wild is less than that in the hatchery where activity in the nets contributed to tag loss.

We observed no difference in survival of tagged and untagged trout in the hatchery. However, survival of tagged trout released in a natural environment could not be determined because factors affecting survival in the hatchery differed greatly from those in natural environments.

Growth of rainbow trout in the hatchery pond was inhibited slightly by tags. Smith (1957), Youngs (1958), Eschmeyer (1959), and Webster (1962) also noted that jaw tags retarded the growth of several species of fish. In contrast, the mean condition factors of tagged rainbow trout captured after a year at liberty in Lake Michigan were not significantly different from those of a like group of unmarked trout (Table 6). However the sample sizes were small.

Fin clips.--Pelvic, pectoral, and adipose fin clips can be useful for field experiments on rainbow trout. In our study, 96, 99, and 100%, respectively, were easily recognized (one-half or less regenerated) at the end of 24 months. Shetter (1951) and Johnson and Shelton (1958), who removed these fins from small salmonids, also found little regeneration of excised pectoral and adipose fins. However, they reported that regeneration of the pelvic fin was common, perhaps because they marked small fish.

In our hatchery study, survival of fin-clipped rainbow trout probably was not directly comparable with survival in a natural environment. However, in a hatchery study of four groups of small lake trout (marked by clipping the dorsal and adipose, right pectoral, left pectoral, or right pelvic fin), Shetter (1952) concluded that fin-clipped lake trout do not suffer greater mortality than unmarked trout in natural environments.

In our hatchery study, fin clipping did not affect growth for at least 14 months. In Lake Michigan, pectoral and adipose clips also apparently did not affect growth for a like period. An analysis of variance

Table 6.--Average length and condition factor of marked and unmarked rainbow trout after a season of growth in Lake Michigan[1]

Type of mark	Origin	Year marked	Number examined[2]	Average length (inches)	Average condition factor
No. 10 ring tag	Hatchery	1956, 1958	16	16.9	37
No. 3 jaw tag	Hatchery	1955	5	16.7	37
No. 3 jaw tag	Wild	1951-1956	13	15.0	36
Dorsal and right or left pectoral	Hatchery	1957	15	15.2	39
Adipose and right pectoral	Hatchery	1957	22	16.5	38
None	Wild	1953, 1958	28	16.9	39

[1] All fish were released in May and June in the Black River at lengths of 6-9 inches. They were recovered the following spring in the Black River after a season of growth in Lake Michigan.

[2] One-third of the tagged trout were ripe females; all others were ripe males.

showed that the condition factor of recovered fin-clipped rainbow trout (dorsal and right or left pectoral, adipose and right pectoral) was not different from that of unmarked trout (Table 6).

Maxillary clips. --The maxillary clips can be used in experiments where rainbow trout are examined by trained observers, since 95% of the clipped maxillaries were recognizable (one-half or less regenerated) at the end of 24 months. It is unlikely that this small clip has an adverse effect on survival and growth.

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