ICES ANNUAL SCIENCE CONFERENCE
Copenhagen, Denmark, Oktober 2002

Theme session T T:11

Icelandic salmon ranching:problems and policy issues - A historical perspective -

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EV-2002-005

Reykjavík, Iceland

2002

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Introduction

Ranching of Atlantic salmon in Iceland started with the establishment of Kollafjörður Experimental Fish Farm in 1961 (Guðjónsson 1973). The first smolts were released in 1964 with considerable returns of salmon in 1965. The primary purpose of the fish farm was to strengthen aquaculture and enhancement efforts in Iceland by developing good quality salmon smolts (Ísaksson 1976). The release experiments and subsequent returns of salmon to the fish farm led to a pilot ranching operation, which provided considerable income to the farm. Several smaller release operations started in the 1960s such as the Lárós ranching station in the Breiðafjörður area and Súgandafjörður release site on the northwest peninsula (Ísaksson and Óskarsson 1986).

The introduction of coded wire tags (CWT) to Iceland in the 1970s (Ísaksson and Bergman 1978) was a major technological breakthrough in the methodology used to evaluate sea survival and return-rates to ranching facilities. These tags have since that time been exclusively used to evaluate return-rates of wild and ranched smolt and provided valuable information on straying between ranching facilities and into salmon rivers (Ísaksson et.al. 1997). Important information on the feeding and behaviour of ranched salmon has also been aquired through the recapture of tagged and untagged postsmolts in coastal waters (Sturlaugsson 2000) and through the use of Data Storage Tags (Sturlaugsson et. al. 1997).

The main impetus for conducting salmon ranching in Iceland is the fact that no salmon fishery is allowed within Iceland´s territorial limits and salmon are thus only harvested in terminal fisheries, mostly by angling. Exempted were a few sites with heritable netting rights, which now have been closed down.

In the early 1980s after experimental ranching had been carried our for 15 years at Kollafjörður Fish Farm and the "Lárós" ranching facility, Oregon Aqua, which conducted experimental ranching at Westport, Oregon, USA became interested in setting up a commercial salmon ranching venture in Iceland and established the Vogalax operation in "Vogavík" on the "Reykjanes" peninsula, which was operated experimentally until 1994. A smaller operation Pólarlax was established at Straumsvík on Reykjanes peninsula at a similar time. In 1988 a Swedish-Icelandic company Silfurlax inc. established a salmon ranching facility in Hraunsfjörður on Iceland´s west coast, which was in operation until 1995.

The establishment of the commercial ranching operations coincided with a low return-rate period, which prevailed all through the 1990s . All the commercial operations have thus closed down and Kollafjörður Experimental Fish Farm has been converted over to a facility for selective breeding of salmon for farming.

Although commercial ranching has been closed down there is still ongoing enhancement activity, which is more or less a spin-off from the experimental ranching conducted at "Kollafjörður". A prime example are annual smolt releases into the "Rangá" rivers, which have supported a sizeable sports fishery of Atlantic salmon in a river, which does not naturally produce salmon. There are also enhancement activities in many natural salmon rivers, which utilize the native stock from the rivers.

The 40 years of experimental and commercial ranching have provided considerable experience and insight into the problems related to large scale ranching, both with respect to reciprocal straying of ranched and wild salmon, harvesting methods, illegal fishing and related issues. It has also provided considerable scientific information on ranching potential in a country, which is on the boundary of warm and cold oceanic currents, whose relative strength can affect return-rates and growth of salmon in many ways. This paper will review this experience from a historical perspective and discuss likely changes in Icelandic policies related to ranching activity.

Definition of ranching

Ranching has been defined in many ways in different parts of the world depending on political systems and the programs being carried out. In USA and Canada public enhancement of Pacific and Atlantic salmon rivers using smolts is frequently referred to as ranching. Same is true for cooperative ranching efforts of fishermen in Alaska, releasing smolts to enhance their pink salmon fisheries. Similarly smolt release activities for enhancement in European rivers have frequently been referred to as ranching.

For the purpose of public policy and clarity it has been very important to distinguish clearly between various aquaculture efforts in Iceland. One clearly needs other guidelines for enhancement efforts in natural salmon rivers than in commercial ranching operations. For this purpose the following definitions have been adopted in Iceland.

Ranching is defined as large scale releases of salmon smolts by private companies with the intent of harvesting all the salmon upon return at the release site. Genetic selection of the stock to improve performance is logical and desirable and all the salmon are harvested at the release site. This applies to all Icelandic ranching stations.

Sustenance of angling with smolts is used for the activity, where salmon smolts are released into a non-productive river to create angling, where none existed before. A stock adapted to the ranching process is desirable for maximum performance and natural propagation will be limited. A prime example is the maintenance of angling in the Rangá rivers.

Enhancement is here used to define all other activities, such as releases of fry and smolts by government or companies for mitigation or restoration purposes. Use of indigenous stock of wild origin is often mandatory and natural propagation is the dominant process.

Ranching development

Figure 1 shows the location of the major ranching facilities in operation in the late1980s and the development in total releases of salmon smolts for ranching. Most of the ranching development took place on Iceland´s west coast in the "Faxaflói" and "Breiðafjörður" area although minor releases were carried out on the north coast. The numbers released for ranching were small until 1986 but increased rapidly thereafter reaching a peak of almost 6 million smolts in 1990. After 1995 the numbers released dwindled and were more or less terminated after 1998.

As indicated in the figure most of the larger ranching facilities were located on peninsulas far away from major salmon producing areas (50-100 km). This location reduced the danger of straying of ranched salmon into salmon rivers but may in some cases have increased the risk of incidental harvest of migrating wild salmon in the estuarine traps. This was the cause of considerable controversy between various stakeholders in Iceland as discussed in a later section.

