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# Update on the Status of NAFO SA 3 - 6 Porbeagle Shark (Lamna nasus)

by

**R.N. O'Boyle[2], G.M. Fowler[3], P.C.F. Hurley[3], W. Joyce[4], and M.A. Showell[3]**

2. Office of the Regional Advisory Process
Bedford Institute of Oceanography
Dartmouth, Nova Scotia, B2Y 4A2

3. Marine Fish Division
Bedford Institute of Oceanography
Dartmouth, Nova Scotia, B2Y 4A2

4. Joyce Marine Research Limited
Halifax, Nova Scotia

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## Abstract

The fishery in the Northwest Atlantic started in 1961 when Norway and Faroe Islands reported landing 1924t. Landings reached 9283t in 1964 and the resource appeared to have collapsed by 1967. The Faroe Islands reported annual landings of about 350t during the 1970s-1980s, which appeared sustainable. Canada started directing for porbeagle in 1991. Landings rose to 1,925t by 1992 and dropped to 1425t in 1993 when the Faroese fleet left the fishery. Landings were 1054t and 1338t in 1996 and 1997 against quotas of 1500t and 1000t respectively. Porbeagle has a relatively low pup production rate and is consequently very sensitive to over-exploitation. Since 1991, landings have averaged about 1500t annually. There is some evidence of declines in spring catch rates in recent years which suggests that abundance may have declined. Given uncertainties in our knowledge of the resource, it would not be prudent to harvest above the 1997 TAC of 1000t until the observed declines in catch rates can be explained. Further, while a 1000t TAC in 1998 would represent a reduction in catch, it is uncertain if this reduction would be sufficient to arrest the decline in population abundance suggested by the decline in catch rates.



## Résumé

La pêche dans l'Atlantique nord-ouest a débuté en 1961 lorsque la Norvège et les îles Féroé ont signalé des débarquements de 1 924 t. Ils ont atteint 9 283 t en 1964 et il semble que les stocks étaient épuisés en 1967. Les îles Féroé ont signalé des débarquements annuels de 350 t environ au cours des années 1970 et 1980, ce qui semble être une valeur durable. Le Canada a amorcé une pêche dirigée du requin-taupe commun en 1991. Les débarquements ont atteint 1 925 t en 1992 et sont tombés à 1 425 t en 1993 lorsque la flottille des îles Féroé a abandonné cette pêche. Les débarquements se sont élevés à 1 054 t en 1996 et à 1 338 t en 1997, pour des quotas respectifs de 1 500 t et de 1 000 t. Le taux de reproduction de ce requin est relativement faible et est donc très sensible à la surexploitation. Depuis 1991, les débarquements annuels moyens ont été de 1 500 t environ. Il semble y avoir eu baisse des taux de capture de printemps au cours des dernières années, ce qui porte à croire à une baisse de l'abondance. Étant donné le caractère incertain de nos connaissances de cette ressource, il serait imprudent de dépasser le TAC de 1 000 t fixé pour 1997 tant que le déclin des taux de capture n'aura pas été expliqué. Un TAC de 1 000 t pour 1998 donnerait lieu à une baisse des captures mais il n'est pas certain qu'une telle réduction suffirait à stopper le déclin de la population que semble indiquer la baisse des taux de capture.

## Introduction

The porbeagle shark is a cold-temperate species that occurs in the North Atlantic, South Atlantic and South Pacific areas. The species extends from Newfoundland to New Jersey and possibly to South Carolina in the West Atlantic and from Iceland and the Western Barents Sea to Madeira and Morocco and into the Mediterranean Sea in the East Atlantic. It is the only pelagic shark species for which a commercial fishery presently exists in Canadian Atlantic waters.

Prior to 1994, the Department of Fisheries and Oceans (DFO) did not have an active program of research on sharks. Increasing interest by industry to exploit sharks - particularly porbeagle and blue - stimulated the Marine Fish Division at the Bedford Institute of Oceanography (BIO) to initiate a modest research and assessment effort on sharks. The first Stock Status Report (SSR) on porbeagle was produced in June 1995 (Anon.,1995). In the fall of 1995, it was decided to form an Elasmobranch Assessment team which would undertake producing the Research Documents and Stock Status Reports (SSRs) for porbeagle and other elasmobranchs as part of the Maritime Region's Regional Advisory Process (RAP). The team produced the second and most recent SSR (Anon., 1996) in April 1996. It was planned at that time to update the SSR on porbeagle in April 1998.

The 1996 SSR stated that the 1995 catch and effort of porbeagle should be used as a ceiling to harvesting. DFO set the 1997 TAC at 1000t for conservation reasons, which was lower than the maximum (1375t) permissible by the 1996 SSR. Industry was concerned with this action and requested the update of the 1996 SSR before establishment of the 1998 TAC. It was agreed that an SSR would be produced for review at the 23-27 March 1998 meeting of RAP.

Since the 1996 RAP, the focus of the Elasmobranch Assessment team has been the establishment of new data collection and processing protocols to meet the long-term scientific monitoring needs of the fishery, as well as the processing of historical information. This has been a large task which is still on-going. Therefore, the team was not in a position to produce a full assessment of porbeagle at the March 1998 meeting. It was agreed that the review would consist of a summary of the information to date on the resource. Specifically, the remit of the 1998 RAP meeting for sharks was to:

- Review catch, effort and size information from the 1997 and historical fishery to provide guidance for the establishment of 1998 harvest levels. Prepare a Stock Status Report.

This report summarizes the most recent information on porbeagle sharks in the Northwest Atlantic. An earlier version of this report was presented to shark licence holders at BIO on 13 March, to solicit their input. The meeting minutes are attached (appendix I).

## Management History

Efforts to develop a fisheries management plan for pelagic sharks in Atlantic Canada began in 1992. Pelagic sharks were not covered by fisheries regulations and amendments were required to the Fisheries Act. These amendments did not come into force until May 1994. Between 1992 and 1994, a plan was developed through the Atlantic Large Pelagics Advisory Committee (ALPAC), the Committee that develops the Management Plans for the bluefin tuna and swordfish fisheries in Atlantic Canada. Following amendments to the Fisheries Act, a ban on "finning" sharks (the removal of the dorsal fin and at sea disposal of the finless carcass) was announced in June 1994 and a Management Plan for porbeagle, shortfin mako and blue sharks was announced in July 1994. However, there were problems implementing the Management Plan due to interpretation of the clause that determined eligibility for a license, and thus no licenses were issued in 1994. Further industry consultation outside of ALPAC was conducted in March 1995 and recreational interests were included at that time. Industry consensus was reached on the need to strength the control of the commercial fishery but no consensus was reached on how to regulate the recreational fishery. A revised but interim Management Plan was announced in July 1995.

The 1995 Fisheries Management Plan for pelagic sharks in Atlantic Canada established non-restrictive catch levels for porbeagle (1500t), shortfin mako (250t) and blue (250t) sharks in the directed shark fishery, limited the number of licenses by defining eligibility criteria, specified that licenses would be exploratory (one year duration), prohibited "finning", restricted fishing gears, established seasons, restricted fishing area, limited by-catch of other species in the directed shark fishery, restricted the recreational fishery to hook and release only, and specified scientific data requirements. The non-restrictive catch levels approximated the reported landings of these species in Atlantic Canada in 1992 and were not based upon estimates of stock abundance. License eligibility criteria required active participation in the directed fishery in four of the previous five years, as documented by sales records. In addition, a limited number of licenses could be issued in areas of Atlantic Canada where there had been no previous fishing effort directed at these species. Exploratory licenses are valid only for the year that they are issued with no obligation that they be re-issued in the future. Fins could only be sold in proportion to a maximum of five percent of dressed carcass weight aboard a vessel and could not remain aboard the vessel after the associated carcasses were removed. Fishing gears to be used in the directed fishery were limited to longline, handline or rod and reel gear for commercial licenses and to rod and reel only for recreational licenses. The Management Plan included provision for restricting fishing seasons although there were no restrictions imposed in 1995. Vessels less than 65 ft in length were restricted to home areas by the Sector Management Policy of DFO, and specific time/area closures were implemented for all vessels to limit by-catches of bluefin tuna and small swordfish, where these were known to be a problem. Recreational licenses were limited to hook and release until such time as suitable criteria were developed which might allow for the retention of sharks by recreational anglers. These criteria have not yet been developed. The Management Plan made provision for the collection of catch and effort data, through completion and submission of logbooks, and for collection of sampling data (species, sex, length, weight) for each shark landed, through a dockside monitoring program (DMP).

The Management Plan was rolled over into 1996, with minor modifications, to provide time for the development of the more comprehensive plan. The latter was developed in 1996 and was finally released as the Canadian Atlantic Pelagic Shark Management Plan 1997-99 (Anon., 1997) in early 1997. The current Management Plan is designed to govern the exploitation of large pelagic shark species (porbeagle, blue, shortfin mako and other sharks, excluding spiny dogfish) during 1997 - 1999. The vision of this plan is the maintenance of a biologically sustainable resource supporting a self-reliant fishery. Conservation will not be compromised and a precautionary approach will guide decision-making. The specific objectives are:

- To provide for a reasonable scientific basis for management. This implies the collection of information essential to assess the health and potential of shark stocks in Canadian waters and which allow establishment of yield and effort levels for long-term sustainable harvesting.

- To control the commercial and recreational shark fisheries in Atlantic Canada so that they are economically viable in the long-term. To be viable implies the ability to survive downturns with only a normal business failure rate and without government assistance.

- To foster partnerships with the industry on the scientific study and management of this resource.

The current fishery is at the commercial and stock assessment stage, in which the emphasis is on determining whether or not the resource can sustain a commercially viable operation, and on collecting scientific data in order to build databases for stock assessment purposes. In this context, the fishing licences are considered exploratory.

During 1998 and 1999, discussions will be held to develop the shark management plan for 2000 and beyond.

## Population Biology

*Stock Structure*

Research programs on shark distributions rely mainly on tagging studies. In 1962, the United States National Marine Fisheries Service (NMFS) initiated a shark tagging program which relied heavily on the volunteer participation of sport and commercial fishers. These program activities, although heavily concentrated in the northeastern US, have become international in scope and at the end of 1994, taggers from 31 countries were involved (Casey et al, 1995). This program has tagged 942 porbeagle sharks between 1962-97 within the coastal waters of New England and the Canadian Atlantic; 96 have been recaptured and indicate movement within this area. To date, there is no evidence of long distance migrations like those of the blue or mako shark (Kohler and Natanson, pers comm).

From 1961-84, Canada conducted a number of projects to tag large pelagic fishes, mainly swordfish and tunas; in a number of cases, sharks caught incidentally during these projects were also tagged (Burnett et al. 1987). Eight porbeagle were tagged; none have been recovered. In 1994, Canada initiated a shark tagging program in cooperation with sport and commercial fishers. Since the inception of the shark tagging program, 270 porbeagle sharks have been tagged and released throughout the Canadian Atlantic. To date, twelve recoveries have been made. One recapture was made in the Gulf of Maine and one on the Grand Banks; the other ten were all recaptured on the Scotian Shelf. These returns do not indicate TransAtlantic movement.

Aasen (1963) reported that 92 porbeagle sharks had been tagged in the northwest Atlantic in 1961. He indicated that porbeagles tagged on Platts Bank in the Gulf of Maine had been recaptured on the Scotian Shelf, in the Gulf of St. Lawrence, and on the Grand Banks. Myklevoll (1989) indicated that a total of about 550 porbeagle sharks had been tagged in the northwest Atlantic and that 47 recaptures have been reported; however he reported no details of recapture locations.

Stevens (1990) reported that 26 porbeagle sharks had been tagged by recreational anglers in the coastal waters of England. Eight recaptures ranged from northern Norway to northern Spain and he concluded a homogeneous stock structure in the eastern Atlantic. Porbeagle sharks have also been tagged by recreational anglers in coastal waters of Ireland (Green, pers. comm) but no details are available.

As stated earlier, porbeagle sharks are thought to prefer cold temperate waters. Castro (1983) suggested that they preferred waters colder than 19°C, while Scott and Scott (1988) suggested that the preferred temperature is colder than 16°C. Preliminary data collected recently by commercial fishers in the Canadian Atlantic indicate this preference is in the the range of 10-14°C. Carey et al. (1981) and Block and Carey (1985) demonstrated that porbeagle maintain an elevated body temperature, as much as 5°C above ambient water temperature, by means of a large suprahepatic rete mirabile, or counter-current heat exchanger. This capability likely contributes to the tolerance or preference of these relatively cold temperatures. This cold water temperature preference would largely restrict the species distribution to the north temperate waters of the Canadian continental shelf. It would also limit the occurrence of this species off the eastern United States.

In summary, the stock structure of the porbeagle shark is presently unknown, although the history of the fishery suggests that separate populations may exist in the east and west Atlantic. Based on tagging, there is no evidence of long distance migrations, as in blue and mako sharks and for pragmatic purposes, the stock is defined by NAFO Subareas 3 to 6.

*Reproduction*

Porbeagles are ovoviviparous and oophageous, with litter size ranging from 1 to 5 (Compagno, 1984). Males mature between 150 - 200 cm in total length while females mature between 200 - 250 cm (Aasen, 1961). This provides an age at first maturity of four and eight for males and females respectively (see below). Aasen (1963) observed no embryos in mature females during July - September, while large embryos were reported by fishermen on Flemish Cap in late May. Similar observations had been made in the Gulf of Maine in November and January (Bigelow and Schroeder, 1948). This suggests that parturition occurs in the spring (late May - early June), a time when porbeagle ascend from the deeper water into the surface water and feed intensively (Aasen , 1963). Aasen (1963) felt that porbeagle reproduce every year and that gestation (development of the embryo) lasts about 8 months. These observations and the presence of full sperm sacs in the female point to an autumn (September - October) mating, and suggest a gap between parturition and mating. Gauld (1989) reports that off the Shetlands, mating occurs later, in December - January, while parturition occurs in summer or autumn, rather than the spring. It may be that the reproductive cycle is later in the Northeast Atlantic.

Aasen's (1963) estimate of eight months for the length of gestation is at variance with estimates made by other authors. Based on the size frequency of embryos that he observed, Shann (1923) reported that gestation could take two years. Holden (1974) pointed out that, based on Aasen's (1963) data, growth in the first year of life was about 20cm/year. He pointed out that length at birth is around 66 - 75 cm (Aasen, 1963) with an $L_0$ of 72 cm. Holden (1974) considered that the production of such large young after only eight months would require an in-utero growth rate of 100 cm/year. He felt that this was unreasonable and indicated a longer gestation period. More recently, preliminary analysis by Pratt (pers comm) of material collected in the Canadian Atlantic in October/November 1993 and April 1994 tends to suggest that gestation is about eight months duration. The majority of females examined in the fall were gravid, supporting an annual reproductive cycle.

Based on the above, it is suggested that mating in the Northwest Atlantic occurs in September - October. The embryos grow in the uterus and are born the following spring. The mean number of embryos born per female observed by Aasen (1963) was 3.7, or about two per horn of the uterus. If gestation is only 8 months long and the reproductive cycle is annual, then maximum average pup production is four per year.

*Movements*

Observations on many shark species suggest that there is segregation by sex and size (Pratt, 1979). In some cases, after mating, the pregnant females move to separate areas during gestation and pupping. The females appear to remain separated from males and juveniles until the next breeding season. Pups are seldom observed with juveniles or adults of either sex, suggesting the existence of discrete nursery areas. There are observations from commercial fisheries that support sex segregation in porbeagles. Gauld (1989), in his observations of the 1987-88 winter fishery off the Shetland Islands, noted a sex ratio (M/F) of 1:1.3. In the Spanish swordfish longline fishery off Spain and the Azores, the majority of porbeagle bycatch occurs in the winter with males outnumbering females two to one (Mejuto, 1985), suggesting a seasonal difference in distribution by sex. In the first year of commercial exploitation of this species in the northwest Atlantic, Aasen (1963) reported an overall sex ratio of 1:1, with some catches containing marked predominance of one or the other sex. He concluded shoaling by sex. In examining the July - September 1961 fishery, he also noted that the size of porbeagles increased from west to east and concluded that the migration was size specific.

Size composition data collected by the DFO Scotia-Fundy Fisheries Observer Program (FOP) from 1987-96 were used to evaluate the seasonal migration of porbeagle sharks in the Canadian Atlantic. These data come from 1032 sets made by Faroese and Canadian offshore vessels directing for porbeagle (tables 1 and 2, figures 1 and 2). Aasen (1961) indicated that female porbeagle in the northeast Atlantic matured between 200-250cm. Here, 200cm is used as an estimate of size at first maturity. The number of porbeagle caught by sex, the sex ratio, and the proportions of females greaster than 200cm were used to examine the seasonal migration of the porbeagle shark in the Canadian Atlantic.

Catches in March occur primarily on the edge of the Scotian Shelf between Georges Bank and Sable Island. Males are predominant in March catches (sex ratio 1.5:1 male:female) (Table 3). Females in March catches are mostly immature, only 7% of females caught in catches were mature (based on first maturity at 200cm, Aasen 1961) (Table 3, Figure 1). This suggests that mature females have segregated away from the main body of the population. The mean size of females of 151cm is much lower than 163cm for males, due to few large females in catches (Table 3, Figure 1a). The fishery extends eastward along the Shelf edge in April. Although there are more females in the catches, males are still predominant and the sex ratio is 1.3. The size compositions and percent mature females are similar to March. As fishing progresses up onto the Shelf in May, males are still predominant in catches and sex ratio remains 1.3. However there is an increase in the proportion of larger porbeagle in the catches. The mean size of 179cm of males is still larger than of females (172cm). The proportion of mature females in catches increases, and 23% of females are mature. As fishing extends further onto the Shelf and eastward in June, males are still predominant in catches, but the sex ratio falls to 1.2. There is a further increase in the proportion of larger sharks in the catches. The mean size of both sexes increases, males to 183cm and females to 179cm, and 27% of females in the catch are mature. Very small porbeagle (80+cm) first appear in catches on the Shelf in June/July, and may be young-of-the-year, consistent with the length at $t_0$ of 72cm from the von Bertalanffy growth curve of Aasen (1963). Fishing progresses into the Gulf of St. Lawrence and onto the Grand Banks in late June/early July. On the Shelf, the sex ratio is 1.0 in July and less than one through August, September and October. Mean size falls to approximately 170cm for both sexes in July and August and decreases further in September on the Shelf. The majority of females in catches on the Shelf are immature. In November and December, males predominant in catches again on the Shelf and mean size of both sexes increases.

In the Gulf, catches are predominantly males in July (sex ratio 2.3) and are composed primarily of large porbeagle. Mean size of males and females are 193cm and 180cm respectively and 29% of females are mature. In August, there are more females in the catch. The sex ratio is 0.8 and the mean size of males decreases to 186cm while for females, mean size increases to 190cm and 40% of females are mature. In September, the sex ratio decreases to 0.7 and mean size of males decreases to 177cm but mean size of females remains at 188cm and 38% of females are mature. In October, the mean size of females drops to 164cm and only 13% of females are mature. The mean size of females in November is 170cm and 20% are mature. There are predominantly large porbeagle in catches initially but mean size decreases through to November

On the Grand Banks, primarily large porbeagle of both sexes occur in June catches. In August, catches are still primarily of large porbeagle with 46% of the females being mature. Females are predominant in catches in September to November, and mean size increases for both sexes. The proportion of mature females increases from 47 to 84%.

In summary, males and immature females predominate in catches on the Shelf edge in March and April. The data indicate that mature females segregate from the main body of the population during this period. This would be consistent with segregation of gravid females. The proportion of mature females in the catches increases in May and June and this would be consistent with segregation of females during parturition, which is believed to occur in May/June. Fish move onto the Shelf in May and eastward along the Shelf in May and June, moving into the Gulf of St. Lawrence and onto Grand Banks in late June/early July. Larger porbeagle move off the Shelf into the Gulf of St. Lawrence and onto the Grand Banks first, followed by the younger sharks; males may move earlier than females. Large porbeagle begin to leave the Gulf in September and large females predominate catches on the Grand Banks in September to November. This is when mating is believed to occur and aggregations on the Grand Banks are likely mating aggregations.

These observations were generally confirmed during the industry consultation. The offshore sector noted that as the season progressed, sharks in their catches got larger whereas the opposite was experienced by the inshore sector on the Scotian Shelf. The offshore vessels, not limited by Sector Management, follow the larger porbeagle into the Gulf of St. Lawrence and onto the Grand Banks, while inshore vessels restricted to the Scotian Shelf likely exploit primarily juveniles during the summer and early fall period.

*Growth and Natural Mortality*

Since O'Boyle et al (1996), there is no new information to report on growth and mortality. However, modes occur in the fishery size frequency data. It might be possible to use this to confirm or otherwise, the Aasen (1963) growth model currently being used. Also, MFD has undertaken a joint age and growth study with NMFS which will use this information.

## The Fishery

*Landings Trends*

As more fully reported in O'Boyle et al (1996), the fishery for porbeagle started in the Northeast Atlantic prior to 1930 (Table 4). During 1930-65, Norway was the principle harvester. In the early 1960s, the Norwegian fleets left the Northeast Atlantic and exploited the relatively virgin resource in the Northwest Atlantic (Figure 3). The population apparently collapsed by the mid - 1960s (Myklevoll, 1989) and the Norwegian fleet returned to the Northeast. After a peak in landings in the early 1970s, the yield has remained low.

In the Northwest Atlantic, annual landings in the Norwegian fishery peaked at 8060t in 1964, the highest ever observed, either before or since (Figure 4). At about the same time, the Faroese fleet entered the fishery, with landings over 1000t reported in 1964-65. While the Norwegians left the area, the Faroese remained, annually catching about 350t until the late 1980s. Since 1987, landings by the Faroese fleet, as reported by Canadian observers, increased to 1199t and 1171t in 1991 and 1992 respectively. This fleet was restricted to 400t in 1993 and was excluded from the Canadian zone thereafter. It is interesting to note that the rise of Faroese landings during 1991-92 was coincident with this fleet leaving the high seas salmon fishery (Windsor and Hutchinson, 1994). It is also worthwhile noting that the 1987 - 93 Faroe landings, as reported to NAFO, are lower than the Canadian observer estimates. The FOP estimates are used in this assessment.

| | **1987** | **1988** | **1989** | **1990** | **1991** | **1992** | **1993** |
|---|---|---|---|---|---|---|---|
| **FOP** | 381 | 374 | 479 | 551 | 1199 | 1171 | 467 |
| **NAFO** | 260 | 270 | 456 | 530 | 610 | 559 | |

The Japanese fleet reported modest landings in the late 1960s. More recently, the US has reported minor landings of porbeagle and France (SP) reported 39t for the first time in 1996.

The Canadian fleet caught minor amounts of porbeagle until 1991, when effort dramatically increased. Canada became the main exploiter of porbeagle in the North Atlantic when the

Faroese was restricted from the Canadian zone in 1994. The recent TAC and Canadian landings history for porbeagle are:

| Year | 1995 | 1996 | 1997 |
|---|---|---|---|
| **Catch Limits** | 1500 | 1500 | 1000 |
| **Canadian Catch** | 1375 | 1015 | 1338 |

It is important to note that, contrary to the non-restrictive catch limits set in 1995 and 1996, the 1997 TAC is a true harvest limit that should not in principle be overrun. However, in 1997, exactly this happened. Trip hails are used to monitor landings against a TAC. When the total of the hails is within a certain percent of the TAC, the fishery is closed. The final landings are subsequently tallied from the official statistical files. In 1997, some of the trip hails reported sharks, not specified, as being landed. Consequently, these landings were not counted against the porbeagle quota. When the landings reports were subsequently made, it was realized that the 1997 TAC had been overrun.

In 1997, landings were 1338t, up from the 1015t of 1996 but below Canadian landings of 1550 and 1375 t in 1994 and 1995 respectively. It should be noted that at time of writing of this report, 1304t of this total had been assigned by fleet. The following tables are based on the 1304t catch. Preliminary reports for 1998 indicate that landings are down at the beginning of the season (Table 5). In the industry consultations, it was felt that this was due to abnormally cold water temperatures in the fishing area. Drinkwater (pers comm) confirmed that a body of cold water was first observed on the Halifax line and further south in October 1997. By December, this water was starting to penetrate into the Emerald Basin and by February 1998, temperatures in the Basin were abnormally low by about one degree. This cold water is currently entering the Gulf of Maine.

Porbeagle are also caught incidentally to other Canadian fisheries (Table 6). However, reported landings of this activity are very low, compared to the directed fishery.

*Seasonal Trends in the Fishery*

During 1987 - 93, the Faroese fleet was fully observed by DFO. Thus, there is very accurate information on when and where this fleet was fishing, and the size composition of the catch. Unfortunately, the size composition information is only currently available for the Scotia-Fundy FOP. Table 7 provides an overview of this fleet's landings by year, month, and area. Fishing occurred in two pulses during the year - March to June and September to November.

