Fish, Nancy

From: James Fletcher <unfa34@gmail.com>
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To: Batsavage, Chris; Fish, Nancy
Subject: [External] 1. RECENT EXPERIENCES IN OCEAN RANCHING: THE CASES OF JAPAN, UNITED STATES AND ICELAND

http://www.fao.org/docrep/005/Y1805E/y1805e07.htm#TopOfPage
FOR THE MARINE FISHERIES COMMISSION!
CAN SOUTHERN FLOUNDERS BE OCEAN RANCHED IN NORTH CAROLINA SOUNDS?
WOULD YOU SEE THAT THE NCMF COMMISSION GET A COPY OF THIS FOR A DISCUSSION ON SOUTHERN FLOUNDERS/ WHO EVER WROTE THE SOUTHERN FLOUNDER MANAGEMENT PLAN SHOULD BE ASKED WHY OCEAN RANCHING WAS NOT MENTIONED AS AN ALTERNATIVE TO REDUCED HARVEST!

--
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1. RECENT EXPERIENCES IN OCEAN RANCHING: THE CASES OF JAPAN, UNITED STATES AND ICELAND

This section reviews the ocean ranching experience in three countries; Japan, United States and Iceland. Ranching methods, industry structure and government participation and support will be described. Moreover, due to lack of quantitative data, an attempt will be made to provide qualitative assessments of the economics of the ocean ranching activities in these countries and to delineate the division of costs and benefits between the private and public sectors paying special attention to direct and indirect government subsidies. Final sections of the chapter highlight the similarities and dissimilarities in the ocean ranching experience of these countries and speculate about its future.

1.1 Ocean Ranching in Japan

Japan has a long tradition in fish farming and is currently a one of the largest producers of aqua- and mariculture products in the world. Thus, in 1996, Japanese aquaculture production was the third highest in the world exceeding 1,000,000 metric tonnes[2] and the second highest in terms of value (FAO, 1999). At the same time, Japan is one of the world's greatest fishing nations and, according to the Ministry of Agriculture Forestry and Fisheries white paper (JMAFF, 1990), ocean ranching forms an important part of Japanese fisheries policy. This, however, is not pure ocean ranching but stock enhancement ocean ranching for the benefit of the Japanese ocean fishery. Consequently, the ultimate output is not included in the aqua-mariculture statistics but the landings statistics.

In the 1970's, improved technology for ocean ranching of salmon and scallops initiated a wave of growth in ocean ranching (Suda, 1991). Since then, stock enhancement ocean ranching involving several species including salmon, scallops and sea bream, has expanded dramatically. Currently, over 70 species are being released for ocean ranching although in most cases only on an experimental scale. Hatching techniques for several more species are being investigated (Suda, 1991). In 1988, over 5.5 billion fry were released for ocean ranching with chum salmon and scallops comprising the great majority (JASF, 1990).

Species

Over 80 species of anadromous and marine species are currently hatched and reared in Japan. Of these, over 70 are released for ocean ranching of which over

ten are ocean ranched on a large scale. By far the most important in terms of volume is salmon especially chum (*Oncorhyncus keta*) and Ezo scallop (*Patinopecten yessoensis*). In 1987, Japan released about two billion chum salmon fry recovering about 50 million individuals (Isaksson, 1988) and about three billion scallop juveniles (Suda, 1991).

Other important ocean ranching species are sea bream, especially the red variety (Pagrus major), Japanese flounder (*Paralichtys olivaceus*), Kuruma prawn (*Penaeus jabonicus*), abalone (*Nordicus discus*), blue crab (*Portinus triubercularis*) and several others.

In addition to scallops and abalone, several varieties of molluscs are subject to marine cultivation. Mostly, however, the activity must be classified as mariculture rather than sea ranching.

Ranching methods

The methods of fertilization, hatching and release vary across the different species. The methods are broadly similar, however. The ocean ranched fish is for the most part captured at sea by fishermen (usually inshore fishermen). Compared to this stock enhancement ocean ranching, river stock enhancement is insignificant. Pure ocean ranching, i.e. ocean ranching for slaughter recovery, appears to be virtually non-existent.

Industry structure and evolution

The essential structure of the Japanese ocean ranching industry is quite simple. The government (federal and municipal) runs the research, hatching and release operations. The fishing industry, especially the inshore fishing industry, harvests the grown fish. In some cases, the ranching operation is a joint venture by the municipal authorities and the local fishermen's association. Mostly, however, the fishermen are not directly involved in the hatching and release operation. However, since local fishermen in Japan, usually have more or less exclusive fishing rights in their respective inshore areas, they normally co-operate with the ocean ranching efforts of the authorities.

In response to declining ocean catches of several valuable species and encouraged by advances in ocean ranching technology, the Japanese ocean ranching operations expanded greatly in the 1970s. Since then several species have been subject to a dramatically increased levels of ocean ranching as indicated in the Table 1.1 adapted from Isaksson (1988) and Suda (1991).

The ocean ranching programme in Japan has met with varying degrees of success. For some species (chum salmon and Ezo scallop), the increase in catch has been noting short of dramatic. For others, previously declining catches have merely been stabilized (Red Sea bream). It seems clear, however, that the ocean ranching programme as a whole has become crucial for the inshore fisheries. According to Suda (1991), ranched fish constituted about 18% of the total value of the inshore fisheries in the late 1980s.

(a) *Chum salmon*

Ocean ranching of chum salmon commenced in the 1960s. The early release programme was a small scale one. In the face of declining catches, releases were dramatically increased in the late 1960s and early 1970s. Since this seemed to

yield good results releases continued to increase reaching the current level of about 2 billion smolts annually in the early 1980s.

The ocean ranched chum salmon are recaptured at sea when they return for spawning by inshore fishermen using mostly trap-nets. Judged by the development of the chum harvest, this ocean ranching programme has been very successful. Annual harvests have increased almost ten-fold since the early 1960s. This is illustrated in Figure 1.1.

