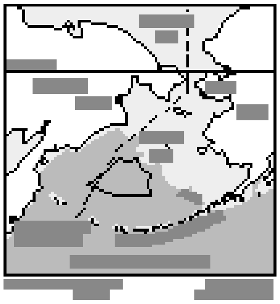


Map 4. **The "donut hole" high seas enclave sustained an important DWF fishery for walleye pollock**

■ Case Study: Walleye Pollock and the North Pacific "Donut Hole"

ECOSYSTEM

Environmental Conditions

The Bering Sea is a sub-polar area bounded by the Aleutian Islands in the south and the Bering Strait in the north. It has a total surface of 2,274,020 km^2 and a mean depth of 1,636 m. The Bering Sea is generally regarded as an extension of the North Pacific Ocean, significantly influenced by the Arctic Ocean (Canfield, 1993). The eastern Bering Sea is considered as one of the most productive marine ecosystems in the world, a feature probably related to the size of its continental shelf which, at 500 km wide at its narrowest point, is the second widest in the world (Bakkala, 1993). The "donut hole" is a portion of the Bering Sea surrounded by the EEZs of Russia and the United States. It lies just off the eastern Bering Sea on the Aleutian Basin, and at 55,000 square nautical miles comprises 19 per cent of the Aleutian Basin and 8 per cent of the Bering Sea. The "donut hole" is essentially a high-seas enclave outside the jurisdiction of any country.

Food Chain

The Aleutian Basin, and in particular the pollock stocks of the "donut hole", depend greatly on resources from the eastern Bering Sea. A large part of the yearly primary production from the outer shelf of the eastern Bering Sea is channelled into the pelagic food web of the Aleutian Basin though the effect of tidal currents. This energy supply is what supports the large population of walleye pollock and other semi-demersal species of this area (Bakkala, 1993).

THE DWF NATIONS

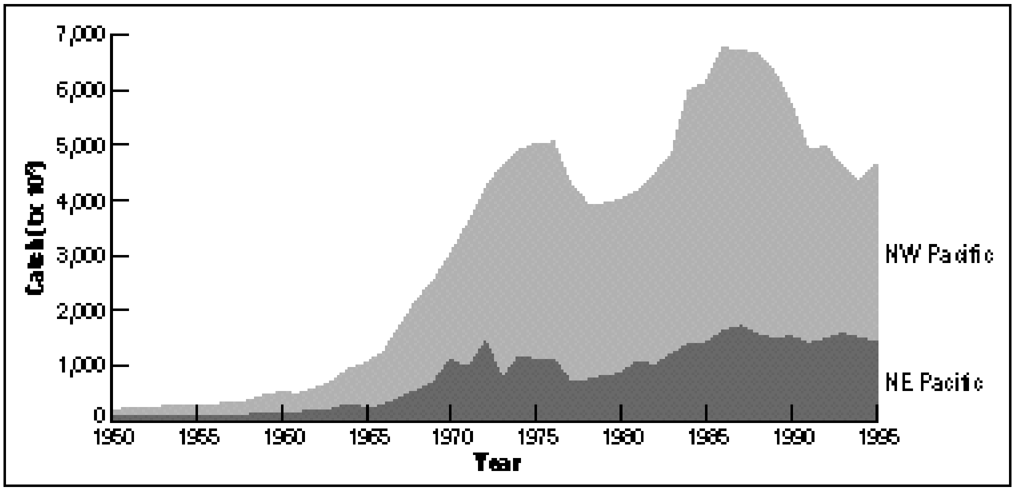
The modern exploitation of fisheries in the Bering Sea started in the early 1950s when Japanese vessels began fishing for flatfishes, mainly yellowfin sole (*Pleuronectes asper*). The Soviet fleet followed at the end of the decade. Although there were some catches of walleye pollock (*Theragra chalcogramma*) in the late 1950s, the real breakthrough in the exploitation of this fish came in the 1960s. According to Bakkala (1993), the major development in the fishery was the implementation by Japan of on-board production methods for surimi (minced meat) from pollock. The Japanese fishery thus shifted to walleye pollock and production grew from 175,000 t in 1964 to 1.9 million t in 1972.

Other nations followed suit, among them the Republic of Korea (1968), Poland (1973), Taiwan (1974), Germany (1980), and Portugal (1984). Although most of these countries fished for pollock, their catches were minor compared with those of Japan. By 1988, however, the United States was catching all of the pollock in the eastern Bering Sea and delivering it to foreign vessels through joint-venture fisheries that were set up soon after declaration of the 200-mile EEZ (Bakkala, 1993; Traynor et al., 1990).

THE FISHERY RESOURCES

Walleye pollock is the single most important fishery resource of the entire North Pacific and particularly the Bering Sea. This species single-handedly supported peak catches of 6.7 million t in 1987 (Figure 6), more than 7 per cent of all fishery catches in the world that year. The Sea of Okhotsk and the eastern Bering Sea are the main fishing grounds, although important catches are also taken in the Aleutian Basin's "donut hole". According to data from the early 1990s taken from Wespestad (1993),

Figure 6. **Most of the reported catches of walleye pollock are taken in the northwest Pacific**



FAO 1995

40 per cent and 56 per cent of the total pollock catches are taken in the Sea of Okhotsk and Bering Sea respectively; the "donut hole" (Aleutian Basin) and the eastern Bering Sea catches account for 19 per cent and 23 per cent of the total.

After pollock, groundfish constitute the most important commercial fisheries in the Bering Sea, specially yellowfin sole, Pacific halibut (*Hippoglossoides stenolepis*), Pacific cod (*Gadus macrocephalus*), sablefish (*Anoplopoma fimbria*), and Pacific Ocean perch (*Sebastes alutus*). Other important fishery resources for DWFs in the Bering Sea are Pacific salmon (*Oncorhynchus* spp.), king crabs (*Lithodes* spp. and *Paralithodes* spp.), and snow crabs (*Chionoecetes* spp.). The Japanese catches of Pacific salmon inside the "donut hole" were phased out in 1991.

Wespestad (1993) summarizes information on the biology of walleye pollock. The species is endemic to the North Pacific. In the eastern Bering Sea, pollock live on average to 9 years, but strong year classes remain abundant for up to 12-15 years; the oldest recorded age is 21 years. They mature at about age 3-4 (40-45 cm or 0.5 kilogram (kg)) and tend to become more demersal as they age. The natural mortality rate is estimated at 0.3 for fish less than 2 years old (Bakkala, 1993) and there are reports of cannibalism in this species. The maximum sustainable yield estimate for the eastern Bering Sea pollock stock is 1.5 million t. Genetic studies have shown the existence of two clearly distinct stocks of pollock, one in the Bering Sea-Gulf of Alaska region, and another in the Sea of Okhotsk (Iwata, 1975; cited in Bakkala, 1993). There is less clear information about stock structure in the Bering Sea. Some studies suggest the presence of western and eastern stocks but evidence is not conclusive. Furthermore, the eastern Bering Sea might host several stocks. Length-at-age data suggest a stock inhabiting the NE shelf and slope and the Aleutian Basin that would be distinct from pollock in the remaining eastern Bering Sea (Lynde et al., 1986; cited in Traynor et al., 1990). However, genetic studies do not support this hypothesis (Grante and Utter, 1980; cited in Traynor et al., 1990). A basin stock, a northeastern slope stock and a rest of the eastern Bering shelf and slope stock were suggested by studies showing differences in spawning site and fecundities (Hinckley, 1987; cited in Traynor et al., 1990).

According to reports from the International North Pacific Fisheries Commission (INPFC) (1992), poor recruitment since 1984 caused declines in pollock abundance in the eastern Bering Sea and Aleutian regions towards the early 1990s. The allowable biological catch for 1992 was estimated at 1.497 million t, based on a policy of an F0.1 exploitation rate. In general, pollock stocks appeared to be in decline in most regions of the Bering Sea.

HISTORICAL CATCHES

The fishery for walleye pollock in the "donut hole" developed in the mid-1980s as a result of the exclusion of DWFs from inside the EEZs of the USSR and the United States (Traynor et al., 1990; Dunlap, 1995). Catches increased rapidly from over 180,000 t in 1983 to 1.3 million t in 1987. The main DWFs involved in fishing operations inside the "donut hole" were Japan, the Republic of Korea, and Poland, although the USSR and China also participated in the fishery (Table 8). During this period, the catches of pollock in the "donut hole" slightly exceeded those made by United States vessels in the eastern Bering Sea (Traynor et al., 1990). During the peak year of 1989, the 1.4 million t of pollock caught in the "donut hole" represented 22 per cent of the world catches of this species. International management of the walleye pollock resource led to a moratorium of fishing in the "donut hole" area since 1993 which is still in place (see agreements section).

Table 8. **Reported catch (t x 10^3) of walleye pollock in the donut hole area 1983-1992**

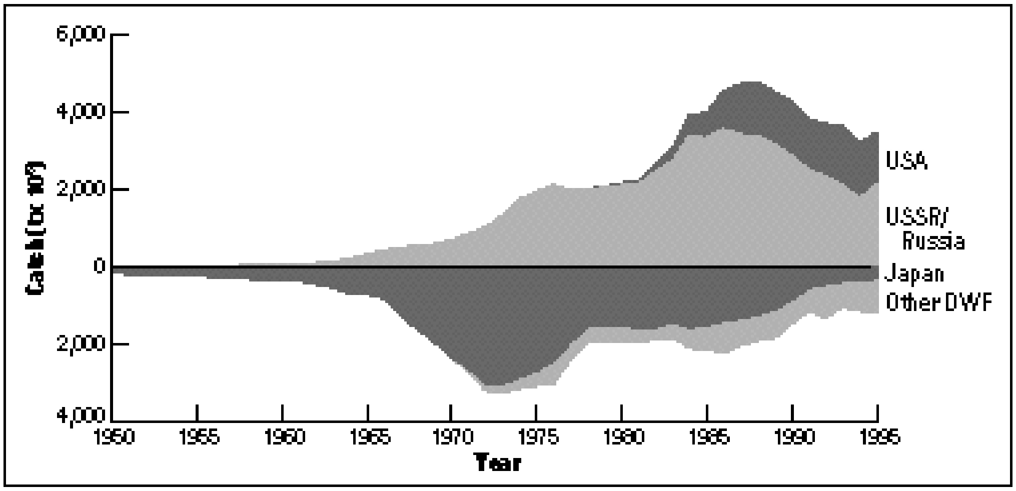
Year	China	Japan	Korea Rep.	Poland	USSR/FSU	Total
1983	-	-	-	-	-	175
1984	-	-	-	-	-	181
1985	2	164	82	116	-	363
1986	3	706	156	163	12	1,040
1987	17	804	242	230	34	1,326
1988	18	750	269	299	61	1,378
1989	31	655	342	269	151	1,416
1990	28	417	244	223	5	917
1991	17	140	78	55	3	293
1992	-	-	-	-	-	11

Sources: Traynor et al., 1990; McDorman, 1991; Canfield, 1995; and Wespestad, 1993

A comparison of pollock catches of DWFs and countries surrounding the "donut hole" (United States and USSR) outlines the major trends of the fishery in the North Pacific (Figure 7). Up until the mid-1970s the catches by DWFs – led by Japan – far exceeded those of the local nations. This trend was reversed with the implementation of 200-mile EEZs. While the DWFs' share decreased, the ex-USSR rapidly increased its share and has since taken the largest part of the total pollock catch, mainly in the Sea of Okhostk. The United States has also expanded its catches of pollock since the early 1980s. During the late 1980s DWFs' catches showed a slight increase due to catches taken inside the "donut hole" after the DWFs were excluded from their former main fishing grounds in the eastern Bering Sea. Overall, pollock catches of foreign fleets have declined steadily since the early 1970s.

