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International Council for the
Exploration of the Sea

C.M.1977/H:4 - APPENDIX
Pelagic Fish (Northern) Committee

PROVISIONAL INFORMATION AND DATA FOR ALLOCATION OF RESOURCES
UNDER THE NEW EXTENDED NATIONAL FISHERIES JURISDICTION REGIME

CAPELIN, BARENTS SEA

ICELANDIC STOCK OF CAPELIN

NORWEGIAN SPRING SPAWNING HERRING

ICELANDIC SPRING SPAWNING HERRING and

ICELANDIC SUMMER SPAWNING HERRING

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^{x)} General Secretary
ICES
Charlottenlund Slot
2920 Charlottenlund
Denmark

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PROVISIONAL INFORMATION AND DATA FOR ALLOCATION OF
RESOURCES UNDER THE NEW EXTENDED NATIONAL FISHERIES
JURISDICTION REGIME

CAPELIN, BARENTS SEA

1. General Biology

1.1. Spawning times and areas

The majority of the Barents Sea capelin spawn when they are 3-5 years old, depending on the growth rate. Normally 4 years old fish dominate in the spawning stock. Most of the capelin spawn only once. The most important spawning period at the Norwegian coast is in March and April, but spawning may occur to a lesser extent during the period February - July. Spawning takes place on gravel and sand bottom mainly within the depths from 10 - 100 m (DRAGESUND et al. 1973). Potential spawning areas are found along the Norwegian and the U.S.S.R. coast from Vesterålen in the west to the entrance of the White Sea in the east (Fig. 1). The capelin usually spawn only in parts of this area, most often between North Cape and the Rybachi Peninsula. Incubation time varies from 1 to 2 months, depending on the temperature.

1.2. Area of distribution and migrations

Most of the Barents Sea can be considered as feeding area for capelin (Fig. 1). After hatching the larvae drift with the current towards north and east, and 0-group capelin may in some year be found as far north as 77°N (ANON. 1974a).

The distribution of 1 and 2 years old capelin is usually farther north than that of the 0-group. The older capelin can be found north to the ice border at approximately 80°N during the autumn. During summer the capelin mostly occur as scattering layers,

although schools suitable for purse seining are also found. In the autumn the capelin migrate southwards in front of the advancing ice border. The immature capelin do not enter the warm water along the coast, and remain in far offshore waters throughout the winter. The maturing capelin tend to aggregate in certain areas before they continue their migration towards the coast. One relatively well defined such area is between the Skolpen Bank and the Goose Bank. Often the maturing capelin also aggregate in the Tiddly Bank - Thor Iversen Bank area, and north of the North Cape Bank. From these areas the capelin then move towards the coast, as shown in Fig. 1 (ANON. 1974b). In the aggregation areas, and during the migration from there to the coast, the capelin is often found in schools suitable for purse seining.

2. Exploitation and management

The Barents Sea capelin is exploited practically only by Norway and the U.S.S.R. Since the middle of the 1960s the Norwegian fishery has developed rapidly and increased from 20 thousand tonnes in 1964 to 1.5 million tonnes in 1972. Up to 1974 Norway took more than 96 percents of the total catch. After 1974, however, the U.S.S.R. have increased their effort and in 1975 took 31 % of the total catch (Table 1).

Traditionally the Norwegian fishery for capelin has been based upon the spawning stock coming to the coast during late winter and early spring. In recent years this typically coastal fishery has been extended into the open sea with large purse seiners operating far off the coast (Fig. 3). The fishery starts in January and the fleet follows the capelin from the "aggregation areas" towards the coast. Nearer the coast, smaller vessels with pelagic trawl join the fishery. The fishery continues in the spawning areas and on spent fish. Usually the fishery terminates in April, although a few catches may be taken as late as June.

In 1968 Norwegian vessels started fishing for capelin during the summer/autumn. This fishery starts in the end of July and may last until the beginning of November. The catch consists of two to four years old capelin. In the earlier years, the main fishery

took place northeast of Hope Island, along the eastern coast of Edge Island and north to King Karl's Land. Since 1975 the fishery has also extended into the north-eastern part of the Barents Sea (Fig. 4). The Norwegian summer catch is exclusively taken by purse seiners.

The sharp increase in the Norwegian capelin catches since 1964 is connected with a drastic increase in effort, achieved mainly by the introduction of large purse seiners which are able to operate in rough weather. As a result, the seasons have been much extended and fishing far offshore has been possible.

The Norwegian capelin fishery has been subject to national regulation in various forms. The last years opening dates have been set for both the winter fishery and the summer fishery. During the summer fishery certain areas have been closed to avoid exploitation of I-group capelin. During the spawning period the most important spawning grounds have been closed to fishing. In periods of heavy fishing, the fishery has also been restricted due to limitation of the processing capacity.

No information regarding the management of the U.S.S.R. fishery was made available to the Working Group.

3. Present state of the stock

The abundance of the Barents Sea capelin stock is subject to large variations (Table 3). During the last years the stock has increased from 3.8×10^6 tonnes in September 1973 to 6.5×10^6 tonnes in 1975. In September 1976 the stock was estimated to 5.2×10^6 tonnes. These are acoustic estimates including I-group and older capelin.

In Table 3 is also given estimates of the spawning stock as the quantity of capelin 14.5 cm or longer recorded during the acoustic surveys in September. These estimates are known to be too low, as the large capelin some times is found too close to the bottom to be recorded effectively with echo sounders.

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APPENDIX I

Table 1. Catch per year of capelin (tonnes) from the Barents Sea 1964 - 1977.

| Year | NORWAY | | | U.S.S.R. | OTHER COUNTRIES (Poland, Iceland, Faeroe Islands) | Distribution in percent | | |
|------|----------------------|----------|------------|----------|---|-------------------------|----------|--------|
| | Winter | Summer | Sum | | | NORWAY | U.S.S.R. | OTHERS |
| | | | | | | | | |
| 1964 | 19 626 | | 19 626 | 50 | | 99.7 | 0.3 | |
| 65 | 217 324 | | 217 324 | 7 200 | | 96.8 | 3.2 | |
| 66 | 379 626 | | 379 626 | 9 400 | | 97.6 | 2.4 | |
| 67 | 402 819 | | 402 819 | 5 700 | | 98.6 | 1.4 | |
| 68 | 482 783 | 39 388 | 522 171 | 15 400 | | 97.1 | 2.9 | |
| 69 | 435 816 | 243 119 | 678 935 | 500 | | 99.9 | 0.1 | |
| 70 | 968 668 | 332 190 | 1 300 858 | 13 057 | | 99.0 | 1.0 | |
| 71 | 1 302 717 | 68 990 | 1 371 707 | 20 832 | | 98.5 | 1.5 | |
| 72 | 1 207 596 | 347 011 | 1 554 607 | 37 004 | | 97.7 | 2.3 | |
| 73 | 1 085 980 | 204 846 | 1 290 826 | 45 007 | | 96.6 | 3.4 | |
| 74 | 745 567 | 239 951 | 985 518 | 162 495 | | 85.8 | 14.2 | |
| 75 | 556 107 | 358 602 | 914 709 | 431 314 | 42 886 | 66.0 | 31.0 | 3.0 |
| 76 | 1 213 091 | 711 476* | 1 929 567* | | | | | |
| 77 | 1 372 000 (approx.)* | | | | | | | |

Source: Norway Feitsildfiskernes Salgslag
 U.S.S.R. Bulletin Statistique des Peches Maritimes
 * Preliminary statistics

APPENDIX 1

Table 2. Norwegian capelin catches in 1976 according to areas given in Fig. 2.

Winter fishery (Jan. - June)

| Area | Catch (tonnes) | Area | Catch (tonnes) |
|------|----------------|------|----------------|
| 0302 | 21 545 | 1001 | 3 333 |
| 03 | 111 174 | 02 | 2 115 |
| 04 | 3 222 | 03 | 1 226 |
| 05 | 511 | 04 | 40 936 |
| 06 | 50 110 | 05 | 119 931 |
| 07 | 255 324 | 06 | 46 396 |
| 08 | 11 407 | 1007 | 16 477 |
| 10 | 72 043 | | |
| 11 | 72 943 | 1212 | 971 |
| 12 | 46 471 | 19 | 2 777 |
| 13 | 18 285 | 1220 | 17 815 |
| 14 | 7 233 | | |
| 15 | 2 366 | 1302 | 8 860 |
| 16 | 1 090 | 03 | 439 |
| 17 | 23 567 | 04 | 373 |
| 18 | 40 171 | 05 | 338 |
| 19 | 33 781 | 06 | 2 101 |
| 20 | 11 313 | 08 | 27 768 |
| 21 | 1 643 | 09 | 11 734 |
| 22 | 1 171 | 11 | 1 824 |
| 0323 | 7 937 | 1312 | 1 234 |
| | | | |
| 0405 | 451 | 1402 | 318 |
| 07 | 68 | 03 | 9 989 |
| 10 | 184 | 04 | 4 686 |
| 11 | 1 359 | 1426 | 41 |
| 12 | 859 | | |
| 13 | 18 390 | | |
| 14 | 13 506 | | |
| 15 | 66 | | |
| 24 | 14 008 | | |
| 25 | 33 036 | | |
| 0426 | 56 393 | | |

APPENDIX 1

Table 2. (continued)

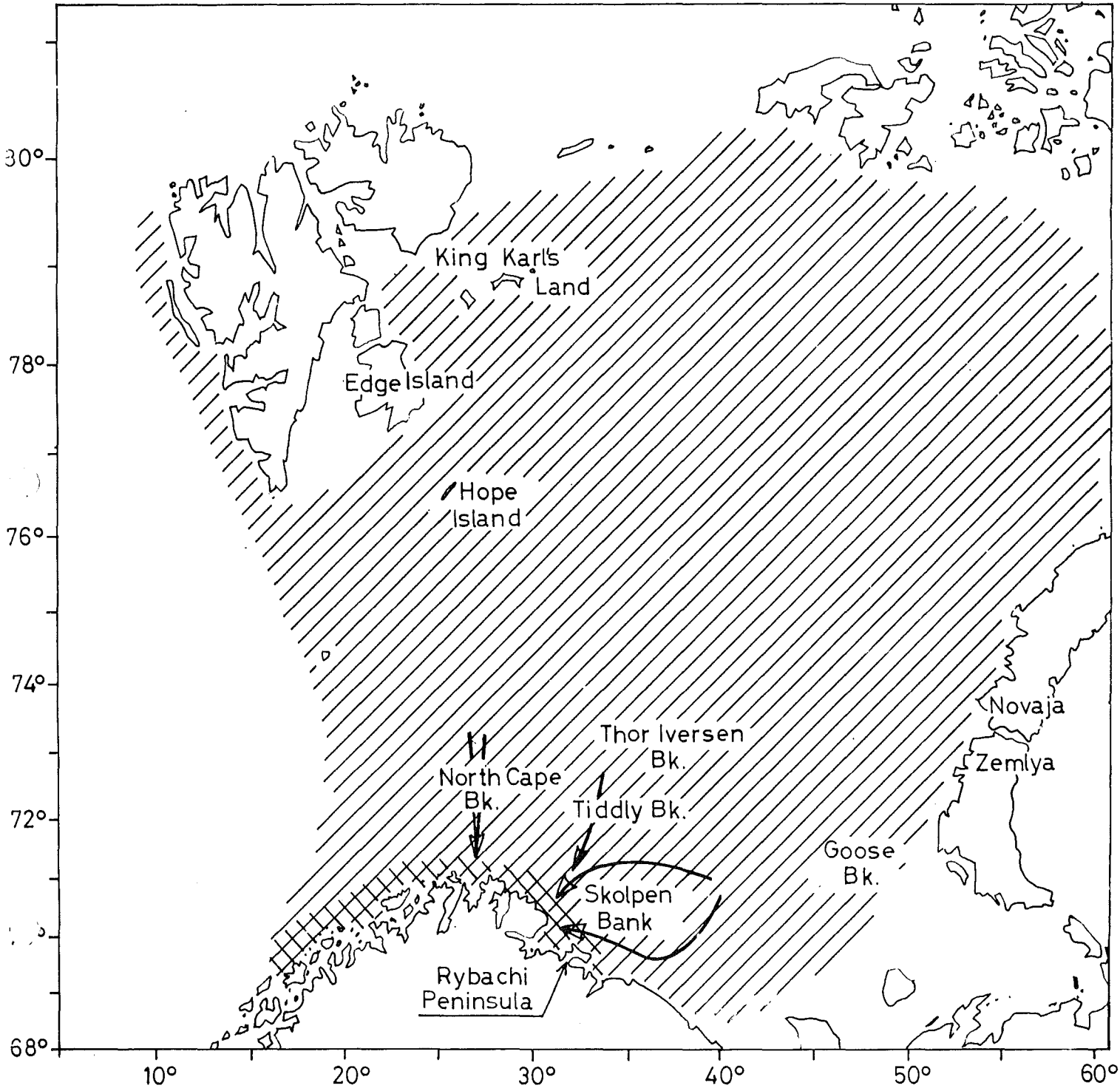
Summer fishery (July - Nov.)