The increase in the chum harvest illustrated in Figure 1.1 is quite remarkable. Given the low and rather stable level of catches in the early 1960s, before the inception of the ocean ranching programme, it seems highly likely that this increase is due to the programme. This conjecture is in fact verified by biological investigation of the catches (Suda, 1991). Also, although release numbers before 1977 were not available, the subsequent correlation between releases and harvest illustrated in the diagram is quite striking.

(b) *Ezo scallops*

During the early 1960s, the harvest of the valuable Ezo scallop declined considerably, apparently due to overfishing. For this reason, an extensive ocean ranching programme was initiated. The species was hatched artificially and the resulting fry raised to a sufficiently large size before release. At the same time, stocks of natural predators were systematically reduced in the area of release. This strategy soon produced very good results and the harvest of Ezo scallop increased drastically. The path of harvest and releases is illustrated in Figure 1.2.

Table 1.1
Number of fry released for ocean ranching: Major species
(Million individuals)

Species	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Herring	-	-	-	-	-	-	0,1	0,6	0,6	0,7	1,0	1,3
Red sea-bream	4,7	5,1	8,6	10,4	12,0	12,9	15,6	16,2	12,7	17,2	23,7	17,4
Flounder	0,3	0,3	0,9	2,4	2,7	2,9	3,3	4,6	4,6	5,9	8,8	8,9
Tiger puffer	0,6	0,6	0,6	0,4	0,5	0,8	0,7	0,6	0,9	0,8	1,1	0,8
Kuruma prawn	256	280	337	298	302	275	301	294	291	307	337	324
Blue crab	6,9	7,9	12,2	11,5	11,2	15,0	19,5	20,0	27,1	30,1	20,6	26,3
Scallop	2139	1567	1699	2132	2127	1647	1607	1776	2010	2192	2926	3027
Abalone	7,0	7,1	8,5	10,6	12,1	12,3	18,3	19,0	17,6	21,3	22,4	20,6
Chum salmon	1106	1212	1463	1896	1818	1977	2031	2033	2042	1985	1989	2050

Source: Isaksson (1988), Suda (1991)

Figure 1.1 ***Japanese chum salmon harvest and ocean releases***

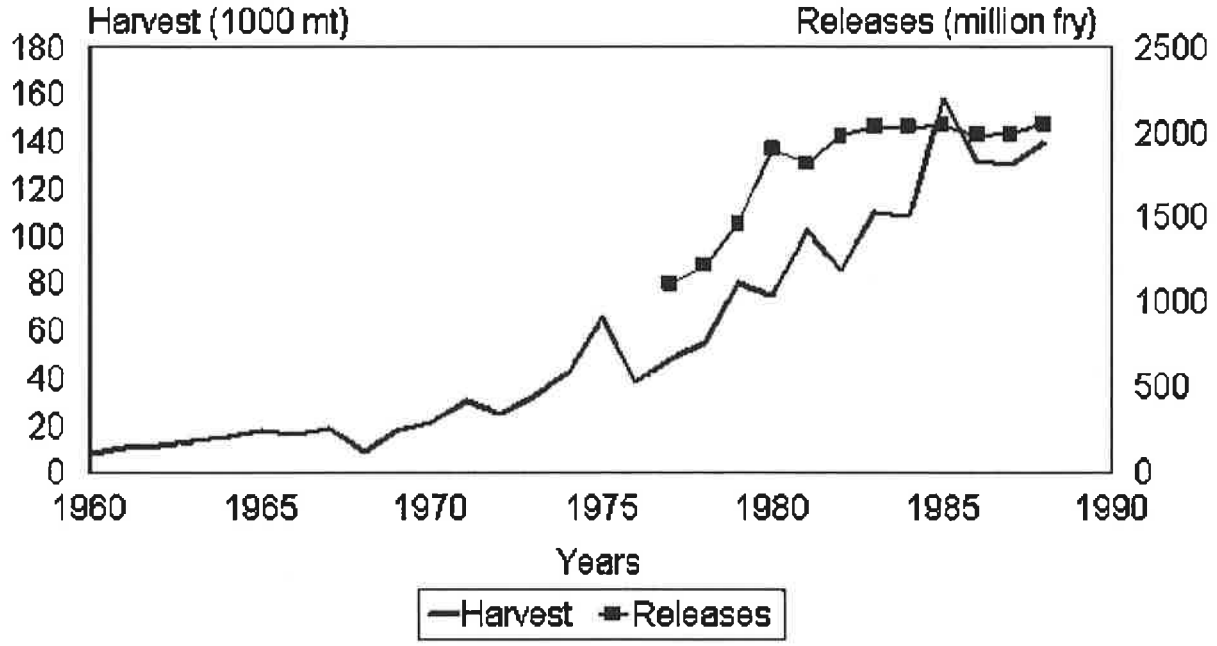
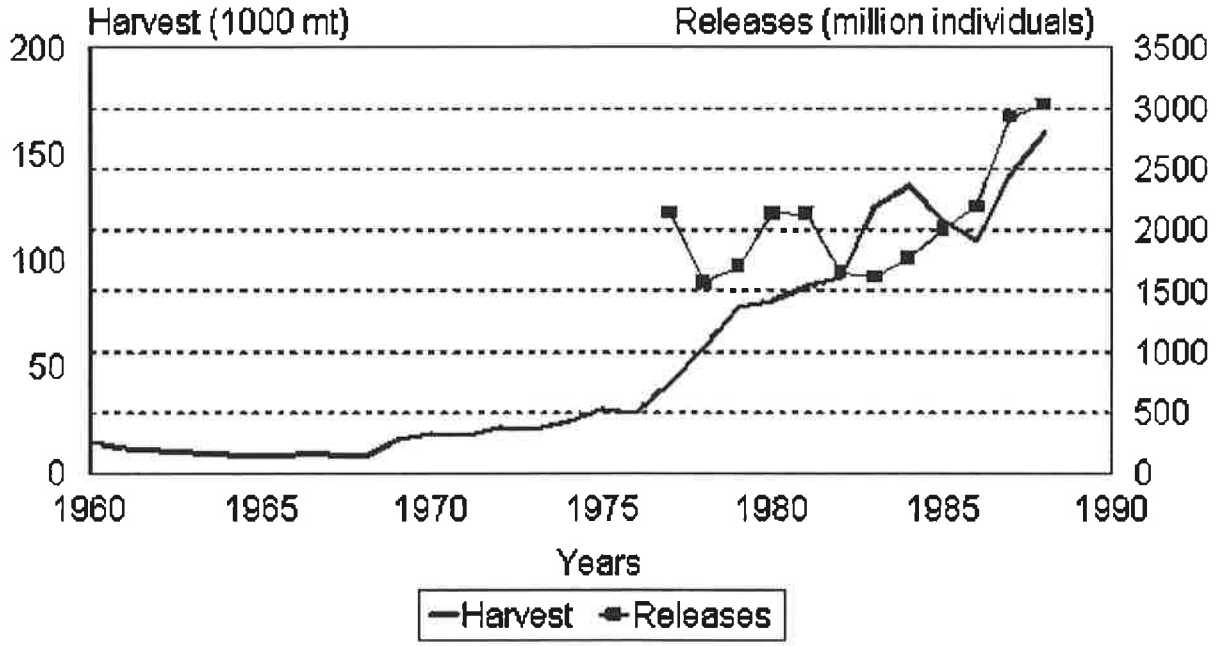


