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INTRODUCTION

Seven odontocete species are regularly targeted by hunters in Greenlandic waters. Beluga (*Delphinapterus leucas*) and narwhal (*Monodon monoceros*) are hunted under annual quotas, while Atlantic white-sided (*Lagenorhynchus acutus*), white beaked dolphin (*Lagenorhynchus albirostris*), harbour porpoise (*Phocoena phocoena*), killer whale (*Orcinus orca*) and long-finned pilot whale (*Globicephala melas*) are hunted without quotas. Since 1993, a total of 103,899 small cetaceans are recorded in the North Atlantic Marine Mammal Commission (NAMMCO) catch database[1] as hunted in Greenland. Catch records began in 1993 for beluga, harbour porpoise and narwhal, 1995 for pilot whale, 1996 for killer whale and 2003 for Atlantic white-sided/white beaked dolphin (and 2006 for northern bottlenose whales). There are additionally northern bottlenose whale data in the catch database, which are thought to be incorrect entries.[2] Between 2003-2022, 72,970 small cetaceans were reported killed in Greenland. In 2022, the NAMMCO database reports 4,206 small cetaceans as hunted in Greenland.

Knowledge of population status and trends is generally poor for most small cetacean species in Greenland, as is the understanding of the impact of hunting and other anthropogenic impacts. Inadequate monitoring and reporting of takes means that a significant number of hunted individuals are unreported and there is incomplete accounting for struck and lost cetaceans, although the number of which is expected to be high. Whilst struck and lost rates are highly variable, it has been indicated that when narwhal hunts occur near the ice-edge, more than half of the animals killed may be lost (Reeves *et al.,* 2014). The failure to recover struck small cetaceans has welfare as well as conservation implications that are seldom considered by the International Whaling Commission (IWC), although the Working Group on Whale Killing Methods and Welfare Issues has encouraged incorporation of data collection and reduction of struck and lost rates in initiatives in Greenland relating to the beluga and narwhal hunts. Similarly, the time to death of successfully hunted and recovered small cetaceans is rarely considered by the IWC.[3]

Some of the targeted populations are experiencing significant declines in abundance, to the point where recovery may be compromised. Scientific concerns have been raised about the unsustainability of a number of these hunts, by the Scientific Committee's of NAMMCO and the IWC (IWC, 2022). Naalakkersuisut has been slow to heed scientific advice, including from its own Scientific Authority, and in some cases, disregards it. The IWC Scientific Committee has recommended that no small cetacean removals (live capture or directed harvest) should be authorised for any population until a complete and up-to-date assessment of sustainability has been completed (IWC, 2016; 2017; 2018; 2019; 2021; 2022).

To ensure the protection of small cetaceans in Greenland, the government should urgently implement measures for all small cetacean hunts consistent with international conservation management recommendations, ensuring sustainability and taking into account other causes of mortality including stuck

[1] Catch database - NAMMCO
[2] Northern Bottlenose Whale - NAMMCO
[3] The Working Group on Whale Killing Methods and Welfare Issues (iwc.int)

and lost, bycatch and other anthropogenic threats. Such measures must be precautionary, based upon up-to-date knowledge of population status and trends, and account for recovery rates.

KEYWORDS

Greenland; direct takes; small cetacean; conservation; regulations; monitoring; beluga; narwhal; harbour porpoise; Atlantic white-sided dolphin; white beaked dolphin; killer whale; long-finned pilot whale

DISCUSSION

METHODS OF HUNTING

Monodontids (Beluga and Narwhal)
Beluga and narwhal are hunted using several different methods including with harpoons thrown from *qayaqs,* (traditional small boats) in open water close to the ice edge. The whale is initially harpooned with a hand-held harpoon then shot with a rifle (NAMMCO, 2014). Floats attached to the harpoon line are used to reduce the likelihood of losing the whale.

In a few places in Northern and Eastern Greenland, according to a Municipality Executive Order, during winter and when sea ice is at its maximum, the whales can also be captured with nets set in open water or under the sea-ice. Each net is 10 metres high and 30–40 m long with a 380 mm mesh-size. The nets are anchored to land by a wire or chain and held upright by floats. The base of the net is not secured but weighted down with stones. Another netting method is free floating nets anchored underwater at one end. Nets are checked daily for captures, and live entrapped animals are shot (NAMMCO, 2014).