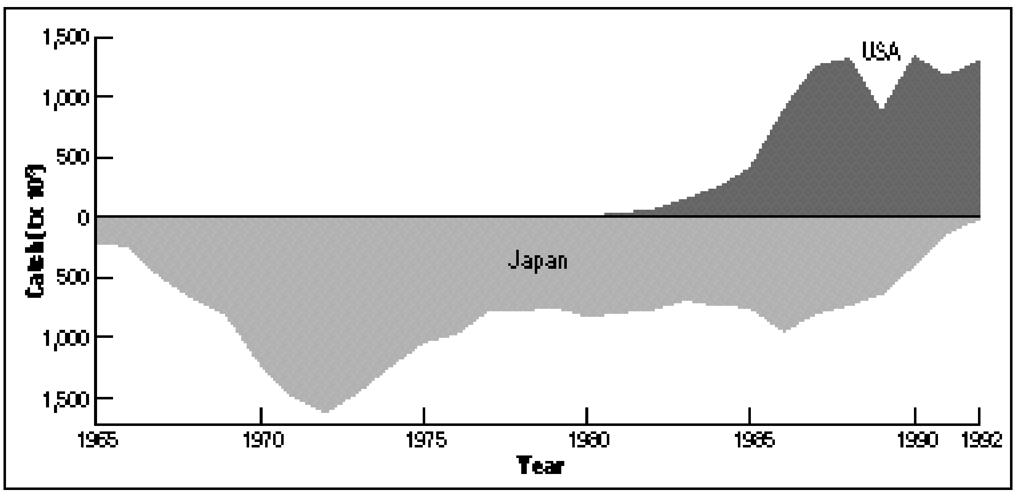
Catch statistics specific to the Bering Sea are available only for the United States and Japan through the INPFC reports. These partial data show the same trend as the whole

Figure 7. **DWFs took the largest part of the walleye pollock catch until the mid-1970s**



North Pacific data: a reassignment of catches from DWFs to the coastal nations (Figure 8). While Japan took most of the pollock until 1980, a slow but definite growth of United States pollock catches since the mid-1980s was matched by a concurrent decrease of Japanese catches. By 1992, Japan had ceased to fish for pollock in the Bering Sea.

Figure 8. **Japan's walleye pollock catches were gradually replaced by USA catches**



INPFC data

Two events were responsible for this trend. First the establishment of joint-venture fisheries in the eastern Bering Sea inside the United States EEZ to replace DWFs, and second the moratorium on pollock fishing inside the "donut hole" area – which was the last enclave of DWFs in the Bering Sea – since 1993.

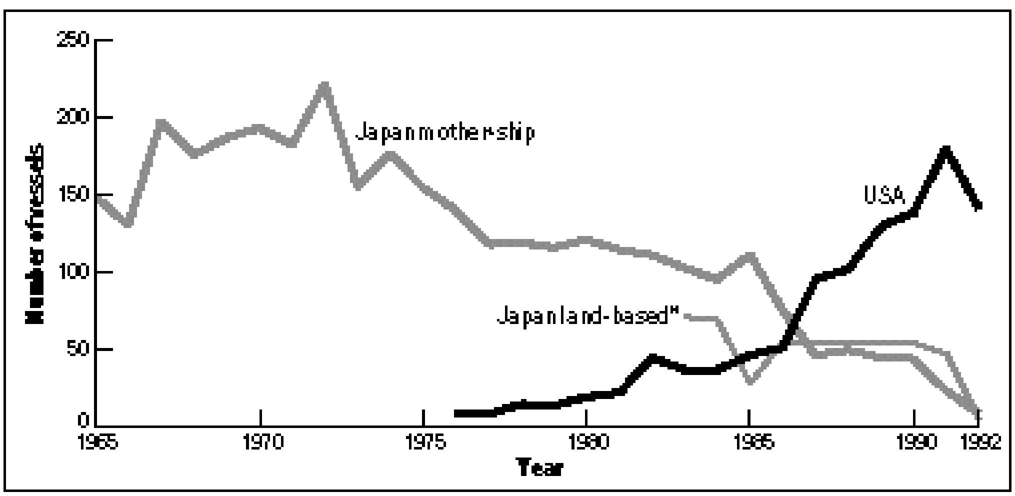
FLEET CHARACTERISTICS AND NUMBERS

Information on the size, number, and characteristics of the fishing fleets is fragmentary. Bakkala (1993) provides some data on the fleets catching pollock in the eastern Bering Sea. Japan had two different fleets targeting pollock in the 1970s. The mother-ship fishery used large processing vessels supplied by fleets of trawl catchers. These catcher vessels used Danish seines, pair trawls, and stern trawls to fish pollock and ranged from about 100 to 350 GRT. The second fleet was composed of land-based stern trawlers of 2,500 to 5,500 GRT. These vessels were prohibited from transhipping at sea and had to return to land their catches in Japan. Soviet factory stern trawlers fishing for pollock were of 2,600 to 3,900 GRT, and Republic of Korean stern trawlers ranged between 2,200 and 5,700 GRT. Fredin (1987) indicates that the number of Japanese mother-ship groundfish fleets in the Bering Sea increased from 2 in 1954 to 33 in 1961. By 1984, 6 mother-ship fleets supplied by 77 catcher vessels were operating in the Bering Sea while 43 land-based stern trawlers were also present (INPFC, 1987).

There is no readily available information on the number of vessels fishing in the “donut hole”. Limited data on sightings of foreign vessels indicate that these peaked at 2,470 vessels during 1990-1991, were 1,221 in 1989, and fell to 871 during 1991-1992 (Canfield, 1993). It should be noted that sightings include an unknown number of multiple sightings of the same vessels.

The INPFC is an alternative source of partial information on number of vessels fishing for groundfish in the Bering Sea. However, it is difficult to distinguish how many of these vessels were fishing for pollock and how many were targeting other groundfish stocks. The data presented in Figure 9 mirror the trends observed in the share of the catch by these two countries (see above). Japan maintained between 100 and 180 trawling vessels until 1983, then decreased steadily to only 11 boats in 1992. Meanwhile the United States fleet grew rapidly between 1986 and 1992, virtually replacing the Japanese fleet.

Figure 9. **The number of trawlers in the Bering Sea reflects the changes in the share of the catches between Japan and the United States**



*information not available prior to 1975 but vessels known to have operated in the Bering Sea
INPFC data

FISHERIES MANAGEMENT

Before the declaration of EEZ regimes by the United States and USSR, the management of the Bering Sea fisheries was mostly a decision of each country. Initially, the United States had jurisdiction only in a 3-mile zone from the coast. Under this provision, the United States permitted groundfish trawling in its waters starting in 1942. The Japanese

DWF was managed directly by the Japanese government. In 1959, Japan declared some areas closed to its own trawl fisheries in the Bering Sea and around some of the Aleutian Islands, mainly to avoid gear conflicts with other fisheries (Fredin, 1987). Furthermore, Japan limited the number of licences and areas of operation of all components of its groundfish fleets in the Bering Sea during 1967. The United States extended its jurisdiction to a 9-mile contiguous fishery zone in 1966 which led to a number of bilateral fishing agreements. These provided some limited management measures for pollock. Area and seasonal closures were established during several years. In the early 1970s, pollock quotas agreed upon were: Japan 1.5 million t (1973), 1.3 million t (1974), and 1.1 million t (1975-1976); the USSR 210,000 t (1975-1976). These quotas were based on average catches over a number of preceding years and were intended to serve as a cap while stock assessments were carried out (Fredin, 1987).

The implementation of the EEZ regime by the United States in the eastern Bering Sea during 1977 changed the rules of the game. Optimum yield (OY) levels for the different groundfish species were identified by United States scientists and used to provide fishing quotas for DWFs. The OYs for pollock ranged between 950,000 t and 1.5 million t during 1977-1985. In addition to this, DWFs were required: (1) to stop fishing in the United States EEZ once the specified quotas were fulfilled; (2) to carry on-board United States observers at no cost to the United States (in contrast to this, see the Mauritania and Senegal case study above); and (3) to provide the United States government with catch and effort statistics for each vessel on a regular basis. Additional regulations were included to minimize the bycatches of juvenile Pacific halibut.

Initial efforts for international fisheries management in the North Pacific took shape in 1952 in the form of the INPFC. This body – formed by Canada, Japan, and the United States – was to undertake research and management of fishery resources for situations where no bilateral agreements existed between at least two of the member countries. Effectively, the work of INPFC was centred on salmon stocks. Although some research on groundfish took place under the auspices of the INPFC (sablefish and Pacific Ocean perch), no management recommendations were ever issued for walleye pollock (Fredin, 1987).

Extended jurisdiction in the late 1970s initiated a process of retreat of the DWFs from coastal nations' waters. The DWFs fishing pollock in the eastern Bering Sea were replaced by joint-venture fisheries in the early 1980s, forcing the rapid development of the Aleutian Basin's "donut hole" pollock fishery. The uncontrolled growth of this fishery spurred worries about overfishing and the effects of Aleutian Basin catches on the pollock populations of the eastern Bering Sea. Such worries were underscored by the precipitous fall of pollock catches in the "donut hole" during 1989-1991 and the accompanying decreases in catch per unit effort (Canfield, 1993).

Effective management of the "donut hole" fishery did not come about until the early 1990s. This took shape in the Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea which is one of the rare examples of successful international cooperation. This agreement – detailed below – offered the possibility of a complete halt of fishing in the "donut hole" area. Under provisions of this agreement, all DWFs involved in the "donut hole" pollock fishery during the 1980s agreed to stop fishing from 1993 in order to allow recovery of a depleted stock in need of strong conservation measures. At time of writing of this paper, the moratorium on pollock fishing is still in force and is scheduled for review in 1998.

BYCATCH

Information on bycatch in the walleye pollock fisheries of the Bering Sea is not readily available. According to Canfield (1993), some reports indicate that Alaskan trawlers fishing for pollock and Pacific cod discarded about 9,000 t of halibut and some 250,000 t of groundfish in 1990. However, it is difficult to know how much of this pertains to pollock-targeted fishing. Judging from the nature of the "donut hole" fishery for pollock where all the fishing is by mid-water trawl it is expected that only minimal problems of bycatch occur.

FISHING AGREEMENTS

During the 1950s and 1960s, all of the bilateral agreements between nations fishing in the Bering Sea included provisions for avoiding gear conflicts and bycatch of valuable species but no provisions existed for the management of pollock stocks. For example, an agreement of May 1967 imposed some time/area restrictions for trawling by Japanese vessels in parts of the Aleutian Islands, but in the words of Fredin (1987), controlling the impact of foreign fisheries on pollock and other groundfish stocks was not an issue for the United States at that time. This changed drastically in 1972-1973 when Japan and the USSR agreed to a United States proposal of adopting catch quotas for pollock for the first time in addition to seasonal/area restrictions (see management above). Most of the bilateral agreements of the mid-1970s were political tools used to allocate shares of the fishery rather than means of "selling" fish to DWFs as is the case in many DWF situations in other parts of the world.

