

Not to be cited without prior reference to the authors

*International Council for
the Exploration of the Sea*



*Anadromous and
Catadromous Fish
Committee C.M.1994/M:13*

The incidence of farmed Atlantic salmon in the long-line fishery at Faroes and in Norwegian home waters

L.P. HANSEN *Norwegian Institute for Nature Research, Tungasletta 2, N-7005 Trondheim, Norway*

R.A. LUND *Norwegian Institute for Nature Research, Tungasletta 2, N-7005 Trondheim, Norway*

J.A. JACOBSEN *Fiskirannsoknarstovan, Noatun, FR-100 Torshavn, Faroe Islands*

Abstract

We estimated the incidence of farmed Atlantic salmon in fisheries and stocks, using samples of salmon that were systematically collected from marine fisheries in Norwegian home waters and at Faroes. Furthermore, we also estimated the proportion of farmed salmon caught in Norwegian rivers by anglers and in spawning stocks. In Norwegian home waters identification was carried out by a combination of examination of external morphology of the salmon and by scale analysis. At Faroes we analysed scales only. During the commercial fishing seasons 1989-1993, the proportion of farmed salmon (unweighted means) in the Norwegian coastal fisheries has varied between 44 and 49%, which is significantly higher than in fjord fisheries where the proportion of farmed fish has varied between 10 and 21%. In freshwater the proportion of farmed salmon in anglers catches is relatively low, and has varied between 4 and 7% during the same period. However, when examining catches of brood stocks, the proportion increased considerably and varied between 21 and 38%. But the incidence of farmed fish in brood stocks appears to have declined in recent years. In all groups there are considerable variations between localities. At Faroes the samples collected in the 1982/83 and 1985/86 fishing seasons showed 1 and 4% proportions of farmed fish respectively. In the 1989/90, 1990/91 and - 1991/92 fishing seasons, the proportion of farmed fish varied between 37 and 44%, whereas in the research fishery in the 1992/93 season 27% of the salmon were estimated to be of farmed origin.

Introduction

Salmon escape from fish farms at all life stages. The escapees are caught in fisheries and enter freshwater to spawn (e.g. Hansen et al. 1987; Gausen & Moen 1991; Webb et al. 1991). Estimates, based on analyses of morphological characters and scale patterns (e.g. Lund et al. 1991; 1992; Økland et al. 1993), suggest that between 30 and 40% of the overall marine catches of salmon in Norwegian home waters are of farmed origin.

There is direct evidence that farmed salmon escaped from Norway occur in the high seas fishery at Faroes (Hansen et al. 1987), and a recent study demonstrates that the occurrence of farmed fish in this area is of the same magnitude as in coastal fisheries in Norway (Hansen et al. 1993).

When assessing wild salmon stocks from catch statistics, a high occurrence of reared salmon in the catches will reduce the precision of the estimates if they are not accounted for. It is therefore of great importance to identify and adjust for errors caused by this.

The aim of this paper is to present estimates of the proportion of farmed fish in the Faroese long-line fishery during recent years and review and update the material collected from Norwegian home waters.

Material and Methods

Samples of Atlantic salmon were systematically obtained from marine bag-net fisheries along the Norwegian coast and in fjords during the fishing season lasting from 1 June to 5 August. In freshwater, fish were collected during two periods: (1) 1 June to 18 August which corresponds with the angling season in most rivers; (2) 18 August to 30 November when samples were collected from brood stock fisheries.

As a part of a continued biological sampling programme of Atlantic salmon in the long-line fishery within the Faroes EEZ, fish were examined in order to estimate the occurrence of reared salmon in the fishery. The material analysed was available from the 1982/83, 1985/86, 1989/90, 1990/91, 1991/92 and 1992/93 fishing seasons, and was collected from the areas north of the Faroes.

In Norwegian home waters identification was carried out by a combination of examination of external morphology of the salmon and by scale analysis (Lund et al. 1989; Lund & Hansen 1991). At Faroes we analysed scales only. Scales were collected from the area above the lateral line between the dorsal and adipose fin. This method of identification has been developed by analysis of scales from Norwegian salmon of known origin (Lund & Hansen 1991).

Results

In Norwegian marine fisheries the proportion of farmed salmon appears to have been relatively stable since 1989 (Table 1). During the commercial fishing season the proportion of farmed salmon (unweighted means) on the coastal fisheries has varied between 44 and 49%, which is significantly higher than in fjord fisheries where the proportion of farmed fish has varied between 10 and 21%. In freshwater

the proportion of farmed salmon in anglers catches is relatively low, and has varied between 4 and 7% during the same period. However, when examining catches of brood stocks, the proportion increased considerably and varied between 21 and 38% (Table 2). But the incidence of farmed fish in brood stocks appears to have declined in recent years. In all groups there are considerable variations between localities.