The hunt for narwhals in Scoresby Sound in Southeast Greenland is primarily an opportunistic open water hunt from fast moving speedboats. Hunters will either target individual whales when spotted or drive single or groups of whales into ~50 m long set nets deployed from shore (NAMMCO, 2014).

In West Greenland, in accordance with biological advice, regulations on the size of vessels used for beluga and narwhal hunting have been introduced with the intention of favouring certain socioeconomic groups that depend on hunting while decreasing the total catch. Some communities have introduced bylaws that, for instance, make the use of kayaks mandatory for hunting beluga and narwhal in order to prevent outside participation (Nielsen and Meilby, 2013).

Hunting methods vary depending on region. For instance, the former municipalities of Qaanaaq and Upernavik in West Greenland have developed regulations stipulating that the hunters may only use *qayaqs* (small skiffs) and harpoons. They prohibit hunting whales by surrounding, trapping or blocking them against land or the ice edge.

Other small cetaceans
Hunts of harbour porpoise, dolphins, pilot whales and killer whales take place in ice-free, off-shore areas using rifles fired from small, open boats as the primary method of take. They are normally conducted as a collective hunt involving a number of individuals and vessels. When the cetaceans are spotted, the hunters approach the animals and shoot from a range of 5-30 m (NAMMCO, 2014).

The schooling behaviour of pilot whales makes the hunt relatively easy, compared to hunts for harbour porpoises and dolphins. A rifle shot behind the dorsal fin may not cause instantaneous death, but the animal may be immobilised facilitating retrieval. Head shots are normally instantly lethal, but the hunters avoid head shots due to the high risk of losing the whale. Head shot whales usually sink fast and can easily be lost before they

can be retrieved with the *nissik* (long shafted gaff hook of 4-7 metres). Hunters have also observed that head shots may induce violent reflex movements which can be dangerous to the hunters and damage the boat.

MANAGEMENT OF SMALL CETACEAN HUNTS

Naalakkersuisut, the Greenlandic Home Rule Government is responsible for the management of small cetacean populations in Greenland. The Greenland Institute of Natural Resources (GINR) conducts research and monitoring to provide the government with management advice with the intention that fishing and hunting are sustainable.

Large whale hunts (as well as hunts for polar bears and walrus) are regulated by licenses and are exclusive for full time hunters. Both leisure hunters and full-time hunters can apply for a licence to hunt beluga and narwhal (as well as caribou and muskoxen).

Catches of species harvested according to quotas (including beluga and narwhal) are reported in more detailed special forms which include, for each catch, date and position, information about the hunting method and time to death and biological data such as age class, gender, size, reproductive state and stomach contents (Kovacs *et al.,* 2021).

Anyone older than 12, with a registered address in Greenland, irrespective of nationality can apply for a leisure hunter permit. The permit gives you the right to hunt all the species that are not regulated by quotas or protected without applying for a license. For cetaceans, that means all toothed whales, except sperm whales, which are protected, and beluga and narwhal, for which you need a license.

For some species, quotas and licenses are given for specific populations, or management units. When giving advice, management units correspond to biologically meaning populations where this is possible.

Sassat

When a *sassat* (referring to beluga or narwhal trapped in sea ice without the possibility to reach open water) hunt occurs in North Greenland, the hunters are allowed to kill the whales without these takes counting against the regular quota as sassat hunts are subject to different regulations overseen by the Ministry of Hunting.[4]

SMALL CETACEAN HUNTS WITH QUOTA

Beluga

Between 1993-2022, a total of 9,589 belugas were recorded as hunted in Greenland (Figure 2).[5]

Three beluga populations have been identified in Greenland (Table 1; Ugarte *et al.,* 2020). Until the early 1920s, there was an aggregation of belugas that spent most of the autumn, winter and early spring in the fjords of Southwest Greenland. However, that population was driven to extinction by unsustainable hunting in the local drive net fisheries early in the last century (Heide-Jørgensen, 1994) and only two populations remain. Belugas are only transient visitors to East Greenland and, therefore, no population data are provided in Table 1 (Ugarte *et al.,* 2020).