Figure 1.2 ***Ezo scallop harvest and ocean releases***



As indicated in Figure 1.2, the harvest of Ezo scallop has increased about ten-fold since the inception of the ocean ranching programme. This is in all likelihood due to the effects of the programme. It should be noted, however, that this remarkable success depends not only on the release of huge numbers of scallop fry but also on the systematic eradication of predators from the release grounds and a subsequent careful monitoring of the situation to avoid overstocking.

(c) Red Sea bream

Red sea-bream is a highly valuable food species. Catches declined significantly in the early 1970's leading to the adoption of an ocean ranching stock enhancement program. The hatching technology was developed in the 1960s.

The results of the stock enhancement ocean ranching programme are not quite determinate. Catches have not increased. In fact they have continued to decline albeit at a much slower rate. A high fraction of captured fish now stems from the release program. In some areas e.g. Kagoshima Bay up to 80% of the catch (especially in the inshore areas) is ranched fish (Matsuda *et al.*, 1995).

According to a recent estimate (Matsuda *et al.*, 1995), the Kagoshima Bay sea bream ocean ranching project, is economically sound with total benefits exceeding total costs. A fundamental reason for this result is that the fishery is closed access one and neither fleet nor effort can expand even when the fishery is highly profitable.

Profitability

The ocean ranching programme in Japan is mostly funded by the government. The net social benefits of the programme are unclear. Some studies (e.g. Matsuda *et al.*, 1995) indicate that the net benefits of at least some of the programmes may be positive. Even in those cases, however, it is not clear whether a private operation could be profitable.

Distribution of costs and benefits

As already stated the Japanese government funds most of the ocean ranching program and, in co-operation with prefectural governments, operates most of the ocean ranching research centers and hatcheries. Thus, basically the costs of the ocean ranching programme are borne by the government, that is the taxpayer. The benefits, however, primarily befall the fishermen and, to the extent that market prices are reduced as a result of the effort, the consumers. As pointed out above, it is not clear that the net benefits to the consumers (which are also the taxpayers) are positive.

In many respects, the ocean ranching programme is similar to agricultural supports which are also quite extensive in Japan [OECD, 1998]. Fisheries, especially inshore fisheries, constitute a traditional activity on which certain villages and even family lineages depend. It appears that it has been regarded as the government's responsibility to sustain these traditional fishing activities.

The outlook

Ocean ranching in Japan looks quite stable, provided the government continues to support it. Given a continuing decline in the traditional offshore and inshore fisheries, this appears quite likely. In fact, the ocean ranching activity may even be further expanded, in particular if there are further advances in ocean ranching techniques and, consequently, recoveries.

1.2 Ocean Ranching in the United States

Ocean ranching for the purpose of stock enhancement began in the United States in the late 19th century with the first hatchery established in 1872 (Isaksson, 1988). The objective of this activity was to enhance runs of anadromous species, mainly salmon, to rivers especially those that had been damaged by logging, railroad and dam construction etc. (Nehlsen *et al.*, 1991). This early stock enhancement activity is now judged to have been largely ineffective (Isaksson, 1988). With time, however, rearing and release methods were improved and there is currently a

good deal of river stock enhancement activity taking place. At the same time, stock enhancement of salmon and other species for ocean harvesting has become more common.

Commercial interest for pure ocean ranching of salmon emerged in late 1960s and 1970s. The main interest was in ocean ranching of salmon and focussed, in particular, on the four West Coast states, which offer in many respects good conditions for salmon ocean ranching. A limited number of licences for commercial ventures of this types were issued in California (1 licence) and Oregon (12 licences) in the 1970s. Since then there has be a moratorium on the issue of more licences, mainly due to environmental concerns. In any case, these commercial ocean ranching operations have not turned out to be economical. (Anonymous, 1992).

In the states of Washington and Alaska, all commercial applications for ocean ranching licences were turned down. In Alaska, however, non-profit organizations (mainly fishermen's co-operatives) were allowed to engage in ocean ranching of salmon. Several of these have been established and, apparently, been quite successful. The reason seems to be that they tend to be dominated by salmon fishermen that benefit from increased catches, as the ranched fish return to their areas of release.

Species

Several species are ocean ranched in the US today. By far the greatest ocean ranching efforts concern salmon; both the Atlantic variety and, in particular the various species of Pacific salmon (Anonymous, 1992). Other anadromous species subject to significant ocean ranching are striped bass, especially in Chesapeake Bay and California, and certain species of sturgeon (*Acipenser oxyrhynchus, Brevirostrum* and *transmontanus)* on both coasts of the US (Smith, 1986).

The only marine fish ranched in large numbers is red drum (*sciaenops ocellatus*) in the southern states, including Texas, Alabama and Florida (Anonymous, 1992).

Several species of molluscs are also subject to stock enhancement although being fairly sedentary, ranching may be a misnomer. Thus, virtually all oyster producing states depend on oyster stock enhancement (Manzi, 1990). Hatchery reared scallops are also ocean ranched in some of the eastern states and clams in the northern states on both coasts (Anonymous, 1992).

