FOCUS ON MARINE RESEARCH

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SIMULATED SALMON ESCAPES

– a series of experiments at the Institute of Marine Research

INSTITUTE OF MARINE RESEARCH
HAVFORSKINGSINSTITUTTET

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Photo: Ove Skilbrei

A species that has to be adapted to a life in captivity is subjected to a process in which it is gradually altered via goal-oriented breeding in order to enable the desired characteristics to emerge. The primary objective of such a programme is often to improve the characteristics of the species with respect to flesh quality, growth rate or resistance to disease. Because farmed individuals have a high survival rate and broodstock fish are selected on the basis of relatively few criteria, the cultured animals may become more "specialised " than the wild strains from which they originated - their genetic variability is reduced after many generations in culture. In nature, environmental conditions are more variable and challenging than those in a fish farm. Adaptation and survival demand a wide range of responses and behaviours which are not necessarily maintained in culture. If an individual escapes from a fish farm, there is a good likelihood that both the escapee itself and its descendents will have a reduced ability to survive in nature.

FARMED SALMON A THREAT

Where salmon in nature are concerned, we believe that local adaptations have led to differences between strains from different rivers (body shape, growth rate, size and age at sexual maturation, time of spawning, time of smolt migration, etc.). It is likely that escaped fish that migrate upriver will manage less well than the river's own native strain, and that wild strains may thus absorb some external influences without losing their own special characteristics. When this takes place on a larger scale, however, crossing-breeding with escapees may lead to a reduction in the production of a river. In the worst case, it is feared that local adaptations may be lost if there is a massive immigration over several years of foreign fish that produce offspring.

The salmon farming industry has developed at an explosive rate in Norway in the course of only a few decades. In 2004, almost 150 million smolt were released into the sea. The number of wild salmon is now only a fraction of the number held in captivity, and it is this ratio that is capable of creating conflicts between aquaculture and the conservation of wild stocks. There is no reason to believe that large numbers of farmed salmon are escaping from Norwegian fish farms, when escapes are measured as a percentage of the fish in the sea-cages. The problem is that even marginal percentages of escapes are capable of leading to high proportions of escapees in rivers.

NEED FOR KNOWLEDGE

The problem of escapes of salmon has led to the introduction of security zones around important salmon rivers. This protective measure has recently been strengthened and formalised via the designation of national salmon rivers and salmon fjords. The question has also been raised of whether tagging all farmed salmon would be a useful means of improving the control of escapes. Discussions of this sort illustrate the need for better knowledge about how escaped salmon disperse and survive.

A number of different problems are important for estimating the degree to which escapes damage wild salmon stocks, and for the evaluation of