Figures 2-4 show the facilities and some of the activity taking place at the major ranching stations. The "Kollafjörður" fish farm and the "Vogalax" ranching station were conducting ranching from a releases site with an adjacent smolt facility. The "Lárós" and "Silfurlax" ranching operations were carried out from a releases site with no on-site smolt rearing. Smolt were thus transported to the release site from distant rearing stations.

Figure 5 shows the total Icelandic salmon catches including the catch landed in ranching operations. During the 1988 through 1996 harvest year the ranched proportion was a dominant share of the total salmon catch. The ranched contribution peaked in 1993 when over 200 thousand salmon were harvested at ranching stations, amounting to ca. 600 tonnes. By the year 2001 the ranching contribution was non-existent.

Information from tagging experiments

Tagging methods and recovery

Since 1974 the coded wire tags (CWT) (Bergman et al. 1968) have been the standard tag used in Icelandic ranching experiments (Isaksson and Bergman 1978) and in monitoring of wild smolts (Antonsson et al. 2002). Figure 6 shows the tagging equipment in current use as well as the size and shape of the tag. The operation is manual with one person tagging and a second person adipose clipping

smolts, which aids in visual identification of a tagged salmon when caught in a ranching station or angled in a salmon river. Although identification of individuals might be possible, identification of release groups has been the standard practice in Icelandic ranching operations.

Recovery of CWTs at ranching stations is relatively speedy as the salmon are harvested in a terminal fishery and adipose clipped salmon can be visually identified. The tags can then be identified with a magnetic detector and disected from the snout.

Recovery of CWTs from anglers is more cumbersome and anglers need to be constantly reminded that adipose clipped salmon carry microtags. Icelandic angling is, however, fairly centralized as all anglers are required to document their catch in a fishing lodge and in-river wardens frequently inspect the catch to identify tagged fish. The snout of tagged salmon is then removed and sent for identification to the Institute of Freshwater Fisheries.

One can assume that the recovery of CWTs in major salmon rivers, especially in Western Iceland, has been fairly efficient in the past but there are concerns that the rapid increase in the "catch and release" method of angling in many rivers will reduce this efficiency in the future.

Returns in commercial ranching

Figure 7. shows the return-rates of CWT tagged salmon to 4 major salmon ranching stations on Iceland´s west coast broken into age classes at return. Also shown are the cumulative releases of CWTs at each site since the 1980 release year. Vogalax and Silfurlax were new commercial ventures and only had returns for a limited period, but Kollafjörður and Lárós were experimental facilities, which had been operated since the mid-1960s. Kollafjörður and Vogalax were using the Kollafjörður ranching stock , which was also primarily used at Silfurlax. Lárós, on the other hand, was using its own ranching stock.

The return figures will not be analysed in any detail as the main purpose of showing the figure is to demonstrate main trends in return rates. It is clear that return rates prior to 1989 release year are considerably better than in later years. For all the stations the total annual return rates after the 1989 release year are mostly below 4 % and frequently below 3 % whereas returns in the 6-8 % range were frequent in the earlier period. A similar reduction has been noted in the abundance of wild Atlantic salmon in the 1990s where angling catches have rarely exceeded the 25 year average (Guðbergsson 2002). The most pronounced reduction in the wild salmon has been in the 2SW component, especially on Iceland´s north coast where the relative abundance of 2SW salmon as predicted from grilse in the previous season has changed (Gudjonsson et al 1995).

Decline in the 2SW salmon component

Figure 8 shows the development in the ratio of grilse and 2SW salmon in the wild salmon stocks in west and southern Iceland and for the north and east coasts for the last 40 years. As the figure indicates there has been a significant trend towards grilsification in both areas but the change is, however, more dramatic on the north coast, where grilse were commonly less than 40 % of the component but are now mostly over 60 %. There seems to have been a dramatic change in 1985 for both areas with no reverse trend since then. It is interesting to note that there was a dramatic decline in salmon catches in West Greenland in the early 1980s, which has continued with the exception of a few years in the late 1980s (Anon 1999). Since Icelandic west coast salmon as well as some north coast salmon feed in West Greenland, it seems likely that common factors are affecting the abundance of 2SW salmon in both areas.

The relative contribution of 2SW salmon in ranching operations has also been notably depressed in recent years. Return figures from Kollafjörður Fish Farm for the 1966-1994 period shown in figure 9 seem to confirm the decline in 2SW abundance in the 1990s. As the figure indicates, which also shows the relative return age for the respective release years, low returns of grilse in the 1980s frequently resulted in higher returns of 2SW salmon in the following year. Although fairly apparent in the 1980s this seems to break down in the 1990s. Proportions of 2SW salmon in the Kollafjörður stock were generally lower in the 1970s, probably due to its origin as a wild grilse stock, which was subsequently selected towards a later maturity.

Decline in the 2SW component is well known all over the north Atlantic as reflected in the advice of ICES to NASCO each year. Although many scientists believe that this decline is due to adverse environmental conditions there is no concrete evidence showing the importance of individual factors and major international studies need to get underway to fill this big gap in our knowledge.

Effect of oceanic conditions

It seems likely that the reduced return rates of grilse as well as 2SW salmon are linked to adverse feeding conditions in the ocean. These conditions not only affect the return rates of salmon but also their growth and size at return. Figure 10 shows a model composed with data from Kollafjörður Fish Farm, which links grilse return rates, grilse mean weight and sex ratio as well as the proportional contribution of grilse in the corresponding year class to oceanic conditions (Ísaksson 1995). The model shows that warmer and favourable sea conditons increase the proportions of grilse relative to 2SW salmon, elevate the return rate and weight of grilse and pushes up the ratio of females in the returns. Colder and less favourable sea conditions, on the other hand, reduce return rates as well as the weight of grilse and tend to motivate the fish to stay an extra year in the sea. The observed variation in survival, mean weight and age of maturity are highly important for the viability of the ranching industry, which must provide a uniform product for the international market.

