

NORWEGIAN UN-MANDATED CATCHES AND EFFORT

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ABSTRACT

This contribution presents unreported catches for selected fisheries and species from Norwegian waters, with particular emphasis on cod (*Gadus morhua*) in the Barents Sea between 1950 and late 1990s. Estimated discard rates ranged from over 20% in the 50s to approximately 10% of reported landings in the 90s. Additional species covered include redfish (*Sebastes* spp.), blue whiting (*Micromesistius poutassou*), haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*) and saithe (*Pollachius virens*). Some information on shrimp (*Pandalus borealis*) and marine mammals is also presented.

INTRODUCTION

Historically, the Norwegian fisheries were based on small vessels fishing along the Norwegian coast. After World War II offshore fisheries developed rapidly, vessels became larger and technological development in the 1950s and 1960s revolutionized the fisheries. Some of the technological developments that increased the efficiency and the capacity of fishers were the use of synthetic fibers for trawls and seines; larger vessels; increased horsepower; 'power blocks' in seine fisheries; and echo-sounders which made it easier to locate the fish and find new fishing grounds. These improvements led to record catches of, among others, cod (*Gadus morhua*), herring (*Clupea harengus*) and shrimp (*Pandalus borealis*). The increased catches led to overexploitation of many stocks, and the population of Norwegian spring spawning herring collapsed towards the end of the 1960s, which led to a fishing ban for Norwegian spring spawning herring in 1972. Appendix 1 provides information on Norwegian catch and effort data.

The depletion of fish stocks and the increased fishing capacity of the fleet led to the exploitation of other species and new locations. In the late 1960s and early 1970s several new fisheries were started. The fisheries for capelin (*Mallotus villosus*), herring in the North Sea, shrimp in the Barents Sea, the industrial fishery for Norway

pout (*Trisopterus esmarki*) and sandeels (*Ammodytes* spp.) were all developed in the early 1970s. The government took control over the management of the most important fish species in the 1970s and the first total allowable catch (TAC) was imposed for capelin in 1974; this was followed by a TAC for demersal fish in 1975. ICES has given management advice regularly since the early 1960s. Increased mesh size, catch quotas (TACs), closed areas and reduced effort have been some of the recommendations made by ICES (Nakken, 1998). National economic zones (Exclusive Economic Zones EEZ) were introduced in 1977, and Norway and the USSR agreed on an equal sharing of the cod stock in the Barents Sea. Fishing by other countries within the EEZ and Barents Sea was reduced gradually (Jakobsen, 1993). The fishery for Norwegian spring spawning herring was reopened in the late 1970s, but under stricter control.

Efficiency and fishing capacity continued to increase in the 1980s and 1990s. In the early 1980s by-catch limitations in the shrimp fishery were introduced and increase in mesh size and an area closure system were implemented in the fisheries for gadoid species in the Barents Sea. Under the area closure system, an area is closed to fishing when the number of undersized fish of the targeted species in the catches exceeds 15%. In the mid-1980s a 'collapse' of the cod, haddock (*Melanogrammus aeglefinus*) and capelin stocks occurred in the Barents Sea. As a result, the capelin fishery was closed in 1986 and reopened only in 1991. Cannibalism was substantial in the cod stock because of the lack of food for cod. The fisheries were characterized by a substantial increase in discarding until the late 1980s when a discard ban was introduced. At first the discard ban applied only to cod, haddock and saithe (*Pollachius virens*), but now it applies to most species. Its effectiveness is uncertain.

Norwegian pelagic whaling for big whales was stopped in 1972. The International Whaling Commission (IWC) banned all whaling in 1987, but Norway opposed this decision. According to the IWC rules, Norway was not obliged to abide by the whaling moratorium. The Norwegian government stopped commercial whaling for small whales in 1987 and reopened it in 1993. However, catches between 1987 and 1993 continued under the banner of scientific whaling.