Quotas for beluga takes were introduced by the Naalakkersuisut in 2004. The quota in West Greenland has varied from a minimum of 140 in 2006 to a maximum of 452 individuals in 2019. However, in 2020, 2021 and 2022, quotas for beluga sub-populations in North Water and West Greenland were set at 593, 608 and 595 individuals, respectively. These quotas are substantially higher than in previous years. It has been more than

[4] Hvalfangst: En god isvinter til Sassat | Sermitsiaq.AG
[5] Catch database - NAMMCO

20 years (in 2000, before quotas were established) since this many beluga were allowed to be hunted in a single year. The annual quota in North Water and West Greenland for 2023 is 294 belugas.[6]

There is no resident population of belugas in East Greenland. Nevertheless, quotas were set for the first time in 2022, allowing a catch of 30 whales in total from 2022 to 2027.[7]

Excess catches from one year are subtracted from the next, and unused quotas are carried over to the next year. Therefore, the quota in a single year can be higher than the advice if the previous year the catch was low. If for any reason the catch was higher than the quota, quotas the following year should be accordingly reduced. Although the NAMMCO catch database does not provide take data for Qaanaaq in 2019, Greenland's national report to NAMMCO indicates an overharvest of 64 belugas that year, and that eight belugas will be subtracted annually from the quota until 2029 to compensate for this (the annual quota for Qaanaaq from 2004-2019 was 20, except in 2018, when it was 22) (NAMMCO, 2021b). In 2021, however, the beluga quota for Qaanaaq increased from 20 to 37, compared to 2020, so that the actual quota from 2021 to 2028 will be 29 belugas per year (NAMMCO, 2020).

Naalakkersuisut decided not to follow NAMMCO SC's recommendations that no beluga hunting be permitted south of 65 N and to implement seasonal closures in other parts of West Greenland, reiterated each year since 2019, to encourage re-establishment of this population (NAMMCO, 2021b). Instead, it has determined that beluga recovery in this area is unlikely due to the increased level of ship traffic, significantly higher numbers of whaling boats, and climate and environmental changes (NAMMCO, 2020). According to NAMMCO SC, the Naalakkersuisut assumes that hunting is not the only reason for beluga reestablishment in this region of West Greenland (NAMMCO, 2020).

NAMMCO SC has repeatedly raised concern over the sustainability of the beluga hunt quotas in East Greenland. Its scientific advice is that "Belugas in East Greenland should remain fully protected, as there is insufficient information to perform an assessment" (NAMMCO, 2022a).

Narwhal

Between 1993-2022, a total of 14,072 narwhal were recorded as hunted in Greenland[8] (Figure 3).

Eight narwhal populations are recognised in Greenlandic waters. Six have a reduced status and four are declining (Melville Bay in the Northwest and Scoresby Sound (Ittoqqortoormiit), Kangerlussuaq and Tasiilaq in the Southeast, see Table 1). The trend of the remaining populations is unknown (Smith Sound in the North and Dove Bugt summer component in the Northeast) (Ugarte *et al.,* 2020). Several narwhal populations in Greenland are small and declining in number and unsustainable hunting is putting the species at risk of local extirpation (Heide-Jørgensen et al., 2020). Narwhal in West Greenland are listed on the Greenland Red List as Near Threatened and in East Greenland as Endangered.

As with beluga, Naalakkersuisut sets the annual quota for narwhal hunts. In West Greenland, quotas were first established in 2004 and, in 2009, split for populations in East Greenland, along with Melville Bay, Inglefield Bredning and West Greenland. Although eight narwhal populations are identified in Table 1, quotas have been split over nine management zones since 2020.

