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EFFECTS OF FIN REMOVAL ON SURVIVAL AND GROWTH OF ARCTIC CHAR IN A HATCHERY ENVIRONMENT[1]

By

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ABSTRACT

Short-term survival and growth of Arctic char *Salvelinus alpinus* marked with various finclips and Floy anchor tags was studied at Clear Hatchery, Clear Air Force Station, Alaska. Mean length of the Arctic char used in the study was about 300 millimeters. There was no difference between the rates of survival of fish marked with various finclips. Rates of survival were more than 0.97 for each finclip treatment group. There was, however, a significant difference between rates of growth of fish marked with the various finclips. Mean rates of growth ranged from 57 to 62 millimeters over 70 days. There was a small but significant difference between the rates of survival for Arctic char marked with Floy anchor tags (0.98) and unmarked Arctic char (0.99). The rate of tag loss was estimated to be about 0.05.

Key Words: Arctic char, *Salvelinus alpinus*, finclip, Floy anchor tags, survival, growth, tag loss.

INTRODUCTION

Fish often are marked by removing fins (finclip) or by attaching tags. This is done to obtain information on growth, survival, movements, abundance, and other aspects of fishery biology. Results are based on examination of fish recaptured after their release. Usually it is assumed that the marking process and the type of mark does not affect the survival or growth of the fish. Failure of these assumptions and/or the loss of tags can invalidate results and give a distorted description of the population.

Studies of the effects of marks on growth and survival of marked fish have yielded mixed results. Nicola and Cordone (1973) found that, depending on which fin was clipped, finclips reduced the rate of survival of fingerling rainbow trout *Oncorhynchus mykiss* by as much as 80%. The rate of growth, however, was not reduced. For juvenile rainbow trout, Shetter (1967) found that jaw-tagged fish grew more slowly than did either finclipped or unmarked fish. However, the differences in growth over 11 months were less than 1.4 cm. Eames and Hino (1983) found that Floy anchor tags, coded wire tags, and trailer tags did not have any significant effect on rates of growth and survival of juvenile chinook salmon *Oncorhynchus tshawytscha* in a lake over two years. The estimated rate of tag loss was 2 to 5%.

By estimating the effect that marks have on fish, data can be adjusted to compensate for these effects. Results will be more accurate and provide fishery managers and scientists with better information.

The purpose of this study was to compare marking effects in a controlled environment for Arctic char *Salvelinus alpinus*. Specifically, objectives of this study were to:

1. Compare the rates of growth between Arctic char marked with Floy anchor tags and unmarked Arctic char;

2. compare the rates of growth between Arctic char marked with different fin clips;

3. compare the rates of survival between Arctic char marked with Floy anchor tags and unmarked Arctic char;

4. compare the rates of survival between Arctic char marked with different fin clips; and,

5. estimate the rate of tag loss for Floy anchor tags.

METHODS

Arctic char used in this experiment were collected as gametes from donors in Aleknagik Lake (near Dillingham, Alaska) during October 1987. The progeny were incubated and reared at Clear Hatchery (near Nenana, Alaska). The mean length of the Arctic char at the start of the experiment was about 300 mm.

On 9 March 1989, personnel from Clear hatchery selected 1,026 of these fish to be retained at the hatchery for their broodstock program. Only Arctic char in good condition were selected for the broodstock program. These fish were not marked with either Floy anchor tags or finclips. The 1,908 Arctic char not selected for the broodstock program were dipnetted from the raceway and finclipped until sample sizes were achieved for each of five groups. Arctic char from four groups were marked by completely removing one fin from each fish. Groups were distinguished by removing different fins (Table 1). The

Table 1. Number of Arctic char marked at Clear Hatchery by type of finclip.

