Northwest Atlantic Fisheries Organization

Serial No. N1804 NAFO SCR Doc. 90/82

SCIENTIFIC COUNCIL MEETING - JUNE 1990

# A Review of the Shrimp Fishery (*Pandalus borealis*) in the Denmark Strait, in the Years 1978-1989

by

U. Skúladóttir

Marine Research Institute, Skulagata 4
P. O. Box 1390, 121 Reykjavik, Iceland

## Abstract

In this paper, an effort has been made to gather and combine all information available on the effort and CPUE as well as catch per month from the shrimp fishery of all countries in the Denmark Strait since the start of the fishery in 1978. Total effort and mean CPUE of all countries combined has been calculated using the figures for nominal catch for every country. It is assumed here that the shrimp stock is the same on both sides of the midline between Iceland and Greenland.

The downward trend in the fishery is studied by looking at the relationship between moving averages of catch of every three years against CPUE in the fourth year of the series. The relationship is linear and significant. The higher the catch, the lower the CPUE.

## Introduction

The Denmark Strait area was first found in September 1976 by Schopka in a cod survey by the research vessel Bjarni Saemundsson. In 1978 the area was searched thoroughly by Hallgrimsson on the shrimper Dalborg. From then on, shrimp fishery was carried out every year by Iceland except in 1982, but most often during the latter part of the year. In 1979 the Norwegians started fishing in the Denmark Strait, expanding the area considerably to the west. Since 1980 other nations started fishing in the area. From then on there have been 6 countries fishing in the area, namely Greenland, Denmark, Faroe Islands, Iceland, Norway and France.

In this paper all data available on the catch, effort and the CPUE, are gathered by months for all strata within the traditional area combined.

An earlier review of the Denmark Strait fishery (Skuladottir 1989) has been reviewed now according to corrections made by Carlsson (personal communication 1990) for Greenland, and also according to the revision of Poulard (personal communication 1990) for France.

## Materials and Methods

For most of the countries there are data presented from logbooks, namely catch and effort. The individual authors have also calculated the CPUE by dividing the catch per month (in kg) by the corresponding effort (in trawling hours).

In order to assess the overall CPUE per every half year, all the effort in the period January to June was summed. Then only the catches that correspond to the stated effort are summed by every half year. The subtotal sum of catch is divided by the subtotal sum of effort to get the CPUE per every half year.

In order to assess the total effort exerted by each country in the area, the nominal catch per month is summed by every half a year. The nominal catch is often higher than the catch reported in logbooks, because of failure on the half of some skippers to fill in and/or hand in reports. Therefore the effort was corrected by every half year by dividing the nominal total catch by the CPUE of the same half year. It has been assumed here that the gear and the efficiency of all vessels of a country is more like that of the ones not reporting of the same country than that of other countries. Therefore the effort was first corrected by individual countries.

When calculating the average catch of every 3 years, the total catch is taken from Table 8 or 9 and CPUE in the 4th year is taken from Table 8 or the CPUE for the whole year. The moving averages of catch of every 3 years were then regressed against the CPUE in the 4th year.

## Results and Discussions

The effort, catch and nominal catch as well as calculated CPUE are presented in Tables 1 to 6 for the countries Greenland, France, Norway, Iceland, Faroe Islands and Denmark by months.

From Table 7 it is notable that there is considerable variation in the CPUE of the different countries. This could be due to gear size and the general efficiency of the respective vessels. There is also a fall in CPUE in the latter half of the year, although to what extent depends on whether vessels are fishing in all months or not. The highest catch rates being in December or September. Moreover, Greenlandic vessels seem to have generally the highest catch rates of all countries after 1982, so the participation of Greenlandic vessels in the latter half of the year plays a significant role.

The yearly catch rate is calculated in Table 8. The catch rate has been falling gradually since the year 1980 and 1981 or from 245 kg per hour to 99 kg, the effort increased gradually to about 55 thousand trawling hours, in 1986 yielding about 11 thousand tons. In spite of doubling the effort there is little gain in addition to the 11 thousand tons fished in 1986.

The total catch is listed in Table 9 as well as advised total allowable catch (TAC) by the Scientific Council of NAFO, by years. There is also the effective TAC of the EEC and later that of the Greenland authorities. The effective TAC has usually been moderate and similar to the advised TAC. The 14,100 tons now advised for the fishery west of the midline between Iceland and Greenland is 40% above the advised TAC.

In order to see the impact the fishery is making on the stock, the moving averages of catch of every 3 years is put against the CPUE in the 4th year (Table 10 and Fig. 1). It turns out that the more shrimp there is removed from the stock the less CPUE becomes. Later when the shrimp of every year have become 3, 2 or 1 year older, depending on when recruited to the fishery. When fitted with a simple line the fit is highly significant.

$$y = -0.01299x + 264.542 \qquad r = 0.9182$$

The value of 99 kg for 1989 is below the line and should have been about 110 kg as is also forecasted by the regression for the year 1990 (Table 10). The CPUE of the first four months of 1990 of Greenland are indicating that the CPUE for 1990 might even decline further. As the preliminary CPUE of the first half of the year is 145 kg for 1990 (Table 1) as compared to 192 kg in 1989.

The continued fall in CPUE since the year 1986 is possibly a sign of a reduction in the size of stock. In the years 1980 to 1990 there might have been improvements in fishing gear. Not much is known about this. Although for Icelandic side it is known that trawls have increased gradually from 1748 meshes (circumference) on the average in 1984 to about 2380 meshes in 1987 and 1988. On the other hand there are rumours that discard rates have increased in the past few years aboard the vessels as shrimps below 24 mm CL are likely to increase the number per kilo below the size limit 120 whole shrimps per kilo, which get the highest prize, bearing in mind that all countries except Iceland have a TAC per boat. According to Smedstad (1989 and 1990) the proportion of males to females has increased in 1988 and 1989 as compared to previous years.

## Conclusion

The fishery in the Denmark Strait appears to have reached the stage where stock level as judged by CPUE is below half of what it was in the early eighties, when all the six countries had joined in the fishery.

Taking into consideration the improvements in gear that might have peaked about the year 1987 and some increase in discard rate especially in the last two years, the total allowable catch should at least not be increased above the present level of 10 thousand tons.