Surveys from 2007, 2012 and 2014 indicate that the summering population of narwhals in Melville Bay is relatively small and catch levels pose risk of population decline. Such catch levels are in excess of those recommended by NAMMCO SC and the Canada/Greenland Joint Commission on Conservation and Management of narwhal and beluga scientific working group (JCNB) (NAMMCO, 2019c). In 2020 and 2021, West Greenland quotas were set consistent with the scientific advice but did not account for the number of

[6] 2023 quotas for beluga whales and narwhals (naalakkersuisut.gl)
[7] 2023 quotas for beluga whales and narwhals (naalakkersuisut.gl)
[8] Catch database - NAMMCO

struck and lost animals, which is expected to be high (NAMMCO, 2019a). Consequently, if the quota was reached, actual takes would be larger than advised.

For example, a total of 106 narwhals were hunted in Melville Bay in 2019. Greenland's progress report to NAMMCO reported that assuming a struck and loss rate of 7.6 percent, 281 narwhals were taken in Melville Bay from 2017-2019 or an average of 94 narwhals per year. This annual take level is considerably higher than scientific advice of 70 narwhals (NAMMCO, 2020).

In the southern zone of East Greenland, NAMMCO SC has recommended a zero narwhal catch since 2017 (NAMMCO, 2018). Nevertheless, according to the NAMMCO catch database, the Naalakkersuisut continues to issue quotas. An ad-hoc working group of NAMMCO SC met in September 2019 to assess the status of narwhal populations in East Greenland (Ittoqqortoormiit, Kangerlussuaq and Tasiilaq). The working group concluded that catches were not sustainable and based on the assessment, the NAMMCO SC recommended total protection of narwhals in East Greenland (NAMMCO, 2019). More recently, a NAMMCO Ad-hoc Working Group on Narwhals in East Greenland (NEGWG) assessment determined that there is a 34% and 30% risk that the hunt in Tasiilaq and Ittoqqortoormiit, respectively, will cause the extinction of these two narwhal populations by 2025.

A 2022 study focused on the Ittoqqortoormiit population in Scoresby Sound in Southeast Greenland found that the combined impact of overharvesting, a declining proportion of females, an overrepresentation of large males and a lack of calves and juveniles has detrimental implications for this small narwhal population (Garde *et al.,* 2022). In 2022, the NAMMCO SC strongly reiterated its management advice to reduce the hunt of narwhals to zero in all three management areas in Southeast Greenland and firmly stressed the urgency for immediate management action to ensure the future presence of narwhal in Southeast Greenland (NAMMCO, 2022).

Naalakkersuisut did not follow this advice and set a quota of 44 and 46 in East Greenland in 2020 and 2021, respectively, albeit with a gradual reduction in the narwhal quota starting in 2020, aiming to reach quotas of 10 narwhals in both Ittoqqortoormiit and Kangerlussuaq by 2023 (NAMMCO, 2020). Despite this, the Naalakkersuisut established a total quota of 50 narwhals for 2022 (15, 15, 20 for Kangerlussuaq (in West Greenland), Tasiilaq, and Ittoqqortoormiit (both in East Greenland), respectively). When informed of these quotas, the NAMMCO SC expressed deep concern (NAMMCO, 2022a).

In 2022, the IWC SC also expressed serious concern over the imminent risk of extirpation of the narwhal population present in Southeast Greenland due to overhunting (IWC, 2022). It recommended that the Naalakkersuisut immediately reduce the quota for the Southeast Greenland narwhal hunt to zero.

Despite the recommendations of two scientific bodies to reduce the narwhal quotas in East Greenland to zero, in December 2022 the Government set a quota for 455 narwhals in West Greenland and 50 in East Greenland. 526 narwhal were reported taken in 2022.

Narwhal populations hunted in Greenland are also hunted in Canada. Using population movement data to determine which populations are available to hunters by area and season, the Joint Working Group of the NAMMCO Scientific Committee Working Group on the Population Status of Narwhal and Beluga in the North Atlantic and the JCNB Scientific Working Group developed a model that estimates the number of individuals removed from each population (Watt *et al.,* 2019). The model estimates removals due to anthropogenic activities (e.g., hunting, noise exposure, fishery bycatch) in multiple locations and seasons where populations are mixed. This model, which has been applied to narwhal, also accounts for struck and lost whales in different hunting situations (Watt *et al.,* 2019).