| Area | Catch (tonnes) | Area | Catch (tonnes) |
|------|----------------|------|----------------|
| 1407 | 430 | | |
| 1412 | 2 100 | | |
| 1508 | 1 790 | | |
| 1509 | 657 | 2301 | 557 |
| | | 02 | 3 994 |
| 1603 | 26 | 03 | 18 401 |
| 06 | 1 809 | 05 | 4 075 |
| 07 | 34 056 | 06 | 72 289 |
| 08 | 164 | 07 | 145 999 |
| 13 | 29 188 | 09 | 9 462 |
| 14 | 38 371 | 10 | 80 421 |
| 15 | 34 955 | 11 | 9 148 |
| 16 | 3 051 | 13 | 49 929 |
| 18 | 485 | 14 | 44 502 |
| 1620 | 843 | 15 | 1 423 |
| | | 2318 | 2 753 |
| 1801 | 24 472 | | |
| 02 | 25 891 | | |
| 03 | 7 405 | | |
| 09 | 1 091 | 2401 | 71 962 |
| 29 | 475 | 02 | 7 495 |
| 1830 | 3 646 | 2404 | 806 |

APPENDIX 1

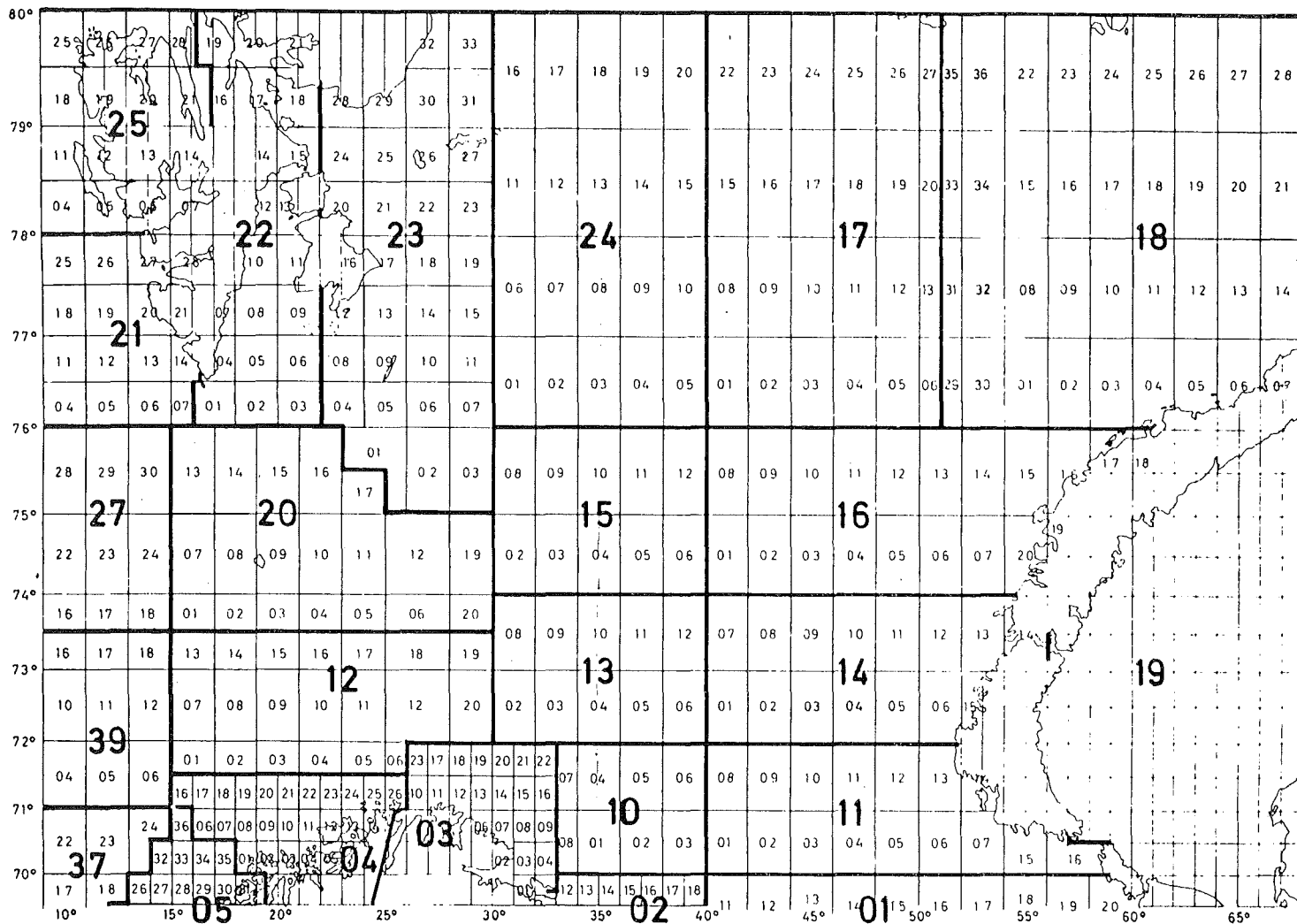
Table 3. Calculated no. of fish (N) and total weight (W) of fish at each age of the Barents Sea capelin in the autumn 1974 - 1976. The numbers for 1 year old fish are unreliable as this age is not completely covered by the surveys.
 N : numbers x 10⁻¹¹ ; W : tonnes x 10⁻⁵.

| Year | Age in years (no. of rings in otoliths) | | | | | | | | | | Total | | Spawning stock |
|------|---|------|-----|------|-----|------|-------------|------|------|------|-------|---|----------------|
| | 1 | | 2 | | 3 | | 4 and older | | N | W | N | W | |
| | N | W | N | W | N | W | N | W | | | | | |
| 1974 | 3.0 | 10.5 | 5.5 | 28.9 | 1.6 | 13.3 | 0.03 | 0.5 | 10.1 | 53.2 | 8 | | |
| 1975 | 2.7 | 8.6 | 3.4 | 22.0 | 2.4 | 24.6 | 0.6 | 9.5 | 9.1 | 64.7 | 18 | | |
| 1976 | 1.7 | 4.8 | 2.4 | 19.2 | 1.4 | 16.8 | 0.7 | 11.1 | 6.2 | 51.9 | 18 | | |



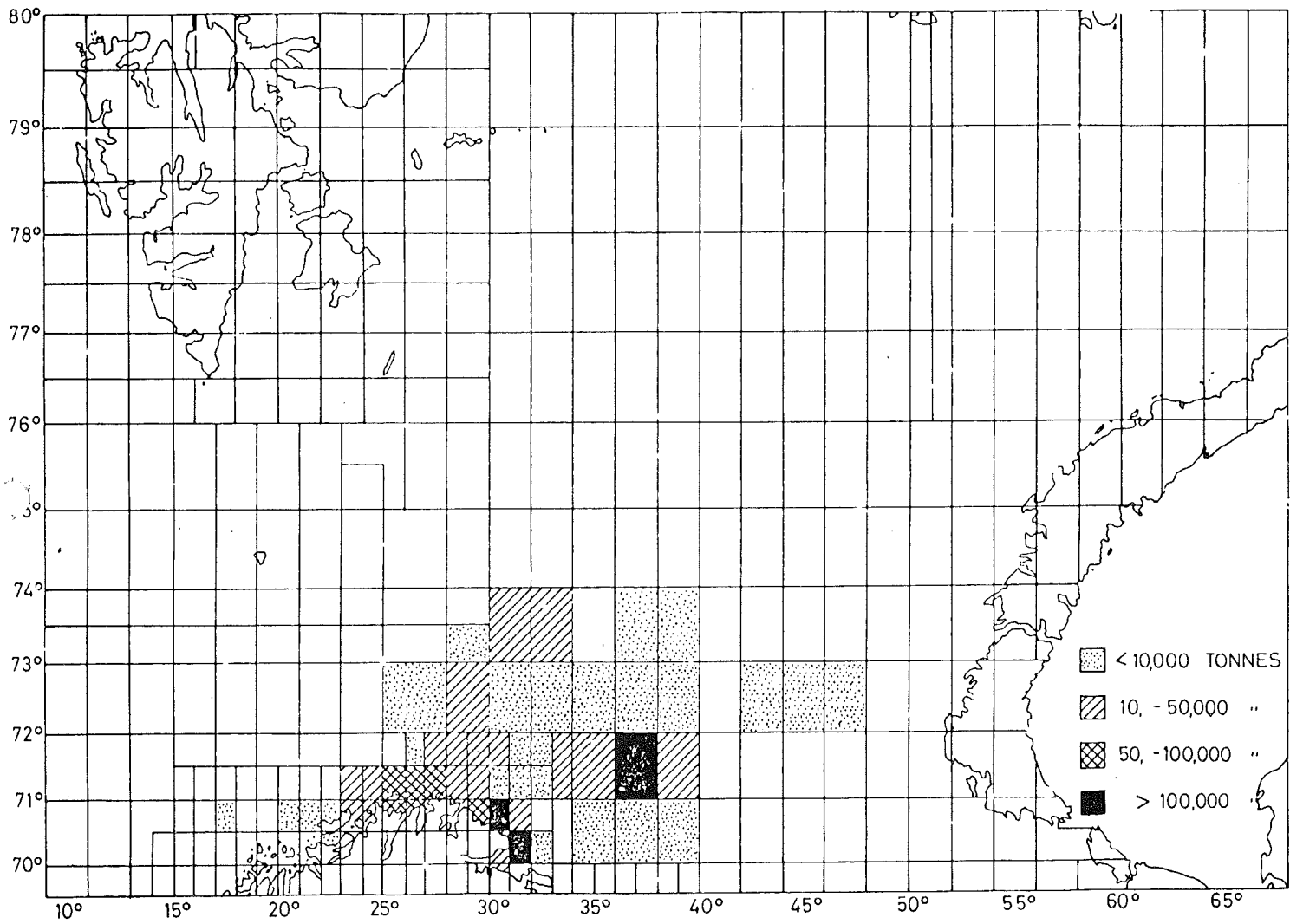
APPENDIX 1

Fig 1. Distribution area of the Barents Sea capelin (hatched), spawning grounds (crosshatched) and migration routes to the spawning grounds (arrows).



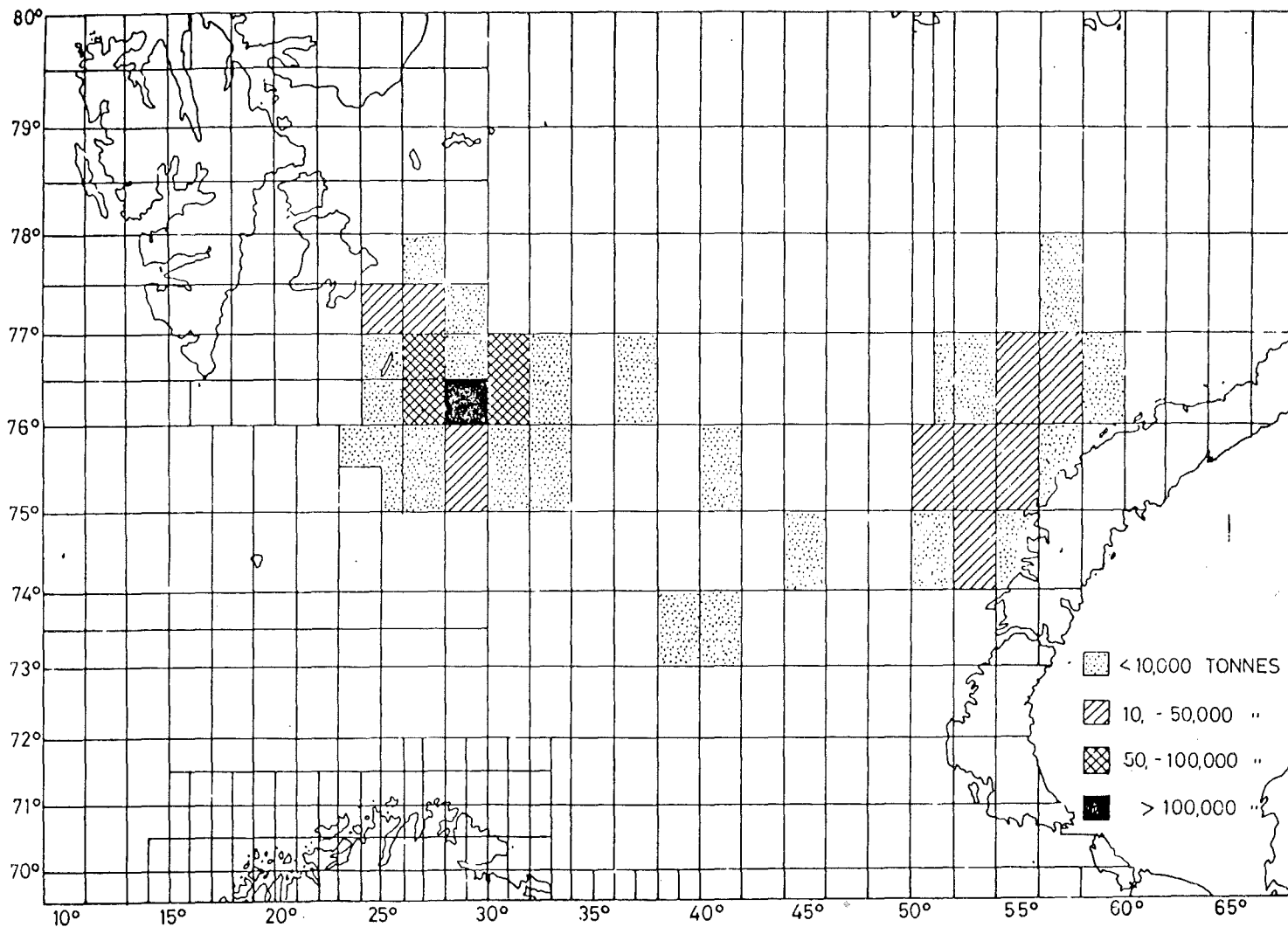
APPENDIX 1

Fig. 2. Key to the statistical areas used in Table 2.