Finally, there have been some, albeit minor, efforts to enhance the stocks of commercially significant crustaceans by artificial hatching followed by ocean ranching. The species involved are mainly lobster (in the north-east) and shrimp in the Gulf of Mexico.

Ranching methods

Ocean ranching methods, although broadly similar, depend on the type of ranching. Typically (at least for salmon and other anadromous species), adult fish are strip spawned, the eggs hatched and the larvae raised in hatcheries. The hatched fish are released at different stages of development. In some cases they are released into rivers and creeks at a relatively early stage of their lives to grow and develop until they smolt and enter seawater. In other cases, they are reared to the smolt stage, at which time they are released to enter seawater. For salmon, this latter practice has gradually become the most common.

The methods of recovery range from (i) ocean fishing to (ii) place of release recapture to (iii) river fishing and combinations of these. In many cases, the objective of ocean ranching is to increase the ocean abundance of the species for harvest by recreational or commercial fishermen (i.e., stock enhancement ocean ranching). In other cases, the purpose of the ocean ranching is to enhance runs of fish into particular rivers. Finally, in pure ocean ranching, the aim is to recover the fish when they return to the place of release. However, irrespective of the type of the ocean ranching operation, in most parts of the US, a significant part of the ranched stock is normally caught at sea by recreational or commercial fishermen.

Industry structure and evolution

The US ocean ranching activity expanded throughout the 20th Century. The bulk of the ocean ranching consists of the stock enhancement of valuable species. This is primarily a government (federal and state) operation. The scale of this activity is substantial. Counting both freshwater and ocean releases, federal and state hatcheries currently release up to two billion individual fry and juveniles for stock enhancement purposes every year (Anonymous, 1992). By far the largest stock enhancement efforts concern salmon. About one billion salmon smolts are released every year from state and federal hatcheries. Most of these releases are captured at sea by commercial and recreational salmon fishermen.

Government expenditures on ocean ranching are quite sizeable. In 1990, the federal government alone may have spent upward of USD 100 million on stock enhancement ocean ranching (Anonymous, 1992).

Compared to the extent of the government stock enhancement operations, private ocean ranching in the US is small. The large scale ocean ranching facilities for salmon established in the 1970s, mainly in the state of Oregon, have proved unprofitable and many have ceased operations (Mayo Associates, 1988). Thus, in 1990 only three of the initial 11 licencees were still active in the business (Anonymous, 1992).

The only successful private ocean ranching in the US appears to be the Alaskan salmon ranching programme. This was initially authorized by the state legislature in the early 1970s with the aim of salmon stock enhancement. The first state hatchery for salmon commenced operations in 1971. In 1974, private non-profit salmon ranching was permitted. Permits are granted to individuals and organizations deemed qualified. The permits are for indefinite duration but not transferable. The permits do not allow pure salmon ranching, i.e. salmon ranching for the purpose of recapture at the site of release as in the Icelandic and Oregon ocean ranching operations. They are only granted for stock enhancement purposes. Nevertheless, the programme has attracted private interest and met with a fair degree of success.

The private ocean ranching in Alaska is generally carried out by co-operatives dominated by salmon fishermen. They find this activity profitable for reasons apparently specific to the nature of the Alaskan ocean salmon fishery. First entry into the Alaskan salmon fishery is strictly limited and the fishery is dominated by local fishermen with a long tradition in the fishery. Second, the fishery is under tight biological control that *inter alia* keeps track of individual salmon runs and, with the help of area/time closures and openings, endeavours to maintain the size of each substock. Third, it appears that the co-operative spirit among Alaskan salmon fishermen is such that when ranched salmon are caught by outside fishermen they

are generally returned to the owners of the original hatchery (Anonymous, 1992). For all these reasons, the extraneous fishing of ranched salmon is relatively little, and the fraction of salmon returning to the general area of release, where they may be harvested e.g. by purse seine by the local fishermen, is quite high. As a result, it makes good sense for local fishermen, especially those in relatively isolated areas, to establish a private "non-profit" salmon enhancement and ranching operation of this type.

In 1991, there were 21 private non-profit hatcheries run by fishermen's co-operatives compared to 19 public ones. (Anonymous, 1992). The private non-profit hatcheries include both large (revenues of over 1 million USD) and small operations. The large operations are usually regional co-operatives dominated by local salmon fishermen. The smaller ones are generally owned by individuals in the fishing industry. The main species being ranched in Alaska are pink and chum salmon. As the fry of these species can be released in saltwater a few days after hatching, hatchery costs are minimal. On the other hand, the market price of these species of salmon is low and most of the harvest is for canneries. Attempts are underway to hatch sockeye salmon which is much more valuable (Isaksson, 1994).

Profitability

As discussed above, ocean ranching in the US is primarily a government operation. However, there are some private ocean ranching operations in Oregon and Alaska. The ones in Oregon have not been profitable and most private ocean-ranching operations there have ceased (Mayo Associates, 1988; Anonymous 1992). On the other hand, the non-profit co-operative ocean ranching operations in Alaska seem to work (Boyce, 1990; Isaksson, 1994), although Isaksson (1994) doubts that they can actually repay the investment in hatcheries.

A major problem for private ocean ranching in the US is the lack of ownership over the ranched salmon. In most parts of the US, an ocean ranching operation will have to endure more or less widespread harvest of its releases by ocean fishermen, both commercial and recreational fishery. This constitutes a major external diseconomy which has contributed substantially to the poor economic results of the private ranching operations. Thus, Anderson and Wilen (1986) argue that the combination of weak property rights in the fish for the ocean rancher and a common property fishery on the ranching grounds will generally result in an unprofitable ranching operation.

For the private ocean ranching operations in the US, it should also be noticed that this industry has to meet substantial costs in terms of licencing, permits, environmental regulations etc. It is not clear to what extent, these charges actually reflect social costs. Similarly, although not privately profitable, it may be the case that the private ocean ranching operations, by providing external social benefits in terms of increased ocean harvest, may be socially profitable. The fact that the government is active in stock enhancement ocean ranching operations suggests that this may in fact be felt to be the case.