SMALL CETACEAN HUNTS WITHOUT QUOTAS

Hunting of small cetaceans, other than beluga and narwhal, is not regulated in Greenland. There are no quotas for Atlantic white-sided dolphin, white-beaked dolphin, harbour porpoise, killer whale and long-finned pilot

whale. Inadequate data on the status of these species (Table 1; Ugarte *et al.,* 2020) makes it impossible to assess whether catches are sustainable.

Licensed recreational hunters are permitted to hunt non-quota small cetaceans. A total of 5,205 recreational hunting licences were issued in 2021[9] resulting in the take of 3,389 non-quota small cetaceans.

Atlantic white-sided and white beaked dolphin

Between 2003-2022, a total of 2,547 Atlantic white-sided and white beaked dolphins were recorded as hunted in Greenland (Figure 4).[10] White-beaked dolphins represent the majority of the takes, but Atlantic white-sided dolphins are also caught, especially in South Greenland (NAMMCO, 2022a). The data do not distinguish between the two species, similar to the data collected during research surveys where the two species are grouped together (NAMMCO, 2022b). The catch data are expected to be differentiated from 2022 (NAMMCO, 2022b).

Two populations of white beaked dolphins and one population of Atlantic white-sided dolphins are recognised in Greenlandic waters. There are no population estimates and the status and trend is unknown for both species (Table 1; Ugarte *et al.,* 2020).

In 2022, the IWC SC noted the high number of Atlantic white-sided dolphins reported as direct takes in recent years in Greenland (IWC, 2022), as well as in Norway, Canada, and the Faroe Islands (Cipriano, 2018). These hunts have occurred without a full assessment of the status of the Atlantic white-sided dolphin at the species and population level. The IWC SC reiterated its general and longstanding recommendation that no small cetacean removals should be authorised until a full assessment of species status has been made (IWC, 2016; 2017; 2018; 2019; 2021; 2022). In 2014, IWC SC noted that applying Potential Biological Removal (PBR) approach to Greenland's white-beaked dolphin population reveals that a sustainable harvest level would be approximately 125 dolphins per year (IWC, 2014), a figure which has been exceeded since 2019 (Figure 4).

Populations of Atlantic white-sided dolphins have reduced mtDNA nucleotide diversity throughout their range (Banguera-Hinestroza *et al.,* 2014) and may be vulnerable to further loss in genetic diversity when subject to threats such as bycatch and direct takes.

Harbour porpoise

Between 1993-2022, a total of 70,807 harbour porpoise, or an average of 2,360 per year, were recorded as hunted in Greenland (Figure 5). The highest recorded catch of 3,331 porpoises was reported in 2020 (Figures 5). The third highest catch of 3,199 porpoises was recorded in 2022. Two populations of harbour porpoise are recognised in Greenlandic waters. Abundance estimates are available for West Greenland from 2007 and West and East Greenland from 2015 (NAMMCO, 2019b). The status and trend is unknown for both (Table 1; Ugarte *et al.,* 2020).

In 2013, NAMMCO SC recommended that Greenland take a closer look at the accuracy of catch data for harbour porpoises (and killer whales – see below). The government of Greenland responded by agreeing to set quotas beginning in 2023 (NAMMCO, 2021b).

In 2019, the NAMMCO SC Working Group on Harbour Porpoise estimated that the annual total take that would provide a 70 percent chance of population increase is 2,900 individuals (NAMMCO, 2019b). The Working Group evaluated bycatch data from 1965 to 1982 to obtain a time series of best estimates of total removals for use in its assessment (NAMMCO, 2019b). After correction for struck and lost, this corresponds to a total landed catch of 2,629. With correction for underreporting, the catch expected to be reported for a total

[9] Catches license by type, Municipality, geographic location, Hunting license and time. PxWeb (stat.gl)
[10] Catch database - NAMMCO

removal of 2,900 would be no more than 1,869 individuals (NAMMCO, 2019b). Yet, the reported harbour porpoise catch has exceeded 1,869 every year since 2001, except in 2008 (Figure 5).