APPENDIX 1

Fig. 3. Distribution of catches during the winter fishery 1976.



APPENDIX 1

Fig. 4. Distribution of catches during the summer fishery 1976.

PROVISIONAL INFORMATION AND DATA FOR ALLOCATION OF RESOURCES
UNDER THE NEW EXTENDED NATIONAL FISHERIES JURISDICTION REGIME

The Icelandic stock of capelin

1. General description of stock structure, biology and life history of the Icelandic capelin

1.1 Spawning time and areas

The Icelandic capelin spawn mainly during the second half of March and the first half of April. Further spawning also takes place later in April, May and June. The first spawners arrive at the southeast coast of Iceland in late January or during the first three weeks of February and migrate westwards along the south coast. The spawning begins, usually off the western south coast some three or four weeks later. Subsequent runs of capelin may spawn elsewhere of the south and southeast coast. The main spawning area extends from southeast Iceland along the south coast to the Snæfellsnes peninsula or Látrabjarg in the west. This main spawning lasts from about three to six weeks. The south and west coast spawning is usually finished sometime during the first half of April.

Spawning also takes place off the eastern north coast of Iceland, as well as sometimes off the western north coast. This is a later spawning and sometimes lasts throughout May into early June. In 1977 some spawning took place on the outer banks off the northwest peninsula. This phenomenon has not been observed before. The spawning grounds of the Icelandic capelin are shown in Figure 1.

1.2 Larval, postlarval and juvenile fish distribution

After hatching, the larvae and postlarvae mainly drift with the current to the west and north of Iceland, In some years at least, considerable proportions also drift towards east Greenland. The larvae hatching at southeast Iceland probably drift northwards along the east coast. The feeding area of the capelin during its first summer and autumn is therefore very wide and in some cases even oceanic, as is shown in Figure 2.

In early winter, 0-group capelin migrate towards the shore and during the first winter they are distributed in coastal waters. Dense concentrations of mainly 1-group capelin are most often found off the north coast of Iceland.

1.3 Distribution and migration of young and adult stock components

2- and 3-groups are usually mixed on the feeding grounds in the deep waters to the north and northwest of Iceland. In recent years there has been a shift of the main feeding area of the capelin to the west, and last year's late summer and

autumn fishery mainly took place to the north and northwest of the northwestern peninsula. The feeding area is shown in Figure 3.

In late November and December this mixture of juveniles and maturing fish migrates eastwards in deep waters off north and northwest Iceland. In early January, the migrating capelin are usually found near the edge of the continental shelf off northeast Iceland. The migration continues southwards as mature and immature fish segregate. The juveniles remain in the cold waters off east Iceland, while the spawners continue the migration to the warm waters at southeast Iceland. The most important spawning and feeding migrations, as well as overwintering grounds, are shown in Figures 4 and 5.

2. Exploitation and management

2.1 The fishery

The Icelandic capelin catch is given in Table 1 for the years 1964-1976.

Prior to this period, capelin was only caught for bait and the catch was only a few hundred tons a year. The increased catch in the seventies is to a large extent due to extension of the fishing season as indicated in Table 1. Summer fishing of capelin started in 1975, but was not successful until 1976, when 125 000 tons were taken.

Although the capelin have at times been fished successfully with pelagic trawl, the catch taken in this way has, on the whole, been negligible. The gear used almost exclusively is a purse seine both during the winter fishery on the spawning migration and during the summer fishery on the feeding concentrations.

2.2 Stock fluctuations

As yet, it has not been possible to evaluate the absolute size of the Icelandic stock of capelin. Research aimed at obtaining this data makes it clear, however, that it must be counted in millions of tons. Almost throughout the period 1966-1977 the spawning runs have always been of a large size and this, together with other information, suggest a relatively stable stock which has remained on a high level of abundance. An exception is 1970 when the spawning migration was unusually small and the spawning grounds much restricted in size.

2.3 Long-term yields

In the absence of concrete data on the actual stock size of the Icelandic capelin, it is difficult to assess its long-term yield. Considering the information at hand, as well as the apparent stability of the stock in the past years and the possible exploitation pattern of the future, it is suggested that the long-term yield may lie somewhere around one million metric tons per year.

2.4 Exploitation pattern

Obviously, the exploitation pattern of the Icelandic capelin has been relatively simple. Until the summer of 1976, this fishery was based exclusively on spawning and pre-spawning capelin. With the introduction of the summer fishery, the catch includes young adults as well as pre-spawners, but so far there has been no fishery of any importance on juveniles.

2.5 Management

Regulatory measures have mainly been precautionary in nature. Since 1973 there has been a closed season from 14 May lasting for 2-3 months. In addition, the juvenile overwintering areas have been closed for all fishing. In 1975 a minimum landing size of 12 cm was introduced.

3. Nominal catch and fishing effort statistics in relation to zones and their historical changes

3.1 The fishery for bait at north, south and west Iceland prior to 1964

The fishery was exclusively coastal, being conducted with purse seines or drag nets at or just off the shore. The amounts caught were negligible.

3.2 The winter season

3.2.1 After the spawning migrations enter coastal waters at southeast Iceland, they have been fished extensively since 1965. This fishery lasts for 4 - 8 weeks, depending upon environmental and biological factors. The yield has been between 170 and 430 thousand tons annually for the last nine years. Most of the above catch is taken in immediate coastal waters and almost never farther offshore than 25 n.m.

3.2.2 In 1973 a new phase of the winter capelin fishery came into being, also based on capelin that were migrating towards the spawning grounds. This fishery is conducted further offshore (usually 45-80 n.m.) taking place off east, north-east and north Iceland in January and February. Annual fluctuations in the yield are considerable, the catch having varied between 28 000 and 245 000 tons.

3.3 The summer and autumn fishery

This fishery is a novelty , having existed for one season only. The total catch in 1976 amounted to 111 000 tons and was taken off north and north-west Iceland. Negligible amounts only were taken on the Greenland side of the median line between the northwest peninsula of Iceland and Greenland, and no great opportunities seemed to be in that area in 1976.

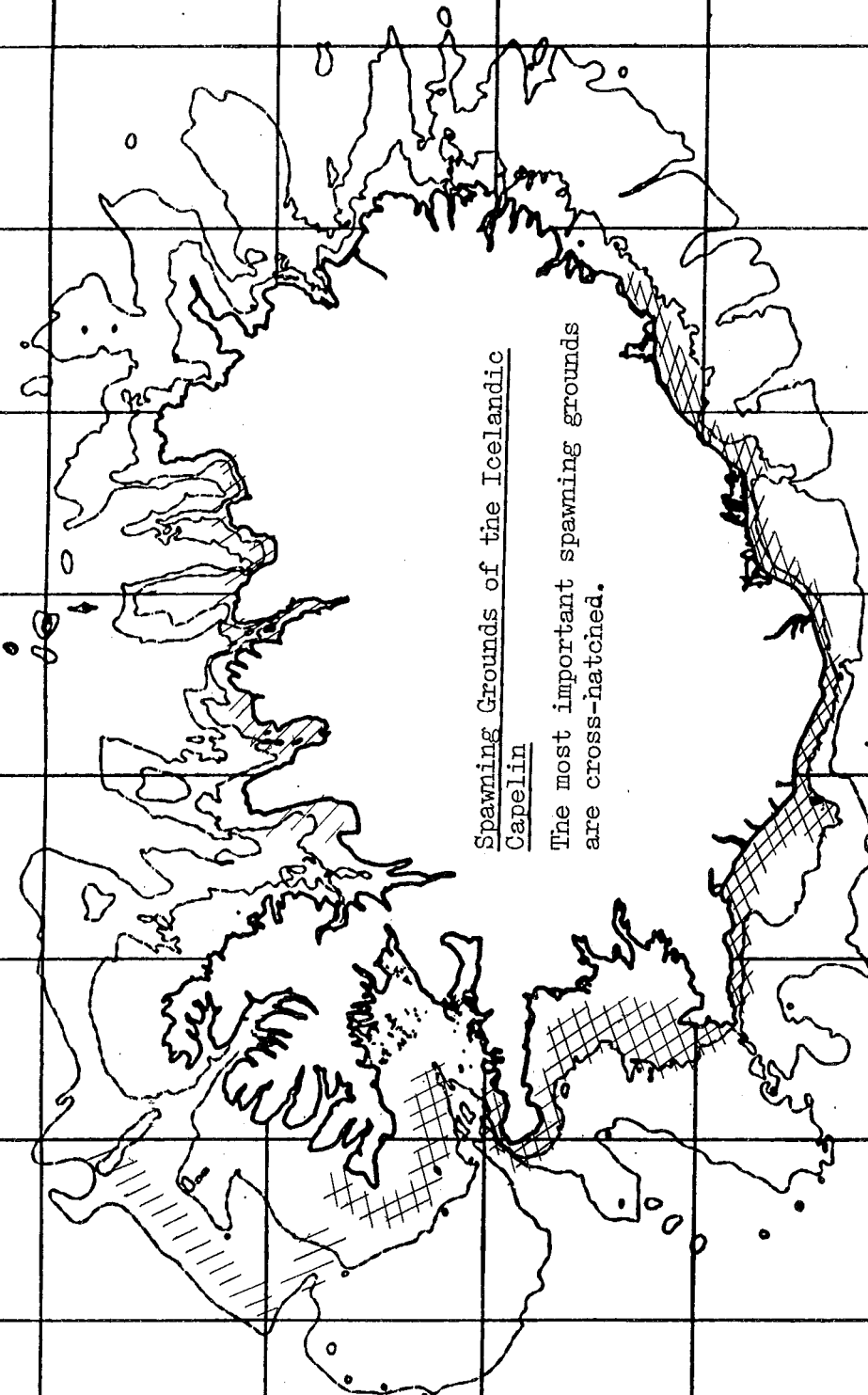
The location of the feeding ground is, however, subject to considerable annual variations. Earlier surveys have, however, shown that during the summer the heaviest feeding most frequently takes place in deep waters directly off the north coast of Iceland.

The total yield of the Icelandic capelin fishery for the years 1964-1977 is shown in Table 1.

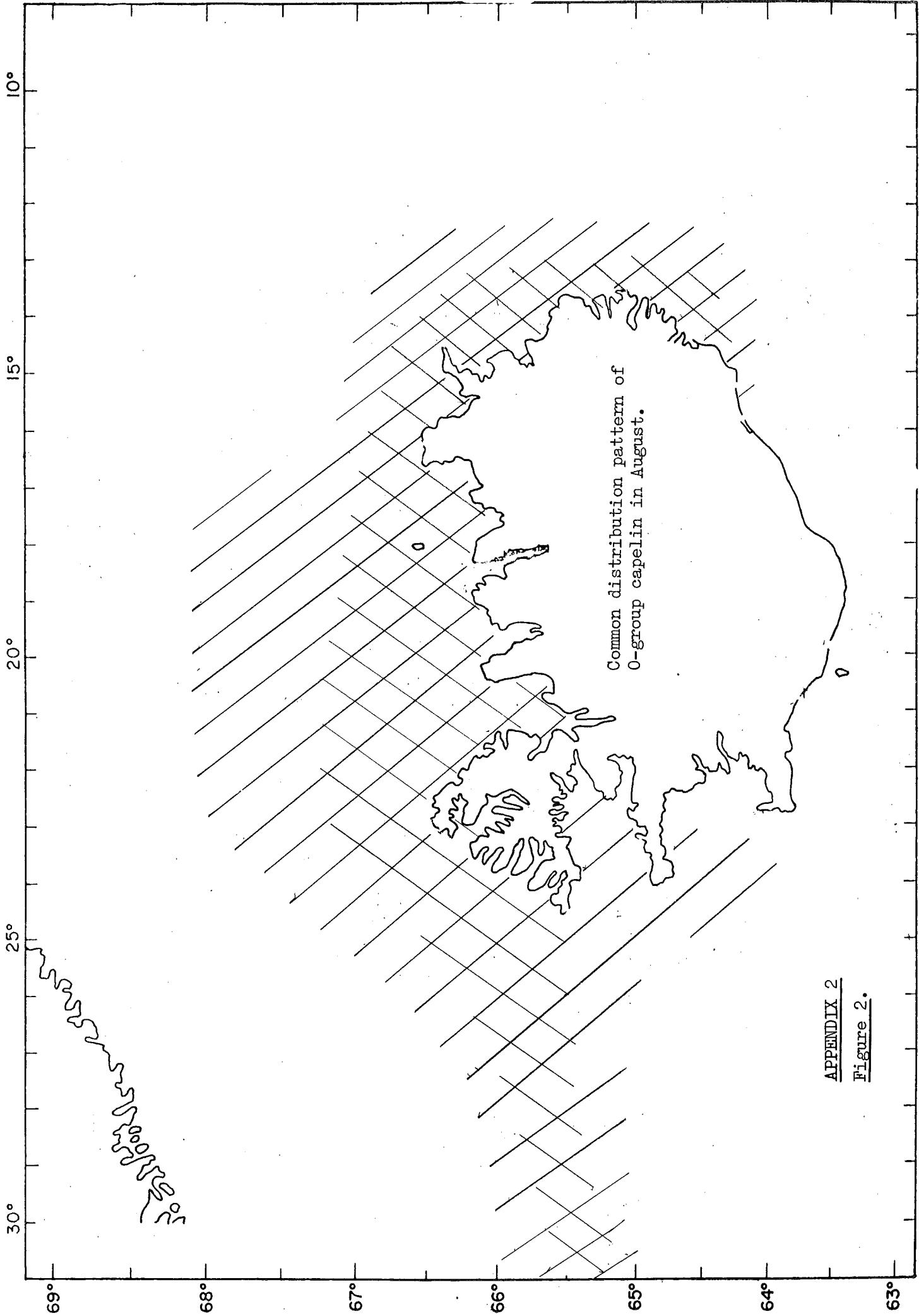
APPENDIX 2

Table 1 The annual catch (thousand tons) of Icelandic capelin by areas (fisheries) in the years 1964-1977.