Management problems

During the ranching period there was a 6 fold increase in the total Icelandic salmon catches, peaking in 1993 (figure 5). As most of the ranching took place on Iceland´s west coast, it is probably safe to assume that the migration of salmon in that area during the peak of the season was ten-fold compared with earlier periods. Although the absolute quantities of salmon migrating along the Icelandic coast have never been greater, the return-rates to ranching stations as well as to rivers were at a low point. Thus, when the ranching stations were harvesting their salmon in great quantities in the estuarine areas, the catches in many salmon rivers were rather bleak. Many river owners and anglers therefore speculatively blamed the ranching stations for low angling success in rivers claiming that wild salmon were being harvested in their traps. As expected some ranched salmon were also recaptured in rivers creating concerns regarding genetic integrity of the wild salmon stocks.

As most of the ranching stations had rather small quantities of freshwater at their disposal, they were operating their traps in estuarine areas, which were within their jurisdiction according to Icelandic law, but were thus more prone to catch salmon straying from other ranching stations and even rivers. Waiting for the salmon to enter freshwater traps proved impractical due to the great quantities of salmon returning during a short period and the demands of the international market for a bright and silvery salmon. There was also evidence that a delay in recapture could lead to more straying into rivers. The salmon thus had to be harvested within days of arrival to the release site. The dispute between the above mentioned stakeholders was thus in a predicament situation, where efficient recapture of ranched salmon increased the danger of catching incidental wild salmon but decreased the straying into rivers later in the season. Inefficient recaptures, on the other hand, decreased the market value of the ranched salmon and increased the danger of straying into salmon rivers in the spawning season.

It was thus highly important to determine the extent of straying of wild salmon to ranching stations as well as the occurrence of ranched salmon in rivers. Since the ranching stations were obliged to microtag (CWT) at least 10 % of their releases up to a maximum of 100 thousand tags for large releases, it was possible to launch a study into this problem. The results were presented by Isaksson et. al.(1997) and will only be highlighted here.

Figure 11 shows the reciprocal straying between ranching stations, from ranching stations into rivers and from rivers into ranching stations based on the recaptures of CWTs during the period from 1988 through 1995. Of approximately 800 thousand ranched salmon returning during this period 96 % returned to ranching stations, 1,7 % strayed into rivers and 1,7 % were caught in coastal nets, mostly in the “Hvalfjörður” area. The cumulative straying of ranched salmon into rivers was about 14 thousand salmon during this 8 year period corresponding to 1700 salmon per annum. It was estimated, on the other hand, that the ranching stations harvested in total 7700 salmon of wild origin and from river enhancement during this 8 year period, corresponding to approximately 1000 salmon per year. These salmon were to a greater extent from enhancement releases into rivers and originated from a significant number of salmon rivers, primarily on Iceland´s west coast.

Although not discussed in this context, there was considerable straying of ranched salmon between ranching stations during this period (Isaksson et. al. 1997) and there was direct evidence of ranched salmon being attracted to run-offs of coastal fish farms, which they encountered en-route to their

final destination. In one instance over 500 salmon entered an abandoned ranching station, which had not been utilized for several years. This in combination with the straying between ranching stations probably demonstrates some inaccuracy in the ability of the salmon to distinguish between stations with a great concentration of salmon and high niveau of smell from feeds and faeces, which the smolts have inevitably been accustomed to prior to their sea-ward migration.

Another problem associated with the ranching operations was increased poaching both in illegal and legal coastal nets as well as through by-catches in various nets set out to catch marine species. This was due to the large quantities of salmon migrating along the coast in late June and July. Ranched salmon were also schooling into harbours, where fishermen gathered and hooked the fish with illegal gear. Great quantities entered the run-offs of landbased salmon farms, where illegal seining was noticed. It seems clear that this activity also increased to some extent the illegal harvest of wild salmon.To counteract this the enforcement effort had to be greatly increased in the whole of western Iceland, where most of the ranching took place.

As seen in figure 5 commercial ranching was minimal after 1996 and had completely closed down by 2001. The effects that these operations may have had on the wild populations were thus only short term and no longer term effects have been noted. The experience, however, remains and indicates that the following policies with respect to ranching should be adopted:

- Caution should be exercised in permitting large scale ranching without a thorough environmental evaluation.
- Ranching stations should operate on a river with considerable flow of water, where freshwater trapping of returning salmon can be performed.
- Releases should be performed above the salmon traps to motivate the salmon in migrating upstream.
- All of the smolts released for ranching should be microtagged (CWT) for speedy identification, if they are found in salmon rivers or other ranching stations.
- Large ranching stations should be located far from salmon producing areas.
- Large scale ranching will create unexpected problems regarding poaching and unlawful angling, which can only be dealt with through strong enforcement and inspection of the coastline and to some extent the commercial fishing boats.

It can finally be concluded that large scale ranching in rural areas can create some logistic problems with respect to smolt releases as well as the harvest and slaughtering of returning salmon, which may affect the success of the operation. It must furthermore be viable at fairly low return rates, which can prevail for successive years.

Sustenance of angling with smolts

Although commercial ranching is no longer carried out in Iceland , releases of smolts to improve angling are carried out in a number of rivers. One river stands out in this respect, the Rangá river, which has been built up as a salmon river through smolt releases. The river is located on Iceland´s south coast close to the town of Hella and is actually composed of two tributaries, the West-Rangá and East Rangá .

Figure 12 shows the releases of smolts and the resulting angling catches in the Rangá rivers from 1990 through 2001. Releases have ranged from 50-100 thousand smolts in the early years to 400 thousand smolts in the last 5 years. Angling catches in the early years averaged 1000 salmon but have risen to 3000-5000 salmon in recent years, making the Rangá rivers some of the best angling rivers in Iceland.