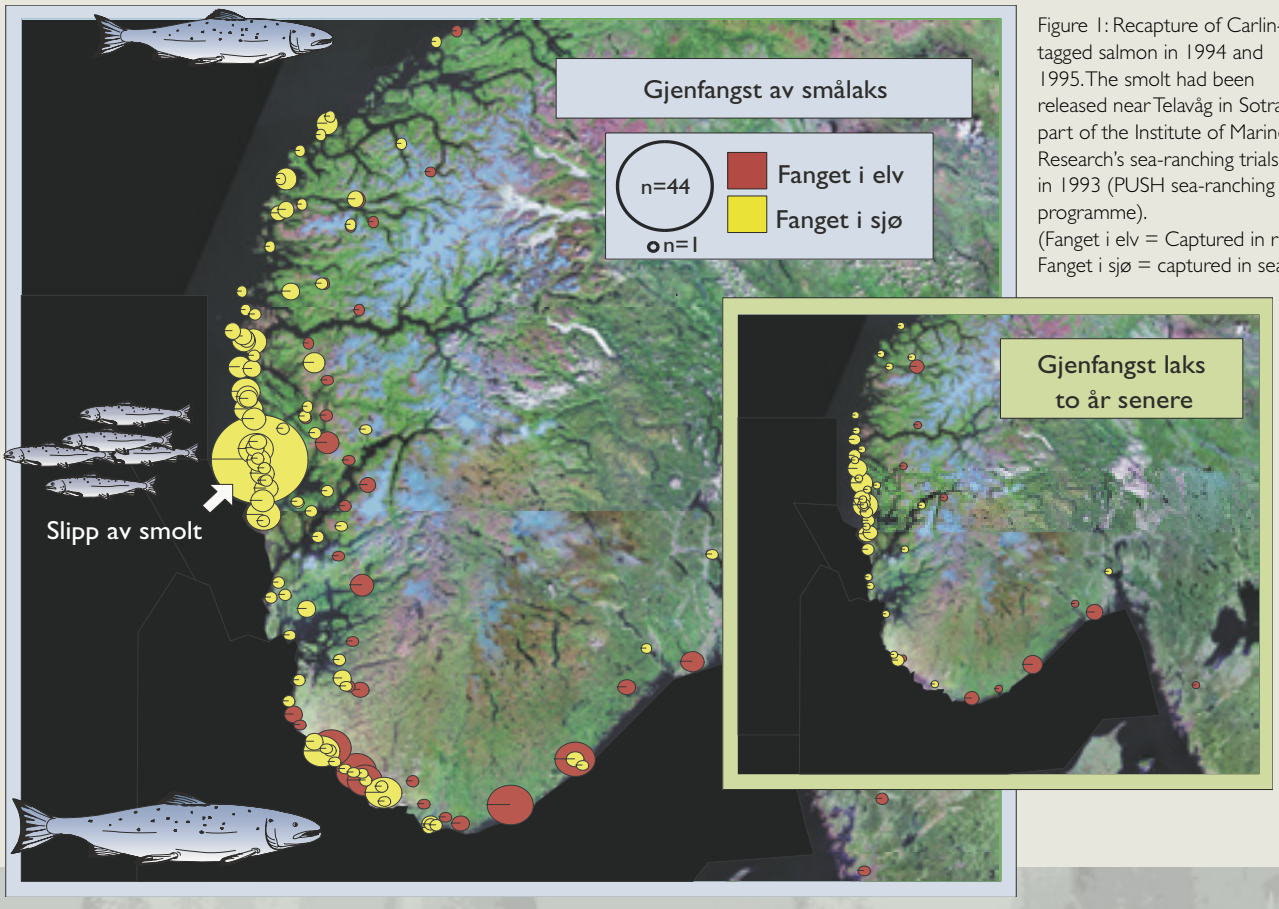

Figure 1: Recapture of Carlin-tagged salmon in 1994 and 1995. The smolt had been released near Telavåg in Sotra as part of the Institute of Marine Research's sea-ranching trials in 1993 (PUSH sea-ranching programme).
(Fanget i elv = Captured in river, Fanget i sjø = captured in sea.)

possible measures. How many escaped salmon survive and migrate upriver, to what extent do they spread out from the escape locality (see example in Figure 1), and to what extent do they manage to breed into wild salmon stocks. Grown fish that escape are easily observed near where they have escaped, when they are taken in gill-nets in the sea or head for river estuaries. However, such fish are fairly uncompetitive in comparison with wild fish in the river. Nor is it certain that all the salmon that escape late in life actually migrate upriver. Escapes at the smolt stage, on the other hand, may easily pass unnoticed (they are not easily caught), and these fish have a life-cycle that differs less from that of wild fish, so that they may be more viable when they migrate upstream to spawn.

In order to be able to assess the importance of escapees we will need to know more about the importance of the timing of escapes, both in terms of season and of the age and size of the fish concerned. Because fish are capable of spreading out over wide geographical distances (see Figure 1), more experience of tagging/recapture studies from different parts of the country would also be useful. We can expect that the results will vary according to the dominant current systems in the area, distances to fjords and open coast, etc. Knowledge of this sort is of importance for the evaluation of risks and of the effects of protective measures such as salmon fjords.

In order to gather more information about the behaviour, survival and dispersal of escaped salmon, the Institute of Marine Research started a series of experiments in 2005. While earlier studies have largely been carried out on the offspring of wild parents, the proposed studies use current aquaculture material. If all the necessary permissions are given and as long as there are no outbreaks of disease at any of the sites involved in our plans, the Institute of Marine Research plans to carry out this series of experiments in 2005, studying the following three problems:

Figure 2:
Farmed smolt tagged with T-bar anchor tags. These tags carry
(HAVFORSK, BERGEN, NORWAY) and the Institute of Marin
(www.imr.no), where information regarding the Institute's tagg
can be found.

individual codes, an address
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ging studies of different species

1) Escapes at the smolt stage

– Releases of smolts and post-smolts from the Institute of Marine Research, Matre

Escapes at the smolt stage can be more serious than escapes of adult fish. Smolt are likely to have a higher rate of return migration than fish released at a later stage in their life cycle. Furthermore, fish released in the spring display a virtually normal pattern of migration in the sea. When such fish return to the coast together with wild fish, they may be virtually undamaged in terms of fin injuries, etc. They will often pass for wild fish if they are caught in rivers, and inspection is based only on appearance. These fish will also display more natural behaviour in the river than recently escaped fish, which may increase their chances of reproductive success.