At Faroes the samples collected in the 1982/83 and 1985/86 fishing seasons showed 1 and 4% proportions of farmed fish respectively. In the 1989/90, 1990/91 and 1991/92 fishing seasons, the proportion of farmed fish varied between 37 and 44%, whereas in the research fishery in the 1992/93 season 27% of the salmon were estimated to be of farmed origin (Table 3). It must be noted, however that this last season a relatively high proportion of the fish could not be determined as reared or wild. This reduces the precision of the estimate.

Discussion

In fisheries on the Norwegian coast the proportion of farmed salmon in the catches is systematically higher than in fjord fisheries, and even more so in the angling catches during the period 1989-1993. The reason for this difference is that a large proportion of escaped farmed salmon enters fjords and rivers after the fishing season has closed (Lund et al. 1991). In a single salmon fishery in western Scotland, Webb & Youngson (1992) estimated that 22% of the catch were of reared origin. Because this value was based on morphological data alone, it cannot be compared directly with the values obtained in Norway.

The high numbers of escapees from fish farms in the Faroes fishery is of the same order of magnitude as in Norwegian home water fisheries. Previous analyses of the origin of wild salmon in the Faroes fishery have suggested that Norwegian salmon is the major component of the catch (Jakupstovu 1988). Other countries contributing to this fishery are Russia, Scotland, Ireland, Sweden, Iceland and Finland.

The present material shows that large numbers of reared salmon have been present in the Faroes long-line fishery over the past four fishing seasons, despite that the number of fish sampled in the 1989/1990 and 1990/1991 seasons was small. However, analyses of scale samples collected during the 1982/83 and 1985/86 fishing seasons showed that during these years the occurrence of reared fish was small. This is supported by the fact that the overall production of farmed salmon at that time was much smaller than at present.

The methodology used in the present study tends to underestimate the proportion of reared fish, in particular those escaped at the freshwater stage, or at an early marine stage (Lund et al. 1989; Lund & Hansen 1991). On the other hand, the method will also detect a part of salmon released for ranching or as smolts in stock enhancement programmes. However, a large part of these fish carry external or internal tags, often combined with fin clips. The salmon analysed in the present material were screened for tags, and tagged fish were not included in the analysis. Furthermore, the number of hatchery reared smolts released into rivers in the east Atlantic is relatively small compared with the number of wild salmon present, except in Iceland where ranching has been established as an industry. However, very few fish tagged in Icelandic ranching operations have been reported from the Faroese

fishery, suggesting that they exploit other feeding areas. All in all, this suggests that deliberately released salmon smolts are a small component of the salmon sampled, and that escaped farmed salmon account for the major proportion.

Production of farmed salmon in the east Atlantic takes mainly place in four countries (Anon. 1993). The production of farmed salmon in 1991 and 1992 was 155,000 and 140,000 tonnes in Norway, and the corresponding figures from Scotland were 40,000 and 36,000 tonnes respectively. In the Faroe Islands the production of farmed salmon was 15,000 and 17,000 tonnes the two respective years. In Ireland ca 9,000 tonnes were produced both years.

Salmon escape from cages in relatively high numbers. Research carried out in Norway indicates that adults of escaped farmed fish in most cases return to the area from where they escaped (Hansen & Jonsson 1991). The high proportion of farmed salmon in the Norwegian home water fisheries combined with the fact that Norway accounts for the major production of farmed salmon in the Atlantic, strongly suggest that most farmed salmon occurring in the Norwegian Sea are of Norwegian origin. It is also reasonable that farmed fish escaping from cages in Scotland, Faroes and Ireland also contribute to the Faroese fishery.

When assessing salmon fisheries and wild salmon stocks, it is important to estimate the farmed and ranched component. A high proportion of such fish present, which are not accounted for, will overestimate the catches of wild salmon and mask the size and status of the wild stocks.

Acknowledgements

We sincerely thank the crew on "Polarlaks", and Suni Lamhauge for carrying out the sampling. We are also much indebted to Gunnell Østborg and Finn Økland for helpful assistance in the laboratory. The Faroese Government, the Norwegian Research Council and the Directorate for Nature Management provided financial support.

References

- Anon. 1993. Report of the north Atlantic salmon working group. *I.C.E.S. C.M. 1993/Assess:10*, 210 pp.
- Gausen, D. & Moen, V. 1991. Large-scale escapes of farmed Atlantic salmon (*Salmo salar*) into Norwegian rivers threaten natural populations. *Canadian Journal of Fisheries and Aquatic Sciences* **48**, 945-957.
- Hansen, L.P. & Jonsson, B. (1991) The effect of timing of Atlantic salmon smolt and post-smolt release on the distribution of adult return. *Aquaculture* **98**, 61-67.
- Hansen, L.P., Døving, K.B. & Jonsson, B. 1987. Migration of farmed adult Atlantic salmon with and without olfactory sense, released on the Norwegian coast. *Journal of Fish Biology* **30**, 713-721.