Since the 1990s, a considerable amount of research has focused on improving gear selectivity. The use of sorting grids (also called by-catch reduction devices) in the Barents Sea shrimp fishery were made compulsory by Norway

and Russia in 1993. The sorting grids proved to be very effective and a sorting grid system has been compulsory in the bottom trawl fishery for gadoid species in the Barents Sea since 1997. Ongoing research is being conducted for the use of sorting grids on purse seine vessels involved in the mackerel and saithe fishery.

Since 1950, Norwegian fisheries have followed a trend of decreasing numbers of fishers and vessels as the catch capacity of the fleet increases. Furthermore, as operating expenses have increased, fishing organizations have applied pressure on management to increase quotas. In recent years, this has resulted in the overexploitation of the Northeast Arctic cod stock.

Northeast Arctic cod

Garrod (1967) estimated discards of northeast arctic cod in the English, Barents Sea cod fishery. Garrod, as well as others, showed that discarding was a big problem in the trawl fishery for Northeast Arctic cod. I have also estimated the discards of this fishery and looked at some effects of this bias in catch statistics. (Dingsør, in prep).

The discards of northeast arctic cod are originally the estimated discards of three, four and five year-olds in the bottom trawl fishery. The numbers at age discarded were converted into weights using the Arctic Fisheries Working Group (AFWG) weight-at-age relationships (Anon., 2000a), these weights being fixed for the years 1950-1982. However, there is reason to believe that the stock weights at age in the 1950s and 1960s were actually lower, causing the estimated biomass to be too large. The weights may have been lower when the stock was larger and intraspecific food competition was potentially greater.

The discards at age were estimated by taking the age proportions of the cod stock for each year, simulating a fishery of the stock with the mesh sizes used and their selection curves for the respective years. The catches of three to five year-olds were then adjusted according to the age proportions of the estimated catches; catches were only adjusted upwards. The age proportions of the stock for the years 1950-1982 were gathered from the AFWG stock numbers at age, estimated by standard Virtual Population Analysis (VPA; Anon., 2000a). Since the catch numbers at age have a large influence on the results of the VPA, the adjusted catch numbers were used in the VPA to estimate new stock numbers at age. These new stock numbers were then used to re-adjust the catches. This procedure

was performed twice. For the years 1983-1998, the Norwegian bottom trawl surveys were used to find the age proportions of the stock. The estimated discards were found by subtracting the AFWG catch numbers from the adjusted catch numbers.

Norwegian, Russian (USSR), English, West German, and a group composed of other countries' discards were estimated for the period 1950-1976 for ICES areas I and IIb. Catches in area IIa were not adjusted since most of these are from the fishery on the fish migrating to the spawning grounds and very few 3-5 year-old cod occur in this area. Russian and the 'group of other countries' catches in area I and IIb were adjusted for the years 1982-1998. Norwegian catches in area I and IIb were adjusted for the years 1982-1984. Total Norwegian trawl catches at age, summed for areas I, IIa and IIb, were adjusted for the years 1985-1998. The available Norwegian catch data were stratified by gear only, not area.

No catch-at-age data by country and area are available for the years 1977 – 1981. Total catch numbers at age, nominal catch (tonnes) by countries and total nominal catch (tonnes) by trawl and other gears for each area are available (Anon., 2000a). Catch numbers at age were divided into Norwegian catches and catches by the remaining countries. It is assumed that only Norway uses other gear types and therefore the Norwegian catches were divided between trawl catches and catches by other gear types. The Norwegian trawl catches and catches by remaining countries were then adjusted as explained previously.

However, the method used may inaccurately estimate the discards in some cases. These cases arise from applying the same age proportions across all gear types, from a strong year class entering a fishery, or if a new technology was introduced which limited bycatch.

