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A pre-COSEWIC assessment of Porbeagle Shark (*Lamna nasus*) in Newfoundland and Labrador waters

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

Reassessment of the Porbeagle Shark (*Lamna nasus*) has recently been proposed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), under Canada's *Species at Risk Act* (*SARA*). Although COSEWIC first designated the Porbeagle Shark as Endangered in May 2004, and recommended its listing on Schedule 1 of *SARA*, the Government of Canada decided not to list this species after a series of public consultations in June 2006. This paper summarizes available information on the Porbeagle Shark in Newfoundland and Labrador (NL) waters to support a reassessment of this species by COSEWIC. Fisheries and Oceans Canada's (DFO) NL annual research surveys cannot be used to determine the NL distribution and population status of Porbeagle Sharks because they are rarely captured by survey gear. Porbeagle Shark discards remain unrecorded in all fisheries statistics, with the exception of those collected by Canadian Fisheries Observers. The latter constitute the only reliable source of information on discarding at sea. Fisheries statistics, including the Northwest Atlantic Fisheries Organization's (NAFO) STATLANT-21A database, DFO-NL Zonal Interchange File Format (ZIFF), and the Newfoundland Fisheries Observer Program (NFOP) database, provide very limited information on NL Porbeagle Shark landings. Furthermore, large numbers of this species are apparently being removed from the NL population as dead bycatch, which are discarded at sea in teleost-directed fisheries.

Évaluation pré-COSEPAC du requin-taupe commun (*Lamna nasus*) dans les eaux de Terre-Neuve-et-Labrador

RÉSUMÉ

Le Comité sur la situation des espèces en péril au Canada (COSEPAC) a récemment proposé que le requin-taupe commun (*Lamna nasus*) fasse l'objet d'une réévaluation en vertu de la *Loi sur les espèces en péril* (*LEP*) du Canada. Même si, en mai 2004, le COSEPAC avait désigné le requin-taupe commun comme espèce menacée, recommandant ainsi son inscription à l'annexe 1 de la *LEP*, le gouvernement du Canada avait décidé de ne pas inscrire l'espèce après une série de consultations publiques tenues en juin 2006. Ce document résume les renseignements disponibles sur le requin-taupe commun des eaux de Terre-Neuve-et-Labrador (T.-N.-L.) et vise à appuyer une réévaluation de l'espèce par le COSEPAC. Les relevés de recherche de Pêches et Océans Canada (MPO), région de T.-N.-L., ne peuvent servir à déterminer l'aire de répartition et l'état de la population du requin-taupe commun, car ce dernier n'est que rarement capturé à l'aide des engins de relevé. Les requins-taupes communs rejetés à la mer restent non déclarés dans toutes les statistiques de pêches, à l'exception de ceux qui sont attrapés par les observateurs des pêches du Canada. Ces derniers représentent la seule source de renseignements fiable sur les rejets en mer. Les statistiques des pêches, dont la base de données STATLANT-21A de l'Organisation des pêches de l'Atlantique Nord-Ouest, la base de données Zonal Interchange File Format du MPO et la base de données du programme des observateurs des pêches de T.-N.-L. ne fournissent que très peu de renseignements sur les débarquements de requin-taupe commun dans la province. Qui plus est, de nombreux individus de cette espèce sont apparemment éliminés de la population de T.-N.-L. du fait qu'ils sont rejetés en mer comme prises accessoires au cours des activités de pêche ciblant les poissons téléostéens.

INTRODUCTION

The application of Canada's *Species at Risk Act* (*SARA*), proclaimed in June 2003, begins with an assessment of a species' risk of extinction by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). COSEWIC is a non-governmental advisory body that has been established to provide the scientific foundation for listing species under *SARA*. Therefore, a species assessment initiates the regulatory process in which the competent Minister must decide whether or not to accept the COSEWIC designation and list a species in Schedule 1 of *SARA*. If listed, that species is then legally protected under *SARA*. If the species is already listed in Schedule 1, the Minister may then decide to keep the species on the list, reclassify it as per the COSEWIC assessment, or remove it from the list (i.e., Section 27 of *SARA*).

The Porbeagle Shark is a widely distributed lamnid shark, and the only representative of its genus in the North Atlantic. Similar to many other shark species, Porbeagles are characterized by a long generation time (18 years; Campana et al. 2002), low fecundity (average of four pups per mature female per year; Jensen et al. 2002), and late sexual maturation (13 years of age for females, and 8 for males; Natanson et al. 2002). These life-history traits render Porbeagles particularly vulnerable to human-induced mortality. The COSEWIC first assessed Porbeagle Shark in May 2004, and designated it as Endangered, due to its low productivity combined with declines in abundance as a consequence of excessive fishing mortality. COSEWIC recommended that Porbeagle be listed on Schedule1 of *SARA*. However, following public consultations in June 2006, the Government of Canada decided not to list Porbeagle Shark on Schedule 1, but instead to continue to manage this species under the authority of the Federal *Fisheries Act*. A conservation strategy was then developed to support rebuilding of Porbeagle Shark populations in Atlantic Canada by limiting the directed fishery in Canada, and by reducing its bycatch in other fisheries conducted in Canada's Exclusive Economic Zone (EEZ; DFO 2007; see DFO 2012 for progress report on implementation).

The COSEWIC has since proposed the reassessment of Porbeagle Shark (*Lamna nasus*) under *SARA*. Fisheries and Oceans Canada (DFO), as a generator and archivist of data on marine species, must provide COSEWIC with the best information available to ensure that an accurate assessment (or reassessment) of the status of a species can be undertaken. This paper summarizes available information on Porbeagle Shark in Newfoundland and Labrador (NL) waters to support reassessment of this species by COSEWIC.

MATERIALS AND METHODS

SURVEY DATA

While annual fisheries-independent surveys have been carried out in the NL Region (Fig. 1) since 1946, there are very few records of captures of Porbeagle Sharks. In only eight instances were Porbeagle Sharks captured in research survey gear. Each occurrence was plotted in this paper to assist in defining the geographic range of this species in NL waters.

FISHERIES DATA

Fisheries data available in the NL Region include the Northwest Atlantic Fisheries Organization (NAFO) STATLANT-21A database, which contains commercial landings from NAFO Subareas 0, 1, 2, and 3, as reported by member countries from 1961 to 2011. In addition, commercial bycatch, discards, and length frequency data from 1979 to 2011 were obtained from the National Fisheries Observer Program (NFOP) database, which contains set-by-set information collected at sea in a standardized format by trained Canadian Fisheries Observers. A third source of fisheries data was the DFO-NL ZIFF (Zonal Interchange File Format)

database, which was created in 1985 to compile commercial landings reported by Canadian fishers (as recorded in their logbooks and on fish plants' purchase slips). It must be noted that discards (even of target species) are never reported to NAFO or to DFO-NL Statistics Branch (for ZIFF). Therefore, the only reliable source of data on discarding at sea comes from Canadian Fisheries Observers.