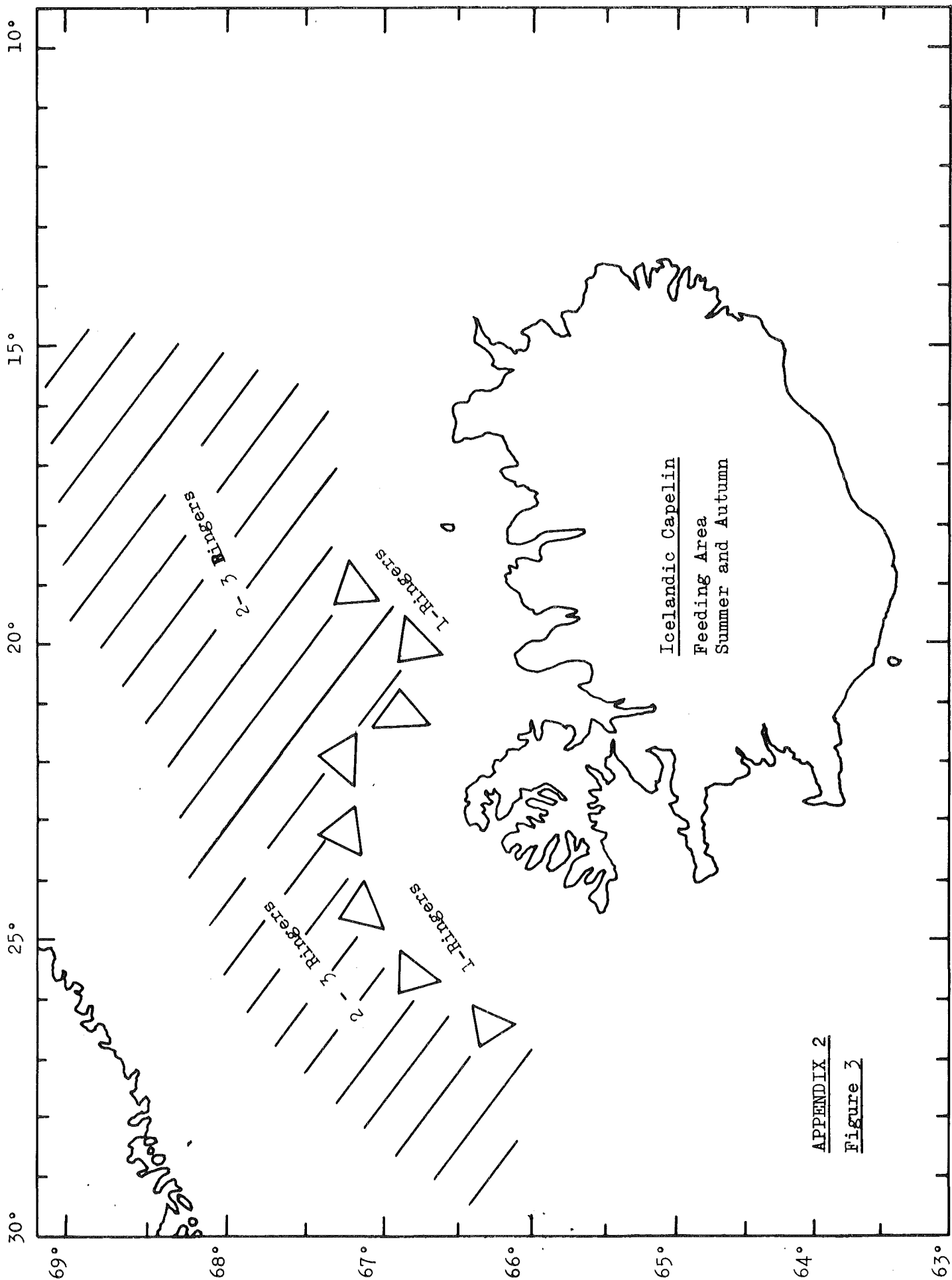
| Year | Coastal off S & SW Iceland February-April | Offshore off E, NE and N Iceland January & February | Offshore off N and NW Iceland July-December | Total Catch |
|------|---|---|---|-------------|
| 1964 | 8.6 | | | 8.6 |
| 1965 | 49.7 | | | 49.7 |
| 1966 | 124.5 | | | 124.5 |
| 1967 | 97.2 | | | 97.2 |
| 1968 | 78.1 | | | 78.1 |
| 1969 | 170.6 | | | 170.6 |
| 1970 | 188.8 | 2.0 | | 190.8 |
| 1971 | 182.9 | | | 182.9 |
| 1972 | 276.5 | | | 276.5 |
| 1973 | 345.3 | 95.6 | | 440.9 |
| 1974 | 433.8 | 28.1 | | 461.9 |
| 1975 | 335.6 | 122.0 | 3.1 | 460.7 |
| 1976 | 252.1 | 86.6 | 111.4 | 450.1 |
| 1977 | 300.0 | 245.0 | | |

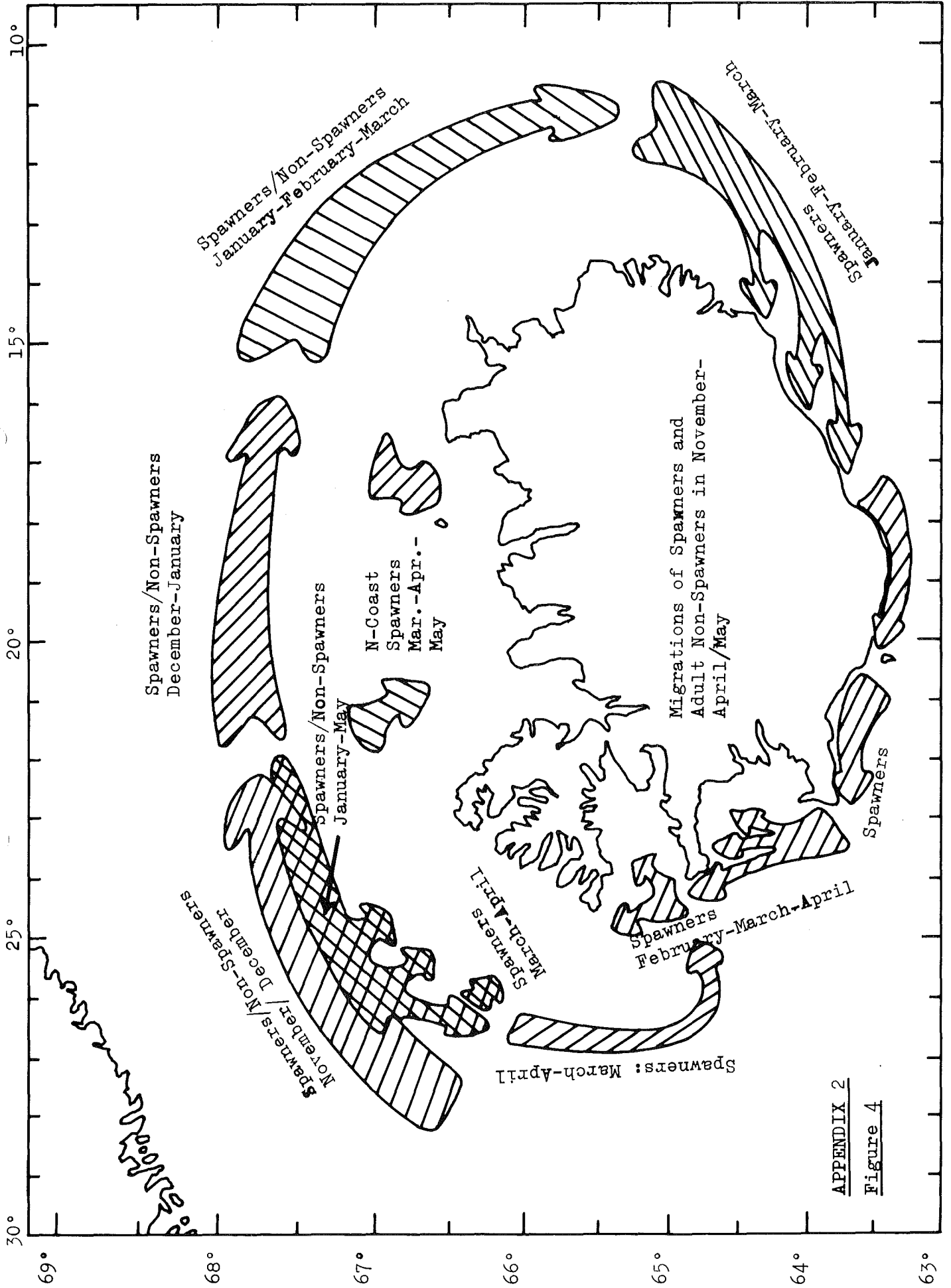


APPENDIX 2
Figure 1

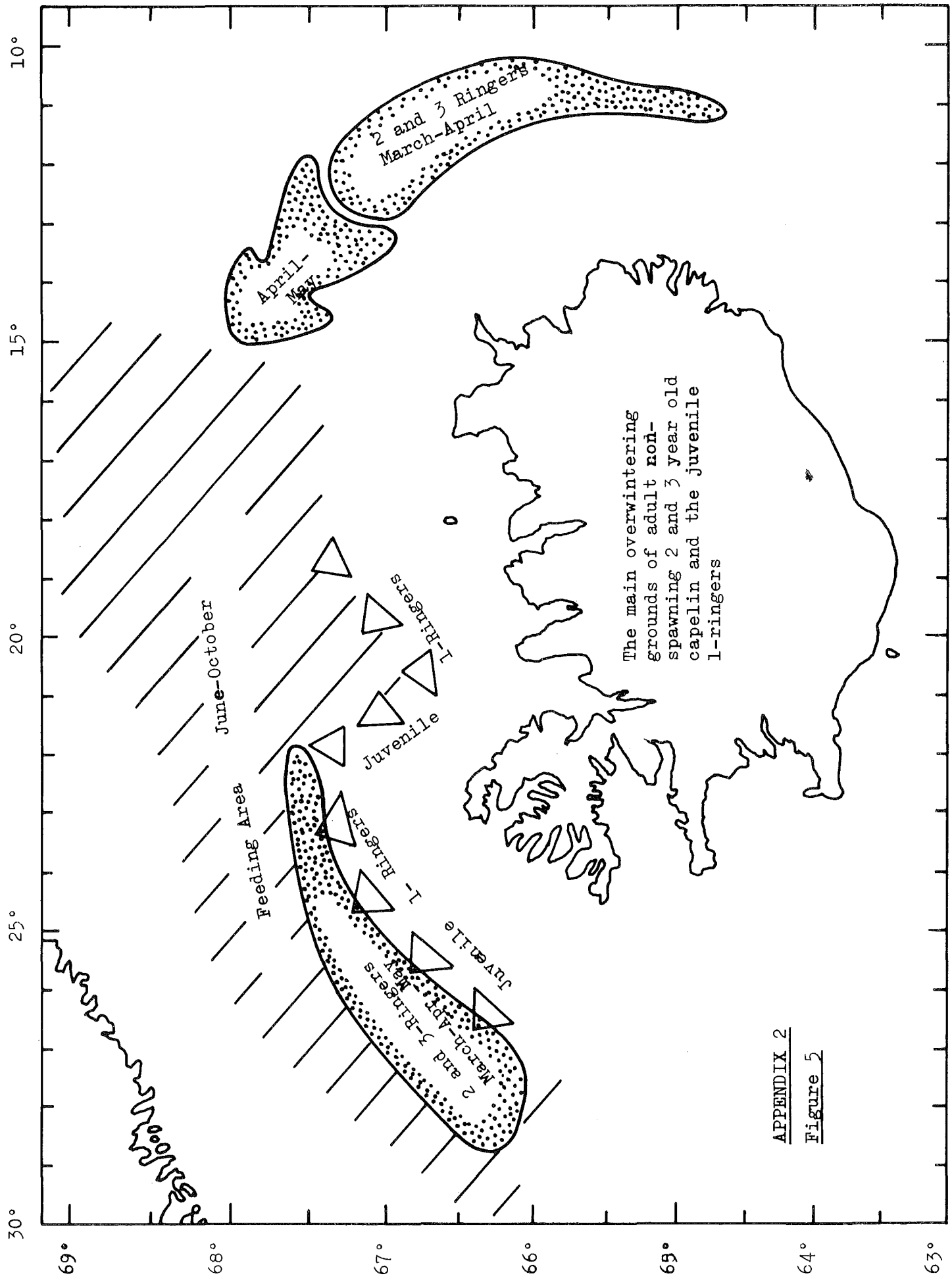


APPENDIX 2
Figure 2.