Since the age proportions applied were the same for Norwegian trawl, other gear types and other countries, the estimated discards may be inaccurate. The nominal discards for 1981 may also be inaccurate since they seem too large in comparison to surrounding years. However, this anomaly may have resulted from a cold-water intrusion into the Barents Sea in 1980 and 1981, which shifted the stock to an extreme westward distribution. This would have resulted in low catches for Russian vessels and a high proportion of Norwegian catches taken by other gear types. Since the vessels in the other gear type category usually catch a smaller proportion of small fish

than a trawl does, an overestimate of discards could have occurred.

Discard rates for other year classes may be overestimated when a strong year class enters the fishery. This occurred, for example, in the Russian cod fishery in 1973 when the strong 1970 year-class entered the fishery and high discards of four and five year-olds, rather than of three year-olds, occurred. The reason for this is not quite clear since Norway and England both have high discard rates of three year-olds. It may be an effect of the distribution of the year-classes, as it is known that cod has a more westerly distribution by age; young cod are distributed further to the east than older cod (Nakken and Raknes, 1987).

Estimated discards in the 1990s may also have been overestimated since the use of sorting grids, which improves gear selectivity, was voluntary in the mid-1990s and compulsory since 1997. The closure of fishing locations, which have too large a proportion of small fish in catches, would also be a source of overestimation.

The results show that average discards by percentage of total catch decreased for all countries combined (Table 1). The decrease was probably due to increases in mesh size (Table 2). There is some variation of discard amounts between countries although Norway generally has less discards than the other countries. This is because discards are not estimated for conventional gear types, which catch approximately two-thirds of the Norwegian quota, and also because of larger mesh size used by Norway in comparison to the other countries.

Table 1. Estimated cod discards in % of total catch, averaged per decade.

| Decade | Discards |
|--------|----------|
| 1950s | 22 |
| 1960s | 14 |
| 1970s | 9 |
| 1980s | 9 |
| 1990s | 10 |

In some cases it may be better to assign the estimated values of discards as 'un-mandated' catches. During the heydays of the former Soviet Union, it was always assumed that discards were zero/non-existent. Results show that this was not true and may, in fact, support suggestions that Soviet vessels caught and landed a lot of small fish that never showed up in the catch statistics.

Table 2. Cod end mesh sizes (mm) used in Northeast Arctic cod (*Gadus morhua*) fisheries. The mesh sizes apply to nylon since 1967. Mesh sizes of 135 mm apply to all vessels in Norwegian EEZ and to Norwegian vessels in the Grey zone (the area under joint Russian and Norwegian jurisdiction). Mesh sizes of 125 mm apply to all vessels in the Russian EEZ and to Russian vessels in the Grey zone.

| Year | Norway | Other countries |
|------|--------|-----------------|
| 1946 | 80 | 80 |
| 1954 | 110 | 110 |
| 1963 | 130 | 120 |
| 1982 | 135 | 125 |

Redfish

By-catch of fish, especially small redfish (*Sebastes* spp.) in the Barents Sea shrimp fishery has been substantial. By-catch-induced discards in the shrimp fishery during the years 1983-1986, which were estimated by the Norwegian Institute of Marine Research, are believed to be among the most extensive ever (Table 3, Figure 1). The by-catch was estimated in numbers and was converted to weights by assuming that the mean weight was 100 gram. However, the by-catches of redfish have been successfully reduced starting with the introduction of a sorting grid in 1989 which was made compulsory from 1993 in both Norwegian and Russian EEZ, as well as in the areas around Svalbard (Isaksen, 1997).