For the Canadian fishery, the analysis of temporal and spatial patterns was made possible by the compilation of set by set logbook information for 1991 - 97. This dataset was also used in the catch rate analysis presented later in the section on Resource Status. The Canadian fishery can be considered as composed of two fleets - those vessels greater than 100 ft length overall (LOA) and the rest being primarily smaller vessels in the 40 - 60 ft LOA range (Table 8).

The seasonal movements of the vessels greater than 100 ft LOA (Figure 5, Table 9a) show initial fishing in the south, with movement up the coast as the season progresses. From an inter-annual perspective (Figure 6), this fleet did not fish as extensively in 4T after 1994, as in previous years. Also, landings of this fleet sector declined from a maximum of 1457 t in 1994 to 846t in 1997. It should be kept in mind however that effort dramatically dropped in 1996 with the loss of one of the three vessels fishing. In 1995, this fleet fished 416 sets. This compares to 286 sets fished in 1997, an almost 30 percent drop in effort.

The seasonal fishing patterns of the remaining vessels are quite different (Figure 7, Table 9b). This fleet fishes throughout the year almost exclusively in 4WX, with some fishing in SA 5. As seen from the inter-annual pattern (Figure 8), this has not changed over time, except for an overall increase in effort. This fleet is far more active now than in 1994, when it first recorded significant landings.

*Size Composition of the Landings*

Size composition information in the 1987 - 93 offshore fishery is available from the FOP. This has been presented earlier in Figure 2. As stated above, only the data for the Scotia-Fundy FOP was available.

Catch size composition information has also been collected directly by the Canadian fishing industry. During 1995 - 96, a special study was undertaken to capture lenth and weight data of individual sharks for all sharks caught on one of the offshore vessels. In addition, since 1996, the dressed weights of individual sharks have been collected on receiving tallies. This information is to be supplemented with length data in 1998. So far, a data base of these data has been established but more data processing is required to provide a consistent dataset of size frequency information.

## Resource Status

The only sources of information available to determine resource abundance trends are commercial catch rates (CPUE) from the Faroese and Canadian fleets. Regarding the former, the fleet was 100 percent observed from 1987 to 1993, the last year this fleet operated in the Canadian zone. Unfortunately, only the Scotia-Fundy FOP dataset was available by the time the analyses below were undertaken.

Regarding the Canadian fishery, as stated earlier, much of the logbook information since 1991 has been processed and has been used in the analysis below. Observer information on the Canadian fishery is relatively sparse (only one observed trip in 1997) and has not been used. This is the first analysis of catch rates for this fishery utilizing Canadian commercial logbook data. The data for the Canadian offshore fishery have been combined with those from the Faroese fishery in a multiplicative analysis to provide trends in catch rates and, by assumption, relative abundance, during 1987 - 97. In all cases, catch rate is defined as kg per hook. Also, it should be noted that null sets were not included (no information on these). Otherwise, all set information was included. Finally, a lognormal distribution was assumed in all analyses.

As mentioned earlier, the Canadian inshore fishery is relatively new, having increased in effort only since 1994. As well, this fleet has undergone catch rate improvements normally associated with a developing fishery. Consequently, the CPUE trends are not used as abundance indices.

*Offshore Catch Rates*

There have only been a handful of vessels involved in the offshore fishery since 1987. The raw, unstandardized catch rate trend during 1987 - 97 (Figure 9a) indicates an overall decline from about 3.5 kg/hk in 1990 to below 2 kg/hk in 1996, with a small increase in 1997. Over the same period, there was a rise in both the total number of hooks and sets to reach a peak in 1994 with a reduction thereafter, this being explained by the exit of one of the offshore vessels from the fishery, as explained earlier (Figure 9b). However, the number of hooks per set has increased as well (Figure 9c), a trend which produces a relatively constant catch per set (Figure 9d). Catch per hook is considered to be more reflective of abundance than catch per set.

An initial analysis of variance (ANOVA) of the catch per hook data was undertaken to resolve the significance of vessel, month, year, and area effects as well as interaction terms. As seen from the table below, inclusion of all offshore data into one analysis resulted in a number of significant interaction terms, which confound the main effects, including year.

| | Df | Deviance | Resid. Df | Resid. Dev | F Value | Pr(F) |
|---|---|---|---|---|---|---|
| NULL | | | 2997 | 3494.029 | | |
| YEARC | 10 | 125.6722 | 2987 | 3368.357 | 13.67923 | 0.000000000 |
| MONTHC | 10 | 107.5742 | 2977 | 3260.783 | 11.70929 | 0.000000000 |
| CFV | 4 | 56.4145 | 2973 | 3204.369 | 15.35158 | 0.000000000 |
| REGION | 5 | 13.9951 | 2968 | 3190.373 | 3.04670 | 0.009540898 |
| YEARC:MONTHC | 62 | 266.6517 | 2906 | 2923.722 | 4.68139 | 0.000000000 |
| YEARC:CFV | 11 | 52.8501 | 2895 | 2870.872 | 5.22968 | 0.000000033 |
| YEARC:REGION | 34 | 89.4144 | 2861 | 2781.457 | 2.86254 | 0.000000075 |
| MONTHC:REGION | 35 | 107.0304 | 2826 | 2674.427 | 3.32860 | 0.000000000 |
| CFV:REGION | 18 | 44.8218 | 2808 | 2629.605 | 2.71044 | 0.000126687 |
| MONTHC:CFV | 31 | 78.3528 | 2777 | 2551.252 | 2.75116 | 0.000000767 |

Exploratory analyses were then undertaken to see if further breakdown of the dataset would eliminate the interaction terms. Specifically, as the porbeagle fishery is characterized by separate April - June Scotian Shelf and September - November Grand Banks concentrations of effort, we next focused the analysis on these two predominant fisheries. The ANOVA tables for these two seasons are given below. As the Newfoundland FOP data was not available, the fall analysis was restricted to 1991 - 97. It is interesting to note that whereas the raw CPUE for the spring fishery (Fig 10) declined during 1991 - 97, that for the fall fishery (Fig 11) first declined, increased to 1996 , and then declined in 1997. If the population movements described above are correct, the spring catch rates would be reflective of smaller sharks than those in the fall on the Grand Banks. The fall fishery may be fishing the mating aggregations which would complicate interpretation of catch rates as an abundance index. For this reason, only the spring catch rates were considered further.

**GRAND BANKS (SA 2-3), SEPT-NOV**

| | Df | Deviance | Resid. Df | Resid. Dev | F Value | Pr(F) |
|---|---|---|---|---|---|---|
| NULL | | | 553 | 402.8235 | | |
| CFV | 4 | 36.02580 | 549 | 366.7977 | 15.42076 | 0.0000000 |
| YEARC | 6 | 29.99538 | 543 | 336.8023 | 8.55964 | 0.0000000 |
| MONTHC | 2 | 1.90732 | 541 | 334.8950 | 1.63285 | 0.1963769 |
| YEARC:MONTHC | 12 | 18.32061 | 529 | 316.5743 | 2.61403 | 0.0021526 |
| YEARC:CFV | 4 | 5.64994 | 525 | 310.9244 | 2.41844 | 0.0476732 |
| MONTHC:CFV | 7 | 8.38815 | 518 | 302.5363 | 2.05173 | 0.0471605 |

**SCOTIAN SHELF (SA 4WX), APRIL-JUNE**

| | Df | Deviance | Resid. Df | Resid. Dev | F Value | Pr(F) |
|---|---|---|---|---|---|---|
| NULL | | | 1247 | 1510.060 | | |
| YEARC | 10 | 116.9101 | 1237 | 1393.150 | 11.68362 | 0.0000000 |
| CFV | 4 | 26.8831 | 1233 | 1366.267 | 6.71653 | 0.0000241 |
| MONTHC | 2 | 14.7531 | 1231 | 1351.514 | 7.37191 | 0.0006581 |
| REGION | 1 | 1.2327 | 1230 | 1350.281 | 1.23191 | 0.2672630 |
| YEARC:MONTHC | 19 | 80.0773 | 1211 | 1270.204 | 4.21193 | 0.0000000 |
| YEARC:REGION | 10 | 42.3895 | 1201 | 1227.815 | 4.23627 | 0.0000083 |
| YEARC:CFV | 8 | 28.9668 | 1193 | 1198.848 | 3.61856 | 0.0003621 |
| CFV:REGION | 4 | 8.1405 | 1189 | 1190.707 | 2.03384 | 0.0874803 |
| MONTHC:REGION | 2 | 2.3432 | 1187 | 1188.364 | 1.17085 | 0.3104625 |
| MONTHC:CFV | 8 | 8.6184 | 1179 | 1179.746 | 1.07662 | 0.3768430 |

A number of further data explorations were undertaken to see if the interaction terms could be eliminated. Various month, area and vessel combinations were attempted. Year - vessel interactions were eliminated by removal of vessels that prosecuted the fishery for under four years each, although, as seen from the following table, other interactions with year persisted.

| | Df | Deviance | Resid. Df | Resid. Dev | F Value | Pr(F) |
|---|---|---|---|---|---|---|
| NULL | | | 894 | 1109.615 | | |
| YEARC | 10 | 112.7866 | 884 | 996.828 | 11.06045 | 0.0000000 |
| MONTHC | 2 | 11.1279 | 882 | 985.700 | 5.45633 | 0.0044215 |
| CFV | 2 | 2.7426 | 880 | 982.958 | 1.34475 | 0.2611643 |
| REGION | 1 | 0.8385 | 879 | 982.119 | 0.82223 | 0.3647874 |
| YEARC:MONTHC | 18 | 75.5499 | 861 | 906.570 | 4.11601 | 0.0000000 |
| YEARC:REGION | 10 | 34.1242 | 851 | 872.445 | 3.34640 | 0.0002754 |
| CFV:REGION | 1 | 2.3830 | 850 | 870.062 | 2.33687 | 0.1267188 |
| MONTHC:CFV | 3 | 6.3598 | 847 | 863.703 | 2.07893 | 0.1014949 |
| MONTHC:REGION | 2 | 2.9943 | 845 | 860.708 | 1.46816 | 0.2309375 |
| YEARC:CFV | 3 | 2.0971 | 842 | 858.611 | 0.68550 | 0.5610283 |

Therefore six unique area-month models (4W - 4X, April - June) were run to avoid the interactions with year. All except the 4X June model were significant (Table 10, Figure 12). April catch rates in 4W exhibit high variability with no trend (fig 12a) whereas those in 4X in the same month undergo a consistent decline since the late 1980s (fig 12b). In May, 4W catch rates undergo a significant decline in 1988 and 1989, rise to relatively high rates by 1991 and then decline thereafter (fig 12c). In 1997, catch rates increase from the low values observed in 1996. In contrast, the 4X May catch rates (fig 12d) initially rise to a series high in 1989, are relatively stable until 1993 and decline thereafter. Again, catch rates increase between 1996 and 1997. In June, 4W catch rates (fig 12e) were very high in the late 1980s and have declined since with again a modest rise between 1996 and 1997. The observed catch rates for 4X in June (fig 12f) show high values in the late 1980s - early 1990s with a decline thereafter. Unfortunately there is no data for 1997.

*Offshore Catch Rates by Shark Size*

Analyses were undertaken to determine if changes in shark size composition in the fishery throughout the year could account for the interaction with year effects observed in the models given above. Set by set total length frequency data for one of the vessels were available from the FOP. Data have also been provided by industry - largely interdorsal lengths as well as over 2500 fork length/interdorsal length pairs. Regression analysis of these data gave a good fork length to interdorsal length relationship (Table 11), which, in conjunction with the total length to fork length relationship

Fork Length = 1.794 + 0.897 (Total Length)

of Kohler et al (1993), was used to convert the interdorsal length information into total lengths. These data were then matched to the set by set catch and effort data and the mean length of porbeagle in that set calculated. An examination of the catch rates by mean length per set for each year (Figure 13) indicated a difference in catch rates for sets with sharks of a mean length above and below 180 cm. Therefore, the catch rates for one of the offshore vessels was reanalysed using year, month (April - June) and shark length (LT and GE 180 cm) as factors. Due to data availability, area had to be restricted to 4WX, and 1988, 1994, and 1997 were lost from the analysis. Also, 1996 was reduced to the month of May, and had only one mean length across all sets (a trip length frequency).

The ANOVA model below shows only one significant interaction with year, and that is with length.

| | Df | Deviance | Resid. Df | Resid. Dev | F Value | Pr(F) |
|---|---|---|---|---|---|---|
| NULL | | | 401 | 457.6230 | | |
| LENFAC | 1 | 39.94797 | 400 | 417.6750 | 44.53313 | 0.0000000 |
| YEARC | 7 | 35.03086 | 393 | 382.6442 | 5.57881 | 0.0000040 |
| REGION | 1 | 0.94448 | 392 | 381.6997 | 1.05288 | 0.3055216 |
| MONTHC | 2 | 0.63261 | 390 | 381.0671 | 0.35261 | 0.7030898 |
| LENFAC:REGION | 1 | 5.57161 | 389 | 375.4955 | 6.21111 | 0.0131368 |
| YEARC:LENFAC | 6 | 29.54785 | 383 | 345.9476 | 5.48988 | 0.0000185 |
| MONTHC:LENFAC | 2 | 6.26908 | 381 | 339.6785 | 3.49432 | 0.0313866 |
| MONTHC:REGION | 2 | 2.45188 | 379 | 337.2267 | 1.36665 | 0.2562578 |
| YEARC:REGION | 5 | 3.38286 | 374 | 333.8438 | 0.75423 | 0.5833981 |
| MONTHC:YEARC | 8 | 5.52740 | 366 | 328.3164 | 0.77023 | 0.6292662 |

The nature of the interaction between year and length, depicted in Figure 14, is interesting. While catch rates decline over time, on an annual basis, whenever catch rates for large sharks increase, the catch rates for small sharks decline, and vice versa. This may be related to porbeagle segregating by size and/or maturity. This requires further examination. Splitting the dataset by larger/smaller sharks gave the model provided in Table 12 for sharks under 180cm total length. With both 4W and 4X, plus April - June, there are no significant interactions with year.

Regarding large sharks, there is insufficient data to eliminate the interactions with year (see table below) and thus the analysis was not pursued further.

| | Df | Deviance | Resid. Df | Resid. Dev | F Value | Pr(F) |
|---|---|---|---|---|---|---|
| NULL | | | 142 | 156.1461 | | |
| YEARC | 6 | 15.52572 | 136 | 140.6204 | 2.867085 | 0.0118668 |
| REGION | 1 | 7.86325 | 135 | 132.7571 | 8.712488 | 0.0037702 |
| MONTHC | 1 | 2.62751 | 134 | 130.1296 | 2.911282 | 0.0904255 |
| MONTHC:REGION | 1 | 7.30488 | 133 | 122.8247 | 8.093813 | 0.0051855 |
| MONTHC:YEARC | 3 | 7.47306 | 130 | 115.3517 | 2.760053 | 0.0449693 |
| YEARC:REGION | 4 | 1.63331 | 126 | 113.7183 | 0.452426 | 0.7704657 |

*Inshore Catch Rates*

With no data for this component of the fishery prior to 1994, and very little data prior to 1996, the inshore catch rates are not considered indicative of abundance trends. A preliminary analysis of 4WX catch rates for directed and licensed vessels less than 100ft LOA, shows a consistent increase in catch rates since 1995. Such a trend is however symptomatic of a learning curve for new entrants to the porbeagle fishery, and has been observed with other new vessels even when prevailing trends among experienced fishers was downward. As the majority of the licenses for this component did not become active until 1996, it is likely that an appropriate time series of index catch rates can only be initiated in 1998.

*Summary*

The Norwegians and Faroese exploited a virgin resource in the early 1960s and with landings of over 9000t, apparently collapsed the population. During the 1970s and 1980s, the Faroese caught about 350t annually. Given the low productivity of porbeagle, the population likely recovered only slowly during this period. In the late 1980s, the first time that reliable catch rate data are available, the Faroese fleet increased its effort and pushed catch over 1000t. Canadian fishing effort increased in the early 1990s, however that for the offshore subsequently decreased from the mid-1990s while that for the inshore increased. Prior to 1992, catch rates were relatively high, compared to subsequent years. Since 1994, landings have averaged 1306t, and during this period, depending on the area and season chosen, catch rates have either remained stable or declined.

## Outlook

Since the 1996 assessment (O'Boyle at al. 1996), considerable progress has been made to improve the assessment of Subarea 3 - 6 porbeagle shark. Data sets have been established on the catch, effort and size composition of the fishery, as well as sampling protocols put in place to ensure the collection of this information in the future. However, much remains to be done and it is not possible at this time to provide an assessment based on Sequential Population Analysis (SPA) and Yield Per Recruit (YPR) models, as applied in many stock assessments. However, the catch rate trends presented in the previous section show some evidence of abundance declines since the mid 1990s and are a source for concern. This is particularly relevant when one considers that the fishery is for scientific monitoring purposes.

O'Boyle at al (1996) provide an analysis of the sensitivity of this resource to exploitation, based on the equilibrium model of Brander (1981), which is a modification of that of Holden (1974). At that time, it was considered that E, the annual litter size, could be either two or four, depending on whether or not gestation lasted 8 or 20 months. Recent work by Pratt (pers comm) suggests that the gestation period is 8 months and thus E is four. If one assumes $t_m$, the mean age of first maturity of a female as eight, and natural and thus immature shark mortality ($Z_i$) as 0.18, then total mortality on the adults could go as high as 0.47 (Figure 15). If 0.18 of this has to account for natural mortality, this allows a maximum of 0.29 for fishing mortality. As pointed out by O'Boyle et al (1996), these calculations are very sensitive to the estimates of $Z_i$, E and $t_m$. For instance, increasing $t_m$ by two years to 10 decreases the replacement $Z_m$ to 0.33, while decreasing it by two years increases the replacement $Z_m$ to 0.68. The sensitivity of Zm to Zi is given in Figure 15. For E and $t_m$ of 4 and 8, increasing Zi above 0.18 will result in Zm falling below Zi at a Zi value of about 0.25. From the commercial size composition information, it is evident that a large part of the catch is of immature animals and thus Zi is likely to be greater than 0.18. The uncertainties in these relationships underline the need to take a precautionary approach to the harvesting of the resource.

Porbeagle sharks are long-lived, and produce low numbers of offspring. This combination of life history characteristics makes porbeagle sharks highly susceptible to over-exploitation. The high catch levels experienced in the early 1960s did not appear sustainable. However, the fishery appeared sustainable during the 1970s and 1980s when landings averaged 350t annually. The catch level of 1,500t in the 1995 and 1996 Management Plans was not based upon estimates of stock abundance and may not be sustainable. Since 1991, landings have averaged about 1500t annually, and there is some evidence from spring catch rates to suggest that abundance may have declined. Given the uncertainties in our knowledge of the resource, it would not be prudent to harvest above the 1997 TAC of 1000t until the observed recent declines in catch rates can be explained. Further, while a 1000t TAC in 1998 would represent a reduction in catch, it is uncertain if this reduction would be sufficient to arrest the decline in population abundance suggested by the decline in catch rates.

It is very important that the provisions of the 1997-99 Shark Management Plan be implemented to ensure orderly harvesting of the resource. In particular, the scientific component to collect the information necessary to fill the identified knowledge gaps should be enhanced.

This species is part of a large pelagic species complex that includes tunas, swordfish, billfishes, and other species of large sharks. Management of the porbeagle shark fishery needs to consider interactions with other species in the complex.

The stock area of this species extends beyond the Canadian Zone. Management of this resource in the future could benefit from bilateral cooperation. Notwithstanding this, benefits to Canadian fisheries could be realized through unilateral action.

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## Appendix I. Pre-RAP Presentation of Porbeagle Assessment Results to Industry and DFO Science

As a prelude to the presentation, it was noted that this is the second stock assessment for porbeagle in Canadian waters, and much is left to be done. In particular, most of the time leading up to this meeting was spent in compilation and confirmation of the basic catch-effort data. A more complete analysis of the data must await the next assessment cycle.

Trends presented in the biological review of porbeagle were generally accepted. The offshore industry agreed that smaller individuals were caught only on the Scotian Shelf in the fall, and that larger individuals were caught more often on the Grand Banks. The spatial patterns in size described from observer data of offshore vessels were not seen by the inshore vessels, mainly because they were restricted to fishing on the Scotian Shelf, as inshore vessels are limited to home ports by the DFO Sector Management Policy.

Further analysis of these data are required to determine if distribution is affected by water temperature, and if the modes in the length frequency plots represent age groups.

Most of the discussion focused on the offshore catch-effort data, since the inshore data only started being collected seriously in 1995. The catch figures were accepted as given, although it was noted that the decline in landings over the last 1-2 years was due in part to the sale of one of the three offshore vessels which directed for porbeagle. The 1997 effort data for the inshore fleet is believed to be more accurate than that of previous years; the accuracy of the offshore catch and effort data was discussed and this resulted in a sebsequent comparison of data.

Interpretation of the catch rate trends was not straight forward. Further analysis is required to determine if the catch rates for April and June are similar to those of May. In addition, the catch rates need to be disaggregated by vessel, given the recent loss of one vessel. Substantial shifts in the annual size composition indicate that the catch rates also need to be broken down by size category. These additional analyses may remove the interaction effects which currently confound the catch rate analysis.

Table 1. Distribution of Scotia-Fundy observed fishing nets.

| Year | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | 0 |
| 2 | | | | | | | | | | | 0 |
| 3 | | | | | | | 11 | 2 | 15 | 43 | 71 |
| 4 | 9 | | 27 | 30 | 25 | 48 | 55 | | 4 | 1 | 199 |
| 5 | 12 | | 30 | 30 | 53 | 46 | 55 | | | | 226 |
| 6 | | | 8 | 32 | 54 | 50 | 28 | | | | 172 |
| 7 | | | | | 21 | 26 | | | | | 47 |
| 8 | | | | | 2 | 25 | 28 | 5 | | | 60 |
| 9 | | | | | 71 | 51 | 9 | 28 | | | 159 |
| 10 | | | | | 10 | 31 | | | | | 41 |
| 11 | | | | | | 20 | | | 24 | | 44 |
| 12 | | | | | | | | | 13 | | 13 |
| Total | 21 | 0 | 65 | 92 | 236 | 297 | 186 | 35 | 56 | 44 | 1032 |

Table 2. Summary of Scotia-Fundy fisheries observer data (1987-96).

| Year | No. vessels | No. trips | No. sets | No. hooks | No. males | No. females |
|---|---|---|---|---|---|---|
| 1987 | 1 | 2 | 21 | 32544 | 610 | 478 |
| 1988 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1989 | 1 | 1 | 65 | 11136 | 3496 | 2341 |
| 1990 | 1 | 3 | 92 | 38496 | 4573 | 3789 |
| 1991 | 3 | 10 | 236 | 224506 | 8283 | 7691 |
| 1992 | 2 | 10 | 297 | 320134 | 7449 | 7105 |
| 1993 | 3 | 7 | 186 | 166380 | 6545 | 4955 |
| 1994 | 1 | 1 | 35 | 47080 | 391 | 381 |
| 1995 | 2 | 3 | 56 | 25152 | 1640 | 1186 |
| 1996 | 2 | 2 | 44 | 78273 | 1509 | 851 |
| Total | | 39 | 1032 | 943701 | 34496 | 28777 |

Table 3. Sex ratio of porbeagle catches in directed fishery (percent females caught), percent of females mature, and mean total length (ccm) by month by area from S-F Observer data (1987-96).