## References

Bertrand, J., A. Battaglia, P. Derible, and J. C. Poulard. 1988. Catch effort and biological data of shrimp (*Pandalus borealis*) in the French fisheries off Greenland in 1986 and 1987. NAFO SCR Doc., No. 50, Serial No. N1490, 17 p.

Carlsson, D. M. 1981. Data on the shrimp fishery at East Greenland in 1980 and 1981. NAFO SCR Doc., No. 165, Serial No. N473. 14 p.

1984. Data on the shrimp fishery at East Greenland in 1983 compared to earlier years. NAFO SCR Doc., No. 5, Serial No. N774, 12 p.

1985. Data on the shrimp fishery at East Greenland in 1984 compared to earlier years. NAFO SCR Doc., No. 12, Serial No. N946, 14 p.

1986. Data on the shrimp fishery at East Greenland in 1985 compared to earlier years. NAFO SCR Doc., No. 5, Serial No. N1103, 14 p.

1987. The commercial shrimp fishery in the Denmark Strait in 1985 and 1986. NAFO SCR Doc., No. 9, Serial No. N1277, 26 p.

1988. The commercial shrimp fishery in the Denmark Strait in 1987. NAFO SCR Doc., No. 57, Serial No. N1497, 12 p.

Carlsson, D. M., and P. Kanneworff. 1990. The commercial shrimp fishery in Denmark Strait in 1989 and early 1990. NAFO SCR Doc., No. 42, Serial No. N1759, 22 p.

Høydal, K. 1980. Observations on the Faroese Prawn Fishery in East Greenland, March to June 1980. NAFO SCR Doc., No. 172, Serial No. N259, 9 p.

Hallgrimsson, I., and U. Skuladottir. 1985. The Icelandic shrimp (*Pandalus borealis*) fishery in Denmark Strait in 1984. NAFO SCR Doc., No. 11, Serial No. N945, 4 p.

1988. The Icelandic shrimp (Pandalus borealis) fishery in the Denmark Strait in 1987. NAFO SCR Doc., No. 64, Serial No. N1506, 10 p.

NAFO Scientific Council Reports 1979-80.

NAFO Scientific Council Reports 1983.

Skuladottir, U. 1985. The sustainable yield of Pandalus borealis in the Denmark Strait Area. NAFO SCR Doc., No. 15, Serial No. N949, 6 p.

1989. A review of the shrimp fishery, *Pandalus borealis*, in Denmark Strait. NAFO SCR Doc., No. 36, Serial No. N1613, 14 p.

Skuladottir, U., and I. Hallgrimsson. 1987. The Icelandic shrimp (*Pandalus borealis*) fishery in the Denmark Strait in 1986. NAFO SCR Doc., No. 4, Serial No. N1272, 10 p.

Smedstad, O. M. 1988. Preliminary report of a cruise with M/T "Masi" to East Greenland Waters in September 1987. NAFO SCR Doc., No. 48, Serial No. N1488, 10 p.

1990. Preliminary report of a cruise with M/T *Håkøy-II* to East Greenland waters in September 1989. NAFO SCR Doc., No. 12, Serial No. N1724, 13 p.

Smedstad, O. M., and S. Torheim. 1989. Norwegian investigations on shrimp (*Pandalus borealis*) in East Greenland Waters in 1988. NAFO SCR Doc., No. 18, Serial No. N1594, 12 p.

1990. Norwegian investigations on shrimp (*Pandalus borealis*) in East Greenland waters in 1989. NAFO SCR Doc., No. 11, Serial No. N1723, 13 p.

Table 1. Catch rates (kg per hour trawling) and corresponding effort (hours trawling) and catch (tons) from the shrimp fishery in Denmark Strait by Greenland (and Denmark in the years1980-1982) in two periods of the year.