This problem has become more topical since Rådgivende Biologer AS and NINA have evaluated sample of scales from spawning fish in rivers in the autumn. There is ample evidence that fish that have escaped as smolt are over-represented among the escapees found in the rivers. The extent of early escapes is not known, partly because such small fish are not caught by traditional angling in the fjords and on the coast.

This summer, the Institute of Marine Research, Matre will carry out simulated escapes of salmon. A total of 12,000 one-year-old smolt will be tagged (see Figure 2). The first 2000 individuals will be released a short time after transfer to the sea-cages, and a further five groups of 2000 fish will be released every two or three weeks throughout the summer. The idea is to set up a detailed study of the relationships between survival, pattern of recapture and time in the sea before escape.

2) Survival and recapture relative to escape locality and season

– Releases of post-smolt and small salmon from commercial fish farms on the coast

The commercial fish farms that are participating in this collaborative study are spread along much of the coast of Norway (Figure 3). The point of these simulated escapes is to obtain more detailed knowledge of the survival and pattern of recapture of escaped farmed salmon, in terms of location of escape and time of year. These fish will therefore be released both as post-smolts and as small salmon. The problem of protected fjord areas will be tackled by releasing fish within and just outside a fjord system (the Hardanger Fjord).

Up to 1000 post-smolts will be released in simulated escapes from seven or eight commercial farms. Throughout the following year, new groups from the same smolt groups will be released, each of them containing up to 500 small salmon. All the fish will be tagged with external tags (see Figure 2). The experiment is done in cooperation between the Institute of Marine Research, Marine Harvest Norway AS, Stolt Sea Farm A/S, Seafarm Invest AS, Vega Sjøfarm og Volden Group AS.

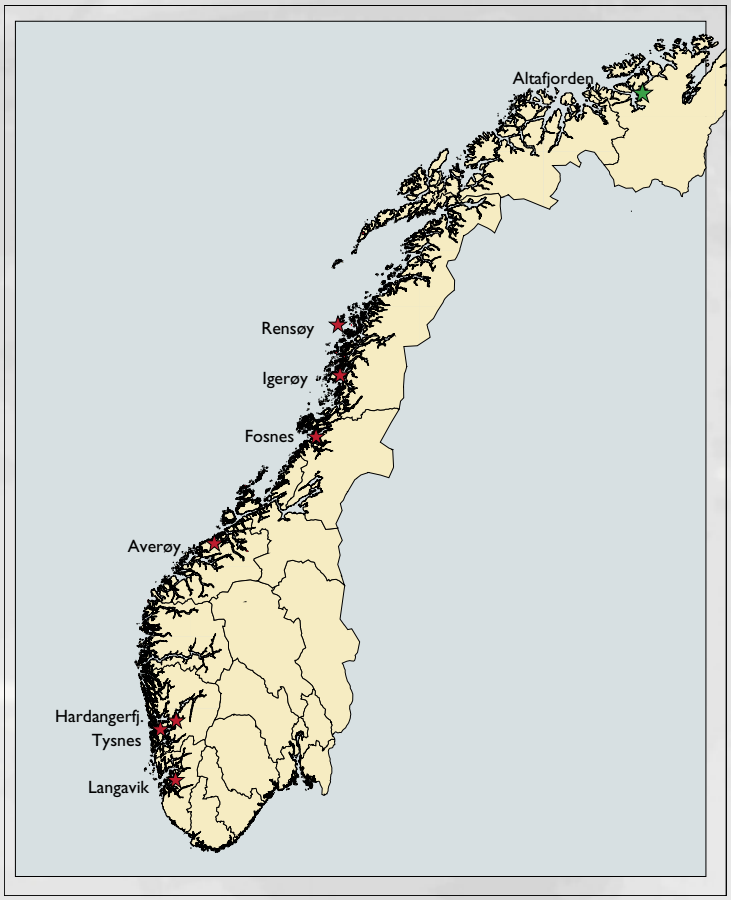

Figure 3: Locations of planned simulated escapes of externally tagged post-smolt and small salmon in 2005–2006. The most northerly location has just been added, and permissions for this site have still to be obtained at the time of writing.