Table 3. Estimated by-catch of small redfish (*Sebastes* spp.) in the Norwegian and foreign shrimp fishery north of 60°N, and reported landings of redfish for the same area and period.

| Year | By-catch (tonnes) | Landings (tonnes) |
|------|-------------------|-------------------|
| 1983 | 13,800 | 4,651 |
| 1984 | 23,900 | 2,027 |
| 1985 | 78,300 | 2,932 |
| 1986 | 33,500 | 5,411 |
| 1987 | 22,300 | 3,124 |

Blue whiting (Poutassou)

The Norwegian industrial trawl fishery catches a considerable amount of blue whiting (*Micromesistius poutassou*). However, official catches for most years are considerably smaller than the estimated catches, which are considered to be more accurate and are used by the ICES Working Group (Anon., 2000b). The fishing vessels and the landing stations report the catches to the Norwegian Directorate of Fisheries, which in turn reports to ICES. In addition, a control agency samples catches when landed and estimates the round weight of blue whiting in the catches. The un-mandated catches reported in this report are the differences between the

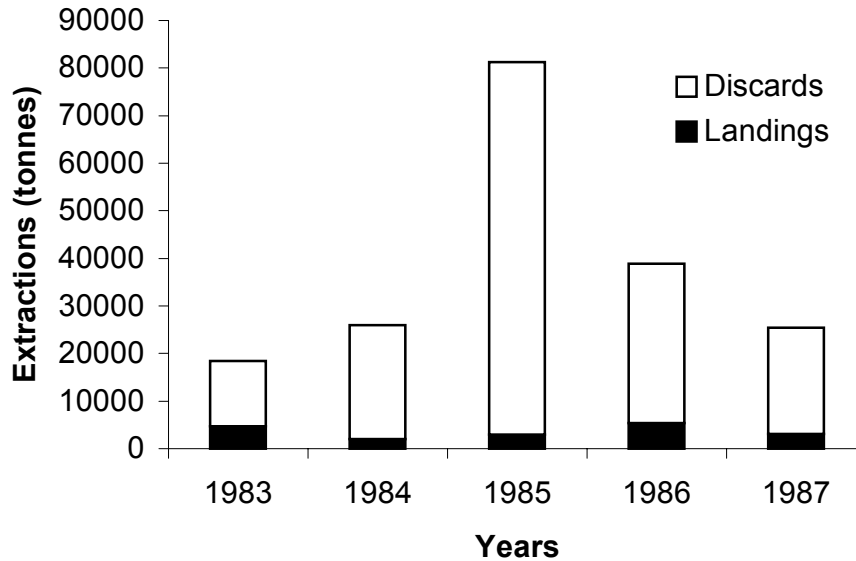


Figure 1. Total extractions of redfish (*Sebastes* spp.) from ICES area I, broken down into reported landings and discards by the shrimp fishery.

estimated catches and official catches. In the fishery for Norway pout and blue whiting, it has been common in recent years to register the catch as the species that represents at least 50% of the delivery. This over-reporting of target species and under-reporting of incidental by-catches causes negative values in the years 1997-1999 for target species. The over-reported catches were all allocated to haddock, saithe, whiting and other species. The industrial by-catches are estimated by the Working Group on the assessment of demersal stocks in the North Sea and Skagerrak (Anon., 2000c).

Haddock, whiting and saithe in the North Sea

The un-mandated catches of haddock, whiting (*Merlangius merlangus*) and saithe include discards and industrial by-catch. The saithe data also include unreported catches. The total annual international discard estimates of haddock and whiting in the North Sea were derived by extrapolation from Scottish data (Anon., 2000c). The Working Group (WG) estimated the by-catch of haddock, whiting and saithe in the Norwegian and Danish industrial fishery for Norway pout and sandeels in the North Sea. The unreported catches of saithe are the differences between the official statistics and the information provided by members of the WG. In some years, French catches belonging to area IIa are included in the official statistics of area IVa and IIIa. These catches are subtracted from the unreported catches and cause negative values.