The most important international agreement for managing pollock fisheries in the Bering Sea is the Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea. This agreement, signed by China, Japan, Poland, Russia, the Republic of Korea, and the United States in 1994, came into force in 1995. Dunlap (1995) provides a compelling account of the development of this agreement. In his opinion, it has a unique combination of enforcement mechanisms, and offers potential to become one of the most effective multinational agreements ever reached. It is one of the few fishing agreements in the world signed by all the parties fishing in the area of interest. The agreement was developed during 1991-1994 in a very swift process which was undoubtedly fertilized by the rapid and evident collapse of the stocks in question. Unequivocal evidence of the decline in pollock abundance in the Aleutian Basin was becoming available as the ten conference meetings proceeded, causing a swift change in the positions initially adopted by the DWF nations. This fortunate incident was perhaps the most important breakthrough in the signing of the convention. Under the terms of reference of this agreement, the contracting parties agreed to a suite of commitments aimed at the conservation, management, and optimal utilization of the pollock resources of the central Bering Sea ("donut hole" area). Among the most important aspects of the agreement are: (1) provisions for the determination of annual harvest levels and individual nation quotas for each year; (2) effective mechanisms for dealing with non-complying parties; (3) broad provisions for dealing with nations who are not a party to the agreement and intend to undermine the objectives of the Conference; (4) cooperation in research and exchange of fisheries data; (5) satellite tracking for all fishing vessels; and (6) establishment of a scientific observer programme for full coverage of fishing activities.

BENEFITS

One obvious benefit from the occurrence of DWFs in the Bering Sea is probably the discovery and development of the important pollock fisheries. It was the Japanese who found a use for pollock in the form of surimi. The coastal nations, in particular the United States, have capitalized through joint-venture fisheries and thanks to extended jurisdiction, on the market and fisheries developed by the DWFs, particularly Japan. At the end of the day, there is benefit for all nations as the management brought about in recent years will be the only chance to avoid repetition of the far too common overexploitation of marine stocks that occurs in most open access situations.

However, the most important benefit derived (even though a little late) from the fishing activities of DWFs in the "donut hole", was the realization of the recent agreement for conservation and management of pollock describe in the preceding section. This agreement constitutes a breakthrough in modern international fisheries agreements for the "high seas" and will probably serve as the benchmark for several years to come.

CONFLICTS

Overall, the DWF fisheries in the Bering Sea area have been devoid of major conflicts. Ignoring the overexploitation of the pollock resource in the "donut hole", currently under a recovery regime, there have been no major negative effects of DWF activities.

For a number of years, there were several instances of alleged illegal incursions of DWF vessels from the "donut hole" into the eastern Bering Sea to catch pollock. Between 1989 and 1992, at least 11 seizures of vessels supposedly fishing pollock in the "donut hole" were made by the United States Coast Guard in the eastern Bering Sea (Canfield, 1993). These relatively minor problems have apparently been successfully resolved through the "donut hole" agreement described above. Recent news, however, indicates that illegal fishing in the Bering Sea is still attempted occasionally by some nations. A Chinese vessel was recently caught fishing illegally for salmon in the Russian EEZ (*The Vancouver Sun*, 1998; Omori, 1998). On 31 May 1998, the Russian fisheries enforcement vessel *Brest* intercepted and seized 13 trawlers from the Democratic People's Republic of Korea allegedly fishing illegally in Russian waters in the Bering Sea (Dow Jones News, 1998).

■ Case Study: Iceland and DWFs*

ECOSYSTEM

Environmental Conditions

The three major current systems that influence Icelandic waters are (1) the warm and saline Irminger current – an offshoot from the Gulf Stream – flowing from the south; (2) the colder and less saline East Greenland current of Arctic origin flowing from the

* Prepared by Hreidar Valtysson

northwest; and (3) the East Iceland current from the northeast, made up from mixing of cold arctic waters and the warmer Gulf Stream northeast of Iceland (Map 5) (Stefánsson, 1962). There is also a freshwater-induced coastal current flowing clockwise around the country. The Irminger current and the mixing of all these currents is the main reason for the high productivity found in Icelandic waters. The Irminger current keeps the waters south and west of Iceland relatively warm and stable both inter- and intra-annually.

Map 5. **Iceland has moved from being a nation hosting DWFs to becoming a DWFN itself**

Phytoplankton blooms around Iceland occur in early spring and autumn. The spring bloom is driven by longer-lasting days and by warmer, stratified waters. This allows phytoplankton to stay in the surface waters. By summer, the rapid growth of the phytoplankton renders the surface waters nutrient deficient and photosynthesis declines to a low level. The autumn bloom is aided by vertical mixing caused by temperature differentials in the air-sea interface. Stronger bloom years are generally linked to warmer ocean temperatures caused by a stronger Irminger current. The total primary production in Icelandic waters has been estimated to be around 55 million t carbon annually, or 218 g carbon m^{-2} y^{-1} in the continental shelf and 151 g carbon m^{-2} y^{-1} offshore (Thórthardóttir, 1995). The biomass of zooplankton (dominated by the copepod *Calanus finmarchius*) in northern surface waters increases in May, then declines during the summer. Productivity is generally greater in the waters south and west of the country, where blooms also occur earlier and autumn blooms are also more prominent (Ástthórsson and Gíslason, 1995; Gíslason and Ástthórsson, 1997).

Food Chain

Among the large benthic invertebrate fauna in Icelandic waters, the most important crustaceans are northern shrimp (*Pandalus borealis*), Norway lobster or scampi (*Nephrops norvegicus*), and a few crab species that are currently not utilized. The main molluscs are the Icelandic scallop (*Chlamys islandica*), ocean quaghog (*Arctica islandica*), horse mussel (*Modiolus modiolus*), common mussel (*Mytilus edulis*), and whelk (*Buccinum undatum*). The only echinoderm fished is the green sea urchin (*Strongylocentrotus droebachensis*). These are all low in the food web, either filter feeders or bottom scavengers, or feeding on algae.

The main pelagic species off Iceland are capelin (*Mallotus villosus*) in the colder waters and herring (*Clupea harengus*) in the warmer waters. They feed on zooplankton, mostly copepods. Other common pelagic or benthopelagic species such as redfishes (*Sebastes* spp.), blue whiting (*Micromesistius poutassou*), Norway pout (*Trisopterus esmarki*), Arctic cod (*Boreogadus saida*), greater silver smelt (*Argentina silus*), and sandeels (*Ammodytidae*) share similar trophic levels. They feed predominantly on euphasids but also other zooplankton and benthic invertebrates. Many of these fishes are important food for other species. Basking sharks (*Cetorhinus maximus*), fin whales (*Balaenoptera physalus*), and sei whales (*B. borealis*) are common in Icelandic waters and feed also predominantly on zooplankton, as does the much rarer blue whale (*B. musculus*). Minke (*B. acutorostrata*) and humpback whales (*Megaptera novaeangliae*) are also abundant but feed on fish as well as zooplankton.

The main benthic feeding fish are haddock (*Melanogrammus aeglefinus*), wolf-fishes (*Anarhichas lupus* and *A. minor*), grenadiers (*Macrouridae*), rattails (*Chimeridae*), sculpins (*Cottidae*), eelpouts (*Lycodidae*), common skate (*Raja batis*), starry ray (*Raja radiata*), and flatfishes. However, they feed also on capelin in large quantities when available. Higher in the trophic level are the piscivorous fishes, dominated by Atlantic cod in the warmer waters and by Greenland halibut (*Reinhardtius hippoglossoides*) in colder regions. Other species in this level are mostly gadoids such as saithe (*Pollachius virens*), whiting (*Merlangius merlangus*), tusk (*Brosme brosme*), and lings (*Molva molva* and *M. dypterygia*). Other less numerous groups are salmonids, Atlantic halibut (*Hippoglossus hippoglossus*), spiny dogfish (*Squalus acanthias*), and angler fish (*Lophius piscatorius*). In general, species in this group eat mostly small invertebrates when small, shrimp and capelin at medium sizes, and other fish when fully grown. The top predators are the Greenland shark (*Somniosus microcephalus*), porbeagle (*Lamna nasus*), seals, and toothed whales, which eat squid and various fish species (Pálsson, 1983; Jónsson, 1992; Anon., 1997a).

THE COASTAL NATION

Iceland is the second largest island in Europe, and lies close to the Arctic Circle in the North Atlantic. The maritime boundaries are Greenland in the west and northwest, Jan Mayen (Norwegian) in the north, and the Faeroe Islands in the southeast. The total size of the 200-mile EEZ is 758,000 km^2, of which 111,000 km^2 is continental shelf less than 200 m deep, where most of the fishing is done. The south shore is characterized by sandy beaches without good harbours; the west, north, and east coasts however have many fjords and bays with good harbours. The total length of the coastline is about 5,000 km.

Considering how far north it is, the climate in Iceland is temperate but is nevertheless not well suited for agriculture. Only 1 per cent of the land is cultivated, a further 20 per cent is used in summer for pasture, the rest is glaciers, lava fields, deserts, and other wasteland. Besides fish, relatively cheap electricity from hydro and geothermal power plants is almost the only other natural resource. Virtually no minerals are available in commercial quantities.

About 270,000 people of homogeneous Norwegian/Celtic ancestry live in Iceland. More than half of them live in or close to the capital Reykjavik and the rest mostly in small fishing villages scattered along the coast. Agriculture, mainly sheep farming, has historically been the mainstay of the economy, fisheries coming close second, usually being conducted seasonally by the farmers or farm workers. This century, fisheries have however become far more important, and are the main reason the nation was able to develop from a poor agricultural country to a prosperous modern society. Since fisheries are so dominant, the economy is vulnerable to fluctuations in fish prices and stock sizes.

THE FISHERY RESOURCES

The most important fishery resources in Icelandic waters are medium- to long-lived demersal species typified by the Atlantic cod; the most obvious exception is the capelin which is a short-lived pelagic fish.

Most of the important species do not generally leave the Icelandic EEZ, the exceptions are: (1) capelin that undertake large-scale feeding migrations up to Jan Mayen in the north and Greenland in the northwest; (2) Greenland halibut which undertake feeding/spawning migrations to Greenlandic and Faeroese waters; (3) blue whiting which spawn in British waters but undertake feeding migrations to Icelandic waters; (4) the large whales which use Icelandic waters for feeding but have nursery areas in tropical waters; (5) the Norwegian spring-spawning herring stock, which when not depressed spends the summers and winters feeding in Icelandic waters (see Boxed Case Study 2). In addition to these migratory species, there are straddling stocks such as shrimp and some of the redfishes living on the edge of the Icelandic EEZ. Occasionally, some quantities of mackerel (*Scomber scombrus*), horse mackerel (*Trachurus trachurus*), squid, and bluefin tuna (*Thunnus thynnus*) wander through the Icelandic EEZ, but generally not in fishable quantities.

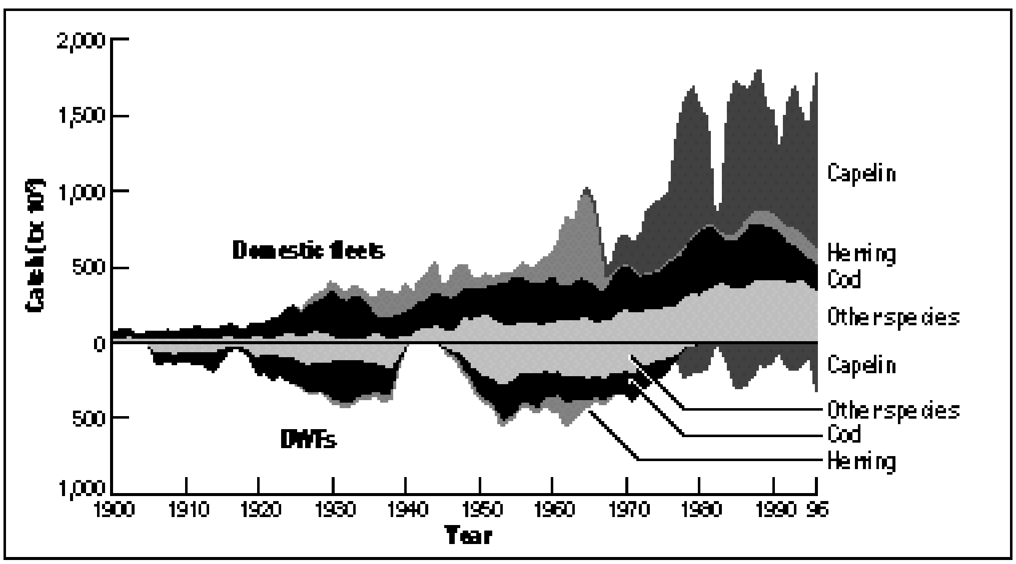
Few boats use only one gear or target one species. Purse-seiners catch capelin during part of the year, herring in other seasons, and sometimes trawl for shrimp during other parts of the year. Many of the smaller shrimp boats switch seasonally between Danish seine, gillnet, shrimp trawl, and longline. Large trawlers fish for Atlantic cod in one season, Greenland halibut in another, redfish the third, and then go for Atlantic cod or shrimp in distant waters.

