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Evaluation of two tagging methods used to study the efficiency of Atlantic salmon hatchery operations in Iceland

by

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Abstract

Microtags injected into the snout of Atlantic salmon smolts were compared to the conventional Carlin tag with respect to survival and tag-loss. The results showed that microtagged smolts had considerably higher survival and only fractional tag-loss compared with Carlin tagged smolts. It also turned out that the Carlin tags impaired oceanic growth. There was an indication, that the increase in survival with size of smolt, often found with Carlin tags, is an artifact of the tag.

Introduction

The Atlantic salmon (*Salmo salar*) in Iceland is a very valuable species, especially as a supreme sportsfish. The catch which has been about 60,000 salmon in the last couple of years, has been increasing steadily since the 1940's, partly due to increased fishing efficiency and partly because of fish cultural activity such as building of salmon ladders and releases of various type of salmon fry and smolts.

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It is widely accepted that the main factors controlling the abundance of this species in productive river systems are the extent of spawning grounds and nursery areas for fry. It is therefore of no use of release salmon fry into a salmon stream which is already producing at full capacity. While the stream may offer options such as areas above impassable waterfalls or tributaries that by nature will allow productive use of fry plants, planting the productive area with anything but smolts cannot be expected to produce added adults returns.

Because we rarely have a basis for predicting the results of a given smolt-plant we need a means to measure the performance of our efforts. However, once the young salmon are released there is usually no innate characteristic of the fish that allows us to determine whether specific adults resulted from our planting so it is necessary to mark the individuals before release. Historically, this has been accomplished for Atlantic salmon primarily with Carlin and other dangler-type tags and with fin excision.

In Iceland, extensive experimentation involving smolt tagging and "ocean ranching" has been conducted at the Kollafjörður Experimental Fish Farm, since 1966. Review of the facilities and tagging experiments is presented by Gudjonsson (1970) and Isaksson (1976). Most of the tagging experiments have been carried out using Carlin or plastic tags. These are external dangler type tags which have been shown to have considerable negative effect on survival (Isaksson 1976). It is, therefore, of great importance to find a salmon tag which does not effect the survival of the fish and can be economically applied to great numbers of smolts. The purpose of the present experiment is to determine whether the microtag of Jefferts et. al. (1963), which has been used extensively for similar purposes with Pacific salmon (Onchorhynchus sp.) is better than the conventional tags used for Atlantic salmon with respect to survival, tag retention and general applicability.

The Tagging Technique

Carlin tags have been used extensively in Atlantic salmon research in Europe. These tags have high information capacity

since each fish has a number which can be seen on the outside. They have given considerable information about the migration of salmon in the high seas; a number of Icelandic tags have been recovered in West-Greenland, Norway and the Faroe Islands.

The microtagging technique was developed in recent years for marking Pacific salmon. Methods of application and recovery are described by Bergman et. al. (1968). These tiny encoded tags are injected into the snout of smolts and must be excised upon return to be decoded. Consequently their use with Atlantic salmon is restricted to applications where the tag can be conveniently retrieved. Since the tag allows many different identifications and has been shown with Pacific salmon to have relatively low tag loss or tag induced mortality, it was felt that the technique could provide considerable new information about Atlantic salmon smolt survival and would be an excellent tool to calibrate the dangler tags.

Each salmon tagged with the microtag in these experiments had its adipose fin removed. This speeds up recovery since the adipose clipped salmon can be recognized by this external mark. The adipose fin does not regenerate and its loss apparently does not have a major effect on the survival under the conditions discussed here.

During recovery, all microtagged salmon were taken from the salmon trap at the Kollafjörður station. Inside the station each salmon with a missing adipose was checked for a magnetic tag with a special detector. If the salmon did have a tag, the tag was removed with a cork bore no. 7-9. The cores were put in labelled vials and subsequently dissected and decoded. It was a fairly efficient process and 2 people accomplished 50-60 cores per hour.

The Experiments

The tagging experiments were conducted during the 1974 and 1975 tagging seasons. The primary purpose was to calibrate the Carlin tag by comparing the survival of fish carrying this tag to the survival of microtagged fish in the same size category, and

to use microtags to check on dangler tag loss. The detailed experimental design and the numbers tagged are shown in table 1 for both years. Length is used as a major variable because evidence exists (Ísaksson 1976) that dangler tag effects are more extreme on small fish. In the 1974 experiment, the two smaller length groups overlap because sorting was done previously with a mechanical bar-grader, but in the 1975 experiment, hand sorting was performed to make groups more exact. It should be noted that some of the blocks in the experimantal design are empty, which was caused by the lack of smolts of certain types or sizes. This also accounts for uneven sample sizes. The principal measure of Carlin tag loss was based on double taggin with Carlin and microtags.