3) Behaviour of adult escapees

– Releases of adult salmon carrying acoustic transmitters in the Hardanger Fjord

Little is known about the behaviour of escaped salmon. When such fish are observed in nets, etc., questions are asked as to whether they come from nearby farms and how long they have been in the area (see examples of catches in gill-nets in Figure 4). Do the fish spread out rapidly, or would it be possible to capture some of the escapees in the immediate vicinity? Fish which escape in the autumn have often been observed moving towards river estuaries. Are these immature or sexually maturing fish? The Hardanger Fjord is a suitable area for the study of such problems. Recently, there has been public interest in observations of relatively large numbers of escaped salmon. At the same time, the Institute of Marine Research has been carrying out an internal project in which monitoring data from the past few years have been gathered; these data show, among other things, that a large proportion of escapees are immature. We do not know to what extent these fish are recent escapees, or whether they remain in the fjord on a more or less permanent basis.

In order to increase our knowledge in this field, we will tag and release 100 salmon (two releases of 50 fish) from a commercial fish farm in the Hardanger Fjord in autumn 2005. First we will insert an acoustic tag that transmits a sound signal, as well as the normal external tag. (Figure 2). The movements of the fish will be registered whenever they come within range of listening buoys which will be set out at various locations. The buoys will also pick up information from a depth sensor in the tag, so that we can also register how deep these fish are swimming.

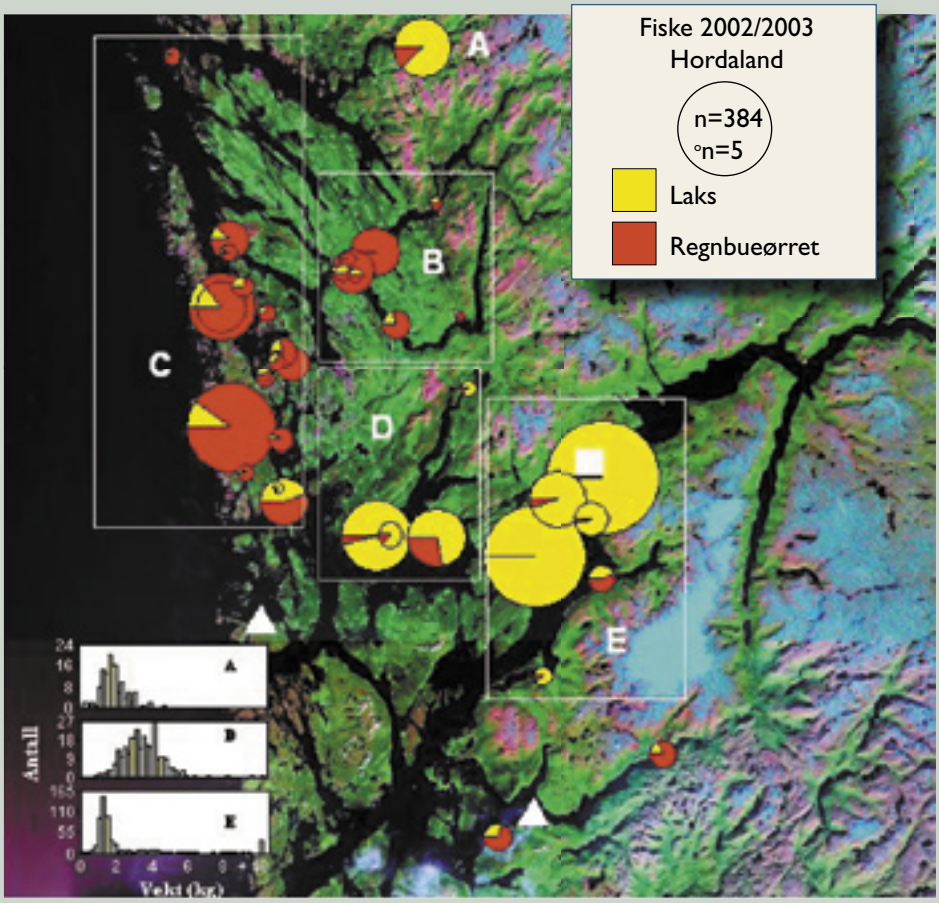

Figure 4: Overview of captures of salmon and rainbow trout reported to the Institute of Marine Research from fisheries of escaped farmed fish in 2002–2003. Zones B–D have been used to calculate catch per unit effort (CPUE). Escapes registered during this period are marked with a white square for salmon and a triangle for rainbow trout. The weight distributions of salmon caught in zones A, D and E are shown in the figure. From the report "Distribution of escaped fish in the sea and the importance of salmon lice for the survival of salmon in the sea": http://ww.imr.no/_data/page/4793/romt_fisk_og_lus.pdf

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