To estimate total bycatch of Porbeagle Shark in various NL fisheries, a method based on Campana et al. (2011) was used with the NFOP database for 1985-2011. Reported landings of the target species by fishery (summed by year) in ZIFF-NL was divided by the observed kept weight of this target species by year (e.g., Swordfish+tunas; Atlantic Cod; Yellowtail Flounder). This factor was then multiplied by the observed catch weight (=kept+discards) of Porbeagle Shark in each fishery by year in order to "bump up" Porbeagle bycatch estimates to the entire fishery. However, a lack of comparable data between ZIFF-NL and NFOP for each fishery in some years restricted the application of this method. Although the NFOP database contained adequate records of Porbeagle kept and discard weights for several fisheries in particular years, the ZIFF-NL database either had no reported landings of the target species in those fisheries, or contained landings of said target species in years other than those covered by the NFOP. This situation also precluded inclusion of the temporal variables "quarter" (Campana et al. 2011) and "month" (Hanke et al. 2012) while applying this method to NL commercial data. In addition, given that the ZIFF-NL database does not contain a variable to indicate the number of sets fished, ZIFF total landings of each target species could not be weighted by this variable (as per Campana et al. 2011), and a decision was also made to not weigh any data (e.g., ZIFF) by the amount of gear fished, because this exercise would further limit the number of Porbeagle total bycatch estimates by year. It must be noted that shark bycatch estimates presented here cannot be validated. However, identification of large sharks in Div. 3LNOP by NL Observers since 1991 is considered reasonably accurate, given that shark species ID training and specimen verification were provided on an ongoing basis to NL Observers.

In addition to providing length frequencies of Porbeagle catch in large pelagic longline fisheries, the NFOP database was also used to map the distribution of Porbeagle Shark in NL waters. Furthermore, secondary locations were also plotted, to indicate Porbeagle Shark captures reported by NL commercial or recreational fishers targeting other species. Shark species identifications confirmed by DFO-NL Science staff were also mapped.

RESULTS AND DISCUSSION

Porbeagle Sharks are rarely captured in DFO annual research surveys conducted in the NL Region; this is probably due to extremely low catchability of this large pelagic species in demersal survey trawls (Benjamins et al. 2010). Only eight Porbeagles were caught in survey trawls over the past 65 years. Seven of these cases occurred in 1960, in NAFO Div. 3N on the southern Grand Bank. The other occurrence was in 1988 off of southern Newfoundland, in NAFO Subdiv. 3Ps.

NAFO-reported data suggested that there were two periods of peak landings of Porbeagle Shark in Newfoundland and Labrador waters. The first was in 1962-68, yielding a 770 t annual average (with peaks of over 1,000 t in 1964 and 1965) from undisclosed Divisions of NAFO Subarea 3; the second, from 1992 to 2000, yielded a 307 t average from Div. 3LNOP (Table 1; Fig. 2). In 1979-83, average annual landings in Div. 3LNOP were 86 t, which became negligible over 1984-87, then averaged 121 t in 1988-90. As of 2003, landings reported to NAFO have rarely exceeded 10 t. Over 1961-2011, many countries have reported landing Porbeagle Sharks, including Norway, Japan, Spain, France, and the United States. From 1964 to the early 1990s, the Faroe Islands (Denmark) landed a significant amount of Porbeagle. As of 1994, with the prohibition of foreign-registered vessels from fishing stocks inside Canada's EEZ, Canadian fishers became a major source of reported Porbeagle landings, particularly in Div. 3O and

Subdiv. 3Ps. Given that discards are never reported by NAFO member countries, actual removals of Porbeagle Shark from the NL population have been, and will continue to be, higher than what available statistics indicate. This ongoing, substantial impediment to assessing the impacts of teleost-directed fisheries on this species in Canadian waters is reflected on a global scale, where some regions experience bycatch mortalities of Porbeagle and other large pelagic sharks that may be twice as high as what reported landings indicate (FAO 2004; Campana et al. 2006; ICES 2006).

With respect to Canadian-reported landings in the DFO-NL ZIFF database, it must be noted that discarding of Porbeagle bycatch at sea in NL fisheries occurred frequently in recent years, and remains unreported in the fishery statistics. Therefore, significant removals of this species are unquantifiable, and cannot be integrated into scientific assessments of population status. Figure 3 depicts only a few locations of unreported Porbeagle discards in 2011-2012. One such example is during the Atlantic Cod stewardship gillnet fishery conducted in Hermitage Bay (off southern Newfoundland) in May-July 2012, where one commercial fisher bycaught thirty Porbeagle Sharks over this three-month period. Other licensed vessels fishing the same area at that time also bycaught many Porbeagles, though no formal statistical records exist. Furthermore, some NL fishers have perceived an increasing frequency of Porbeagles in their inshore commercial gear over the past five years, with the 2012 fishing season containing the highest numbers of such encounters to date. However, reasons for this perceived increase have not been investigated. ZIFF statistics do not reflect these frequent entanglements with fishing gear, because shark bycatch is discarded at sea, and thus rarely landed by NL fishers. ZIFF data indicate negligible commercial landings of Porbeagle from NL waters since 2004, with 96 t landed from Div. 3L in a Swordfish-directed longline fishery conducted in 1997, and 73-86 t landed from Div. 3LNOP in a Porbeagle-directed longline fishery in 1995 and 1998 (Tables 2 and 3; Figs. 4 and 5).

Based on NFOP data scaled up to entire fisheries, catches of this species occurred mainly in other NL groundfish fisheries as compared to Porbeagle-directed fisheries (Tables 4 and 5; Figs. 6 and 9). Porbeagle-directed fisheries were conducted in the NL Region by foreign-registered vessels (primarily from the Faroe Islands) during 1979-81 (11 t average annual catch) and 1987-1993 (56 t annual average; Table 4; Fig. 6). Porbeagle Shark bycatch occurred as far north as NAFO Div. 2H and 2J, where it was caught in directed fisheries for Northern Shrimp and Atlantic Cod (Fig. 7). Porbeagles were also occasionally captured in Greenland Halibut, Roundnose Grenadier, and redfish fisheries, and in otter trawls targeting various flatfish species (e.g., Yellowtail Flounder, Witch Flounder, American Plaice). While Porbeagle Sharks were occasionally caught north of the Grand Bank, the most common locations of bycatch were the Grand Bank (Div. 3LNO) and Subdiv. 3Ps (Figs. 7 and 8). In these areas, bycatch occurred in directed fisheries for Atlantic Cod, Monkfish, White Hake, skate, redfish, and flatfish (primarily Yellowtail Flounder; Figs. 6 and 9). Scaled up Porbeagle bycatch estimates suggested that a 60 t average was caught annually in the Atlantic Cod gillnet fishery from 1997 to 2004 (with a 1999 peak of 242 t), and a Monkfish gillnet fishery caught 324 t of Porbeagle in 1994. More recently, estimates indicate that a White Hake gillnet fishery caught 18 t in 2009, and a Yellowtail Flounder otter trawl fishery caught 19 t in 2010. Porbeagle Sharks were also captured in Div. 3LNO Swordfish and tuna-directed longline fisheries, in which several Fisheries Observers and DFO-NL Fisheries Officers noted that Porbeagle bycatch was usually dead when discarded at sea, and never reported in fisheries statistics other than those of Canadian Fisheries Observers and of Fisheries Officers' (DFO-NL Conservation and Protection) inspections of fishing vessels at sea.

Porbeagle "catch" length frequencies, collected by Canadian Fisheries Observers (i.e., NFOP) aboard Faroese vessels fishing pelagic longlines in Div. 3LNO and Subdiv. 3Ps over 1987-93, represented a range of males from 80 cm to 247 cm Fork Length (FL) (with a 304 cm specimen in 1988), and females from 81 cm to 280 cm FL (with a 317 cm Porbeagle in 1988; Fig. 10).

With sexes combined, these data are bimodal, with one mode at 90-100 cm (with peaks at 94-95 cm), and another at 170-210 cm (with a 190 cm peak). From 1999 to 2006, Canadian Observers sampled Porbeagles ranging from 88 cm to 270 cm TL in Div. 3O and Subdiv. 3Ps fixed gillnet fisheries targeting other species (Fig. 11). However, the small sample size precluded further analyses.