Public assistance

The government is the main player in the ocean ranching business in the US. This participation amounts to a very substantial public assistance for the ocean ranching activity. For the private industry, on the other hand, there is little direct

public support. For the most part, this industry has to operate within the same commercial laws as any other industry in the US. However, for the private industry there are indirect supports in terms of public research results and scientific advice made available to the private business. Above this, there is very little public support for the private industry. In some cases, public regulations helpful to the private industry have been set. In other case, the regulations are decidedly unhelpful. Overall, public regulation and legislation can not be regarded as particularly friendly to private ocean ranching enterprises in the US. Its main concern is environmental conservation and it appears that pure ocean ranching is generally regarded as environmentally detrimental.

Distribution of costs and benefits

Only a very small part of the ocean ranching operations in the US are privately run. This means that most of the costs are borne by the general public via federal and state governments. The benefits mostly befall recreational and commercial fishermen in marine fishing states. The effect on US consumer prices is probably small as most of the commodities are internationally traded ones. Hence, broadly speaking, the US ocean ranching industry is a publicly run industry for rather restricted private benefits.

Outlook

The outlook for private ocean ranching of anadromous species such as salmon is poor. With extensive ocean harvesting of these species, falling prices and highly variable recovery rates, the economics of this activity are simply not favourable enough. Hence, pure ocean ranching of these species is expected to continue to contract.

A possible exception to this general outlook for anadromous species is the Alaskan type of stock enhancement ocean ranching of salmon discussed above. To date this activity, although clearly not greatly profitable, seems to be economically sustainable. The main reasons seem to be very low hatching costs and relatively high recovery rates due, at least partly, to minimal outside harvesting of the ranched fish (Isaksson, 1994).

The outlook for private ocean ranching of relatively sedentary species such as molluscs is considerably brighter. Oyster farming is already well established and profitable. It is, on the other hand, more like traditional mariculture than ocean ranching. Stock enhancement ocean ranching of scallops has already begun with public support. It remains to see whether it can be privately profitable.

It seems likely that publicly funded (federal and state) stock enhancement ocean ranching of various species will continue and even intensify. It is unclear, however, to what extent the expenditure is justified by the benefits.

1.3 Ocean Ranching in Iceland

Ocean ranching in Iceland is confined to a single species, Atlantic salmon (*Salmo salar*). Iceland offers in some respects favourable conditions for ocean ranching of salmon. It is well endowed with salmon rivers, has an abundance of unpolluted fresh water, a biologically very productive ocean environment and, last but not least, ocean fishing of salmon is illegal.

Stock enhancement for the purpose of enhancing runs of Atlantic salmon to rivers has taken place in Iceland since the early part of this century (Palsson, 1995). Initially, this stock enhancement activity consisted of hatching and releasing fry at an early age into rivers where they had to fend for themselves for a number of years (usually 2-4) until they reached smolt size. Given the length of time the released fry spent in the rivers before entering the ocean, it is actually doubtful whether this activity is properly characterized as ocean ranching. With improved rearing technology, however, there has been an increase in releases of individuals at or very close to smolt size in which case the activity is more properly classified as stock enhancement ocean ranching.

Pure ocean ranching of Atlantic salmon, i.e. ocean ranching for slaughter recovery, was initiated by the government in the 1961 by the establishment of the State Salmon Rearing Station. A number of large-scale private ocean ranching facilities [3] were established in the 1980s. The ocean ranching activity reached a peak in the early 1990s with 6 facilities in operation, overall releases of about 6 million smolts and annual recovery of about 500 metric tonnes (Stefansson, 1995). Due to poor economic results, however, the pure ocean ranching activity has contracted substantially since then. By now it has virtually disappeared.

Species

As already mentioned, ocean ranching in Iceland is currently based on only one species, Atlantic salmon. This species is ranched both for the purpose of stock enhancement in rivers (stock enhancement ocean ranching) and slaughter recovery (pure ocean ranching).

Ranching methods

The smolts used for ocean ranching are produced in specialized hatching and rearing stations. Employing highly technical processes (heated water and artificial light cycles) to speed up their development, the fry are normally reared to smolt size (about 30 g) in one year although there are also some two year smolts (usually about 50 g). In the wild, by comparison, the development time, before smolting, is usually up to four years.

In the pure ocean ranching activity, the smolts are usually released into small streams, lakes or ponds close to the shoreline. In ocean ranching for river stock enhancement, the smolts are invariably released into the river itself.

The mature salmon return to the place of release, most (about 90% of returns) after one year in the ocean at which time they have reached an average weight of 2.7 kg. Some return after two years in the ocean at which time their average weight is 6.2 kg. (Stefansson, 1996)

In pure ocean ranching the recovery of returning salmon is often problematic as the salmon have proved reluctant to swim into the small stream or pond outlets employed by the ocean ranching stations. For these reasons, most of these stations have found it necessary to employ specially designed traps and nets for the recovery process (Arnfinnsson, 1988; Geirsson, 1988; Oddson, 1988). Examples of these traps and the recovery mechanism in two different stations are illustrated in Figure 1.3.

Another problem is that as the salmon runs approach the release area they tend to follow the shoreline. On this passage they are relatively easily caught.