| | January - June | | | | July - December | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Month | CPUE | Effort | Catch | Month | CPUE | Effort | Catch |
| 1980 | Apr | 672 | 35 | 23.5 | Jul | 71 | 60 | 4.2 |
| | May | 392 | 1295 | 507.6 | Aug | 17 | 32 | 0.5 |
| | Jun | 139 | 315 | 43.8 | Sep | 181 | 482 | 87.2 |
| | | | | | Oct | 107 | 1165 | 124.7 |
| | | | | | Nov | 145 | 465 | 67.4 |
| | Subtotal | 350 | 1645 | 575.0 | Subtotal | 129 | 2204 | 284.0 |
| | Total | 350 | 1665 | 582.0 | Total | 129 | 2483 | 320.0 |
| 1981 | Apr | 486 | 1343 | 652.7 | | | | |
| | May | 263 | 914 | 240.4 | | | | |
| | Jun | 123 | 6 | 0.7 | | | | |
| | Subtotal | 395 | 2263 | 893.8 | | | | |
| | Total | 395 | 4013 | 1585.0 | | | | |
| 1982 | Mar | 160 | 763 | 122.1 | | | | |
| | Apr | 195 | 1570 | 306.2 | | | | |
| | May | 280 | 1394 | 390.0 | | | | |
| | Subtotal | 220 | 3727 | 818.3 | | | | |
| | Total | 220 | 8432 | 1855.0 | | | | |
| 1983 | Mar | 345 | 484 | 167.0 | | | | |
| | Apr | 160 | 457 | 73.0 | | | | |
| | Subtotal | 255 | 941 | 240.0 | | | | |
| | Total | 255 | 5752 | 1467.0 | | | | |
| 1984 | Jan | 600 | 105 | 63.0 | | | | |
| | Feb | 356 | 312 | 111.0 | | | | |
| | Mar | 224 | 281 | 63.0 | | | | |
| | Subtotal | 340 | 698 | 237.0 | | | | |
| | Total | 340 | 6627 | 2250.0 | | | | |
| 1985 | Jan | 318 | 647 | 206.0 | Oct | 146 | 51 | 7.0 |
| | Feb | 309 | 610 | 188.0 | Nov | 230 | 360 | 83.0 |
| | Mar | 218 | 570 | 124.0 | Dec | 272 | 643 | 175.0 |
| | Apr | 228 | 625 | 143.0 | | | | |
| | Subtotal | 270 | 2452 | 661.0 | Subtotal | 251 | 1054 | 265.0 |
| | Total | 270 | 6469 | 1744.0 | Total | 251 | 3389 | 852.0 |
| 1986 | Jan | 302 | 1565 | 473.0 | Oct | 50 | 77 | 4.0 |
| | Feb | 222 | 2593 | 576.0 | Nov | 326 | 686 | 223.0 |
| | Mar | 403 | 2413 | 972.0 | Dec | 529 | 1160 | 614.0 |
| | Apr | 252 | 1032 | 260.0 | | | | |
| | May | 136 | 602 | 82.0 | | | | |
| | Subtotal | 288 | 8205 | 2363.0 | Subtotal | 437 | 1923 | 841.0 |
| | Total | 288 | 14265 | 4114.0 | Total | 437 | 3812 | 1667.0 |
| 1987 | Jan | 348 | 3608 | 1256.0 | Aug | 113 | 81 | 9.0 |
| | Feb | 322 | 4471 | 1440.0 | Sep | 253 | 400 | 101.0 |
| | Mar | 296 | 2965 | 878.0 | Oct | 199 | 751 | 149.0 |
| | Apr | 208 | 951 | 198.0 | Nov | 162 | 1915 | 310.0 |
| | May | 300 | 403 | 121.0 | Dec | 115 | 4067 | 468.0 |
| | Subtotal | 314 | 12398 | 3893 | Subtotal | 144 | 7214 | 1037 |
| | Total | 314 | 17866 | 5547.0 | Total | 144 | 7513 | 1080.0 |
| *1988 | Jan | 301 | 6951 | 2092.0 | Aug | 117 | 1019 | 119.0 |
| | Feb | 228 | 7950 | 1797.0 | Sep | 121 | 1487 | 180.0 |
| | Mar | 152 | 6408 | 974.0 | Oct | 105 | 2565 | 269.0 |
| | Apr | 104 | 1121 | 117.0 | Nov | 157 | 3202 | 503.0 |
| | May | 114 | 550 | 63.0 | Dec | 203 | 4903 | 995.0 |
| | Subtotal | 219 | 22980 | 5043.0 | Subtotal | 157 | 13176 | 2066.0 |
| | Total | 219 | 24083 | 5285.0 | Total | 157 | 13788 | 2162.0 |
| *1989 | Jan | 249 | 6859 | 1708.0 | Jul | 27 | 15 | 0.0 |
| | Feb | 215 | 6335 | 1362.0 | Aug | 44 | 713 | 31.0 |
| | Mar | 131 | 3900 | 511.0 | Sep | 59 | 2280 | 135.0 |
| | Apr | 197 | 3505 | 690.0 | Oct | 98 | 2600 | 250.0 |
| | May | 68 | 2312 | 157.0 | Nov | 67 | 7004 | 469.0 |
| | Jun | 39 | 137 | 5.0 | Dec | 84 | 7097 | 596.0 |
| | Subtotal | 192 | 23048 | 4433 | Subtotal | 75 | 19709 | 1481 |
| | Total | 192 | 23246 | 4471.0 | Total | 75 | 20095 | 1510.0 |
| *1990 | Jan | 137 | 8039 | 1101.0 | | | | |
| | Feb | 160 | 5407 | 865.0 | | | | |
| | Mar | 136 | 2454 | 334.0 | | | | |
| | Apr | 51 | 3 | 0.0 | | | | |
| | May | | | | | | | |
| | Jun | | | | | | | |
| | Subtotal | 145 | 15903 | 2300 | | | | |
| | Total | | 30990 | 4482.0 | | | | |

* Preliminary

Table 2. Catch rates (kg per hour trawling) and corresponding effort (hours trawling) and catch (tons) from the shrimp fishery in Denmark Strait by France in two periods of the year.

| | January - June | | | | July - December | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Month | CPUE | Effort | Catch | Month | CPUE | Effort | Catch |
| 1981 | Apr | 424 | 160 | 67.8 | | | | |
| | May | 241 | 557 | 134.3 | | | | |
| | Jun | 145 | 257 | 37.4 | | | | |
| | Subtotal | 246 | 974 | 239.5 | | | | |
| | Total | 246 | 1436 | 353.0 | | | | |
| 1982 | Apr | 206 | 345 | 71.1 | | | | |
| | May | 258 | 577 | 148.9 | | | | |
| | Jun | 179 | 247 | 44.1 | | | | |
| | Subtotal | 226 | 1169 | 264.1 | | | | |
| | Total | 226 | 1833 | 414.0 | | | | |
| 1983 | Apr | 166 | 252 | 41.7 | | | | |
| | May | 246 | 254 | 62.5 | | | | |
| | Jun | 159 | 213 | 33.8 | | | | |
| | Subtotal | 192 | 719 | 138.0 | | | | |
| | Total | 192 | 1516 | 291.0 | | | | |
| 1984 | Mar | 208 | 200 | 41.7 | | | | |
| | Apr | 290 | 1044 | 303.3 | | | | |
| | May | 205 | 517 | 106.2 | | | | |
| | Subtotal | 256 | 1761 | 451.2 | | | | |
| | Total | 256 | 1951 | 500.0 | | | | |
| 1985 | Apr | 231 | 381 | 87.9 | Oct | 170 | 405 | 68.7 |
| | May | 199 | 605 | 120.4 | Nov | 170 | 55 | 9.3 |
| | Jun | 118 | 220 | 26.0 | | | | |
| | Subtotal | 194 | 1206 | 234.3 | Subtotal | 170 | 460 | 78.0 |
| | Total | 194 | 2594 | 504.0 | Total | 170 | 814 | 138.0 |
| 1986 | Mar | 230 | 68 | 15.7 | Sep | 243 | 237 | 57.6 |
| | Apr | 175 | 1225 | 214.5 | Oct | 214 | 510 | 109.4 |
| | May | 184 | 1551 | 285.1 | Nov | 119 | 44 | 5.2 |
| | Jun | 124 | 355 | 43.9 | | | | |
| | Subtotal | 175 | 3199 | 559.2 | Subtotal | 218 | 791 | 172.2 |
| | Total | 175 | 3415 | 597.0 | Total | 218 | 841 | 183.0 |
| *1987 | Apr | 227 | 400 | 90.9 | Sep | | | 94.0 |
| | May | 250 | 578 | 144.7 | Oct | | | 59.0 |
| | | | | | Nov | | | 170.0 |
| | Subtotal | 241 | 978 | 235.6 | Subtotal | | | 323.0 |
| | Total | 241 | 2599 | 626.0 | Total | | | 405.0 |
| *1988 | Apr | 147 | 462 | 68.1 | Aug | | | 2.0 |
| | May | 136 | 473 | 64.2 | Sept | | | 48.0 |
| | Subtotal | 141 | 935 | 132.3 | | | | |
| | Total | 141 | 3138 | 444.0 | Total | | | 50.0 |
| *1989 | Mar | 203 | 247 | 50.2 | Jul | 58 | 116 | 6.7 |
| | Apr | 192 | 907 | 174.2 | Aug | 59 | 409 | 24.0 |
| | May | 23 | 23 | 0.5 | | | | |
| | Subtotal | 191 | 1177 | 225 | Subtotal | 58 | 525 | 30.7 |
| | Total | 191 | 1525 | 291.3 | Total | 58 | 1536 | 89.8 |