Campana and Gibson (2008) indicated that both pupping grounds and mating grounds are sensitive areas which are essential to the protection and recovery of Porbeagle populations. Regarding the former, a recent study using archival satellite pop-up tags showed that all mature females which released tags in the spring were found in the Sargasso Sea, between Cuba and Bermuda, indicating that this is a major pupping ground for the Northwest Atlantic population (Campana et al. 2010). The location of a pupping area within Canada's EEZ is presently unknown. However, new research (Campana et al. 2012) has located at least two Porbeagle mating grounds in the Canadian EEZ: one on the Grand Banks (off of southern Newfoundland), including the entrance to the Gulf of St. Lawrence; and another on Georges Bank (southwest of Nova Scotia). In NL waters, one verified encounter of a 2.3 m FL pregnant Porbeagle occurred on 15 December 2010 near Gooseberry Cove, Trinity Bay. This approximately 230 kg female, bearing four partially developed pups with yolk sacs (2 males of 41.3 cm FL, 2 females of 40.6 cm FL), was caught in commercial herring nets, and had teeth marks on both pectoral fins (i.e., "bite marks" from a male, which occur during mating).

In conclusion, DFO-NL annual research surveys rarely capture Porbeagle Sharks, and thus cannot be used to determine their NL distribution and population status. It appears as though large numbers of this species are being removed from the NL population as largely unrecorded bycatch and are discarded at sea in teleost-directed fisheries. Prior research indicates that the NL population is potentially unable to withstand even moderate levels of incidental mortality in Canadian groundfish fisheries (Kulka et al. 2005; Benjamins et al. 2010). Therefore, a high degree of caution must be exercised when determining regulatory measures for effective conservation of this low-resilience species in Canadian Atlantic waters.

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Table 1. NAFO-reported landings (tons) of Porbeagle Shark in Div. 3KLNOP and unreported Divisions in Subarea 3, 1960-2011 (STATLANT-21A). Data do not include discards.

Year	3K	3L	3N	3O	3P_total	SA 3_unknown Divisions
1960	-	-	-	-	-	-
1961	-	-	67	39	46	-
1962	-	-	-	-	-	283
1963	-	-	-	-	2	736
1964	1	-	-	-	6	1,030
1965	-	-	-	3	2	1,078
1966	-	-	-	-	-	741
1967	-	-	-	-	-	589
1968	-	1	-	-	-	931
1969	-	-	-	-	-	-
1970	-	-	-	-	-	205
1971	-	-	-	-	-	-
1972	-	-	-	-	-	29
1973	-	-	-	-	-	-
1974	-	-	-	-	-	-
1975	-	-	-	-	-	-
1976	-	-	-	-	-	-
1977	-	-	-	4	-	-
1978	-	-	-	-	20	-
1979	-	48	28	15	7	-
1980	-	25	19	23	44	-
1981	-	6	-	13	-	-
1982	-	-	-	-	-	-
1983	-	37	7	21	12	-
1984	-	-	-	1	-	-
1985	-	-	-	3	-	-
1986	-	-	-	-	-	-
1987	-	-	-	-	-	-
1988	-	54	19	17	1	-
1989	-	41	53	38	6	-
1990	-	72	40	21	2	-
1991	-	-	-	4	8	-
1992	-	21	57	22	253	-
1993	250	90	43	51	155	-
1994	-	101	39	33	119	-
1995	2	87	41	135	203	-
1996	-	78	43	41	178	-
1997	-	119	44	14	86	-
1998	-	96	58	13	107	-
1999	-	30	1	11	127	-
2000	-	56	30	35	146	-
2001	-	-	-	25	13	-
2002	-	-	-	24	3	-
2003	-	-	-	1	4	-
2004	-	-	-	-	4	-
2005	-	-	10	-	1	-
2006	-	-	6	-	2	-
2007	-	-	-	-	4	-

Year	3K	3L	3N	3O	3P_total	SA 3_unknown Divisions
2008	-	-	11	-	-	-
2009	-	-	-	2	7	-
2010	-	-	-	2	1	-
2011	-	-	-	-	-	-

Table 2. ZIFF-reported landings (kgs) of Porbeagle Shark from pelagic longlines in Div. 3LNOP by month and year (including unrecorded months), 1994-2011. Data do not include discards.

Year	1	2	3	4	5	6	7	8	9	10	11	12	Month not recorded
1994	-	-	-	-	-	-	-	-	-	-	-	-	467
1995	-	-	-	-	-	-	-	-	46,836	22,326	-	-	3,746
1996	-	-	-	-	-	-	-	-	-	77	-	-	1,381
1997	-	-	-	-	-	-	-	-	-	-	-	-	96,191
1998	-	-	-	-	-	-	-	50,156	36,275	-	-	-	-
1999	-	-	-	-	-	-	78	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	48	-	-	-	-	-
2001	-	-	-	-	-	-	-	127	10	34	55	-	-
2002	-	-	-	-	88	205	-	146	218	-	-	-	-
2003	-	-	198	-	-	512	62	-	139	-	-	-	-
2004	-	-	-	-	-	-	-	-	31	-	-	-	-
2005	-	-	-	-	-	-	-	-	-	-	-	-	-
2006	-	-	-	105	-	-	-	-	-	-	-	-	-
2007	-	-	-	-	-	-	-	-	-	-	-	-	-
2008	-	-	-	-	-	-	-	-	-	-	-	-	-
2009	-	-	-	-	-	61	-	-	113	622	-	-	-
2010	-	-	-	-	53	-	248	93	6	65	-	-	-
2011	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 3. ZIFF-reported landings (kgs) of Porbeagle Shark from gillnets in Div. 3LOP by month and year, 1994-2011. Data do not include discards.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1994		-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	0	-	-
1996	-	-	-	-	-	144	-	-	-	0	-	-
1997	-	-	-	-	-	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-	-	0	191	-	-
1999	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	92	0	-	0	-	-	-
2001	-	-	-	-	-	346	272	100	-	-	-	-
2002	-	-	-	-	-	-	254	600	162	41	-	-
2003	-	-	-	-	-	0	94	-	66	-	-	-
2004	-	-	-	-	-	-	111	-	-	-	-	-
2005	-	-	-	-	-	-	-	10	0	17	-	-
2006	-	-	-	-	-	-	-	-	-	-	-	-
2007	-	-	-	-	-	-	-	-	-	-	-	-
2008	-	-	-	-	-	0	16	-	-	-	-	-
2009	-	-	-	-	-	-	-	0	0	-	-	-
2010	-	-	-	-	-	-	38	-	9	-	-	-
2011	-	-	-	-	-	-	49	-	-	-	-	-

Table 4. Observed annual catch weights (tons) of Porbeagle Shark by fishery and gear in Div. 3LNOP inside Canada's Exclusive Economic Zone, 1979-2010. Data are from Canadian Fisheries Observers, and include discards. Note that these data depended on the annual degree of NFOP coverage of each fishery, and were not scaled up to the whole fishery for this Table.