APPENDIX 2
Figure 4



APPENDIX 2
Figure 5

PROVISIONAL INFORMATION AND DATA FOR ALLOCATION OF RESOURCES
UNDER THE NEW EXTENDED NATIONAL FISHERIES JURISDICTION REGIME

A. NORWEGIAN SPRING SPAWNING HERRING

1. General biology

1.1. Spawning times and areas

From the beginning of this century and up to about 1955 the main spawning took place off the coast of western Norway, between Egersund and Stadt. From 1955 and onwards the main spawning gradually took place farther north off Møre and Trøndelag. However, spawning also took place off Helgeland and especially in recent years as far north as off Lofoten. Since 1955 the spawning time changed from January or February to March. In the 60s some spawning also occurred on the Sandø-bank, east of Faroes (Jakobsson, 1970). The changes in spawning grounds during the period 1950-68 are shown in Figures 1-3.

1.2 Larval, post-larval and juvenile fish distribution

The larvae from the Norwegian spawning grounds are transported northward with the coastal currents. The larval stage lasts for about 2 months, and during that time some larvae will drift into fjords and bays on the Norwegian coast, but some will remain in the outer coastal areas until metamorphosis.

The 0-group in the coastal areas migrate into the fjords in autumn, but in years with large 0-group abundance the distribution of the 0-group was very widespread and ranged from the fjords of western and northern Norway to the open ocean of the Norwegian Sea and the Barents Sea (DRAGESUND, 1970). However, in the last 10 years, oceanic 0-group herring have only been found in significant numbers in 1973 and 1976, and the main nursery area of the young herring has been the Norwegian coastal waters. The Working Group had no information on distribution of larvae and juvenils from the spawning on Sandøy bank.

1.3. Distribution and migration of young and adult stock components

As 1 and 2-group the herring feed in Norwegian coastal areas and in the SW Barents Sea. During periods of exceptionally high abundance these age groups had a much wider distribution. Young herring from the southern coastal areas usually accumulated as 1 or 2 years old fish in the area Helgeland - Troms. Young herring in Finnmark usually spent one more year in the coastal areas before they began their migration to the Norwegian Sea to join the adult stock.

Traditionally, the adult herring migrated from the spawning grounds on the Norwegian coast to the summer feeding grounds in the Iceland - Jan Mayen area (Fridriksson, 1944; Devold, 1963). In the late 1960s the main feeding grounds moved further north and east to the Jan Mayen - Bear Island area. During autumn the adult herring concentrated in an area east of Iceland, where they remained until January when the migrations to the spawning areas at the Norwegian coast began. The changes in migration pattern of the adult herring during the period 1950-68 are shown in Figures 1-3.

In the 1970s, the migration pattern has changed drastically. Both the juvenile and adult herring have remained in Norwegian coastal waters throughout the year.

2. Exploitation and management

2.1. The fisheries

Traditionally the main fishery on the adult stock has taken place along the Norwegian coast prior to and during the spawning season (the winter herring fishery) and on the feeding grounds off North and East Iceland as well as in the oceanic areas between Iceland and Jan Mayen (the summer and autumn herring fishery). The catches in each of these fisheries are given by countries in Tables 1-3.

In addition to the fishery on adults there has been a fishery on young and adolescent herring in the Norwegian fjords and coastal areas, mainly in northern Norway. This fishery was based on small-herring (mainly 0- and I-group) and fat-herring (mainly I- to IV-group). Total catches in the different fisheries during the period 1950 - 1976 are shown in Table 4.

2.2. Rate of exploitation and changes in stock size

The exploitation of Norwegian spring spawning herring during the period 1950 - 1974 has been described in previous working group reports and by DRAGESUND and ULLTANG (1975). A brief summary is given below.

Total catch of adult herring has fluctuated widely corresponding to recruitment of strong year-classes. Thus, the very strong 1950 year-class caused high catches in the adult herring fisheries in the mid-1950s and the strong year-classes of 1959 and 1960 resulted in high catches level the years 1964 - 1967. The high catches in the latter period were associated with a sharp increase in the fishing mortalities mainly due to increased effort generated in the summer and autumn herring. Prior to 1963 the fishing mortalities were at a rather low constant level (Figure 4).

During the whole period 1950 - 1970 the exploitation rate on young herring was high, and it has been demonstrated a clear correlation between year-class strength and fishing mortalities. The purse seine fishery in Norwegian coastal waters generated much higher fishing mortalities on weak or moderate year-classes than on strong ones, and weak or moderate year-classes survived the fishery in only very small quantities to an age of 4 years old. The 1961 year-class was the last one which recruited the spawning stock in any quantities. Some fish of the 1963 and 1964 year-classes survived to an age of 4 years, but these were, however, practically fished out in the fat-herring fishery in 1968 off the coast of Finnmark. Thus, there was practically no recruitment to the adult stock after 1966. This inevitably resulted in the decline in adult stock size (Fig.5). The decline was accelerated by the increased exploitation of the adult component.

2.3. Management

The almost complete collapse of the stock was already a reality before management actions were taken.

In 1972 - 1974 the fishery was regulated by an agreement between Iceland, Norway and USSR. There were no catches of adult herring

apart from some small quantities taken for scientific purposes, and the catches of small- and fat-herring were limited by catch quotas. In 1975 and 1976 the fishery has been regulated by a NEAFC agreement. In 1975 a TAC of 3 500 tons was set and in 1976 no commercial fishery was permitted.

2.4. Long-term sustainable yield

No firm estimate of the long-term sustainable yield has ever been made. The mean annual catch in the period 1950 - 1959 was 1 264 thousand tons, and the stock was still in a healthy state at the beginning of the 1960s. The long-term yield, however, is very dependent on the pattern of exploitation. With a lower exploitation rate on young herring, the stock could have sustained a higher catch than the above-mentioned mean catch. With a rational exploitation pattern there therefore reasons to believe that the long-term sustainable yield will be of the order of at least 1 500 000 tons.

3. Distribution of catches in relation to Economic Zones

Nearly all the catches in the winter herring and small- and fat-herring fisheries (Table 4) have been taken within the Norwegian zones. These catches have been plotted as percentage of total catches for the different years in the period 1950 - 1970 in Figure 6 . The rest of the catches (catches from the summer and autumn herring fisheries) have partly been taken within the Icelandic zone and partly further northeast in the Jan Mayen - Bear Island area. The proportion taken within the Icelandic zone has varied between periods. During the period 1950 - 1962 a large part of the summer and autumn herring fishery was going on within the Icelandic zone, while in 1963 - 1966 the fishery also took place in the Jan Mayen - Bear Island area, as a result of the shift in the location of the feeding areas described in section 1. This was especially pronounced in 1967-69. During the spawning migration, some catches were also taken in the Faroe zone. Since 1970 all catches of Norwegian spring spawning herring have been taken within the Norwegian zone.

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APPENDIX 3

Table 1. Summer and autumn fishery (Norwegian spring spawners).

Catch (in thousands of tons)
of adult non-spawning herring 1950 - 1970.

| Year | Iceland | Norway | USSR | Faroes | Germany | Total |
|------|---------|--------|-------|--------|---------|---------|
| 1950 | 30.7 | 10.1 | 14.0 | - | - | 54.8 |
| 1951 | 48.9 | 14.3 | 41.7 | - | - | 104.9 |
| 1952 | 9.2 | 19.6 | 61.0 | - | - | 89.8 |
| 1953 | 31.5 | 22.1 | 101.5 | 16.2 | - | 171.3 |
| 1954 | 15.2 | 11.4 | 133.3 | 27.4 | - | 187.3 |
| 1955 | 18.1 | 13.9 | 168.2 | 12.9 | - | 213.1 |
| 1956 | 41.2 | 14.8 | 188.8 | 23.0 | - | 267.8 |
| 1957 | 18.2 | 17.5 | 239.9 | 16.2 | - | 291.8 |
| 1958 | 22.6 | 11.4 | 306.1 | 15.8 | - | 355.9 |
| 1959 | 34.5 | 10.5 | 314.9 | 13.0 | - | 372.9 |
| 1960 | 26.7 | 18.3 | 365.7 | 9.4 | - | 420.1 |
| 1961 | 85.0 | 42.0 | 207.7 | 16.9 | - | 351.6 |
| 1962 | 176.2 | 72.1 | 159.6 | 9.8 | - | 417.7 |
| 1963 | 177.5 | 68.9 | 278.7 | 12.9 | - | 538.0 |
| 1964 | 367.4 | 80.1 | 231.9 | 18.3 | - | 697.7 |
| 1965 | 540.0 | 33.1 | 324.4 | 31.5 | 5.6 | 934.6 |
| 1966 | 691.4 | 37.0 | 296.6 | 44.0 | 22.7 | 1 091.7 |
| 1967 | 359.3 | 52.1 | 236.2 | 17.7 | 7.4 | 672.7 |
| 1968 | 75.2 | 30.1 | 111.3 | 10.6 | 1.1 | 228.3 |
| 1969 | 0.1 | 0.7 | 0.5 | 2.0 | 0.3 | 3.6 |
| 1970 | 0.0 | 0.0 | >0.1 | 0.0 | 0.0 | >0.1 |

This fishery took place mainly in the feeding and wintering areas as shown in Figures 1-3.

From Coop.Res.Rep., No.30.

APPENDIX 3

Table 2. Winter fishery. (Norwegian spring spawners).

Catch (in thousands of tons)
of Norwegian winter herring 1950 - 1970.

| Year | Norway | USSR | Faroes | Iceland | Germany | Total |
|------|---------|-------|--------|---------|---------|---------|
| 1950 | 771.3 | - | - | - | - | 771.3 |
| 1951 | 888.0 | 1.3 | - | - | - | 889.3 |
| 1952 | 820.5 | 8.9 | - | - | - | 829.4 |
| 1953 | 670.1 | 8.5 | - | - | - | 678.6 |
| 1954 | 1 092.2 | 26.7 | 0.2 | - | - | 1 119.1 |
| 1955 | 965.4 | 38.8 | 0.2 | - | - | 1 004.4 |
| 1956 | 1 145.9 | 46.2 | 0.7 | - | - | 1 192.8 |
| 1957 | 795.6 | 60.1 | 0.8 | - | - | 856.5 |
| 1958 | 345.3 | 81.9 | 1.9 | - | - | 429.1 |
| 1959 | 416.4 | 93.1 | 0.7 | - | - | 510.2 |
| 1960 | 300.1 | 99.3 | 1.6 | - | - | 401.0 |
| 1961 | 69.6 | 77.3 | - | - | - | 146.3 |
| 1962 | 84.1 | 49.4 | - | - | - | 133.5 |
| 1963 | 61.5 | 71.3 | - | - | - | 132.8 |
| 1964 | 286.3 | 133.9 | - | - | - | 420.2 |
| 1965 | 226.4 | 164.8 | - | - | - | 391.2 |
| 1966 | 460.9 | 150.8 | 16.7 | - | 3.4 | 631.8 |
| 1967 | 371.6 | 67.7 | 17.2 | - | 2.3 | 458.8 |
| 1968 | 25.6 | 13.0 | 5.5 | - | 0.7 | 44.8 |
| 1969 | 14.9 | 2.7 | 2.4 | 0.5 | 0.0 | 20.5 |
| 1970 | 20.3 | 0.0 | 0.6 | 0.0 | 0.0 | 20.9 |

This fishery took place mainly in the spawning areas as shown in Figures 1-3.

From Coop.Res.Rep., No.30.

APPENDIX 3

Table 3. Total catch.

Catch (in thousands of tons) of adult and pre-recruit
Norwegian spring spawning herring 1950 - 1970

| Year | Iceland | Norway | USSR | Faroes | Germany | Total |
|------|---------|---------|-------|--------|---------|---------|
| 1950 | 30.7 | 781.4 | 14.0 | - | - | 826.1 |
| 1951 | 48.9 | 902.3 | 43.0 | - | - | 994.2 |
| 1952 | 9.2 | 840.1 | 69.9 | - | - | 919.2 |
| 1953 | 31.5 | 692.2 | 110.0 | 16.2 | - | 849.9 |
| 1954 | 15.2 | 1 103.6 | 160.0 | 27.6 | - | 1 306.4 |
| 1955 | 18.1 | 979.3 | 207.0 | 13.1 | - | 1 217.5 |
| 1956 | 41.2 | 1 160.7 | 235.0 | 23.7 | - | 1 460.6 |
| 1957 | 18.2 | 813.1 | 300.0 | 17.0 | - | 1 148.3 |
| 1958 | 22.6 | 356.7 | 388.0 | 17.7 | - | 785.0 |
| 1959 | 34.5 | 426.9 | 408.0 | 13.7 | - | 883.1 |
| 1960 | 26.7 | 318.4 | 465.0 | 11.0 | - | 821.1 |
| 1961 | 85.0 | 111.0 | 285.0 | 16.9 | - | 497.9 |
| 1962 | 176.2 | 156.2 | 209.0 | 9.8 | - | 551.2 |
| 1963 | 177.5 | 130.4 | 350.0 | 12.9 | - | 670.8 |
| 1964 | 367.4 | 366.4 | 365.8 | 18.3 | - | 1 117.9 |
| 1965 | 540.0 | 259.5 | 489.2 | 31.5 | 5.6 | 1 325.8 |
| 1966 | 691.4 | 497.9 | 447.4 | 60.7 | 26.1 | 1 723.5 |
| 1967 | 359.3 | 423.7 | 303.9 | 34.9 | 9.7 | 1 131.5 |
| 1968 | 75.2 | 55.7 | 124.3 | 16.1 | 1.8 | 273.1 |
| 1969 | 0.6 | 15.6 | 3.2 | 4.4 | 0.3 | 24.1 |
| 1970 | 0.0 | 20.3 | 0.0 | 0.6 | 0.0 | 20.9 |

From Coop.Res.Rep., No.30.