In addition to the above parameters it was dicided to test in the 1975 tagging experiment two release methods and three release times. Microtagged smolts were released above and below a freshwater lagoon which is located in the Kollafjörður watershed and might delay migration. Smolts with varying degree of smoltification were released in April, May and June. This was done in order to see variability in survival and weight as a function of release time as well as the influence of smoltification. The experimantal design is shown in table 2. Unfortunately there are numerous gaps in the table due to shortages of smolts in these particular groups. The smolts from each group were released when they were expected to yield the most information. Thus, the early smoltifiers (1-year-early) were released in April and May, the late smoltifiers (1-year-late) in May and June. The degree of smoltification was primarily judged by the amount of degree-days that the smolts had been exposed to before release.

Results

A. Comparison of microtag and Carlin tags.

The comparison of microtags and Carlin tags with respect to survival and weight in the 1974 tag experiments is shown in table 3. The following conclusions were drawn.

1. On the average 1.6 microtagged salmon returned for each Carlin tagged salmon when released in the same numbers.

2. There was a strong indication that the Carlin tags especially reduced survival in smaller size classes. On the other hand some groups of small microtagged smolts had very good survival.

3. Upon adult return, the microtagged salmon were 100 to 300 grams heavier than the Carlin tagged salmon, with the greatest difference in the small smolts, again suggesting the greater effect of Carlin tags on smaller fish.

4. There were no differences in sex ratios of returning adults tagged with Carlin tags and microtags.

5. Tag loss (Table 4) of Carlin tags was approximately 10% (90%, confidence interval 2.4%-17.1%), plastic tags attached with polyethylene thread had a mean loss of 24% (conf. Interv. 16.1%-33.9%), microtags had a mean loss of 1.7% (conf. Interv. 1.3%-2.1%).

Due to inferior smolt quality, unsuitable release time and excessive handling during size grading the 1975 comparison gave very poor returns which provided less conclusive comparison between the two tag types. This data will not be elaborated on in this summary.

B. Comparison of time and location of smolt releases.

The pertinent data from the 1975 tagging experiment is shown in figure 1. Main findings were as follows.

1. Smolt releases above the lagoon at Kollafjörður Fish Farm were superior to releases below the lagoon in all comparisons. This was inconsistent with results obtained in the 1973 tagging experiment (Ísaksson 1976) and the 1976 tagging experiment which seem to favor releases below the lagoon.

2. June smolt releases were superior to May releases and April releases were much inferior to all other release times in all smolt types tested in the 1975 experiments.

3. Smolts released in June were significantly smaller at return than smolts released in May.

4. Smolts released in June tended to return earlier as adults than smolts released in May, which relates to size differences.

References

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Table 1. Experimental design of 1974 and 1975 tagging experiment regarding calibration of Carlin tags and tag loss.

1974 experiment

Type of tag	Type of smolt	Fork length (cm) 9.5-14.5	13.6-16.5	16.6-19.5
Carlin-[1]	2-year-outdoor	500	2x500-[2]	2x500
	2-year-photoperiod	2x500	2x500	2x500
Microtag	2-year-photoperiod	2x500	2x950	78
	1-year-photoperiod	2x500	2x1000	
Microtag & ventral	2-year-outdoor	2x500 L.V.	2x1000 R.V.	2x500 R.V.
Carlin & microtag	2-year-outdoor		843	
Plastic & microtag	2-year-outdoor			1000

1975 experiment

Type of tag	Type of smolt	Fork length (cm) 9.5-11.9	12.0-14.4	14.5-17.0
Carlin-[1]	2-year-outdoor	800	800	800
		2x400	2x400	2x400
Microtag	1-Year-photoperiod		2x400	2x400
Carlin & microtag	2-year-outdoor	400	400	400

1) Carlin tags were divided into replicates of odd and even tag numbers.

2) 2x500 means two replicates of 500 each; in one replicate, all fish bear the same microtag code.

Table 2. Experimental design of 1975 comparisons of smolt types by age, release times, and above- and below-lagoon release locations.

Age	Smolt-type	April 25		May 25		June 25	
		Above lagoon	Below lagoon	Above lagoon	Below lagoon	Above lagoon	Below lagoon
	Early photoperiod		500	500	500		
			500	500	500		
	Usual	500	500 [1)]	500	500	500	500
		500	500	500	500	500	500
	Late			500	500		500
				500	500		500
2-year	Usual photoperiod			500			
				525			
	Outdoor	2x500	500	2x590	500	500	500
		2x500	560	2x590	500	500	570
Total = 18,835, excluding [1)]							

1) In addition, two replicates of 500 each that received unusually severe handling were released.

Table 3. Comparison of Microtags and Carlin tags in the 1974 Tagging Experiment. All the figures are obtained from grilse recoveries in 1975 except for the ones in parenthesis which include the second recovery season.