* Preliminary

Table 3. Catch rate (kg per hour trawling) and cooresponding effort (hours trawling) and catch (tons) from the shrimp fishery in Denmark Strait by Norway.

| | January - June | | | | July - December | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Month | CPUE | Effort | Catch | Month | CPUE | Effort | Catch |
| 1980 | Mar | 904 | 398 | 360.0 | Aug | 95 | 874 | 83.0 |
| | Apr | 704 | 793 | 558.0 | Sept | 145 | 2883 | 418.0 |
| | May | 378 | 1071 | 405.0 | Oct | 99 | 3071 | 304.0 |
| | Jun | 98 | 714 | 70.0 | Nov | 160 | 1181 | 189.0 |
| | Subtotal | 468 | 2976 | 1393.0 | Subtotal | 124 | 8009 | 994.0 |
| | Total | 468 | 3108 | 1455.0 | Total | 124 | 8106 | 1006.0 |
| 1981 | Mar | 364 | 137 | 50.0 | Aug | 42 | 167 | 7.0 |
| | Apr | 296 | 3848 | 1139.0 | Sep | 46 | 65 | 3.0 |
| | May | 161 | 4057 | 653.0 | | | | |
| | Jun | 119 | 1101 | 131.0 | | | | |
| | Subtotal | 216 | 9143 | 1973.0 | Subtotal | 43 | 232 | 10.0 |
| | Total | 216 | 9296 | 2006.0 | Total | 43 | 232 | 10.0 |
| 1982 | Mar | 197 | 1548 | 305.0 | | | | |
| | Apr | 171 | 4450 | 761.0 | | | | |
| | May | 248 | 3339 | 828.0 | | | | |
| | Total | 203 | 9337 | 1894.0 | | | | |
| 1983 | Apr | 128 | 2734 | 350.0 | Jul | 133 | 45 | 6.0 |
| | May | 255 | 1439 | 367.0 | Aug | 98 | 622 | 61.0 |
| | Jun | 143 | 1797 | 257.0 | | | | |
| | SubTotal | 163 | 5970 | 974.0 | Subtotal | 101 | 667 | 67.0 |
| | Total | 163 | 6830 | 1114.0 | Total | 101 | 6100 | 613.0 |
| 1984 | Feb | 232 | 341 | 79.0 | | | | |
| | Mar | 224 | 2777 | 622.0 | | | | |
| | Apr | 183 | 4000 | 732.0 | | | | |
| | May | 167 | 2994 | 500.0 | | | | |
| | Subtotal | 191 | 10112 | 1933.0 | | | | |
| | Total | 191 | 11141 | 2128.0 | | | | |
| 1985 | Mar | 184 | 4130 | 760.0 | | | | |
| | Apr | 166 | 5994 | 995.0 | | | | |
| | May | 137 | 1964 | 269.0 | | | | |
| | Subtotal | 166 | 12088 | 2024.0 | | | | |
| | Total | 166 | 12355 | 2051.0 | | | | |
| 1986 | Jan | 112 | 277 | 31.0 | Jul | 71 | 28 | 2.0 |
| | Feb | 141 | 1475 | 208.0 | Aug | 131 | 885 | 116.0 |
| | Mar | 166 | 4400 | 737.0 | Sep | 110 | 427 | 47.0 |
| | Apr | 133 | 4120 | 548.0 | | | | |
| | May | 131 | 2573 | 337.0 | | | | |
| | Total | 145 | 12845 | 1861.0 | Total | 123 | 1340 | 165.0 |
| *1987 | Feb | 187 | 802 | 150.0 | Aug | 124 | 258 | 32.0 |
| | Mar | 140 | 4036 | 565.0 | Sep | 135 | 1659 | 224.0 |
| | Apr | 123 | 4886 | 601.0 | Oct | 91 | 2055 | 187.0 |
| | May | 133 | 1473 | 196.0 | Nov | 47 | 1213 | 57.0 |
| | Subtotal | 135 | 11197 | 1512.0 | Subtotal | 96 | 5185 | 500.0 |
| | Total | 135 | 11353 | 1533.0 | Total | 96 | 5261 | 507.0 |
| *1988 | Jan | 66 | 30 | 2 | Jul | 71 | 14 | 1 |
| | Feb | 112 | 2438 | 273 | Aug | 96 | 2271 | 218 |
| | Mar | 76 | 4013 | 305 | Sep | 86 | 3267 | 281 |
| | Apr | 74 | 4635 | 343 | Oct | 71 | 2479 | 176 |
| | May | 82 | 3939 | 323 | Nov | 61 | 295 | 18 |
| | June | 108 | 259 | 28 | | | | |
| | Subtotal | 83 | 15314 | 1274 | Subtotal | 83 | 8312 | 693 |
| | Total | | 15314 | 1274 | Total | | 9332 | 778 |
| *1989 | Jan | 199 | 422 | 84 | | | | |
| | Feb | 129 | 496 | 64 | Aug | 35 | 1600 | 56 |
| | Mar | 70 | 2300 | 161 | Sep | 37 | 6459 | 239 |
| | Apr | 88 | 4318 | 380 | Oct | 55 | 7309 | 402 |
| | May | 35 | 457 | 16 | Nov | 47 | 6106 | 287 |
| | June | 26 | 538 | 14 | Dec | 94 | 2883 | 271 |
| | Subtotal | 84 | 8532 | 719 | Subtotal | 52 | 24358 | 1255 |
| | Total | 84 | 8354 | 704 | Total | 52 | 27056 | 1394 |