The project on the Rangá rivers is unique as the rivers did not produce salmon naturally to any extent prior to the start of the project. The project thus represents a minor ranching project, where the returning salmon are exclusively harvested by angling. All the smolts are released from release ponds, which improves return rates and controls to some extent the fishing beats as the returning salmon tend to congregate close to the release site (Jóhannsson et. al. 1996). Releases of smolts into other Icelandic rivers are entirely based on in-river stocks and carried out on a much smaller scale. Salmon from enhancement activity are thus only a minor part of the migrating population in most rivers.

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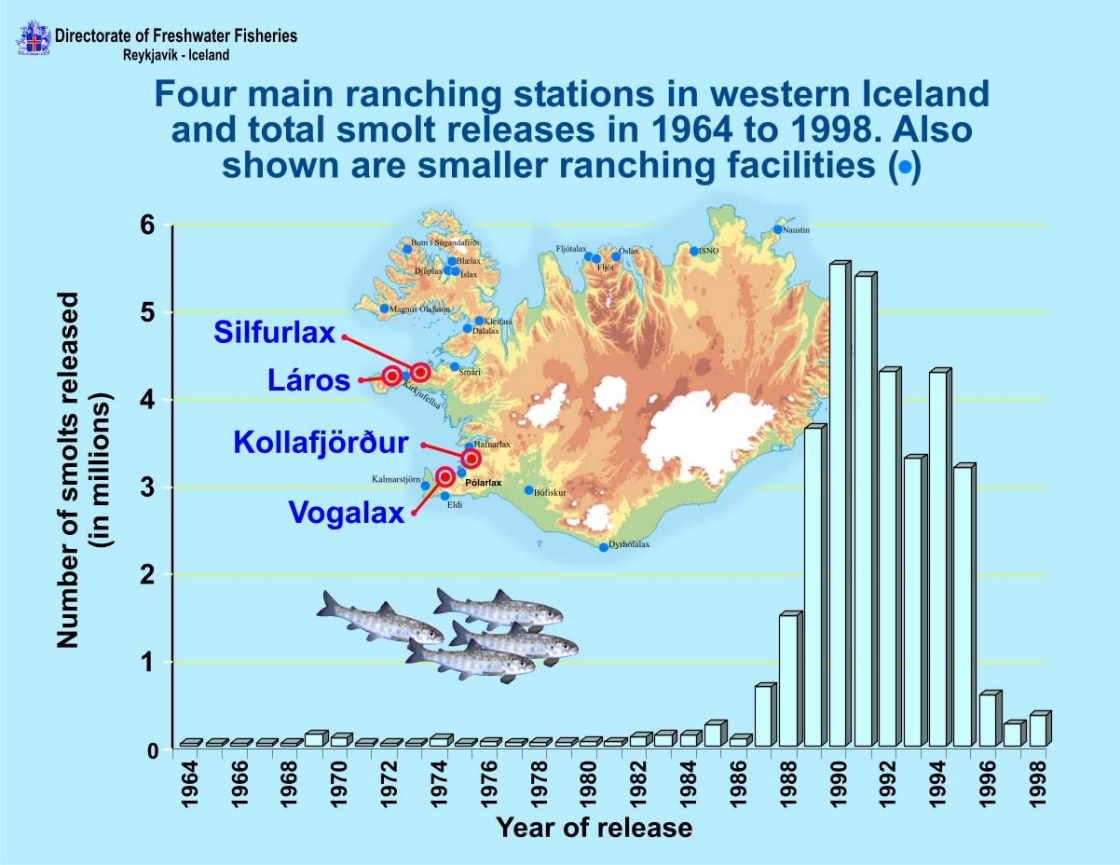

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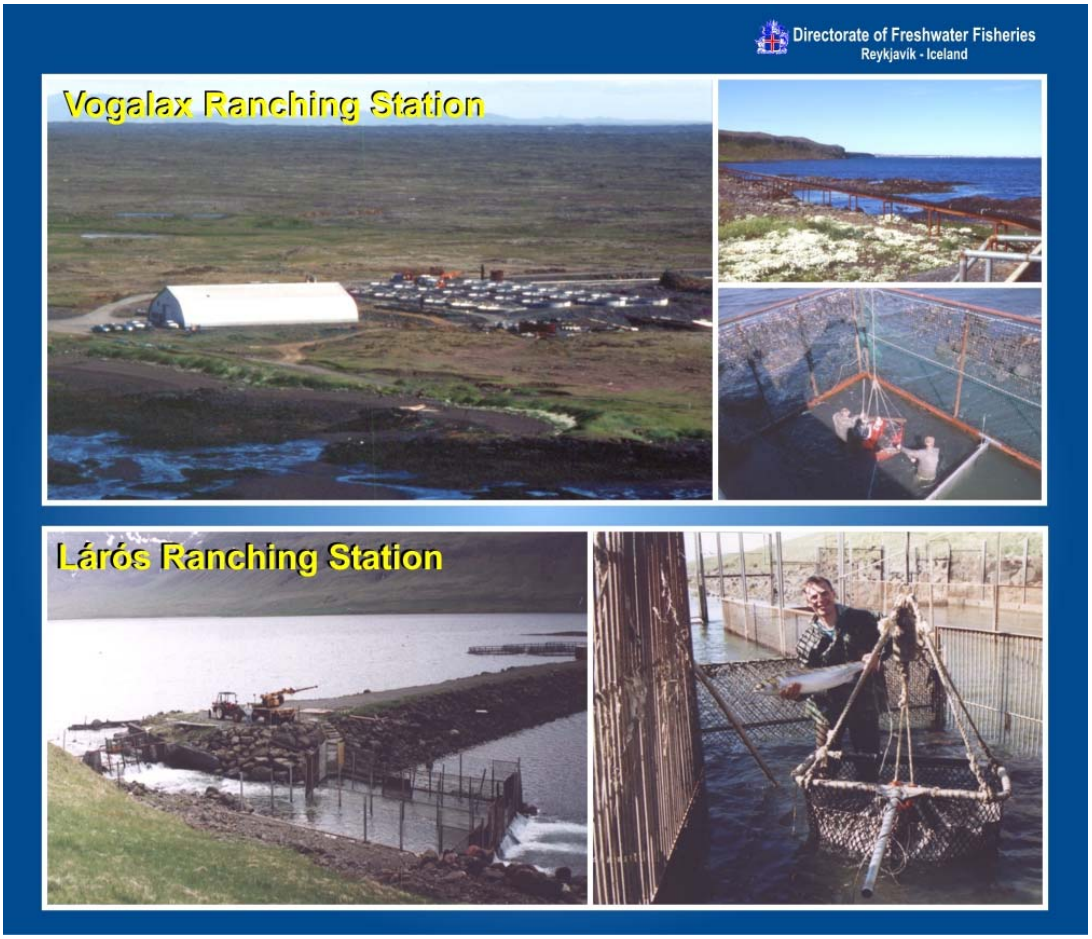