Type of tag	Type of smolt	Size of smolts cm.	Return rate	Mean weight of return	Sex ratio % females	Number tagged
Microtag	2-year-outdoor	9.5-14.5	7.6 (8.8)	2.39	42%	1000
		13.6-16.5	7.5 (8.0)	2.49	60%	2000
		16.6-19.5	13.0(13.4)	2.85	58%	1000
	2-year-photo-period	9.5-14.5	11.9(13.3)	2.51	57%	1100
		13.6-16.5	10.9(11.6)	2.70	57%	1900
		16.6-19.5	11.5 -	2.82	-	78
	1-year photo-period	9.5-14.5	6.9 (7.4)	2.83	45%	1000
		13.6-14.5	6.4 (6.6)	2.95	64%	2000
Carlin	2-year outdoor	9.5-14.5	3.2 (4.5)	2.09	40%	500
		13.6-16.5	4.7 (5.1)	2.24	52%	1000
		16.6-19.5	8.5 (8.7)	2.67	60%	1000

Table 4. Tag loss for three different tag types used in the 1974-1975 experiments.

Tag used	Number returning	Number returning without tag	Percent tag loss	90% conf.interv.	Experiment year
Carlin with steel wire	41	4	9.8	2.4-17.1	1974 and 1975 pooled
Plastic with polyethylene	62	15	24,2	16.1-33.9	1974
Microtag	2,960	49	1.7	1.3-2.1	1974 and 1975 pooled

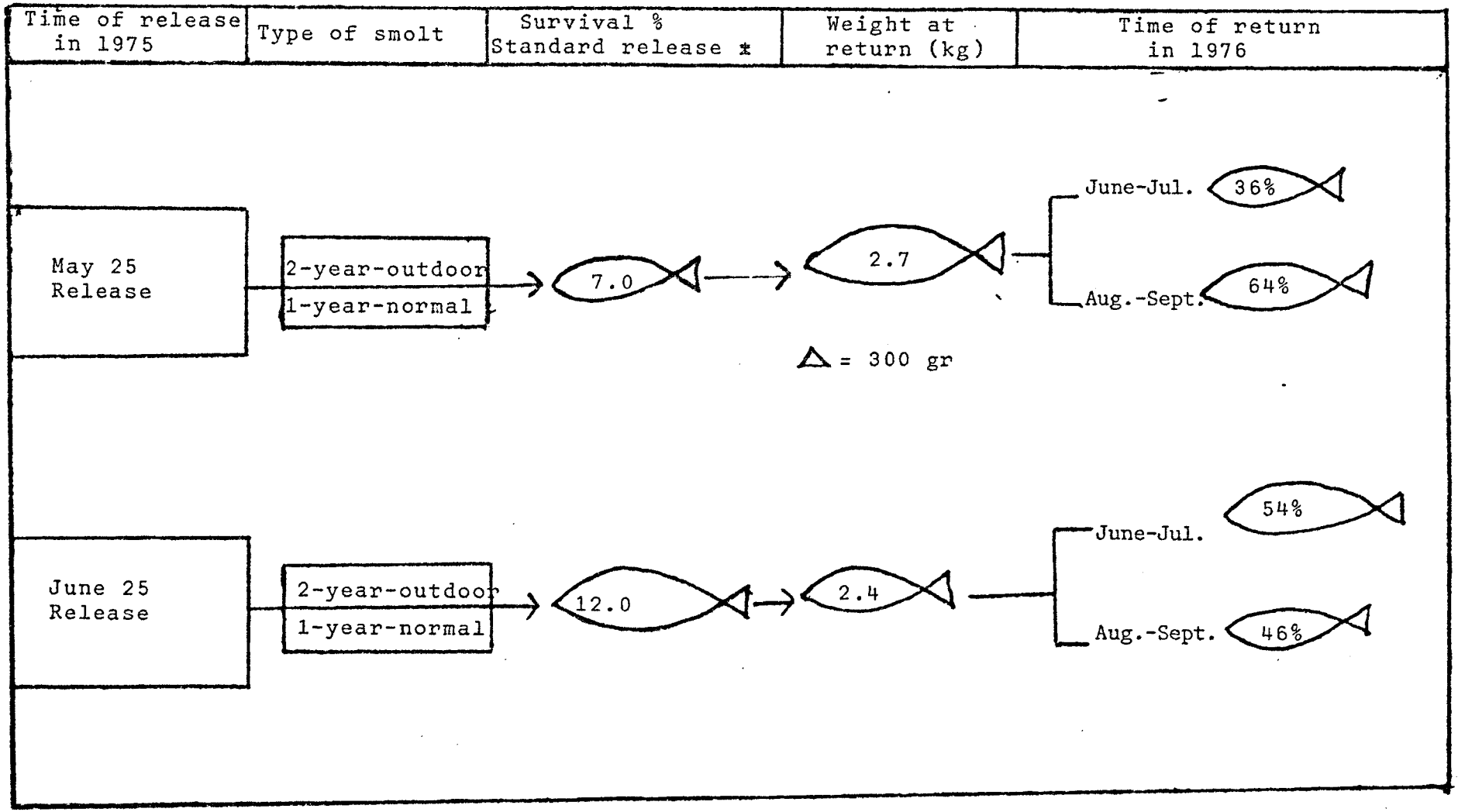

Figure 1. Migration timing and mean weight at return as a function of release time. Also shown are percent returns. Only values for the largest and most representative smolt groups are shown. Different fish sizes indicate a difference at the .05 level using analysis of variance procedures.

* Release from outdoor ponds, above lagoon.