* Preliminary

Table 4. Catch rates (kg per hour trawling) and corresponding effort (hours trawling) and catch (tons) from the shrimp fishery in Denmark Strait by Iceland in two periods of the year.

| | January - June | | | | July - December | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Month | CPUE | Effort | Catch | Month | CPUE | Effort | Catch |
| 1978 | May | 191 | 52 | 9.9 | Jul | 180 | 238 | 38.1 |
| | Jun | 221 | 246 | 54.3 | Aug | 184 | 111 | 18.2 |
| | | | | | Sept | 277 | 198 | 54.7 |
| | | | | | Oct | 462 | 149 | 68.9 |
| | | | | | Nov | 567 | 176 | 99.8 |
| | | | | | Dec | 243 | 80 | 19.5 |
| | Total | 215 | 298 | 64.2 | Total | 314 | 952 | 299.2 |
| 1979 | May | 239 | 31 | 7.4 | Jul | 178 | 37 | 6.6 |
| | Jun | 174 | 135 | 23.5 | Aug | 214 | 656 | 140.0 |
| | | | | | Sep | 255 | 561 | 142.9 |
| | | | | | oct | 283 | 276 | 78.1 |
| | | | | | nov | 194 | 342 | 66.3 |
| | | | | | dec | 187 | 110 | 20.5 |
| | Total | 186 | 166 | 30.9 | Total | 229 | 1982 | 454.4 |
| 1980 | Jun | 125 | 1425 | 177.6 | Jul | 90 | 1478 | 133.6 |
| | | | | | Aug | 104 | 1176 | 121.8 |
| | | | | | Sep | 123 | 851 | 104.2 |
| | | | | | Oct | 96 | 802 | 77.2 |
| | | | | | Subtotal | 101 | 4307 | 436.8 |
| | Total | 125 | 1760 | 219.3 | Total | 101 | 5318 | 539.4 |
| 1981 | Jun | 99 | 688 | 68.0 | Jul | 79 | 603 | 47.3 |
| | | | | | Aug | 39 | 245 | 9.6 |
| | Total | 99 | 688 | 68.0 | Total | 67 | 848 | 56.9 |
| 1982 | No fishery | | | | | | | |
| 1983 | Jun | 99 | 52 | 5.1 | Oct | 172 | 80 | 13.8 |
| | | | | | Nov | 155 | 158 | 24.5 |
| | Total | 99 | 52 | 5.1 | Total | 161 | 238 | 38.3 |
| 1984 | Jun | 42 | 53 | 2.2 | Jul | 69 | 655 | 45.4 |
| | | | | | Aug | 69 | 116 | 8.0 |
| | | | | | Sep | 99 | 1546 | 152.7 |
| | | | | | Oct | 154 | 1887 | 291.0 |
| | | | | | Nov | 74 | 2391 | 175.7 |
| | | | | | Dec | 118 | 569 | 66.8 |
| | Total | 42 | 53 | 2.2 | Total | 103 | 7164 | 739.6 |
| 1985 | Feb | 105 | 80 | 8.3 | Jul | 100 | 3477 | 347.1 |
| | Mar | 13 | 8 | 0.1 | Aug | 82 | 3393 | 278.6 |
| | Apr | 22 | 22 | 0.5 | Sep | 90 | 4377 | 392.2 |
| | May | 70 | 2558 | 179.0 | Oct | 82 | 2022 | 166.2 |
| | Jun | 114 | 1837 | 210.1 | Nov | 83 | 1232 | 101.9 |
| | | | | | Dec | 253 | 443 | 112.0 |
| | Total | 88 | 4485 | 396.0 | Total | 94 | 14944 | 1398.0 |
| 1986 | Apr | 21 | 19 | 0.5 | Jul | 123 | 92 | 11.2 |
| | May | 74 | 2806 | 206.7 | Aug | 95 | 2163 | 204.8 |
| | Jun | 53 | 64 | 3.4 | Sep | 94 | 2689 | 251.8 |
| | | | | | Oct | 82 | 1892 | 155.7 |
| | | | | | Nov | 96 | 947 | 91.4 |
| | | | | | Dec | 494 | 228 | 112.8 |
| | Subtotal | 73 | 2889 | 210.6 | Subtotal | 103 | 8011 | 827.5 |
| | Total | 73 | 3205 | 234.0 | Total | 103 | 8893 | 916.0 |
| *1987 | | | | | Jul | 98 | 447 | 43.7 |
| | | | | | Aug | 83 | 3399 | 283.6 |
| | | | | | Sep | 92 | 3078 | 251.4 |
| | | | | | Oct | 61 | 2012 | 123.3 |
| | | | | | Nov | 75 | 1482 | 111.8 |
| | | | | | Dec | 106 | 259 | 27.3 |
| | | | | | Subtotal | 79 | 10677 | 841.1 |
| | | | | | Total | 79 | 16835 | 1330.0 |
| *1988 | Jan | 90 | 23 | 2.1 | Jul | 47 | 977 | 45.7 |
| | Feb | 42 | 21 | 0.8 | Aug | 52 | 4596 | 238.1 |
| | Jun | 108 | 1463 | 158.5 | Sep | 62 | 6257 | 386.1 |
| | | | | | Oct | 52 | 7166 | 372.3 |
| | | | | | Nov | 26 | 363 | 9.5 |
| | Subtotal | 107 | 1507 | 161.4 | Subtotal | 54 | 19359 | 1051.7 |
| | Total | | 1769 | 189.5 | Total | | 22735 | 1234.5 |
| * 1989 | | | | | Aug | 51 | 3910 | 197.5 |
| | May | 154 | 2234 | 344.9 | Sep | 41 | 4558 | 186.4 |
| | Jun | 84 | 4188 | 349.6 | Oct | 27 | 321 | 8.5 |
| | Subtotal | 108 | 6422 | 694.5 | Subtotal | 45 | 8789 | 392.4 |
| | Total | | 7835 | 847.3 | Total | | 10722 | 478.7 |