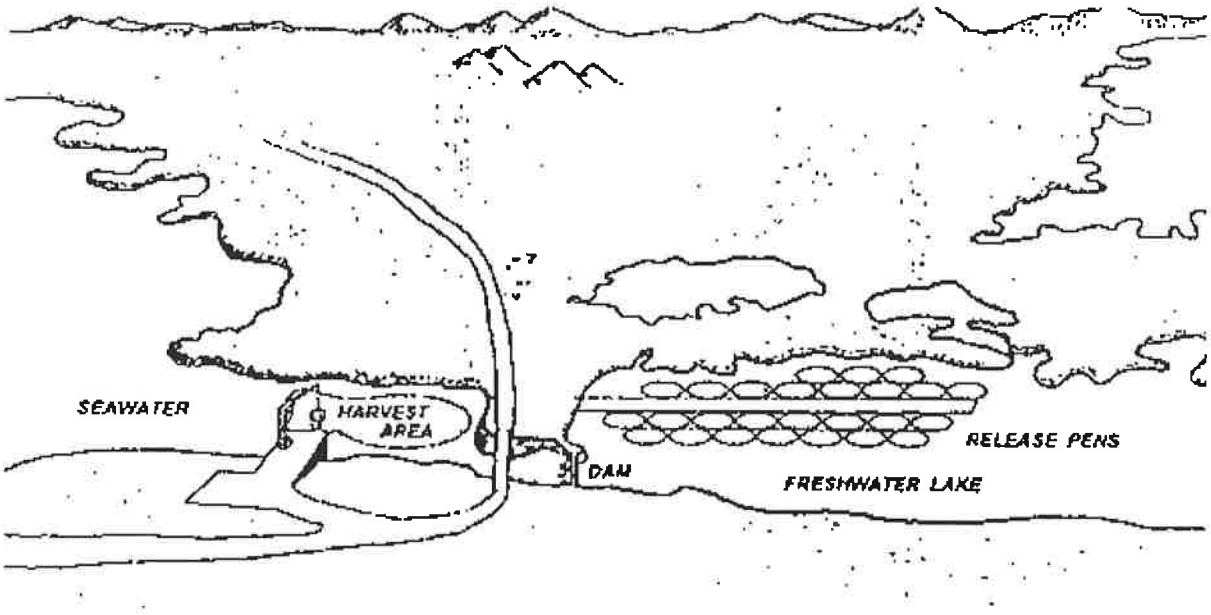
Consequently, in spite of this activity being illegal, the ranching companies complain of poaching of this salmon before it reaches the ranching station. However, informed observers do not regard the volume of poaching to be significant.

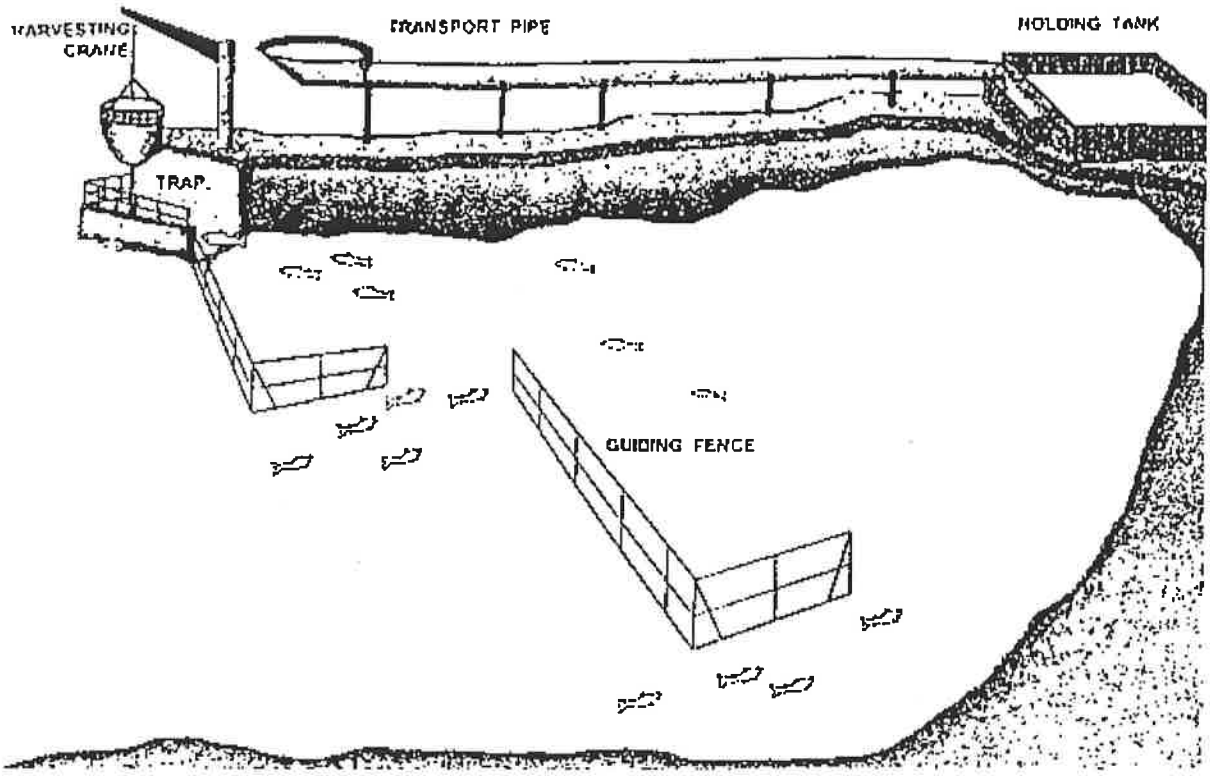
Evolution of industry

Starting in the early 1900s, ocean ranching of salmon for stock enhancement purposes has expanded throughout this century. Initially, the techniques employed were simple. Eggs were fertilized and hatched and the fry released into rivers at the yolk-sack stage or reared for a relatively short period of time in ponds before release. This practice was deemed to be successful and gradually expanded. With time, the hatching and rearing techniques have improved and the release of large fingerlings close to smolt size has become the most commonly used method. In 1994, about 300.000 smolts were released in rivers for stock enhancement purposes (Stefansson, 1995).

The economic basis for this type of stock enhancement ocean ranching is the high market value of salmon fishing licences in rivers. Almost all salmon rivers are privately owned and operated as commercial concerns. The owners have found it advantageous to limit the number of rods in the rivers with the result that the price of fishing licences is very high.[4] Under these circumstances, stock enhancement ocean ranching as described above appears to be profitable.

Figure 1.3
Salmon recovery mechanism in two Icelandic ocean ranching facilities
(Isaksson, 1994)





Pure ocean ranching commenced in the 1960's. The State Salmon Rearing Station was established in 1961 for the purpose of producing fingerlings for stock enhancement in rivers and ocean ranching (Gudjonsson, 1988). Its first release of smolts for ocean ranching took place in 1963. From then until the late 1980s this State facility was the largest ocean rancher in Iceland.