Finclip	Number
Adipose	380
Caudal	390
None	358
Pectoral	390
Ventral	390
Total	1,907

fifth group of Arctic char was not finclipped and was used as a control. Arctic char in all five groups also were marked with uniquely numbered Floy anchor tags. The length of each fish was measured to the nearest millimeter from tip-of-snout to fork-of-tail (FL). During the marking process the Arctic char were immobilized by immersion in water treated with carbon dioxide.

When the Arctic char were examined during the marking procedure, about 25% of the fish had missing or deformed fins. This aberration was probably caused from the wearing away of fins as the fish rubbed against the concrete raceway.

The Arctic char broodstock and the Arctic char marked with Floy tags and finclips were kept in the same raceway but were separated by a divider. The broodstock occupied the upstream one-third of the raceway. Partway through the experiment, when the Arctic char grew to a size that exceeded the capacity of the raceway, the marked fish were moved to a separate raceway. At this time there was a noticeable difference in length and weight between the broodstock and the marked fish. The broodstock were fed a normal amount of food while the marked fish were fed less than a normal amount of food because of a shortage of commercially available fish food.

On 18 May 1989, each marked fish was measured (FL), examined for a finclip, and the tag number recorded. During the experiment tags that were dislodged from the fish were recovered and the tag numbers recorded. Mortalities were inspected for a finclip and the tag numbers recorded.

Analysis of Growth

The effect of different finclips on the growth of Arctic char was evaluated with analysis of variance (ANOVA) using the general linear models procedure from the computer program SAS. The null hypothesis was that growth of marked Arctic char was not influenced by which fin was removed. Growth was defined as the difference between the length of a fish at the end of the experiment and the length of the same fish at the start. A fish was not used in the analysis if; (1) at the end of the experiment, it could not be determined which fin had been removed; (2) when no length was recorded at the end of the experiment due to death or a lost tag during the experiment; or (3) when the length at the end of the experiment was less than the length at the start. When the latter happened, the length was assumed to have been recorded incorrectly.

Analysis of Survival

The effect of Floy anchor tags on the rate of survival of Arctic char was evaluated using a chi-square test. The null hypothesis was that fate was independent of being tagged. A fish was not used in the analysis if it had been removed for some reason other than death before the end of the experiment.

The effect of different finclips on the rate of survival of Arctic char was evaluated using a chi-square test. The null hypothesis was that fate was independent of fin removal. A fish was not used in the analysis if the fin recorded as removed was not the same at the start and end of the experiment, or if the fish did not have a tag at the end of the experiment.

Analysis of Tag Loss

The rate of tag loss during the experiment was estimated as follows:

$$\hat{p} = \frac{n_l}{n_t} \quad (1)$$

$$V(\hat{p}) = \frac{\hat{p}(1-\hat{p})}{n_t-1} \quad (2)$$

where:

$\hat{p}$ = the estimate of the proportion of tags lost during the experiment;

$V(\hat{p})$ = the variance of p;

n_l = the number of tags that were lost during the experiment; and,

n_t = the number of fish that were tagged.

A fish was not used in the analysis if it did not recover from the marking procedure, or if the fish was removed before the end of the experiment.

RESULTS

Of 1,550 Arctic char marked with a finclip, and 358 with no finclip, 376 and 369, respectively, could not be used in the analysis of growth and survival. This was due to either recording errors or the inability to distinguish between a finclip and fin wear in the raceway. Thirty-three fish died during the experiment and 14 were removed.

Analysis of Growth

Comparisons of growth between the broodstock Arctic char (untagged) and marked Arctic char were invalid because feeding schedules and water temperatures were different. Visual examination of marked and unmarked Arctic char in the raceways indicated that the mean length and weight of the unmarked broodstock were obviously larger than the mean length and weight of the marked Arctic char.

Mean growth for all five groups of finclipped Arctic char ranged from about 57 mm to 62 mm (Table 2). Results from the analysis of variance suggested that growth was different for at least one group of Arctic char ($F = 3.39$, $P = 0.01$; Table 2). Further analysis was done using Tukey's multiple comparison test (in the software SAS) to test for between-group differences. The results of this test suggested that average growth was significantly less for Arctic char that had a ventral finclip (Table 2).