* Preliminary

Table 5. Catch rates (kg per hour trawling) and corresponding effort (hours trawling) and catch (tons) from the shrimp fishery in Denmark Strait by Faroe Islands

| | January - June | | | | July-December | |
|---|---|---|---|---|---|---|
| Year | Month | CPUE | Effort | Catch | Month | Catch |
| 1980 | Mar | 1015 | 40 | 40.5 | Oct | 128.0 |
| | Apr | 641 | 1159 | 743.1 | Nov | 213.0 |
| | May | 373 | 1011 | 377.1 | | |
| | June | 210 | 1001 | 210.3 | | |
| | Subtotal | 427 | 3212 | 1371.0 | Subtotal | |
| | Total | 427 | 9115 | 3892.0 | Total | 341.0 |
| 1981 | Apr | | | 41.0 | Sep. | 22.0 |
| | May | | | 430.0 | Oct. | 5.0 |
| | June | | | 215.0 | | |
| | Total | | | 686.0 | Total | 27.0 |
| 1982 | Feb | | | 94.0 | | |
| | Mar | | | 308.0 | | |
| | Apr | | | 243.0 | | |
| | May | | | 92.0 | | |
| | Total | | | 737.0 | | |
| 1983 | Mar | | | 185.0 | | |
| | Apr | | | 122.0 | | |
| | May | | | 63.0 | | |
| | June | | | 73.0 | | |
| | Total | | | 443.0 | | |
| 1984 | Mar | | | 220.0 | Nov | 43.0 |
| | Apr | | | 193.0 | Dec | 49.0 |
| | May | | | 163.0 | | |
| | Total | | | 576.0 | Total | 92.0 |
| 1985 | Feb | | | 46.0 | Oct | 78.0 |
| | Mar | | | 136.0 | Nov | 101.0 |
| | Apr | | | 209.0 | Dec | 91.0 |
| | May | | | 13.0 | | |
| | Total | | | 404.0 | Total | 270.0 |
| 1986 | Jan | | | 185.0 | Sept | 2.0 |
| | Feb | | | 158.0 | Oct | 3.0 |
| | Mar | | | 87.0 | Nov | 94.0 |
| | Apr | | | 41.0 | Dec | 122.0 |
| | May | | | 35.0 | | |
| | Total | | | 506.0 | Total | 221.0 |
| *1987 | Jan | | | 84.0 | Oct | 1.0 |
| | Feb | | | 184.0 | Nov | 80.0 |
| | Mar | | | 70.0 | Dec | 139.0 |
| | May | | | 37.0 | | |
| | Total | | | 375.0 | Total | 220.0 |
| *1988 | Jan | | | 228.0 | Aug | 10 |
| | Feb | | | 301.0 | | |
| | Mar | | | 69.0 | | |
| | Apr | | | 36.0 | | |
| | May | | | 35.0 | | |
| | Total | | | 669 | | 10 |
| *1989 | Jan | | | 150 | | |
| | Feb | | | 86 | | |
| | Mar | | | 99 | | |
| | Apr | | | 103 | Nov | 24 |
| | May | | | 1 | Dec | 132 |
| | Total | | | 439 | Total | 156 |

* Preliminary

Table 6. Catch (tons) from the shrimp fishery in Denmark Strait by Denmark.

| | January-June | | July-December | |
|---|---|---|---|---|
| Year | Month | Catch | Month | Catch |
| 1983 | Mar | 38.0 | | |
| | Apr | 166.0 | | |
| | Total | 204.0 | | |
| 1984 | Jan | 284.0 | | |
| | Feb | 102.0 | | |
| | Apr | 57.0 | | |
| | Total | 443.0 | | |
| 1985 | Mar | 44.0 | | |
| | Apr | 96.0 | | |
| | May | 10.0 | | |
| | Total | 353.0 | | |
| 1986 | Jan | 260.0 | Nov | 27 |
| | Feb | 28.0 | Dec | 30 |
| | Mar | 54.0 | | |
| | Apr | 51.0 | | |
| | May | 50.0 | | |
| | Total | 443.0 | Total | 57 |
| *1987 | Feb | 99.0 | Sept | 4 |
| | Mar | 173.0 | Oct | 26 |
| | Apr | 141.0 | Nov | 20 |
| | May | 18.0 | Dec | 74 |
| | Total | 431.0 | Total | 124 |
| *1988 | Jan | 156 | Sept | 23 |
| | Feb | 147 | Oct | 19 |
| | Mar | 23 | Nov | 36 |
| | Apr | 3 | Dec | 37 |
| | Total | 329 | Total | 115 |
| * 1989 | Jan | 92 | Aug | 9 |
| | Feb | 153 | Sept | 20 |
| | Mar | 36 | Oct | 19 |
| | | | Nov | 17 |
| | June | 1 | Dec | 19 |
| | Total | 282 | Total | 84 |

* Preliminary

Table 7. Catch rates (kg per hour trawling) and corresponding effort (hours trawling) and catch (tons) from the shrimp fishery in Denmark Strait by all natons combined in two periods of the year.