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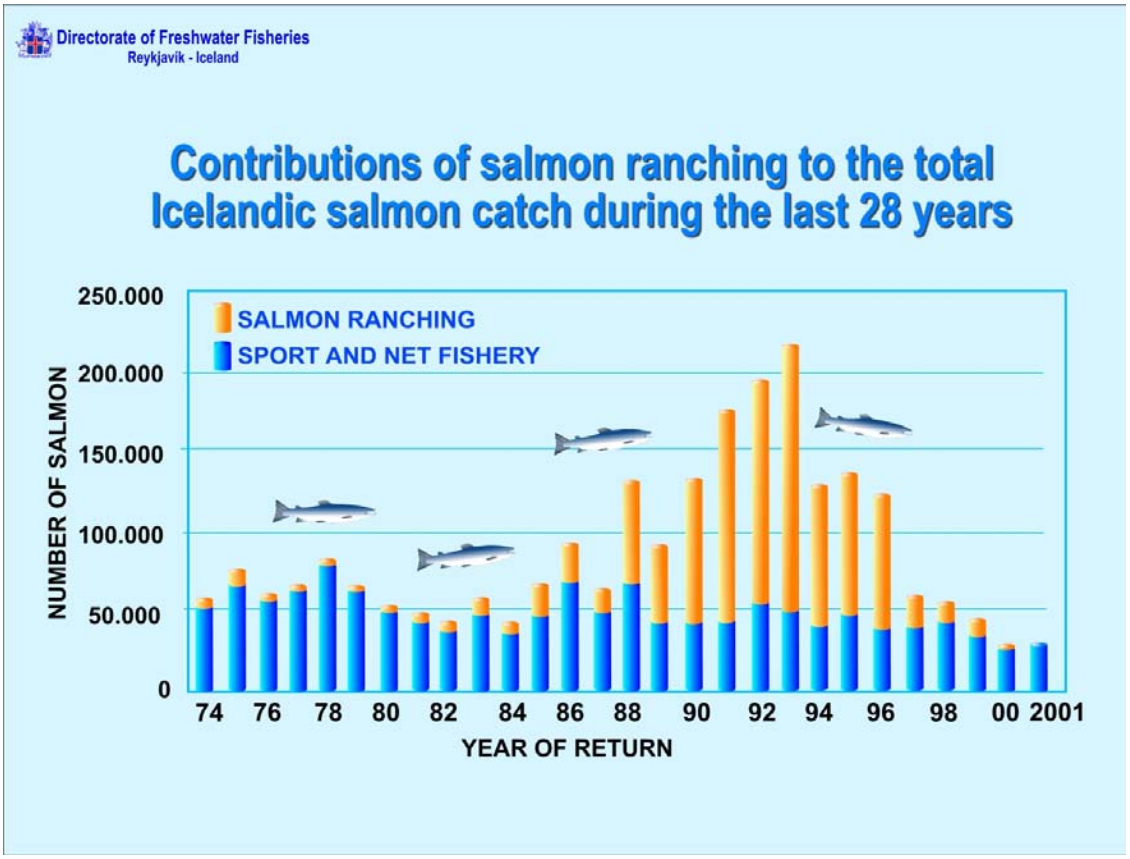