Analysis of Survival

Results from the chi-square test indicated that fate was dependent on having been tagged ($\chi^2 = 5.54$, $P = 0.02$; Table 3). The rate of survival for the unmarked broodstock was 0.99 (seven dead, 1,019 live at the end of the experiment). The overall rate of survival for the tagged Arctic char was 0.98 (33 dead, 1,861 live at the end of the experiment).

Results from the chi-square test indicated that fate was independent of fin removal ($\chi^2 = 1.71$, $P = 0.79$; Table 4). The rate of survival for all five groups of marked Arctic char ranged from 0.97 to 0.98 (Table 4).

Table 2. Results of analysis of variance and Tukey's comparison of the mean growth of Arctic char with different finclips.

Finclip	Mean	Number	Tukey Grouping	
Adipose	62	302		A
Caudal	61	317	B	A
None	60	256	B	A
Pectoral	59	316	B	A
Ventral	57	294	B	

Alpha	0.05
Degrees of Freedom	1,480
Mean Square Error	312.44
Critical Value	3.86
Minimum Significant Difference	3.97

Table 3. Results of contingency table analysis comparing the rates of survival of marked and unmarked Arctic char.

	Fate	
Marked	Dead	Live
No	7 1%	1,019 99%
Yes	33 2%	1,861 98%
Chi-square	5.54	
Degrees of Freedom	1	
P-Value	0.02	

Table 4. Results of contingency table analysis comparing the rates of survival of Arctic char with different finclips.

Finclip	Fate	
	Dead	Live
Adipose	6 2%	302 98%
Caudal	8 2%	320 98%
None	4 2%	256 98%
Pectoral	6 2%	318 98%
Ventral	9 3%	296 97%
Chi-square	1.71	
Degrees of Freedom	4	
P-value	0.79	

Analysis of Tag Loss

Of 1,908 Arctic char originally tagged, 14 were removed and 33 died before the end of the experiment (Table 5). There were 97 Arctic char that had lost tags. The estimated proportion of tags lost during the experiment was 0.05 (SE = 0.005).

DISCUSSION

Although differences in rates of growth were statistically significant between the five groups of finclipped Arctic char, the maximum difference between means was small (about 5 mm) and was judged not biologically significant. The result from the ANOVA was significant because the sample sizes were large (n = 256 to 317) which increased the ability to detect a small difference. Based on these results it is concluded that finclips did not appreciably affect the growth or survival of Arctic char.

The test to compare the rates of survival for tagged and untagged (broodstock) Arctic char was biased because of the study design. The tagged fish included those that were rejected for the broodstock program because of poor condition. The tagged fish also were moved to a raceway with cooler water and fed less than the broodstock. Although the difference between the rates of survival of tagged and untagged Arctic char was statistically significant, the difference was small (0.98 and 0.99, respectively), and is not judged to be biologically significant. The rates of survival for all marked and unmarked Arctic char used in this study were quite high which suggests that large Arctic char at least in a hatchery environment are not affected by Floy tags, different finclips, or combinations of both.

Size of the fish and the type of mark used also affects survival and growth. The mean length of Arctic char used in this study was about 300 mm. Eames and Hino (1983) found that Floy anchor tags did not affect the growth and survival of juvenile chinook salmon of at least 150 mm in fork length. However, jaw tags applied to juvenile rainbow trout did lower the growth rate and angler exploitation rates (Shetter 1967).

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Table 5. Death of Arctic char following the marking procedure.

Day	Adipose	Caudal	Control	Pectoral	Ventral
1	1			2	1
2		1			1
6				1	
7		1		1	
11	1	1	1	1	1
13		1			
18	1				1
21				1	
22			1		
24			1	1	
31		1			
34					2
36				1	1
50				1	
52		1			
55					1
61	1				
68	1		1	1	
Total	5	6	4	10	8

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