

THE FUTURE OF SEA-RANCHING
PROBLEMS AND PERSPECTIVES

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INTRODUCTION

Salmon ranching has been defined as the release of juvenile salmon into marine waters where they grow, unprotected, utilizing natural foods until they are harvested at a marketable size (Thorpe 1979). The methods of harvest, however, differ greatly between countries.

In some countries such as Sweden, United States and Japan the hatchery produced fish are harvested at sea, either at the feeding grounds or during their spawning migration. Salmon in this case are a common resource and most hatcheries are government owned. Ranching by private companies is here very difficult and in some cases unlawful.

In a few countries the returning salmon are harvested primarily in freshwater during their spawning migration. Iceland is a prime examples of this, where salmon fishing in the sea has been banned since 1932. This has opened up possibilities for private salmon ranching which is gradually building up. The success of this type of ranching depends on very accurate homing of salmon which in most cases has not been a problem. The establishment of private ranching operations in Iceland has been eased by the fact that all streams are owned by the local farmers. Fishing right has thus been acquired by purchasing land close to a stream. Fishing rights can, on the other hand, not be separated from land ownership.

One can say that salmon ranching with various species of Pacific salmon dates back over 100 years. This technology has evolved so that over 50.000 tonnes per year or 20-30% of the total catch of Pacific salmon are derived from hatchery released fish (Thorpe 1979).

The first salmon ranching efforts with Atlantic salmon under the common resource regime were started in Sweden just after 1950 (P.O. Larson 1980). In 1956 the Research Trust of Iceland started a ranching operation at the Furnace installations, which had considerable returns into freshwater during the first twenty years (Piggins 1980). Expanding drift net fisheries off the Irish coast as well as high seas fisheries off the Faroes have reduced return-rates considerably in recent years (Piggins personal communication). Experimental ranching in Iceland started when Kollafjörður Experimental Fish Farm was established in 1961. It was soon evident that private ranching operations might be profitable in some parts of Iceland as a result of the ban on sea fishery for salmon within the Icelandic territorial limits.

The following paper will primarily deal with the salmon ranching operations in Iceland, results obtained and problems encountered.

RANCHING IN ICELAND

Ranching practices

Ranching in Iceland can be basically divided into 4 categories depending on release and site characteristics.

1. Release from a rearing station using stream for attraction.
2. Release from a rearing station using pumped well water for attraction.
3. Releases from a release site using stream for attraction.
4. Release from a release site using pumped well water for attraction.

Each of these methods will be briefly discussed with pertinent advantages and disadvantages. The major facilities mentioned are shown in figure 1.

1. Rearing stations using stream water for attraction

This is the conventional method developed at Kollafjörður Fish Farm. It has the major advantage that smolts do not have to be transported long distances for release. Returning salmon enter the water system quite readily, especially during freshets so harvesting is easy. Releases are usually volitional from freshwater ponds and function well since the water shed heats up readily in the spring approaching 11-12°C during smolt migration in June. Saltwater adaption of smolts has been tried with good success.

Major disadvantages of Kollafjörður are great tidal differences, up to 4.5 meters, which expose large areas of tidal flats on the low tide. This feature is characteristic for sites located at the head of fjords in Iceland and poses threats to smolts when migrating to sea and only allows migration of adults on the high tide.

The return rates to Kollafjörður Fish Farm have in recent years been in the 5-10% range but occasional groups have returned at 15-20% rate.

No other ranching facilities of this type have been in operation in Iceland.

2. Rearing stations using pumped well water for attraction

The only facility of this type is the Pólarlax rearing station, 10 km south of Reykjavík (figure 1). This station was built in 1980 and released its first smolts in 1981. It uses pumped well water at 4°C for rearing which must be heated to 13°C by mixing it with hot water from an aluminium smelter. The station is situated on a rocky coast with heavy wave action in winter. It must rely on runoff from the hatchery plus auxiliary well water to attract returning salmon.

One advantage of this method as in the previous case is that smolts can be released directly from the facility. The actual method of release, however, is very critical and has not been successfully worked out. Another advantage is a steep littoral gradient in this area which facilitates migration of juveniles and adults in and out from the station. This feature is very important if salmon ranching is scaled up to a size where continuous migration of salmon into the facility is important. The dependence of well water for attraction, however, seems to be a major drawback compared to facilities where run-off streams provide auxiliary water with occasional freshets during rearing periods.

Early release trials showed that salmon would not enter a fish ladder with run-off from the hatchery although flows seemed adequate (Isaksson 1982). The building of a small seawater lagoon in front of the rearing station, where the salmon are trapped, has partly solved this problem.

Return rates to Pólarlax approached 3% from their first release in 1981, but have since been lower.

3. Release sites depending on run-off water

The most prominent sites of this type are Lárós and Lake Lón ranching stations. Both stations, although in different geographical areas have similar layout. The ranching facility is composed of a big lake, fed by spring and river water, with a short stretch of stream connecting it to the sea. Both sites use smolts from distant rearing stations for ranching. The smolts are reared on the lake in floating pens for a month before release.