	Longlines	Longlines	Gillnets	Gillnets	Gillnets	Gillnets	Otter Trawls
Year	**Porbeagle-DIR**	**Swordfish & tunas-DIR**	**Atl.Cod-DIR**	**White Hake-DIR**	**Turbot-DIR**	**Monkfish-DIR**	**Yellowtail-DIR**
1979	0.3	-	-	-	-	-	-
1980	16.0	-	-	-	-	-	-
1981	6.2	-	0.1	-	-	-	-
1982	-	-	-	0.0	-	-	-
1983	-	-	-	1.3	-	-	-
1984	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-
1987	56.4	0.1	-	-	-	-	-
1988	57.9	-	-	-	-	-	-
1989	75.9	-	-	-	-	-	-
1990	46.6	0.2	-	-	-	-	-
1991	18.9	-	-	-	-	-	-
1992	82.3	-	-	-	-	-	0.2
1993	8.8	-	0.2	0.1	0.1	-	-
1994	-	-	-	-	-	0.1	-
1995	-	-	-	3.3	-	-	-
1996	-	-	-	-	-	-	-
1997	-	-	0.5	-	-	-	-
1998	-	-	1.1	-	-	-	-
1999	-	-	0.9	-	1.3	-	-
2000	-	-	0.2	-	0.1	-	-
2001	-	-	0.2	-	-	0.0	0.0
2002	-	-	0.1	-	-	0.4	-
2003	-	-	0.0	-	-	0.0	0.9
2004	-	-	0.8	-	-	0.2	0.5
2005	-	-	-	-	0.1	0.5	-
2006	-	-	0.1	-	0.2	-	-
2007	-	-	-	-	1.0	-	-
2008	-	-	-	0.3	-	0.3	0.3
2009	-	-	-	0.8	0.7	0.3	-
2010	-	-	-	-	0.1	-	2.3
2011	-	-	-	-	-	-	-

Table 5. Estimated annual total bycatch (tons) of Porbeagle Shark by fishery in Div. 3LNOP inside Canada's Exclusive Economic Zone, 1985-2010. Data are from Canadian Fisheries Observers and DFO-NL ZIFF in comparable years. Note that these unweighted estimates are scaled up to the entire fishery, and depended on whether Canadian landings were reported in ZIFF, and the annual degree of NFOP coverage of each fishery. The symbol "X" denotes that calculations were not possible due to absence of ZIFF landings.

	Longlines	Longlines	Gillnets	Gillnets	Gillnets	Gillnets	Otter Trawls
Year	**Porbeagle**	**Swordfish & tunas**	**Atl.Cod**	**White Hake**	**Turbot**	**Monkfish**	**Yellowtail Flounder**
1979	X	-	-	-	-	-	-
1980	X	-	-	-	-	-	-
1981	X	-	X	-	-	-	-
1982	-	-	-	X	-	-	-
1983	-	-	-	X	-	-	-
1984	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-
1987	X	X	-	-	-	-	-
1988	X	-	-	-	-	-	-
1989	X	-	-	-	-	-	-
1990	X	4.1	-	-	-	-	-
1991	X	-	-	-	-	-	-
1992	X	-	-	-	-	-	0.0
1993	X	-	0.5	0.3	0.4	-	-
1994	-	-	-	-	-	324.4	-
1995	X	-	-	9.5	-	-	-
1996	-	-	-	-	-	-	-
1997	-	-	29.1	-	-	-	-
1998	-	-	54.1	-	-	-	-
1999	-	-	242.3	-	18.3	-	-
2000	-	-	28.6	-	0.5	-	-
2001	-	-	18.7	-	-	0.1	0.1
2002	-	-	9.5	-	-	1.4	-
2003	-	-	3.9	-	-	0.2	1.4
2004	-	-	91.7	-	-	2.5	1.2
2005	-	-	-	-	0.4	4.8	-
2006	-	-	19.1	-	1.4	-	-
2007	-	-	-	-	8.0	-	-
2008	-	-	-	3.4	-	3.9	1.2
2009	-	-	-	18.3	13.6	3.2	-
2010	-	-	-	-	3.3	-	19.4
2011	-	-	-	-	-	-	-

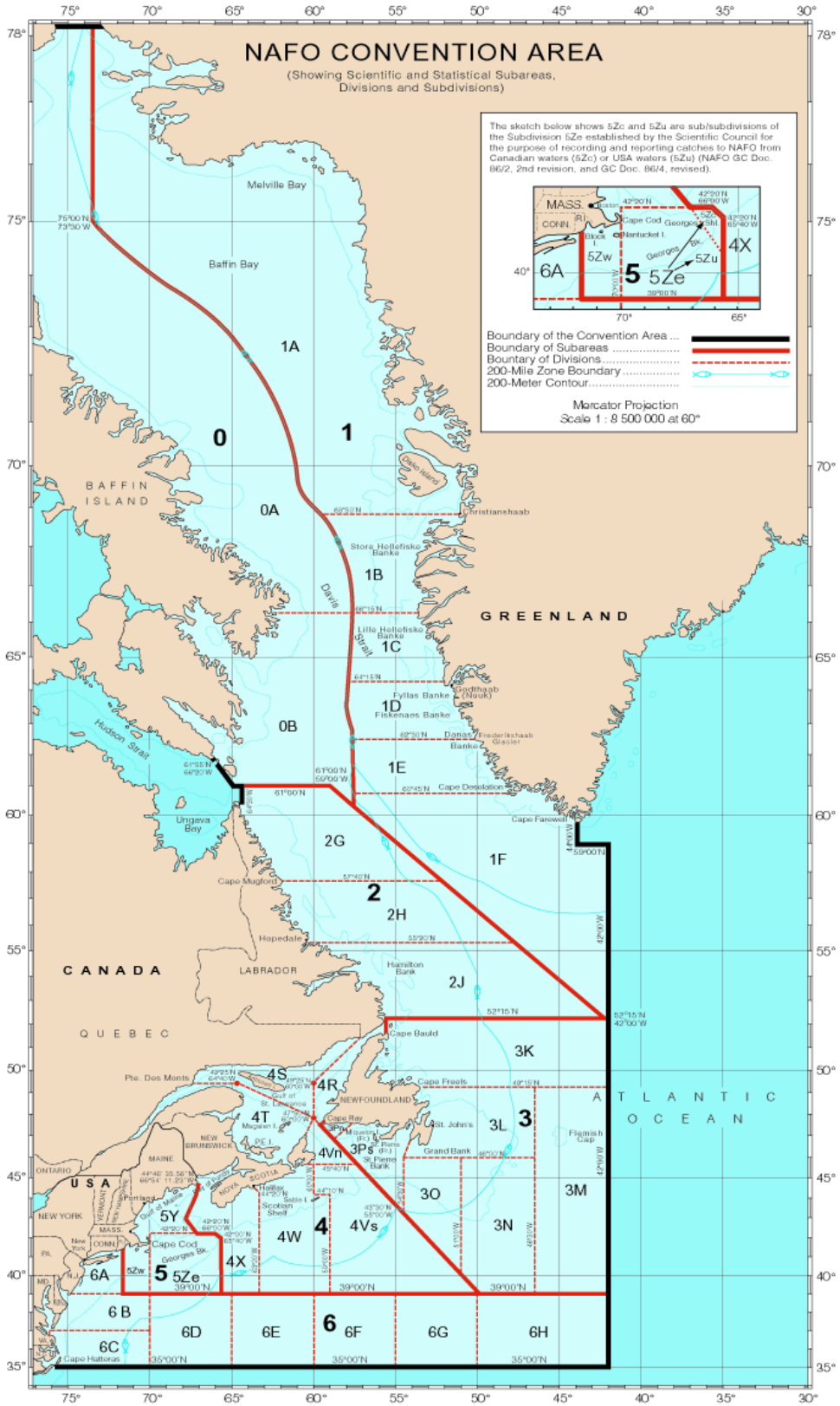

Figure 1. Map of NAFO Divisions in relation to Canada's Exclusive Economic Zone.