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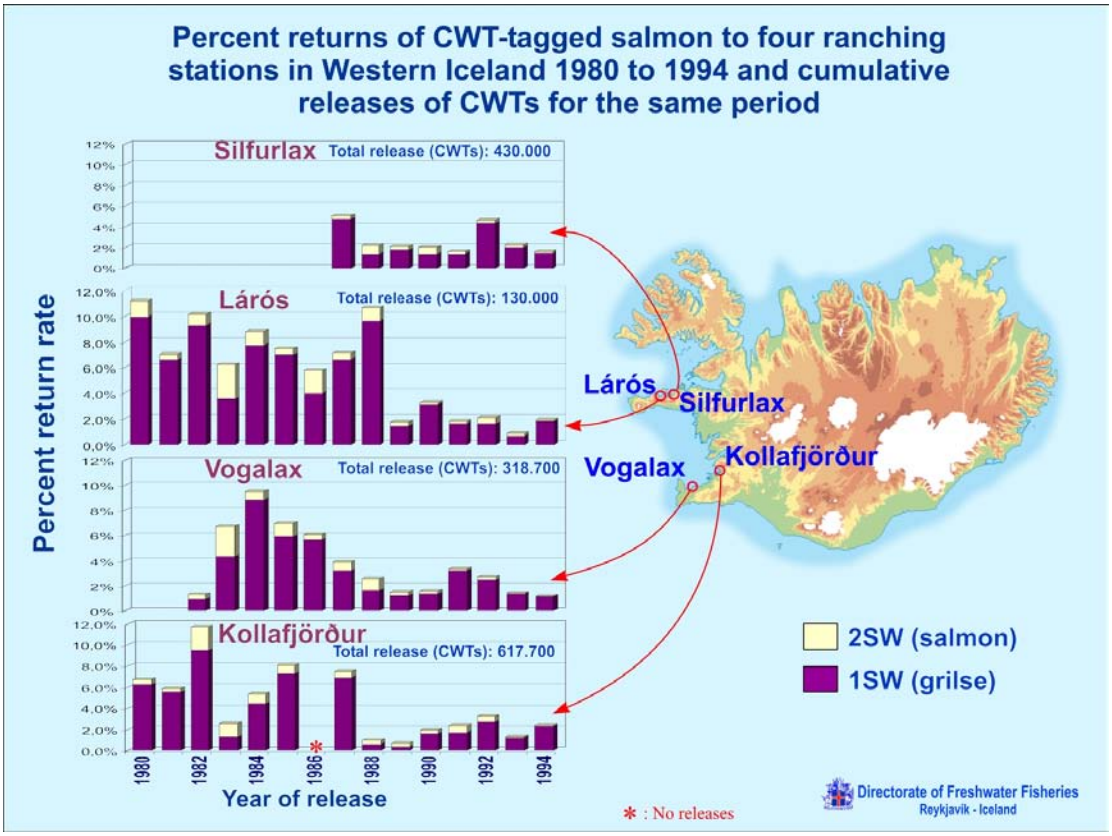

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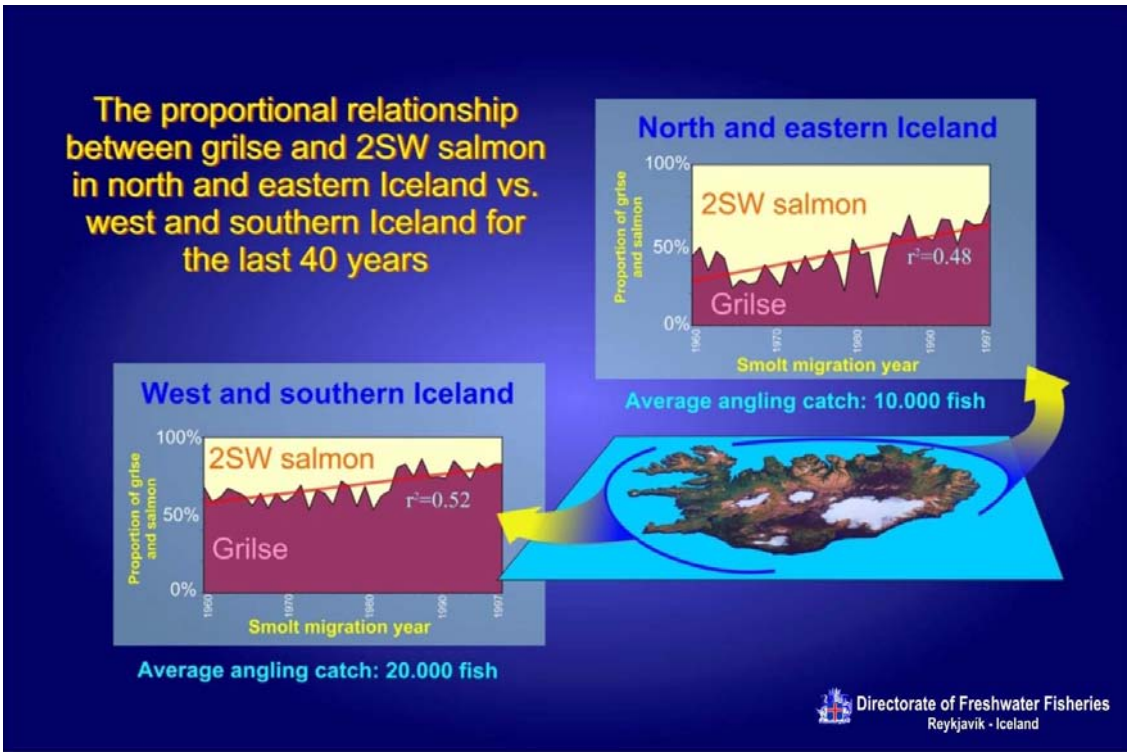

