OCEAN MORTALITY OF RANCHED SALMON DURING THE SECOND YEAR IN THE SEA. SMOLTS RELEASED 1988 AND 1989

By JONAS JONASSON

INSTITUTE OF FRESHWATER FISHERIES
VAGNHÖFÐI 7 112 REYKJAVIK ICELAND
TEL:+354-1-676400 TELEFAX 354-1-676420

Reykjavík, febrúar 1992 VMST-R/92003

OCEAN MORTALITY OF RANCHED SALMON DURING THE SECOND YEAR IN THE SEA. SMOLTS RELEASED 1988 AND 1989.

INTRODUCTION.

Survival rate during the second year at sea depends on many factors such as predation and fishing.

The purpose of the following estimations of mortality in the second year is to evaluate whether one should use two-sea-winter salmon stocks for ranching instead of grilse stock. At the same time the results can also give an indication of mortality of wild stocks during the second year in the sea.

In ocean ranching programs of returns micro tagged salmon in Iceland are quite well documented as almost all returning salmon return to the site of release. Salmon not returning to the site of release (strayers) return to other ranching sites or to rivers where tags are retrieved.

METHODS.

Survival rate during the second year at sea was calculated according to Murphy's method (Ricker, 1975, pp. 200-202). Murphy used the method to estimate survival during the last year of sea life. In his experiments solver salmon (Oncorhynchus kisutch) mature at age 2 and 3; among mature age-2 salmon males are in excess, whereas females are usually in excess at age 3. This is similar for Atlantic salmon in sea ranching in the southwestern part of Iceland where salmon return as 1-sea-winter salmon (grilse) and two-sea-winter salmon. Three-sea-winter salmon are seldom found. Males frequently dominate in the grilse whereas 2-sea-winter fish are mostly females.

Let there be M' males and F' females approaching the end of their first year in sea (approaching grilse). Let x be the fraction

of 1-sea-winter males which matures, y the fraction of 1-sea-winter females that mature, and S the survival rate of non-maturing 1+ sea-winter salmon of both sexes up to the time they approach maturity as 2-sea-winter salmon. Then the expected numbers in each category are as below, and can be equated to observed numbers A, B, C, D:

	1-sea-winter salmon			2-sea-winter salmon
	Total	Maturing	Not maturing	Maturing
Males	M′	M′x=A	M′(1-x)	SM′(1-x)=C
Females	F′	F′y=B	F′(1-y)	SF′(1-y)=D

For 1-sea-winter matures (grilse), males exceed females and the difference is A-B=M′x-F′y.
For 2-sea-winter matures, females usually exceed males and the difference is D-C=S(M′x-F′y+F′-M′). If we know the ratio of the two sexes before any mature as 1-sea-winter salmon then M′/F′=a. The best approach to 'a' is killing a random sample of outgoing smolts in a ranching program and study their sex ratio, and assume that mortality of sexes is the same before they reach maturity as 1-sea-winter fish. The expressions can be developed algebraically into estimates of S (Survival).

$$S = \frac{a*D-C}{A-a*B}$$

Where the numbers of females and males returning as 2-sea-winter fish, corrected for sex ratio of outgoing smolts are in the numerator, and in the denominator, grilse counted one year earlier and also corrected for sex ratio.

Mortality is then calculated as 1-S.

If a fishery attacks 2-sea-winter salmon near the end of the life span, the method can still be used if the two sexes ar equally vulnerable or if the catch of each sex can be added in to C and D. In that event fishing mortality is included in the estimate of total mortality (1-S). If a significant number of 1-sea-winter salmon are caught in the sea, the method will fail unless estimates of number and sex of these removals are obtained and brought into the equations. In Iceland all fishing for salmon in the sea is illegal so one would expect that fishing mortality was negligible.

MATERIAL.