| area | month | number males caught | number females caught | total caught | sex ratio | percent female caught | percent female mature (200+cm) | mean length males | mean length females |
|---|---|---|---|---|---|---|---|---|---|
| Shelf | 1 | | | | | | | | |
| Shelf | 2 | | | | | | | | |
| Shelf | 3 | 2790 | 1832 | 4622 | 1.52 | 39.64 | 6.71 | 162.76 | 150.51 |
| Shelf | 4 | 9178 | 7035 | 16213 | 1.30 | 43.39 | 6.30 | 160.69 | 153.35 |
| Shelf | 5 | 8808 | 6716 | 15524 | 1.31 | 43.26 | 23.21 | 178.59 | 172.45 |
| Shelf | 6 | 5841 | 4853 | 10694 | 1.20 | 45.38 | 26.58 | 183.30 | 178.97 |
| Shelf | 7 | 780 | 775 | 1555 | 1.01 | 49.84 | 21.68 | 171.24 | 170.44 |
| Shelf | 8 | 51 | 84 | 135 | 0.61 | 62.22 | 33.33 | 172.67 | 173.14 |
| Shelf | 9 | 322 | 387 | 709 | 0.83 | 54.58 | 15.25 | 139.86 | 149.43 |
| Shelf | 10 | 176 | 190 | 366 | 0.93 | 51.91 | 16.32 | 168.55 | 163.22 |
| Shelf | 11 | 456 | 279 | 735 | 1.63 | 37.96 | 15.41 | 167.29 | 146.54 |
| Shelf | 12 | 79 | 47 | 126 | 1.68 | 37.30 | 63.83 | 199.99 | 209.15 |
| Shelf | total | 28519 | 22276 | 50795 | 1.28 | 43.85 | 17.05 | 171.39 | 165.25 |
| Gulf | 1 | | | | | | | | |
| Gulf | 2 | | | | | | | | |
| Gulf | 3 | | | | | | | | |
| Gulf | 4 | | | | | | | | |
| Gulf | 5 | | | | | | | | |
| Gulf | 6 | | | | | | | | |
| Gulf | 7 | 405 | 174 | 579 | 2.33 | 30.05 | 28.74 | 192.54 | 179.90 |
| Gulf | 8 | 260 | 327 | 587 | 0.80 | 55.71 | 39.76 | 186.04 | 190.45 |
| Gulf | 9 | 1503 | 2083 | 3586 | 0.72 | 58.09 | 37.83 | 176.90 | 188.02 |
| Gulf | 10 | 421 | 350 | 771 | 1.20 | 45.40 | 13.43 | 173.77 | 163.76 |
| Gulf | 11 | 281 | 341 | 622 | 0.82 | 54.82 | 19.65 | 165.29 | 169.91 |
| Gulf | 12 | 218 | 53 | 271 | 4.11 | 19.56 | 26.42 | 205.94 | 188.83 |
| Gulf | total | 3088 | 3328 | 6416 | 0.93 | 51.87 | 32.93 | 180.29 | 183.44 |
| Grand Banks | 1 | | | | | | | | |
| Grand Banks | 2 | | | | | | | | |
| Grand Banks | 3 | | | | | | | | |
| Grand Banks | 4 | | | | | | | | |
| Grand Banks | 5 | | | | | | | | |
| Grand Banks | 6 | 140 | 190 | 330 | 0.74 | 57.58 | 63.16 | 205.79 | 206.78 |
| Grand Banks | 7 | | | | | | | | |
| Grand Banks | 8 | 533 | 335 | 868 | 1.59 | 38.59 | 46.27 | 196.81 | 191.07 |
| Grand Banks | 9 | 1706 | 1921 | 3627 | 0.89 | 52.96 | 46.64 | 187.97 | 191.83 |
| Grand Banks | 10 | 482 | 606 | 1088 | 0.80 | 55.70 | 60.40 | 191.83 | 200.90 |
| Grand Banks | 11 | 214 | 305 | 519 | 0.70 | 58.77 | 83.93 | 206.93 | 223.28 |
| Grand Banks | 12 | | | | | | | | |
| Grand Banks | total | 3075 | 3357 | 6432 | 0.92 | 52.19 | 52.83 | 192.24 | 197.09 |

## Table 4. Reported Landings (t) by Country of Porbeagle Shark in the North Atlantic

### Northwest Atlantic (NAFO Areas 0 - 6)

| Year | Canada | Faroe Is | Norway | USA | France (SP) | Spain | Japan | Iceland | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1950 | | | | | | | | | |
| 1951 | | | | | | | | | |
| 1952 | | | | | | | | | |
| 1953 | | | | | | | | | |
| 1954 | | | | | | | | | |
| 1955 | | | | | | | | | |
| 1956 | | | | | | | | | |
| 1957 | | | | | | | | | |
| 1958 | | | | | | | | | |
| 1959 | | | | | | | | | |
| 1960 | | | | | | | | | |
| 1961 | | 100 | 1824 | | | | | | 1924 |
| 1962 | | 800 | 2216 | | | | | | 3016 |
| 1963 | | 800 | 5763 | | | | | | 6563 |
| 1964 | | 1214 | 8060 | | | | | 9 | 9283 |
| 1965 | 28 | 1088 | 4045 | | | | | | 5161 |
| 1966 | | 741 | 1373 | | | | | | 2114 |
| 1967 | | 589 | | | | | 36 | | 625 |
| 1968 | | 662 | 269 | | | | 138 | | 1069 |
| 1969 | | 865 | | | | | 208 | | 1073 |
| 1970 | | 205 | | | | | 674 | | 879 |
| 1971 | | 231 | | | | | 221 | | 452 |
| 1972 | | 260 | 87 | | | | | | 347 |
| 1973 | | 269 | | | | | | | 269 |
| 1974 | | | | | | | | | |
| 1975 | | 80 | | | | | | | 80 |
| 1976 | | 307 | | | | | | | 307 |
| 1977 | | 295 | | | | 2 | | | 297 |
| 1978 | 1 | 121 | | | | | | | 122 |
| 1979 | 2 | 299 | | | | | | | 301 |
| 1980 | 1 | 425 | | | | | | | 426 |
| 1981 | | 344 | | | | | | | 344 |
| 1982 | 1 | 259 | | | | | | | 260 |
| 1983 | 9 | 256 | | | | | | | 265 |
| 1984 | 20 | 126 | 17 | | | | | | 163 |
| 1985 | 26 | 210 | | | | | | | 236 |
| 1986 | 24 | 270 | | | | | | | 294 |
| 1987 | 59 | 381 | | 12 | | | | | 452 |
| 1988 | 83 | 374 | | 32 | | | | | 489 |
| 1989 | 73 | 479 | | 3 | | | | | 555 |
| 1990 | 78 | 551 | | 19 | | | | | 648 |
| 1991 | 329 | 1199 | | 16 | | | | | 1544 |
| 1992 | 741 | 1171 | | 13 | | | | | 1925 |
| 1993 | 919 | 467 | | 39 | | | | | 1425 |
| 1994 | 1550 | | | 64 | | | | | 1614 |
| 1995 | 1375 | | | | | | | | 1375 |
| 1996 | 1015 | | | | 39 | | | | 1054 |
| 1997 | 1338 | | | | | | | | 1338 |

### Northeast Atlantic / North Atlantic

| Year | Denmark | Faroe Is | France | Iceland | Norway | Portugal | Spain | Sweden | Channel Is | Germany | Total | North Atlantic Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950 | 1900 | | | | 1300 | | | | | | 3200 | 3200 |
| 1951 | 1600 | | | | 800 | | | | | | 2400 | 2400 |
| 1952 | 1600 | | | | 600 | | | | | | 2200 | 2200 |
| 1953 | 1100 | 100 | | | 700 | | | | | | 1900 | 1900 |
| 1954 | 700 | 300 | | | 600 | | | | | | 1600 | 1600 |
| 1955 | 600 | 100 | | | 900 | | | | | | 1600 | 1600 |
| 1956 | 400 | | | | 900 | | | | | | 1300 | 1300 |
| 1957 | 600 | 100 | | | 1100 | | | | | | 1800 | 1800 |
| 1958 | 900 | 300 | | | 1100 | | | | | | 2300 | 2300 |
| 1959 | 600 | 600 | | | 900 | | | | | | 2100 | 2100 |
| 1960 | 400 | 500 | | | 1500 | | | | | | 2400 | 2400 |
| 1961 | 600 | | | | 1000 | | | | | | 1600 | 3524 |
| 1962 | 400 | | | | 100 | | | | | | 500 | 3516 |
| 1963 | 200 | | | | 100 | | | | | | 300 | 6863 |
| 1964 | 300 | | | | 100 | | | | | | 400 | 9683 |
| 1965 | 200 | | | | 300 | | | | | | 500 | 5661 |
| 1966 | 200 | | | | 300 | | | | | | 500 | 2614 |
| 1967 | 200 | | | | 400 | | | | | | 600 | 1225 |
| 1968 | 100 | | | | 900 | | | | | | 1000 | 2069 |
| 1969 | 100 | | | | 900 | | | | | | 1000 | 2073 |
| 1970 | 200 | | | | 300 | | 3800 | | | | 4300 | 5179 |
| 1971 | 400 | | | | 200 | | 3800 | | | | 4400 | 4852 |
| 1972 | 500 | | | | 300 | | 2700 | | | | 3500 | 3847 |
| 1973 | 200 | | | | 200 | | | | | | 400 | 669 |
| 1974 | 170 | | | 2 | 165 | | | 3 | | 3 | 343 | 343 |
| 1975 | 265 | | | 4 | 304 | | | 1 | | 3 | 577 | 657 |
| 1976 | 233 | 1 | | 3 | 259 | | | 1 | | | 497 | 804 |
| 1977 | 289 | 5 | | 3 | 77 | | | | | | 374 | 671 |
| 1978 | 112 | 9 | 833 | | 76 | | 2087 | 3 | | | 3120 | 3242 |
| 1979 | 71 | 25 | 1092 | 1 | 105 | | | 1 | | | 1295 | 1596 |
| 1980 | 175 | 8 | 896 | 1 | 84 | | | 8 | | | 1172 | 1598 |
| 1981 | 159 | 6 | 768 | | 93 | | | 5 | | | 1031 | 1375 |
| 1982 | 85 | 17 | 198 | 1 | 34 | | | 6 | | | 341 | 601 |
| 1983 | 45 | 12 | 792 | | 32 | | | 5 | | | 886 | 1151 |
| 1984 | 39 | | 411 | 1 | 96 | | | 9 | | | 556 | 719 |
| 1985 | 72 | 12 | 254 | | 80 | | | 10 | 12 | | 440 | 676 |
| 1986 | 114 | 12 | 260 | | 24 | | | 8 | 7 | | 425 | 719 |
| 1987 | 55 | 33 | 280 | | 25 | 3 | | 5 | 3 | | 404 | 856 |
| 1988 | 32 | 18 | 446 | | 12 | 3 | | 3 | 9 | | 523 | 1012 |
| 1989 | 33 | 14 | 351 | | 26 | 2 | | 3 | 15 | | 444 | 999 |
| 1990 | 46 | 14 | 561 | | 44 | 2 | | 2 | 15 | | 684 | 1332 |
| 1991 | 85 | 7 | 309 | | 32 | 1 | | 2 | 14 | | 450 | 1994 |
| 1992 | 80 | 20 | 496 | 1 | 42 | | | 4 | | | 643 | 2568 |
| 1993 | 91 | 76 | 643 | 3 | 23 | | | 3 | | | 839 | 2264 |
| 1994 | 94 | 48 | 828 | 4 | 25 | | | 2 | | 22 | 1023 | 2637 |
| 1995 | 86 | 44 | 621 | 6 | 27 | | | 2 | | | 786 | 2161 |
| 1996 | | | | | | | | | | | | |
| 1997 | | | | | | | | | | | | |

Notes: Northwest Atlantic Data (All Countries) for 1950 - 60 is from FAO (ICCAT Report of Shark Working Group, Miami, 26 - 28 February 1996)
Northwest Atlantic Data (Canada) for 1961 - 90 is from NAFO Computer file
Northwest Atlantic Data (Canada) for 1991 is from DFO Zonal Statistics File (coded as mackerel shark, known from logs to be porbeagle, code for porbeagle not created yet)
Northwest Atlantic Data (Canada) for 1992 - 97 is from DFO Zonal Statistics File; 1997 is preliminary
Northwest Atlantic Data (Faroe Is & Norway) for 1961 - 63 is from FAO (ICCAT Report of Shark Working Group, Miami, 26 - 28 February 1996)
Northwest Atlantic Data (Faroe Is & Norway) for 1964 - 86 is from NAFO Computer file
Northwest Atlantic Data (Faroe Is & Norway) for 1987 - 97 is from DFO Observer Program
Northwest Atlantic Data (US) for 1961 - 94 is from FAO (ICCAT Report of Shark Working Group, Miami, 26 - 28 February 1996)
Northwest Atlantic Data (Other) for 1961 - 97 is from NAFO Computer file (1996 is G. Moulton, pers comm)
Northeast Atlantic Data is from FAO Statistics(1997)

DATE: 98/03/14
(Z96103P)

Table 5.

- SCOTIA FUNDY REGION -
SHARK QUANTITY (KGS) AND # OF VESSELS BY WEEK BY GEAR
FOR THE YEARS 1993 - 1998 FOR SPECIES CODE 369 - PORBEAGLE SHARK ONLY

PAGE:

LONGLINE

| WEEK | 1993 | | 1994 | | 1995 | | 1996 | | 1997 | | 1998 | | CUMULATIVE QUANTITY 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan 1 to Jan 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 832 | 1 | 3,024 | 2 | 0 | 0 | 0 | 0 | 832 | 3,024 |
| Jan 8 to Jan 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15,763 | 1 | 2,366 | 3 | 0 | 0 | 0 | 0 | 16,595 | 5,390 |
| Jan 15 to Jan 21 | 0 | 0 | 0 | 0 | 0 | 0 | 19,997 | 3 | 15,122 | 3 | 12,867 | 2 | 0 | 0 | 0 | 19,997 | 31,717 | 18,257 |
| Jan 22 to Jan 28 | 0 | 0 | 77 | 1 | 497 | 2 | 1,973 | 1 | 0 | 0 | 1,240 | 1 | 0 | 77 | 497 | 21,970 | 31,717 | 19,497 |
| Jan 29 to Feb 4 | 0 | 0 | 1,619 | 1 | 0 | 0 | 943 | 1 | 9,722 | 9 | 329 | 1 | 0 | 1,696 | 497 | 22,913 | 41,439 | 19,826 |
| Feb 5 to Feb 11 | 0 | 0 | 69 | 1 | 0 | 0 | 13,804 | 1 | 21,947 | 7 | 0 | 0 | 0 | 1,765 | 497 | 36,717 | 63,386 | 19,826 |
| Feb 12 to Feb 18 | 0 | 0 | 0 | 0 | 7,333 | 1 | 0 | 0 | 6,860 | 2 | 4,276 | 1 | 0 | 1,765 | 7,830 | 36,717 | 70,246 | 24,102 |
| Feb 19 to Feb 25 | 0 | 0 | 0 | 0 | 0 | 0 | 12,937 | 3 | 256 | 2 | 0 | 0 | 0 | 1,765 | 7,830 | 49,654 | 70,502 | 24,102 |
| Feb 26 to Mar 4 | 0 | 0 | 0 | 0 | 17,871 | 2 | 19,926 | 3 | 2,415 | 4 | 0 | 0 | 0 | 1,765 | 25,700 | 69,580 | 72,917 | 24,102 |
| Mar 5 to Mar 11 | 0 | 0 | 0 | 0 | 377 | 1 | 401 | 2 | 642 | 1 | 90 | 1 | 0 | 1,765 | 26,077 | 69,981 | 73,560 | 24,192 |
| Mar 12 to Mar 18 | 0 | 0 | 0 | 0 | 1,203 | 3 | 21,999 | 5 | 492 | 1 | 0 | 0 | 0 | 1,765 | 27,279 | 91,980 | 74,052 | 24,192 |
| Mar 19 to Mar 25 | 0 | 0 | 0 | 0 | 0 | 0 | 2,509 | 3 | 2,711 | 1 | 0 | 0 | 0 | 1,765 | 27,279 | 94,489 | 76,762 | 24,192 |
| Mar 26 to Apr 1 | 50 | 1 | 0 | 0 | 198 | 2 | 30,109 | 9 | 20,740 | 6 | 0 | 0 | 50 | 1,765 | 27,478 | 124,598 | 97,502 | 24,192 |
| Apr 2 to Apr 8 | 0 | 0 | 0 | 0 | 46,793 | 1 | 85,065 | 2 | 164,335 | 8 | 0 | 0 | 50 | 1,765 | 74,270 | 209,663 | 261,837 | 24,192 |
| Apr 9 to Apr 15 | 83 | 1 | 69 | 1 | 78,598 | 5 | 1,773 | 3 | 4,909 | 6 | 0 | 0 | 133 | 1,834 | 152,869 | 211,436 | 266,746 | 24,192 |
| Apr 16 to Apr 22 | 72,674 | 2 | 0 | 0 | 9,445 | 5 | 7,093 | 3 | 11,184 | 3 | 0 | 0 | 72,807 | 1,834 | 162,314 | 218,529 | 277,930 | 24,192 |
| Apr 23 to Apr 29 | 0 | 0 | 75,498 | 3 | 89,066 | 3 | 33,250 | 5 | 50,554 | 8 | 0 | 0 | 72,807 | 77,332 | 251,380 | 251,779 | 328,485 | 24,192 |
| Apr 30 to May 6 | 0 | 0 | 280,341 | 4 | 6,136 | 4 | 86,136 | 3 | 101,978 | 6 | 0 | 0 | 72,807 | 357,672 | 257,515 | 337,915 | 430,462 | 24,192 |
| May 7 to May 13 | 142,983 | 3 | 0 | 0 | 24,912 | 6 | 9,926 | 5 | 30,291 | 6 | 0 | 0 | 215,790 | 357,672 | 282,427 | 347,841 | 460,754 | 24,192 |
| May 14 to May 20 | 0 | 0 | 76,760 | 1 | 177,051 | 3 | 3,734 | 4 | 2,102 | 3 | 0 | 0 | 215,790 | 434,432 | 459,478 | 351,575 | 462,856 | 24,192 |
| May 21 to May 27 | 0 | 0 | 3,437 | 2 | 12,931 | 4 | 20,177 | 3 | 12,902 | 5 | 0 | 0 | 215,790 | 437,869 | 472,408 | 371,752 | 475,759 | 24,192 |
| May 28 to June 3 | 0 | 0 | 342 | 2 | 12,300 | 3 | 148,970 | 6 | 88,813 | 7 | 0 | 0 | 215,790 | 438,211 | 484,708 | 520,723 | 564,571 | 24,192 |
| June 4 to June 10 | 68,884 | 1 | 82,448 | 4 | 94,232 | 6 | 650 | 2 | 22,834 | 4 | 0 | 0 | 284,674 | 520,659 | 578,940 | 521,373 | 587,406 | 24,192 |
| June 11 to June 17 | 10,335 | 1 | 221,834 | 4 | 89,558 | 4 | 10,835 | 5 | 36,813 | 7 | 0 | 0 | 295,009 | 742,493 | 668,499 | 532,209 | 624,218 | 24,192 |
| June 18 to June 24 | 0 | 0 | 82 | 1 | 9,275 | 2 | 280 | 2 | 16,946 | 4 | 0 | 0 | 295,009 | 742,575 | 677,773 | 532,489 | 641,165 | 24,192 |
| June 25 to July 1 | 0 | 0 | 67 | 2 | 344 | 2 | 1,311 | 2 | 7,051 | 5 | 0 | 0 | 295,009 | 742,642 | 678,117 | 533,800 | 648,216 | 24,192 |
| July 2 to July 8 | 146 | 1 | 463 | 5 | 84,267 | 5 | 62,524 | 2 | 81,365 | 4 | 0 | 0 | 295,155 | 743,105 | 762,385 | 596,324 | 729,581 | 24,192 |
| July 9 to July 15 | 66,518 | 3 | 60,549 | 8 | 2,967 | 2 | 58,635 | 2 | 33,073 | 5 | 0 | 0 | 361,674 | 803,654 | 765,352 | 654,959 | 762,654 | 24,192 |
| July 16 to July 22 | 87,637 | 4 | 118,247 | 9 | 22,853 | 2 | 459 | 2 | 867 | 4 | 0 | 0 | 449,310 | 921,900 | 788,204 | 655,418 | 763,520 | 24,192 |
| July 23 to July 29 | 142 | 1 | 3,607 | 9 | 2,094 | 2 | 2,455 | 2 | 13,193 | 2 | 0 | 0 | 449,453 | 925,507 | 790,298 | 657,873 | 776,713 | 24,192 |
| July 30 to Aug 5 | 106 | 3 | 853 | 4 | 3,868 | 5 | 3,789 | 8 | 934 | 3 | 0 | 0 | 449,559 | 926,360 | 794,166 | 661,662 | 777,647 | 24,192 |
| Aug 6 to Aug 12 | 0 | 0 | 803 | 5 | 61,497 | 5 | 1,763 | 6 | 1,525 | 3 | 0 | 0 | 449,559 | 927,164 | 855,664 | 663,425 | 779,172 | 24,192 |
| Aug 13 to Aug 19 | 9,025 | 2 | 494 | 4 | 657 | 4 | 5,996 | 6 | 1,280 | 3 | 0 | 0 | 458,584 | 927,658 | 856,321 | 669,421 | 780,452 | 24,192 |
| Aug 20 to Aug 26 | 263 | 3 | 3,129 | 6 | 20,310 | 3 | 1,700 | 5 | 2,907 | 4 | 0 | 0 | 458,848 | 930,786 | 876,630 | 671,121 | 783,358 | 24,192 |
| Aug 27 to Sep 2 | 91 | 1 | 8,723 | 7 | 1,374 | 2 | 786 | 11 | 1,949 | 5 | 0 | 0 | 458,939 | 939,510 | 878,004 | 671,908 | 785,307 | 24,192 |
| Sep 3 to Sep 9 | 0 | 0 | 6,597 | 4 | 2,307 | 9 | 15 | 1 | 1,070 | 4 | 0 | 0 | 458,939 | 946,106 | 880,311 | 671,922 | 786,377 | 24,192 |
| Sep 10 to Sep 16 | 100,002 | 1 | 6,780 | 6 | 1,483 | 5 | 912 | 5 | 2,137 | 5 | 0 | 0 | 558,941 | 952,887 | 881,794 | 672,834 | 788,514 | 24,192 |
| Sep 17 to Sep 23 | 37 | 1 | 81,386 | 10 | 6,386 | 11 | 57 | 1 | 100,636 | 8 | 0 | 0 | 558,978 | 1,034,273 | 888,180 | 672,891 | 889,150 | 24,192 |
| Sep 24 to Sep 30 | 0 | 0 | 58,254 | 6 | 82,030 | 4 | 966 | 2 | 1,398 | 10 | 0 | 0 | 558,978 | 1,092,527 | 970,210 | 673,857 | 890,548 | 24,192 |
| Oct 1 to Oct 7 | 0 | 0 | 213 | 2 | 2,237 | 9 | 102,336 | 15 | 4,231 | 6 | 0 | 0 | 558,978 | 1,092,740 | 972,447 | 776,193 | 894,779 | 24,192 |
| Oct 8 to Oct 15 | 88,415 | 2 | 1,783 | 4 | 5,392 | 14 | 274 | 3 | 76,758 | 3 | 0 | 0 | 647,393 | 1,094,523 | 977,838 | 776,468 | 971,537 | 24,192 |
| Oct 16 to Oct 22 | 41 | 1 | 14,310 | 5 | 872 | 2 | 0 | 0 | 7,763 | 2 | 0 | 0 | 647,434 | 1,108,833 | 978,710 | 776,468 | 979,300 | 24,192 |
| Oct 23 to Oct 29 | 0 | 0 | 5,393 | 2 | 0 | 0 | 3,973 | 3 | 6,426 | 1 | 0 | 0 | 647,434 | 1,114,226 | 978,710 | 780,441 | 985,726 | 24,192 |
| Oct 30 to Nov 5 | 0 | 0 | 146,603 | 8 | 85,377 | 2 | 3,627 | 2 | 111 | 1 | 0 | 0 | 647,434 | 1,260,829 | 1,064,087 | 784,068 | 985,837 | 24,192 |
| Nov 6 to Nov 12 | 94,838 | 1 | 45,248 | 5 | 0 | 0 | 90,130 | 6 | 118,215 | 4 | 0 | 0 | 742,272 | 1,306,076 | 1,064,087 | 874,198 | 1,104,052 | 24,192 |
| Nov 13 to Nov 19 | 94,872 | 1 | 1,245 | 6 | 0 | 0 | 934 | 1 | 485 | 3 | 0 | 0 | 837,144 | 1,307,321 | 1,064,087 | 875,132 | 1,104,537 | 24,192 |
| Nov 20 to Nov 26 | 0 | 0 | 0 | 0 | 107,267 | 2 | 2,872 | 3 | 168 | 2 | 0 | 0 | 837,144 | 1,307,321 | 1,171,355 | 878,004 | 1,104,705 | 24,192 |
| Nov 27 to Dec 3 | 0 | 0 | 88,131 | 2 | 57,380 | 1 | 89,441 | 2 | 216 | 1 | 0 | 0 | 837,144 | 1,395,452 | 1,228,735 | 967,445 | 1,104,921 | 24,192 |
| Dec 4 to Dec 10 | 30,849 | 1 | 31,152 | 2 | 0 | 0 | 3,998 | 2 | 51 | 1 | 0 | 0 | 867,993 | 1,426,604 | 1,228,735 | 971,443 | 1,104,972 | 24,192 |
| Dec 11 to Dec 17 | 0 | 0 | 78,639 | 1 | 210 | 2 | 724 | 1 | 0 | 0 | 0 | 0 | 867,993 | 1,505,244 | 1,228,945 | 972,169 | 1,104,972 | 24,192 |
| Dec 18 to Dec 24 | 47,275 | 1 | 34,789 | 1 | 73,709 | 3 | 22,196 | 3 | 58 | 1 | 0 | 0 | 915,268 | 1,540,033 | 1,302,654 | 994,364 | 1,105,030 | 24,192 |
| Dec 25 to Dec 31 | 0 | 0 | 0 | 0 | 0 | 0 | 14,581 | 2 | 130 | 1 | 0 | 0 | 915,268 | 1,540,033 | 1,302,654 | 1,008,945 | 1,105,160 | 24,192 |
| | 915,268 | | 1,540,033 | | 1,302,654 | | 1,008,945 | | 1,105,160 | | 24,192 | | | | | | | |