The most important fishery resources of Iceland can roughly be split into ten major groups as follows.

Offshore Groundfish

This fishery is conducted on the continental shelf with bottom trawls. Atlantic cod is the main target species but others such as haddock, saithe, tusk, common ling, wolf-fishes, and flatfishes are also important. The distinction between bycatch and target species in this fishery is however blurred, depending on the quota status of the boats and area fished. Economically, this fishery – which was started late last century by British trawlers – is the most important. Before World War I, total groundfish catches were around 200,000 t/y, mostly Atlantic cod (Figure 10). Between the wars, catches were 400,000-700,000 t/y, and after World War II they ranged from 600,000 to 800,000 t; roughly half of this is Atlantic cod. About two-thirds of the groundfish catches were taken by trawlers, the rest by smaller inshore boats. The importance of Atlantic cod in trawl

Figure 10. **Capelin, herring, and cod have dominated the catches in Icelandic waters by foreign and domestic fleets**



fisheries has been diminishing lately because of restricted quotas. Other species in deeper waters, such as Greenland halibut, redfishes, and shrimp are being targeted more in turn.

Inshore Groundfish

Similar in species composition to the offshore fishery, this is however more seasonal and is conducted by many small, primarily Icelandic boats with handlines, longlines, or gillnets. Catches from these boats were below 100,000 t/y until after World War I, when they increased to about 150,000 t before the Great Depression. After World War II catches increased to 300,000 t and have remained at that level since.

Pelagic Fish

Capelin and herring are the main target in these fisheries, but Norway pout and blue whiting have also been targeted. These fisheries are usually conducted with purse seines, but also recently with pelagic trawls. Until the mid-1920s, herring catches in Icelandic waters were around 10,000 t/y, mainly by Norwegian boats. Catches increased steadily after Iceland joined the fishery. Production reached a peak of 770,000 t in 1966, but collapsed almost entirely two years later. The Icelandic summer-spawning stock has recovered and now supports a fishery of 100,000 t/y. This stock is currently the only herring stock in Icelandic waters and is only fished by Icelanders. Capelin fisheries started around 1963 and increased rapidly, specially after the collapse of herring stocks. Since 1978, with few exceptions, the capelin has sustained a catch of around 1 million t/y, by boats from Iceland, Norway, the Faeroe Islands, and Greenland. Landings from these fisheries are now usually more than half of the total annual catch in Icelandic waters, but since most of it is reduced to meal the total value is not as high as for many of the demersal species.

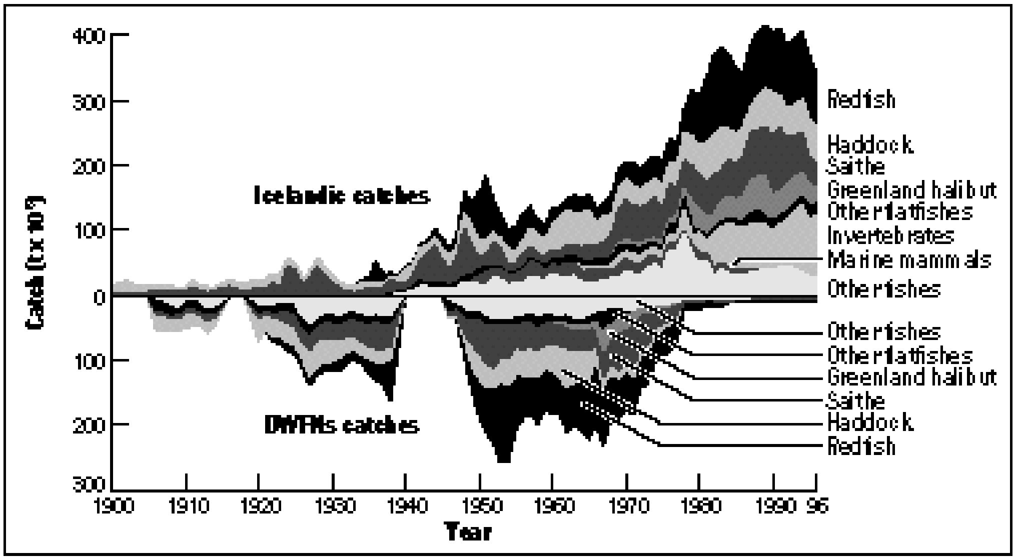
Greenland Halibut

This is a recent bottom trawl fishery conducted in deep waters west, north, and east of Iceland. The Greenland halibut fishery was probably started in the 1950s by the German countries. However, early on, landings of Greenland and Atlantic halibut were not separated so the statistics by species are not readily available. Catches increased rapidly and reached a peak of 30,000 t in 1974 when fleets from the USSR and later Poland joined the fishery. Catch declined rapidly afterwards due to the extended fisheries jurisdiction regime. Icelandic catches for this species started to increase rapidly after 1976, Faeroese catches after 1979, and Greenlandic catches after 1991. The total catch from these countries reached a peak of 60,000 t in 1989, mainly by Icelanders, but has declined since. The stock now shows signs of overfishing.

Redfish

These fisheries target the three major redfish stocks in rather deep waters south and west of Iceland. *Sebastes marinus* and demersal *S. mentella* are primarily caught with bottom trawls, but mid-water trawls are used for oceanic *S. mentella*. The fishery was developed mainly by German trawlers after World War II with catches of 50,000 – 100,000 t/y although Icelandic catches were also substantial (Figure 11). After the 200-mile EEZ declaration, catches of redfish by Icelanders increased. Initially most of the bottom trawl catches were *S. marinus*, but recently the annual catches of the two species have been similar at around 40,000 – 50,000 t each. These catches are almost entirely by Iceland. Catches of oceanic redfish started in 1982 by the USSR. Iceland joined the oceanic

Figure 11. **Catches of other species than cod, capelin, and herring in Icelandic waters**



redfish fishery in 1989. Recently catches have been around 150,000 t/y. The majority of these catches are however conducted outside the Icelandic EEZ and the foreign fleets have never fished for this stock in Icelandic waters. The demersal redfish stocks show signs of overexploitation, but very little is known of the status of the mid-water stock.

Offshore Shrimp

The shrimp fishery is exclusively conducted by Icelandic vessels using fine mesh trawl nets mainly off northern Iceland. The offshore shrimp fishery began on an experimental basis in 1975, catches increased sharply after 1983 to the current level of around 60,000 t/y. One of the shrimp stocks however lives on the Dhorn Bank at the boundary of the Greenlandic and Icelandic EEZs. This is a small stock and has therefore not sustained large-scale fisheries by Icelanders; other nations are however targeting it in Greenlandic waters. The shrimp catches are now the second most valuable in Icelandic waters after Atlantic cod. Bycatch is very low compared to many shrimp fisheries in warmer waters since species diversity is lower in these waters and the use of sorting grids is compulsory.

Inshore Shrimp

The fishery takes place in western and northern Iceland fjords with similar gear but smaller boats than the offshore fishery. Experimental shrimp fisheries started in 1924, but it was not until the late 1950s that real fisheries started. Since 1970, the inshore shrimp fisheries have fluctuated between 5,000 and 10,000 t/y. Only Icelanders have been involved in this fishery. Furthermore, large offshore shrimp trawlers are not allowed to catch inshore shrimp; only small boats from local towns are allowed to fish in each fjord. The smaller inshore shrimp boats can however buy quotas for offshore shrimp.

Flatfish

With the exception of plaice (*Pleuronectes platessa*) and halibut, Icelanders did not target the flatfish species in large quantities until recently. British trawlers however targeted them intensively until declaration of the Icelandic EEZ. This was followed by a 15-year period of low flatfish catches. The large-scale fishery started in the early 1980s by Icelandic boats using Danish seines. At first plaice was the main target, but from 1984 to 1988 catches of dab (*Limanda limanda*), lemon sole (*Microstomus kitt*), witch flounder (*Glyptocephalus cynoglossus*), megrim (*Lepidorhombus whiffiagonis*), and long rough dab (*Hippoglossoides platessoides*) started to increase sequentially. Currently the total catches of flatfishes in Icelandic waters have been around 30,000 t (10,000 t of plaice, 5,000 t of dab and long rough dab, 2,000 t of witch flounder, 1,000 t of lemon sole, and less than 500 t of megrim). In general, flatfish catches are now larger than before DWFs were driven out of the fishery (Hjörleifsson et al., 1998). Roughly half of the catches of plaice, megrim, and lemon sole are taken with Danish seines, the rest is caught by demersal trawlers. Atlantic cod, haddock, and other demersal species are a frequent bycatch in these fisheries.

Norway Lobster

The Norway lobster or scampi fishery takes place along the south shore with fine mesh trawls. The bycatch rate is high, especially for various flatfish species. Norway lobster is the most valuable species per weight in Icelandic waters. The fisheries started after World War II by foreign boats. These caught up to 500 t/y, but ceased after the extension of the Icelandic EEZ. In 1958 Icelanders started fishing for Norway lobster, the catches increased rapidly to more than 5,000 t/y but then declined and have been around 2,000 t/y for the last two decades. Currently only Icelandic vessels fish for Norway lobster in Icelandic waters.

Other Benthic Invertebrates

This fishery targets large benthic invertebrates, mainly with ploughs. Scallop has been the main target, but plough catches of sea urchin and ocean quaghog, and catches of whelk with traps have increased recently. The scallop fisheries started in 1969 and increased until 1982 when they levelled off at around 10,000 t/y. The ocean quaghog fishery started in 1987 and has been fluctuating up to 6,000 t/y. The sea urchin fishery started in 1992 with around 1,000 t/y, and the whelk fishery started in 1996, and is still very much on an experimental basis. Only Icelanders have been involved in these fisheries. The bycatch rate of other benthic invertebrates can sometimes be high.

Other Fisheries

Many other minor fisheries exist or have existed in Iceland. Examples are the lumpsucker (*Cyclopterus lumpus*) fishery with specialized gillnets, the Atlantic halibut fishery with longlines, the porbeagle fishery with special hooks, the Greenland shark fisheries (prior to this century) with handline, and sport fisheries for brown trout (*Salmo trutta*), Arctic char (*Salvelinus alpinus*), and salmon (*Salmo salar*). The latter fishery is mainly conducted in freshwater, since it is illegal to catch salmon in the sea. Whaling and sealing can also be put into this group. Most of these fisheries were only conducted by Iceland; the exceptions are whaling by Norwegians early this century and longline fisheries for halibut up to this day by the Faeroese.