The material used is from two yearclasses of smolts reared at the Experimental Fish Farm in Kollafjordur SW Iceland in connection with the selective breeding work. In yearclass 1988 11.276 smolts were released of Kollafjordur ranching stock and in yearclass 1989 54.437 smolts from the same stock were released. Before release a random sample of smolts were killed and sex ratio studied. Returning fish was slaughtered at returning site. Strayers were also reported and included in the sample.

RESULTS AND DISCUSSIONS

In table 1 sex ratio is given for both yearclasses of released smolts.

Table 1. Number of males and females and sex ratio of outgoing smolts released in 1988 and 1989.

Stock	Year	Males ♂	Females ♀	Sex ratio ♂/♀
Kollafjordur	1988	105	105	1.0
Kollafjordur	1989	215	250	0.86

There is no significant difference between the the two yearclasses in sex ratio (χ =0.822 p=0.36). These sex ratios however are the best point estimates for each yearclass for sex ratio and will be used in the calculations for mortalities.

Table 2 shows the number of returning salmon as grilse and 2-sea-winter salmon grouped by sex, and mortality during the second year in the sea calculated by the previous formula.

Table 2. Number of returning salmon as grilse and 2-sea-winter salmon grouped by sex and calculated second year mortality.

Stock	Release Year	Grilse ♂	Grilse ♀	Salmon ♂	Salmon ♀	Mortality %
Kollafjordur	1988	87	13	9	35	65
Kollafjordur	1989	255	31	92	220	57

The data of the returning fish satisfy the assumptions of the above equation, where the number of males is greater than females in the grilse and more females return as 2-sea-winter salmon.

The total returns were quite low the two years or 1,28% for yearclass 1988 and 1,1% for yearclass 1989, presumably due to poor conditions in the sea.

The estimated second year mortality is very high, 65 % for yearclass 1988 and 57% for yearclass 1989. Tomasson (1988)

estimated mortality during the second year to be more than 40-50% given that the sex ratio of outgoing smolts was 1.0 without having data to support it. He concluded that the mortalities were mainly of natural causes, because there is little to indicate that the salmon from ranching programs in Iceland are caught at the high seas and no sea fishing takes place in home waters. It is known that 2-sea-winter salmon from Iceland migrate to the coast of Greenland and to the area around the Faroe Islands (Gudjonsson 1989). During the years 1989 to 1991 fishing for salmon at the sea was common in these areas and may have resulted in lower survival during these years, but it is very difficult to estimate the mortalities due to fishing alone. It is difficult to imagine natural predators on 2-sea-winter fish. These might be seals and large whales.

In the summer of 1992 more information will be added with the third yearclass where sex ratio is known on a family basis in connection with the selective breeding work for ocean ranching in Iceland. But the results show that one should seriously consider to using only grilse stocks for ranching because mortality is so high in the second year in the sea.

In the report of the working group on North Atlantic Salmon (Copenhagen 14-21 March 1991), natural mortality rate is estimated 12% per year in the West Greenland sea. The results in this paper give total mortalities that are about 5 times higher. The reason for this wide divergence in mortality estimates need to be investigated.

REFERENCES

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada, Bulletin 191.

Ricker, W.E., 1976. Review of the rate of growth and mortality fo Pacific salmon in salt water, and noncatch mortality caused by fishing. Journal of the Fisheries Research Board of

Canada 33:1483-1524.

Ritter, J.A., 1987. Marine migration and natural mortality of North American salmon (Salmo Salar L.) A doctoral thesis submitted to Dalhousie University, Nova Scotia. As quoted by Tomasson, T. 1988, about natural mortality in the sea. (Náttúrleg dánartala í sjó. Rit Veiðimálastofnunar um hafbeit bls 76-88.)

Tomasson T., Isaksson A., Oskarsson S., 1987. Ocean mortality of ranched salmon during the second year in the sea. Smolts released 1979-1982. A report presented to the Anaxat working group on Atlantic salmon at its meeting 9th-20th of March 1987.

Guðjónsson Th., 1989,. Merktir laxar veiddir utan Íslands. Skýrsla Veiðimálastofnunar VMST-R/89034 7 bls.