Hansen, L.P., Jacobsen, J.A. & Lund, R.A. 1993. High number of farmed Atlantic salmon, *Salmo salar* L., observed in oceanic waters north of the Faroe Islands. *Aquaculture and Fisheries Management* **24**, 777-781.

Jakupsstovu, H. i. 1988. Exploitation and migration of salmon in Faroese waters. In: *Atlantic Salmon: Planning for the Future* (ed. by D.H. Mills & D.J. Piggins), pp. 458-482. Croom Helm, London & Sydney.

Lund, R.A. & Hansen, L.P. 1991. Identification of wild and reared Atlantic salmon, *Salmo salar* L., using scale characters. *Aquaculture and Fisheries Management* **22**, 499-508.

Lund, R.A., Hansen, L.P. & Järvi, T. 1989. Identification of reared and wild salmon by external morphology, size of fins and scale characteristics. *NINA Forskningsrapport* **1**, 1-54 (In Norwegian with English summary).

Lund, R.A., Økland, F. & Hansen, L.P. 1991. Farmed Atlantic salmon in fisheries and rivers in Norway. *Aquaculture* **98**, 143-150.

Lund, R.A., Økland, F. & Hansen, L.P. 1992. Escapes of reared salmon in marine homewater and in riverine fisheries in 1991. *NINA Oppdragsmelding* **143**, 1-16 (In Norwegian with English summary).

Økland, F., Lund, R.A. & Hansen, L.P. 1993. Escapes of reared salmon in marine homewater and in riverine fisheries in 1992. *NINA Oppdragsmelding* **223**, 1-19 (In Norwegian with English summary).

Webb, J.H. & Youngson, A.F. (1992) Reared Atlantic salmon, *Salmo salar* L., in the catches of a salmon fishery on the western coast of Scotland. *Aquaculture and Fisheries Management* **23**, 393-397.

Webb, J.H., Hay, D.V., Cunningham, P.D. & Youngson, A.F. (1991) The spawning behaviour of escaped farmed salmon and wild adult salmon (*Salmo salar* L.), in a northern Scottish river. *Aquaculture* **98**, 97-110.

Table 1. Proportion of farmed Atlantic salmon (unweighted means) in marine fisheries in Norway 1989 -1993. n = number of salmon examined.

Year	n	No. localities	%	Range(%)
<i>Coast</i>				
1989	1217	7	45	7 - 66
1990	2481	9	48	16 - 64
1991	1245	6	49	29 - 63
1992	1162	7	44	4 - 72
1993	1477	7	47	1 - 60
<i>Fjords</i>				
1989	803	4	14	8 - 29
1990	940	5	15	6 - 36
1991	336	3	10	6 - 16
1992	307	1	21	-
1993	520	4	20	7 - 47

Table 2. Proportion of farmed Atlantic salmon (unweighted means) in rod catches (1 June - 18 August) and brood stocks (18 August - 30 November) in 1989 -1993. n = number of salmon examined. E = number of rivers sampled.

År	1 June - 18 August				18 August - 30 November			
	n	E	%	Range	n	E	%	Range
1989	5744	39	7	0-26	1791	16	38	2-77
1990	5380	39	7	0-55	2004	21	33	2-82
1991	3707	27	5	0-23	1563	22	25	0-82
1992	4034	31	5	0-24	1394	19	27	0-71
1993	2314	20	4	0-22	1032	16	21	0-64

Table 3. Proportion of farmed salmon in samples from the Faroes salmon fisheries in the period 1983 - 1993. Indet. = number of fish not possible to classify.

Season	Time	Wild	Reared	Indet.	Total	% reared
1982/1983	February 1983	48	1	1	50	2
	March 1983	63	1	2	66	2
	April 1983	63	0	5	68	0
1982/1983	Febr. - April 1983	174	2	8	184	1
1985/1986	January 1986	52	2	3	57	4
	February 1986	53	4	3	60	7
	April 1986	62	2	1	65	3
1985/1986	Jan. - April 1986	167	8	7	182	4
1989/1990	February 1990	36	32	5	73	44
1990/1991	December 1990	49	42	8	99	42
1991/1992	December 1991	71	43	5	119	36
	February 1992	76	76	6	158	48
	March 1992	57	20	2	79	25
	April 1992	66	27	5	98	28
1991/1992	Dec. 1991 - April 1992	271	166	18	454	37
1992/1993	Nov. - Dec. 1992	65	26	28	119	22
	March 1993	125	61	14	200	31
1992/1993	Nov 1992 - March 1993	191	87	41	319	27