# Table 6. Canadian Reported Landings (t) of Porbeagle Shark by Fishery

| Year | Directed Longline | Bycatch Swordfish | Bycatch Tuna | Bycatch Other | Total |
|---|---|---|---|---|---|
| 1987 | | | | | |
| 1988 | | | | | |
| 1989 | | | | | |
| 1990 | | | | | |
| 1991 | 329 | | | 0 | 329 |
| 1992 | 734 | 0 | | 7 | 741 |
| 1993 | 913 | 0 | 0 | 6 | 919 |
| 1994 | 1533 | 7 | 2 | 8 | 1550 |
| 1995 | 1347 | 15 | 0 | 13 | 1375 |
| 1996 | 1002 | 4 | 1 | 8 | 1015 |
| 1997 | 1284 | 5 | 0 | 15 | 1304 |

Notes: 1997 is preliminary

## Table 7. Catch (t) of Porbeagle Shark by the Faroese Fishery in the Canadian Zone as reported by the Fishery Observer Program

| Year | Subarea | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Subarea Landings | | Total Landings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1987 | 2-3 | | | | | | | | | 52.9 | 27.5 | 39.9 | | 120.3 | | |
| | 4RST | | | | | | | | | | 0.8 | | | 0.8 | | |
| | 4V | | | | | | | | | | 19.5 | | | 19.5 | | |
| | 4W | | | 4.5 | 28.6 | 78.0 | | | | | | | | 111.0 | | |
| | 4X/5Y | | | 23.3 | 77.1 | 29.1 | | | | | | | | 129.5 | | |
| | 5Z | | | | | | | | | | | | | 0.0 | | 381.1 |
| 1988 | 2-3 | | | | | | | | | 37.8 | 71.9 | 18.2 | | 128.0 | | |
| | 4RST | | | | | | | | | | | | | 0.0 | | |
| | 4V | | | | | | | | | | | | | 0.0 | | |
| | 4W | | | . | 9.1 | 2.4 | 20.7 | | | | | | | 32.3 | | |
| | 4X/5Y | | | 16.4 | 103.2 | 79.0 | 15.6 | | | | | | | 214.2 | | |
| | 5Z | | | | | | | | | | | | | 0.0 | | 374.4 |
| 1989 | 2-3 | | | | | | | | | 0.6 | 74.6 | 63.8 | | 139.0 | | |
| | 4RST | | | | | | | | | 11.1 | 1.3 | | | 12.4 | | |
| | 4V | | | | | | | | | | 17.7 | | | 17.7 | | |
| | 4W | | | . | 21.3 | 1.0 | 46.2 | | | | | | | 68.5 | | |
| | 4X/5Y | | | . | 67.1 | 148.0 | 25.8 | | | | | | | 240.9 | | |
| | 5Z | | | | | | | | | | | | | 0.0 | | 478.5 |
| 1990 | 2-3 | | | | | | | | | 68.1 | 34.9 | 35.3 | | 138.3 | | |
| | 4RST | | | | | | | | | | | | | 0.0 | | |
| | 4V | | | | | | | | | | 5.8 | | | 5.8 | | |
| | 4W | | | . | 34.7 | 28.3 | 167.0 | | | | | | | 229.9 | | |
| | 4X/5Y | | | 0.6 | 85.0 | 86.2 | 4.8 | | | | | | | 176.5 | | |
| | 5Z | | | | | | | | | | | | | 0.0 | | 550.6 |
| 1991 | 2-3 | | | . | . | . | . | . | . | 102.8 | 52.5 | | | 155.3 | | |
| | 4RST | | | . | . | . | . | . | . | 114.5 | 67.3 | 49.5 | | 231.3 | | |
| | 4V | | | . | . | . | . | . | 1.4 | . | 53.9 | | | 55.3 | | |
| | 4W | | | . | 57.9 | 60.5 | 103.3 | 36.1 | 0.0 | . | | | | 257.9 | | |
| | 4X/5Y | | | 1.9 | 212.2 | 157.7 | 125.0 | 1.9 | . | . | | | | 498.7 | | |
| | 5Z | | | | | | | | | | | | | 0.0 | | 1198.6 |
| 1992 | 2-3 | | | . | . | . | . | . | 12.0 | 111.3 | 134.3 | 143.6 | | 401.2 | | |
| | 4RST | | | . | . | . | . | 30.3 | 29.0 | 77.4 | . | 0.3 | | 136.9 | | |
| | 4V | | | . | . | . | 2.9 | 54.1 | 14.0 | 2.5 | 29.1 | 0.2 | | 102.8 | | |
| | 4W | | | . | 28.1 | 112.9 | 80.5 | 6.6 | . | 0.3 | . | . | | 228.4 | | |
| | 4X/5Y | | | . | 109.3 | 97.8 | 94.2 | 0.3 | . | . | . | . | | 301.6 | | |
| | 5Z | | | | | | | | | | | | | 0.0 | | 1170.9 |
| 1993 | 2-3 | | | | | | 30.3 | | | 18.5 | 16.2 | | | 65.0 | | |
| | 4RST | | | | | | | | | | 19.5 | | | 19.5 | | |
| | 4V | | | . | 16.2 | 35.6 | 8.2 | | | | 9.2 | | | 69.1 | | |
| | 4W | | | . | 93.2 | 88.0 | 12.9 | | | | | | | 194.2 | | |
| | 4X/5Y | | | 45.0 | 31.2 | 43.3 | . | | | | | | | 119.5 | | |
| | 5Z | | | | | | | | | | | | | 0.0 | | 467.4 |

Table 8. Characteristics of Scotia-Fundy vessels with licences to direct for porbeagle.

| Fleet | Tonnage Class | Gross Tonnage | Length (ft) | Horsepower |
|---|---|---|---|---|
| | 4 | 354 | 154 | 600 |
| Offshore | 5 | 585 | 153 | 746 |
| | 4 | 360 | 105 | 600 |
| | 4 | 186 | 94 | 671 |
| | 3 | 84 | 64 | 475 |
| | 3 | 77 | 64 | 1150 |
| | 3 | 92 | 54 | 425 |
| Rest | 3 | 65 | 54 | 404 |
| | 2 | 45 | 48 | 265 |
| | 2 | 46 | 44 | 300 |
| | 2 | 48 | 44 | 349 |
| | 2 | 28 | 42 | 270 |
| | 2 | 29 | 42 | 210 |
| | 2 | 28 | 42 | 210 |
| | 2 | 28 | 42 | 198 |
| | 2 | 30 | 39 | 154 |
| | 1 | 7 | 38 | 152 |

**Table 9a. Reported Landings (t) of Porbeagle Shark by Licensed & Directing Canadian Vessels >= 100'.**

| Year | Subarea | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Subarea Landings | Subarea Sets | Total Landings | Total Sets | Total Hooks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1991 | 2-3 | . | . | . | . | . | . | . | . | | 38.6 | 74.3 | 48.8 | 161.7 | 26 | | | |
| | 4RST | . | . | . | . | . | . | . | . | . | 62.6 | . | . | 62.6 | 18 | | | |
| | 4V | . | . | . | . | . | . | . | 0.0 | . | . | . | 0.4 | 0.4 | 2 | | | |
| | 4W | . | . | . | . | . | . | . | 60.6 | . | 34.2 | . | . | 94.9 | 33 | | | |
| | 4X/5Y | . | . | . | . | . | . | . | 0.3 | . | . | . | 7.9 | 8.2 | 5 | | | |
| | 5Z | . | . | . | . | . | . | . | . | . | . | . | 1.0 | 1.0 | 1 | 328.8 | 85 | 109364 |
| 1992 | 2-3 | . | . | . | 4.1 | . | . | 0.3 | 59.1 | . | 148.7 | 17.4 | . | 229.6 | 81 | | | |
| | 4RST | . | . | . | . | . | . | . | 6.7 | . | 6.8 | 114.9 | . | 128.4 | 42 | | | |
| | 4V | . | . | . | 17.0 | . | 0.0 | . | 0.2 | . | . | 1.6 | . | 18.8 | 8 | | | |
| | 4W | . | . | . | 30.3 | 6.3 | 17.8 | 35.9 | 1.1 | . | 2.6 | 9.6 | 0.2 | 103.8 | 46 | | | |
| | 4X/5Y | . | 0.1 | . | 2.5 | . | 25.5 | 78.0 | 0.9 | . | 0.2 | 0.1 | . | 107.3 | 35 | | | |
| | 5Z | . | 50.7 | . | 2.5 | . | 92.7 | 0.4 | . | . | . | . | . | 146.2 | 23 | 734.1 | 235 | 272908 |
| 1993 | 2-3 | . | . | . | . | . | . | 34.5 | 7.8 | 100.0 | 6.5 | 130.1 | 59.8 | 338.7 | 139 | | | |
| | 4RST | . | . | . | . | . | . | 58.2 | 0.3 | . | 81.5 | 7.6 | . | 147.5 | 45 | | | |
| | 4V | . | . | . | . | . | . | 0.5 | 0.8 | . | . | 10.4 | 0.7 | 12.4 | 11 | | | |
| | 4W | . | . | . | 30.4 | 55.8 | 42.4 | 11.3 | . | . | 0.4 | 41.6 | 11.7 | 193.6 | 69 | | | |
| | 4X/5Y | . | . | . | 40.4 | 86.0 | 36.8 | 49.2 | . | . | . | . | 5.9 | 218.2 | 54 | | | |
| | 5Z | . | . | . | 1.8 | 1.1 | . | 0.0 | . | . | . | . | . | 2.9 | 3 | 913.3 | 321 | 410053 |
| 1994 | 2-3 | . | . | . | . | . | 25.8 | 26.6 | . | 100.8 | . | 133.0 | 4.1 | 290.3 | 130 | | | |
| | 4RST | . | . | . | . | . | . | 31.7 | . | 30.3 | . | 10.0 | . | 72.0 | 38 | | | |
| | 4V | . | . | . | . | 35.0 | 3.4 | 29.9 | . | . | . | 0.6 | 17.7 | 86.6 | 33 | | | |
| | 4W | 1.6 | 0.1 | . | 60.7 | 276.5 | 262.1 | 53.2 | . | 1.7 | . | 43.3 | 147.1 | 846.2 | 208 | | | |
| | 4X/5Y | . | . | . | 14.0 | 39.4 | 1.0 | 29.9 | . | . | . | . | 62.9 | 147.3 | 54 | | | |
| | 5Z | . | . | . | . | 6.0 | 8.3 | . | . | . | . | . | 0.6 | 14.9 | 7 | 1457.3 | 470 | 667003 |
| 1995 | 2-3 | . | . | . | . | . | 47.2 | 70.0 | 69.2 | 81.7 | 154.5 | 106.7 | . | 529.3 | 174 | | | |
| | 4RST | . | . | . | . | . | . | 2.9 | 3.4 | . | . | . | 12.3 | 18.5 | 11 | | | |
| | 4V | . | . | . | . | 30.7 | 52.5 | 16.4 | . | . | . | 0.5 | 53.6 | 153.7 | 51 | | | |
| | 4W | . | . | . | 115.6 | 125.5 | 37.4 | 12.3 | . | . | . | . | 56.3 | 347.2 | 124 | | | |
| | 4X/5Y | . | . | . | 78.6 | 9.4 | 14.2 | 4.0 | . | . | . | . | 8.7 | 114.9 | 49 | | | |
| | 5Z | . | . | . | 11.8 | 11.2 | 2.0 | . | . | . | . | . | . | 25.1 | 7 | 1188.7 | 416 | 639073 |
| 1996 | 2-3 | . | . | . | . | . | . | 50.2 | . | . | 96.3 | 149.4 | . | 295.9 | 73 | | | |
| | 4RST | . | . | . | . | . | . | . | . | . | . | 5.5 | . | 5.5 | 3 | | | |
| | 4V | . | . | . | . | . | . | 0.5 | . | . | . | 22.6 | . | 23.1 | 7 | | | |
| | 4W | 11.1 | . | 15.8 | 16.3 | 15.9 | 30.0 | 41.3 | . | . | . | . | 16.0 | 146.5 | 78 | | | |
| | 4X/5Y | 1.1 | . | 1.3 | 67.7 | 107.4 | 59.3 | 28.4 | . | . | . | . | 1.1 | 266.3 | 94 | | | |
| | 5Z | . | . | 0.7 | . | . | . | 0.7 | . | . | . | . | . | 1.3 | 2 | 738.6 | 257 | 420730 |
| 1997 | 2-3 | . | . | . | . | . | . | 11.5 | . | 96.2 | 118.9 | 109.5 | . | 336.1 | 99 | | | |
| | 4RST | . | . | . | . | . | . | 1.0 | . | . | 48.3 | . | . | 47.3 | 15 | | | |
| | 4V | . | . | . | . | . | . | 28.9 | . | . | 8.9 | 8.6 | . | 46.4 | 24 | | | |
| | 4W | . | . | . | 158.0 | 17.3 | 110.8 | 65.8 | . | . | . | . | . | 351.8 | 102 | | | |
| | 4X/5Y | . | . | . | 102.0 | 48.1 | . | . | . | . | . | . | . | 150.1 | 44 | | | |
| | 5Z | . | . | . | . | 10.2 | . | . | . | . | . | . | . | 10.2 | 2 | 941.9 | 286 | 443182 |

Notes: 1997 is preliminary

## Table 9b. Reported Landings (t) of Porbeagle Shark by Canada, excluding Vessels in Table 9a.

| Year | Subarea | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Subarea Landings | Total Landings | Total Hooks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1991 | 2-3 | . | . | . | . | . | . | . | . | . | . | . | . | 0.0 | | |
| | 4RST | . | . | . | . | . | . | . | . | . | . | . | . | 0.0 | | |
| | 4V | . | . | . | . | . | . | . | . | . | . | . | . | 0.0 | | |
| | 4W | . | . | . | . | . | . | . | . | . | . | . | . | 0.0 | | |
| | 4X/5Y | 0.1 | . | . | . | . | . | . | . | . | . | . | . | 0.1 | | |
| | 5Z | . | . | . | . | . | . | . | . | . | . | . | . | 0.0 | 0.1 | |
| 1992 | 2-3 | . | . | . | . | . | . | . | . | . | . | . | . | 0.0 | | |
| | 4RST | . | . | . | . | . | . | . | . | . | . | . | . | 0.0 | | |
| | 4V | . | . | . | . | . | . | . | . | . | . | . | 0.5 | 0.5 | | |
| | 4W | . | . | . | . | . | 0.6 | 0.0 | . | 0.3 | 0.1 | 0.1 | 0.1 | 1.3 | | |
| | 4X/5Y | . | . | . | . | . | 0.1 | 0.1 | 0.7 | 1.2 | 0.2 | 0.1 | . | 2.3 | | |
| | 5Z | . | . | . | . | . | 2.2 | . | . | 0.1 | . | . | . | 2.3 | 6.4 | |
| 1993 | 2-3 | 0.3 | . | . | . | . | . | . | . | . | . | . | . | 0.3 | | |
| | 4RST | . | . | . | . | . | . | . | . | . | . | . | . | 0.0 | | |
| | 4V | . | . | 0.2 | 0.4 | . | . | . | . | . | . | . | . | 0.6 | | |
| | 4W | . | 0.1 | . | 0.0 | . | . | 0.7 | 0.2 | 0.2 | 0.1 | . | . | 1.2 | | |
| | 4X/5Y | 0.2 | 0.2 | . | 0.1 | 0.5 | 0.1 | 0.2 | 0.2 | 0.0 | . | . | . | 1.5 | | |
| | 5Z | 0.3 | 1.4 | . | 0.1 | . | . | . | . | . | . | . | . | 1.8 | 5.4 | |
| 1994 | 2-3 | 0.1 | . | . | 0.1 | 0.1 | . | . | 0.3 | 0.1 | . | . | . | 0.7 | | |
| | 4RST | . | . | . | . | . | . | . | . | . | . | . | . | 0.0 | | |
| | 4V | . | . | . | . | . | . | 3.3 | 0.3 | 0.3 | . | . | 0.1 | 4.0 | | |
| | 4W | . | . | . | 0.9 | 3.3 | . | 5.5 | 9.9 | 14.8 | 21.7 | 3.2 | . | 59.3 | | |
| | 4X/5Y | . | . | . | . | 0.2 | 4.1 | 2.5 | 3.8 | 6.3 | 3.4 | 2.6 | 0.1 | 23.0 | | |
| | 5Z | . | . | . | . | . | 0.1 | 0.2 | . | . | . | . | . | 0.2 | 87.2 | |
| 1995 | 2-3 | . | . | 0.2 | . | 0.1 | . | . | 0.1 | 0.1 | . | 0.1 | . | 0.6 | | |
| | 4RST | . | . | . | . | . | . | . | . | . | . | . | . | 0.0 | | |
| | 4V | 0.4 | . | 0.1 | 0.1 | . | . | 0.1 | 3.9 | 2.0 | 0.2 | . | . | 6.7 | | |
| | 4W | . | 9.1 | 1.6 | 19.9 | 9.3 | 30.7 | 6.3 | 1.1 | 6.1 | 7.5 | 0.1 | . | 91.6 | | |
| | 4X/5Y | 0.2 | 3.2 | 12.8 | 0.6 | 42.8 | 11.1 | 0.7 | 10.1 | 3.2 | 0.7 | 0.2 | 0.4 | 85.9 | | |
| | 5Z | . | . | . | . | . | . | . | 0.1 | . | 0.3 | . | . | 0.4 | 185.2 | |
| 1996 | 2-3 | . | . | 0.1 | . | 0.5 | . | 0.0 | 0.7 | . | . | 0.1 | . | 1.3 | | |
| | 4RST | . | . | . | . | . | . | . | . | . | . | . | . | 0.0 | | |
| | 4V | 0.1 | . | 0.0 | . | 0.8 | . | 0.3 | 1.5 | 0.5 | 2.3 | . | 0.2 | 5.8 | | |
| | 4W | 9.6 | 13.9 | 50.3 | 18.6 | 30.8 | 13.8 | 5.6 | 7.3 | 1.6 | 7.5 | 8.3 | 24.6 | 191.8 | | |
| | 4X/5Y | 0.1 | . | 1.3 | 27.0 | 16.7 | 8.0 | 1.6 | 1.1 | 0.4 | 1.2 | 0.4 | 0.3 | 58.2 | | |
| | 5Z | . | 13.8 | 1.9 | 0.7 | 0.2 | . | . | . | . | 0.1 | 0.3 | 0.8 | 17.8 | 275.0 | 160229 |
| 1997 | 2-3 | . | . | 0.2 | . | . | . | 0.6 | 0.3 | 0.1 | . | 0.6 | . | 1.7 | | |
| | 4RST | . | . | . | . | . | . | . | . | . | . | . | . | 0.0 | | |
| | 4V | 0.2 | . | 0.1 | . | . | . | 0.3 | 2.1 | 0.1 | . | . | . | 2.7 | | |
| | 4W | 37.0 | 26.8 | 6.1 | 31.2 | 22.8 | 55.4 | 12.0 | 4.3 | 6.8 | 6.6 | 0.2 | . | 208.9 | | |
| | 4X/5Y | . | 1.0 | 2.5 | 36.5 | 34.3 | 23.0 | 6.5 | 0.9 | 1.1 | 13.2 | 1.0 | 0.3 | 120.4 | | |
| | 5Z | . | 8.4 | 16.7 | . | . | 1.2 | 1.0 | . | 0.3 | . | 0.1 | 0.2 | 27.8 | 361.6 | 160132 |

Notes: 1997 is preliminary

Table 10a. Catch Rate Standardization Model for Offshore Vessels operating in 4W during April

| | Df | Deviance | Resid Df | Resid Dev | F Value | Pr(F) |
|---|---|---|---|---|---|---|
| NULL | | | 143 | 101.2128 | | |
| YEAR | 9 | 13.57999 | 134 | 87.6328 | 2.307252 | 0.01918644 |

| Coefficients | Value | Std. Error | t value |
|---|---|---|---|
| (Intercept) | 0.86563060 | 0.3301455 | 2.62196679 |
| YEAR_88 | -0.55596745 | 0.5718288 | -0.97226202 |
| YEAR_89 | -0.71832795 | 0.4896849 | -1.46691858 |
| YEAR_90 | -0.29906661 | 0.4043440 | -0.73963403 |
| YEAR_92 | -0.34240927 | 0.4262160 | -0.80337022 |
| YEAR_93 | -0.24130910 | 0.3597677 | -0.67073579 |
| YEAR_94 | -0.33048524 | 0.3616563 | -0.91381026 |
| YEAR_95 | -0.48421311 | 0.3649896 | -1.32664904 |
| YEAR_96 | -0.47402932 | 0.6602910 | -0.71790965 |
| YEAR_97 | -0.00958926 | 0.3812192 | -0.02515419 |

(Dispersion Parameter for Gaussian family taken to be 0.6539764 )

| Year | 1987 | 1988 | 1989 | 1990 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|---|
| Predicted CPUE | 3.129 | 1.699 | 1.509 | 2.384 | 2.262 | 2.569 | 4.548 | 2.011 | 1.746 | 3.213 |
| CPUE Variance | 7.329 | 2.028 | 1.251 | 3.989 | 3.591 | 4.560 | 14.979 | 2.612 | 2.381 | 7.443 |

Table 10b. Catch Rate Standardization Model for Offshore Vessels operating in 4W during May

| | Df | Deviance | Resid Df | Resid Dev | F Value | Pr(F) |
|---|---|---|---|---|---|---|
| NULL | | | 222 | 241.4076 | | |
| YEAR | 10 | 42.32828 | 212 | 199.0793 | 4.507548 | 8.741732e-006 |

| Coefficients | Value | Std. Error | t value |
|---|---|---|---|
| (Intercept) | 0.9925338 | 0.2502070 | 3.9668505 |
| YEAR_88 | -2.2519975 | 0.5453135 | -4.1297297 |
| YEAR_89 | -2.4554952 | 0.7294725 | -3.3661243 |
| YEAR_90 | -0.5579139 | 0.3956120 | -1.4102551 |
| YEAR_91 | -0.1245965 | 0.3956120 | -0.3149461 |
| YEAR_92 | -0.4608786 | 0.3432812 | -1.3425687 |
| YEAR_93 | -0.3016000 | 0.3017610 | -0.9994664 |
| YEAR_94 | -0.2138338 | 0.2933937 | -0.7288289 |
| YEAR_95 | -0.5926442 | 0.2966199 | -1.9979921 |
| YEAR_96 | -1.3290187 | 0.3432812 | -3.8715163 |
| YEAR_97 | -0.6345073 | 0.2954919 | -2.1472916 |

(Dispersion Parameter for Gaussian family taken to be 0.9390533 )

| Year | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Predicted CPUE | 4.191 | 0.405 | 0.293 | 2.362 | 3.643 | 2.653 | 3.153 | 3.451 | 2.361 | 1.114 | 2.265 |
| CPUE Variance | 11.207 | 0.649 | 0.776 | 3.342 | 8.553 | 4.252 | 6.096 | 7.353 | 3.154 | 0.349 | 2.836 |

Table 10c. Catch Rate Standardization Model for Offshore Vessels operating in 4W during June

| | Df | Deviance | Resid Df | Resid Dev | F Value | Pr(F) |
|---|---|---|---|---|---|---|
| NULL | | | 146 | 325.5189 | | |
| YEAR | 9 | 146.7008 | 137 | 178.8181 | 12.48818 | 2.531308e-014 |

| Coefficients | Value | Std. Error | t value |
|---|---|---|---|
| (Intercept) | 1.0775613 | 0.5109288 | 2.1090244 |
| YEAR_89 | 1.3795362 | 0.8343433 | 1.6534396 |
| YEAR_90 | 0.1860772 | 0.5518662 | 0.3371781 |
| YEAR_91 | -0.5990601 | 0.5742344 | -1.0432326 |
| YEAR_92 | -0.7367424 | 0.5899698 | -1.2487799 |
| YEAR_93 | -0.7051548 | 0.7225625 | -0.9759084 |
| YEAR_94 | -0.1171909 | 0.5546747 | -0.2112787 |
| YEAR_95 | -2.4239991 | 0.6689628 | -3.6235182 |
| YEAR_96 | -3.1612398 | 0.6162033 | -5.1301894 |
| YEAR_97 | -1.3635417 | 0.5616345 | -2.4278098 |

(Dispersion Parameter for Gaussian family taken to be 1.305241 )

| Year | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|---|
| Predicted CPUE | 4.975 | 18.119 | 6.681 | 3.009 | 2.598 | 2.458 | 4.926 | 0.457 | 0.226 | 1.411 |
| CPUE Variance | 14.538 | 211.464 | 23.568 | 4.506 | 3.192 | 3.241 | 12.736 | 0.713 | 0.589 | 0.396 |

Table 10d. Catch Rate Standardization Model for Offshore Vessels operating in 4X during April

| | Df | Deviance | Resid Df | Resid Dev | F Value | Pr(F) |
|---|---|---|---|---|---|---|
| NULL | | | 159 | 148.4099 | | |
| YEAR | 9 | 18.81778 | 150 | 129.5921 | 2.420129 | 0.01354846 |

| Coefficients | Value | Std. Error | t value |
|---|---|---|---|
| (Intercept) | 0.6515945 | 0.2078398 | 3.1350807 |
| YEAR_88 | 0.2365063 | 0.2788463 | 0.8481602 |
| YEAR_89 | -0.3006020 | 0.2871719 | -1.0467666 |
| YEAR_90 | 0.2451845 | 0.3019842 | 0.8119116 |
| YEAR_92 | -0.4291001 | 0.3174805 | -1.3515794 |
| YEAR_93 | -0.1294094 | 0.3599891 | -0.3594814 |
| YEAR_94 | -0.8395296 | 0.4326530 | -1.9404225 |
| YEAR_95 | -0.8556257 | 0.3489098 | -2.4522832 |
| YEAR_96 | -0.2338308 | 0.2788463 | -0.8385652 |
| YEAR_97 | -0.6273108 | 0.3888326 | -1.6133183 |

(Dispersion Parameter for Gaussian family taken to be 0.8639475 )

| Year | 1987 | 1988 | 1989 | 1990 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|---|
| Predicted CPUE | 2.900 | 3.690 | 2.152 | 3.697 | 1.875 | 2.494 | 1.191 | 1.211 | 2.306 | 1.500 |
| CPUE Variance | 5.363 | 8.843 | 2.669 | 8.944 | 1.830 | 3.957 | 0.520 | 0.396 | 3.165 | 0.655 |

Table 10e. Catch Rate Standardization Model for Offshore Vessels operating in 4X during May

| | Df | Deviance | Resid Df | Resid Dev | F Value | Pr(F) |
|---|---|---|---|---|---|---|
| NULL | | | 164 | 168.3944 | | |
| YEAR | 8 | 23.54 | 156 | 144.8544 | 3.168907 | 0.002350777 |

| Coefficients | Value | Std. Error | t value |
|---|---|---|---|
| (Intercept) | 0.521991513 | 0.3047218 | 1.71301027 |
| YEAR_88 | -0.004941298 | 0.3702326 | -0.01334647 |
| YEAR_89 | 0.379758798 | 0.3549901 | 1.06977288 |
| YEAR_90 | 0.286857927 | 0.3702326 | 0.77480458 |
| YEAR_91 | 0.241330435 | 0.3800548 | 0.63498850 |
| YEAR_92 | 0.293687370 | 0.4125952 | 0.71180507 |
| YEAR_93 | 0.351844242 | 0.4309417 | 0.81645448 |
| YEAR_96 | -0.582826789 | 0.3491026 | -1.66949981 |
| YEAR_97 | -0.527543776 | 0.4053178 | -1.30155578 |

(Dispersion Parameter for Gaussian family taken to be 0.9285535 )

| Year | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|
| Predicted CPUE | 2.567 | 2.617 | 3.867 | 3.504 | 3.336 | 3.470 | 3.650 | 1.480 | 1.531 |
| CPUE Variance | 4.074 | 4.114 | 9.401 | 7.718 | 6.994 | 7.704 | 8.623 | 0.239 | 0.390 |

Table 11. Regression analysis of the relationship between fork length and interdorsal length for porbeagle sharks. This relationship was used in the generation of total lengths in offshore catch rate models.