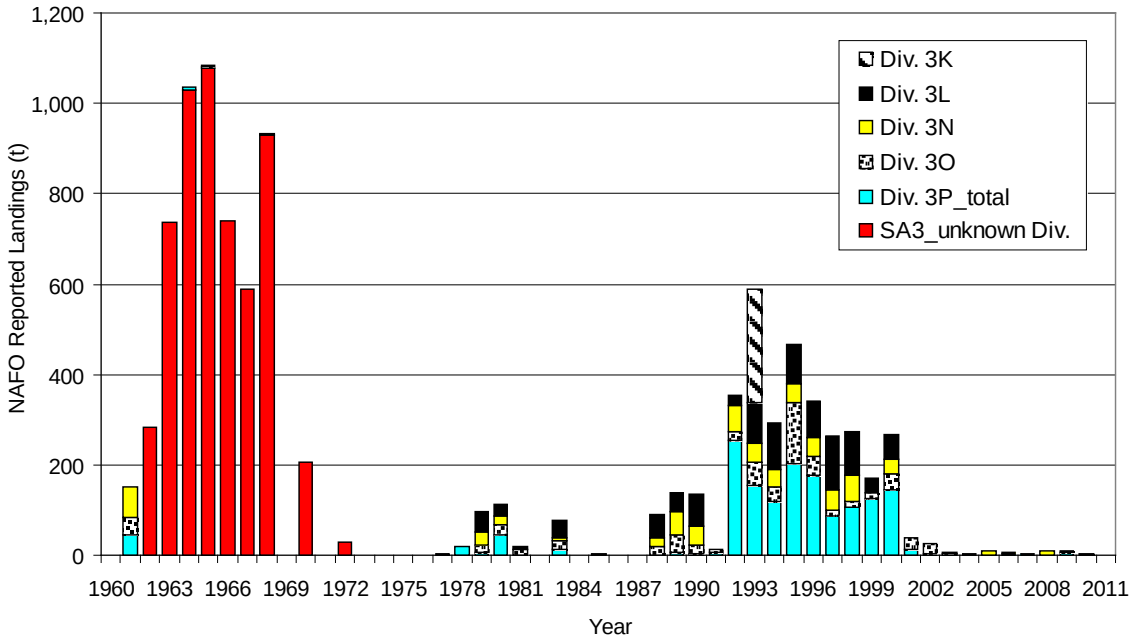

Figure 2. NAFO-reported landings (tons) of Porbeagle Shark by Canada and other countries in Divisions 3KLNOP, 1961-2011 (STATLANT-21A). Data do not include discards.

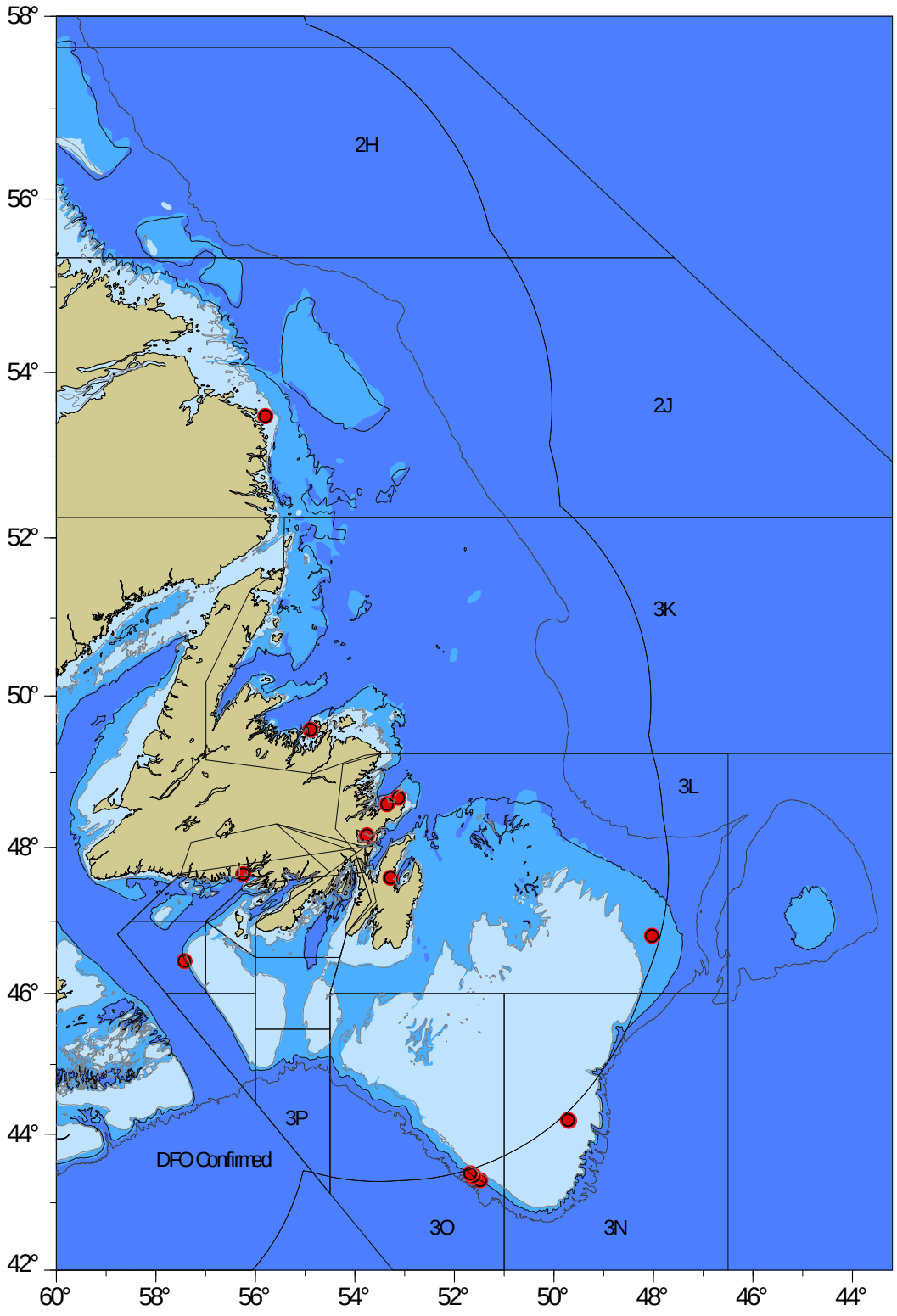

Figure 3. Map showing the locations of Porbeagle Sharks caught by NL fishers in other directed fisheries in 2010-11 (species identifications confirmed by DFO-NL Science staff). Note that these records are not represented by any statistical database.

