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Retention of Half-Length Coded-Wire Tags in Alaskan Sockeye Salmon, *Oncorhynchus nerka*, Tagged as Emergent Fry

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ABSTRACT

Half-length coded-wire tags were implanted in emergent sockeye salmon, *Oncorhynchus nerka*, fry weighing between 0.13 and 0.14 g (approximately 3,500 fish per pound) at Big Lake Hatchery in 1984 and 1985. Replicated treatment groups were established with all combinations of tagged, untagged, clipped (adipose fin), or unmarked fish (four groups, 10 replicates). Fish were held in indoor tanks until May 1986. Tag-retention rates ranged between 92% and 98% for all fish alive at the end of the study and between 93% and 99% for samples of fish that died during the holding period. The regrowth of clipped adipose fins was negligible. Fish in two of the replicate tanks (one with tags only and the other with tags and clipped adipose fins) had to be destroyed early in the study because of an outbreak of infectious hematopoietic necrosis.

KEY WORDS: Tagging, coded-wire tags, sockeye salmon, tag retention, fin clipping, marking, half-length tags.

INTRODUCTION

Coded-wire tags (Jefferts et al. 1963) are used extensively to mark juvenile Pacific salmon, *Oncorhynchus* spp., for identification of treatment lots in returning adults. The 1-mm length of the original stainless-steel tags precludes their application to juvenile fish weighing less than a few grams. A half-length coded-wire tag (HLCWT) was developed to enable very small fish to be tagged.

Both chum, *O. keta*, (Opdycke and Zajac 1981) and pink, *O. gorbuscha*, (Kaill et al. 1986; Thrower and Smoker 1984) salmon fry have been successfully marked with HLCWTs. In fact, all five species of Pacific salmon have been tagged with HLCWTs in Alaska; but except for the above studies, there has been little documentation of the effects or results of applying the HLCWT to very small fish. This includes short- and long-term mortality of tagged fish and short- and long-term tag retention. Since the standard formulas used to expand tag recoveries assume no differential mortality of tagged versus untagged fish and no tag loss (PMFC 1985), these studies are very important.

The HLCWT has been shown to be effective for chum salmon tagged at 0.8 g (Opdycke and Zajac 1981) and pink salmon tagged as small as 0.23 g (Kaill et al. 1986). We wished, however, to initiate HLCWT programs with sockeye salmon, *O. nerka*, which are usually released between 0.15 and 0.25 g in Alaska. Since these fish are much smaller than the pink or chum salmon for which HLCWT feasibility studies had been completed, we designed special tests for sockeye salmon. We examined tagging rates, tag retention, mortality of tagged and untagged fish, and adipose-fin regeneration. The fish used in our study were not released; thus no information could be obtained on adult returns of tagged fish.

METHODS

Study fish were obtained from the Big Lake Hatchery, a state facility located northwest of Palmer in southcentral Alaska. In the spring of 1984, four treatment lots were established as follows: (1) 2,000 fish with HLCWT only, (2) 3,000 fish with clipped adipose fin plus HLCWT (Ad/HLCWT), (3) 2,000 fish with clipped adipose fin only (Ad/only), and (4) 3,000 fish with no mark or tag (Table 1). The tags were applied by a crew experienced in tagging fry-sized (approximately 0.4 g) coho salmon, *O. kisutch*. Finclipping was done by another crew with no previous marking experience. In the spring of 1985, two additional

Table 1. Rates of marking, tagging, and initial mortality of emergent sockeye salmon fry in the four treatment groups.

Treatment group	N	Speed (fish/hr)	Number in crew	Fish mortality
HLCWT	2,108	256	1	10
Ad/HLCWT	3,235	260	2	13
Ad/only	2,015	276	1	11
No mark	3,046	---	-	14

lots (Ad/only and HLCWT only) of 1,000 fry each were added to the study to replace experimental lots that had been destroyed because of an outbreak of infectious hematopoietic necrosis (IHN) in the laboratory.