**Regression: Fork Length vs Interdorsal Length**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .946[a] | .894 | .894 | 9.30 |

a. Predictors: (Constant), Interdorsal Length

**ANOVA[b]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 1849876.614 | 1 | 1849876.614 | 21369.590 | .000[a] |
| | Residual | 219184.718 | 2532 | 86.566 | | |
| | Total | 2069061.333 | 2533 | | | |

a. Predictors: (Constant), Interdorasal Length

b. Dependent Variable: Fork Length

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 27.967 | .875 | | 31.967 | .000 |
| | Interdorsal Length | 2.718 | .019 | .946 | 146.183 | .000 |

a. Dependent Variable: Fork Length

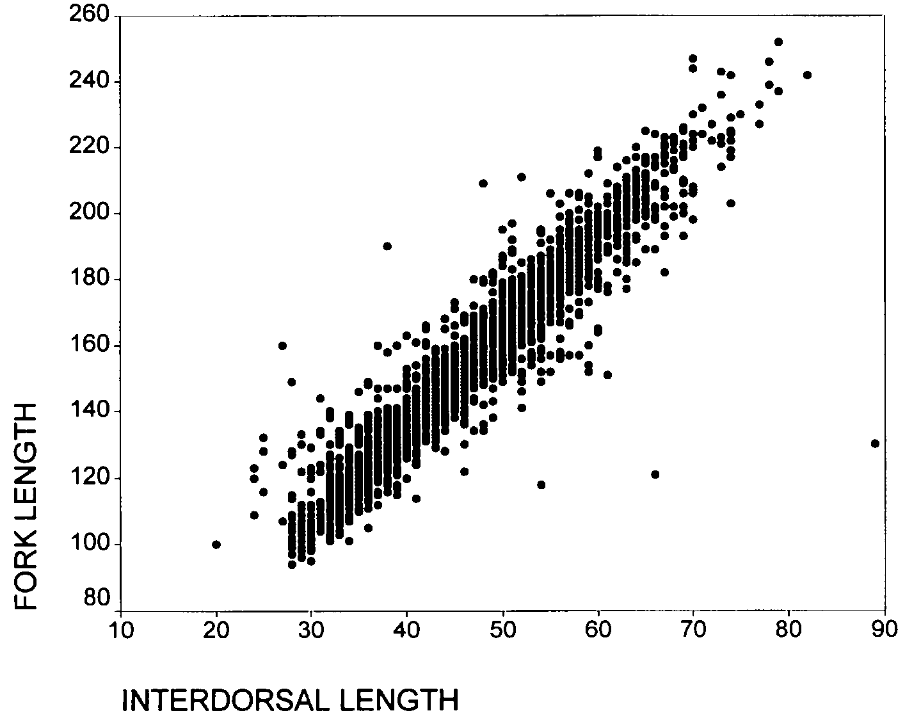

Table 12. Catch Rate Analysis of one offshore vessel using only sets where the mean length was less than 180cm.

| | Df | Deviance | Resid Df | Resid Dev | F Value | Pr(F) |
|---|---|---|---|---|---|---|
| NULL | | | 249 | 252.3015 | | |
| YEAR | 7 | 38.82829 | 242 | 213.4732 | 6.90282 | 0.0000002 |
| REGION | 1 | 10.09289 | 241 | 203.3803 | 12.56005 | 0.0004796 |
| MONTH | 2 | 1.37835 | 239 | 202.0019 | 0.85764 | 0.4255505 |
| MONTH:REGION | 2 | 9.31371 | 237 | 192.6882 | 5.79521 | 0.0035166 |
| YEAR:REGION | 5 | 4.29088 | 232 | 188.3973 | 1.06795 | 0.3789678 |
| MONTH:YEAR | 8 | 8.39755 | 224 | 179.9998 | 1.30629 | 0.2413391 |

| | Df | Deviance | Resid Df | Resid Dev | F Value | Pr(F) |
|---|---|---|---|---|---|---|
| NULL | | | 249 | 252.3015 | | |
| YEAR | 7 | 38.82829 | 242 | 213.4732 | 6.82250 | 0.0000002 |
| REGION | 1 | 10.09289 | 241 | 203.3803 | 12.41391 | 0.0005112 |
| MONTH | 2 | 1.37835 | 239 | 202.0019 | 0.84766 | 0.4297111 |
| MONTH:REGION | 2 | 9.31371 | 237 | 192.6882 | 5.72778 | 0.0037214 |

| Coefficients | Value | Std. Error | t value |
|---|---|---|---|
| (Intercept) | 1.0381120 | 0.2655507 | 3.9092807 |
| YEAR_89 | -1.0418481 | 0.2659367 | -3.9176544 |
| YEAR_90 | -0.4213585 | 0.2534408 | -1.6625521 |
| YEAR_91 | -0.4303384 | 0.3161977 | -1.3609789 |
| YEAR_92 | -0.7437806 | 0.2615774 | -2.8434439 |
| YEAR_93 | -0.3720022 | 0.3150985 | -1.1805905 |
| YEAR_95 | -0.7882886 | 0.3044873 | -2.5889046 |
| YEAR_96 | -1.5154208 | 0.2916970 | -5.1951889 |
| REGION | 0.1627684 | 0.2034553 | 0.8000206 |
| MONTHC5 | -0.2576354 | 0.1951318 | -1.3203145 |
| MONTHC6 | -0.8663374 | 0.2926808 | -2.9600082 |
| REGION:MONTHC5 | 0.1893908 | 0.2569807 | 0.7369845 |
| REGION:MONTHC6 | 1.2807795 | 0.3831039 | 3.3431648 |

(Dispersion Parameter for Gaussian family taken to be 0.8130305 )

| Year | 1987 | 1989 | 1990 | 1991 | 1992 | 1993 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|---|
| Predicted CPUE | 4.859 | 1.737 | 3.237 | 3.142 | 2.340 | 3.325 | 2.199 | 1.067 |
| CPUE Variance | 16.084 | 1.418 | 6.905 | 6.644 | 3.395 | 7.487 | 3.008 | 0.340 |
| Catch, t | 93.288 | 104.918 | 185.999 | 96.517 | 122.853 | 82.331 | 61.051 | 33.758 |
| Effort, (CATCH /CPUE) | 453.281 | 182.200 | 602.164 | 303.329 | 287.515 | 273.778 | 134.275 | 36.005 |

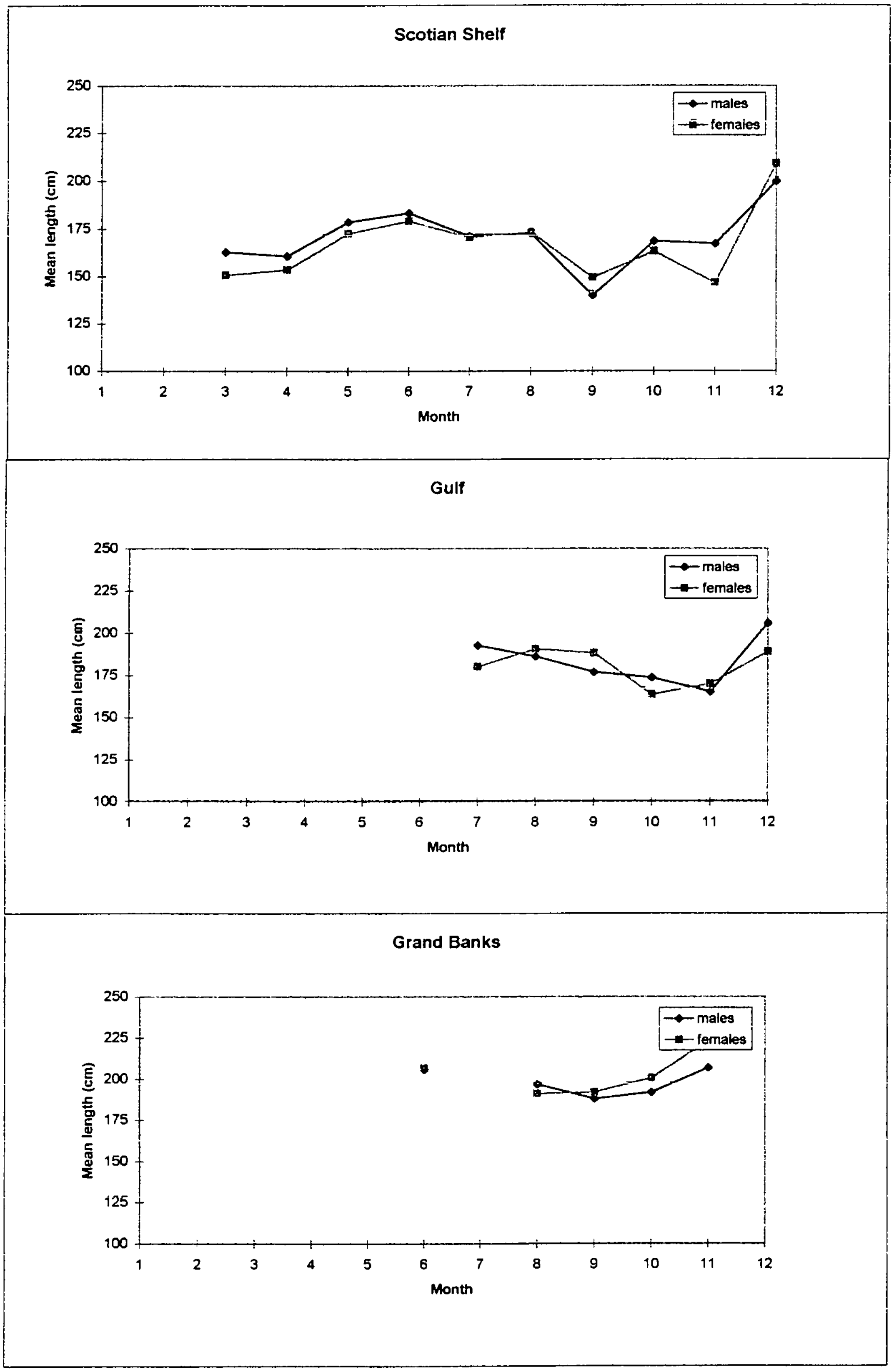


Figure 1. Mean length of porbeagle sharks by month by area by sex from S-F Observer data.

Figure 2 (a): Size composition of male and female porbeagle sharks (in 1 cm intervals) by area, in the directed fishery in March, from S-F Observer data 1987-96.

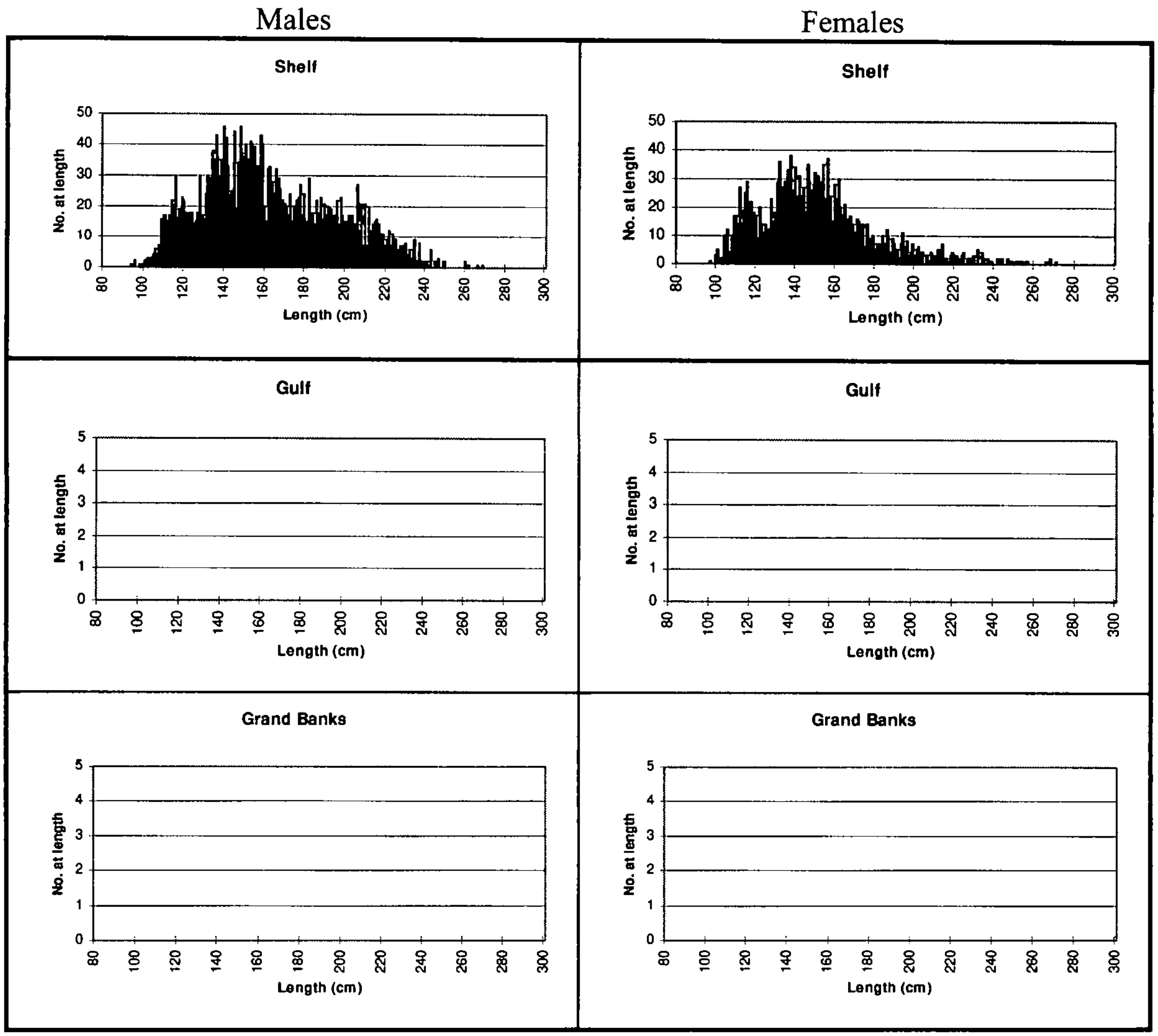

Figure 2 (b): Size composition of male and female porbeagle sharks (in 1 cm intervals) by area, in the directed fishery in April, from S-F Observer data 1987-96.

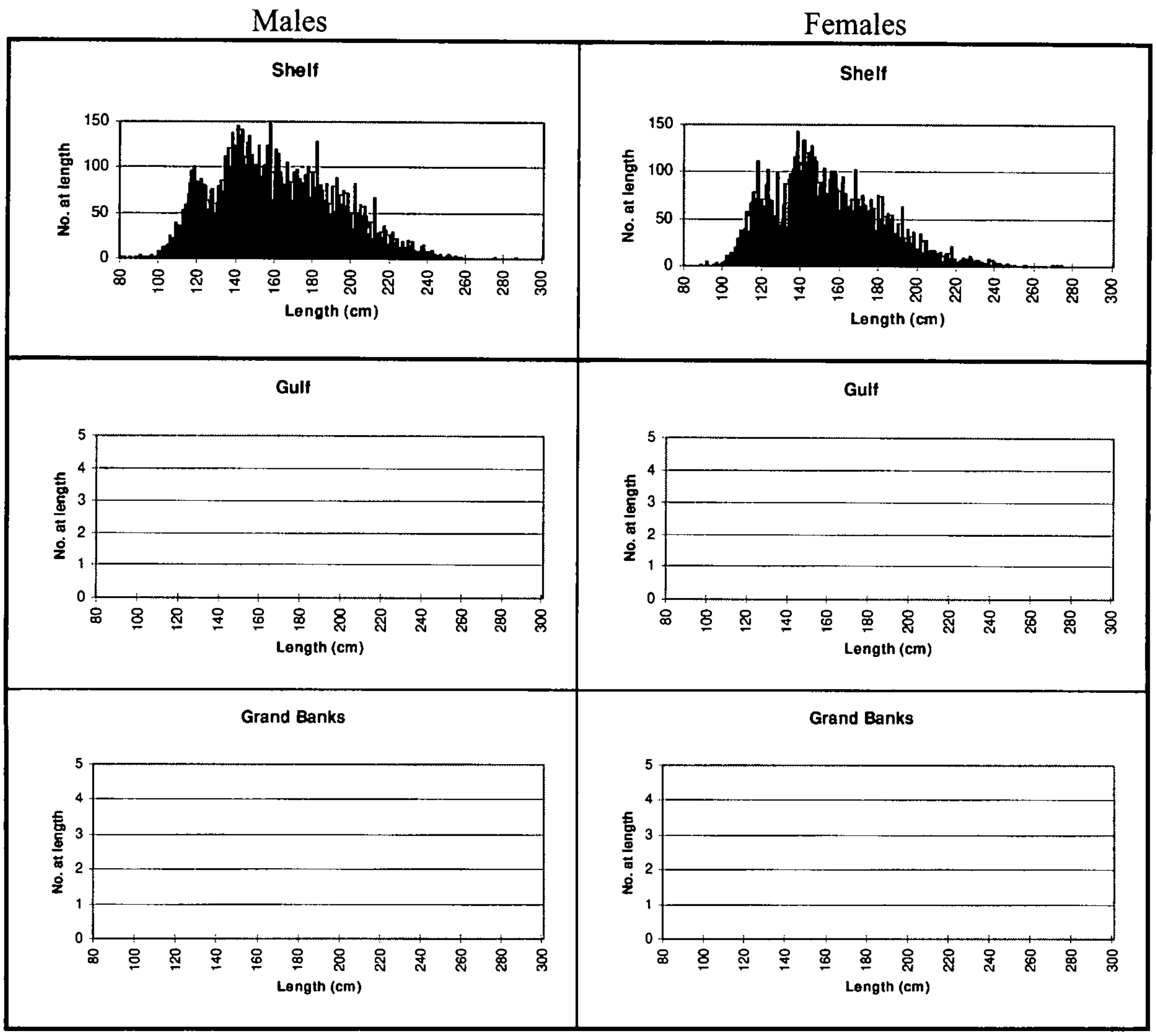

Figure 2 (c): Size composition of male and female porbeagle sharks (in 1 cm intervals) by area, in the directed fishery in May, from S-F Observer data 1987-96.

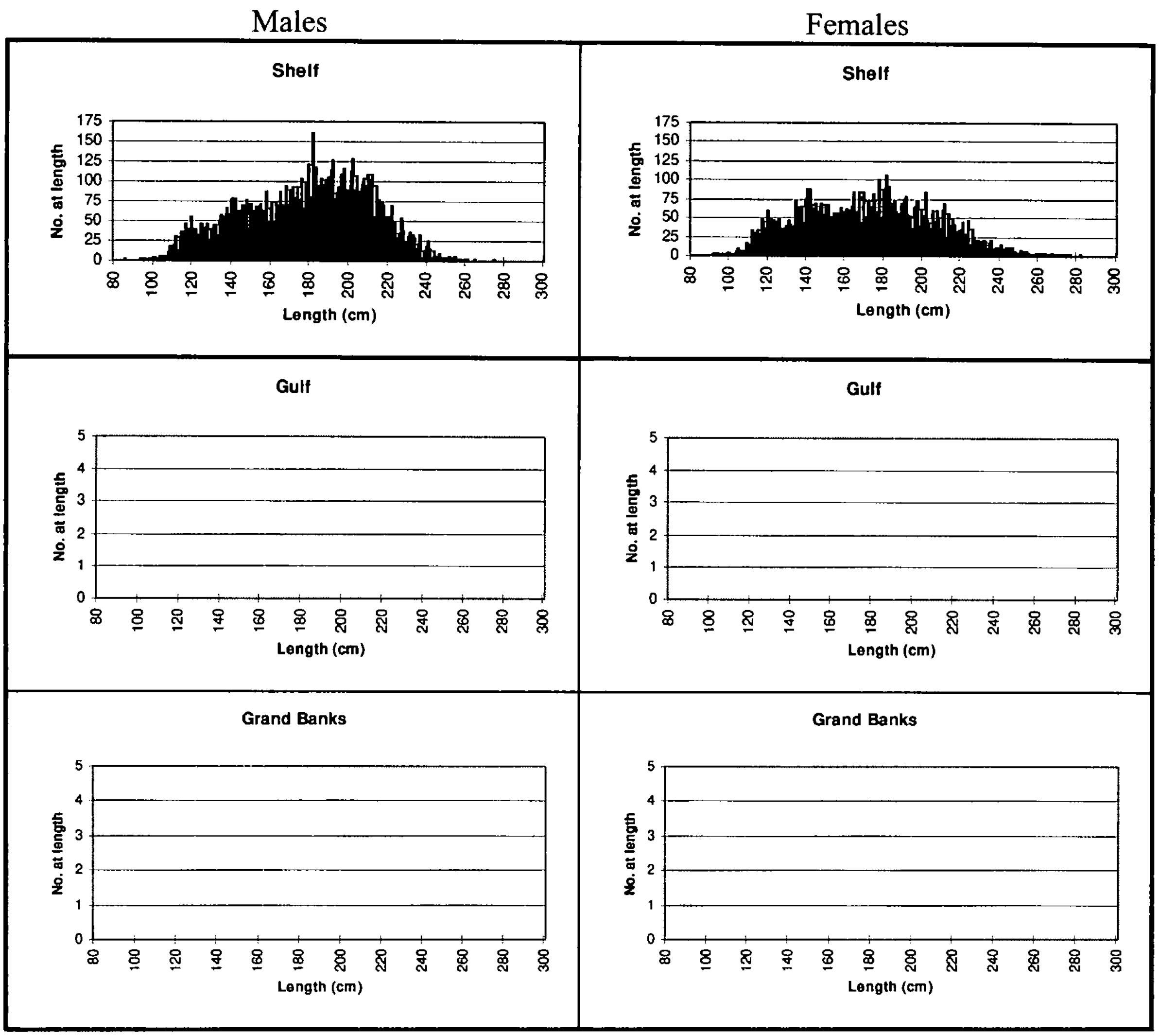

Figure 2 (d): Size composition of male and female porbeagle sharks (in 1 cm intervals) by area, in the directed fishery in June, from S-F Observer data 1987-96.