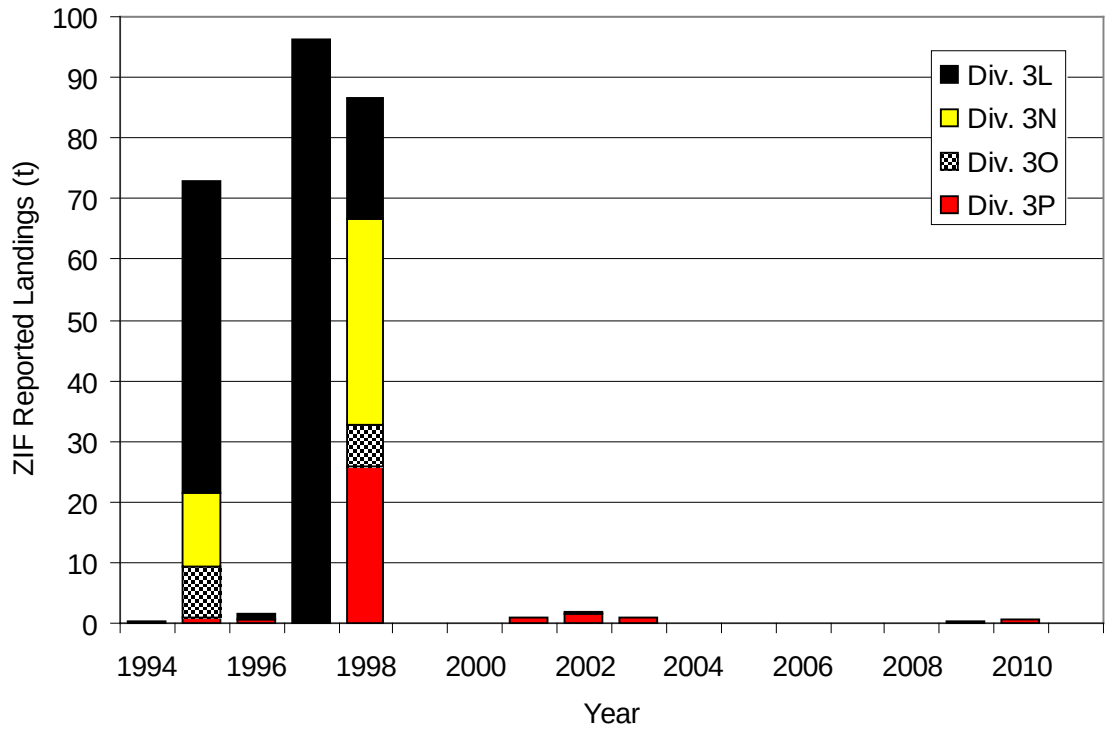

Figure 4. Canadian reported annual landings of Porbeagle Shark in Div. 3LNOP inside Canada's EEZ, 1994-2011. Note that 1995 and 1998 data represent Porbeagle-directed fisheries; 1997 data represent Swordfish-directed (Xiphius gladius) fisheries. Data do not include discards.

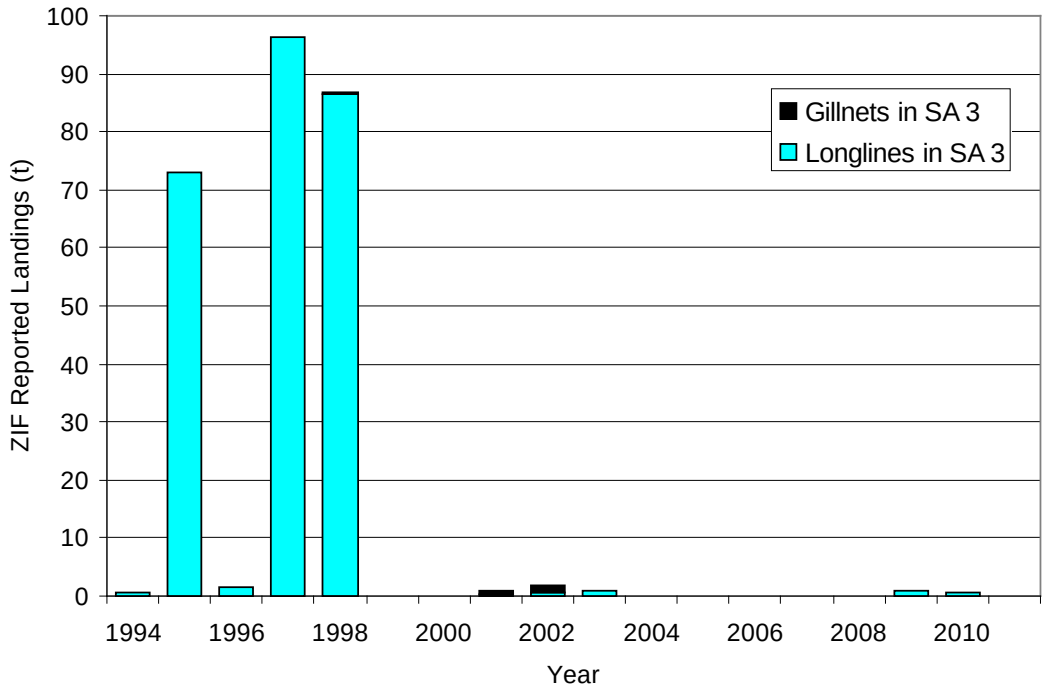

Figure 5. Canadian reported annual landings of Porbeagle Shark by longlines and gillnets in Subarea 3 of Canada's EEZ, 1994-2011. Note that 1995 and 1998 data represent Porbeagle-directed fisheries; 1997 data represent Swordfish-directed (Xiphius gladius) fisheries. Data do not include discards.

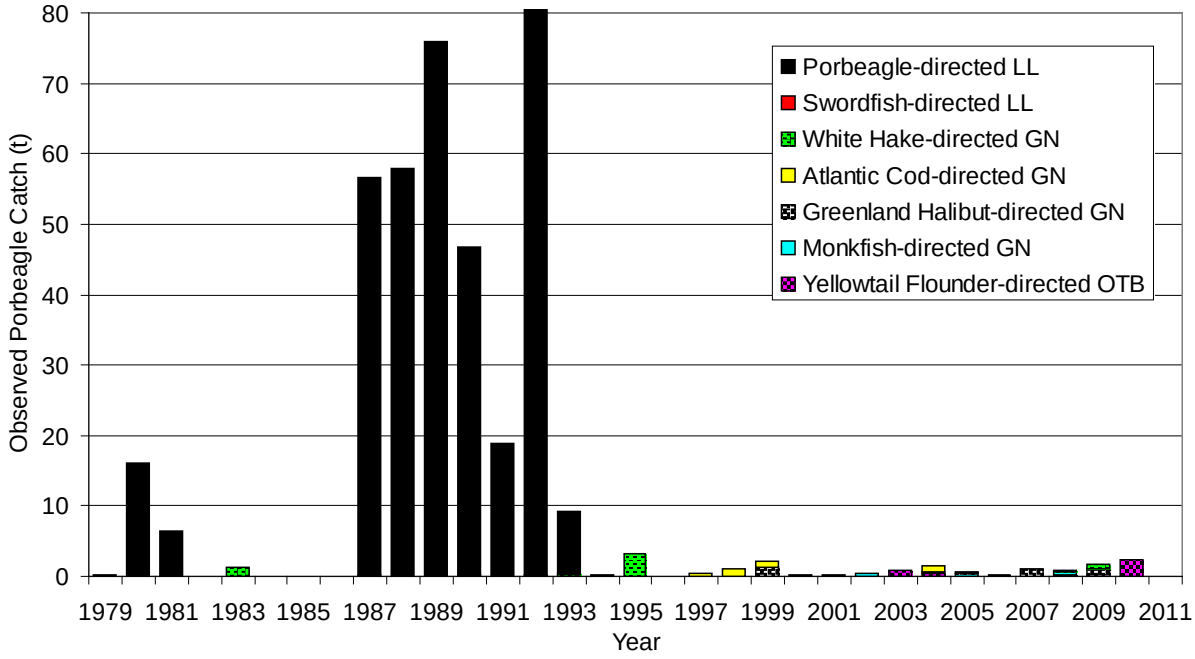

Figure 6. Observed commercial catch (tons) of Porbeagle Shark by fishery in Division 3LNOP in Canada's EEZ, 1979-2011. Data are from Canadian Fisheries Observers, and include discards. Note that Porbeagle-directed and Swordfish-directed (Xiphius gladius) data in years prior to 1994 represent foreign-registered vessels

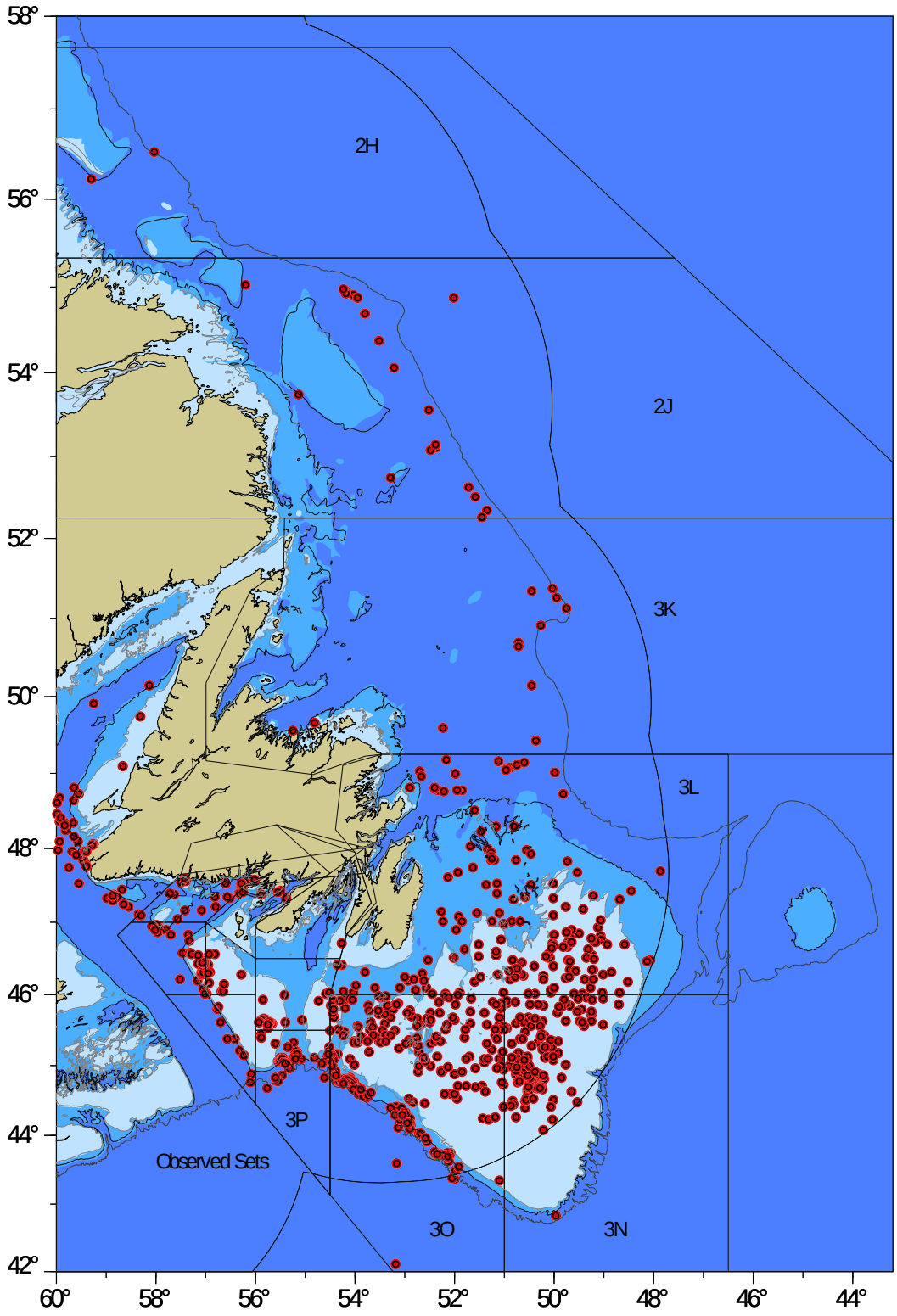

Figure 7. Locations of observed commercial catch (all fisheries) of Porbeagle Shark by Canada and other countries, 1979-2010. Data are from Canadian Fisheries Observers.

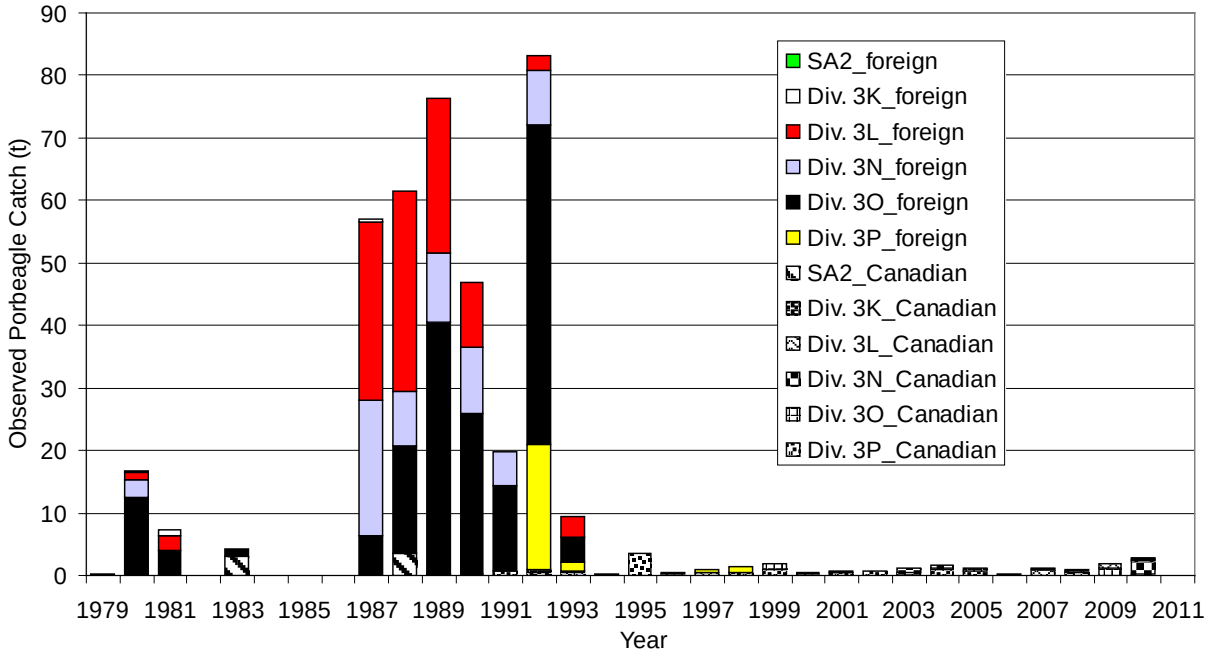

Figure 8. Observed commercial catch (tons; all gears) of Porbeagle Shark by Canada and other countries by NAFO Division, 1979-2011. Data are from Canadian Fisheries Observers, and include discards.

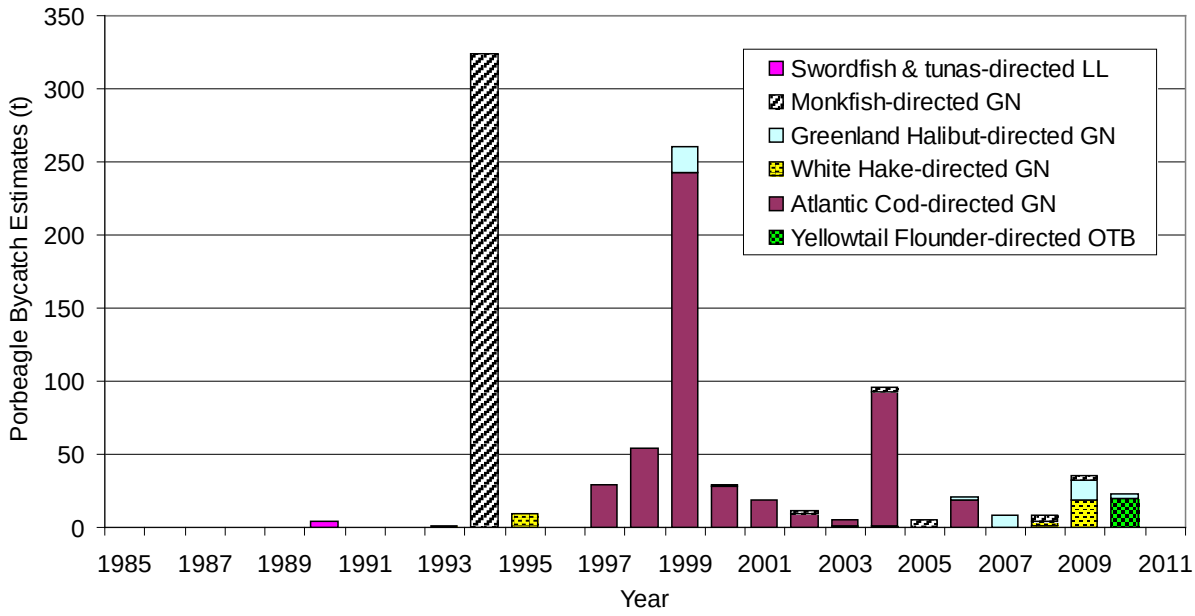

Figure 9. Estimated annual total bycatch (tons) of Porbeagle Shark by fishery in Division 3LNOP inside Canada's 200-mile limit, 1985-2011. Data are from Canadian Fisheries Observers and DFO-NL ZIFF in comparable years. Note that these unweighted estimates are scaled up to the entire fishery, and contingent on whether Canadian landings were reported in ZIFF, and the annual degree of NFOP coverage of each fishery.

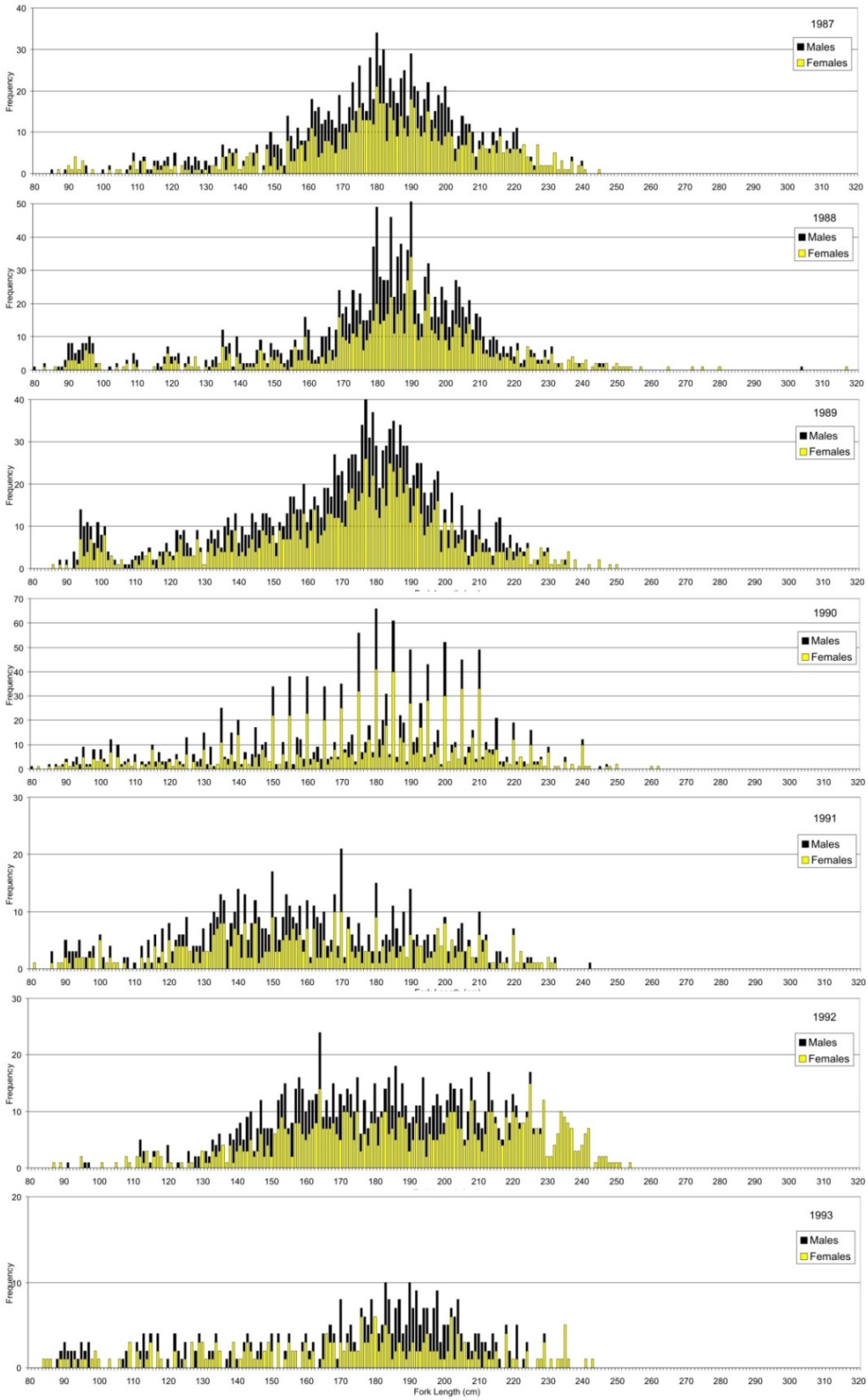

Figure 10. Male and female length distributions in observed commercial catches by longlines in Division 3LNOP, 1987-1993. Data are from Canadian Fisheries Observers, and include discards.

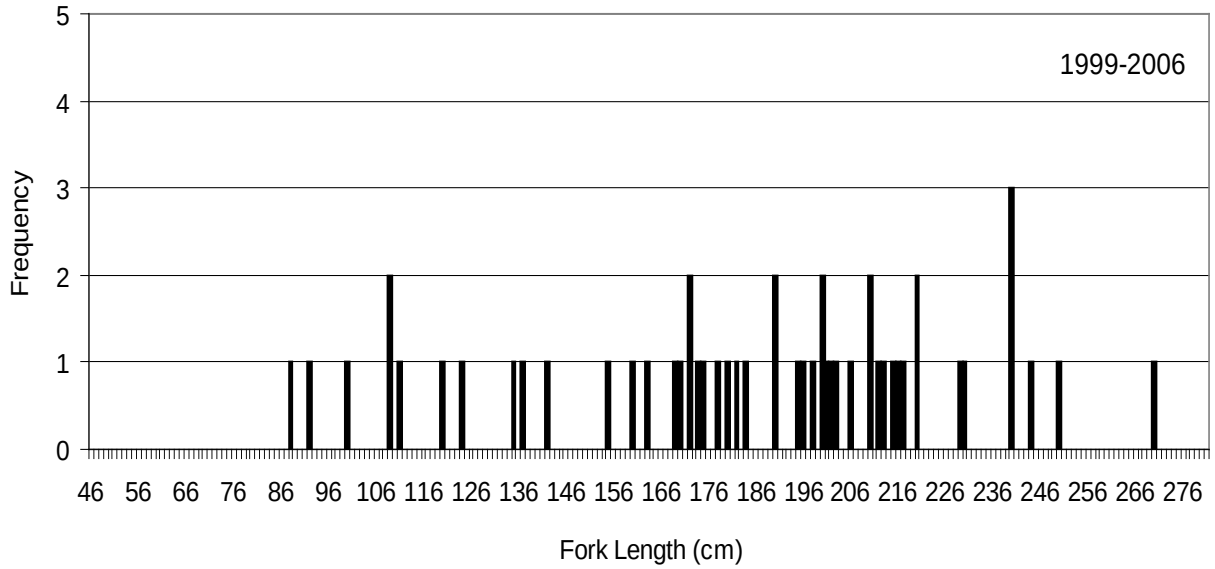

Figure 11. Porbeagle length distributions (sexes combined) in observed commercial catches by gillnets in Division 3O and Subdivision 3Ps, 1999-2006. Data are from Canadian Fisheries Observers, and include discards.