| | | January-June | | | July - December | | |
|---|---|---|---|---|---|---|---|
| Year | Country | CPUE | Effort | Catch | CPUE | Effort | Catch |
| 1978 | Iceland | 215 | 298 | 64.2 | 314 | 952 | 299.2 |
| 1979 | Iceland | 186 | 166 | 30.9 | 229 | 1982 | 454.4 |
| 1980 | Greenland, Danmark | 350 | 1665 | 582.0 | 129 | 2483 | 320.0 |
| | France | | | 50.0 | | | |
| | Norway | 468 | 3108 | 1455.0 | 124 | 8106 | 1006.0 |
| | Iceland | 125 | 1760 | 219.3 | 101 | 5318 | 539.4 |
| | Faroe Islands | 427 | 9115 | 3892.0 | | | 341.0 |
| | Subtotal | 393 | 15648 | 6148.3 | 117 | 15907 | 1865.4 |
| | Total | 393 | 15775 | 6198.3 | 117 | 18815 | 2206.4 |
| 1981 | Greenland, Danmark | 395 | 4013 | 1585.0 | | | |
| | France | 246 | 1436 | 353.0 | | | |
| | Norway | 216 | 9296 | 2006.0 | 43 | 232 | 10.0 |
| | Iceland | 99 | 688 | 68.0 | 67 | 848 | 56.9 |
| | Faroe Islands | | | 686.0 | | | 27.0 |
| | Subtotal | 260 | 15433 | 4012.0 | 62 | 1080 | 66.9 |
| | Total | 260 | 18072 | 4698.0 | 62 | 1516 | 93.9 |
| 1982 | Greenland, Danmark | 220 | 8432 | 1855.0 | | | |
| | France | 226 | 1833 | 414.0 | | | |
| | Norway | 203 | 9337 | 1894.0 | | | |
| | Faroe Islands | | | 737.0 | | | |
| | Subtotal | 212 | 19602 | 4163.0 | | | |
| | Total | 212 | 23072 | 4900.0 | | | |
| 1983 | Greenland | 255 | 5752 | 1467.0 | | | |
| | France | 192 | 1516 | 291.0 | | | |
| | Norway | 163 | 6830 | 1114.0 | 101 | 6100 | 613.0 |
| | Iceland | 99 | 52 | 5.1 | 161 | 238 | 38.3 |
| | Danmark | | | 204.0 | | | |
| | Faroe Islands | | | 443.0 | | | |
| | Subtotal | 203 | 14150 | 2877.1 | 103 | 6338 | 651.3 |
| | Total | 203 | 17332 | 3524.1 | 103 | 6338 | 651.3 |
| 1984 | Greenland | 340 | 6627 | 2250.0 | | | |
| | France | 256 | 1951 | 500.0 | | | |
| | Norway | 191 | 11141 | 2128.0 | | | |
| | Iceland | 42 | 53 | 2.2 | 103 | 7164 | 739.6 |
| | Danmark | | | 443.0 | | | |
| | Faroe Islands | | | 576.0 | | | 92.0 |
| | Subtotal | 247 | 19772 | 4880.2 | 103 | 7164 | 739.6 |
| | Total | 247 | 23900 | 5899.2 | 103 | 8074 | 831.6 |

Table 7 continued

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1985 | Greenland | 270 | 6469 | 1744.0 | 251 | 3389 | 852.0 |
| | France | 194 | 2594 | 504.0 | 170 | 814 | 138.0 |
| | Norway | 166 | 12355 | 2051.0 | | | |
| | Iceland | 88 | 4485 | 396.0 | 94 | 14944 | 1398.0 |
| | Danmark | | | 353.0 | | | |
| | Faroe Islands | | | 404.0 | | | 270.0 |
| | Subtotal | 181 | 25903 | 4695.0 | 125 | 19147 | 2388.0 |
| | Total | 181 | 30079 | 5452.0 | 125 | 21312 | 2658.0 |
| 1986 | Greenland | 288 | 14285 | 4114.0 | 437 | 3811 | 1667.0 |
| | France | 175 | 3415 | 597.0 | 218 | 841 | 183.0 |
| | Norway | 145 | 12845 | 1861.0 | 123 | 1340 | 165.0 |
| | Iceland | 73 | 3205 | 234.0 | 103 | 8893 | 916.0 |
| | Danmark | | | 443.0 | | | 57.0 |
| | Faroe Islands | | | 506.0 | | | 221.0 |
| | Subtotal | 202 | 33750 | 6806.0 | 197 | 14885 | 2931.0 |
| | Total | 202 | 38456 | 7755.0 | 197 | 16297 | 3209.0 |
| * 1987 | Greenland | 314 | 17666 | 5547.0 | 144 | 7513 | 1080.0 |
| | Norway | 135 | 11353 | 1533.0 | 96 | 5261 | 507.0 |
| | Iceland | | | | 79 | 16835 | 1330.0 |
| | France | 241 | 2599 | 626.0 | | | 405.0 |
| | Danmark | | | 431.0 | | | 124.0 |
| | Faroe Islands | | | 375.0 | | | 220.0 |
| | Subtotal | 244 | 31618 | 7706.0 | 99 | 29609 | 2917.0 |
| | Total | 244 | 34925 | 8512.0 | 99 | 37212 | 3666.0 |
| * 1988 | Greenland | 219 | 24083 | 5285.0 | 157 | 13788 | 2162.0 |
| | Norway | 83 | 15314 | 1274.0 | 83 | 9332 | 778.0 |
| | Iceland | 107 | 1769 | 189.5 | 54 | 22735 | 1234.5 |
| | France | 141 | 3138 | 444.0 | | | 50.0 |
| | Danmark | | | 329.0 | | | 115.0 |
| | Faroe Islands | | | 669.0 | | | 10.0 |
| | Subtotal | 164 | 41166 | 6748.5 | 91 | 45855 | 4174.5 |
| | Total | 164 | 49962 | 8190.5 | 91 | 47777 | 4349.5 |
| * 1989 | Greenland | 192 | 23246 | 4471.0 | 75 | 20095 | 1510.0 |
| | Norway | 84 | 8354 | 704.0 | 52 | 27056 | 1394.0 |
| | Iceland | 108 | 7835 | 847.3 | 45 | 10722 | 478.7 |
| | France | 191 | 1525 | 291.3 | 58 | 1536 | 89.8 |
| | Danmark | | | 282.0 | | | 84.0 |
| | Faroe Islands | | | 439.0 | | | 156.0 |
| | Subtotal | 154 | 40960 | 6313.6 | 58 | 59409 | 3472.5 |
| | Total | 154 | 45638 | 7034.6 | 58 | 63515 | 3712.5 |

*eliminary

Table 8. Catch rates (kg per hour trawling) and corresponding effort (hours trawling) and catch (tons) from the shrimp fishery in Denmark Strait by years .