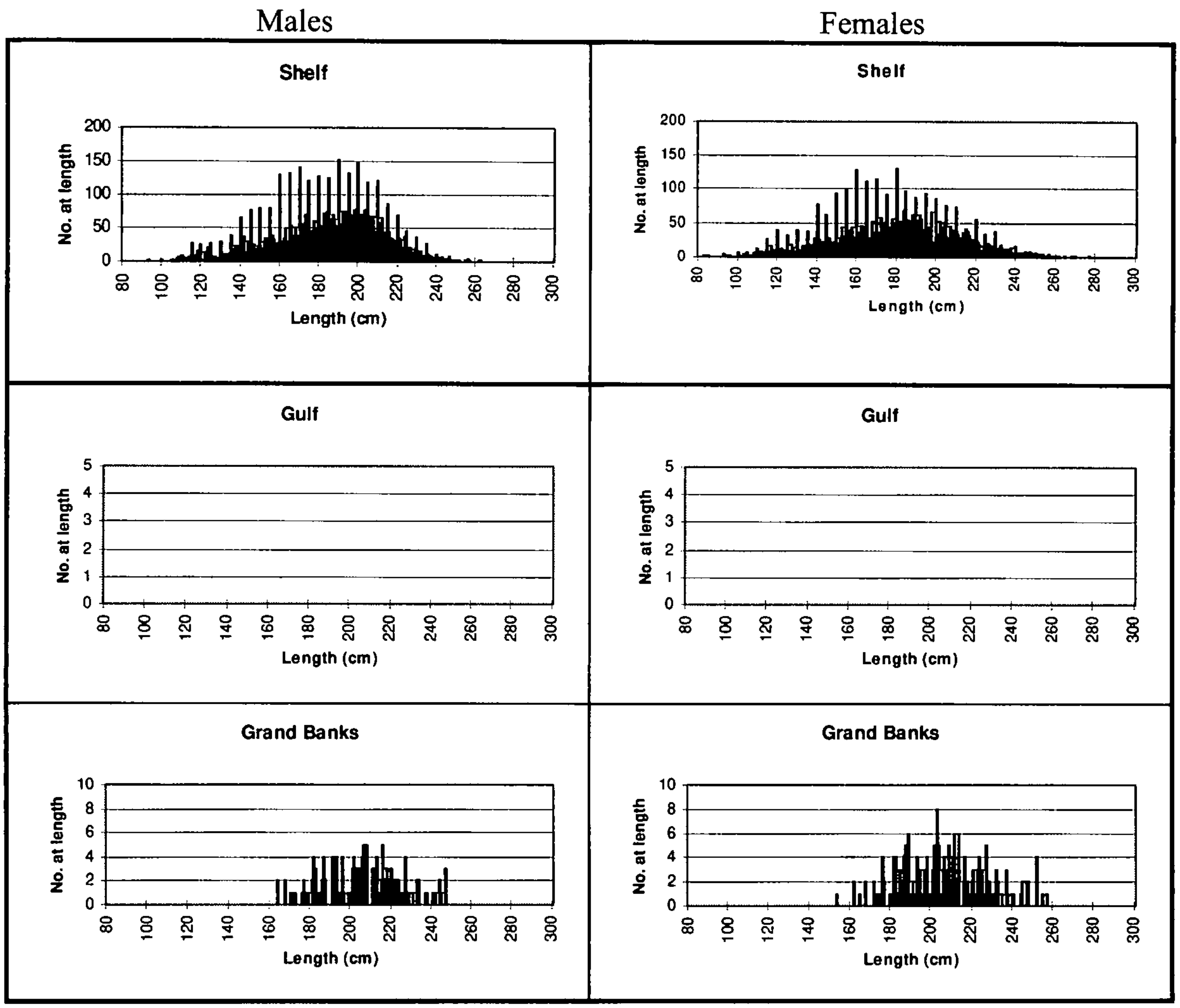

Figure 2 (e): Size composition of male and female porbeagle sharks (in 1 cm intervals) by area, in the directed fishery in July, from S-F Observer data 1987-96.

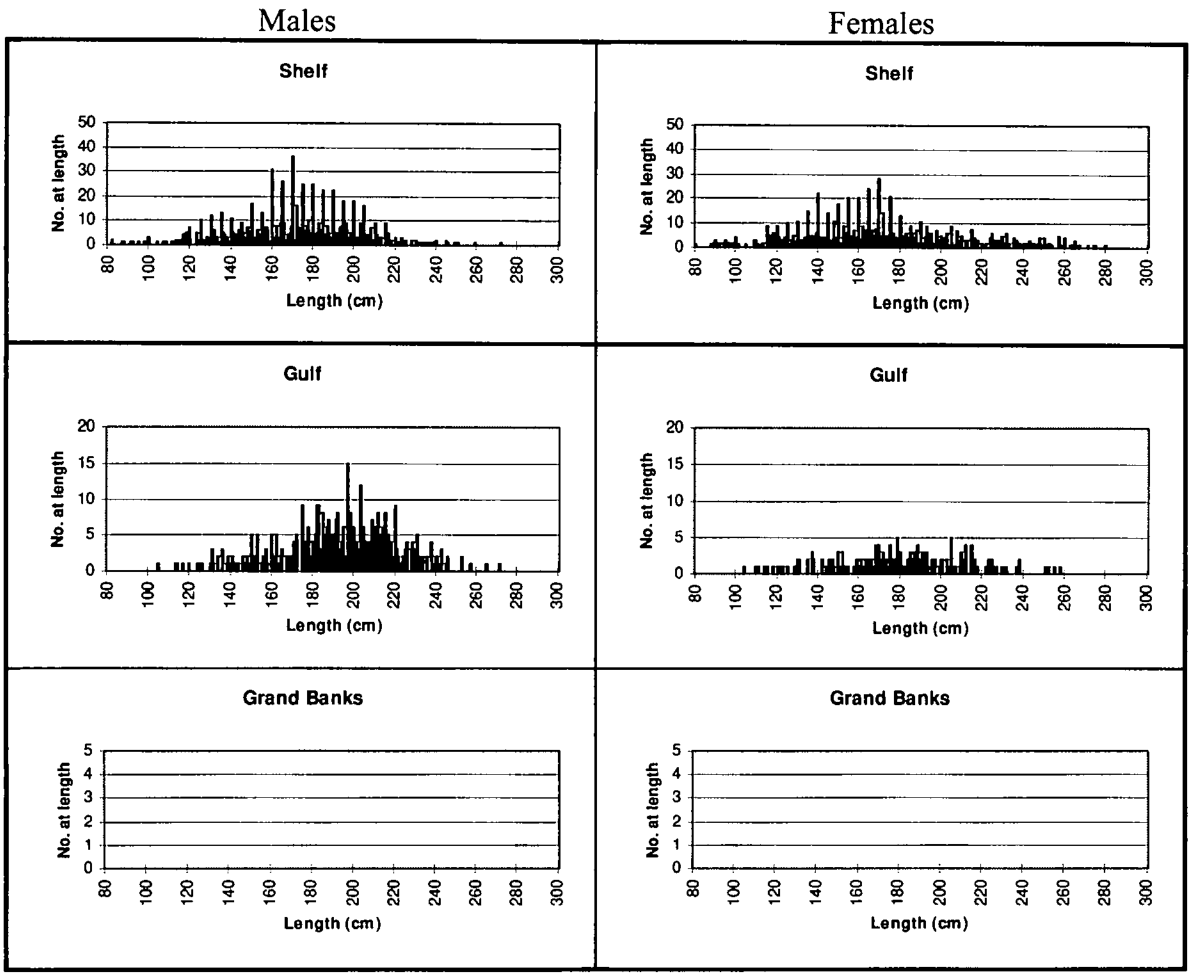

Figure 2 (f): Size composition of male and female porbeagle sharks (in 1 cm intervals) by area, in the directed fishery in August, from S-F Observer data 1987-96.

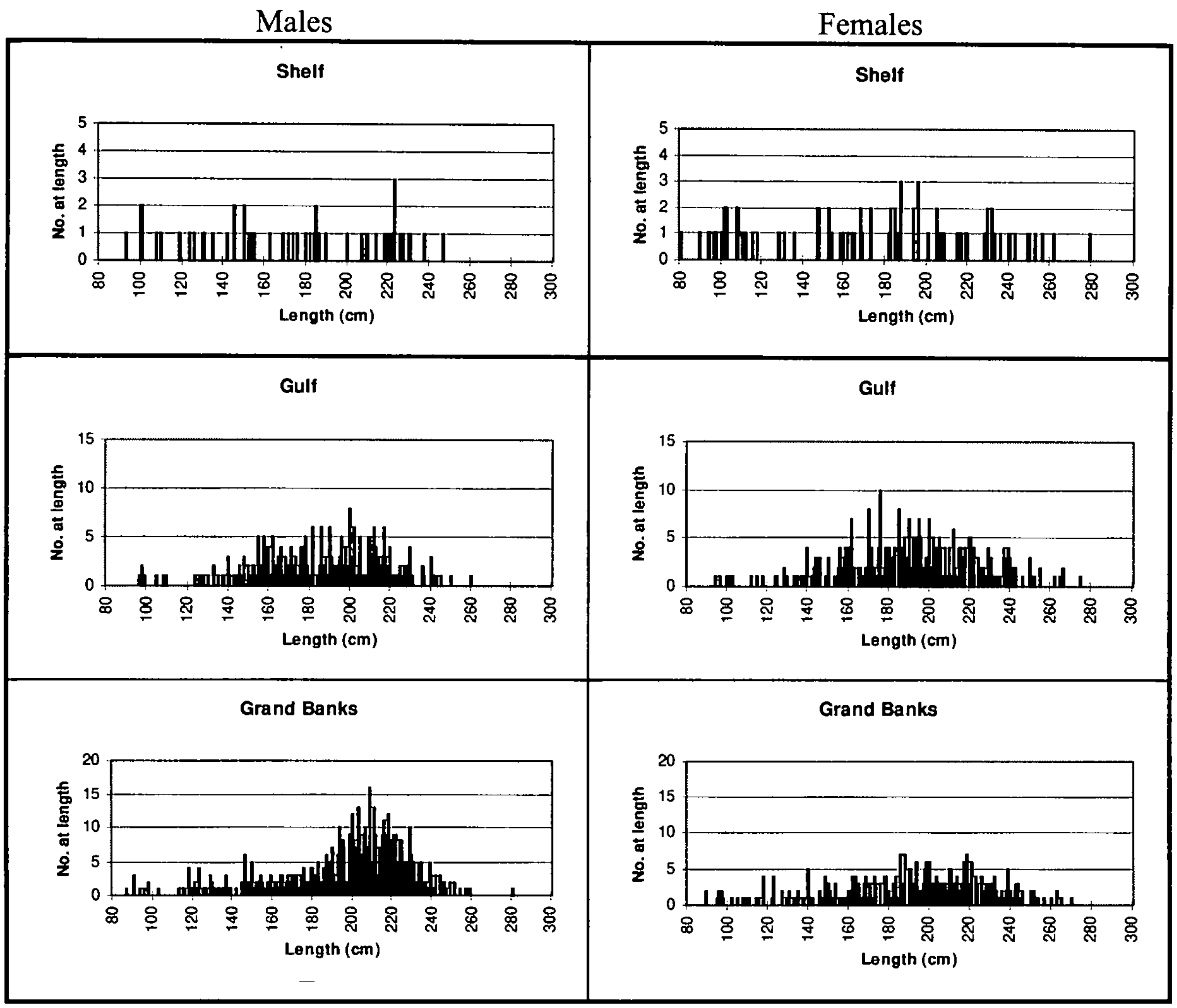

Figure 2 (g): Size composition of male and female porbeagle sharks (in 1 cm intervals) by area, in the directed fishery in September, from S-F Observer data 1987-96.

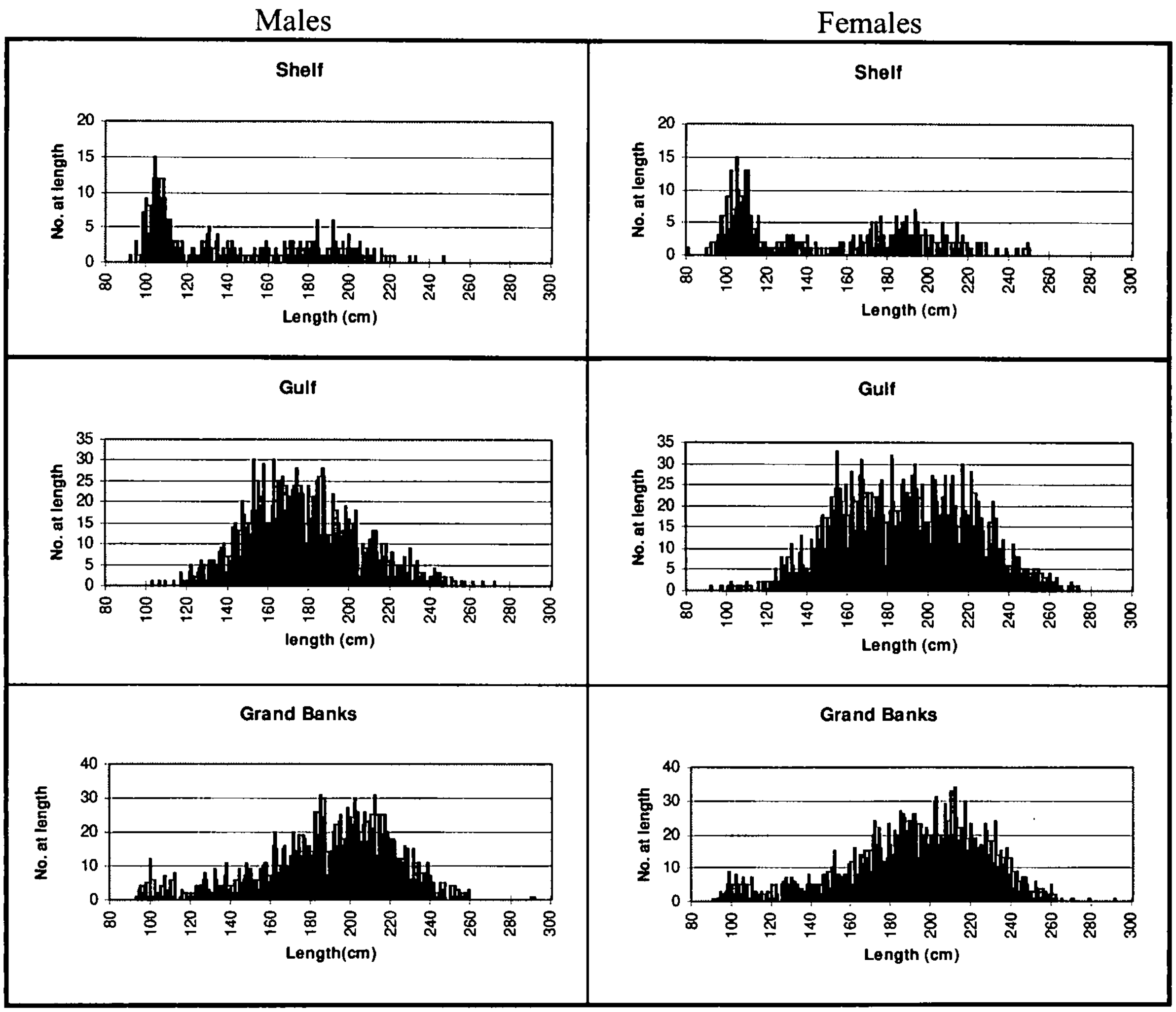

Figure 2 (h): Size composition of male and female porbeagle sharks (in 1 cm intervals) by area, in the directed fishery in October, from S-F Observer data 1987-96.

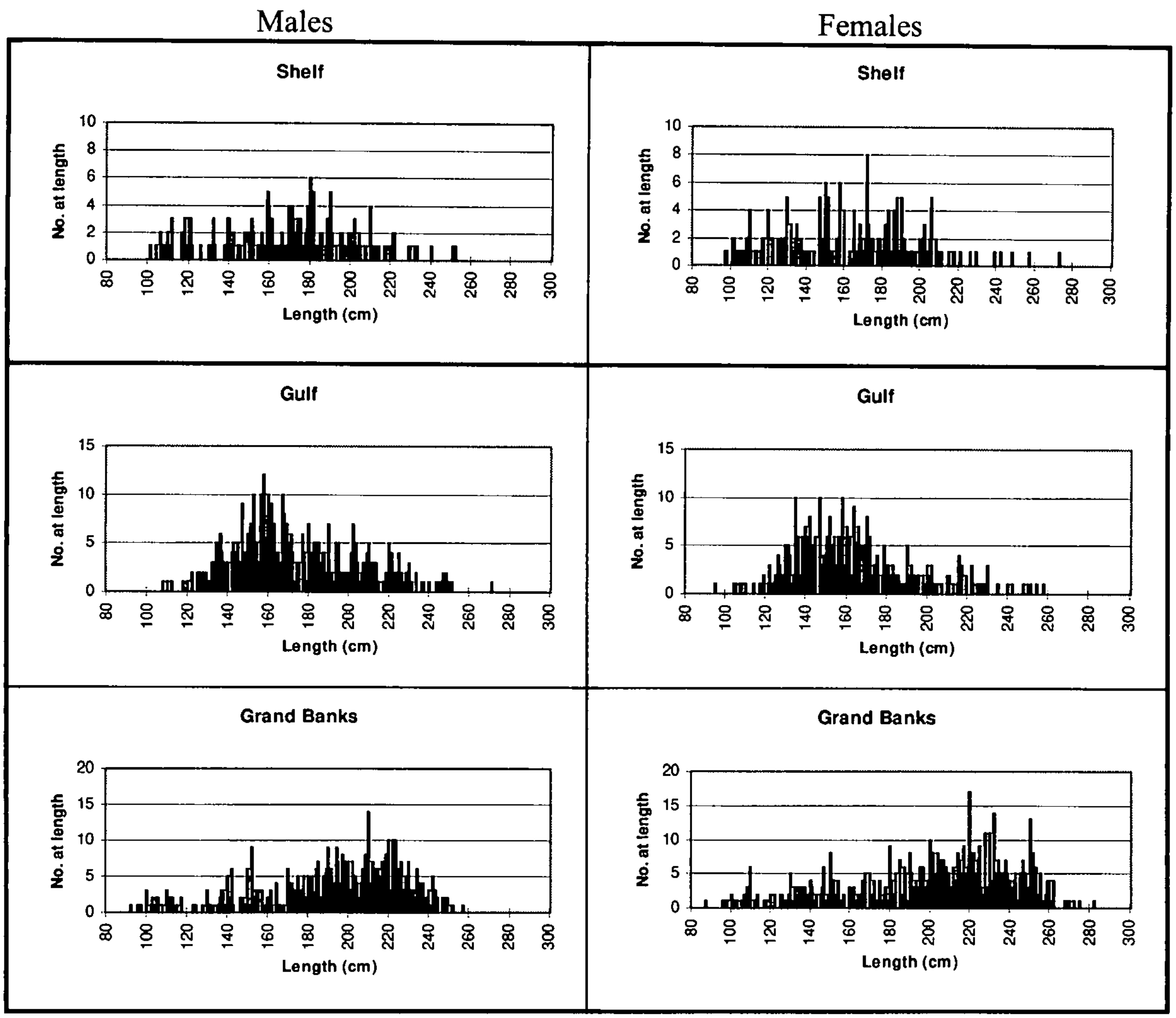

Figure 2 (i): Size composition of male and female porbeagle sharks (in 1 cm intervals) by area, in the directed fishery in November, from S-F Observer data 1987-96.

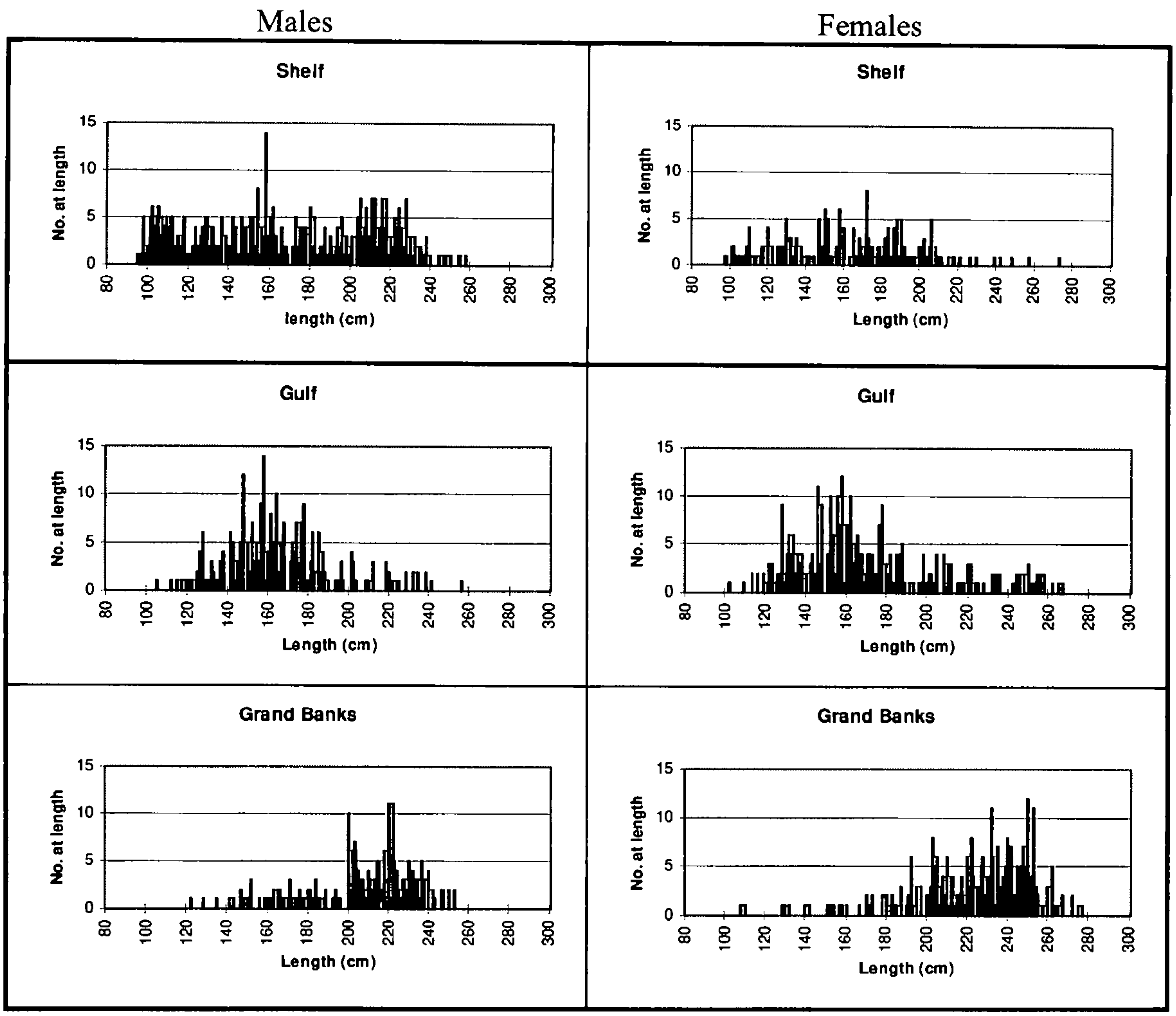

**Figure 2(j).** **Size composition of male and female porbeagle sharks (in 1 cm intervals) by area, in the directed fishery in December, from S-F Observer data 1987-96.**

