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Relationship Between Smolt Size and Tag Return Rate for Hatchery-Reared Atlantic salmon (*Salmo salar*)

by

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ABSTRACT

The relationship between smolt size and tag return rate is examined in eight groups of hatchery-reared Atlantic salmon produced and distributed in the Maritime Provinces of Canada. Within groups the rate of tag return increased with smolt fork length up to a varying threshold size between 19 and 22 cm, and then either leveled off or declined slightly with further increases in smolt size. The direct relationship between size and tag return rate up to the threshold size was attributed to predatory causes and size-related physiological differences, although no explanation is apparent for the possible decrease in the return rate for smolts exceeding the threshold size.

INTRODUCTION

An objective of the hatchery evaluation program for Atlantic salmon hatcheries operated in the three Maritime Provinces of Canada has been to define limits on various parameters pertinent to optimizing the production capability of the hatcheries. One of the parameters that has received considerable discussion since the hatcheries started producing smolts in the mid-1960's has been smolt size. It is obvious to fish culturists that cost per unit smolt increases with smolt size, as the larger the smolt the greater the food cost per individual and the fewer that can be produced in a given facility.

In this paper I make no attempt to define optimum smolt size, as this will vary with the hatchery facilities and operation and the fisheries management program the hatchery is supporting. The purpose of this paper is to define the relationship between smolt size and tag return rate. The data presented herein is in support of preliminary results pertaining to size and return rate reported by Ritter (1972), as well as information published for smolts produced in Swedish hatcheries and released in rivers emptying into the Baltic Sea (Carlin 1968; and Peterson 1971 and 1973).

METHODS

Data presented are for two groups of 1-year smolts (A and B) and six groups of 2-year smolts (C to H) produced in hatcheries situated in Nova Scotia and New Brunswick.

The smolts in each group were marked with modified Carlin-type tags (Saunders 1968) in late winter and early spring, just prior to release. Individual fork length measurements were recorded to the nearest millimeter at tagging. Because of the closeness of tagging to release time, growth between tagging and migration as smolts is assumed to be negligible.

Smolts within each group are of common river and hatchery origin and released in the same river and year. The groups were released in different years from 1971 to 1975.

Smolts in Groups A, D, E, G, and H were of Saint John River, New Brunswick, origin, whereas smolts in Groups B and F were from parents of the Medway River, Nova Scotia. Group C, smolts originated from parent fish of the Miramichi River, New Brunswick.

Six of the groups of smolts were released in their native rivers while the two groups of Medway River origin were stocked in a river situated adjacent to and flowing parallel to the Medway River.

Tag returns used to calculate the return rates include returns from fisheries, plus escapement to the river as determined from trap counts, with the exception of data for Group C smolts. Return rates for this group of smolts is based on returns from fisheries only, a factor which is partially responsible for the low return rates recorded for the group. In the analysis of the data, smolt lengths were rounded off to the nearest cm (i.e., the 14 cm smolts include those with lengths 13.5 cm to 14.4 cm).

RESULTS AND DISCUSSION

Within the groups of smolts the rate of tag return increased with smolt fork length up to 19 or 20 cm (Fig. 1). This direct relationship between smolt size and tag return rate was the same for both 1-year and 2-year smolts and consistent with that reported in the literature (Carlin 1968; Peterson 1971 and 1973; and Ritter 1972).

The pattern of tag return rate for smolts exceeding 20 cm in fork length was variable, as tag return rates among these larger fish fluctuated both higher and lower than that recorded for the 19 or 20 cm smolts. A portion of this variability appeared to be attributed to the small number of tagged individuals in the upper size frequency classes. To reduce this effect, data for these size frequency classes in Groups D to H were combined with adjacent classes and are presented in Table 1.

TABLE 1. Comparison of tag return data for three size classes of hatchery-reared Atlantic salmon smolts. Data is presented for 2-year smolts within Groups D to H.

Group	Size class (cm)	No. released	% of total no. released	Tag return No.	Tag return %
D	19-20	17,104	46.8	332	1.94
	21-22	6,719	18.4	139	2.07
	>23	856	2.3	10	1.17
E	19-20	6.164	25.8	142	2.30
	21-22	10,922	45.7	284	2.60
	>23	6,100	25.5	134	2.20
F	19-20	3,041	38.0	96	3.16
	21-22	2,080	26.0	81	3.89
	>23	1,258	15.7	34	2.70
G	19-20	1,078	9.0	42	3.90
	21-22	3,482	29.0	130	3.73
	>23	6,924	57.7	217	3.13
H	19-20	2,745	22.9	72	2.62
	21-22	5,693	47.5	124	2.18
	>23	2,795	23.3	68	2.43

When adjacent size frequency classes were combined, rate of tag return peaked among smolts between 19 and 22 cm in fork length, and then either leveled off or declined slightly with further increases in smolt size. In four of the five groups tag return rate dropped off among smolts exceeding the 21-22 cm size class. This drop-off in return rate was tested by chi-square analysis and found to be non-significant ($P>0.05$).

The results of these investigations confirm that tag return rates do not continue to increase with smolt fork length above a threshold size between 19 and 22 cm. This is in agreement with results reported by Carlin (1968) and Ritter (1972). In the set of data presented by Carlin (1968) tag return rate increased with smolt size up to 19 or 20 cm and then leveled off. Data presented by Ritter (1972) showed a peaking of return rate at 19 cm followed by a slight drop-off among smolts larger than 19 cm.

The direct relationship between size and tag return rate for smolts up to the threshold size for peak return rate, found within the 19 to 22 cm range, can be attributed to predatory causes and size-related physiological differences (Carlin 1968; Farmer et al 1977a and 1977b). A decrease in the return rate for smolts exceeding the threshold size, as is suggested by data presented in this paper, is not explainable.

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FIGURE 1. Plot of percent tag return and number released against smolt fork length for two groups of 1-year (A and B) and four groups of 2-year (C, D, E and F) hatchery-reared Atlantic salmon smolts. Each data set was truncated according to an arbitrary but uniform criteria to reduce erroneous fluctuation in return rates associated with few individuals in a frequency class.