APPENDIX 3

Table 4

Catches (in thousand tons) of Norwegian spring spawning herring during the period 1950-1976.

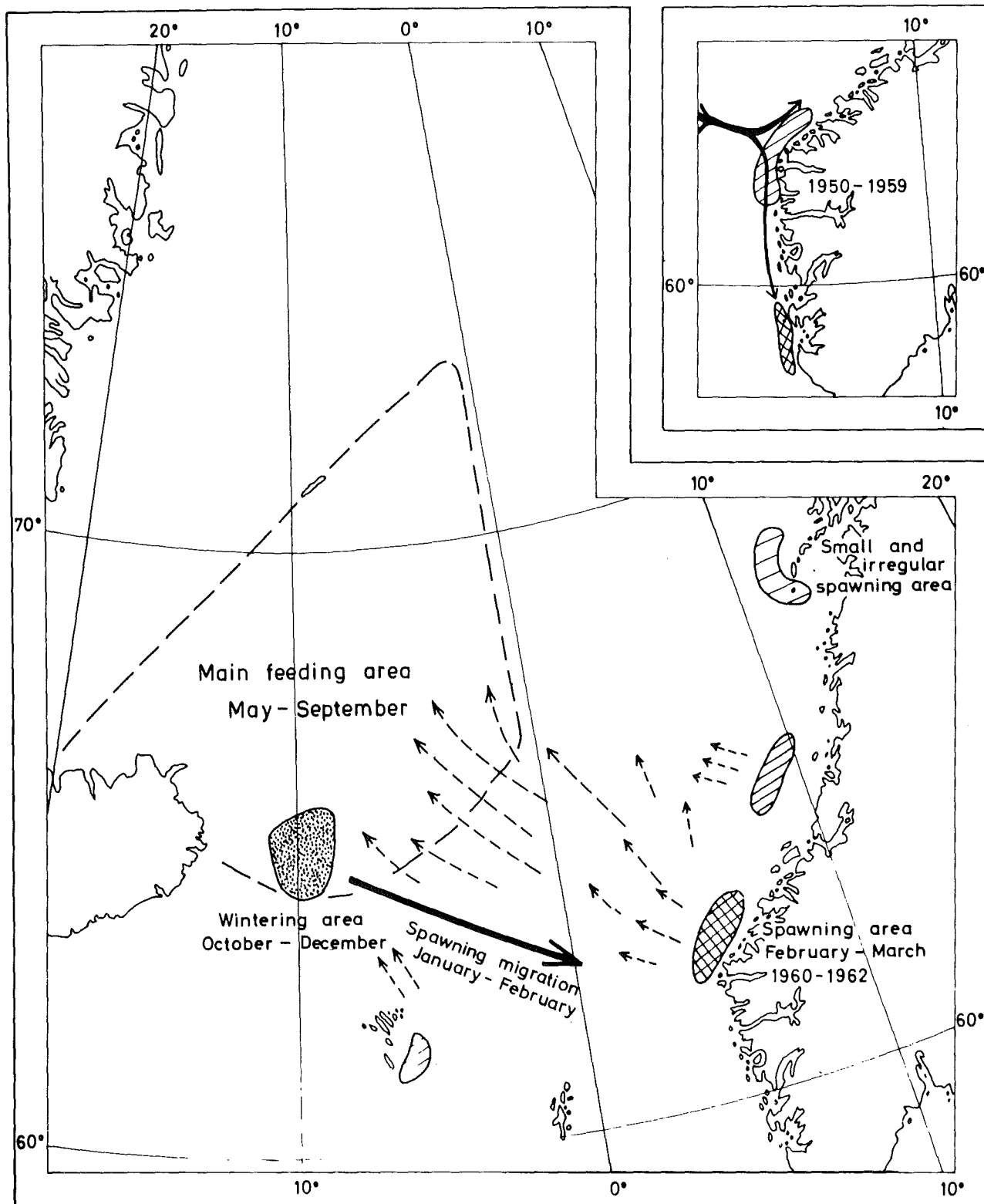
| Year | Winter herring | Summer and autumn herring | Total adult herring | Small and fat herring | Grand Total |
|------|----------------|---------------------------|---------------------|-----------------------|-------------------|
| 1950 | 771.3 | 54.8 | 826.1 | 106.9 | 933.0 |
| 1951 | 889.3 | 104.9 | 994.2 | 284.2 | 1 278.4 |
| 1952 | 829.4 | 89.8 | 919.2 | 335.6 | 1 254.8 |
| 1953 | 678.6 | 171.3 | 849.9 | 240.7 | 1 090.6 |
| 1954 | 1 119.1 | 187.3 | 1 306.4 | 338.1 | 1 644.5 |
| 1955 | 1 004.4 | 213.1 | 1 217.5 | 142.3 | 1 359.8 |
| 1956 | 1 192.8 | 267.8 | 1 460.6 | 198.8 | 1 659.4 |
| 1957 | 856.5 | 291.8 | 1 148.3 | 171.2 | 1 319.5 |
| 1958 | 429.1 | 355.9 | 785.0 | 201.6 | 986.6 |
| 1959 | 510.2 | 372.9 | 883.1 | 228.0 | 1 111.1 |
| 1960 | 401.0 | 420.1 | 821.1 | 280.7 | 1 101.8 |
| 1961 | 146.3 | 351.6 | 497.9 | 332.2 | 830.1 |
| 1962 | 133.5 | 417.7 | 551.2 | 297.4 | 848.6 |
| 1963 | 132.8 | 538.0 | 670.8 | 313.7 | 984.5 |
| 1964 | 420.2 | 697.7 | 1 117.9 | 163.9 | 1 281.8 |
| 1965 | 391.2 | 934.6 | 1 325.8 | 221.9 | 1 547.7 |
| 1966 | 631.8 | 1 091.7 | 1 723.5 | 231.5 | 1 955.0 |
| 1967 | 458.8 | 672.7 | 1 131.5 | 545.7 | 1 677.2 |
| 1968 | 44.8 | 228.3 | 273.1 | 439.1 | 712.2 |
| 1969 | 20.5 | 3.6 | 24.1 | 43.7 | 67.8 |
| 1970 | 20.9 | - | 20.9 | 41.4 | 62.3 |
| 1971 | 6.9 | - | 6.9 | 14.2 | 21.1 |
| 1972 | - | - | - | 13.2 | 13.2 |
| 1973 | - | - | - | 6.8 | 6.8 |
| 1974 | - | - | - | 6.3 | 6.3 |
| 1975 | - | - | - | 3.1 ¹⁾ | 3.1 ¹⁾ |
| 1976 | - | - | - | - | - |

1) The catch in 1975 consists of adult and juvenile herring caught in Norwegian inshore waters during autumn.

From Coop.Res.Rep., No.30 and Norwegian national statistics.

Norwegian Spring-Spawners

Migration routes 1950 - 1962

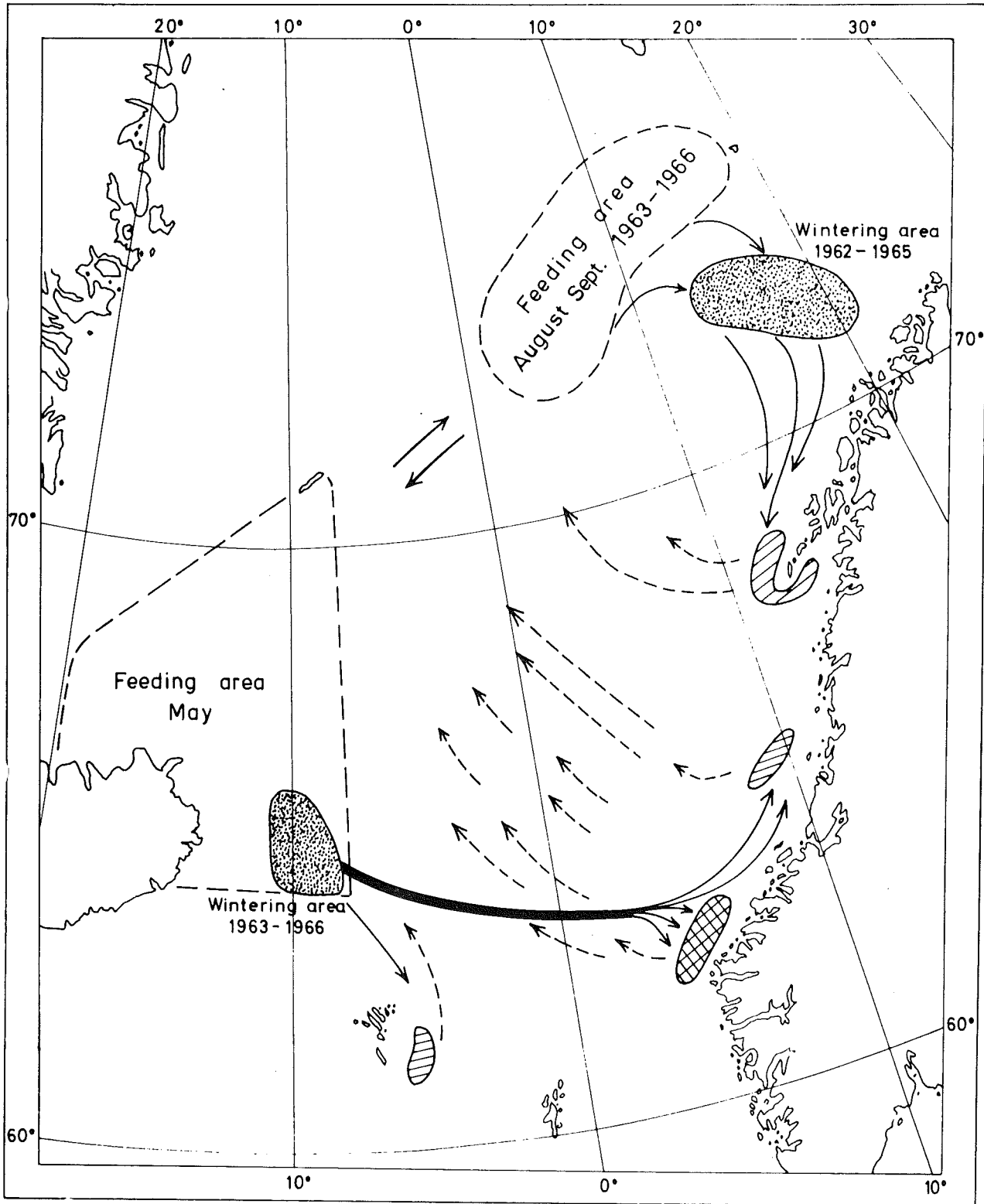


APPENDIX 3. Figure 1

From Coop.Res.Rep., No.17

Norwegian Spring-Spawners

Migration routes 1963 - 1966

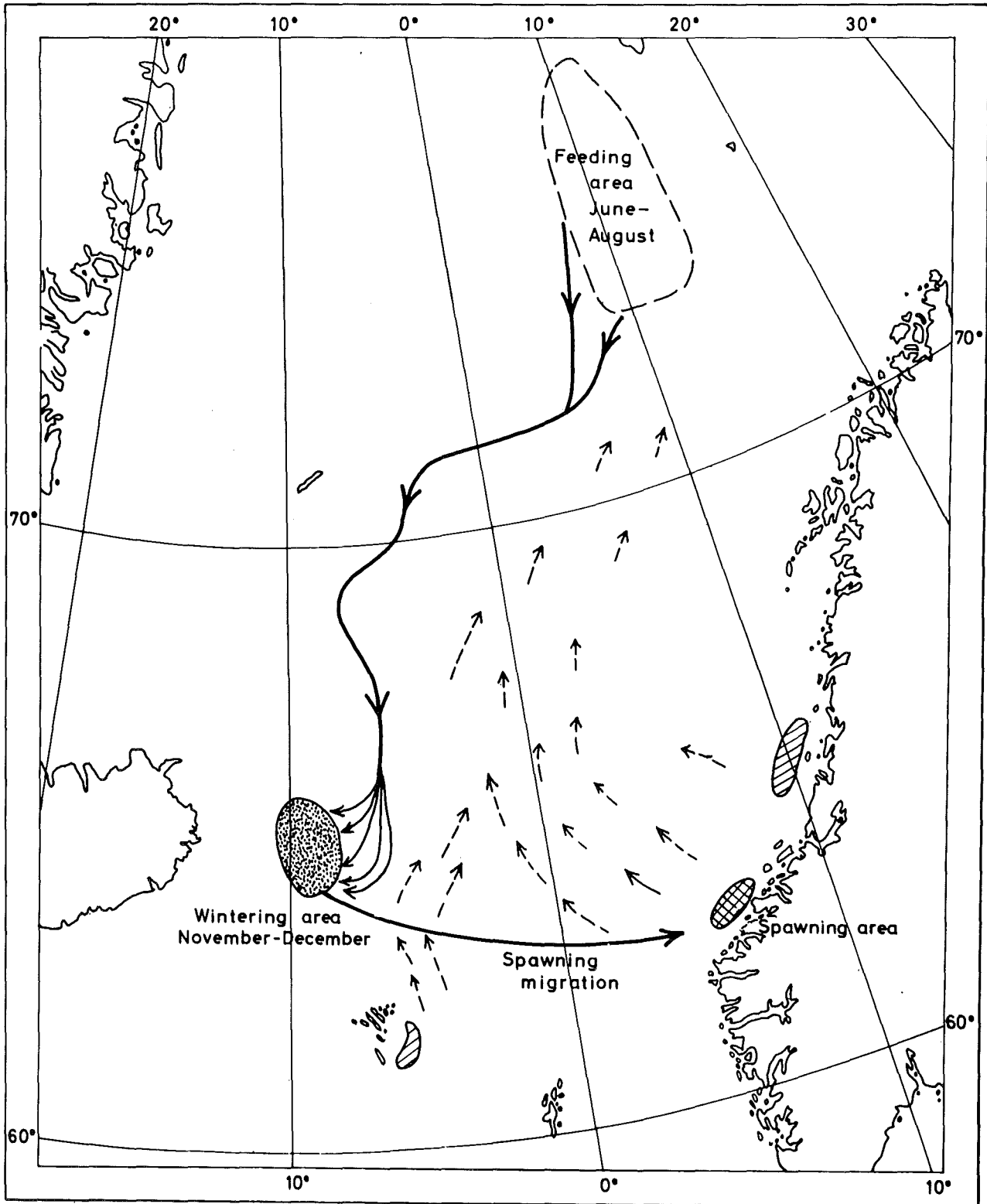


APPENDIX 3. Figure 2.