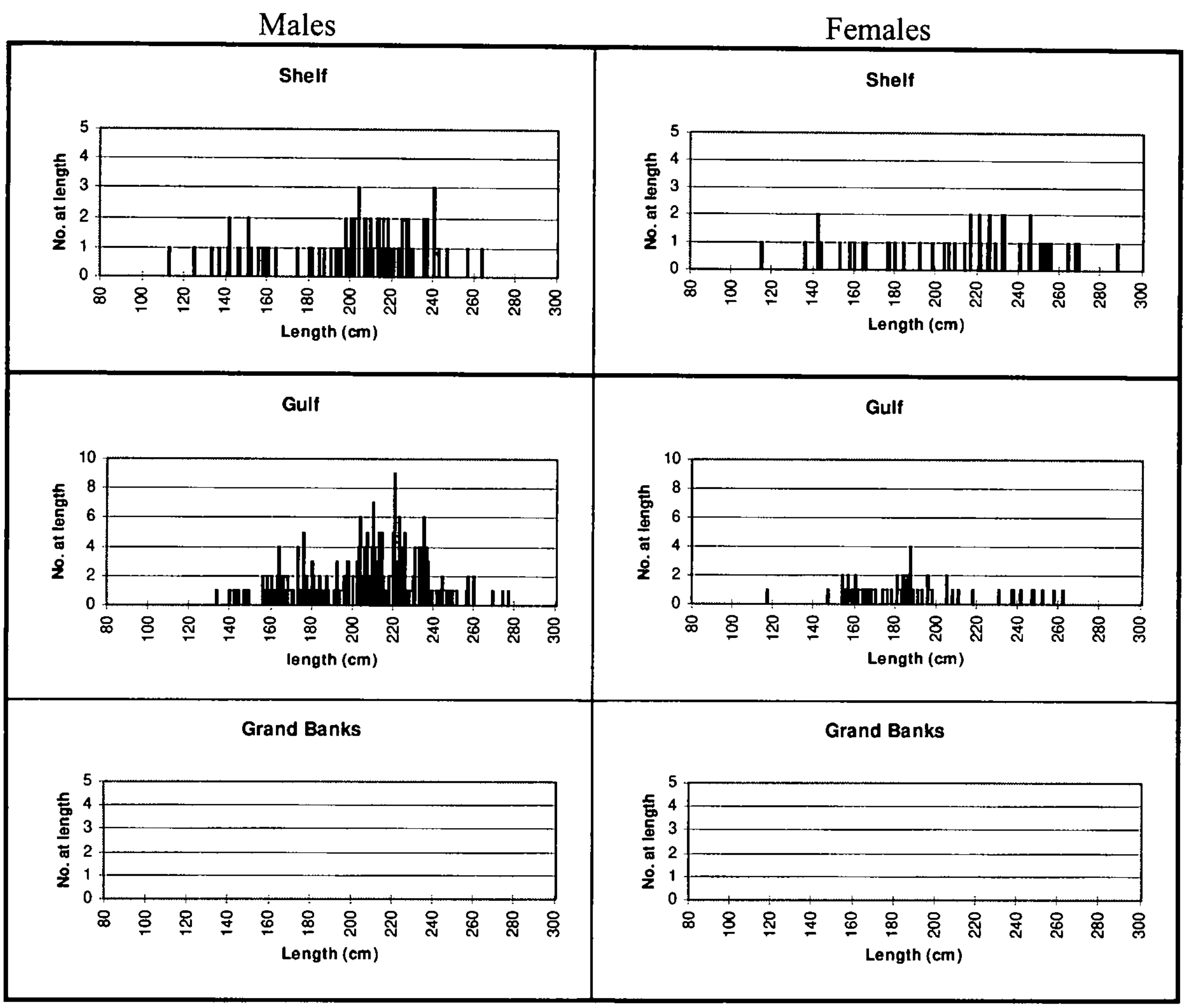

**Figure 3. Reported Landings (t) of Porbeagle in the North Atlantic**

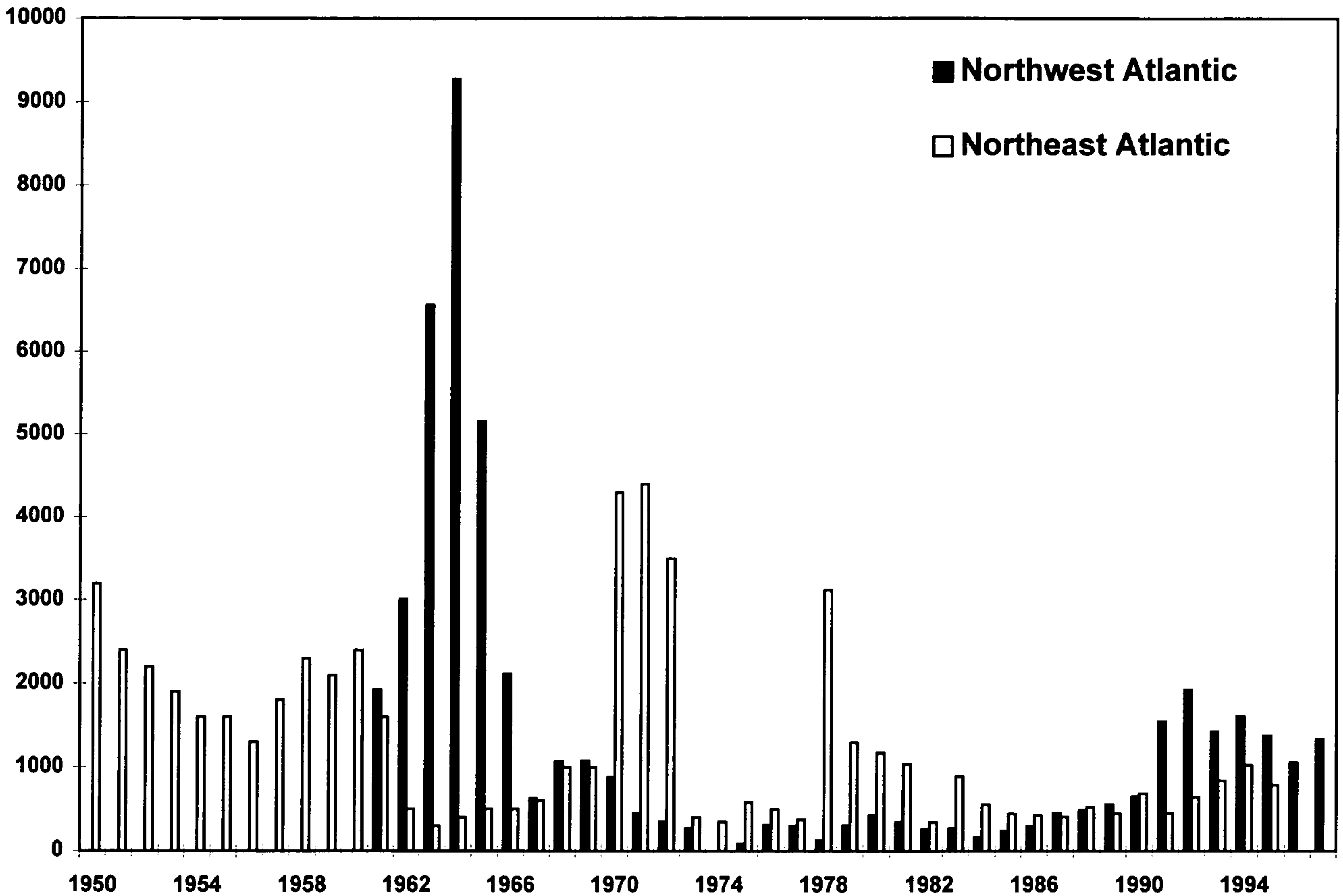

**Figure 4. Reported Landings (t) by Country of Porbeagle in the Northwest Atlantic**

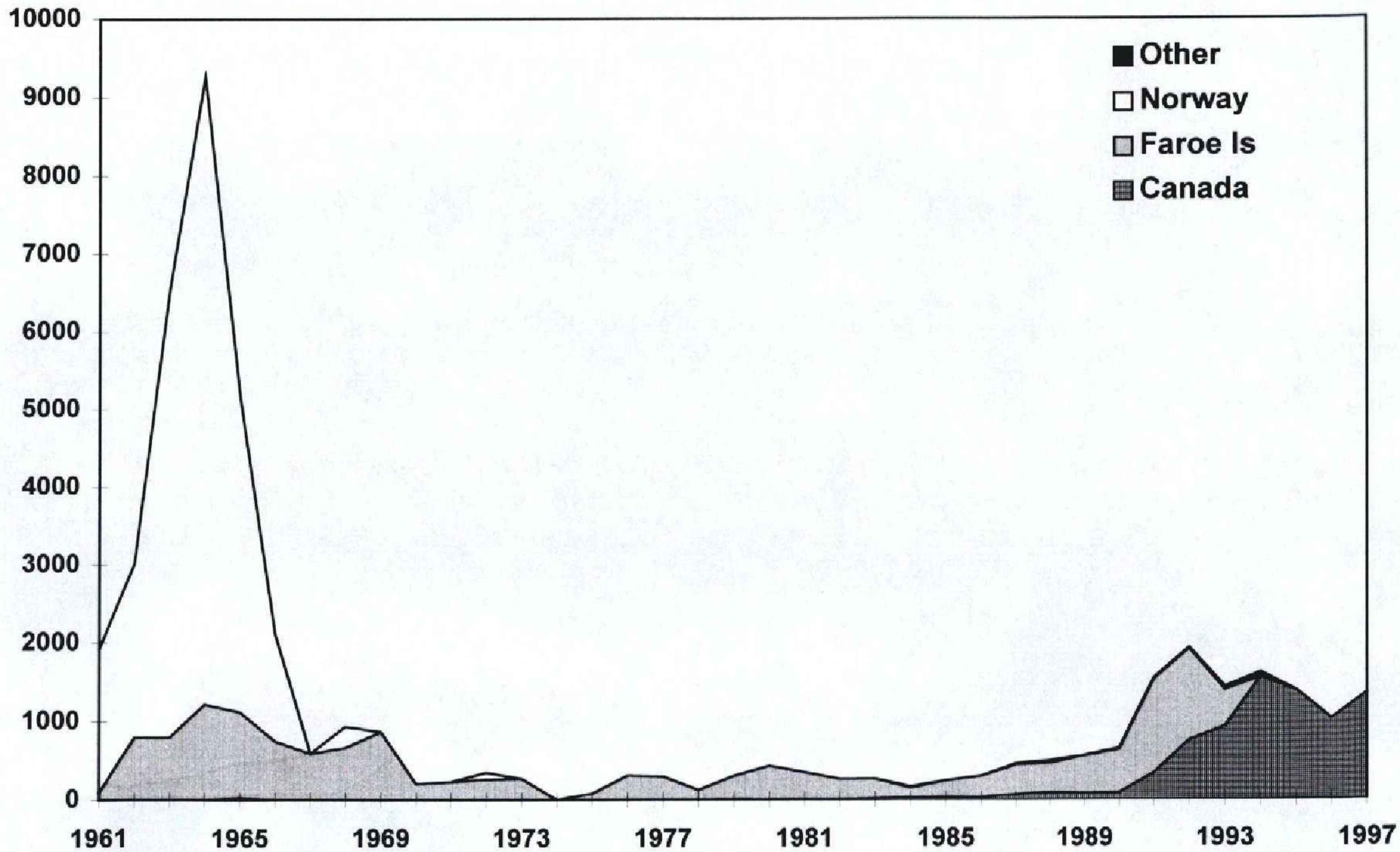

Figure 5. 1991-97 seasonal catch rates (kg/hook) of porbeagle shark by Canadian vessels greater than or equal to 100'.

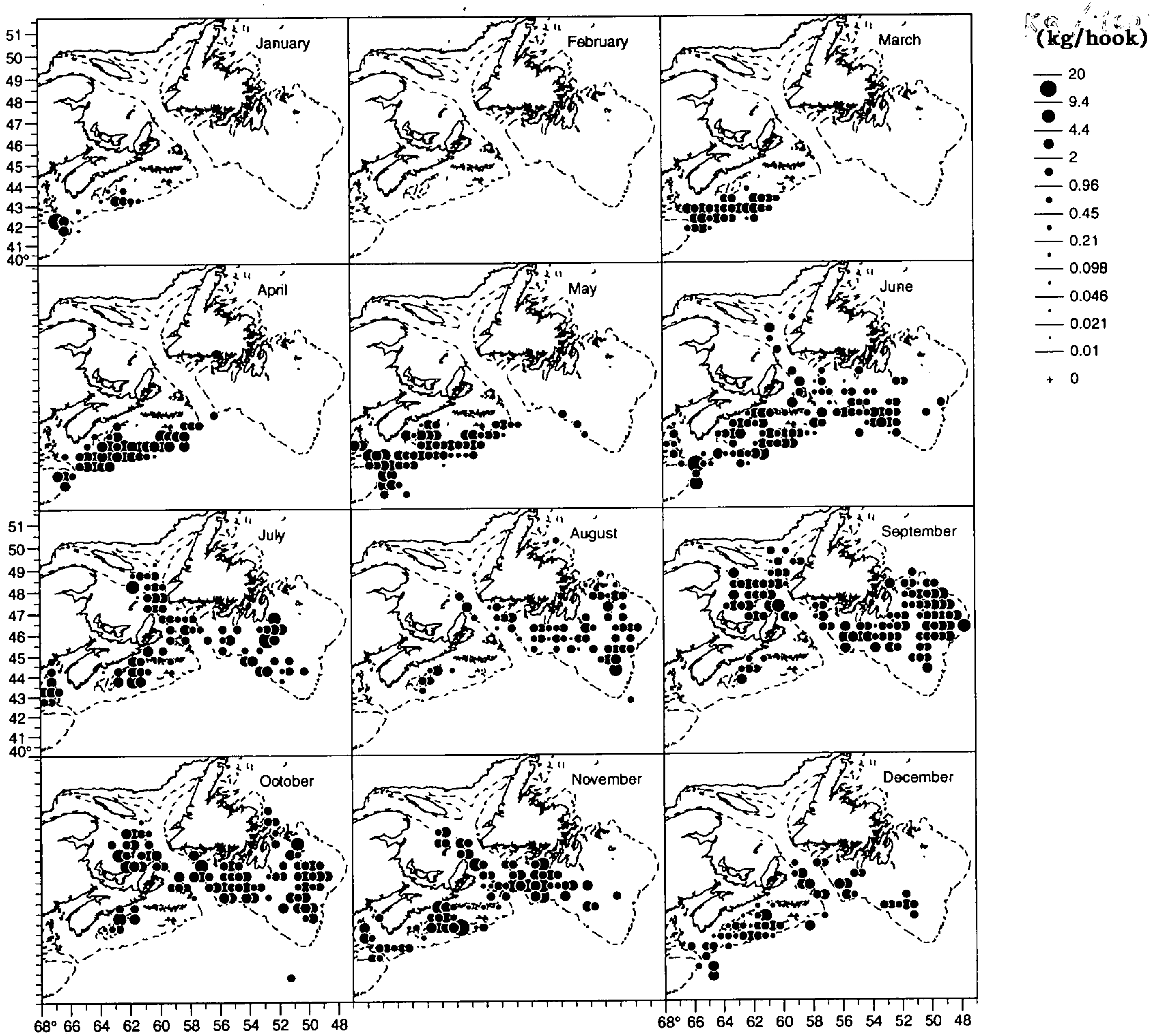

Figure 6. Annual 1991-97 set catch rates (kg/hook) of porbeagle shark by Canadian vessels greater than or equal to 100'.

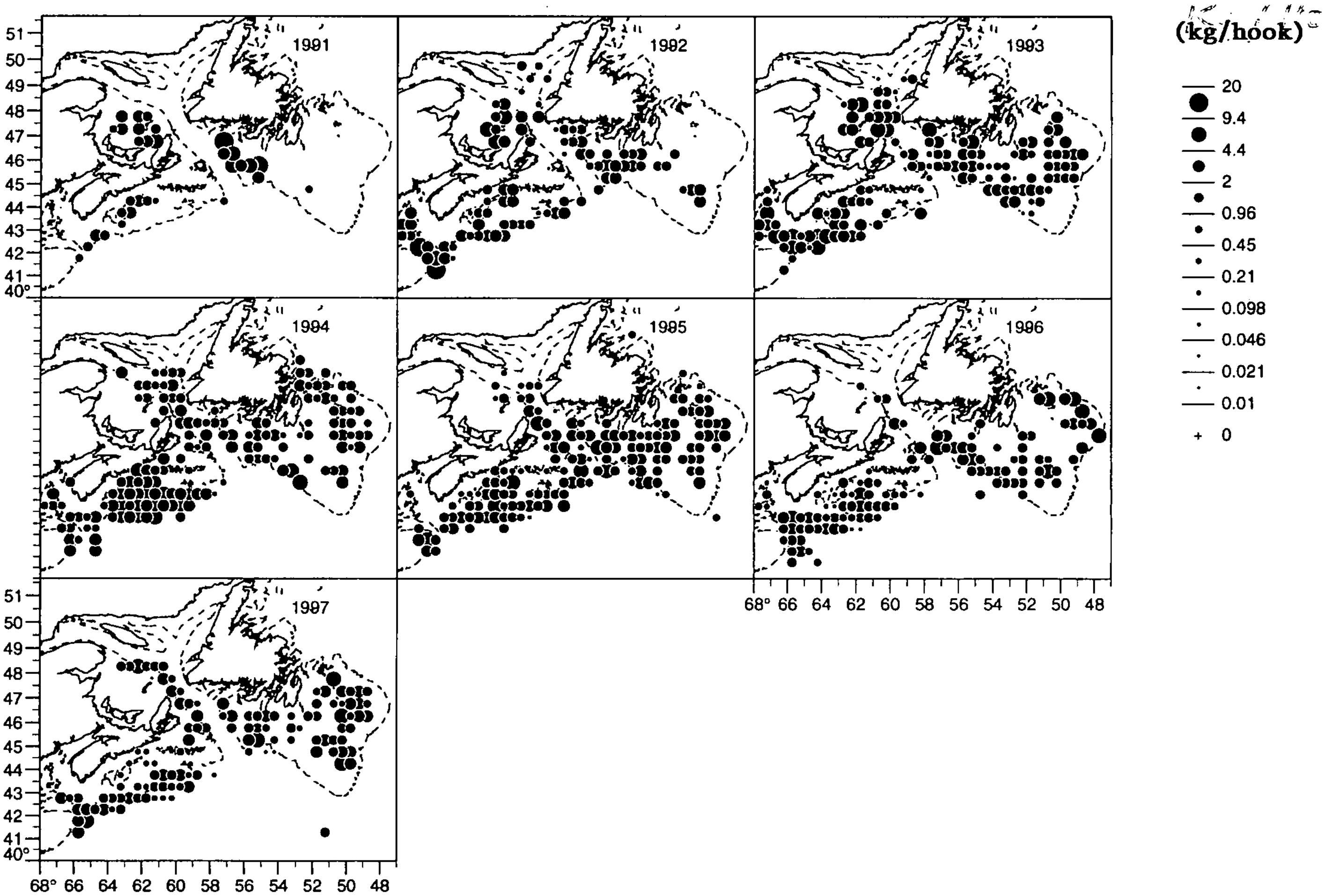

Figure 7. 1994-97 seasonal catch rates (kg/hook) of porbeagle shark by Canadian vessels less than 100'.

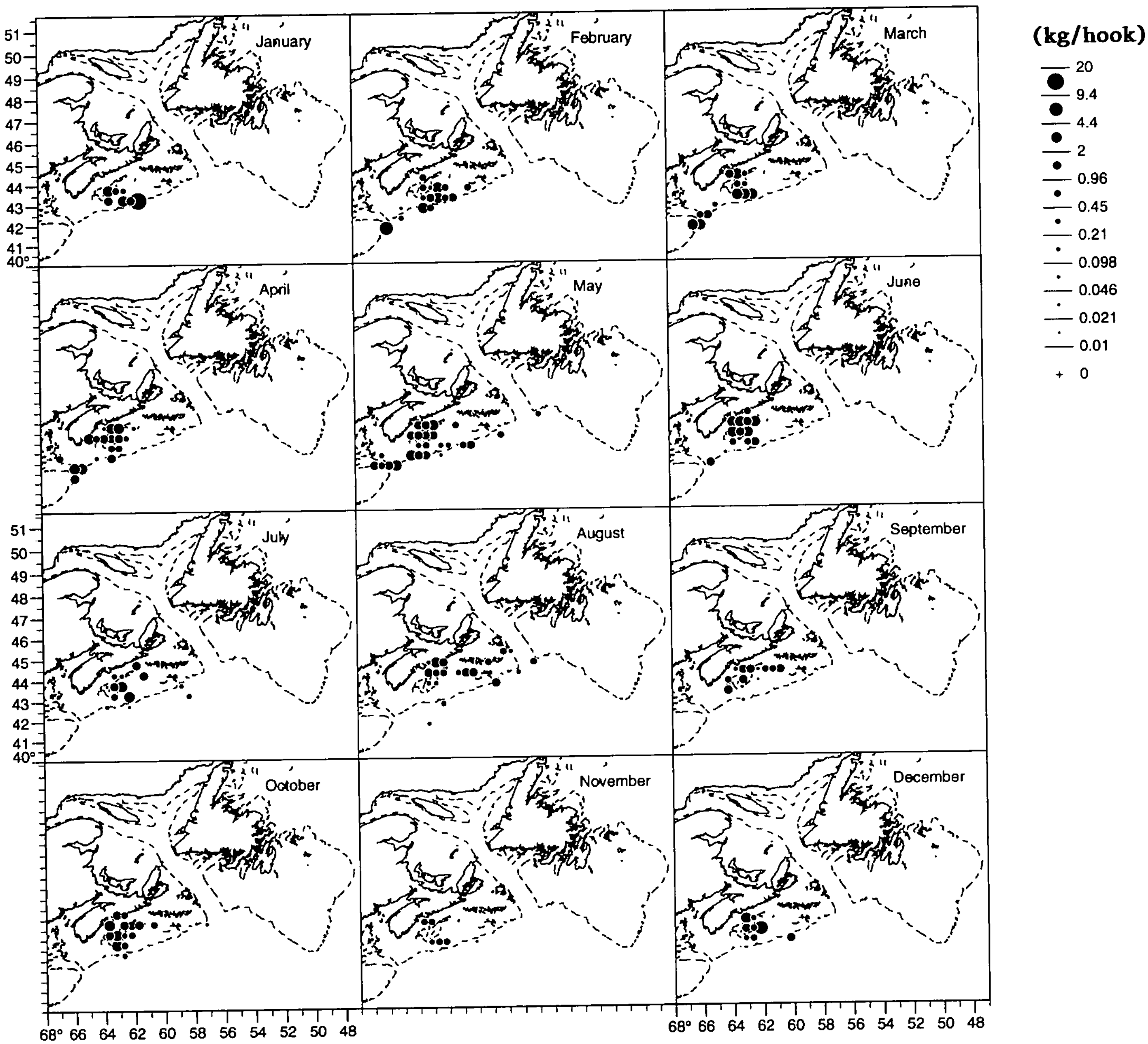

Figure 8. Annual 1994-97 set catch rates (kg/hook) of porbeagle shark by Canadian vessels less than 100'.

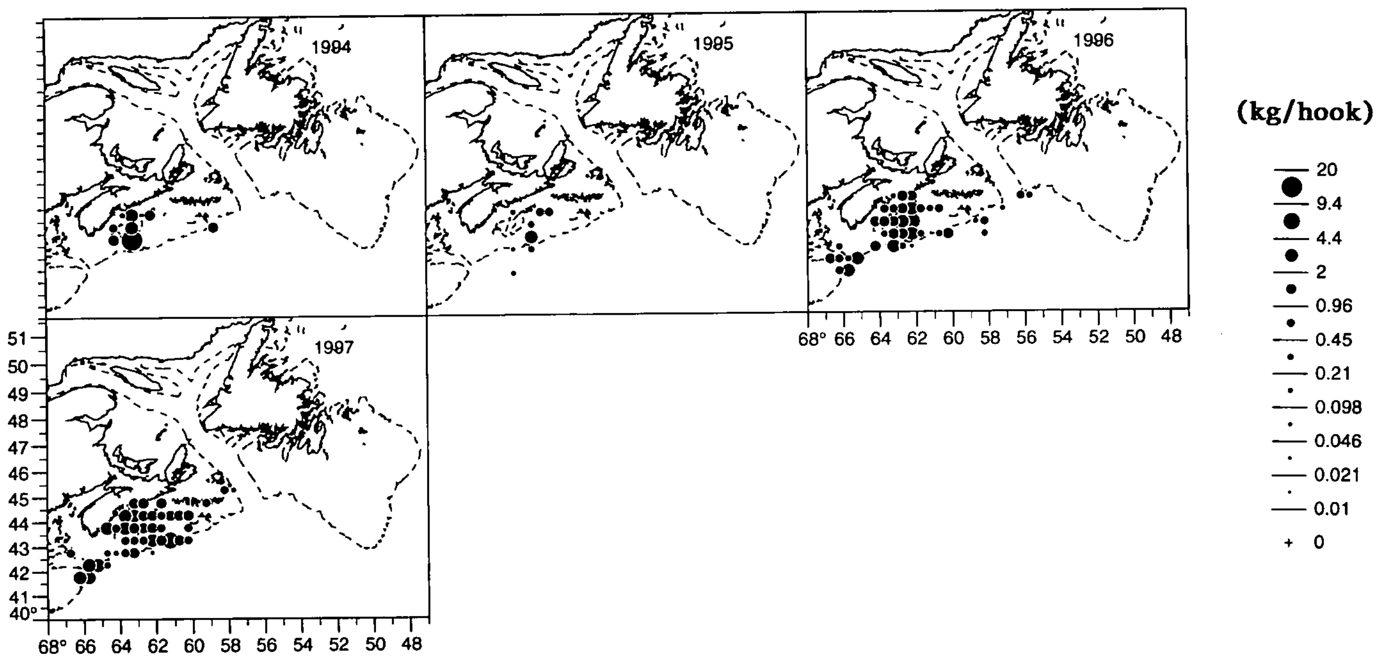

Figure 9a. Catch rates (kg/hook) of porbeagle directed vessels greater than 100' LOA for all months and areas.