The first private ocean ranching operation, Lárós, commenced operations in 1965. However, compared to the ocean ranching activity of the State Salmon Rearing Station, this was a small operation and remained quite insignificant until the 1980s.

Encouraged by relatively good recovery rates in the State Salmon Rearing Facility, the developments in salmon aquaculture worldwide, and the availability of public funding, the private ocean ranching activity expanded dramatically around 1980. In addition to Lárós, 3 more major[5] private ocean ranching projects were established (Vogalax, Pólarlax, Ísnó). Later during the 1980s, three more large ocean ranching operations were established (Óslax, Silfurlax and Hafnarlax).

The economics of these ocean ranching operations, however, proved disappointing. There are two main reasons for this. First, recovery rates declined towards the end of the 1980s and have remained low ever since. Second, the ex-farm unit price of salmon has fallen sharply, presumably due to the greatly increased supply of farmed salmon around the world. These two factors in combination appear to have rendered pure ocean ranching of salmon hopelessly unprofitable in Iceland. As a result, the industry has greatly contracted and it likely to virtually disappear completely within a few years.

In terms of smolt releases, the industry reached a maximum in 1990 and 1991 with close to 6 million smolts released. Maximum production was reached in 1992 and 1993 with about almost 500 metric tonnes of salmon being produced. In 1996,

however, the production level was down to 200 metric tonnes and only about 1.6 million smolts were released.

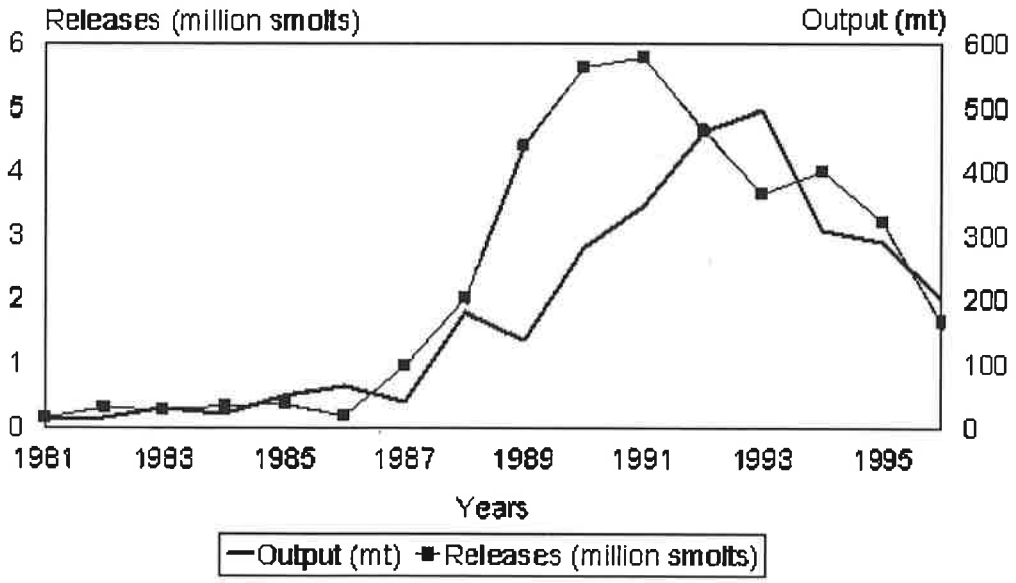
This history of the rise and decline of the Icelandic pure ocean ranching industry is further illustrated in Figure 1.4

The development of turnover and employment closely mirrors that for releases and production illustrated in Figure 1.4. It is of some importance to realize, however, that ocean ranching of salmon along the lines discussed above, is not a labour intensive activity. Labour is required on a sustainable basis for the hatching and rearing process, and seasonally for the release, recovery and slaughter activity. At the height of its activity, in 1990-1992, the number of man years employed in the industry was in the neighbourhood of 50 people. The maximum revenue was about USD 3 million.

Industrial structure

When most active, the Icelandic ocean ranching industry consisted of several private stations (about six large scale ones and a few smaller ones) and one state run facility (The State Salmon Rearing Station). Most of the private companies were organized as limited companies many with substantial foreign shareholding and vertically integrated in that they ran their own hatcheries for fry production, their own slaughter and packaging operations and did their own marketing. Some were also horizontally integrated running salmon aquaculture in pens as well as ocean ranching (Ísnó).

Figure 1.4 *Icelandic pure ocean ranching of salmon*: releases (million smolts) and production (metric tonnes, mt)



Profitability

Profitability has been very poor. The main reasons are lower than expected recovery rates and the falling price of salmon primarily due to the huge increase in supply from salmon mariculture in ocean pens. All the private ocean ranching operations have experienced very substantial losses. As a result, all of them have

either terminated or are in the process of terminating their operations. Some are actually bankrupt.

Public Assistance

Beginning the late 1970s, the Icelandic government determined that fish farming (especially salmon farming) constituted an important opportunity for economic growth and established a support scheme for fish farming operations. Financial support in the form of grants for private research and experimentation and investment loans at preferential rates were made available. This was done mostly through government controlled investment funds and state-owned banks. At the same time, publicly funded scientific research and experimentation into the various aspects of fish farming was greatly increased. A good deal of public infrastructure was provided by the state and municipal government. Finally, the government established a legal and regulatory framework helpful to the industry.

In total, public support for the aqua- and mariculture industry in Iceland has been very substantial indeed. In 1994, about 15 years after the start of the government support programme, the accumulative financial assistance amounted to well over USD 100 million (Palsson, 1995), an amount approximately equal to the total value of all fish farming output to that date. Although the majority of this support went to the shore- and land-based fish farming operations, the ocean ranching industry also received its share. Due to the virtual collapse of that industry, a large part of this financial capital was lost and will never be repaid.