HISTORICAL CATCHES

Total fishery catches in Icelandic waters increased from roughly 200,000 t prior to World War I to about 700,000 t between the wars (Figure 10). After World War II the catches increased to 1.5 million t, then declined again because of the collapse of the herring stocks. Production increased again in the late 1970s and has fluctuated between 1 and 2 million t/y since. These fluctuations are explained by the volatile changes in the size of the capelin stock, which makes up roughly half of the total recent catch.

Icelandic Catches

In Iceland, Atlantic cod has always been the most important fish, accounting for more than half of total demersal catch until the early 1980s. The Icelandic fishery had changed little from the times of the first settlers until the beginning of the 20th century, when small oar or more rarely sail powered boats fished in shallow waters with handlines or longlines. The catches were probably 10,000 – 30,000 t/y during this period (Jónsson, 1994). The first Icelandic owned trawler started operating in 1905 (see also Kurlansky, 1997). At that time the total demersal catch by Icelandic vessels was 55,000 t. By 1924, 40 Icelandic trawlers were operating (Jónsson and Magnússon, 1997), and the total catch had a fourfold increase to 230,000 t. Demersal catches and number of Icelandic boats decreased during the Great Depression, but increased rapidly during and shortly after World War II, to a peak of 490,000 t in 1958. The deterioration of the trawler fleet caused the catches of this sector to fall to 57,000 t in 1972, but this was compensated by increased catches from other sectors; the total catch was 330,000 t that year. After extension of the EEZ to 200 miles, the number of Icelandic trawlers – now mostly state-of-the-art stern trawlers – increased rapidly to more than 100 vessels. Catches also increased rapidly, first catches of Atlantic cod, then followed by other species. New species are also added almost every year to the list of exploited species. Examples of the new fisheries are ratfishes (*Chimaera monstrosa*) and orange roughy (*Hoplostethus atlanticus*) in 1991, green sea urchin in 1993, *Sebastes viviparus* (small redfish species) in 1996, and probably bluefin tuna in 1998. This, together with the decreasing TAC for Atlantic cod has also meant that the importance of Atlantic cod has been declining and was about one-third of total demersal catch of 522,000 t and a quarter of the value of total landings in 1996. Other important demersal species are redfish (14 per cent of total demersal catch and 13 per cent of total landed value in 1996), shrimp (13 and 20 per cent), haddock (11 and 7 per cent), saithe (8 and 3 per cent), Greenland halibut (4 and 7 per cent), wolf-fish (3 and 2 per cent), and plaice (2 and 2 per cent). The trawl fleet now accounts for more than half of the total demersal catches of 520,000 t.

The herring fishery has also been very important for Iceland both economically and historically. It was especially prominent in the 1960s, when 400,000-600,000 t/y were caught (Table 9, Figure 10). The herring stocks collapsed in 1967, and catches remained low for a long time. The herring stocks have however recovered fully now. Iceland takes more than 100,000 t/y from the Icelandic summer-spawning herring stock, and catches of more than 150,000 t in international waters from the Norwegian spring-spawning herring stock (see Boxed Case Study 2).

After the herring stocks collapsed, the Icelandic purse-seiners turned their attention to the capelin, which was largely ignored before. This fishery increased rapidly to around 1 million t/y. The capelin stock size can however fluctuate wildly, since it is short lived and dies after first spawning. In 1982 the stock collapsed and there was a moratorium on capelin fisheries for almost 2 years. The stock however recovered quickly and the capelin now sustains a fishery of up to 1.5 million t/y. Landings from pelagic fisheries are now usually more than

Table 9. **Marine catches in Icelandic waters since 1950 (t x 10³)**

SPECIES	ICELAND				FOREIGN FLEETS			
	Mean catch 1950-1996	Maximum catch 1950-1996	Year of maximum	Catch 1996	Mean catch 1950-1996	Maximum catch 1950-1996	Year of maximum	Catch 1996
Capelin	337.6	1,182.2	1996	1,182.2	49.1	315.2	1996	315.3
Cod	273.0	460.6	1981	180.8	97.9	262.5	1953	0.7
Herring	111.7	590.4	1965	95.9	21.4	172.4	1962	0.0
Redfish	50.4	122.7	1983	67.9	39.4	124.6	1953	0.5
Saithe	44.1	99.8	1991	39.5	26.9	76.4	1971	0.8
Haddock	39.5	67.0	1982	56.3	18.6	65.3	1962	0.6
Marine mammals	13.5	24.2	1957	A few seals	0.0	0.0	-	0.0
Greenland halibut	12.3	58.5	1989	22.1	3.3	30.1	1967	0.0
Shrimp	11.6	75.7	1995	68.7	0.0	0.0	-	0.0
Wolf-fish	10.3	17.8	1991	14.7	4.6	13.4	1952	0.0
Plaice	6.0	14.4	1985	11.1	2.5	8.0	1957	0.0
Iceland scallop	5.0	17.1	1985	8.9	0.0	0.0	-	0.0
Ling	4.3	8.9	1971	3.7	3.1	6.5	1971	0.6
Lumpsucker	3.6	13.1	1984	5.1	0.0	0.0	-	0.0
Tusk	3.4	7.0	1960	5.2	2.9	5.2	1973	1.0
Norway pout	3.2	34.6	1978	0.0	?	0.0	-	0.0
Blue whiting	2.7	34.8	1978	0.3	?	0.0	-	0.0
Norway lobster	2.1	5.6	1963	1.6	0.1	0.6	1959	0.0
Blue ling	1.3	8.1	1980	1.3	1.4	3.4	1966	0.1
Atlantic halibut	1.2	2.4	1951	0.8	1.6	4.6	1950	0.1
Others*	3.3	36.7	1955-1996	28.3	1.8	6.3	1951-1963	0.0

*includes dab, witch flounder, lemon sole, long rough dab, whiting, ocean quahog, megrim, green sea urchin. Year of maximum catch is a range over which the maximum for each species occurs.

half of the total annual catch in Icelandic waters, but since most of it is reduced to meal, the value is only 15 per cent of the total value, lower than for many of the demersal species.

Most of the important stocks in Icelandic waters such as shrimp, Norway lobster, haddock, herring, and capelin are in good condition and sustain considerable fisheries. However the reason the capelin and shrimp are in such a good shape has probably also a lot to do with the low stock size of their main predator, the Atlantic cod. Other stocks such as Greenland halibut, Atlantic halibut, saithe, redfishes, plaice, and witch flounder are however declining. Fishery biologists generally realize this, but managers have been too optimistic or under pressures from the fishing industry and thus often set the TAC higher than recommended. Often the fishers then in turn catch more than the TAC. These stocks were basically sacrificed so Atlantic cod quotas could be reduced. Very little is known about many other stocks that have been exploited at an increasing rate recently.

CATCHES OF THE DWFs

DWFs probably first came to Icelandic waters in the 15th century (Table 10), when English boats were first reported (Jónsson, 1994). Later, boats from the Netherlands and France joined and dominated this fishery. There were also some small contingents of boats from other nations. From 1880 to 1890 there were even American schooners catching halibut in Icelandic waters (Sæmundsson, 1926). The other fleets were however primarily targeting Atlantic cod. The catches from these DWFs were roughly 5,000 – 15,000 t/y from the late 18th century to the beginning of this century. Although considerable at that time, these fisheries probably did not have a great impact on the fish stocks, since the weather limited fishing to the summer months.

Table 10. **Historical and present-day DWFs operating in Icelandic waters**

Nation	Gear	Target species	Period	Annual catch range (t x 10^3)
Belgium	Trawl	Demersal fish	1905* to 1994	1 to 25
Denmark	Danish seine	Flatfish	1890 to 1955	Less than 1
Faeroe Islands	Longline + handline	Cod + haddock	1905* to present day	5 to 50
Faeroe Islands	Purse seine	Herring	1926 to 1966	1 to 10
Faeroe Islands	Purse seine	Capelin	1977 to present day	2 to 65
Finland	Purse seine	Herring	1931 to 1967	1 to 7
France	Handline	Cod	Mid-18th c. to 1915	1 to 5
France	Trawl	Demersal fish	1905* to 1973	1 to 15
Germany	Trawl	Demersal fish	1905* to 1977	10 to 200
Germany	Purse seine	Herring	1931 to 1968	1 to 27
Greenland	Purse seine	Capelin	1993 to present day	2
Italy	Trawl	Demersal fish	Between wars	Unknown but small
Japan	Longline	Bluefin tuna	1996 and 1997	Less than 1
Netherlands	Handline	Cod	Mid-18th to mid-19th c.	1 to 3
Netherlands	Trawl	Demersal fish	1905* to 1965	1 to 3
Norway	Longline	Cod + haddock	1905* to 1989	1 to 15
Norway	Purse seine	Herring	1905* to 1968	10 to 150
Norway	Purse seine	Capelin	1978 to present day	50 to 200
Poland	Trawl	Greenland halibut	1970 to 1974	Less than 1
USSR	Trawl	Greenland halibut	1965 to 1974	1 to 20
USSR	Purse seine	Herring	1960 to 1968	10 to 200
Sweden	?	Demersal fish	1928 to 1950	Less than 1
Sweden	Purse seine	Herring	1905* to 1961	1 to 8
United Kingdom	Handline	Cod	15th to 17th century	Unknown
United Kingdom	Trawl	Demersal fish	1891 to1976	100 to 200
United States	Handline	Atlantic halibut	1880 to 1890	Unknown

*Official statistics not available before 1905.

Large-scale fishing by DWFs started when the first British steam-powered trawler came to Icelandic waters in 1891 (Guthmundsson, 1981; Thór, 1982). The number of trawlers increased rapidly to around 200 in 1904, initially most of them British (both English and Scottish) but later on also a large German fleet. Boats from Belgium, the Netherlands, Denmark, Sweden, France, the Faeroe Islands, Italy, Poland, Norway, and the USSR also fished for groundfish in Icelandic waters, but the quantities caught were far lower than the British and German catches. There are no reports of boats from other nations fishing for groundfish in Icelandic waters.

The first British trawlers came to Icelandic waters for flatfishes; initially they even discarded large quantities of Atlantic cod (Guthmundsson, 1981; Thór, 1982). Later on, Atlantic cod became the main target although other demersal fishes were also important. After World War II, large parts of the German (then West German) catches were saithe and redfish while Eastern European boats were targeting Greenland halibut.

Foreign catches of demersal fishes increased steadily from 132,000 t in 1906 (official statistics are not available earlier) to 343,000 t in 1938 (Figure 10) (Thór, 1995). During World War II, foreign catches in Icelandic waters virtually ceased, but increased rapidly after the war to a peak of 505,000 t in 1953. Catches declined slowly afterwards due to overexploitation and the gradual extension of the Icelandic EEZ. Little less than half of the catches or 100,000-200,000 t/y were Atlantic cod. Catches of other species were around 50,000 t/y for haddock, saithe, and redfish and 1,000-5,000 t for most of the other species. Foreign catches of Atlantic cod were roughly similar to Icelandic catches, but foreign fleets caught much higher quantities of most other species (Anon, 1997b; Jónsson and Magnússon, 1997; Hjörleifsson et al., 1998).

Another historical DWF fishery conducted in Icelandic waters this century was for herring, mainly for the Norwegian spring-spawning stock. Most of these foreign catches were by Norwegian boats, but there were also contingents from the Faeroe Islands, Finland, USSR, Sweden, and Germany (Jónsson and Magnússon, 1997). With two exceptions, the foreign catches of herring were 10,000-20,000 t/y for this entire period. In the 1930s the catches increased slowly to 57,000 t in 1937 and then declined and finally stopped as a result of World War II. The other episode happened after 1958 when catches increased again, to a maximum of 172,000 t in 1962, then declined again and finally stopped entirely when the stock collapsed in 1968. Since then there have not been any herring fisheries in Icelandic waters except by Icelanders.