Fish in the HLCWT, Ad/HLCWT, and Ad/only lots were handled following standard procedures (Moberly et al. 1977), except that the HLCWT fish did not receive adipose finclips and the Ad/only fish did not receive coded-wire tags. Since these experimental fish were not destined for release, we used wire with miscellaneous codes or blank wire for the tags. Because these were some of the smallest fish ever tagged, work proceeded slowly, and tag placement was repeatedly monitored so that adjustments to the machine could be made.

Approximately 10% of the Ad/HLCWT and Ad/only groups were "scored" for quality of the clipped fins (Moberly et al. 1977). The scoring procedure involved recording which of five zones of a fin had been cut, ranging from "A" (completely excised) to "E" (an uncut fin). Scoring of finclips is normally used to adjust mark numbers when rayed fins (e.g., the ventral) are clipped; for the present study, the scoring system was adapted for use with the adipose fin. We combined the scores from the "A" and "B" zones and those from the "C" and "D" zones for data analysis. All scoring was done by the same observer.

After they were tagged and marked, all fish (including the unmarked controls) were transported to the U.S. Fish and Wildlife Service (USF&WS) laboratory in Anchorage. The fish were divided into smaller lots of approximately 1,000 individuals each (Table 2) and loaded into round tanks. Treatments previously had been randomly assigned to tanks that were continuously supplied with well water at a temperature of 4°C throughout the 2-year duration of the study.

Table 2. Summary of growth and mortality of experimentally marked and tagged sockeye salmon.

Tank no.	Treatment	Start of study N	Start of study Mean wt(g)	Start of study Total wt(kg)	End of study N	End of study Mean wt(g)	End of study Total wt(kg)
			Fish obtained in May 1984				
10	No Mark	1,011	0.131	0.13	245	28.49	6.98
14	No Mark	1,023	0.131	0.13	553	13.74	7.60
20	No Mark	1,029	0.131	0.13	537	15.62	8.39
17	Ad/Only	1,002	0.140	0.14	658	12.34	8.12
18	Ad/Only	1,012	0.140	0.14	490	11.15	5.46
8	HLCWT	1,054	0.138	0.15	Fish destroyed		
16	HLCWT	1,050	0.138	0.14	608	14.22	8.65
9	Ad/HLCWT	1,001	0.134	0.13	Fish destroyed		
11	Ad/HLCWT	995	0.134	0.13	372	16.70	6.21
12	Ad/HLCWT	998	0.134	0.13	387	21.87	8.46
			Fish obtained in May 1985				
8	HLCWT				143	4.82	0.69
9	Ad/Only				757	2.83	2.14

Dead fish were removed and counted several times each week. All mortalities collected from the HLCWT and Ad/HLCWT treatment groups were preserved either in 10% formalin or by freezing and sent to the Alaska Department of Fish and Game Coded-Wire Tag Processing Laboratory (Tag Lab) in Juneau for positive determination of tag presence or absence. Some dead fish could not be collected for a variety of reasons (e.g., cannibalism, drain overflows). Randomly selected mortalities from all of the Ad/HLCWT and Ad/only lots were scored for quality of finclip several times during the study.

Our study was concluded in the spring of 1986; remaining live fish from all treatment groups were counted and weighed. All of those from the HLCWT and Ad/HLCWT groups were passed through a quality-control device (QCD) for tag detection. Fish not registering a tag after four passes through the QCD were sent to the Tag Lab for final determination of tag presence or absence. Samples of fish from the Ad/HLCWT and Ad/only tanks were scored for quality of finclips. All fish were subsequently destroyed.

RESULTS

Although the crew was experienced in tagging fry-sized coho salmon, some difficulties were encountered in tagging sockeye salmon fry weighing between 0.13 g and 0.14 g. The greatest difficulty was in achieving the proper angle and depth of the tags. Tag position was continually monitored visually without sacrificing fish. This was possible because the heads of these small fish are transparent.

A properly shaped head mold is essential for accurate tag placement. In this project, the tagging crew made four different head molds before one was found that consistently resulted in good tag placement. Tagging rates averaged approximately 260 fish per hour (Table 1).

The numbers of experimental fish and their weights at the start and end of our study are summarized in Table 2. Major mortalities were due to disease as well as oxygen depletion that was caused by occasional blockage of water flows in some lots.