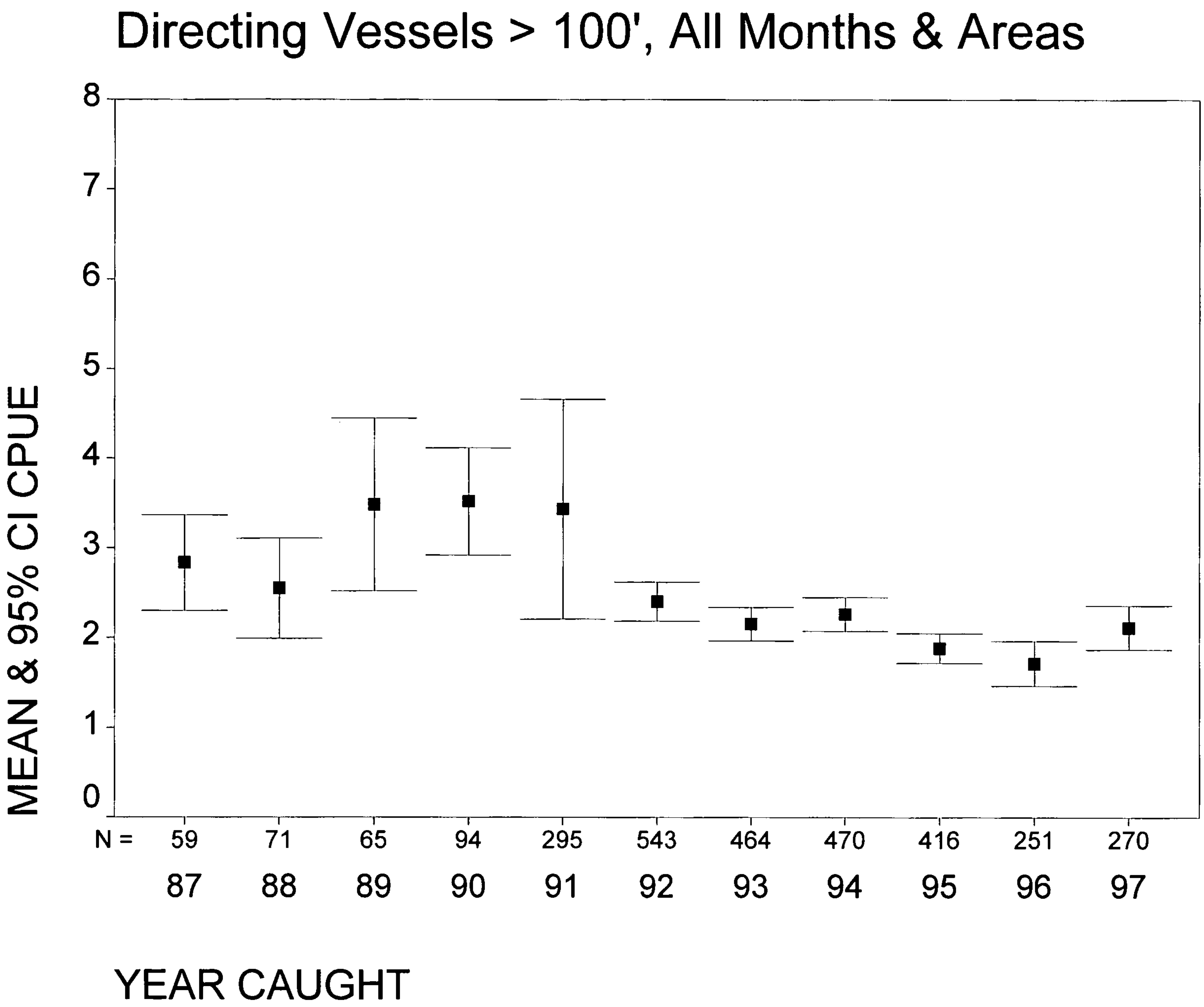

Figure 9b. Trends in Effort for Canadian Vessels greater than 100 ft LOA

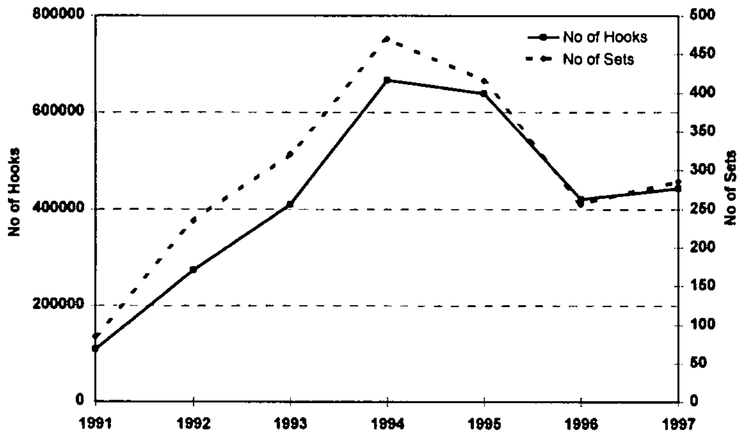


Figure 9c. Trend in Hooks per set for Canadian Vessels greater than 100 ft LOA

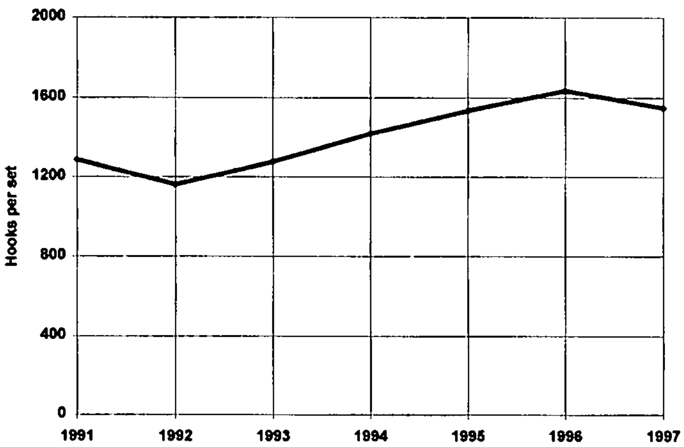


Figure 9d. Trends in Aggregate Catch Rates for Canadian Vessels greater than 100 ft LOA

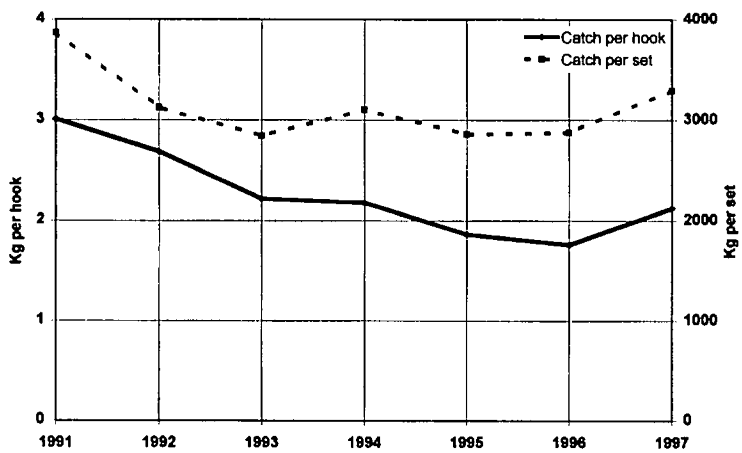

**Figure 10.** Catch rates (kg/hook) for porbeagle directed vessels greater than 100' LOA operating in NAFO Divisions 4WX during the spring.

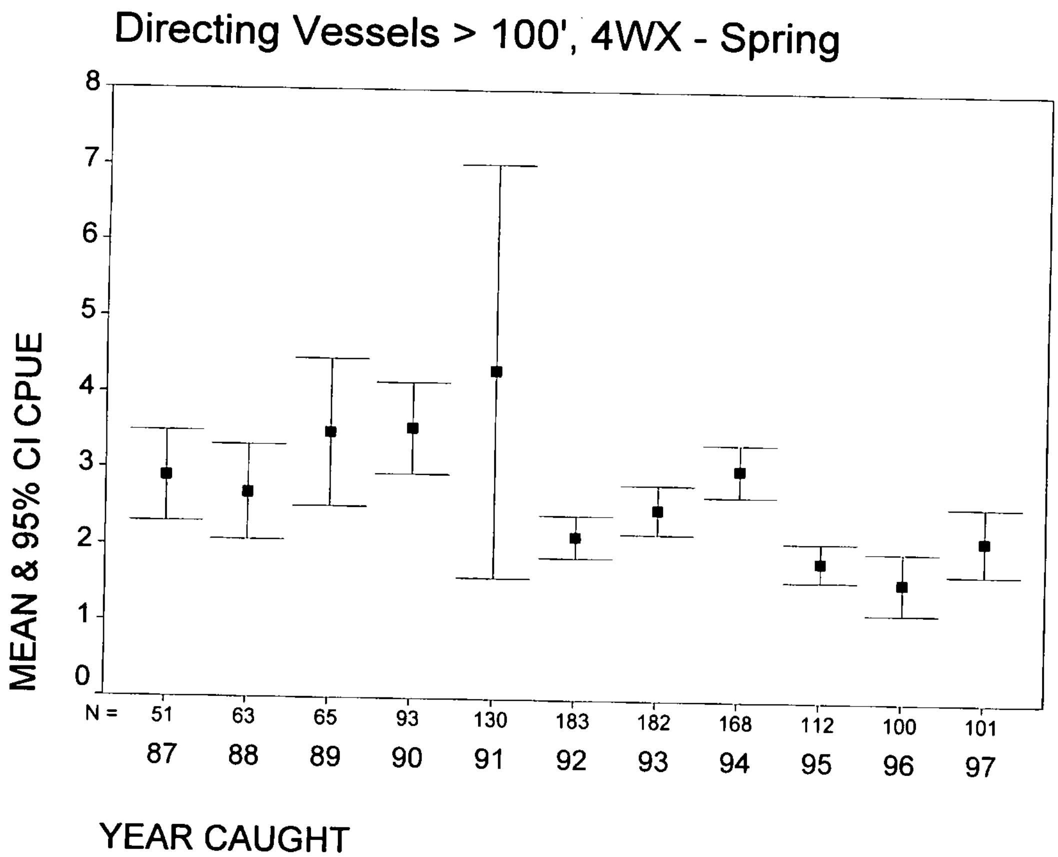

**Figure 11.** **Catch rates (kg/hook) for porbeagle directed vessels greater than 100" LOA operating on the Grand Banks furing the fall.**

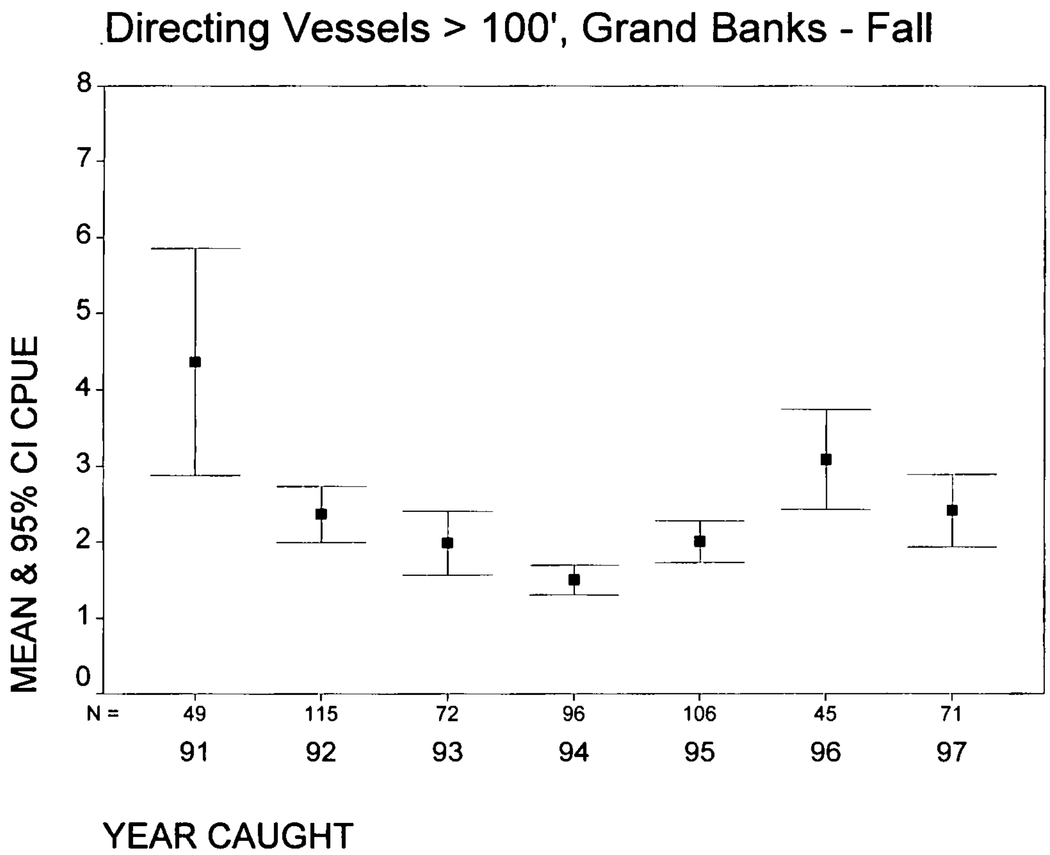

Figure 12. Offshore catch rates (vessels greater than 100' LOA) in 4WX during spring for years providing 5 or more sets. Predicated values from models denoted by plus (+) signs.

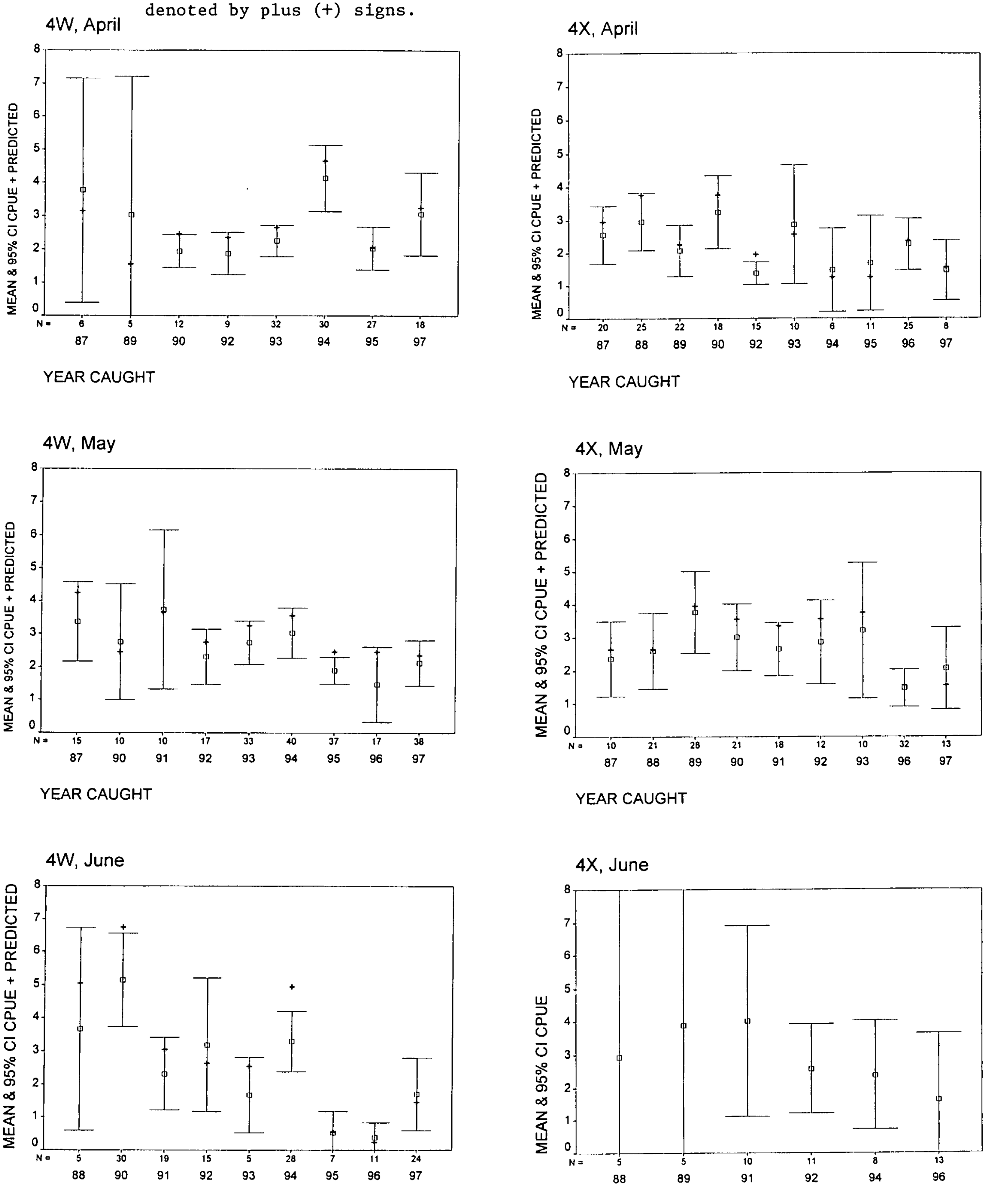

Figure 13. Mean total lengths per set of porbeagle shark used in the analysis of catch rates with length as a factor.

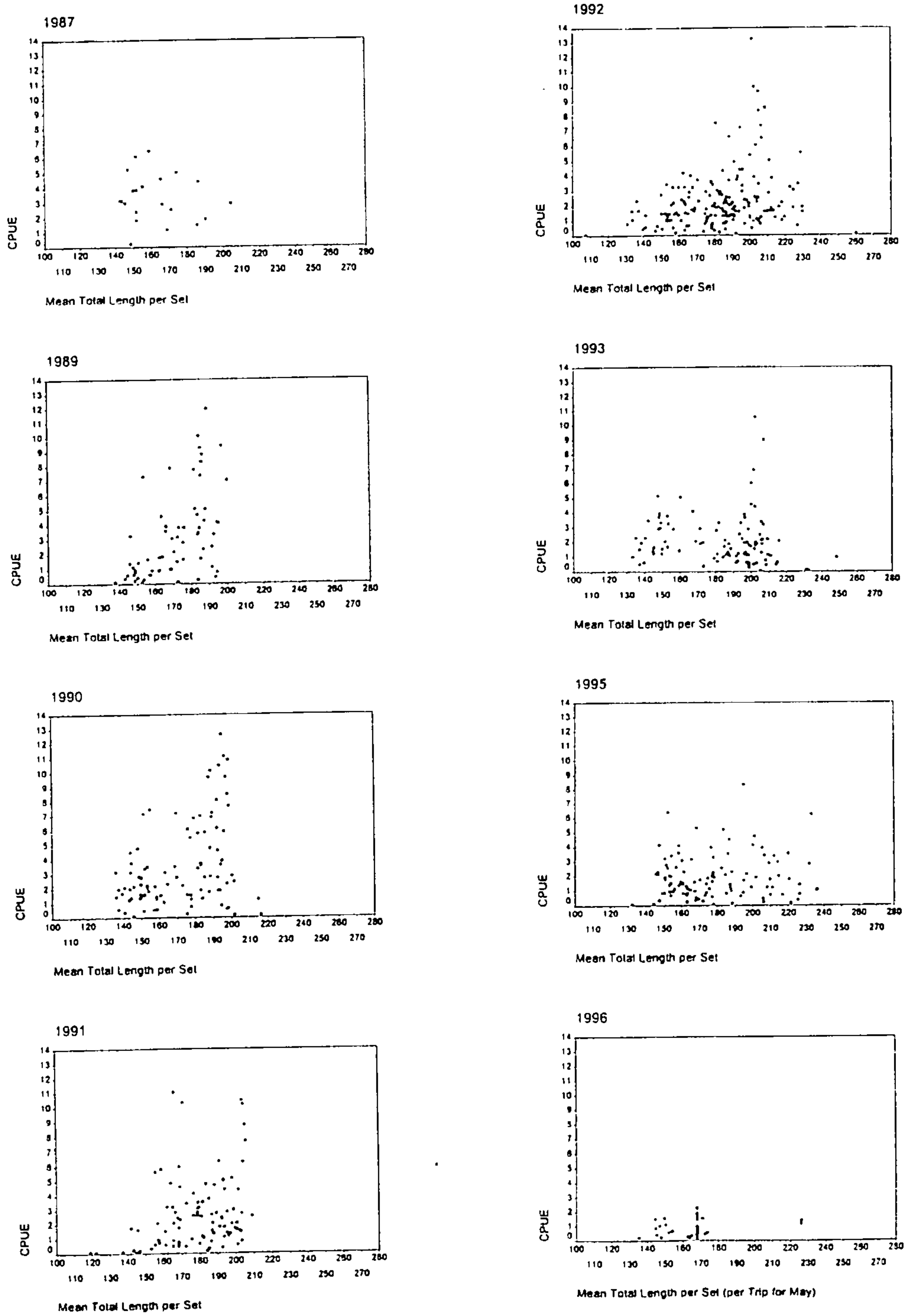

Figure 14.Catch Rate Interaction of Length with Year

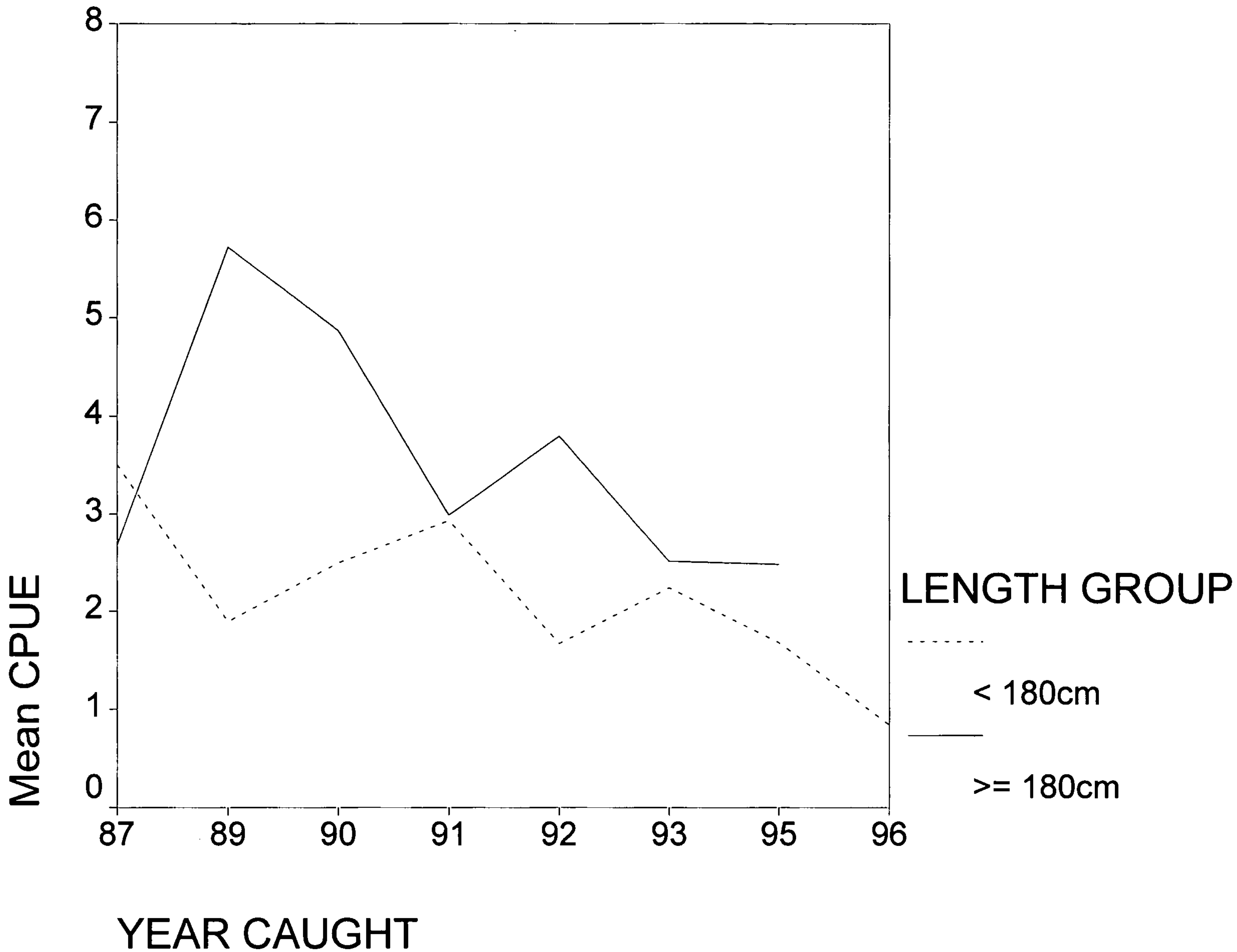

Figure 15. $Z_i$ and Zm for Equilibrium in a Porbeagle Population