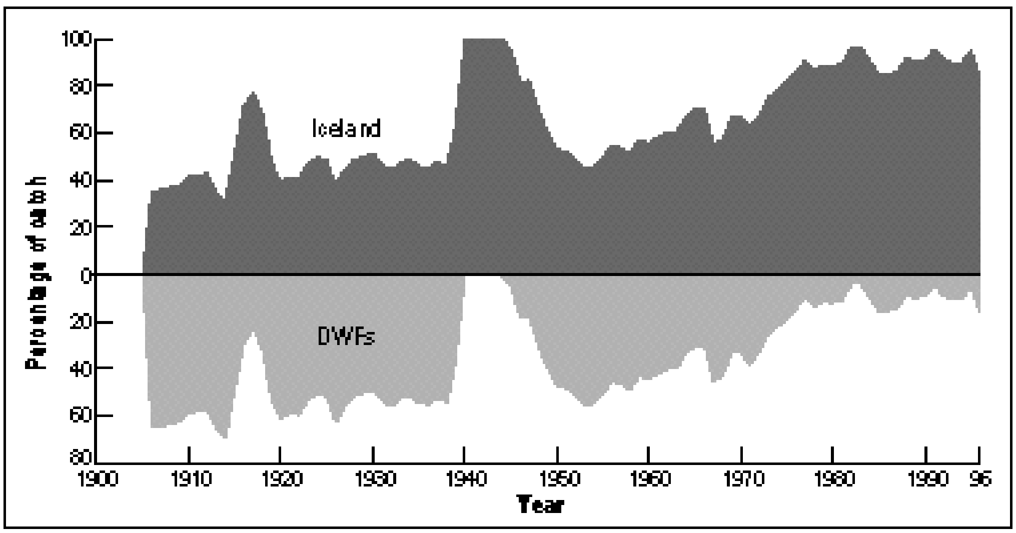
The foreign purse-seine fisheries did not worry Icelanders in any way. The foreign boats generally landed their catches in Iceland and there was a belief that there was enough herring for everyone. The near complete collapse of the herring stocks came as a surprise for all parties involved. In contrast, the foreign-trawler DWF posed many problems for Iceland. The trawlers did not land their catches in Iceland, they frequently destroyed the more primitive Icelandic fishing gear, and, of course, Icelandic fishermen were concerned that the trawlers were destroying the bottom and overexploiting their fish stocks. But since the oceans were considered free for everyone, any real measures to protect the stocks were quite hopeless. The two world wars offered a relief that might have saved the stocks from early collapse. This did not last long however as after the wars the DWFs always came back with larger boats and more advanced equipment, equipment often developed for military use during the wars.

Iceland emerged as an independent nation after World War II and was determined to reduce foreign fisheries in her waters. This resulted in the extension of the Icelandic EEZ to 4 miles in 1952, 12 miles in 1958, 50 miles in 1972, and finally 200 miles in 1975. These extensions resulted in conflicts with DWF nations, primarily Britain and

Germany. These were dubbed “the Cod Wars”. A few shots were fired, and at least one life was lost during the conflicts. In the end, Iceland managed to expel the foreign fleets from the 200-mile zone. Foreign catches have been negligible in Icelandic waters ever since. The only exceptions were a few Belgian trawlers and Norwegian longliners that were allowed to catch small quantities of demersal species until recently, Faeroese longliners that are still allowed to catch various demersal fish species (about 4,500 t in 1996), Greenlandic, Faeroese, and Norwegian boats that have the right to catch 19 per cent of the total capelin TAC, Greenlandic boats that are allowed to catch half of their oceanic redfish TAC, and Faeroese, Norwegian, and Russian boats that are allowed to catch the Norwegian spring-spawning herring stock if it migrates into Icelandic waters. Other foreign boats can, under certain circumstances, get permits to fish experimentally in Icelandic waters. This is however rare, the most recent example happening in 1996 and 1997 when Japanese vessels were allowed to catch bluefin tuna in the southern edge of the Icelandic EEZ. This was allowed because Icelanders did not know how to catch tuna but saw a chance to learn the trade (Anon., 1997c).

Until the middle of this century (with the exceptions of the wars), DWFs took half or more of the total catch in Icelandic waters (Figure 10); after 1955 Icelanders however started catching the larger part. This trend has continued and foreign catches are now only a small part of the total in Icelandic waters (Figure 12).

Figure 12. **Iceland regained control over its fishery resources in the 1970s**



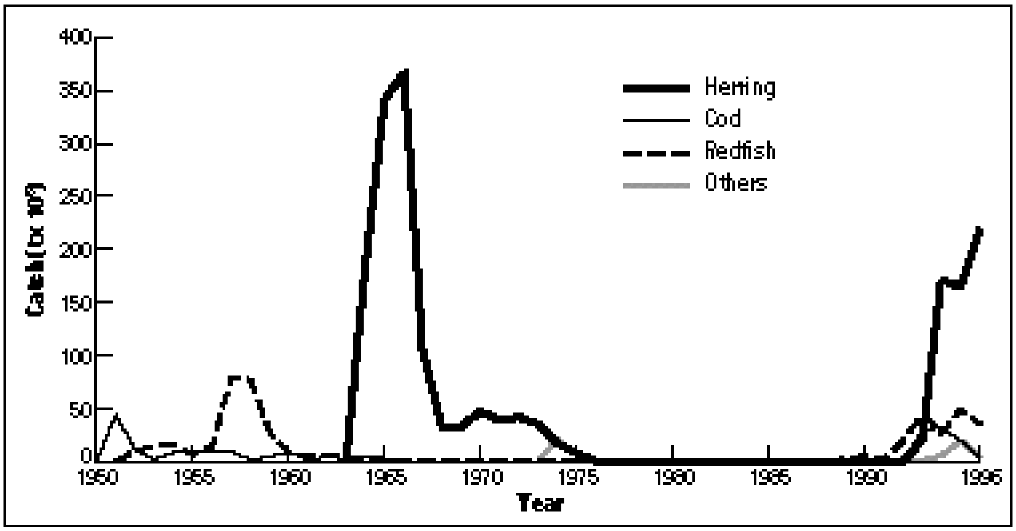
There are several fisheries on straddling stocks just outside Icelandic waters including fisheries for Greenland halibut in Greenlandic and Faeroese waters, for shrimp on the Dhorn Bank, and for oceanic redfish on the Reykjanes ridge southwest of Iceland. In 1996, Iceland and the Faeroe Islands were virtually the only nations catching Greenland halibut in their own waters, 22,000 and 6,000 t/y each respectively. However, 7,500 t were caught in Greenland waters by the United Kingdom, Norway, and Germany (Hjörleifsson, 1997). A similar situation occurs with shrimp on the Dhorn Bank. In 1997, estimated catches in the Greenlandic EEZ were Denmark 301 t, Faeroe Islands 588 t, Greenland 1,355 t, and Norway 1,219 t. Iceland caught 2,856 t in its own EEZ. The catches of oceanic redfish are conducted in international waters by many nations (Magnússon and Magnússon, 1995).

The total catch has been increasing from 60,000 t in 1982 (caught by Russian trawlers) to the current catch of 170,000 t, of which Iceland takes around 30 per cent.

ICELAND AS A DWF NATION

Until recently Iceland has mostly been a coastal fishing nation. There are however some exceptions. Early this century, Icelandic trawlers went fishing experimentally to Newfoundland, Norway, and Greenland (Thorleifsson, 1974). With the exception of Greenlandic waters, these fisheries were not maintained. Other exceptions were herring fisheries in the Norwegian Sea (mainly after the herring stocks collapsed in Icelandic waters), a small scale capelin fishery in Newfoundland waters in the mid-1970s, and considerable Atlantic cod and redfish fisheries in Greenlandic and Newfoundland waters during the 1950s and 1960s (Figure 13) (Óskarsson, 1991).

Figure 13. **Distant water fisheries by the Icelandic fleet have been increasing recently**



The current outward expansion of the Icelandic fleet has two main roots: the shortage of quotas in Icelandic waters, coupled with an oversized fleet, and the recent emergence of some very healthy fishing enterprises that began looking for expansion opportunities. Presently most stocks in Iceland have a TAC, but there is overcapacity in the fishing sector. Accordingly, fleets started to look at fishing opportunities elsewhere. These fisheries are now considerable and are mainly conducted on four species in four areas; Arcto-Norwegian cod outside the Norwegian EEZ in the Barents Sea, oceanic redfish on the Reykjanes ridge close to the Icelandic EEZ, Norwegian spring-spawning herring in the Norwegian Sea, and shrimp on the Flemish Cap off Newfoundland. Other brief experimental fisheries have also been conducted within the 200-mile zone of Rockall (British) and Svalbard (Norwegian). These ventures were actually implemented to find out if the nations claiming these islands were willing to defend the EEZ around them, which they did (Anon., 1994a). The current individual transferable quota (ITQ) system has allowed many Icelandic companies to make very healthy profits. This has allowed them recently to buy fishing companies, boats, and fishing rights, or to act as advisors to foreign companies all over the world. This includes the Falkland Islands, Chile, Mexico, the United States, Canada, Russia, Namibia, Malawi, France, Germany, Lithuania, Poland, and the United Kingdom.

Currently Icelandic companies own the majority of the German DWF. These are not allowed to fish in Icelandic waters but are catching Greenland halibut in Greenlandic waters and redfish on Reykjanes ridge, the same stocks as in Icelandic waters. Large parts of the EU quotas are thus actually used by the Icelanders to fish their own stocks in other waters.

Some Icelandic fishing ventures abroad, such as the pollock fishery of Alaska and squid fishery of the Falkland Islands failed. Others such as the shrimp fisheries in Mexico seem to be successful. Due to reduced or restricted quotas on most species in Icelandic waters, distant water fisheries are without doubt important for the Icelandic economy (see also Bates, 1996). However, with the exception of the Norwegian spring-spawning herring, all the Icelandic distant water catches declined between 1996 and 1997. Some of this can be explained by restricted quotas on the distant water stocks, or by unfavourable environmental conditions. Another factor is that quotas for Atlantic cod in Icelandic waters are increasing and boats can thus fish more at home. If this continues to increase as predicted (Anon., 1997d), then a large part of the incentive for distant water fishery is gone. In a similar way, if the Norwegian spring-spawning herring stock migrates back to Icelandic waters as predicted, this fishery will overnight switch from being a distant water fishery to a coastal fishery, although the catches and fleet composition will be the same. The sustainability of this outward expansion of the Icelandic fleet and fishing companies is thus difficult to evaluate at present time.

FLEET CHARACTERISTICS AND NUMBERS

The capacity of the Icelandic registered fleet declined in 1990 compared to the previous year for the first time since 1970, and continues in a slight decline. The total tonnage decreased until 1992 but has increased since as the boats are getting fewer but larger. In 1996 there were slightly fewer than 2,000 boats licensed to fish in Icelandic waters. The fleet is split into three major categories: about 1,000 small undecked boats, 679 decked boats of various size categories, and 121 trawlers (Anon., 1997b). Fifty-four trawlers are more than 500 GRT and roughly half of the total trawler fleet processes and freezes at sea. The decked boats are the most diverse category and often switched between different fishing gears: 17 of these boats are more than 500 t. These boats and some 30 other slightly smaller vessels are specialized for purse-seining, but can also use other fishing gear. The Icelandic DWF is made up of the large trawlers and the purse-seiners. Distant water fisheries are however only seasonal for most of them. Only seven to ten Icelandic boats fish purely in distant waters, with no fishing rights in Icelandic waters.