Tag-retention rates for fish surviving to the end of the study ranged from 91.6% to 97.6% (Table 3). Tag retention rates for mortalities collected during the study were similarly high and consistent, ranging from 92.6% to 98.8% (Table 4). The average tag retention rate was 96.2% for all lots (Table 5).

Immediately after tagging and marking, 73% of the fish sampled from the Ad/HLCWT lot and 53% of those from the Ad/only lot had clipped adipose fins in the "A" or "B" zones (Table 6). Of the dead fish examined during the study, 91% of the Ad/HLCWT and 77% of the Ad/only lots had clips in the "A" or "B" zones. These proportions were similar to those for the live fish sampled at the end of the study (Table 6).

DISCUSSION

Our study shows that emergent sockeye salmon will retain a HLCWT at rates (>90%) similar to those found for larger fish tagged with full-length tags (at least under laboratory conditions). It does not seem probable the tag-retention rates for released fish would be different than that for fish kept in the laboratory, especially since it has been found that (for full-length tags) most tag loss occurs in the first 30 days after tagging (Blankenship 1981).

Table 3. Tag retention of half-length coded-wire tags in sockeye salmon that remained alive in May 1986.

Tank no.	Treatment	QCD[a/] positive	TL[b/] positive	Negative[c/]	Retention rate	95% c.i.[d/] from	to
			Fish obtained in May 1984				
8	HLCWT	Destroyed because of IHN					
16	HLCWT	580	4	24	96.1%	94%	97%
9	Ad/HLCWT	Destroyed because of IHN					
11	Ad/HLCWT	357	6	9	97.6%	95%	99%
12	Ad/HLCWT	368	5	14	96.4%	94%	98%
			Fish obtained in May 1985				
8	HLCWT	128	3	12	91.6%	85%	95%

a/ The QCD indicated that a tag was present.

b/ The QCD indicated no tag, but one was found at the Tag Lab.

c/ No tag was found by the QCD or the Tag Lab.

d/ 95% confidence intervals computed according to formulas in Fleiss (1981).

Table 4. Half-length coded-wire tag retention for sockeye salmon that died before May 1986.

Tank No.	Treatment	TL positive[a]	Negative[b]	Retention rate (%)	95% c.i.[c] from	95% c.i.[c] to
		Fish obtained in May 1984				
8	HLCWT	477	11	97.7	96	99
16	HLCWT	165	11	93.8	89	97
9	Ad/HLCWT	240	3	98.8	96	100
11	Ad/HLCWT	235	11	95.5	92	98
12	Ad/HLCWT	125	10	92.6	86	96
		Fish obtained in May 1985				
8	HLCWT	31	2	93.9	78	99

a/ The QCD indicated no tag, but one was found at the Tag Lab.

b/ No tag was found by the QCD or the Tag Lab.

c/ 95% confidence intervals computed according to formulas in Fleiss (1981).

Table 5. Summary of half-length coded-wire tag retention in sockeye salmon.

Group	Positive	Negative	Retention rate (%)	95% c.i.[a] from	to
Live at end	1,451	59	96.1	95	97
Mortalities[b]	1,251	47	96.4	95	97
TOTAL	2,702	106	96.2	95	97

a/ 95% confidence intervals computed according to formulas in Fleiss (1981).

b/ Not all mortalities were sampled for tag retention.

Table 6. Percentages of clipped adipose fins in the A+B, C, D, and E zones at different stages of the study.

Date	Treatment group	N	Clip zone A+B	C	D	E
May 1984	Ad/HLCWT	300	73%	19%	7%	1%
	Ad/only	200	53%	26%	12%	10%
June 1984 – Mar 1986	Ad/HLCWT	306	91%	5%	3%	2%
	Ad/only	308	77%	10%	3%	10%
May 1986	Ad/HLCWT	167	91%	5%	2%	2%
	Ad/only	200	80%	6%	5%	9%

We had hoped to examine the time sequence of tag loss in this study, but precautions taken because of the early outbreak of IHN precluded use of the QCD until the end of the study. However, the similarity of the tag retention rates between the fish dying during the study (Table 4) and those alive at the end of it (Table 3) suggests that most tag loss occurred during the first few months. Examination of the tag-retention data for the dead fish by date of collection revealed no discernible change in tag-retention rates over time.