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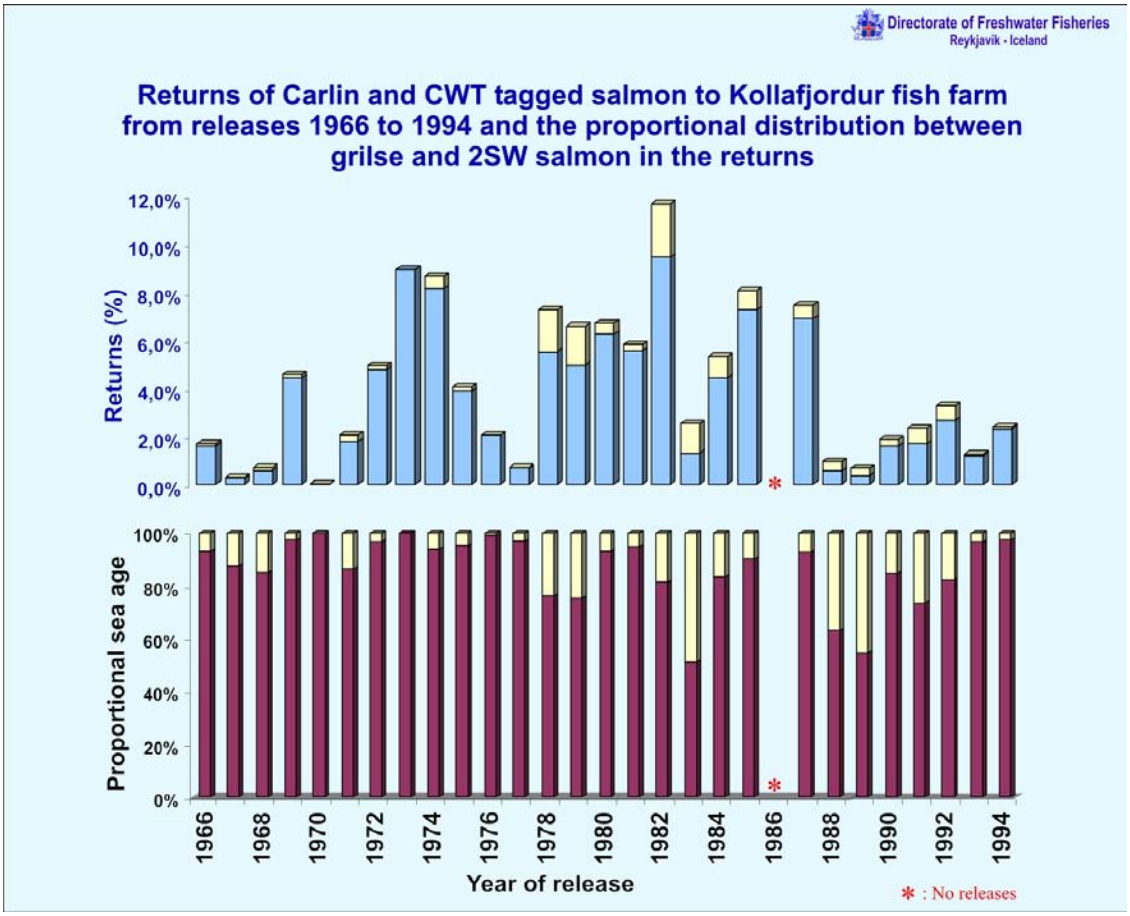

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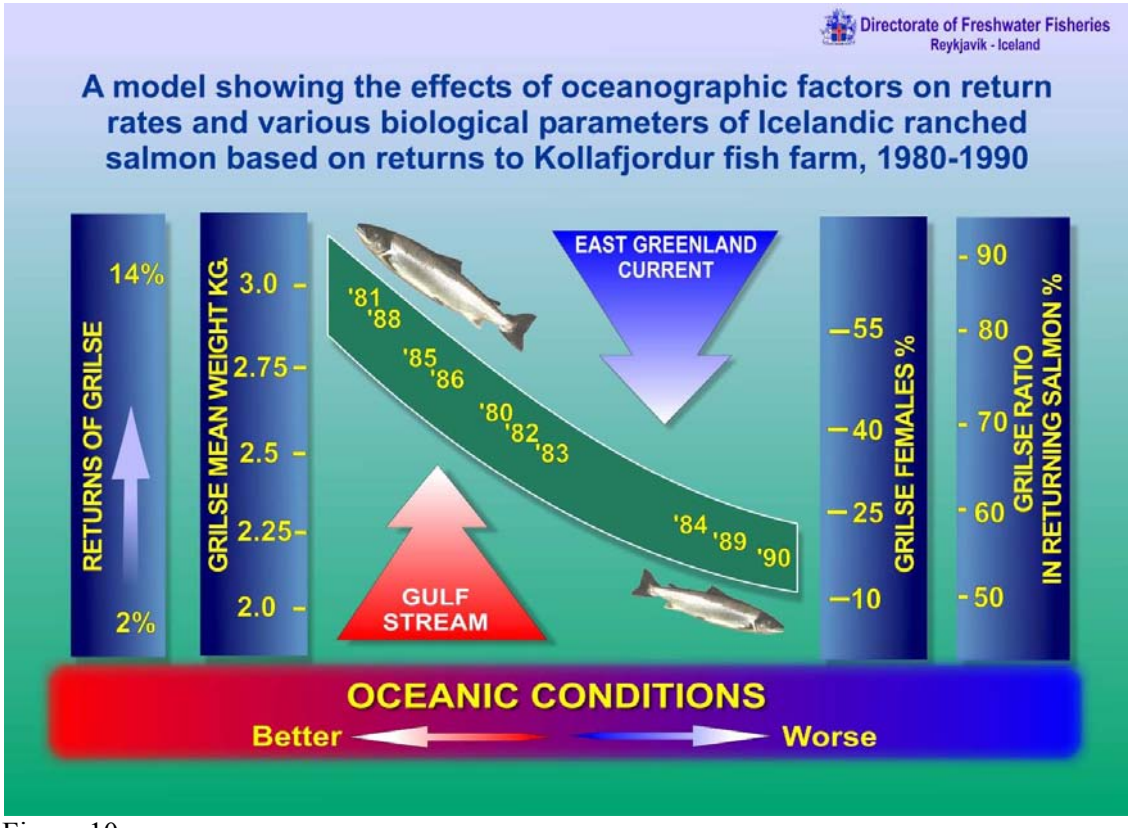