The prospects of salmon ranching in Iceland were greatly enhanced when it became clear that salmon could be ranched at a site distant from the place of rearing. Lárós ranching station which uses primarily smolts from Kollafjörður Fish Farm has been experiencing return rates between 7 and 13% since 1980. This is comparable and sometimes higher than for comparable smolts at Kollafjörður 100 kilometers away. Returns to Lón which is on the north coast (figure 1) have been much lower, which probably relates to less favourable ranching conditions off the north coast.

The Lárós ranching site was erected by diking a fjord at the mouth. This generated favourable ranching conditions by reducing the tidal flats on low tide and making it possible to release from floating pens. This is the cheapest and most effective method of release when large numbers of smolts are involved. It is likely that most ranching facilities of this type will have to be built in a similar way, due to the great tidal difference in Western Iceland.

4. Release sites depending on pumped well water

The only site operating on these principles is at Vogar, run by Iceland Investment Corporation and Oregon Aqua Foods on an experimental basis. Smolts released are purchased from Kollafjörður Fish Farm, reared for a month in heated water, and fully adapted to seawater before release. Smolts are released directly into the sea from plastic lined release ponds.

Returns from a release in 1982 were relatively small but 1983 release of 20.000 smolts has yielded over 1000 grilse which is close to 5% return. Straying to Kollafjörður Fish Farm, as the place of rearing, only 40 km away have been minimal. More have strayed to Pólarlax, 20 km away, which also uses well water for attraction (figure 1).

Salmon seem to be homing relatively well to the site but are reluctant to enter the mixture of well- and seawater provided in the fish ladder. This is similar to the behaviour at Pólarlax hatchery which also uses ground water. Fish are therefore in both cases seined in the estuary.

From the foregoing discussion it should be clear that salmon ranching has taken on many forms in Iceland but the number of stations using each method is fairly small.

Problems

There are numerous problems associated with ranching and they can only be highlighted in this short paper. The major problems seem to be the following.

1. Smolt quality

This has been a major obstacle for the normal progress of ranching in Iceland. Parr have been reared to a certain size without proper respect for the physiological changes which must accompany smoltification. The necessary rearing routine is known but not practiced in all hatcheries.

2. Release techniques

Use of release ponds and net pens have greatly improved returns in ranching experiments. Temperatures at release sites are mostly natural and can have adverse effects on returns in cold years by delaying smoltification. Release time is probably very critical which is sometimes ignored.

3. Difference between geographical areas

Experience shows that ranching potential is better in south and western Iceland than in the northern and eastern parts (Figure 1). In addition to lower return rates there is a greater proportion returning after 2 years in the sea, in northern Iceland partly due to a later smolt migration and colder sea temperatures (Scarnecchia 1983). Some of these large salmon are feeding outside the Icelandic territorial limits and can be harvested by other nations.

4. Distance between ranching sites

There are some restraints on how many ranching stations can operate within a geographical region. Experience from south-western Iceland seems to indicate that they can be fairly close (figure 1). This, however, may depend on the origin of the water used by those stations especially chemical properties. This may be more important than actual distance between the sites.

5. Limited smolt production potential

All Icelandic rearing stations are heating ground water using geothermal water. Runoff water is not suitable due to turbidity during rain. The number of sites with ample ground water and geothermal energy is limited which restrains the smolt production capacity. The present production is ca 800.000 smolts which could be increased manifold by utilizing water reuse systems and by oxygen injection. Considerable ground water resources can still be harnessed for fish culture but heating is in many cases only practical for very large stations, due to the great cost of harnessing and transporting heat.

6. Site characteristics

The various sites and the problems associated with the use of well water versus run-off water have already been discussed. It seems clear that stream water has some characteristics which attract salmon better than well water, even at the same temperature. Solution to this problem is not obvious but will doubtlessly be worked out in time.

7. Conditions in the sea

It is common knowledge that feeding conditions in the sea vary a lot between years. Experience has shown that return rates are double in good years compared to bad ones and the difference can in some cases be greater. Early feeding of the smolts just off the coast is probably very critical and those areas are much affected by cool climate in some years. Research in that area is urgently needed.

Present potential and future perspective

Ranching experiments in Iceland seem to indicate that higher and more stable return rates can be expected in southwestern Iceland where the coast is considerably warmed by the Gulf-stream. The north and east coasts of Iceland are more affected by cold polar-currents which have pronounced effects on natural salmon populations in some years (Scarnecchia 1983). Some ideas on potential return rates as well as grilse-older salmon ratios using comparable stocks are shown in figure 1. Experience in south-western Iceland seems to indicate that total return rates in that area would mostly be in the 5-10% range (150-300 kg/1000 smolts), occasionally exceeding that level. Limited information from ranching experiments on the north coast seems to indicate that returns would often be below the 5% level but with considerably higher proportion of 2-sea-winter fish.

The future of salmon ranching seems to depend primarily on increased smolt production with low production cost per smolt, as well as any possibilities that might exist for increased return rates and size of returning salmon. Those goals could possibly be achieved through selective breeding (Gjedrem and Jónasson 1984).

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Figure 1. The major salmon ranching facilities in Iceland. Also shown is an estimate of the salmon ranching potential in various parts of Iceland.