After tagging naturally produced sockeye salmon fry and releasing them back into the wild, Roth and Stratton (1985) found an average tag-retention rate of 96.1% for 381 fry with clipped adipose fins after an average of 35 days following release. Roth et al. (1984) and Roth et al. (1986) report similar results. The similarity of these retention rates to those reported here also supports the hypothesis that most tag shedding occurs within a few weeks of tagging.

There did not appear to be any regrowth of clipped adipose fins during the 2 years that the fish were in the laboratory. The apparent increase in the fraction of "A" and "B" clips from the initial samples to the intermediate and final samples (Table 6) is likely due to the difficulty of scoring very small fish and the scorer's tendency to err on the side of a poorer clip. The lack of a reduction in the proportion of "A" and "B" clips over time and the consistency of the fractions of "A" and "B" clips between the mortalities and the final samples in both treatment groups strongly indicate that there was little or no regeneration of adipose fins in either group. The consistency of the fraction of "E" clips (no part of the fin missing) within each treatment group throughout all three sample times also supports this conclusion.

The apparent lack of adipose-fin regeneration confirms that the adipose clip is a good indicator for tagged fish, even when they are tagged and clipped at sizes as small as 0.13 g. Apparently, a clipped adipose fin is a better mark for sockeye salmon than a clipped ventral fin, which appears to regenerate substantially in this species (Hauser and Howe 1985). However, if the adipose clip is to be a useful indicator of a tagged adult, the absence of the fin must be obvious to an observer. Even though a half-way-clipped adipose fin probably does not regenerate, it will be less likely to be recognized on an adult fish than a completely missing fin. It is extremely important to take the extra time and care necessary to achieve high-quality adipose finclips when tagging fish of any size, especially emergent fry.

Although we found consistently high tag retention and lack of adipose-fin regeneration in this study, we cannot conclude that half-length coded-wire tagging of sockeye salmon is without problems. Zajac (1985) presents evidence that tagging may increase the susceptibility of groups of already unhealthy fish to disease outbreaks. He states that it is not clear whether this is due to handling stress or to disease transmittal on the tags themselves.

In our study, the only two lots in which IHN occurred were lots that had been tagged. Since fish with IHN had been detected and destroyed at Big Lake Hatchery approximately 2 weeks before our study fish were obtained, it is likely that the study fish harbored the disease in the carrier state. The subsequent disease outbreaks in Tanks 8 and 9 may well have been caused by the stress of tagging. Other sources of stress, such as diet, also have been considered as possible causes of the outbreak. Thus, although it is not clear that tagging led to the IHN outbreak, our study indicates a need for a careful investigation of this question.

No study of the efficacy of tagging is complete without confirmation of reasonable levels of survival of tagged fish to the adult stage. We could not obtain information on survival to the adult stage because we destroyed the study fish. Sockeye salmon fry have been successfully tagged in Alaska and recovered in fresh water during the same season (Roth et al. 1984; Roth and Stratton 1985; Roth et al. 1986; White 1986). Such recoveries of HLCWT tags from adult sockeye salmon tagged as fry would help demonstrate that the HLCWT is an effective mark for sockeye salmon. There are other potential problems with tagging sockeye salmon fry that have not been addressed in our study. For example, Morrison and Zajac (1986) showed that olfactory nerve damage can easily result when very small fish are tagged. Fish with damaged olfactory nerves may exhibit high levels of tag retention and survival as juveniles, but their ability to return to their release site might be impaired. Thus more study is necessary before the HLCWT is adopted for general use with sockeye salmon fry.

We conclude that the marking of emergent sockeye salmon fry with HLCWT is possible, but its application at a production level remains to be demonstrated. If proper care is exercised, tag retention can be acceptably high and adipose-fin regrowth can be negligible. The disease outbreak experienced in our laboratory could not be directly related to the stress of tagging, but such a relationship cannot be ruled out. Sufficient successful recoveries of HLCWTs from adult sockeye salmon tagged as fry will complete the demonstration that this tag is a good way to identify treatment lots of this species.

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