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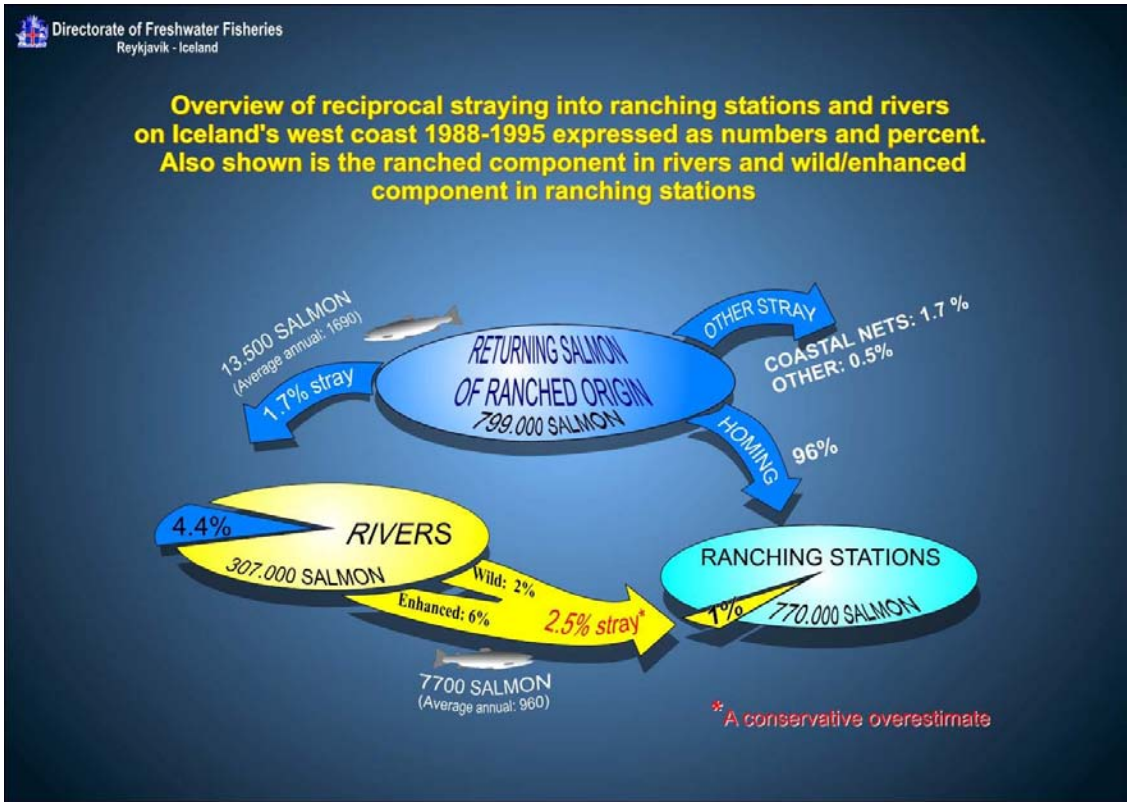

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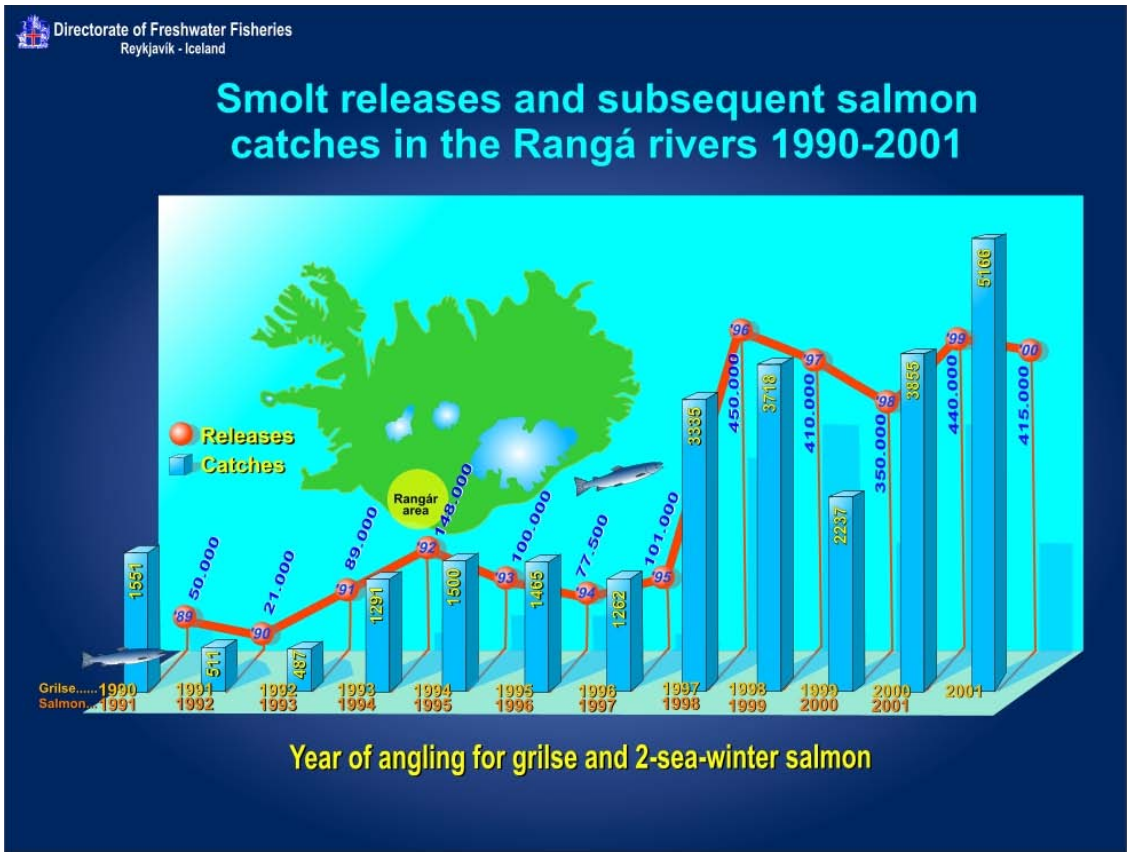

Figure 12.