Northeast Atlantic mackerel and horse mackerel

Only the Netherlands has provided information on discards in the mackerel (*Scomber scombrus*) and horse mackerel (*Trachurus trachurus*) fisheries in recent years (Anon., 2000d). This does not imply that The Netherlands is the only country that has discards, but that it is the only country that records and reports discards to the ICES WG. The information on discards is not applied to any other countries and it is not specified to which countries the earlier discards belong. The area-misreported catches of mackerel are catches caught in area IVa and reported in area VIa. For the years 1995, 1996 and 1998 some of the IVa catches reported are in area IIa. WG members have submitted the information on area-misreported mackerel catches. The unallocated mackerel and horse mackerel catches are adjustments to the official catches, performed by the WG, made from any special knowledge about the fishery such as under- or over-reporting for which there is firm external evidence (Anon., 2000d). Over-reporting and area-misreporting caused the negative unallocated catches of horse mackerel in the present report. The area-misreported horse mackerel catches are not specified to area, but the sum of all the area-misreported catches should be zero.

The un-mandated catches of herring (*Clupea harengus*) south of 62° N are available, although discard information is only available for some unspecified countries (Anon., 2000e). Area misreporting is estimated by the WG. The catches

that are misreported are caught in area IVa, but reported as catches in area VIa.

Shrimp

During the sieving procedure, when the shrimp are sorted by size on board the vessel, it is believed the smallest size fractions of shrimp (proportions below 15-mm carapace length) are discarded in the Swedish and Norwegian shrimp fishery in the ICES areas IIIa and IVa east (Anon., 2000f).

Whales

The whale catches are divided into two groups, big whales and small whales. The big whales were caught during 'pelagic whaling' which mainly took place in the Antarctic, but some whales were also taken in the North Atlantic. Norwegian pelagic whaling was stopped in 1972 and the catch records are collected from *International Whaling Statistics* (1961, 1964, 1970 & 1974). Small-whales were first caught in the 1920s with small boats along the Norwegian coast. In the 1950s and 1960s the vessels increased in size and the catch area expanded to the Barents Sea, Greenland and Newfoundland. The 1950-1953 catches are collected from Statistics Norway, the 1954-1985 catches from *International Whaling Statistics* (1961, 1964, 1970, 1974, 1981 & 1988) and the 1986-1999 catches from *Havets Ressurser* (Toresen *et al.*, 1999 and 2000). All reported catches include whales caught for scientific purposes. The data for whales will be incorporated in the *Sea Around Us* Marine Mammal database (see Kaschner *et al.*, this volume).

Seals

The catches of seals are collected from the *Report of the joint ICES/NAFO Working Group on Harp and Hooded seals* (Anon., 1992, 1999), the Norwegian Directorate of Fisheries (Fiskeridirektøren) and *Havets Ressurser 2000* (Toresen *et al.*, 2000). The catches include incidental catches along the Norwegian coast and catches from scientific sampling conducted by Norway. The data for seals will be incorporated in the *Sea Around Us* Marine Mammal database as well.

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APPENDIX 1

THE NORWEGIAN CATCH AND EFFORT DATA

The Norwegian catch and effort data were obtained from a survey of Norwegian fishing vessels (The Norwegian Directorate of Fisheries, 1999). The fishing vessels included in this survey were those which had an overall length of 8 meters or more and operated on a whole year basis in 1998. These vessels caught 89% by weight of the total official catches. Vessels below 8 meters caught 12,374 tonnes. Vessels between 8 and 12.9 m and the vessels above 13 m that were not included in the survey caught 55,221 and 222,517 tonnes, respectively. No effort data are available for the vessels that were not included in this survey.

The vessels in the Norwegian fisheries are divided into three main groups:

- Vessels fishing for gadoid species;
- Vessels fishing for shrimp;
- Vessels fishing for pelagic species.

The vessels in these three groups are then divided into classes depending on gear and size of vessel (Tables 4-6, please contact author for collaboration). The available fleet characteristics, fleet effort and landings were tabulated. The Norwegian Directorate of Fisheries (NDF) provided the fleets average main engine power. Information that was not available from NDF is marked 'N.A.'. Un-mandated catches are not included in the table, except for blue whiting in vessel class 023.