From Coop.Res.Rep., No.17

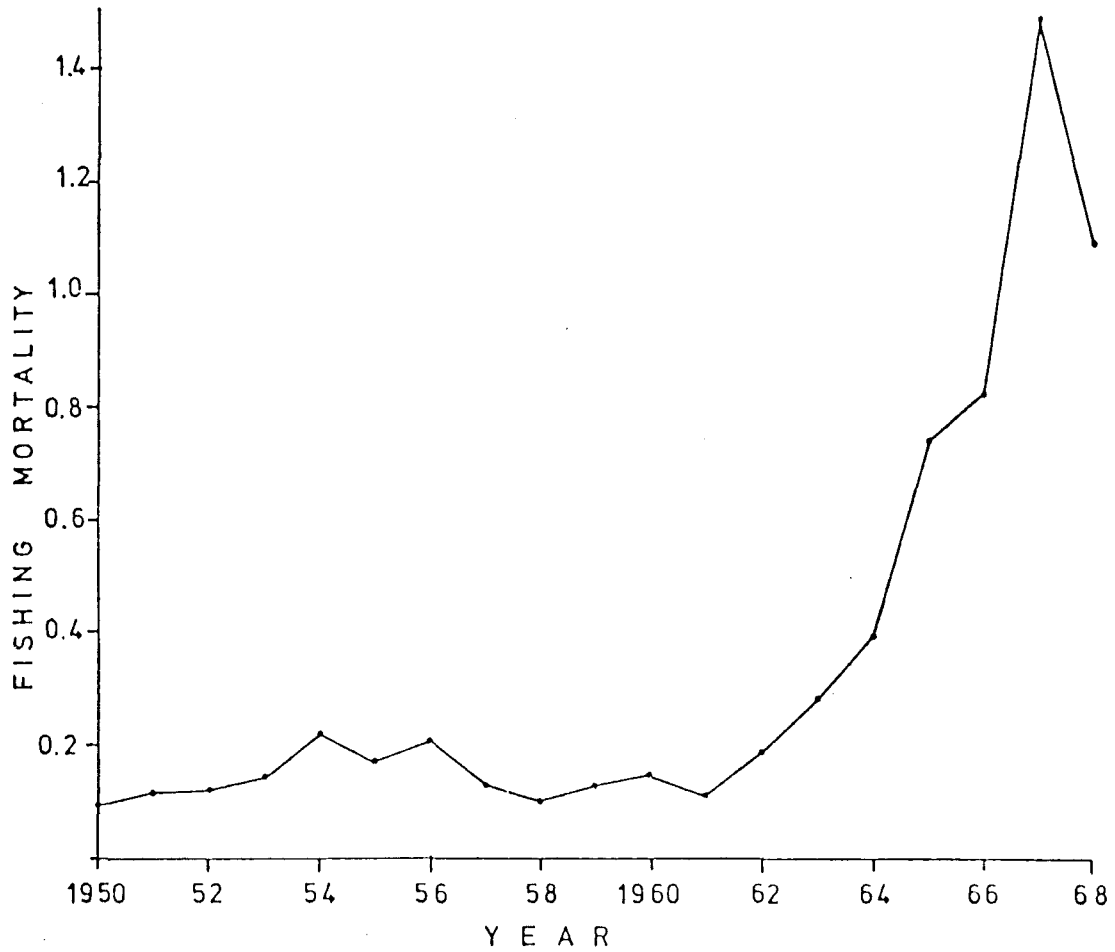
Norwegian Spring-Spawners

Migration routes 1967 - 1968



APPENDIX 3. Figure 3.

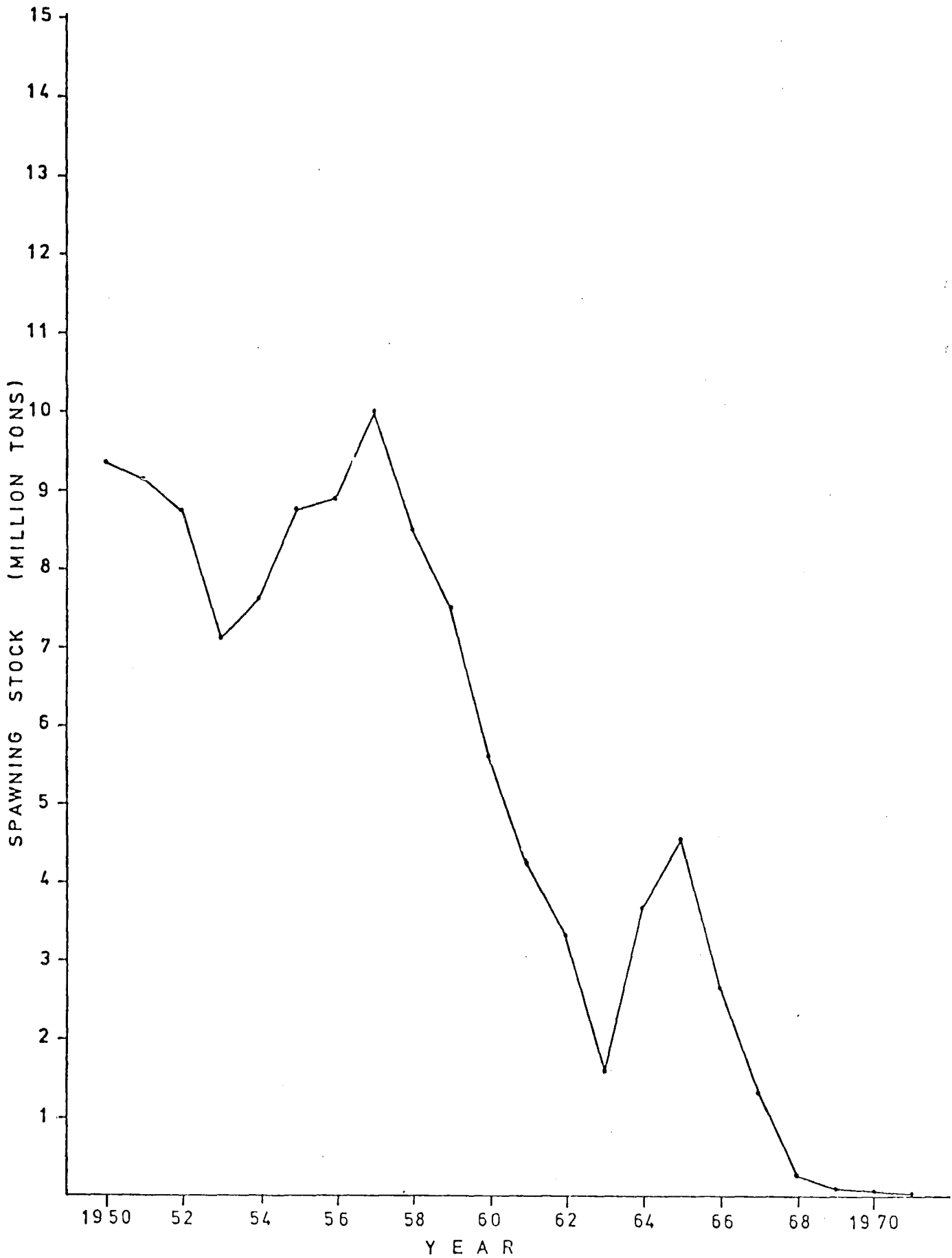
From Coop.Res.Rep., No.17



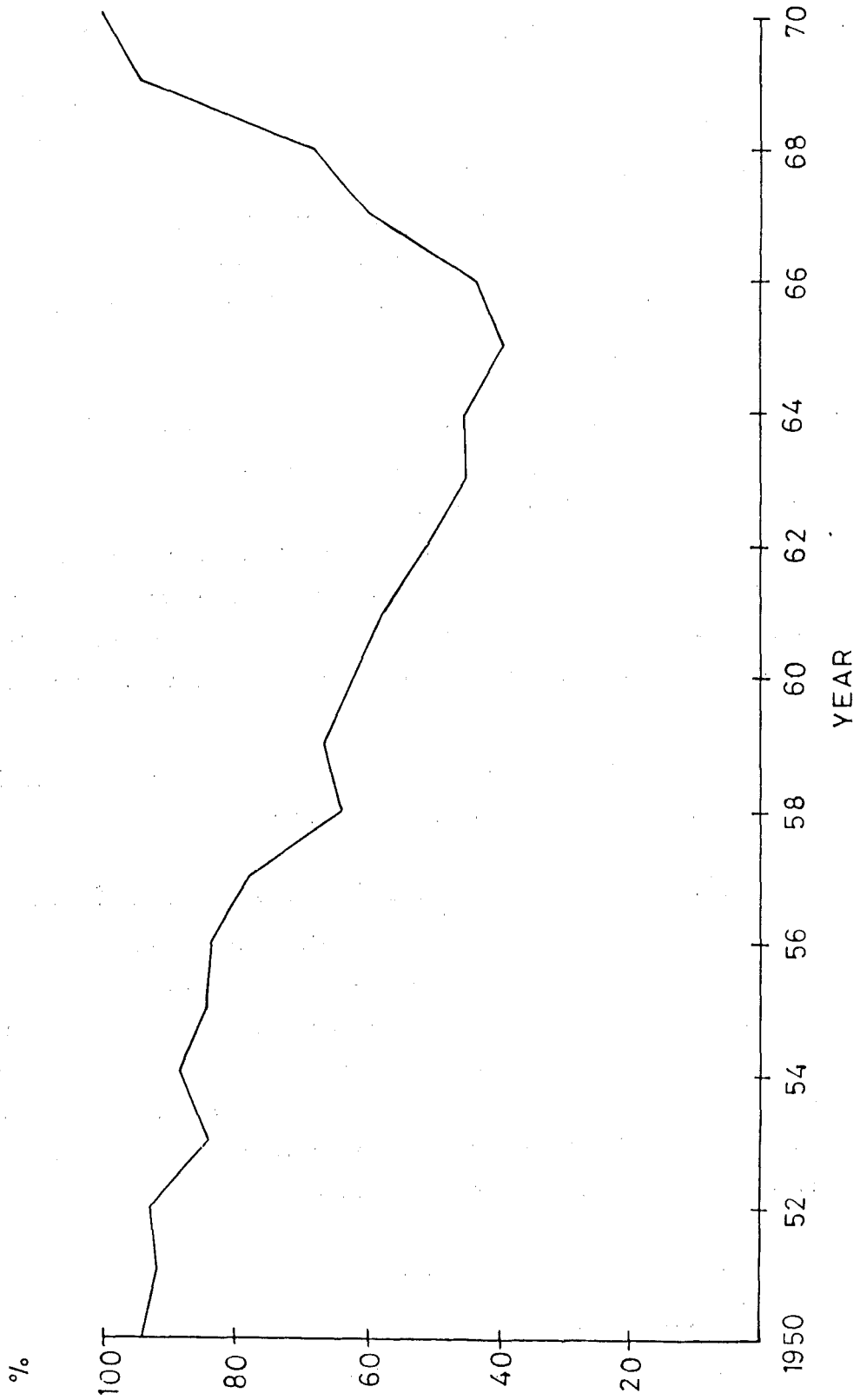
APPENDIX 3. Figure 4.

Norwegian spring spawners. Fishing mortality on 7 year old and older herring.

(from Dragesund and Ulltang, 1975)



APPENDIX 3. Figure 5. Norwegian spring spawning herring.
Spawning stock size in weight.
(from Dragesund and Ulltang, 1975).