The land-based processing industry is made up of 140 freezing plants, 210 salting plants, 30 herring processing factories, 13 scallop plants, and 13 canning factories (Pálsson, 1996). The fishing industry provides full-time jobs for about 6,000 fishers and 7,000 people working on fish processing ashore (Anon., 1997b). This is a total of 11 per cent of the national workforce.

Foreign boats fishing in Icelandic waters are few compared to the Icelandic fleet and their number varies between years. Norwegian purse-seiners and Faeroese purse-seiners and longliners are mostly boats that conduct distant water fisheries seasonally, similar to the Icelandic DWF.

FISHERIES MANAGEMENT BY ICELAND

The priorities of the fishery management in Iceland are (Pálsson, 1996): "To ensure and maintain maximum long-term productivity through responsible exploitation of all marine stocks. To ensure that all decisions are based on the most reliable biological and economic information and conclusions available at any time. To ensure that individuals and enterprises in the Icelandic fisheries sector have clear and generally applicable, non-discriminatory guidelines to follow, providing them with a positive working environment which will strengthen the sector's competitive position internationally."

The Marine Research Institute in Iceland provides assessment of the Icelandic fish stocks. Based on recommendations from scientists, the Ministry of Fisheries decides the TAC for each stock. Currently, the TACs are set exactly as recommended. Recently a catch rule has also been established for Atlantic cod, the annual quota being set at 25 per cent of the fishable stock.

The Directorate of Fisheries, within the Ministry of Fisheries, is responsible for the daily administration of the fisheries. Inspectors from the government monitor adherence to the regulations by monitoring all landings and also by frequently going out to sea with the boats. Production from fish processing plants is also monitored, as are all exports (the Icelandic fish market is very small compared to catches, therefore most of them are exported); this offers several checkpoints. Inspectors from the Directorate of Fisheries, the Coast Guard (whose primary responsibility is to monitor the fishing activities), and the Marine Research Institute all have the power to immediately close areas for all fishing if catches are found to contain high numbers of young fish. The Icelandic Coast Guard also jealously guards the 200-mile EEZ against foreign fleets. As a result of all this, compliance with fishery regulations is believed to be high, and the only major unknown is discarding at sea (Halliday and Pinhorn, 1996).

There are area limits in Icelandic waters depending on the size and gear of fishing vessels. Boats larger than 42 m and all trawlers except shrimpers are not allowed within 12 miles of the coast. Smaller boats can fish up to 3 miles from shore depending on the area, fishing gear, and size of the boat. Furthermore there are many other areas where some fisheries are not allowed, mainly to protect juveniles.

After foreign fleets were expelled from Icelandic waters in 1975, the Icelandic fishing fleet increased rapidly in size. Soon Icelanders were catching more than all the fleets combined prior to the expulsion of the foreigners and, because of this, the fish stock did not get a long respite from fishing. Several attempts were made to try to control the expanding Icelandic fleet. These include overall catch quotas, fisheries licences, fishing period limitations per vessel, increased minimum mesh size to 155 millimetres (mm) (the largest minimum mesh size in the North Atlantic), and real time area closures. Most of these management measures were primarily aimed at protecting the Atlantic cod. These probably slowed down the stock decline but did not manage to reverse it. Furthermore, these measures also led to inefficiency and overcapitalization in the fishery. In 1979, the ITQ system was established in the herring fishery, for the capelin fishery in 1980, in 1984 for groundfish including Atlantic cod, and in 1990 all the fisheries were managed through this system. Only Icelandic citizens are allowed to own these quotas, and in fact with few exceptions, to fish in Icelandic waters. Furthermore foreigners are only allowed to own up to 25 per cent of Icelandic fishing companies. The ITQ system was rather easily circumvented in the beginning and overexploitation thus continued for some time. The system has however been getting more efficient and the declining TACs set by the government have been getting closer to what was recommended by fishery biologists. As a result of this, the Atlantic cod stock, which decreased from about 2.7 million t in the late 1920s to little more than 500,000 t in the early 1990s (Schopka, 1994; Anon., 1997d), has been increasing in size for the last three years, despite poor recruitment for more than a decade.

The main stocks have been efficiently protected under the ITQ system. Its effect on other stocks is however difficult to evaluate at the present time. Although it is illegal, discarding is probably still practised. It is not clear if this is a major problem or has in fact increased much. Other species of low value that have no TAC such as grenadiers, rattails, megrim, starry ray, and long rough dab are however retained or even targeted now instead of being discarded as in the past. The decline of other stocks cannot be blamed directly on the ITQ system; either the catches have simply been higher than recommended as with the redfishes, plaice, and Greenland halibut, or they are almost exclusively caught as bycatch in other fisheries and therefore difficult if not impossible to manage with ITQs, as with the Atlantic halibut and the skate. To make the problem worse, the two last mentioned species are relatively rare, are caught in virtually all fishing gear, of high value per weight, large, long lived, reach maturity late, and are usually caught way before maturity – a recipe for disaster.

Sociologically the system has been very controversial. Some towns have lost large parts of their quotas, while others have accumulated them. There were instances where a large part of the population in some towns was unemployed while in nearby towns there were not enough people to process the fish. The fishing rights are also accumulating in fewer hands, but presumably these are the hands that can run the fishery most efficiently. The main area of controversy has however been that the quotas were originally assigned according to what each vessel was fishing in 1981-1983. This makes it difficult for newcomers to enter the fishery except by buying quotas at high prices.

The economic benefits of the ITQ system are however obvious (see also Arnarson, 1994; Arnarson, 1996; Anon., 1996b). The value of the catch per weight has increased as fishers now go more for quality than quantity. New (non-traditional) stocks are now exploited. The industry has diversified and is less vulnerable to fluctuations in prices and stock sizes. Secondary industries are also thriving because of the increased efficiency of the fishing sector. The secondary industries are in fact currently the most rapidly expanding sector in Iceland. The increased efficiency of the fleet thus has a multiplying effect on the society. This is also one of the major reasons Iceland is now rapidly changing from a coastal fishing country to a DWF nation.

FISHING AGREEMENTS AND CONFLICTS

The catches of Greenland halibut in Icelandic waters are exclusively by Icelanders. This same stock however migrates to Faeroese and Greenlandic waters where other nations are fishing for it. This fishery is regulated by individual countries independently setting their own quotas (Table 11). This stock however needs some protection since it seems

Table 11. **Agreements and conflicts over various species of commercial interest to Iceland**

Species	Area	Other countries involved	Agreements (Yes/No), status
Blue whiting	NE Atlantic	European Union, Faroe Is., USSR (Russia), Norway	Yes, but Iceland not involved
Capelin	Iceland, Greenland, Jan Mayen	Norway, Greenland, Faroe Is.	Yes
Cod	International (Barents Sea)	Norway, USSR (Russia)	No
Greenland halibut	Iceland, Faroe Is., Greenland	Greenland, Faroe Is., Norway, United Kingdom, Germany	No, each country sets its own quota
Groundfish	Iceland	Faroe Is.	Yes
Herring	International (Norwegian sea)	Norway, Faroe Is., USSR (Russia), European Union	Yes
Pelagic fish	Faroe Is.	Faroe Is.	Yes
Redfish	International (Reykjanes ridge)	NEAFC (Iceland, Greenland, Faroe Is., Norway, USSR (Russia), Poland, and European Union) + others	Yes for NEAFC members, non-members fish unrestricted
Shrimp	Iceland, Greenland	Greenland, Faroe Is., Norway, Denmark	No, each country sets its own quota
Shrimp	Flemish Cap of Newfoundland	Faroe Is., Greenland, Norway, Estonia, USSR (Russia), Canada, Lithuania, European Union, Poland	No, effort controls by NAFO, but Iceland has its own quotas

to be declining rapidly. Ironically the German boats that are exploiting the Greenland halibut in Greenlandic waters are or have been owned by Icelanders. The shrimp fishery on the Dhorn Bank is also regulated by individual countries setting their own quotas.

The redfish fishery on Reykjanes ridge is now regulated by the North East Atlantic Fisheries Commission (NEAFC), which includes Iceland, Greenland, the Faeroe Islands, Norway, Russia, Poland, and the EU. The nations that are not members of this agreement, such as the Baltic states, Bulgaria, Canada, Japan, and flag states such as the Marshall Islands and Cyprus, can however fish without restrictions. Ironically again, Icelanders own some of the flag boats. These are however denied access to Icelandic ports (Anon., 1996c). The Icelandic share of the quota in 1998 will be 45,000 t. Greenland and Iceland can catch up to 50 per cent of their quota in the EEZ of the other country. The blue whiting in the northeast Atlantic is considered to be from only one stock, which is managed by NEAFC, as is the redfish. An overall quota is set, but not split between nations. Iceland is however not a participant, since catches in Icelandic waters are low.

The Norwegian spring-spawning herring fishery is regulated with an agreement between Iceland, Norway, Russia, the Faeroes, and the EU (See Boxed Case Study 2). The capelin fishery is regulated with an agreement between Iceland, Norway, and Greenland (boats from the Faeroe Islands usually catch most of the Greenlandic quota).

A total TAC is split between the nations: Iceland has 81 per cent, Greenland 11 per cent, and Norway 8 per cent. The Norwegian share has been reduced since last year and the Icelandic quota increased.

The shrimp fishery off the Flemish Cap is managed by the Northwest Atlantic Fisheries Organization (NAFO). Iceland has however not accepted the current regulation method by effort control, and has thus set its own quotas, based on catches in 1995. Iceland does obey other general agreements, such as having independent observers on each boat and leaving the area fished if bycatch is more than 5 per cent of the total weight of the catch. In 1998, the Icelandic TAC was set to 6,800 t, a reduced quota from the previous year since there are indicators of overfishing. In 1996 the total catches were 51,154 t, of which Iceland caught 20,900 t. In 1997 Iceland caught 6,334 of a total catch of 23,817 t. The other nations fishing for shrimp on the Flemish Cap are the Faeroe Islands 7,335t, Norway 1,974 t, Greenland 100 t, Estonia 3,166 t, Russia 1,067 t, Canada 608 t, Lithuania 1,708 t, EU (Spain and Portugal) 569 t, Poland 288 t, and St Vincent 75 t.

The most severe fishery conflict involving Icelanders is the Atlantic cod fishery in international waters of the Barents Sea. This fishery is currently not regulated, and has caused severe diplomatic conflicts between Iceland and Norway. The current situation in and close to Icelandic waters is thus complicated. Iceland is in conflict with Norway over the Barents Sea cod and the capelin, but is an ally of Norway and Russia in the Norwegian spring-spawning herring fishery against the EU. Icelanders are also alienating the Russians by fishing for cod in the Barents Sea, but the Russians are in turn alienating the Icelanders by catching more than their share of oceanic redfish. Iceland has not reached an agreement with Greenland over the Greenland halibut and the Dhorn-Bank shrimp, of which a large part is caught by EU countries. A large part of the EU quotas is then in turn used by European companies owned by Icelanders, as are some of the boats from non-NEAFC countries fishing for oceanic redfish. The conflicts and agreements involving Icelanders are mostly with neighbouring countries, not against large DWFs coming from far away. The fleets from all the countries involved are roughly similar in composition and technology.