Distribution of costs and benefits

As suggested by the above, the net economic benefits of the pure ocean ranching operations in Iceland have probably been highly negative. These losses have mainly been borne by the investors and, the general public via taxation to cover government outlays, and, since many of the ocean ranching companies have become bankrupt, bank surcharges imposed by the financial sector to cover their losses. Most of the benefits have fallen to labour and suppliers of inputs. As many of the ocean ranching operations are based in region of low population and few employment opportunities, the local benefits have often been quite substantial, although temporary, relative to the local economy.

The outlook

The outlook for pure ocean ranching in Iceland is bleak to say the least. Already in 1994, Isaksson (1994) had come to the conclusion that pure ocean ranching of Atlantic salmon was simply not profitable. The experience since then has confirmed his assessment. The industry has suffered heavy losses and has all but disappeared as a commercial activity.

The outlook for ocean ranching for salmon stock enhancement in rivers is much more sanguine. As explained above, the economics of that operation are entirely different. At the present this activity seems economically sound, as it has been for decades, and is likely to continue to expand in the future.

1.4 Similarities and Dissimilarities

The ocean ranching experience of the three countries reviewed, Japan, United States and Iceland, is in many respects quite similar. They have all have a long history of stock enhancement ocean ranching. All expanded their ocean ranching

activity greatly in the 1960s and 70s. All have extended a great deal of public support for the ocean ranching activity. Finally, they have all ranched similar types of species, namely salmon and other high unit value species.

When it comes to scale, however, the countries are quite different. Japanese ocean ranching is by far the most extensive, both as regards the number species ranched and the overall volume of releases. On these measures, the level of United States ocean ranching is probably no more than a one-third of that of Japan. Compared to these two nations, the Icelandic ocean ranching is and has been quite insignificant.

There are also important differences in the type of ocean ranching operations undertaken. In Japan stock enhancement ocean ranching has always been dominant. In Iceland and the USA, on the other hand, pure ocean ranching has been extensively tried but generally failed.

There are other significant differences. The level of public involvement in the ocean ranching activity differs greatly. In Japan, the ocean ranching is almost exclusively carried out and paid for by the government while the fishermen reap the benefits. In Iceland, although public support for the industry has been substantial, private enterprise has dominated ocean ranching form the outset. First, ocean ranching for stock enhancement in rivers has always for the most part been a private activity although the government has supported it by research. Second, private enterprise has dominated pure ocean ranching in terms of volume since the early 1980s. It should be noted, however, that this does not mean that private investors have actually funded this effort. Due to heavy losses, much of the private ocean ranching businesses have failed, and it seems that a substantial part of the losses will ultimately have to be borne by the public. The United States is in between these two extremes. Although most of the ocean ranching activity is government financed and operated, there is a degree of private activity as well, and has been in the past although as in Iceland most of it has failed.

There seem to be a few general lessons to be learned from the experience of these three countries:

(1) Pure ocean ranching of salmon has failed miserably as a commercial enterprise both in the United States and Iceland, where it has been extensively tried. Hence it seems that this type of ocean ranching is not privately profitable, at least not in these countries.

(2) Currently, there is very little privately profitable ocean ranching of any kind in any of these three countries.[6] This suggests that at the current level of technology and prices, ocean ranching is, in general, not privately profitable. Exceptions are provided by the stock enhancement ocean ranching of salmon for river fishing in Iceland and perhaps the stock enhancement of salmon by fishermen's co-operatives in Alaska, although the latter enjoys significant government support. Both, however, seem to rely on specific circumstances.

(3) Since extensive private attempts at ocean ranching have been carried out both in Iceland and the USA and failed; since the companies in question certainly explored several ways to make their operations profitable without success and since the bulk of the operational costs are not labour but other inputs relatively freely

traded in the global market place, the available evidence certainly does not suggest that there are good economic or development opportunities in pure ocean ranching around the world. This is not to deny the possibility that pure ocean ranching may be profitable in some special cases. The available evidence, however, as limited as it is, tilts the other way.

(4) It is unclear whether the stock enhancement ocean ranching funded by the government in the US and Japan produces net social benefits or not. Most likely, it doesn't. If it does, this would most probably be due to external economies of some kind[7]. Otherwise, the activity would most likely be privately profitable and the private industry would have stepped in as it has for instance in the mariculture business. It is most unfortunate that a comprehensive social cost-benefit study of the stock enhancement ocean ranching in the United States does not seem to be available.

(5) The experience of these countries, especially Japan and Iceland, shows that even extensive ocean ranching is by no means guaranteed to increase stock abundance. In fact, ocean ranching will fail to enhance stocks, unless there is a room for more individuals of the species in the ecology. This suggests the importance of a careful ecological investigation before embarking on an ocean ranching project.

1.5 Outlook

The outlook for private ocean ranching of the pure variety is poor in these three countries. What little there remains of it, will most likely disappear completely the next few years. At matters stand, it seems that only a great improvement in ocean ranching technology or a substantial rise in the price of the product (a highly unlikely event) can change this prognosis. Basically, one may say that the success of salmon mariculture and the expansion in other fish farming has eliminated any chance the ocean ranching business had of surviving in these countries.

Stock enhancement ocean ranching is likely to continue and even to expand as long as the US and Japanese governments are willing to fund it. It seems unlikely that this activity can become privately profitable in the near future.

Given (at best) the very uncertain economics of ocean ranching, it does not seem likely that other countries will find it attractive to initiate or expand their ocean ranching operations. However, if they do so, it will almost certainly be at their governments' initiative and not by private enterprises.

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[2] Excluding the production of sea-weed.
[3] Defined as being designed to release over 1 million smolts per year.
[4] For instance, a price of about USD 1000 per day per rod would not be uncommon.
[5] Major being defined as facilities designed to release 1 million or more smolts per annum.
[6] There is some private stock enhancement ocean ranching in rivers in Iceland and co-operative ocean stock enhancement of salmon in Alaska as well as some private farming of sedentary molluscs (oysters and mussels) in the United States and Japan.

[7] Such as the public good value of social preservation of threatened stocks, maintenance of regional habitation and way of life and so on. It should be noted, however, that these positive externalities are generally counteracted and, in some cases, exceeded by negative externalities such as marine ecological adjustments and shoreline use.