References (Appendix 1)

The Norwegian Directorate of Fisheries (1999). *Lønnsomhetsundersøkelser for helårsdrevne fiskefartøy 8 meter største lengde og over, 1998*. [Profitability survey of Norwegian fishing vessels 8 meter and above operating on a whole year basis 1998] Budsjettneemda for Fiskerinæringen, Fiskeridirektoratet, Bergen, Norway. 169 pp. (In Norwegian, summary in English). www.fiskeridir.no/sider/statistikk/blaabok.html

Table 4. Vessels fishing for gadoid species.

| Code | Vessel type | Area of operation | Vessel length (m) | Vessel tonnage (GRT) |
|------|--|-------------------|-------------------|----------------------|
| 001 | Fisheries with gillnet, and hand-line | North-Norway | 8-12.9 | - |
| 002 | Fisheries with gillnet, and hand-line | North-Norway | 13-20.9 | - |
| 003 | Fisheries with Danish seine | North-Norway | 8-12.9 | - |
| 004 | Fisheries with Danish seine | North-Norway | 13-20.9 | - |
| 005 | Fisheries with long line. | North-Norway | 8-12.9 | - |
| 006 | Fisheries with long line | North-Norway | 13-20.9 | - |
| 007 | Miscellaneous coastal fisheries for cod | South-Norway | 8-12.9 | - |
| 008 | Miscellaneous coastal fisheries for cod | South-Norway | 13-20.9 | - |
| 009 | Fisheries with Danish seine | North-Norway | 21-27.9 | - |
| 010 | Miscellaneous coastal fisheries for cod | All counties | 21-27.9 | - |
| 011 | Fisheries with long line | All counties | ≥ 28 | - |
| 012 | Miscellaneous coastal fisheries for cod | All counties | 28 | - |
| 013 | Freshfish trawlers | - | - | ≥ 250 GRT |
| 014 | Factory trawlers | - | - | ≥ 250 GRT |
| 015 | Other trawlers and small trawlers fishing for saithe, cod (Without quotas or limited quotas) | - | - | - |

Table 5. Vessels fishing for shrimp.

| Code | Vessel type | Vessel size (tonnage (GRT), length (m)) |
|------|---|---|
| 016 | Shrimp trawling | Vessels under 50 GRT, 8-12.9 m (Without shrimp trawl license) |
| 017 | Shrimp trawling | Vessels under 50 GRT, ≥ 13 m (without shrimp trawl license) |
| 018 | Shrimp trawling in combination with other gears | Vessels under 50 GRT, 8-12.9 m (without shrimp trawl license) |
| 019 | Shrimp trawling in combination with other gears | Vessels under 50 GRT, ≥ 13 m (without shrimp trawl license) |
| 020 | Ocean trawling for shrimps. Vessels which have participated in fishing for shrimps in the Greenland area. Vessels with cold storage plant | - |
| 021 | Ocean trawling for shrimps. Vessels which not have participated in fishing for shrimps in the Greenland area. Vessels with cold storage plant | - |
| 022 | Ocean trawling for shrimps. Vessels without cold storage plant | Vessels > 50 GRT |

Table 6. Vessels fishing for pelagic species.

| Code | Vessel type | Vessel size (m) or load capacity (hl) ^{a)} |
|------|--|---|
| 023 | Trawling for Norway pout, sandeels, capelin. (Also vessels with North Sea trawl license) | - |
| 024 | Seining for saithe, herring, mackerel, sprat etc | 8-12.9 m |
| 025 | Seining for saithe, herring, mackerel, sprat | 13-21.34 m |
| 026 | Seining for saithe, herring, mackerel, sprat | 21.35 m and above |
| 027 | Purse seining for capelin, herring, mackerel | Loading capacity up to 7.999 hl |
| 028 | Purse seining for capelin, herring, mackerel | Loading capacity ≥ 8.000 hl |
| 029 | Purse seining for capelin, herring, mackerel. With blue whiting season | - |

^{a)} 1 hl (hectoliter) = 100 liters