APPENDIX 3. Figure 6. Norwegian spring spawning herring. Percentage of total catch taken in the winter herring and small- and fat herring fisheries.

Provisional information and data for allocation
of resources under the new extended national
fisheries jurisdiction regime

B. ICELANDIC SPRING SPAWNING HERRING

1.1 Spawning time and area

The Icelandic spring spawners spawn mainly during the second half of March and the first half of April. During the period of normal abundance the spawning localities were distributed at various places along the south and southwest coast of Iceland as shown on Fig. 1. During the recent period of depletion spawning concentrations have occasionally been located on the spawning grounds near Vestmann Islands. Other spawning localities have probably not been used recently.

1.2. Larval, post-larvel and juvenile fish distribution

The larvae and post-larvae from the spawning grounds near the Vestmann Islands and further west drift along the southwest coast and up north along the west coast and the juvenile fish spend two first winters in the fjords along the west and north coast of Iceland. The larvae from spawning grounds near the southeast corner of Iceland probably drift to the east coast and the herring spend their first winter in the southern east coast fjords of Iceland.

In their third year the herring recruit to the adult stock although they do not generally reach maturity until at the age of four.

1.3.c Distribution and migrations of young and adult stock components

The adult herring are found at the south coast of Iceland in January and February before segregating to the various spawning grounds. After spawning the herring migrate to the feeding grounds off the north coast where they were mixed with Norwegian spring spawners. Towards autumn the stocks segregated. While the Norwegian component assembled in the cold east Icelandic current, the Icelandic spring spawners returned to the warmer waters off the western and southeastern coast of Iceland.

2. Exploitation and management

2.1. The Fisheries

The Icelandic spring spawning herring have traditionally been caught in the north and south coast purse seine and drift net fishery. During the

period 1950 to 1955 the total catch of Iceland spring spawns was between 20 000-25 000 tons. After 1955 the catch reached to a maximum of 274 000 tons in 1962. After 1962 the total catch decreased sharply until 1970 which was the last year when any appreciable catch was taken.

2.2 Rate of exploitation and changes in stock size

During of the period up to 1958 the exploitation rate of the Icelandic spring spawning herring was very low. After 1958 exploitation rate rose very sharply and remained at a high level until the collapse of the stock in the late sixties. During the fifties the biomass of the adult stock was about 800 000 - 1.000 000 tons but declined sharply during the sixties. The long term yield is estimated at about 50 000 tons.

Regulatory measures applied to the stock are identical to that applied to the Icelandic summer spawners. These are described in the section 2-3 on the Icelandic summer spawners.

3. Nominal catch in relations to zones and their historical changes

The nominal catch of the Icelandic spring spawners is given in Table 1. This catch is divided between the south and the north coast fishery. The two fishing areas concerned are both within the Icelandic fisheries zone.

C. ICELANDIC SUMMER SPAWNERS

1.1 Spawning times and areas

The Icelandic summer spawners spawn mainly during July although some spawning may occur in June and as late in September. The spawning areas are shown in Fig. 1.

1.2. Larval, post-larval and juvenile fish distribution

The larval drift of the summer spawning herring follow a similar pattern as that of the spring spawners. During the first winter the summer spawners remain in post-larval state very close inshore at the west and north coast. The distribution of the juvenile fish is also similar to that of the spring spawners, namely that they spend their first two years of life in inshore waters along the northwest, north and east coast, but recruit to the adult stock as one and two ringers when they migrate to the south coast of Iceland. They remain in these waters until they reach maturity as three ringed fish, i. e. four year old fish.

1. 3. Distribution and migration of young and adult stock components

After spawning the adult fish migrate to the feeding grounds off western and eastern Iceland. In the autumn they concentrate at southwest Iceland and used to mix with the spring spawning component throughout the last three months of the year. In recent years, however, the summer spawners have migrated eastwards along the south coast of Iceland at the end of September and the beginning of October and assembled off the eastern south coast in late October. They have concentrated in inshore waters in November-December and January. In the early spring they have again scattered along the various parts of the south coast especially off the western south coast before assembling on the spawning grounds in July.

2. Exploitation and management

2. 1. The Fisheries

The summer spawners were mainly exploited by the south coast drift net fishery. Up to 1955 they made up about 50 % of the catches. During the late fifties the total catch of the summer spawners was about 30 000 tons, When purse seining started at the south coast in 1960 the total catch of summer spawners increased sharply and reached a maximum of 130 000 tons in 1963-(Table 2). The catch remained high until 1965 but fell drastically thereafter until the fishery was stopped measures by regulation at the end of 1971.

Catches in recent years have been taken according to catch quotas.

2. 2 Rate of exploitation and changes in stock size

The rate of exploitation increased sharply during the sixties. In addition the fishing pattern changed as a result of the introduction of purse seining resulting in high exploitation of prerecruits in the sixties.

During the period 1960 to 1977 the biomass of the spawning stock is shown in Figure 2. The long-term yield of the summer spawners is estimated at about 50 000 tons.

2. 3. Management

In 1966 a minimum landing size of 23 cm was introduced for all herring fishing in Icelandic waters. In 1968 it was increased to 25 cm and in 1975 it was increased further to 27 cm.

In 1968 there was a closed seasons from 1. March - 15th August.

In 1969 - 1971 the closed season covered the period 1 February - 1 September each year.

In 1968-1970 a TAC of 50 000 tons was set. In 1971 this was reduced to 25 000 tons.

On the 1. February 1972 herring fishing was forbidden with all other gears than driftnets.

this ban was in force until 1975 when a TAC for purse seining was set at 7500 tons. This TAC was allocated to about 50 boats which in fact took 9200 tons. The fishing season was restricted to 15th September to 1 December.

In 1976 a TAC of 10 000 tons was set for the purse seine fishery. Again this TAC was allocated to about 50 purse seiners, which in fact took 10034 tons. The fishing seasons was restricted to the period 25th September- 25 November. In 1976 the prize of any excess catches would have been confiscated by the state and excess catches in 1975 were subtracted from individual allocations in 1976

3. Nominal catch and fishing effort statistics in the relation to zones and their historical changes

The catches of summer spawning herring are shown in Table 2. These catches are allocated to the north and south coast fishery and it will be seen that by far the major part of each catches are taken at the south coast. Since the south coast fishery is an inshore fishery usually taking place less than twelve miles of the coast especially in later years there has been practically no participation by non-Icelandic vessels in the exploitation of this stock during the period in question.

APPENDIX 3

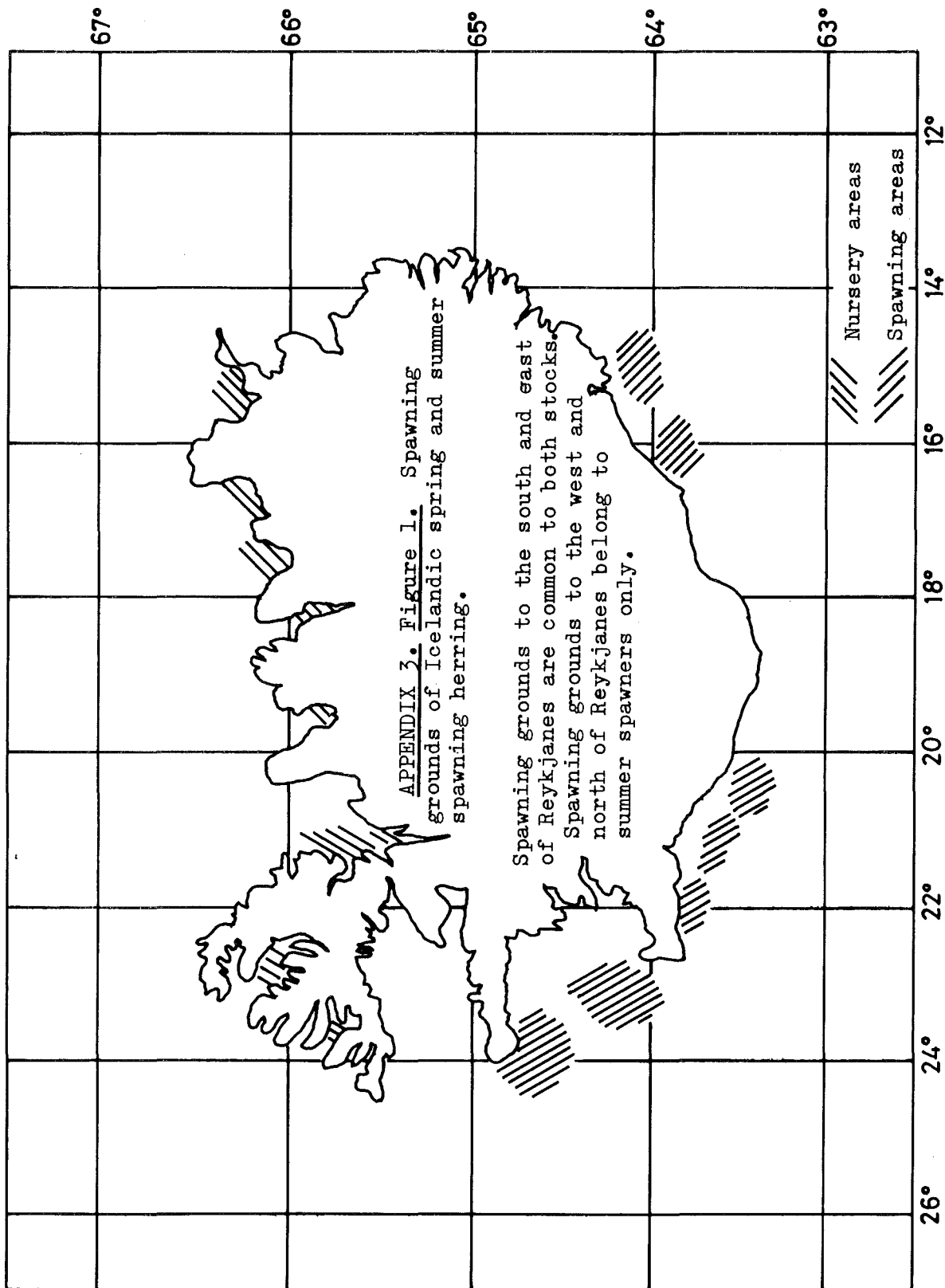
Table 1. Total catch of Icelandic spring spawners

| | North coast | South coast | Total |
|------|-------------|-------------|-------|
| 1950 | 5.5 | 22.2 | 24.7 |
| 51 | 8.2 | 12.0 | 20.2 |
| 52 | 1.1 | 11.2 | 12.3 |
| 53 | 7.3 | 13.1 | 20.4 |
| 54 | 10.4 | 10.7 | 21.1 |
| 55 | 11.4 | 10.0 | 21.4 |
| 56 | 27.4 | 20.4 | 47.8 |
| 57 | 69.0 | 13.5 | 82.5 |
| 58 | 72.9 | 10.8 | 83.7 |
| 59 | 135.2 | 14.7 | 149.9 |
| 1960 | 98.8 | 19.0 | 117.8 |
| 61 | 169.5 | 42.0 | 211.5 |
| 62 | 220.3 | 59.9 | 274.2 |
| 63 | 71.4 | 32.9 | 104.3 |
| 64 | 65.2 | 36.3 | 101.5 |
| 65 | 25.2 | 43.7 | 68.9 |
| 66 | 13.7 | 11.3 | 25.0 |
| 67 | 2.4 | 12.9 | 15.3 |
| 68 | 0.1 | 4.2 | 4.3 |
| 69 | - | 3.6 | 3.6 |
| 1970 | - | 0.4 | 0.4 |
| 1971 | - | 0.2 | 0.2 |

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Table 2. Total catch of Icelandic summer spawners

| | North coast | South coast | Total |
|------|-------------|-------------|-------|
| 1950 | 1.5 | 12.1 | 13.6 |
| 1951 | 1.8 | 14.0 | 15.8 |
| 52 | 0.9 | 9.6 | 10.5 |
| 53 | 3.8 | 13.8 | 17.6 |
| 54 | 1.0 | 10.0 | 11.0 |
| 55 | 0.6 | 13.7 | 14.3 |
| 56 | 3.4 | 10.2 | 13.6 |
| 57 | 13.4 | 9.4 | 22.8 |
| 58 | 9.8 | 23.7 | 33.5 |
| 59 | 21.3 | 13.7 | 35.0 |
| 1960 | 17.9 | 10.6 | 28.5 |
| 61 | 3.9 | 70.1 | 74.0 |
| 62 | 2.4 | 90.5 | 92.9 |
| 63 | 8.2 | 122.1 | 130.3 |
| 64 | 3.9 | 82.6 | 86.5 |
| 65 | 2.9 | 120.0 | 122.9 |
| 66 | 2.6 | 51.8 | 54.4 |
| 67 | 0.4 | 67.3 | 67.7 |
| 68 | | 16.8 | 16.8 |
| 69 | | 19.4 | 19.4 |
| 1970 | | 15.9 | 15.9 |
| 71 | | 11.5 | 11.5 |
| 72 | | 0.3 | 0.3 |
| 73 | | 0.2 | 0.2 |
| 74 | | 1.2 | 1.2 |
| 75 | | 12.8 | 12.8 |
| 76 | | 17.8 | 17.8 |



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Figure 2. Spawning stock size of Icelandic summer spawners.

Source: For years 1960-73 Jakobsson.
1973. For years 1974-77 preliminary results presented to the Working Group.