| Year | Periods | CPUE | Effort | Catch |
|---|---|---|---|---|
| 1980 | Jan-Jun | 393 | 15775 | 6198.3 |
| | Jul-Dec | 117 | 18858 | 2206.4 |
| | Mean/Total | 243 | 34633 | 8404.7 |
| 1981 | Jan-Jun | 260 | 18072 | 4698.0 |
| | Jul-Dec | 62 | 1516 | 93.9 |
| | Mean/Total | 245 | 19588 | 4791.9 |
| 1982 | Jan-Jun | 212 | 23072 | 4900.0 |
| | Jul-Dec | - | - | - |
| | Mean/Total | 212 | 23072 | 4900.0 |
| 1983 | Jan-Jun | 203 | 17332 | 3524.1 |
| | Jul-Dec | 103 | 6338 | 651.3 |
| | Mean/Total | 176 | 23670 | 4175.4 |
| 1984 | Jan-Jun | 247 | 23900 | 5899.2 |
| | Jul-Dec | 103 | 8074 | 831.6 |
| | Mean/Total | 211 | 31974 | 6730.8 |
| 1985 | Jan-Jun | 181 | 30079 | 5452.0 |
| | Jul-Dec | 108 | 21312 | 2658.0 |
| | Mean/Total | 158 | 51391 | 8110.0 |
| 1986 | Jan-Jun | 202 | 38456 | 7755.0 |
| | Jul-Dec | 197 | 16297 | 3209.0 |
| | Mean/Total | 200 | 54753 | 10964.0 |
| *1987 | Jan-Jun | 244 | 34925 | 8512.0 |
| | Jul-Dec | 99 | 37212 | 3666.0 |
| | Mean/Total | 169 | 72137 | 12178.0 |
| * 1988 | Jan-Jun | 164 | 49962 | 8190.5 |
| | Jul-Dec | 93 | 47777 | 4349.5 |
| | Mean/Total | 128 | 97739 | 12540 |
| *1989 | Jan-Jun | 154 | 45638 | 7034.6 |
| | Jul-Dec | 58 | 63515 | 3712.5 |
| | Mean/Total | 99 | 109153 | 10747.1 |

* Preliminary

**Table 9. Nominal catch (Tons) of shrimp in the Denmark Strait.**

| Country | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989*** | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Denmark | - | - | 702 | 581 | 740 | 204 | 443 | 353 | 500 | 555 | 444 | 366 | |
| Faroe Islands | - | - | 4233 | 713 | 737 | 443 | 668 | 674 | 727 | 595 | 679 | 595 | |
| France | - | - | 50 | 353 | 414 | 291 | 500 | 642 | 780 | 1030 | 494 | 381 | |
| Greenland | - | - | 200 | 1004 | 1115 | 1467 | 2250 | 2596 | 5781 | 6627 | 7456 | 5981 | |
| Iceland | 363 | 485 | 759 | 125 | 0 | 43 | 742 | 1794 | 1150 | 1330 | 1424 | 1326 | |
| Norway | - | 800 | 2461 | 2016 | 1896 | 1727 | 2128 | 2051 | 2026 | 2041 | 2052 | 2098 | |
| Total catch | 363 | 1285 | 8405 | 4792 | 4902 | 4175 | 6731 | 8110 | 10964 | 12178 | 12549 | 10747 | |
| Total catch eastern side | 363 | 485 | 759 | 125 | 0 | 43 | 742 | 1794 | 1150 | 1330 | 1424 | 1326 | |
| Total catch western side | 0 | 800 | 7646 | 4667 | 4902 | 4132 | 5989 | 6316 | 9814 | 10848 | 11125 | 9421 | |
| Adviced TAC | - | - | - | - | 4200 | 4200 | 4200 | 5000 | - | - | - | 10000* | 10000* |
| Effective TAC western side | - | - | - | 8000 | 4500 | 5725 | 5245 | 6090 | 7525** | 7725** | 8725** | 9025** | 14100** |

*Adviced for a few years as a precautionary measure.

**Not including Greenland fishery north of 66° 30´ N. (The line lies in the middle of the traditional fishing area.)

***Preliminary.

Table 10. The mean shrimp catch of every 3 years against the CPUE in the 4th year. The linear regression between CPUE and mean catch, shown below is used to forecast the CPUE value for 1990.

| 3 YEARS | MEAN CATCH Tons | 4th YEAR | CPUE Kg |
|---|---|---|---|
| 1977-79 | 549 | 1980 | 243 |
| 1978-80 | 3351 | 1981 | 245 |
| 1979-81 | 4827 | 1982 | 212 |
| 1980-82 | 6033 | 1983 | 176 |
| 1981-83 | 4623 | 1984 | 211 |
| 1982-84 | 5269 | 1985 | 158 |
| 1983-85 | 6339 | 1986 | 200 |
| 1984-86 | 8602 | 1987 | 169 |
| 1985-87 | 10417 | 1988 | 128 |
| 1986-88 | 11897 | 1989 | 99 |
| 1987-89 | 11825 | 1990 | ?110 |

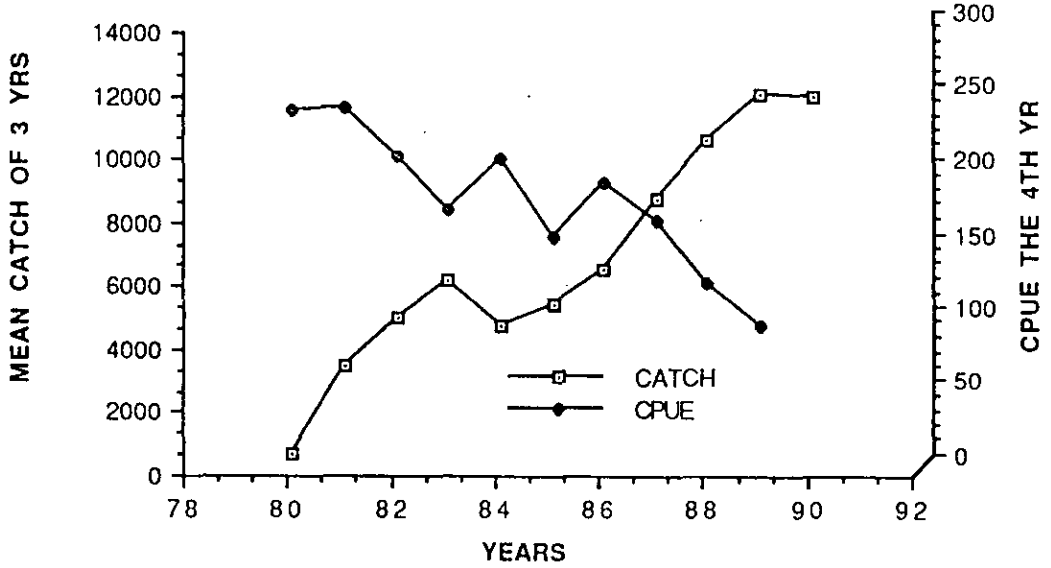


Fig. 1. The shrimp catch of every 3 years in Denmark Strait against the CPUE in the 4th year. As an example the catch of the years 1983-85 was 6339 tons against the mean CPUE 194 kg for the whole year 1986 of all countries, see the 1986 values on the picture. The linear fit is shown here below: