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Estimates of human induced mortality in Northwest Atlantic Harp Seals, 1952-2004

Estimation de la mortalité induite par l'homme chez les phoques du Groenland dans l'Atlantique Nord-ouest, 1952-2004

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Abstract

The Northwest Atlantic harp seal (*Pagophilus groenlandicus*) population is subjected to various types of human induced mortality including subsistence harvests in Greenland and the Canadian Arctic, commercial catches in southern Canadian waters, animals that are killed but not landed ('struck and lost'), and bycatch in commercial fishing gear. Information on catch levels and age structure of removals are necessary for accurate population estimation and responsible management. The objective of this report is to summarized available estimates and update them for the years 1952 - 2004. Commercial and subsistence hunts account for the majority of the removals. Between 1952 and 1971, catches taken in the Canadian commercial hunt averaged in excess of 288,000 seals. Between the introduction of quotas in 1972 and the demise of the large vessel hunt in 1982, an average of 165,000 seals was taken annually. Catches decreased after 1982 and remained low, averaging approximately 52,000, until 1995. Annual catches, consisting primarily of young of the year, increased to an average of 258,000 between 1996 and 2004. The age composition of catches at the Front and in the Gulf were estimated based on reported numbers of pups taken and biological sampling of seals one year of age and older (1+) taken from the commercial harvest and research samples. Prior to 1980, catches in Greenland were consistently less than 20,000 animals. Since 1980 Greenland catches increased relatively steadily to a peak of over 100,000 in 2000. In recent years, catches have declined to just under 70,000. Estimates of the age composition of seals harvested in Greenland were obtained from biological samples collected in West Greenland between 1970 and 1993. Although limited data are available on catches in the Canadian Arctic, they appear to be relatively low (generally <5,000). A recent study indicates that current catches average less than 1,000 per year. Estimates of harp seal bycatch in the Newfoundland lumpfish fishery increased from less than 1,000 in the early 1970s to 46,400 in 1994. By 2003, they had declined to approximately 5,000. Low numbers of harp seals (<1,000) are also caught in US fisheries. The average total removals from 1952 – 1982 was approximately 388,000, but declined to 178,000 per year between 1983 and 1995. Since 1996, higher catches in Canada and Greenland resulted in average annual removals of 471,000. Young of the year account for approximately 68% of the current removals. Due to the limited data available on age structure of older (1+) seals, it may be more appropriate to assume that 1+ age classes are proportion to abundance when using these data to model population dynamics. Appropriate methods of incorporating uncertainty into these estimates of total removals and age structure should be developed.

Résumé

La population de phoques du Groenland de l'Atlantique Nord-Ouest (*Pagophilus groenlandicus*) est soumise à divers types de mortalité induite par l'homme, incluant la chasse de subsistance au Groenland et dans l'Arctique canadien, les captures commerciales dans les eaux du sud du Canada, les animaux abattus mais non débarqués (perdus) et les captures accidentelles dans les engins de pêche commerciaux. Il est nécessaire de disposer de renseignements sur le niveau des captures et la structure par âge des prélèvements pour procéder à une estimation exacte et à une gestion responsable de la population. L'objectif du présent rapport est de résumer les estimations disponibles et de les mettre à jour pour la période s'étendant de 1952 à 2004. Les chasses commerciales et de subsistance sont responsables de la plupart des prélèvements. De 1952 à 1971, les chasseurs commerciaux canadiens ont capturé en moyenne plus de 288 000 individus. Au cours de la période allant de l'imposition de quotas, en 1972, à l'interdiction de la chasse à partir de gros bateaux, en 1982, la moyenne annuelle a chuté à 165 000 phoques. Les captures ont diminué après 1982 et sont demeurées faibles, la moyenne se situant à 52 000 individus environ jusqu'en 1995. Les captures annuelles, composées principalement de jeunes de l'année, ont ensuite augmenté de 1996 à 2004 pour atteindre une moyenne de 258 000 individus. La composition selon l'âge des captures faites sur le Front et dans le Golfe a été estimée à partir du nombre déclaré de jeunes abattus et d'échantillonnages biologiques de phoques âgés d'un an ou plus (1+) faisant partie des prélèvements commerciaux et d'échantillons de recherche. Avant 1980, les captures au Groenland étaient presque toujours inférieures à 20 000 animaux. Depuis 1980, elles ont augmenté de façon constante pour culminer à plus de 100 000 individus en 2000. Ces dernières années, elles ont décliné pour atteindre un peu moins de 70 000 spécimens. Des estimations de la composition selon l'âge au Groenland ont été obtenues à partir d'échantillons biologiques recueillis à l'ouest du Groenland de 1970 à 1993. Bien que les données pour l'Arctique canadien soient limitées, les captures semblent relativement faibles (habituellement < 5 000). Une étude récente indique qu'elles s'établissent actuellement en moyenne à moins de 1 000 individus par année. Les estimations des captures accidentelles de phoques du Groenland dans le cadre de la pêche de la lompe à Terre-Neuve sont passées de moins de 1 000 individus au début des années 1970 à 46 400 en 1994. En 2003, elles avaient diminué pour atteindre environ 5 000 individus. Un faible nombre de phoques du Groenland (< 1 000) est également capturé au cours des pêches américaines. Les prélèvements totaux moyens de 1952 à 1982 s'établissaient à environ 388 000 animaux, mais ils ont baissé à 178 000 par année entre 1983 et 1995. Depuis 1996, des captures plus élevées au Canada et au Groenland ont donné des prélèvements annuels moyens de 471 000 bêtes. Les jeunes de l'année représentent environ 68 % des prélèvements actuels. En raison des données limitées dont on dispose sur la structure par âge des phoques âgés d'un an ou plus (1+), il peut être plus approprié de supposer que les classes d'âges d'un an et plus sont proportionnelles à l'abondance lorsqu'on utilise ces données pour modéliser la dynamique des populations. Il faudrait élaborer des méthodes appropriées pour incorporer un degré d'incertitude dans ces estimations des prélèvements totaux et de la structure par âge.

Introduction

Information on the level of human induced mortality is required for accurate population estimates of any population. It is particularly important for exploited species that are subject to high catch levels where this information is needed to develop a responsible management plan. Mortality can take many forms. For the Northwest Atlantic harp seal (*Pagophilus groenlandicus*) population a number of sources of human induced mortality have been identified including subsistence harvests in Greenland and the Canadian Arctic, commercial catches in southern Canadian waters, animals that are killed but not landed and therefore are not accounted for in the catch statistics, and bycatch in commercial fishing gear (Healey and Stenson 2000). Data on the levels of this mortality have been compiled in the past by a number of authors (e.g. Lavigne 1999, Stenson *et al* 2000, Walsh *et al* 2000, Sjare and Stenson 2002) but has not been summarized in a single report.

Although the Northwest Atlantic harp seal as been harvested commercially since the late 1700s, little was known about the age structure of the harvest for most of this period. Lett and Benjaminsen (1977) presented the first comprehensive age structure of the harvest for the period from 1952-75. Subsequently, inconsistencies in the data were corrected and updated estimates of Canadian and Greenland catch were provided in Bowen (1982), and Sjare *et al.* (1996) for the period up to 1993. Stenson *et al* (199a, 2000) extended this data set up to 1999 and updated Greenland catches based on the revised data presented to the Joint ICES/NAFO Working Group on Harp and Hooded Seals (Anon. 1998, 1999, 2004).

During any hunt some animals are killed, but not recovered and therefore, not included in the catch statistics. This is referred to as 'struck and lost'. The proportion of seals that are lost will depend upon the hunting method, skill of the hunter, location (e.g. on ice or in the water), weather conditions, age and condition of the seal and the time of year (which is correlated with the thickness of the blubber layer in seals that lay down seasonal energy reserves)(Sergeant 1991, Lavigne 1999). Unfortunately, few data are available on the level of struck and lost in pelagic seals and most of it was colleted before 1980. Lavigne (1999) reviewed available data on loss rates in older seals while Rowsell (1977) provided some data on loss rates for young harp seals (beaters) taken on the ice. Sjare and Stenson (2002) estimated struck and loss rates in the Canadian commercial harp seal hunt between 1998 and 1999.

Harp seals are caught in commercial fishing gear, particularly bottom set gillnets, in many parts of their range (Woodley and Lavigne 1991, Lien *et al*. 1994, Read 1994). With the imposition of moratoria and reduced effort in a number of groundfish fisheries, the primary source of mortality in Atlantic Canada is the spring Newfoundland lumpfish fishery (Sjare *et al* 2005). Walsh *et al* 2000 estimated the number of seals caught in this fishery between 1970 and 1998 while Sjare *et al* (2005) updated these estimates to 2003 and provided estimates of variance associated with the bycatch levels. Bycatch of harp seals in U.S. Atlantic fisheries have been summarized by Waring *et al* (2005).

Accurate information on the current and historical levels of human induced mortality is one of the major inputs into the population model used to assess the status of the Northwest Atlantic harp seal population (e. g. Shelton *et al*. 1996, Stenson *et al*. 1999b, Healey and Stenson 2000, Hammill and Stenson 2003, 2005). The objective of this

study is to compile and update available estimates of Canadian and Greenland catches, bycatch, and stuck and lost up to, and including 2004, to produce an estimate of human induced mortality in northwest Atlantic harp seals.

Data and Discussion

Commercial and Subsistence Catches

Harp seals are hunted in three main areas of the Northwest Atlantic. Traditionally, the largest catches have occurred during the winter months in southern Canadian waters near the whelping areas off southern Labrador and/or the Northeast coast of Newfoundland ('the Front' - NAFO Div. 2J and 3KL), and in the Gulf of St. Lawrence ('the Gulf' - NAFO Div. 4STVn). However, this population is also harvested off western and southeastern Greenland (NAFO Div. 1A-F; ICES Area XIVb), and the eastern Canadian Arctic (primarily in the vicinity of Baffin Island). Reported catches for each of these areas are summarized in Table 1 and illustrated in Fig 1.

Front and Gulf

Total catch at the Front and in the Gulf for the years 1952-78 were compiled from values reported in the Statistical Bulletin of the International Commission for Northwest Atlantic Fisheries (ICNAF 1970-77). Subsequent corrections were noted (ICNAF Statistical Bulletins 1985a, b). Total catches for the years 1979-89 were compiled from values reported in the Statistical Bulletin of the Northwest Atlantic Fisheries Organization (NAFO 1984-94). Total catches at the Front and in the Gulf for the years 1989-2004 were provided by DFO Statistics Branch. DFO research catches from both Newfoundland and the Gulf were added to the reported catches. As a result, the catches reported here may differ slightly from those reported by DFO Statistics Branch or summarized by the Joint ICES/NAFO Working Group on Harp and Hooded Seals (Anon. 1998, 1999, 2004).

Prior to the imposition of quotas in 1972, catches at the Front and in the Gulf were highly variable, ranging from 188,000 – 389,000 (average 288,000; SD=52,700; Table 1). Between 1972 and 1982, the varying total allowable catch (TAC) (Anon. 2004) resulted in an average catch of 166,000 (SD=21,300; range 124,000 – 202,000). From 1983 through 1995, catches were reduced (average 52,000; SD=21,300; range 19,000 – 94,000). In 1996, however, catches increased significantly (243,000) and, with the exception of 2000, have continued to increase, reaching a maximum of almost 366,000 in 2004. An average of 258,000 (SD=75,200) seals have been taken annually since 1996.

The age structures of catches during the 1952-1983 period were taken from Bowen (1982) and Roff and Bowen (1986). For the period 1984-2004, the age structure of seals harvested was estimated in the same manner as Bowen (1982), Roff and Bowen (1986), Sjare et al. (1996) and Stenson *et al*. (199a, 2000). The catch statistics provided by ICNAF, NAFO and DFO Statistical Branch are reported according to pelage type. Based upon these reports, Front and Gulf catches can be split into young of the year (age class 0) and seals one year of age and greater (1+) (see Table 1). The numbers of 0 age-class seals taken annually were obtained directly from these data.

The only exceptions occurred in 1998 and 1999 when a portion of the catch was not identified according to pelage. The age of 7% of the catch was not identified in 1998. It was assumed that the proportion of age class 0 in this catch was the same as for the remainder of the catch for which ages were available. In 1999, approximately 22% of the catch did not have assigned ages. As these animals were all from the Gulf of St. Lawrence, the age structure of seals taken by the small boats in the Gulf (which were reported by age) was used. Young of the year accounted for 98% of these seals which was consistent with reports from the area.

The proportion of 1+ animals (1 year of age and older) in the catch was estimated on an annual basis based upon biological samples collected primarily in Newfoundland and the northern Gulf. Most of these samples were obtained from commercial sealers distributed throughout Newfoundland and Labrador who were requested to retain some or all of their harvest for sampling. Additional samples were obtained from research sampling programs conducted by DFO personnel during which seals were collected for biological samples. In the later case, animals were taken during the late winter or spring moult in a manner similar to the commercial hunt. Samples obtained as by-catch and seals taken during the month of March (whelping period) have been excluded due to potential biases in the age ratios. Samples obtained by collectors who exceeded their quotas and sub-sampled their catch were also excluded.

The majority of samples obtained from sealers came from hunters operating small boats. In recent years a greater proportion of samples have been obtained during the longliner hunt, reflecting the increasing importance of this component of the harvest.

Using these data, the proportions-at-age for 1+ animals in the catch was estimated for the period 1984 – 2000 (Table 2). The average proportion of 1+ animals harvested during the recent period of increased hunting (1996- 2000) as used to estimate the proportion of 1+ animals taken for 2001-2004. The estimated number of seals in each age class caught in the Front and Gulf region from 1952-2004 are presented in Table 3.

During the 1950s and early 1960s the proportion of young (age class 0) in the catch ranged from 47% to 89%, although in most years young made up 60-80% of the catch (Fig. 2). From 1963-83 young accounted for over 78% of the catch in practically every year. The majority of these young were whitecoats taken during the large vessel hunt on the whelping concentrations.

With a prohibition in the taking of whitecoat harp seals, the hunt shifted towards older seals and young that had completed their first moult (‘beaters’). The proportion of young in the catch remained relatively high (70-80%) during the mid to late 80s but was reduced to 40 – 60% during the first half of the 1990s (Table 2, Fig 2). Young of the year accounted for less than 52% of the catch in 1994 and 1995. The increased catches in recent years however, have been directed towards young of the year harp seals. The proportion of young in the catch jumped to over 75% of the total in 1996 and has continued to rise. Since 2000, over 95% of the reported harvest belonged to age class 0.

Greenland

Greenland catches for the years 1952 and 1953 were taken from Bowen (1982) and for 1954-2000 from Anon. (2004). Reported catches for 2001-2003 and the first nine months of 2004 were provided by A. Rosing-Asvid, Greenland Institute of Natural Resources,

Nuuk, Greenland. The 2004 partial estimate was scaled up to a full year based upon the proportion of catches that occurred in the first nine months (0.75) observed in the previous 5 years. The Joint ICES/NAFO Working Group on Harp and Hooded Seals (Anon. 1998) examined the issue of stock identity of the Greenland harvest and concluded that all catches from west Greenland, and half of the catch from south-east Greenland should be considered to have come from the Northwest Atlantic harp seal stock. The Greenland catches presented in Table 1 reflect this allocation.

Since the late 19th century catch statistics for Greenland were obtained through a reporting system known as the "Hunters' List-of-Game" (Kapel and Rosing-Asvid 1996). However, in 1987 this reporting system was discontinued. In 1993 a new reporting system (known as "Pininarneq") began and has provided estimates of catches from 1993-98. No catch statistics are available in the time period for which there was no reporting system (1988-92). Kapel and Rosing-Asvid (1996) and Rosing-Asvid (1997) compared the two systems of reporting and concluded that they provided comparable data on catches. The latter study corrected reported catches from 1975-95 due to under-reporting in some communities and among part-time hunters. Adjustments to catches prior to 1975 were not applied since under-reporting was considered to be insignificant for this time period (Rosing-Asvid 1997). Corrected estimates of Greenland catches were summarized by the Joint ICES/NAFO Working Group on Harp and Hooded Seals (Anon. 1998, Table 9b). A small correction factor (4.7%) was applied to the reported catches from 1996 – 2004 based upon the level of under-reporting observed in 1994 and 1995. These years were considered the most appropriate to use for estimating the correction required (A. Rosing-Asvid, pers. com.)

Prior to 1975 reported catches varied from 4,000 – 19,000 (average 10,000; SD=4,000) with generally slightly higher catches in the 1950s than in the 1960s and early 1970s (Table 1). From the mid 1970s up to 1996, catches increased relatively consistently from approximately 7,000 in 1975 to over 100,000 in 2000. Reported catches declined in 2001 to 90,000 and have remained just under 70,000 since 2002.

As noted, no catch statistics are available for 1988-92. Catches were estimated by linear interpolation using the corrected catch totals in 1987 and 1993 as 'endpoints'. The predicted corrected catch values are presented in Table 1.

Prior to 1982, Greenland catches accounted for less than 10% of the total harvest in the Northwest Atlantic. However, with the increased catches in Greenland and decreased Canadian catches, Greenland accounted for almost half of the total reported annual catch in most years between 1984 and 1995. With the increased Canadian catches since 1996 and the recent decline in Greenland catches, they account for approximately 16-18% of the reported catch since 2002.

Previous catch-at-age estimates of harp seals taken in Greenland were given in Bowen (1982) and Roff and Bowen (1986). Because there was no additional data, Sjare *et al*. (1996) calculated a weighted average for each age class, based on catch-at-age frequencies reported for 1978-80 in Roff and Bowen (1986) to the total catch statistics for the years 1984-94, inclusive.

More recently, Kapel (1999) summarized the age structure of harp seals sampled in west Greenland between 1970 and 1993. With the exception of 1981, annual estimates of the age composition of catches are available between 1970 and 1983. Although data were

also available for most years from 1984-93, sample sizes were small and often collected for purposes other than age composition (Kapel 1999).

In this study I have taken the age structure of the Greenland harvest from Stenson *et al.* (1999a, Table 4). They estimated the age structure of seals caught in Greenland from 1952 – 1998 using the data presented in Bowen (1982) and Kapel (1999). The age composition of catches presented in Bowen (1982) were used for the 1952-62 and 1963-69 periods while the annual age structures presented in Kapel (1999) were applied to the annual catches for the period 1970-83. The 1981 age structure was assumed to be the same as 1980. Because of the difficulties identified in using the 1984-93 samples on an annual basis, they combined all samples from central and northwest Greenland over the 1984-91 to estimate an average age composition. Similarly, they combined samples from southwest Greenland between 1986 and 1993. An average of these two samples was then applied to the total catches from 1984-2004 (Table 4).

The estimated numbers of seals taken in each age class by Greenland hunters from 1952-99 are given in Table 5. Catches in Greenland have traditionally consisted mostly of young of the year although a greater proportion of older animals were taken than in Front and Gulf waters (Fig. 3). Prior to the late 1970s, young of the year seals accounted for 50-60% of the total catches. Since then the proportion of young has gradually decreased and based on samples collected between 1984-93 (Kapel 1999), less than 15% of the harvest consisted of young of the year. This trend is supported by comments from hunters included in the harvest reports which indicate that the proportion of adults in the catch increased from 10 – 20% in the late 1970s and early 1980s to approximately 50% since 1993 (Anon. 1999). Length data from harp seals caught in Greenland between 1997 and 1999 (Rosing-Asvid, pers. comm) also suggests that the proportion of 1+ seals (>~115 cm, D. Chabot, pers. comm) taken has remained high.

Canadian Arctic

Catches of harp seals in the Canadian Arctic have not been well documented. The values used for the period 1952 - 1982 are based upon estimates provided in Bowen (1982) and Roff and Bowen (1986) (Table 1). Bowen (1982) estimated an average annual catch (1,784) for the period 1952-77 by averaging a reported catch of 1,768 seals per year during 1962-71 (Smith and Taylor 1977) and annual estimates for 1974-77 provided by D. Sergeant (pers. comm., DFO Ste. Anne de Bellevue, PQ, Canada). Roff and Bowen (1986) reported annual catches for the period 1978-82 provided by D. Goodman (pers. comm., DFO Science Branch, Ottawa, ON Canada). The magnitude of the Arctic harp seal harvest from 1983 through 1996 is unknown. Therefore, the estimated catch in 1982 is assumed to apply to all years during this period (Table 1).

Recently, the Nunavut Wildlife Board published a five year study of marine mammal harvests in Nunavut (June 1996 – May 2001) based upon interviews in each community. (Anon. 2005) The largest catches occurred in the communities of Panqnirtung and Iqaluit, both of which are along the south east coast of Baffin Island. This is consistent with previous reports indicating that these communities account for the majority of harp seals taken in the Canadian Arctic (Stewart *et al*. 1986). In two instances (Iqaluit and Cape Dorset in Year 1), data were not available and the four year average was used. The total catches during this five year study were lower than previously assumed for the 1983 – 1996 period. However, annual catches vary greatly among years in the Arctic and therefore, in order to remain conservative I did not change the estimates for the

earlier time period. The average catch during the harvest study (715 per year) was assumed for 2002 – 2004.

Harp seals may also be taken in northern Quebec. There are no estimates of the total harvest although it is thought to be extremely small (M. Hammill, DFO, Quebec Region, pers. com.).

As there are no recent reports of Arctic harp seal catch-at-age frequencies, I assumed that recent catches have remained at the proportions reported by Roff and Bowen (1986) (Table 6). The estimated numbers of Northwest Atlantic harp seals in each age class are presented in Table 7.

Struck and Lost

In 1999 the National Marine Mammal Peer Review Committee reviewed the available information the proportion of seals that are killed but not recovered (DFO 1999). They concluded that specifically accounting for mortalities associated with struck and lost is more informative than including them as part of an aggregate natural mortality. However, there are limited data on which to base estimates, particularly in northern areas. The following year the same committee reviewed additional data (Sjare and Stenson 2002) and agreed that the level recommended previously be retained (DFO 2000). Based on their recommendations, I have assumed that recovery (and reporting) rates were 99% for young of the year seals killed in southern Canadian waters prior to the end of the large vessel hunt in 1982 and 95% for first year animals after this whitecoat hunt ended. The recovery rate for seals one year of age and older taken in southern Canadian waters and all seals taken in Greenland or the Canadian Arctic was assumed to be 50% (Table 8).

Bycatch in commercial fishing gear

The Newfoundland lumpfish fishery began in 1968 and quickly expanded. Although bycatch of harp seals likely occurred earlier, reports of large numbers of bycatch were not received until 1985 (Sjare *et al*. 2005). Following these reports, a study of bycatch in this fishery using logbooks was initiated. Initial estimates of bycatch in this fishery were provided by Walsh *et al* (2000). Recently, Sjare *et al*. (2005) revised and updated these estimates to 2003 (Table 9). They also provided a breakdown of catches into young of the year (beaters) and seals one year of age and older. Prior to 1976, catches were generally below 1,000 seals. Between the late 1970s and early 1990s catches increased,reaching a peak of 46,000 in 1994. By 2003 catches had declined to a little over 5,000 seals. The average catch and proportion young for the previous 5 years (1999-2003) was applied to 2004.

Data on incidental catches of harp seals in USA fisheries were summarized by Waring *et al* (2005). Catch data were obtained by independent fisheries observers in the Northeast Multispecies Sink Gillnet, Mid-Atlantic Coastal Gillnet and North Atlantic Bottom Trawl fisheries. The majority of catches observed were in the sink gillnet fishery while only occasional catches occurred the other fisheries. However, Waring *et al* (2005) noted that estimates in the bottom trawl fishery should be treated with caution due to low observer coverage. Between 1994 and 1997, an average of 478 seals were caught per year. Catches declined after 1997 with no seals being caught in 2002 and 2003. Catches in

2004 were assumed to be equal to the average catches for the past five years (1999 – 2003).

The proportion of young seals in the US catches was assumed to be the same as that observed in the Newfoundland lumpfish fishery. The age structure of seals one year of age and older was assumed to be the same as observed among the commercial catches in Canada (Table 2). The estimated numbers of Northwest Atlantic harp seals in each age class taken as bycatch in commercial fisheries are presented in Table 10.

Total removals

Combining the estimates of reported Canadian and Greenland catches, struck and lost, and incidental catches in commercial fisheries provides an estimate of human induced mortality for Norwest Atlantic harp seals (Table 11, Fig. 4).

Between 1952 and 1971, removals averaged 388,000 seals, primarily due to commercial catches in southern Canada. Removals fell with the imposition of Canadian quotas in 1971, averaging just over 226,000 for the 1972-1982 period. The decline of Canadian catches between 1983 and 1995 resulted in fewer annual removals (average 178,000) although the contribution of struck and lost to the total increased due to the high level assumed for the Greenland hunt. With higher levels of catches in both Canada and Greenland, total removals increased significantly after 1996 (averaging over 471,000 between 1996 and 2004) reaching levels similar, or slightly higher to, that estimated for the 1950s and 1960s. The single largest removal in the time series (545,000) occurred in 2004 although it remains lower than the peak catches (>600,000) the population was subjected to in the first half of the 19th century (Ryan 1994).

The proportion of young of the year in the removals varied among year (Table 11, Fig. 5). During the period when the whitecoat hunt (1952 – 1983) dominated, an average of 62% of the total annual removals was estimated to be age class 0. From 1982 – 1996 the average proportion of young declined to 34%, reflecting, in part, the greater importance of the Greenland harvest. In recent years the proportion of age class 0 has increased, averaging 68% for the years 2001 - 2004.

General Comments

Determining the age composition of the harp seal removals is extremely difficult (Bowen *et al.* 1983). In particular, it is difficult to obtain sufficient samples that are representative of the different areas, sources of mortality (bycatch, commercial and subsistence hunts, large vessel harvest, small boat harvest, etc.) and methods (shot, netted, etc.), all of which have changed significantly since 1952. Due to the limited commercial hunts during the 1980s and early 1990s and reduced funding for marine mammal research in recent years, collecting the appropriate biological samples to determine the age composition of removals in southern Canadian waters have been more difficult to obtain. Furthermore, during periods of reduced sampling animals are often collected for other reasons (e.g. reproductive rates) that could introduce potential biases into the age composition. The annual estimates of age structure of the removals varies greatly among years, which given the small sample sizes, suggests that many of these differences may be due to sampling error rather than actual changes. For other areas, age composition data are out of date or are not available. This is particularly problematic for the Greenland

catches. In addition, the process of age determination is not without error although I did not consider such errors in this paper. Doubleday and Bowen (1983) found that while young animals can be aged accurately, significant errors in the age of older harp seals can occur.

It is possible, however, to come up with a reasonable approximation of the relative numbers of age class 0 (young of the year) and 1+ (1 year of age and older) seals. In most years, catches from the Canadian commercial harvest dominates the total and since pelage types are reported, we are able to partition the largest part of the removals into age classes. Similarly, Sjare *et al* (2005) have estimated the number of young of the year in the lumpfish bycatch through interviews with fishermen. The greatest source of uncertainty is the Greenland catch. Catches are reported by age group, but it is not clear how the hunters assign pelage types to these groups (A. Rosing-Asvid, pers. com.). Studies currently underway in Greenland hope to resolve this question any may allow us to assign seals to specific age classes more accurately. Given the uncertainties associated with assigning an age structure to older (1+) seals it may be more appropriate to assume age classes are proportion to abundance when using these data to model population dynamics.

It was assumed that these data accurately reflect the levels of removals from each of these sources. Although estimates of the uncertainty associated with the bycatch have been reported (Sjare *et al* 2005, Waring *et al* 2005), there are none available for commercial and subsistence catches which account for the vast majority of the removals. These data should be examined closer and methods developed to estimate probably levels of misreporting. Similarly, the assumed levels of struck and lost should reflect the uncertainty associated with these multipliers.

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Table 1. Summary of harp seal catches in the Northwest Atlantic, 1952-2004. Estimated values are shaded.

	Front and Gulf			Canadian Arctic			Greenland			Total Northwest Atlantic		
Year	0	1+	All	0	1+	All	0	1+	All	0	1+	All
1952	198,063	109,045	307,108	60	1724	1,784	9,676	6,724	16,400	207,799	117,493	325,292
1953	197,975	74,911	272,886	60	1724	1,784	9,676	6,724	16,400	207,711	83,359	291,070
1954	175,034	89,382	264,416	60	1724	1,784	11,299	7,852	19,150	186,393	98,958	285,350
1955	252,297	81,072	333,369	60	1724	1,784	9,165	6,369	15,534	261,522	89,165	350,687
1956	341,397	48,013	389,410	60	1724	1,784	6,474	4,499	10,973	347,931	54,236	402,167
1957	165,438	80,042	245,480	60	1724	1,784	7,602	5,282	12,884	173,100	87,048	260,148
1958	140,996	156,790	297,786	60	1724	1,784	9,962	6,923	16,885	151,018	165,437	316,455
1959	238,832	81,302	320,134	60	1724	1,784	5,268	3,660	8,928	244,160	86,686	330,846
1960	156,168	121,182	277,350	60	1724	1,784	9,531	6,623	16,154	165,759	129,529	295,288
1961	168,819	19,047	187,866	60	1724	1,784	7,078	4,918	11,996	175,957	25,689	201,646
1962	207,088	112,901	319,989	60	1724	1,784	5,015	3,485	8,500	212,163	118,110	330,273
1963	270,419	71,623	342,042	60	1724	1,784	5,864	4,247	10,111	276,343	77,594	353,937
1964	266,382	75,281	341,663	60	1724	1,784	5,338	3,865	9,203	271,780	80,870	352,650
1965	182,758	51,495	234,253	60	1724	1,784	5,388	3,901	9,289	188,206	57,120	245,326
1966	251,135	72,004	323,139	60	1724	1,784	4,093	2,964	7,057	255,288	76,692	331,980
1967	277,750	56,606	334,356	60	1724	1,784	2,460	1,782	4,242	280,270	60,112	340,382
1968	156,458	36,238	192,696	60	1724	1,784	4,127	2,989	7,116	160,645	40,951	201,596
1969	233,340	55,472	288,812	60	1724	1,784	3,734	2,704	6,438	237,134	59,900	297,034
1970	217,431	40,064	257,495	60	1724	1,784	3,310	2,959	6,269	220,801	44,747	265,548
1971	210,579	20,387	230,966	60	1724	1,784	3,502	2,070	5,572	214,141	24,181	238,322
1972	116,810	13,073	129,883	60	1724	1,784	3,431	2,563	5,994	120,301	17,360	137,661
1973	98,335	25,497	123,832	60	1724	1,784	5,091	4,121	9,212	103,486	31,342	134,828
1974	114,825	32,810	147,635	60	1724	1,784	4,597	2,548	7,145	119,482	37,082	156,564
1975	140,638	33,725	174,363	60	1724	1,784	4,165	2,587	6,752	144,863	38,036	182,899
1976	132,085	32,917	165,002	60	1724	1,784	7,209	4,747	11,956	139,354	39,388	178,742
1977	126,982	28,161	155,143	60	1724	1,784	9,899	2,967	12,866	136,941	32,852	169,793
1978	116,190	45,533	161,723	72	2057	2,129	6,981	9,657	16,638	123,242	57,248	180,490
1979	132,458	28,083	160,541	122	3498	3,620	8,841	8,703	17,545	141,421	40,284	181,706
1980	132,421	37,105	169,526	214	6136	6,350	4,022	11,233	15,255	136,657	54,474	191,131
1981	178,394	23,775	202,169	157	4515	4,672	6,057	16,916	22,974	184,608	45,206	229,815
1982	145,274	21,465	166,739	164	4717	4,881	8,280	18,647	26,927	153,718	44,828	198,547
1983	50,058	7,831	57,889	164	4717	4,881	6,759	18,025	24,785	56,982	30,573	87,555
1984	23,922	7,622	31,544	164	4717	4,881	3,686	22,142	25,829	27,772	34,481	62,254
1985	13,334	5,701	19,035	164	4717	4,881	2,966	17,819	20,785	16,465	28,236	44,701
1986	21,888	4,046	25,934	164	4717	4,881	3,725	22,374	26,099	25,777	31,137	56,914
1987	36,350	10,446	46,796	164	4717	4,881	5,403	32,456	37,859	41,917	47,619	89,536
1988	66,972	27,074	94,046	164	4717	4,881	5,768	34,647	40,415	72,904	66,438	139,342
1989	56,346	8,958	65,304	164	4717	4,881	6,133	36,838	42,971	62,643	50,513	113,156
1990	34,402	25,760	60,162	164	4717	4,881	6,498	39,029	45,526	41,064	69,506	110,569
1991	42,382	10,206	52,588	164	4717	4,881	6,862	41,220	48,082	49,408	56,143	105,551
1992	43,866	24,802	68,668	164	4717	4,881	7,227	43,411	50,638	51,257	72,930	124,187
1993	16,401	10,602	27,003	164	4717	4,881	7,592	45,602	53,194	24,157	60,921	85,078
1994	25,223	36,156	61,379	164	4717	4,881	8,518	51,166	59,684	33,905	92,039	125,944
1995	34,106	31,661	65,767	164	4717	4,881	9,462	56,835	66,298	43,732	93,213	136,946
1996	184,856	58,050	242,906	164	4717	4,881	11,101	66,682	77,783	196,121	129,448	325,570

	Front and Gulf			Canadian Arctic			Greenland			Total Northwest Atlantic		
Year	0	1+	All	0	1+	All	0	1+	All	0	1+	All
1997	220,476	43,734	264,210	61	1743	1,804	10,295	61,837	72,131	230,831	107,314	338,145
1998	251,403	31,221	282,624	24	695	719	12,186	73,200	85,387	263,614	105,116	368,730
1999	237,644	6,908	244,552	12	356	368	13,927	83,656	97,583	251,584	90,920	342,503
2000	85,035	7,020	92,055	9	271	280	14,549	87,392	101,941	99,593	94,682	194,276
2001	214,754	11,739	226,493	14	391	405	12,790	76,827	89,617	227,558	88,957	316,515
2002	297,764	14,603	312,367	24	691	715	9,975	59,920	69,895	307,764	75,214	382,977
2003	280,174	9,338	289,512	24	691	715	9,776	58,723	68,499	289,974	68,752	358,726
2004	353,553	12,418	365,971	24	691	715	9,571	57,492	67,064	363,148	70,601	433,750

Table 2. Proportion age composition of 1+ harp seal catches at the Front and Gulf 1984-2004. N indicates the number of samples used to estimate proportions. Proportions at age used for 2001-04 are the average for the period 1996-2000.

	n	1	2	3	4	5	6	7	8	9	10	11	12
1984	222	0.1622	0.3198	0.1486	0.0991	0.0541	0.036	0.0315	0.0135	0.009	0.009	0.018	0.0135
1985	311	0.2508	0.2797	0.1801	0.0836	0.045	0.0322	0.0225	0.0225	0.0096	0.0129	0	0
1986	747	0.2664	0.2182	0.1981	0.0776	0.0361	0.0281	0.0174	0.012	0.0134	0.0067	0.012	0.0107
1987	923	0.1809	0.1679	0.1766	0.1192	0.0585	0.0455	0.026	0.0249	0.0217	0.0173	0.0195	0.0054
1988	591	0.242	0.2386	0.1692	0.1032	0.0508	0.0305	0.0169	0.0186	0.0085	0.0051	0.0034	0.0068
1989	375	0.1627	0.184	0.1467	0.1467	0.1013	0.0533	0.016	0.0107	0.016	0.0053	0.0053	0.0053
1990	278	0.1835	0.1655	0.2086	0.1367	0.0863	0.0432	0.018	0.0036	0.0108	0.0108	0.0144	0.0108
1991	245	0.1796	0.0531	0.102	0.1592	0.151	0.0776	0.0286	0.0163	0.0163	0.0163	0.0327	0.0286
1992	333	0.2673	0.1772	0.0961	0.0931	0.0691	0.0631	0.048	0.018	0.033	0.015	0.012	0.006
1993	684	0.2865	0.1711	0.1155	0.0775	0.0687	0.057	0.038	0.0249	0.0263	0.0132	0.0132	0.0088
1994	607	0.1598	0.1104	0.1318	0.1301	0.0873	0.0675	0.0412	0.0428	0.0297	0.0198	0.0231	0.0115
1995	666	0.2132	0.1547	0.1276	0.0946	0.0991	0.0616	0.0616	0.0255	0.018	0.0105	0.015	0.0105
1996	590	0.2593	0.1881	0.0712	0.0542	0.0475	0.0373	0.0356	0.0237	0.0169	0.0237	0.022	0.0136
1997	592	0.4054	0.1858	0.0625	0.0439	0.0355	0.0287	0.0253	0.0169	0.0118	0.0304	0.022	0.0118
1998	967	0.1944	0.061	0.0641	0.0383	0.0889	0.0765	0.0641	0.0755	0.0527	0.03	0.0445	0.0321
1999	115	0.5304	0.2609	0.0348	0.0087	0.0174	0.0174	0.0087	0.0174	0.0087	0.0174	0.0000	0.0000
2000	498	0.2309	0.1627	0.0241	0.0321	0.0402	0.0522	0.0622	0.0482	0.0482	0.0402	0.0341	0.0281
2001-04		0.3403	0.1676	0.0464	0.0308	0.0455	0.0437	0.0401	0.0395	0.0303	0.0295	0.0252	0.0180

	13	14	15	16	17	18	19	20	21	22	23	24	25
1984	0	0.009	0.009	0.0045	0.0045	0	0	0.0045	0.0135	0	0.0135	0.009	0.018
1985	0.0032	0.0161	0.0096	0.0032	0	0.0032	0.0064	0.0064	0	0	0	0	0.0129
1986	0.004	0.008	0.008	0.0067	0.0013	0.0107	0.0054	0.0094	0.008	0.0054	0.0067	0.0067	0.0228
1987	0.0076	0.0098	0.0119	0.0087	0.0065	0.0054	0.0076	0.0098	0.0054	0.0022	0.0076	0.0065	0.0477
1988	0.0102	0.0051	0.0102	0.0085	0.0068	0.0068	0.0102	0.0118	0	0	0.0017	0.0085	0.0271
1989	0.016	0.008	0.0107	0.0107	0.008	0.0133	0.0053	0.0133	0.0107	0.0187	0.0107	0.008	0.0133
1990	0.0144	0.0036	0.0036	0.0072	0.0036	0.0108	0	0.0144	0	0.0072	0.0108	0	0.0324
1991	0.0286	0.0122	0.0204	0.0041	0.0122	0.0122	0.0082	0.0041	0	0.0041	0	0.0041	0.0286
1992	0.006	0.006	0.003	0.012	0.015	0.009	0.018	0.003	0.003	0	0.006	0.003	0.018
1993	0.0161	0.0044	0.0029	0.0044	0.0058	0.0044	0.0058	0	0.0102	0.0044	0.0029	0.0044	0.0336
1994	0.0165	0.0165	0.0181	0.0082	0.0148	0.0132	0.0082	0.0033	0.0082	0.0066	0.0049	0.0082	0.0181
1995	0.006	0.015	0.015	0.0075	0.009	0.012	0.006	0.009	0.009	0.0015	0.006	0.0015	0.0105
1996	0.0136	0.0169	0.0169	0.0254	0.0254	0.0153	0.0102	0.0102	0.0102	0.0136	0.0085	0.0102	0.0305
1997	0.0186	0.0068	0.0084	0.0118	0.0135	0.0101	0.0068	0.0118	0.0068	0.0051	0.0034	0.0051	0.0118
1998	0.0207	0.0217	0.0155	0.0259	0.0134	0.0165	0.0083	0.0124	0.0114	0.0062	0.0041	0.0062	0.0155
1999	0.0261	0.0000	0.0174	0.0000	0.0174	0.0000	0.0000	0.0000	0.0000	0.0000	0.0087	0.0087	0.0000
2000	0.0321	0.0241	0.0161	0.0301	0.0141	0.0161	0.0080	0.0201	0.0060	0.0000	0.0020	0.0080	0.0201
2001-04	0.0244	0.0131	0.0143	0.0170	0.0146	0.0107	0.0058	0.0111	0.0061	0.0028	0.0046	0.0070	0.0118

Table 3. Estimated age compositions of harp seal catches at the Front and Gulf, 1952-2004.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25+	TOTAL
1952	198,063	5,340	11,758	7,779	5,994	6,856	11,645	8,088	7,914	5,754	6,578	5,618	1,785	1,478	2,182	4,091	1,421	2,233	1,798	984	5,391	873	1	435	1,306	1,743	307,108
1953	197,975	20,602	6,330	5,753	3,744	4,037	3,223	2,825	2,882	2,777	2,330	2,851	1,743	1,370	1,022	1,823	1,989	1,408	906	673	2,541	1,664	937	624	453	404	272,886
1954	175,034	31,645	12,587	3,949	5,625	2,934	3,709	3,329	3,036	2,011	2,908	1,250	2,623	2,533	1,316	1,832	2,196	1,017	337	1,121	831	307	284	718	142	1,142	264,416
1955	252,297	21,800	8,498	6,001	4,321	3,989	3,652	3,113	3,271	2,598	2,942	2,618	2,035	1,555	1,163	2,222	2,080	1,364	739	768	2,374	1,303	779	616	515	756	333,369
1956	341,397	12,068	4,795	3,299	2,629	2,194	2,127	1,909	2,041	1,748	1,838	1,587	1,315	998	848	1,331	1,321	870	578	571	1,505	739	459	389	346	508	389,410
1957	165,438	21,656	7,982	5,330	4,275	3,586	3,464	3,068	3,128	2,684	2,990	2,762	2,080	1,713	1,316	2,309	2,171	1,422	780	826	2,418	1,300	795	611	535	841	245,480
1958	140,996	24,328	9,817	11,311	11,855	10,092	6,589	6,063	5,092	4,813	9,670	5,745	7,088	4,169	3,148	8,813	5,846	2,987	560	1,498	5,374	2,899	2,426	1,007	1,966	3,634	297,786
1959	238,832	21,882	8,185	5,458	4,239	3,788	3,741	3,232	3,247	2,830	3,110	2,695	2,054	1,653	1,280	2,347	2,149	1,422	741	819	2,411	1,299	773	633	526	788	320,134
1960	156,168	32,554	12,672	9,520	6,539	5,561	5,571	4,631	4,505	3,860	4,404	3,896	3,005	2,395	1,784	3,339	3,164	2,046	1,084	1,145	3,568	1,924	1,155	916	779	1,165	277,350
1961	168,819	5,035	1,977	1,951	2,399	810	1,014	1,009	617	586	909	542	310	313	306	154	248	189	99	120	146	0	80	59	9	165	187,866
1962	207,088	29,503	33,876	9,411	8,724	6,173	2,677	2,488	2,568	2,534	1,083	1,242	1,872	966	1,349	1,911	660	1,663	763	578	1,291	159	604	29	152	625	319,989
1963	270,419	9,018	8,102	6,615	3,842	3,014	3,441	3,410	3,360	3,096	3,587	3,450	2,546	2,751	2,770	2,145	2,625	1,794	1,176	924	944	848	628	493	412	632	342,042
1964	266,382	5,685	5,253	5,699	6,561	4,333	6,511	3,375	2,789	2,635	4,106	2,142	2,132	1,643	1,629	2,491	2,014	2,502	3,857	2,010	62	1,953	987	983	1,438	2,491	341,663
1965	182,758	11,710	5,382	4,621	4,901	5,968	5,537	2,094	969	642	1,231	389	1,644	263	1,195	1,029	546	310	671	715	246	464	228	20	29	691	234,253
1966	251,135	13,528	10,652	4,901	4,791	4,987	5,020	4,564	3,091	1,630	1,706	2,224	1,606	1,455	1,631	1,370	1,376	967	1,511	933	1,000	724	299	631	351	1,056	323,139
1967	277,750	14,120	6,348	2,552	2,204	3,117	3,956	3,422	2,406	1,567	1,401	1,790	1,245	984	1,472	1,487	965	1,230	1,344	1,385	898	584	426	482	291	930	334,356
1968	156,458	5,747	4,194	2,800	1,653	1,471	1,504	2,130	2,231	1,524	1,529	1,149	913	854	1,115	950	885	756	1,100	950	677	417	573	299	219	598	192,696
1969	233,340	21,117	2,815	2,859	2,353	2,660	1,963	2,261	2,816	2,056	1,732	1,532	1,013	1,162	1,183	1,229	784	1,265	809	913	757	548	336	411	191	707	288,812
1970	217,431	8,766	7,386	2,580	2,429	2,363	1,363	1,326	1,601	1,437	1,813	1,183	1,129	830	723	866	937	541	538	549	484	350	263	202	133	272	257,495
1971	210,579	7,692	2,568	2,092	1,055	1,047	644	515	446	672	728	464	491	375	168	226	198	139	151	138	90	60	74	46	9	299	230,966
1972	116,810	4,100	2,269	1,319	1,276	601	531	377	309	159	216	248	251	133	211	172	100	121	139	64	195	108	72	45	33	24	129,883
1973	98,335	4,918	3,918	2,755	2,284	3,159	1,051	908	1,023	636	603	725	582	564	415	439	347	211	159	175	180	40	145	18	18	224	123,832
1974	114,825	10,412	5,762	2,137	1,725	1,800	2,671	797	914	1,047	706	492	639	641	445	395	427	371	254	198	103	113	140	76	114	431	147,635
1975	140,638	12,776	6,170	3,106	1,661	1,574	1,437	1,379	787	573	804	505	509	486	346	251	297	215	214	190	86	105	63	68	71	52	174,363
1976	132,085	14,575	7,084	3,923	2,598	888	593	530	544	227	324	315	258	142	179	219	93	105	67	59	64	18	25	41	23	23	165,002
1977	126,982	7,451	5,581	5,131	3,746	1,906	1,062	727	455	192	219	219	154	186	360	385	166	27	38	12	30	15	20	37	22	20	155,143
1978	116,190	15,853	10,031	6,051	4,438	2,963	1,967	647	859	337	578	198	206	222	137	205	109	104	138	70	111	91	79	33	21	85	161,723
1979	132,458	13,686	5,814	2,700	1,668	1,272	789	425	231	217	73	73	79	75	148	153	34	56	55	40	21	21	30	10	11	402	160,541
1980	132,421	14,132	6,565	4,378	2,573	1,994	1,597	1,104	790	555	269	432	413	299	380	345	321	262	27	97	147	81	73	16	10	245	169,526
1981	178,394	5,633	3,077	2,906	2,745	2,421	1,700	1,028	706	295	428	440	310	228	218	221	206	272	183	147	51	166	169	63	29	133	202,169
1982	145,274	7,832	4,229	2,263	1,285	1,428	626	901	363	439	176	297	110	154	99	154	66	198	55	121	121	154	22	77	44	253	166,739
1983	50,058	2,754	1,430	839	447	545	437	275	216	99	135	64	69	33	56	100	48	36	69	40	33	13	3	25	14	51	57,889

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25+	TOTAL
1984	23,922	1,236	2,438	1,133	755	412	274	240	103	69	69	137	103	0	69	69	34	34	0	0	34	103	0	103	69	137	31,542
1985	13,334	1,430	1,595	1,027	477	257	184	128	128	55	74	0	0	18	92	55	18	0	18	36	36	0	0	0	0	74	19,034
1986	21,888	1,078	883	802	314	146	114	70	49	54	27	49	43	16	32	32	27	5	43	22	38	32	22	27	27	92	25,934
1987	36,350	1,889	1,754	1,845	1,245	611	475	272	260	227	181	204	56	79	102	124	91	68	56	79	102	56	23	79	68	498	46,796
1988	66,972	6,549	6,457	4,579	2,793	1,375	825	457	503	230	138	92	184	276	138	276	230	184	184	276	319	0	0	46	230	733	94,046
1989	56,346	1,457	1,648	1,314	1,314	907	477	143	96	143	47	47	47	143	72	96	96	72	119	47	119	96	168	96	72	119	65,304
1990	34,402	4,726	4,262	5,372	3,521	2,223	1,113	464	93	278	278	371	278	371	93	93	185	93	278	0	371	0	185	278	0	834	60,162
1991	42,382	1,833	542	1,041	1,625	1,541	792	292	166	166	166	334	292	292	125	208	42	125	125	84	42	0	42	0	42	292	52,589
1992	43,866	6,630	4,395	2,383	2,309	1,714	1,565	1,190	446	818	372	298	149	149	149	74	298	372	223	446	74	74	0	149	74	446	68,666
1993	16,401	3,037	1,814	1,225	822	728	604	403	264	279	140	140	93	171	47	31	47	61	47	61	0	108	47	31	47	356	27,003
1994	25,223	5,779	3,992	4,766	4,705	3,157	2,441	1,490	1,548	1,074	716	835	416	597	597	655	297	535	477	297	119	297	239	177	297	655	61,379
1995	34,106	6,751	4,898	4,040	2,995	3,138	1,951	1,951	807	570	332	475	332	190	475	475	237	285	380	190	285	285	47	190	47	332	65,767
1996	184,856	15,052	10,919	4,133	3,146	2,757	2,165	2,067	1,376	981	1,376	1,277	789	789	981	981	1,474	1,474	888	592	592	592	789	493	592	1,771	242,906
1997	220,476	17,730	8,126	2,733	1,920	1,553	1,255	1,106	739	516	1,330	962	516	813	297	367	516	590	442	297	516	297	223	149	223	516	264,210
1998	251,403	6,070	1,905	2,001	1,196	2,776	2,389	2,001	2,357	1,646	937	1,389	1,002	646	678	484	809	418	515	259	387	356	194	128	194	484	282,624
1999	237,644	3,664	1,802	240	60	120	120	60	120	60	120	0	0	180	0	120	0	120	0	0	0	0	0	60	60	0	244,552
2000	85,035	1,621	1,142	169	226	282	367	437	338	338	282	240	197	226	169	113	211	99	113	56	141	42	0	14	56	141	92,055
2001	214,754	3,995	1,967	544	361	534	513	471	464	356	346	295	211	286	154	168	199	171	125	68	130	71	33	53	82	139	226,493
2002	297,764	4,969	2,447	677	449	664	638	585	577	443	431	367	263	356	192	209	248	213	156	84	162	88	41	66	102	173	312,367
2003	280,174	3,178	1,565	433	287	425	408	374	369	283	275	235	168	228	123	134	158	136	100	54	103	57	26	42	65	111	289,512
2004	353,553	4,226	2,081	576	382	565	543	498	490	377	366	312	224	303	163	178	211	181	132	72	137	75	35	57	87	147	365,971

Table 4. Proportional age composition of harp seal catches in Greenland (from Bowen 1982 and Kapel 1999).

	0	1	2	3	4	5	6	7	8	9	10	11	12
54-62	0.590	0.160	0.050	0.040	0.030	0.020	0.020	0.010	0.010	0.010	0.010	0.005	0.005
63-69	0.580	0.110	0.070	0.040	0.030	0.030	0.020	0.020	0.010	0.010	0.010	0.007	0.008
1970	0.528	0.064	0.040	0.056	0.032	0.040	0.024	0.032	0.016	0.024	0.024	0.024	0.008
1971	0.629	0.097	0.046	0.069	0.023	0.011	0.011	0.006	0.006	0.017	0.006	0.017	0.011
1972	0.572	0.123	0.080	0.038	0.050	0.024	0.018	0.021	0.004	0.000	0.004	0.003	0.007
1973	0.553	0.216	0.079	0.038	0.011	0.020	0.006	0.005	0.007	0.001	0.005	0.004	0.006
1974	0.643	0.189	0.073	0.007	0.017	0.005	0.010	0.003	0.003	0.002	0.000	0.005	0.007
1975	0.617	0.231	0.071	0.023	0.016	0.003	0.000	0.003	0.003	0.006	0.003	0.003	0.006
1976	0.603	0.223	0.092	0.037	0.017	0.002	0.000	0.000	0.002	0.000	0.002	0.000	0.002
1977	0.769	0.118	0.049	0.019	0.013	0.004	0.001	0.004	0.002	0.001	0.002	0.003	0.003
1978	0.420	0.297	0.109	0.065	0.022	0.018	0.020	0.002	0.008	0.003	0.003	0.003	0.004
1979	0.504	0.201	0.123	0.058	0.024	0.012	0.014	0.009	0.007	0.005	0.003	0.001	0.002
1980	0.264	0.345	0.152	0.095	0.041	0.022	0.013	0.007	0.009	0.005	0.003	0.005	0.003
1981	0.264	0.345	0.152	0.095	0.041	0.022	0.013	0.007	0.009	0.005	0.003	0.005	0.003
1982	0.308	0.275	0.160	0.093	0.043	0.023	0.015	0.008	0.010	0.018	0.013	0.008	0.003
1983	0.273	0.292	0.127	0.094	0.073	0.025	0.025	0.022	0.006	0.013	0.009	0.007	0.006
1984-04	0.143	0.177	0.150	0.146	0.083	0.058	0.044	0.033	0.028	0.012	0.011	0.011	0.004

	13	14	15	16	17	18	19	20	21	22	23	24	25+
54-62	0.003	0.004	0.007	0.003	0.004	0.003	0.003	0.004	0.002	0.002	0.002	0.002	0.002
63-69	0.004	0.005	0.010	0.004	0.005	0.004	0.004	0.006	0.003	0.002	0.002	0.002	0.003
1970	0.016	0.008	0.000	0.000	0.000	0.000	0.000	0.016	0.008	0.008	0.008	0.008	0.016
1971	0.000	0.017	0.006	0.000	0.006	0.006	0.000	0.000	0.006	0.006	0.000	0.000	0.006
1972	0.003	0.001	0.004	0.003	0.001	0.006	0.004	0.003	0.003	0.003	0.003	0.003	0.016
1973	0.006	0.002	0.000	0.007	0.005	0.004	0.004	0.005	0.002	0.002	0.002	0.002	0.005
1974	0.003	0.007	0.002	0.005	0.003	0.000	0.005	0.003	0.002	0.002	0.002	0.002	0.002
1975	0.000	0.003	0.003	0.000	0.000	0.000	0.000	0.003	0.003	0.000	0.000	0.000	0.000
1976	0.002	0.002	0.002	0.005	0.002	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000
1977	0.001	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.002
1978	0.003	0.003	0.002	0.002	0.001	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.008
1979	0.001	0.003	0.001	0.004	0.004	0.001	0.003	0.002	0.004	0.003	0.003	0.002	0.005
1980	0.003	0.001	0.003	0.002	0.000	0.001	0.003	0.003	0.002	0.002	0.002	0.002	0.011
1981	0.003	0.001	0.003	0.002	0.000	0.001	0.003	0.003	0.002	0.002	0.002	0.002	0.011
1982	0.005	0.000	0.003	0.003	0.000	0.003	0.003	0.003	0.003	0.003	0.003	0.000	0.003
1983	0.003	0.001	0.003	0.004	0.004	0.001	0.003	0.001	0.001	0.000	0.000	0.000	0.003
1984-04	0.009	0.005	0.010	0.009	0.008	0.009	0.007	0.009	0.007	0.007	0.006	0.005	0.007

Table 5. Estimated age compositions of harp seal catches in Greenland, 1952-2004.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25+	TOTAL
1952	9,676	2,624	820	656	492	328	328	164	164	164	164	85	88	53	62	113	53	59	43	47	71	34	28	25	28	31	16,400
1953	9,676	2,624	820	656	492	328	328	164	164	164	164	85	88	53	62	113	53	59	43	47	71	34	28	25	28	31	16,400
1954	11,299	3,064	958	766	575	383	383	192	192	192	192	100	103	62	72	132	62	69	51	54	83	40	33	29	33	36	19,150
1955	9,165	2,485	777	621	466	311	311	155	155	155	155	81	84	50	59	107	50	56	41	44	68	32	26	23	26	29	15,534
1956	6,474	1,756	549	439	329	219	219	110	110	110	110	57	59	35	41	76	35	39	29	31	48	23	19	17	19	21	10,973
1957	7,602	2,061	644	515	387	258	258	129	129	129	129	67	69	41	49	89	41	46	34	37	56	27	22	19	22	24	12,884
1958	9,962	2,702	844	675	507	338	338	169	169	169	169	88	91	54	64	117	54	61	45	48	73	35	29	26	29	32	16,885
1959	5,268	1,428	446	357	268	179	179	89	89	89	89	46	48	29	34	62	29	32	24	25	39	19	15	14	15	17	8,928
1960	9,531	2,585	808	646	485	323	323	162	162	162	162	84	87	52	61	111	52	58	43	46	70	34	27	24	27	31	16,154
1961	7,078	1,919	600	480	360	240	240	120	120	120	120	62	65	39	45	83	39	43	32	34	52	25	20	18	20	23	11,996
1962	5,015	1,360	425	340	255	170	170	85	85	85	85	44	46	27	32	59	27	31	22	24	37	18	14	13	14	16	8,500
1963	5,864	1,112	708	404	303	303	202	202	101	101	101	74	76	45	54	98	45	51	37	40	62	29	24	21	24	27	10,111
1964	5,338	1,012	644	368	276	276	184	184	92	92	92	67	69	41	49	89	41	46	34	37	56	27	22	19	22	24	9,203
1965	5,388	1,022	650	372	279	279	186	186	93	93	93	68	70	42	49	90	42	47	34	37	57	27	22	20	22	25	9,289
1966	4,093	776	494	282	212	212	141	141	71	71	71	51	53	32	37	68	32	35	26	28	43	21	17	15	17	19	7,057
1967	2,460	467	297	170	127	127	85	85	42	42	42	31	32	19	22	41	19	21	16	17	26	12	10	9	10	11	4,242
1968	4,127	783	498	285	213	213	142	142	71	71	71	52	54	32	38	69	32	36	26	28	43	21	17	15	17	19	7,116
1969	3,734	708	451	258	193	193	129	129	64	64	64	47	49	29	34	62	29	32	24	26	39	19	15	14	15	17	6,438
1970	3,310	401	251	351	201	251	150	201	100	150	150	150	50	100	50	0	0	0	0	0	100	50	50	50	50	100	6,269
1971	3,502	541	255	382	127	64	64	32	32	96	32	96	64	0	96	32	0	32	32	0	0	32	32	0	0	32	5,572
1972	3,431	736	479	231	301	142	106	124	27	0	27	18	44	18	9	27	18	9	35	27	18	18	18	18	18	98	5,994
1973	5,091	1,986	731	354	103	183	57	46	68	11	46	34	57	57	23	0	68	46	34	34	46	23	23	23	23	46	9,212
1974	4,597	1,351	521	47	118	36	71	24	24	12	0	36	47	24	47	12	36	24	0	36	24	12	12	12	12	12	7,145
1975	4,165	1,556	482	153	110	22	0	22	22	44	22	22	44	0	22	22	0	0	0	0	22	22	0	0	0	0	6,752
1976	7,209	2,670	1,098	445	208	30	0	0	30	0	30	0	30	30	30	30	59	30	0	0	0	30	0	0	0	0	11,956
1977	9,899	1,512	628	242	171	57	14	57	29	14	29	43	43	14	0	0	29	29	0	0	0	14	14	0	0	29	12,866
1978	6,981	4,941	1,815	1,085	374	299	337	37	131	56	56	56	75	56	56	37	37	19	0	0	0	19	19	19	0	131	16,638
1979	8,842	3,534	2,163	1,019	428	214	239	151	126	88	50	25	38	25	50	25	63	63	25	50	38	63	50	50	38	88	17,545
1980	4,022	5,256	2,324	1,442	625	337	192	112	144	80	48	80	48	48	16	48	32	0	16	48	48	32	32	32	32	160	15,255
1981	6,057	7,915	3,499	2,172	941	507	290	169	217	121	72	121	72	72	24	72	48	0	24	72	72	48	48	48	48	241	22,974
1982	8,280	7,405	4,308	2,491	1,144	606	404	202	269	471	337	202	67	135	0	67	67	0	67	67	67	67	67	67	0	67	26,927
1983	6,760	7,240	3,140	2,327	1,810	628	628	554	148	332	222	185	148	74	37	74	111	111	37	74	37	37	0	0	0	74	24,785

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25+	TOTAL
1984	3,686	4,578	3,869	3,780	2,150	1,487	1,125	850	732	308	293	291	115	228	128	261	242	211	227	193	224	193	177	160	128	192	25,829
1985	2,966	3,684	3,113	3,042	1,730	1,197	905	684	589	248	236	235	92	183	103	210	194	170	182	156	180	156	142	129	103	154	20,785
1986	3,725	4,626	3,909	3,819	2,173	1,503	1,137	859	740	311	296	294	116	230	130	264	244	214	229	195	226	195	179	162	130	194	26,099
1987	5,403	6,711	5,671	5,540	3,151	2,180	1,649	1,246	1,073	452	429	427	168	334	188	383	354	310	332	283	328	283	259	235	188	281	37,859
1988	5,768	7,164	6,054	5,914	3,364	2,327	1,760	1,330	1,146	482	458	456	180	357	201	409	378	331	354	302	350	302	277	251	201	300	40,415
1989	6,133	7,617	6,437	6,288	3,577	2,474	1,871	1,414	1,218	512	487	485	191	379	214	435	402	352	377	322	372	322	294	266	214	319	42,971
1990	6,498	8,070	6,819	6,662	3,790	2,621	1,983	1,498	1,291	543	516	514	202	402	226	460	426	373	399	341	394	341	311	282	226	338	45,526
1991	6,862	8,523	7,202	7,036	4,002	2,768	2,094	1,582	1,363	573	545	543	214	424	239	486	450	394	422	360	416	360	329	298	239	357	48,082
1992	7,227	8,976	7,585	7,410	4,215	2,915	2,205	1,666	1,436	604	574	571	225	447	252	512	474	414	444	379	438	379	346	314	252	376	50,638
1993	7,592	9,429	7,968	7,784	4,428	3,063	2,317	1,750	1,508	634	603	600	236	470	264	538	498	435	467	398	460	398	364	330	264	395	53,194
1994	8,518	10,579	8,940	8,734	4,968	3,436	2,599	1,964	1,692	712	677	673	265	527	297	604	558	488	523	447	517	447	408	370	297	443	59,684
1995	9,462	11,752	9,931	9,701	5,519	3,817	2,887	2,182	1,880	791	752	748	294	585	330	670	620	543	581	496	574	496	454	411	330	492	66,298
1996	11,101	13,787	11,651	11,382	6,475	4,478	3,387	2,560	2,205	928	882	878	346	687	387	787	728	637	682	582	673	582	532	482	387	578	77,783
1997	10,295	12,786	10,805	10,555	6,004	4,153	3,141	2,374	2,045	860	818	814	320	637	359	729	675	590	633	540	624	540	494	447	359	536	72,131
1998	12,186	15,135	12,790	12,495	7,108	4,916	3,718	2,810	2,421	1,018	968	963	379	754	424	863	799	699	749	639	739	639	584	529	424	634	85,387
1999	13,927	17,297	14,617	14,280	8,123	5,618	4,250	3,211	2,767	1,164	1,107	1,101	433	861	485	987	913	799	856	730	845	730	668	605	485	725	97,583
2000	14,549	18,069	15,270	14,917	8,486	5,869	4,439	3,355	2,890	1,216	1,156	1,150	453	900	507	1,031	954	834	894	763	882	763	697	632	507	757	101,941
2001	12,790	15,885	13,424	13,114	7,460	5,160	3,903	2,949	2,541	1,069	1,016	1,011	398	791	445	906	838	733	786	671	776	671	613	556	445	666	89,617
2002	9,975	12,389	10,470	10,228	5,818	4,024	3,044	2,300	1,982	834	793	789	310	617	347	707	654	572	613	523	605	523	478	433	347	519	69,895
2003	9,776	12,142	10,261	10,024	5,702	3,944	2,983	2,254	1,942	817	777	773	304	605	341	693	641	561	601	513	593	513	469	425	341	509	68,499
2004	9,571	11,887	10,046	9,814	5,582	3,861	2,921	2,207	1,901	800	761	757	298	592	333	678	627	549	588	502	581	502	459	416	333	498	67,064

Table 6. Proportional age composition of harp seal catches in the Canadian Arctic (from Bowen 1982).

0	1	2	3	4	5	6	7	8	9	10	11	12
0.034	0.066	0.119	0.132	0.090	0.053	0.049	0.052	0.038	0.027	0.044	0.031	0.032

13	14	15	16	17	18	19	20	21	22	23	24	25+
0.019	0.022	0.041	0.019	0.021	0.016	0.017	0.026	0.012	0.010	0.009	0.010	0.011

Table 7. Estimated age compositions of harp seal catches in the Canadian Arctic, 1952-1999.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25+	TOTAL
1952	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1953	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1954	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1955	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1956	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1957	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1958	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1959	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1960	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1961	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1962	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1963	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1964	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1965	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1966	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1967	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1968	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1969	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1970	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1971	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1972	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1973	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1974	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1975	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1976	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1977	60	117	212	236	160	95	87	93	67	49	79	55	57	34	40	73	34	38	28	30	46	22	18	16	18	20	1,784
1978	72	140	253	282	191	113	104	111	80	58	94	66	68	41	48	87	41	45	33	36	55	26	21	19	21	24	2,129
1979	122	237	430	479	325	193	177	189	136	99	160	112	116	69	81	148	69	77	57	61	93	45	37	32	37	41	3,620
1980	214	416	755	840	570	338	310	331	238	174	281	196	203	121	142	260	121	135	100	107	164	78	64	57	64	71	6,350
1981	157	306	555	618	419	249	228	244	175	128	207	144	149	89	105	191	89	100	73	79	120	58	47	42	47	52	4,672
1982	164	320	580	646	438	260	238	255	183	134	216	150	156	93	109	200	93	104	77	82	126	60	49	44	49	55	4,881
1983	164	320	580	646	438	260	238	255	183	134	216	150	156	93	109	200	93	104	77	82	126	60	49	44	49	55	4,881
1984	164	320	580	646	438	260	238	255	183	134	216	150	156	93	109	200	93	104	77	82	126	60	49	44	49	55	4,881
1985	164	320	580	646	438	260	238	255	183	134	216	150	156	93	109	200	93	104	77	82	126	60	49	44	49	55	4,881
1986	164	320	580	646	438	260	238	255	183	134	216	150	156	93	109	200	93	104	77	82	126	60	49	44	49	55	4,881
1987	164	320	580	646	438	260	238	255	183	134	216	150	156	93	109	200	93	104	77	82	126	60	49	44	49	55	4,881
1988	164	320	580	646	438	260	238	255	183	134	216	150	156	93	109	200	93	104	77	82	126	60	49	44	49	55	4,881
1989	164	320	580	646	438	260	238	255	183	134	216	150	156	93	109	200	93	104	77	82	126	60	49	44	49	55	4,881
1990	164	320	580	646	438	260	238	255	183	134	216	150	156	93	109	200	93	104	77	82	126	60	49	44	49	55	4,881
1991	164	320	580	646	438	260	238	255	183	134	216	150	156	93	109	200	93	104	77	82	126	60	49	44	49	55	4,881
1992	164	320	580	646	438	260	238	255	183	134	216	150	156	93	109	200	93	104	77	82	126	60	49	44	49	55	4,881
1993	164	320	580	646	438	260	238	255	183	134	216	150	156	93	109	200	93	104	77	82	126	60	49	44	49	55	4,881
1994	164	320	580	646	438	260	238	255	183	134	216	150	156	93	109	200	93	104	77	82	126	60	49	44	49	55	4,881
1995	164	320	580	646	438	260	238	255	183	134	216	150	156	93	109	200	93	104	77	82	126	60	49	44	49	55	4,881
1996	164	320	580	646	438	260	238	255	183	134	216	150	156	93	109	200	93	104	77	82	126	60	49	44	49	55	4,881
1997	61	118	214	239	162	96	88	94	68	50	80	56	58	34	40	74	34	38	28	30	47	22	18	16	18	20	1,804
1998	24	47	85	95	64	38	35	37	27	20	32	22	23	14	16	29	14	15	11	12	19	9	7	6	7	8	719
1999	12	24	44	49	33	20	18	19	14	10	16	11	12	7	8	15	7	8	6	6	9	5	4	3	4	4	368
2000	9	18	33	37	25	15	14	15	11	8	12	9	9	5	6	11	5	6	4	5	7	3	3	3	3	3	280
2001	14	27	48	54	36	22	20	21	15	11	18	12	13	8	9	17	8	9	6	7	10	5	4	4	4	5	405
2002	24	47	85	95	64	38	35	37	27	20	32	22	23	14	16	29	14	15	11	12	18	9	7	6	7	8	715
2003	24	47	85	95	64	38	35	37	27	20	32	22	23	14	16	29	14	15	11	12	18	9	7	6	7	8	715
2004	24	47	85	95	64	38	35	37	27	20	32	22	23	14	16	29	14	15	11	12	18	9	7	6	7	8	715

Table 8: Proportion of seals recovered (and reported) for young of the year (0) and older (1+) animals.

	Harvest Area			
	Front and Gulf		Can. Arctic and Greenland	
	0	1+	0	1+
1952-1982	0.99	0.50	0.50	0.50
1983-1999	0.95	0.50	0.50	0.50

Table 9. Estimated bycatch of harp seals in commercial fisheries. Catches in the Newfoundland lumpfish fishery are from Sjare et al (2005) while 1994 – 2004 catches in the United States waters are from Waring et al (2005).

	Lumpfish Bycatch			US Bycatch	Totals
	0	1+	Total		
1970	53	15	68		68
1971	391	99	490		490
1972	480	141	621		621
1973	358	107	465		465
1974	141	41	182		182
1975	219	66	285		285
1976	923	169	1,092		1,092
1977	1,281	296	1,577		1,577
1978	2,381	538	2,919		2,919
1979	2,799	511	3,310		3,310
1980	2,454	263	2,717		2,717
1981	3,539	382	3,921		3,921
1982	3,442	343	3,785		3,785
1983	4,504	458	4,962		4,962
1984	3,683	425	4,108		4,108
1985	4,225	632	4,857		4,857
1986	7,136	1,042	8,178		8,178
1987	11,118	1,978	13,096		13,096
1988	7,154	1,391	8,545		8,545
1989	9,457	799	10,256		10,256
1990	2,700	921	3,621		3,621
1991	9,074	615	9,689		9,689
1992	18,969	6,507	25,476		25,476
1993	18,876	7,596	26,472		26,472
1994	35,881	10,513	46,394	861	47,255
1995	13,641	6,060	19,701	694	20,395
1996	10,765	18,347	29,112	89	29,201
1997	13,541	5,059	18,600	269	18,869
1998	3,571	975	4,546	95	4,641
1999	9,750	6,280	16,030	81	16,111
2000	9,715	1,608	11,323	24	11,347
2001	14,572	4,828	19,400	75	19,475
2002	5,492	3,837	9,329	0	9,329
2003	3,486	1,881	5,367	0	5,367
2004	8,494	3,796	12,290	36	12,330

Table 10. Estimated age compositions of harp seals taken as incidental catches in Canadian and US commercial fisheries 1952-2004.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25+	TOTAL
1970	53	3	3	1	1	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	68
1971	391	37	12	10	5	5	3	3	2	3	4	2	2	2	1	1	1	1	1	1	0	0	0	0	0	1	490
1972	480	44	24	14	14	6	6	4	3	2	2	3	3	1	2	2	1	1	1	1	2	1	1	0	0	0	621
1973	358	21	16	12	10	13	4	4	4	3	3	3	2	2	2	2	1	1	1	1	1	0	1	0	0	1	465
1974	141	13	7	3	2	2	3	1	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	1	182
1975	219	25	12	6	3	3	3	3	2	1	2	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	285
1976	923	75	36	20	13	5	3	3	3	1	2	2	1	1	1	1	0	1	0	0	0	0	0	0	0	0	1,092
1977	1,281	78	59	54	39	20	11	8	5	2	2	2	2	2	4	4	2	0	0	0	0	0	0	0	0	0	1,577
1978	2,381	187	119	71	52	35	23	8	10	4	7	2	2	3	2	2	1	1	2	1	1	1	1	0	0	1	2,919
1979	2,799	249	106	49	30	23	14	8	4	4	1	1	1	1	3	3	1	1	1	1	0	0	1	0	0	7	3,310
1980	2,454	100	47	31	18	14	11	8	6	4	2	3	3	2	3	2	2	2	0	1	1	1	1	0	0	2	2,717
1981	3,539	91	49	47	44	39	27	17	11	5	7	7	5	4	4	4	3	4	3	2	1	3	3	1	0	2	3,921
1982	3,442	125	68	36	21	23	10	14	6	7	3	5	2	2	2	2	1	3	1	2	2	2	0	1	1	4	3,785
1983	4,504	161	84	49	26	32	26	16	13	6	8	4	4	2	3	6	3	2	4	2	2	1	0	1	1	3	4,962
1984	3,683	69	136	63	42	23	15	13	6	4	4	8	6	0	4	4	2	2	0	0	2	6	0	6	4	8	4,108
1985	4,225	159	177	114	53	28	20	14	14	6	8	0	0	2	10	6	2	0	2	4	4	0	0	0	0	8	4,857
1986	7,136	278	227	206	81	38	29	18	13	14	7	13	11	4	8	8	7	1	11	6	10	8	6	7	7	24	8,178
1987	11,118	358	332	349	236	116	90	51	49	43	34	39	11	15	19	24	17	13	11	15	19	11	4	15	13	94	13,096
1988	7,154	336	332	235	143	71	42	23	26	12	7	5	9	14	7	14	12	9	9	14	16	0	0	2	12	38	8,545
1989	9,457	130	147	117	117	81	43	13	9	13	4	4	4	13	6	9	9	6	11	4	11	9	15	9	6	11	10,256
1990	2,700	169	152	192	126	79	40	17	3	10	10	13	10	13	3	3	7	3	10	0	13	0	7	10	0	30	3,621
1991	9,074	110	33	63	98	93	48	18	10	10	10	20	18	18	8	13	3	8	8	5	3	0	3	0	3	18	9,689
1992	18,969	1,739	1,153	625	606	450	411	312	117	215	98	78	39	39	39	20	78	98	59	117	20	20	0	39	20	117	25,476
1993	18,876	2,176	1,300	877	589	522	433	289	189	200	100	100	67	122	33	22	33	44	33	44	0	77	33	22	33	255	26,472
1994	36,547	1,711	1,182	1,412	1,393	935	723	441	458	318	212	247	123	177	177	194	88	159	141	88	35	88	71	52	88	194	47,255
1995	14,122	1,338	971	801	594	622	386	386	160	113	66	94	66	38	94	94	47	56	75	38	56	56	9	38	9	66	20,395
1996	10,798	4,772	3,462	1,310	997	874	686	655	436	311	436	405	250	250	311	311	467	467	282	188	188	188	250	156	188	561	29,201
1997	13,737	2,081	954	321	225	182	147	130	87	61	156	113	61	95	35	43	61	69	52	35	61	35	26	17	26	61	18,869
1998	3,646	194	61	64	38	88	76	64	75	52	30	44	32	21	22	15	26	13	16	8	12	11	6	4	6	15	4,641
1999	9,799	3,348	1,647	220	55	110	110	55	110	55	110	0	0	165	0	110	0	110	0	0	0	0	0	55	55	0	16,111
2000	9,736	372	262	39	52	65	84	100	78	78	65	55	45	52	39	26	49	23	26	13	32	10	0	3	13	32	11,347

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25+	TOTAL
2001	14,628	1,649	812	225	149	220	212	194	191	147	143	122	87	118	64	69	82	71	52	28	54	29	14	22	34	57	19,475
2002	5,492	1,306	643	178	118	175	168	154	152	116	113	97	69	94	50	55	65	56	41	22	42	23	11	17	27	45	9,329
2003	3,486	640	315	87	58	86	82	75	74	57	55	47	34	46	25	27	32	27	20	11	21	11	5	9	13	22	5,367
2004[1]	8,522	1,296	638	177	117	173	166	153	150	116	112	96	69	93	50	55	65	56	41	22	42	23	11	17	27	45	12,330

[1] Based on average catch in previous 5 years.

Table 11. Estimated total removals of Norwest Atlantic harp seals, 1952-2004.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25+	TOTAL
1952	219,536	16,162	25,580	17,342	13,292	14,558	24,120	16,690	16,290	11,934	13,642	11,517	3,861	3,129	4,568	8,554	3,015	4,660	3,739	2,121	11,017	1,858	94	952	2,704	3,588	454,522
1953	219,447	46,686	14,724	13,290	8,792	8,920	7,276	6,164	6,226	5,980	5,146	5,983	3,777	2,913	2,248	4,018	4,151	3,010	1,955	1,499	5,317	3,440	1,966	1,330	998	910	386,165
1954	199,519	69,652	27,513	9,902	12,719	6,824	8,358	7,227	6,589	4,503	6,357	2,809	5,566	5,257	2,857	4,074	4,583	2,248	831	2,411	1,921	738	669	1,526	385	2,396	397,434
1955	273,296	48,805	18,973	13,717	9,894	8,789	8,099	6,723	6,987	5,605	6,353	5,508	4,351	3,278	2,523	4,804	4,328	2,916	1,616	1,684	4,975	2,715	1,647	1,311	1,119	1,611	451,625
1956	357,914	27,881	11,111	7,948	6,236	5,017	4,867	4,223	4,435	3,813	4,053	3,398	2,862	2,135	1,859	2,959	2,781	1,895	1,270	1,264	3,197	1,568	991	843	765	1,097	466,385
1957	182,432	47,669	17,676	12,163	9,643	7,877	7,617	6,580	6,648	5,724	6,396	5,768	4,413	3,577	2,809	4,942	4,493	3,013	1,684	1,785	5,040	2,698	1,670	1,293	1,150	1,771	356,529
1958	162,465	54,293	21,747	24,445	25,043	21,049	14,027	12,650	10,656	10,062	19,836	11,776	14,472	8,515	6,504	18,005	11,869	6,171	1,265	3,152	10,987	5,912	4,945	2,097	4,025	7,372	493,338
1959	251,899	46,855	17,687	12,102	9,334	8,123	8,013	6,829	6,807	5,937	6,557	5,593	4,318	3,431	2,708	4,963	4,423	2,984	1,585	1,749	4,992	2,679	1,612	1,325	1,118	1,650	425,272
1960	176,927	70,511	27,383	20,804	14,367	11,958	11,962	9,771	9,467	8,141	9,289	8,070	6,298	4,962	3,770	7,047	6,500	4,284	2,310	2,442	7,368	3,959	2,401	1,913	1,649	2,431	435,985
1961	184,800	14,143	5,578	5,334	5,838	2,290	2,682	2,444	1,608	1,510	2,216	1,319	863	771	783	620	641	540	317	368	488	94	237	186	95	415	236,178
1962	219,330	61,960	69,026	19,974	18,278	12,876	5,868	5,332	5,440	5,336	2,494	2,682	3,950	2,055	2,842	4,085	1,443	3,463	1,627	1,264	2,748	397	1,273	116	369	1,322	455,550
1963	284,999	20,494	18,044	14,511	8,611	6,825	7,460	7,410	7,056	6,492	7,534	7,157	5,359	5,661	5,727	4,631	5,409	3,766	2,483	1,988	2,103	1,799	1,340	1,061	908	1,358	440,187
1964	279,868	13,629	12,218	12,606	13,994	9,408	13,564	7,304	5,896	5,552	8,554	4,528	4,517	3,437	3,435	5,306	4,179	5,173	7,838	4,153	328	4,004	2,054	2,037	2,956	5,071	441,609
1965	195,499	25,698	12,488	10,457	10,679	12,683	11,620	4,746	2,258	1,568	2,806	1,023	3,542	678	2,568	2,383	1,244	789	1,467	1,564	697	1,026	536	111	138	1,471	309,740
1966	261,978	28,843	22,716	10,839	10,325	10,587	10,496	9,596	6,457	3,499	3,711	4,661	3,432	3,041	3,417	3,022	2,883	2,081	3,130	1,982	2,178	1,533	668	1,324	772	2,189	415,362
1967	285,596	29,407	13,714	5,915	4,983	6,679	8,256	7,200	5,031	3,317	3,045	3,752	2,668	2,074	3,069	3,202	2,036	2,579	2,775	2,864	1,940	1,237	908	1,014	638	1,922	405,820
1968	166,413	13,294	9,808	6,641	4,053	3,559	3,467	4,731	4,738	3,288	3,358	2,512	2,047	1,840	2,385	2,183	1,902	1,660	2,309	2,016	1,533	919	1,216	660	508	1,274	248,314
1969	243,285	43,884	6,955	6,705	5,412	5,896	4,358	4,966	5,895	4,339	3,751	3,268	2,237	2,450	2,514	2,728	1,694	2,671	1,722	1,937	1,684	1,177	739	881	449	1,488	363,085
1970	226,420	18,572	15,700	6,335	5,580	5,418	3,201	3,240	3,537	3,273	4,086	2,777	2,473	1,929	1,627	1,878	1,942	1,158	1,132	1,158	1,261	844	662	536	402	785	315,929
1971	220,222	16,738	6,082	5,430	2,690	2,416	1,592	1,282	1,092	1,636	1,681	1,231	1,226	820	608	663	465	418	422	337	272	228	248	124	54	703	268,682
1972	125,453	9,950	5,944	3,585	3,489	1,682	1,455	1,192	809	418	646	644	707	371	522	545	305	337	406	242	520	297	216	158	138	283	160,313
1973	109,989	14,063	9,738	6,701	5,103	6,887	2,395	2,097	2,321	1,395	1,458	1,632	1,395	1,313	957	1,026	900	590	443	479	544	170	372	114	118	580	172,779
1974	125,441	23,773	12,998	4,843	4,009	3,863	5,662	1,828	2,011	2,217	1,571	1,166	1,488	1,398	1,065	960	994	866	564	527	346	294	340	208	288	926	199,645
1975	150,727	28,924	13,741	6,997	3,864	3,385	3,051	2,991	1,753	1,333	1,811	1,165	1,221	1,041	817	692	663	506	484	440	308	298	162	168	178	144	226,865
1976	148,881	34,799	16,824	9,228	5,945	2,030	1,363	1,249	1,284	553	867	742	691	412	498	644	373	346	190	178	220	139	86	114	82	86	227,825
1977	149,464	18,238	12,900	11,273	8,194	4,136	2,338	1,762	1,106	513	655	636	509	470	804	920	459	187	132	84	152	103	105	106	80	137	215,464
1978	133,850	42,054	24,317	14,908	10,059	6,787	4,839	1,598	2,150	907	1,464	642	700	640	483	662	375	337	344	212	333	273	239	142	85	481	248,883
1979	154,521	35,164	16,921	8,444	4,871	3,380	2,423	1,537	990	813	569	421	466	340	562	655	332	393	275	303	305	257	234	186	171	1,069	235,601
1980	144,684	39,709	19,333	13,351	7,553	5,351	4,209	3,102	2,351	1,623	1,198	1,419	1,331	938	1,079	1,308	950	796	286	504	719	383	339	210	212	955	253,896
1981	196,163	27,800	14,312	11,439	8,254	6,392	4,462	2,897	2,209	1,093	1,421	1,416	1,068	783	697	973	690	747	564	598	489	546	532	307	249	856	286,958
1982	167,072	31,240	18,303	10,835	5,755	4,610	2,546	2,729	1,636	2,096	1,460	1,303	668	765	418	844	454	607	399	542	630	565	277	377	187	753	257,071
1983	71,044	20,788	10,383	7,673	5,414	2,898	2,632	2,184	1,106	1,136	1,153	802	749	401	408	754	507	504	369	394	395	221	104	139	127	363	132,648

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25+	TOTAL
1984	36,565	12,339	13,910	11,179	6,729	4,342	3,290	2,702	2,043	1,025	1,159	1,166	753	642	617	1,063	740	701	606	551	769	719	452	619	496	775	105,952
1985	24,522	11,027	10,753	9,542	5,342	3,455	2,674	2,148	1,816	879	1,059	770	497	591	619	935	613	548	556	552	689	432	383	345	305	573	81,627
1986	37,954	12,326	10,972	10,739	5,929	3,855	3,006	2,386	1,956	1,013	1,085	1,000	642	683	551	1,000	736	647	709	604	789	584	505	472	419	705	101,269
1987	60,516	18,198	16,341	16,410	9,904	6,217	4,814	3,595	3,083	1,667	1,687	1,601	772	1,028	819	1,437	1,093	976	941	905	1,131	811	667	731	624	1,763	157,731
1988	89,515	28,401	26,513	22,512	13,333	7,993	5,689	4,107	3,691	1,704	1,632	1,402	1,048	1,466	904	1,783	1,414	1,247	1,240	1,335	1,606	725	652	683	972	2,214	223,781
1989	81,362	18,919	17,477	16,613	10,775	7,364	5,216	3,636	3,003	1,593	1,506	1,370	793	1,244	796	1,469	1,190	1,061	1,156	907	1,245	964	1,036	821	675	997	183,187
1990	52,236	26,401	23,476	25,552	15,622	10,287	6,706	4,449	3,137	1,920	2,031	2,083	1,283	1,745	860	1,509	1,415	1,142	1,518	846	1,795	802	1,099	1,218	551	2,485	192,168
1991	67,740	21,462	16,681	17,508	12,227	9,231	6,295	4,275	3,436	1,758	1,866	2,074	1,340	1,636	953	1,801	1,172	1,251	1,253	1,056	1,170	840	843	684	663	1,425	180,640
1992	79,926	33,592	26,274	21,504	14,530	10,228	8,427	6,535	4,248	3,328	2,423	2,117	1,098	1,417	1,059	1,592	1,807	1,879	1,546	1,932	1,297	1,047	791	1,052	770	1,872	232,292
1993	51,652	27,749	22,023	20,186	11,963	8,623	6,751	5,104	4,100	2,294	2,019	1,882	1,038	1,589	874	1,559	1,308	1,246	1,213	1,127	1,173	1,210	953	831	754	1,867	181,089
1994	80,462	35,068	28,207	29,703	21,615	14,641	11,279	7,858	7,305	4,158	3,430	3,566	1,797	2,610	2,182	3,109	1,984	2,414	2,296	1,738	1,559	1,695	1,463	1,234	1,373	2,499	275,248
1995	69,275	38,983	31,789	29,576	18,497	15,051	10,538	9,160	5,901	3,102	2,667	2,841	1,632	1,774	1,922	2,784	1,949	1,920	2,151	1,574	2,026	1,739	1,110	1,327	862	1,825	261,975
1996	227,914	63,092	49,762	33,632	21,115	15,865	12,268	10,416	7,965	4,397	5,384	5,015	2,832	3,388	3,265	4,246	5,058	4,897	3,575	2,700	2,970	2,657	2,992	2,195	2,244	5,367	505,214
1997	266,574	63,439	39,408	27,559	16,522	11,859	9,184	7,351	5,843	2,951	4,672	3,819	1,893	3,091	1,459	2,441	2,538	2,537	2,279	1,794	2,470	1,771	1,510	1,254	1,240	2,220	487,679
1998	292,721	42,735	29,688	29,321	16,825	15,579	12,388	9,791	9,707	5,435	3,929	4,812	2,859	2,859	2,270	2,792	3,279	2,290	2,576	1,838	2,317	2,026	1,582	1,337	1,262	2,274	504,491
1999	287,839	45,336	34,604	29,392	16,511	11,640	8,898	6,650	5,921	2,530	2,608	2,233	899	2,267	993	2,365	1,845	1,969	1,727	1,478	1,715	1,473	1,345	1,394	1,155	1,461	476,245
2000	128,371	39,806	33,180	30,317	17,546	12,409	9,735	7,725	6,565	3,208	2,976	2,860	1,371	2,318	1,409	2,346	2,394	1,906	2,052	1,665	2,100	1,630	1,403	1,303	1,147	1,838	319,579
2001	266,306	41,488	31,737	27,700	15,898	11,672	9,102	7,096	6,245	3,030	2,921	2,772	1,344	2,295	1,290	2,268	2,180	1,906	1,893	1,526	1,896	1,528	1,318	1,251	1,102	1,680	449,444
2002	338,946	36,154	26,714	22,253	12,832	9,658	7,629	6,029	5,344	2,725	2,648	2,470	1,280	2,078	1,174	1,969	1,906	1,669	1,610	1,271	1,627	1,271	1,070	1,035	947	1,452	493,761
2003	318,026	31,410	24,204	21,265	12,216	8,929	6,962	5,437	4,771	2,313	2,248	2,125	1,043	1,749	996	1,762	1,668	1,464	1,452	1,178	1,465	1,175	1,016	961	845	1,284	457,962
2004	399,893	33,654	25,129	21,220	12,225	9,132	7,190	5,666	5,009	2,524	2,454	2,296	1,175	1,920	1,088	1,849	1,779	1,558	1,513	1,203	1,530	1,202	1,019	980	888	1,358	545,455

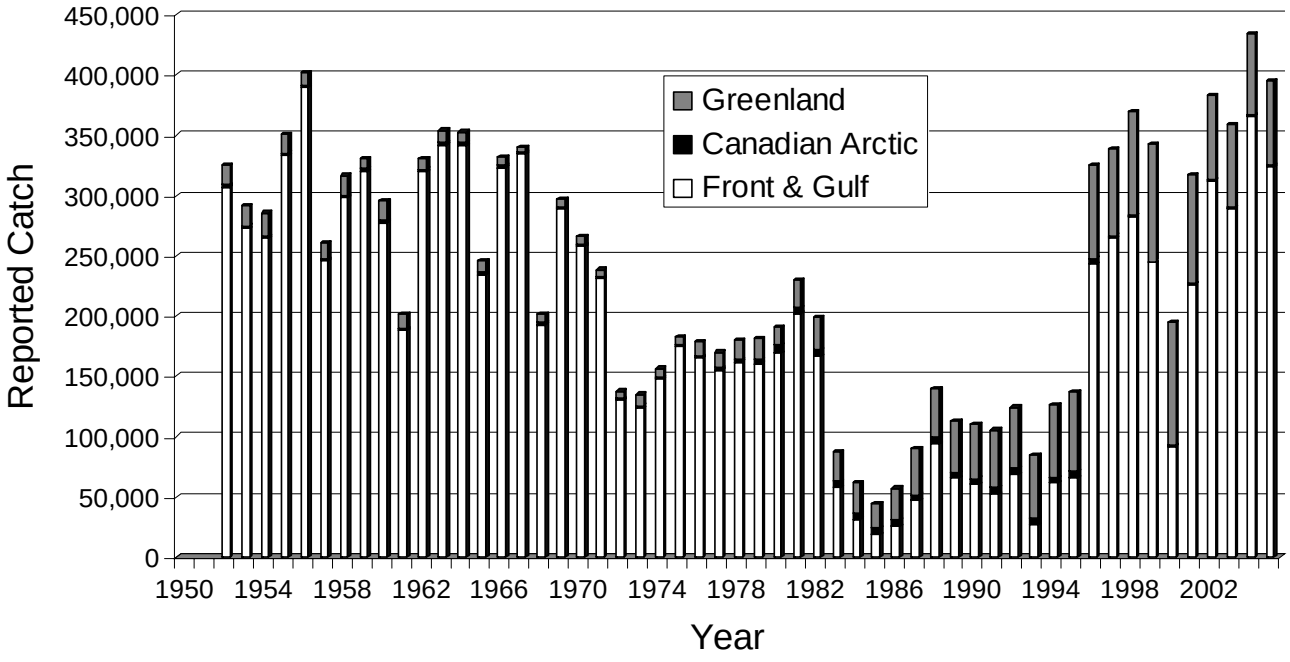

Figure 1. Total reported catches of harp seals in the Northwest Atlantic 1952-99.

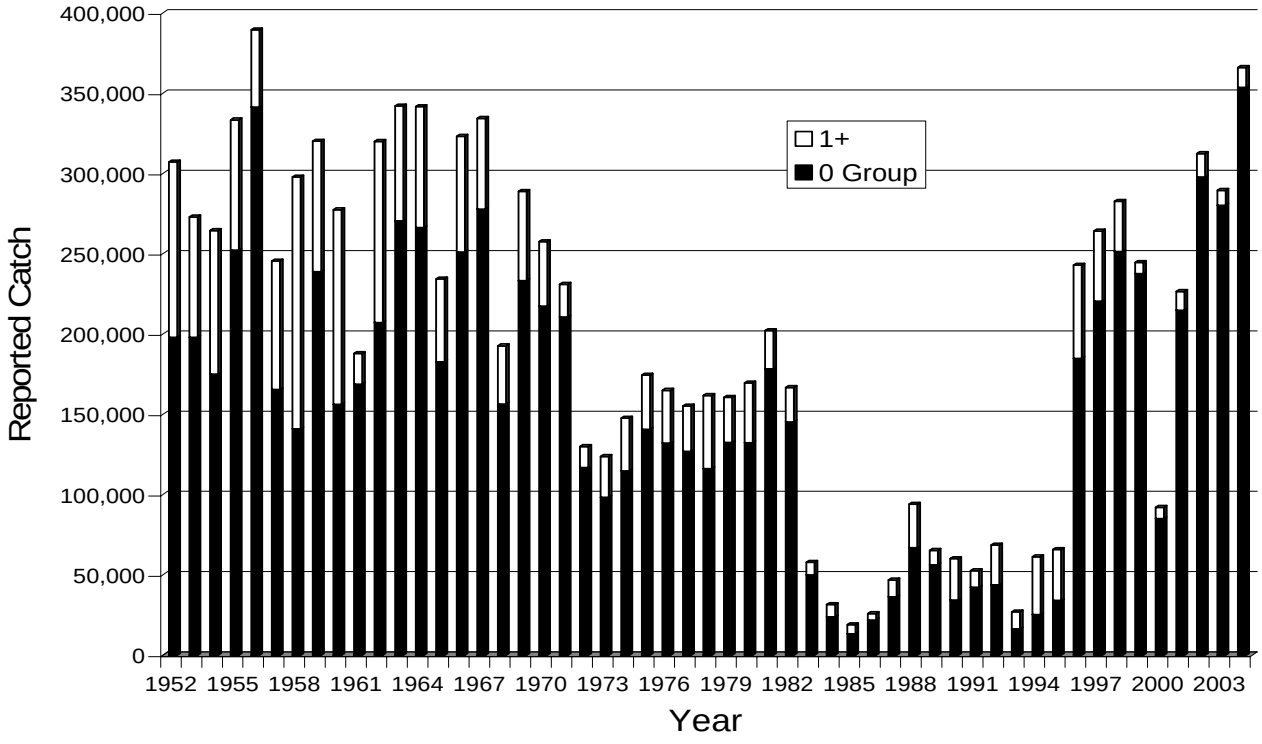

Figure 2. Catches of harp seals in southern Canadian (Front and Gulf) areas 1952-2004.

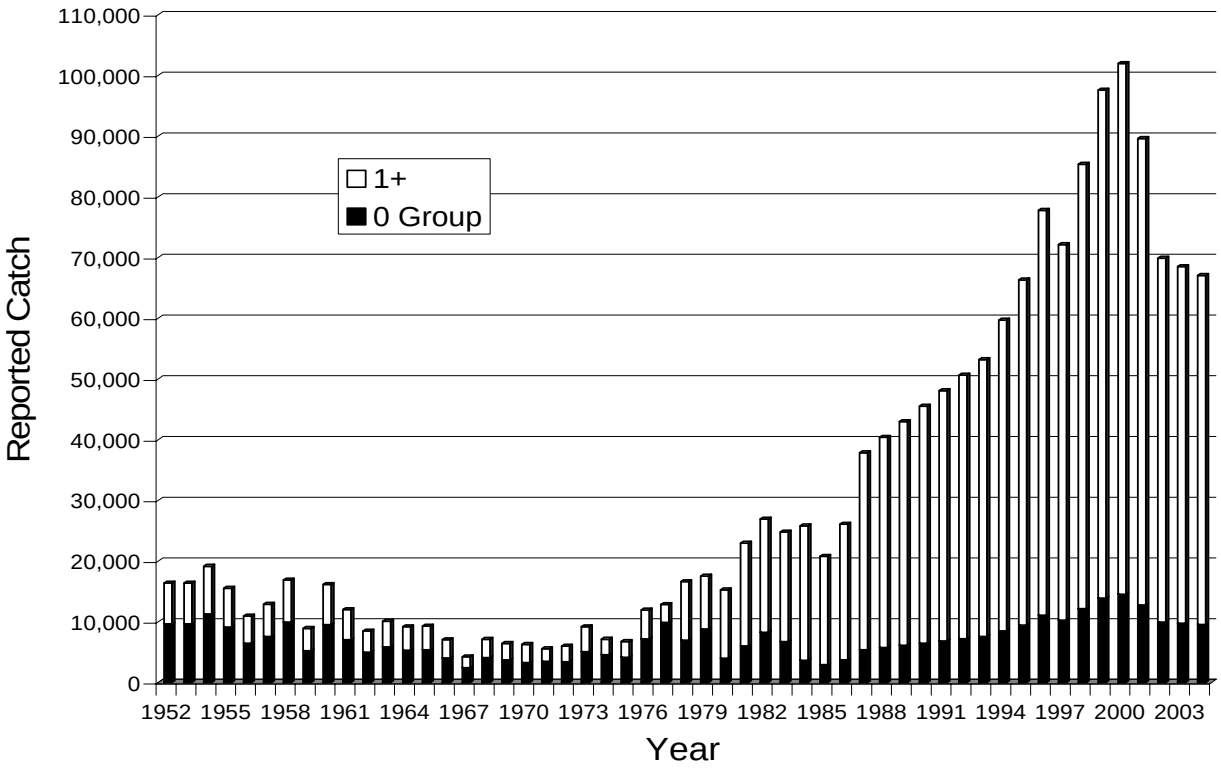

Figure 3. Reported catches of Northwest Atlantic harp seals in Greenland waters 1952-2004. Values for 1952-53, 1988-92 and 2004 are estimated (see text).

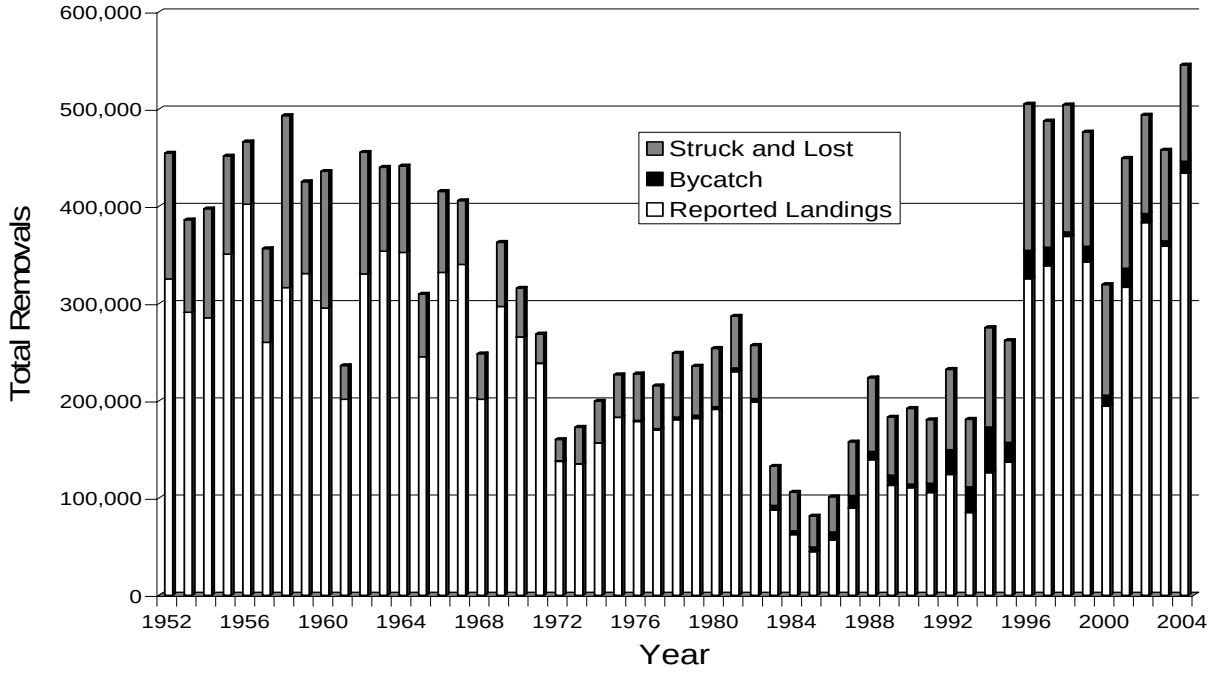

Figure 4. Total removals of Northwest Atlantic harp seals,1952-2004.

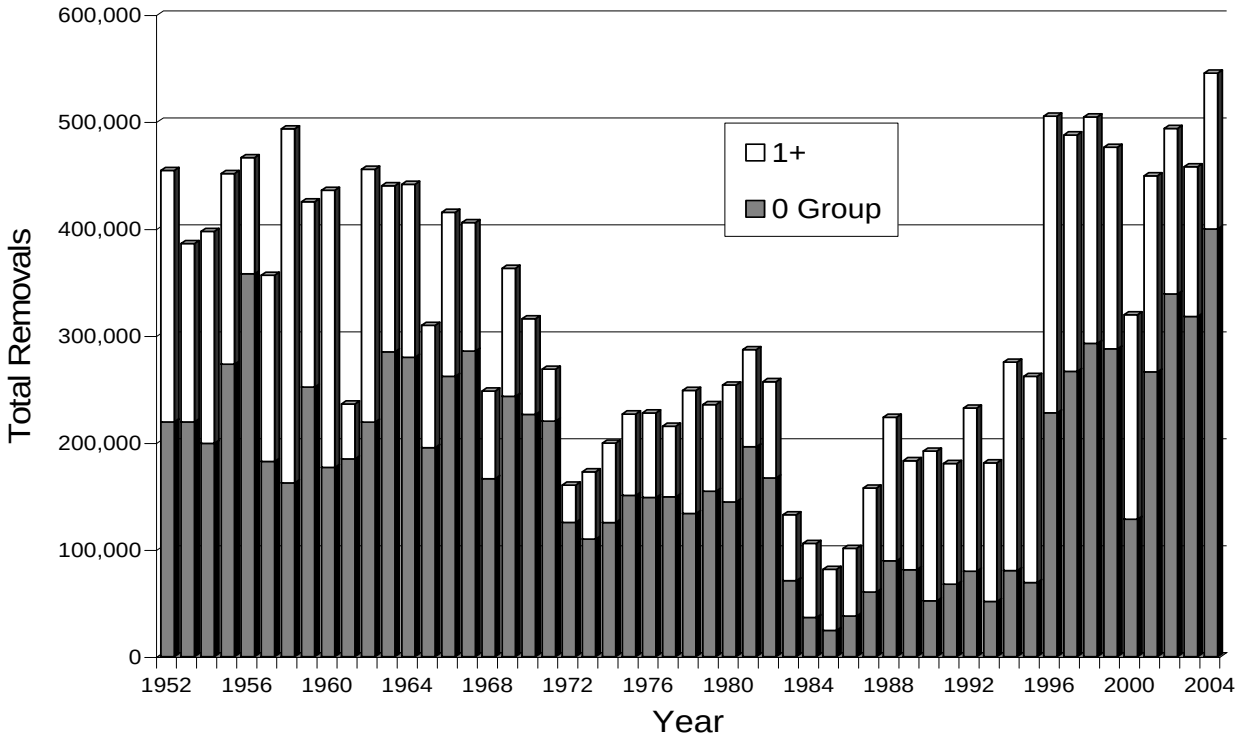

Figure 5. Total removals of Northwest Atlantic harp seals,1952-2004, separated by age class.