The only neighbouring country that there seems to be no conflict with is the Faeroe Islands, which in 1997 was allowed to catch 5,000 t of demersal fish, 30,000 t of capelin, an undetermined amount of blue whiting, and its share of the Norwegian spring-spawning herring stock in Icelandic waters. Icelanders were in turn allowed to catch 2,000 t of herring other than the Norwegian spring-spawning stock, all their share of the Norwegian spring-spawning herring stock, 1,000 t of mackerel, and undetermined amounts of blue whiting in the Faeroese EEZ. The Icelandic quotas have however usually not been caught.

BENEFITS

The successful recovery by Iceland of control over its fishery resources has proven to be the major benefit for this nation. This century, fisheries have been overwhelmingly important for the Icelandic economy. During recent years, the relative importance has been about 75 per cent of export earnings or US$1.3 billion in 1996. Currently there is no direct monetary benefit to Icelanders for allowing other nations to fish in their waters, but as a general rule, DWFs are not allowed in Iceland. The minor exceptions are either based on historical reasons and close ties between the countries as with the Faeroese, or are unavoidable since the stocks migrate between EEZs as with the Greenlanders, Norwegians, and Russians.

Boxed Case Study 2. The Norwegian Spring-Spawning Herring*

The herring (*Clupea harengus*) is one of the most abundant fish species in the world and the most abundant fish in the North Atlantic. It is found on both sides of the North Atlantic, from the Bay of Biscay to the Barents Sea on the east side and from the southwest coast of Greenland to North Carolina in the west. The herring is a pelagic zooplankton feeder, measuring between 30 and 40 cm length. It is a multiple spawner and can reach up to 25 years of age (Jónsson, 1992).

The herring is split into several different stocks, based on where and when they spawn (Hamre, 1990). Historically, the largest of these stocks is the Norwegian spring-spawning herring (NSS herring). This stock spawns along the coast of central Norway. The larvae then drift to nursing areas along the coast of northern Norway and the Barents Sea, where they stay until they mature at age 4-6. Formerly, once mature the herring undertook large-scale feeding migrations to the waters north and east of Iceland (Map 6). During winter the stock condensed into large schools in the waters east of Iceland, during the spring it went back to the Norwegian spawning grounds. But this pattern changed after the stock collapse of the 1960s. In recent years the overwintering areas have been in fjords in northern Norway and the stock has not ventured into Icelandic waters.

The herring stocks in the northeast Atlantic have sustained small-scale coastal fisheries for centuries. This century, however, with increased technology these fisheries evolved into large-scale offshore fisheries. The total catch of the NSS herring was between 200,000 and 400,000 t annually from 1925 until after World War II when they increased rapidly to 1.65 million t in 1956 (Figure 14). The catches declined again until 1962 and then increased again to a peak of nearly 2 million t in 1966, but then collapsed almost entirely (Hamre, 1990). This rapid increase in catches can be explained by rapidly advancing technology, mostly the power block which made the boats able to haul larger catches and sonar which allowed the boats to find schools in deep waters. Most herring stocks in the northeastern Atlantic collapsed during this period. This collapse is now one of the “classics” in the history of fisheries. During this period, oceanographic conditions worsened and colder currents from the north dominated the warmer Atlantic waters. At the same time fishing technology was rapidly advancing and the boats were able to chase the herring wherever it went. Considerable catches of 200,000 to 500,000 t annually of juvenile herring in Norwegian waters were probably also one of the main reasons for the collapse (Jakobsson, 1985). This collapse was a big blow for the economies depending on these fisheries. Icelanders were specially hard hit because of the overwhelming importance of fisheries for their economy. The period between 1960 and 1970 was dubbed the herring years in Iceland. This was a period of great prosperity, unemployment virtually did not exist, and many people became rich in a short time. The herring was the main fuel for this progress. Because of this sociological and economic importance Icelanders now claim a large share of the current NSS herring fishery although the stock has not migrated back to Icelandic waters.

* Prepared by Hreidar Valtysson

Map 6. **Area of distribution of the NSS herring stock and its former migration**

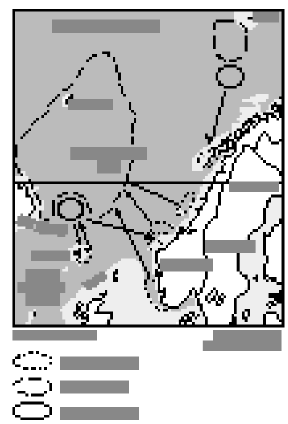
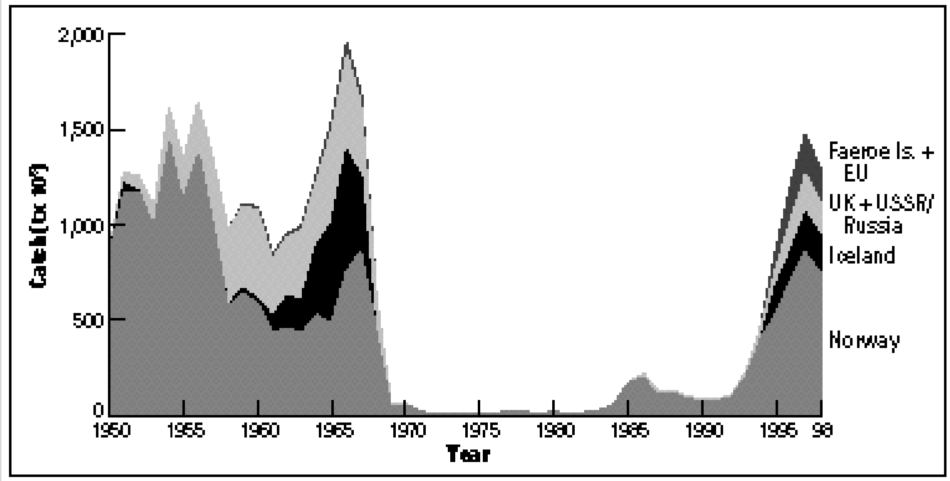


Figure 14. **The NSS herring stock crashed in the late 1960s and has only recently recovered**



The herring fisheries can be split into winter, summer, and the previously mentioned juvenile fisheries. The original fishery was conducted during winter on the spawning grounds in Norway, mainly by Norwegian purse-seiners and drifters. This was the main fishery until 1960, when summer fisheries were for the first time higher (Hamre, 1990). The summer fishery was conducted on the feeding grounds in the Norwegian Sea between Norway and Iceland and in Icelandic waters. At first, this fishery was mainly by Norwegians but after World War I also by Icelanders. Boats from Finland, the Faeroe Islands, USSR, Sweden, and Germany also participated, but Icelandic and Norwegian catches were higher. Catches in Icelandic waters were less than 30,000 t until after World War I when they increased to around 200,000 t (Jónsson and Magnússon, 1997). After the war, catches declined again but increased rapidly after 1960 to more than 600,000 t and then collapsed almost entirely after 1967.

After the collapse in the late 1960s, a near moratorium was established on all herring fisheries in Icelandic and Norwegian waters. The stocks have since slowly recovered. All the herring catches in Icelandic waters since the collapse have been on the Icelandic summer-spawning herring. This stock has historically always been far smaller then the NSS stock and does not undertake migrations outside Iceland's EEZ. The size of the Icelandic stock is now close to record high levels and sustains catches of around 100,000 t annually (Jakobsson, 1992; Anon., 1997d). Another Icelandic stock, the Icelandic spring-spawning herring is however virtually extinct despite a total moratorium on fishing for three decades. The fishery in Icelandic waters is however only conducted by Icelanders.

The NSS stock took longer to recover. Until 1984 catches were always less than 20,000 t/y and the juvenile fishery has almost completely been stopped. From 1986 to 1992, catches were around 100,000 t/y. All these catches were by Norwegian and Russian boats in Norwegian waters. After this time, strong year classes have been recruited to the fishery, the stock has been rebuilding fast, and catches have been increasing rapidly to 1.5 million t in 1997. After the collapse, the stock was carefully managed by the Norwegians. This was made easier since the stock was then almost entirely confined to Norwegian waters. Because of the increased stock size, the NSS herring does now again undertake large migration movements to the Norwegian Sea. Although it has not yet gone back to Icelandic waters, it is expected to do so soon. This has also made management more difficult since the stock spends long periods in international waters. The aim of current management is to keep the spawning stock biomass over 2.5

million t which is regarded as the minimum biologically acceptable level. Furthermore, all fisheries for immature herring have been stopped.

The fishery has been traditionally controlled by the setting of a TAC, which is then divided between the fishing nations according to annual agreements. Since the collapse and until 1994, the TAC was only shared between Norway and USSR/Russia. However, more recently the stock has migrated again to international waters so that multinational agreements have been necessary. In 1996 an agreement was signed between Iceland and the Faeroe Islands, and in 1997 there was an agreement with the EU (mainly Denmark and the Netherlands). The NSS herring fishery is currently regulated with an agreement between Iceland, Norway, Russia, the Faeroe Islands, and the EU. There have however in the past been conflicts with the EU, which claims a larger share of the catch. After some failed attempts at cooperation in the recent past, a successful management agreement for 1997 was finally achieved (Anon., 1996d), and was followed by a similar agreement the following year (Anon., 1997e). Obviously, a regional fisheries management organization appears to be in the making, one which, interestingly, has adopted a top-down approach to resource management, in spite of the apparent dominance of one coastal state, Norway (Orebech et al., 1997). For 1998, Iceland is getting 202,000 t of the total quota, the Faeroe Islands 71,000 t, Norway 741,000 t, Russia 166,600 t, and the EU 109,000 t. The countries can catch a certain percentage of their catch in each other's EEZ. Annual acoustic surveys are conducted by research vessels from all countries involved.

Norway distributes its quotas roughly according to the capacity of its 100 purse-seiners (60 per cent of the total TAC), gross tonnage of the 70 trawlers (10 per cent), or length of the 400 smaller coastal vessels (30 per cent). For the Icelandic boats, 60 per cent of the TAC is split between vessels according to capacity and 40 per cent is split equally. Most of the Icelandic catches are by 50 large purse-seiners, but trawlers also catch a small part of the catch. The Icelandic quotas are partly transferable (sold or leased) between vessels, but the Norwegian quotas are not. No information is currently available on how the other nations split their quotas or the number of boats they use, but the Faroese probably use around 20 purse-seiners and the Russians some 50 trawlers. The division of the TAC between countries has been based on distribution of the stock, historical catches, contribution to scientific research, and the nation's dependency on fisheries. There are however many grey zones within these. Annual acoustic surveys are conducted by research vessels from all fishing countries (Bjørndal et al., 1997).

The herring fisheries have been closely linked to the capelin (*Mallotus villosus*) fisheries. After the collapse of the herring stocks, the Icelandic and Norwegian fleets changed to capelin, which had been virtually ignored before. The Icelandic capelin stock migrates to Norwegian waters close to Jan Mayen. This stock is managed by agreement between Iceland, Norway, and Greenland. Agreements and conflicts involving NSS herring affect this fishery since the same countries are involved and the same fleets are targeting these species. There is also an ecological conflict between these species, recruitment failures of capelin in the Barents Sea having been linked to high mortality rates on larvae and juveniles due to predation by herring (Gjøsætter, 1994). This could also happen in Icelandic waters if the NSS herring migrates back there. Currently the Icelandic capelin stock is at a high level, which might be explained by the low abundance of herring in Icelandic waters. No commercially important fish species depend heavily on adult herring as food, adult capelin is however very important for many species, specially the Atlantic cod. If the capelin stock in Icelandic waters declines due to increase in the stock size of NSS herring, it could affect the growth of the Atlantic cod stock. The increase of the NSS herring stock can thus cause increased management complexity and cause potential future conflicts between the countries bordering the northeastern Atlantic.