In 2019, the NAMMCO SC highlighted that in the previous five years the harbour porpoise hunt off west Greenland had an average removal approximately 30 percent larger than the recommended maximum catch (NAMMCO, 2019a). The IWC SC noted in 2022 that recent evidence suggests that harbour porpoise in West Greenland may be genetically distinct and constitute a unique ecotype (Olsen *et al.,* 2022) raising concerns about the current takes from West Greenland in light of significant levels of under-reporting and estimated bycatch of the species. The IWC SC reiterated, in 2022, its longstanding recommendation that no small cetacean removals should be authorised until a full assessment of the species status is completed.

Killer whale

Between 1996-2022, a total of 439 killer whales were recorded as hunted in Greenland (Figure 6). In 2013, NAMMCO SC recommended that Greenland take a closer look at the accuracy of catch data for killer whales and in 2019, NAMMCO SC recommended caution when setting quotas (NAMMCO, 2021b).

Killer whales from East Greenland, Iceland and Norway are genetically related (Foote *et al.,* 2020). However, specific killer whale populations around Greenland have not been identified, have an unknown status and trend, and there are no population estimates (Table 1; Ugarte *et al.,* 2020).

In 2022, NAMMCO SC advised that given the lack of population data, the continued harvest may jeopardise the presence of killer whales in some areas (NAMMCO, 2022a). The IWC SC, also in 2022, reiterated that the direct takes of killer whales in Greenland (both West and East) are of concern and that there is a need for a full assessment of this population, or populations, impacted by these hunts. The IWC SC reiterated its general, longstanding recommendation that no small cetacean removals (live capture or directed harvest) should be authorised until a full assessment of species status has been made (IWC, 2016; 2017; 2018; 2019; 2021; 2022).

Direct takes of killer whales are motivated by the consumption and sales of mattak and to protect seal prey species to preserve the seal hunting culture (NAMMCO, 2022a). Communities in East Greenland previously recommended controlling killer whale numbers to protect narwhal but this was rejected because killer whales pose no risk to narwhals as their habitats do not overlap (NAMMCO, 2022a). In Southeast Greenland, in 2013 hunters reported that killer whale hunting has become more common as minke whale numbers have declined (Ugarte *et al.,* 2013), with an increase in catches reported since 2010 (Figure 6) (NAMMCO, 2017). Minke whale catches have increased in East Greenland since 2013 (Heide-Jørgensen et al., 2022).

Long-finned pilot whales

Between 1995-2022, a total of 6,320 long-finned pilot whales were recorded as hunted in Greenland (Figure 7).

Two populations of long-finned pilot whales have been identified around Greenland (East and West). Both their status and trend is unknown (Table 1; Ugarte *et al.,* 2020). Takes are concerning given the population estimates of 9,190 and 258 whales off West and East Greenland, respectively. Cumulative historical annual hunt numbers (since records began) have totaled 5,673 whales for West Greenland and 655 whales for East Greenland. These numbers do not cover the whole population range, but the proportion of the population in the coastal waters of Greenland that were surveyed. The actual population sizes are larger, but unknown.

No assessment has been undertaken of the impact of Greenland's pilot whale hunt (NAMMCO, 2022a), although in 2014, the IWC SC questioned its sustainability, noting that '*applying a PBR approach, the sustainable harvest level of pilot whales would be around 50 whales per year*' (IWC, 2014). The IWC SC report states that an estimate based on an adapted IWC's Aboriginal Whaling Management Procedure suggests that an annual take of 70 whales is sustainable. The aerial survey that determined a population estimate did not cover the entire range of pilot whales in West Greenland and the summer aggregation cannot be considered

an isolated stock. Instead, this population is likely connected to pilot whales along Labrador and Newfoundland.

The NAMMCO Pilot Whale Working Group intends to undertake an assessment of the sustainability of the Faroese and Greenlandic hunts in 2023 (NAMMCO, 2022a).

UNDOCUMENTED SMALL CETACEAN DEATHS

NAMMCO SC has strongly recommended that Greenland eliminate underreporting and validate catch statistics (NAMMCO, 2019a). Under-reporting and non-reporting, including of struck and lost individuals, calves separated from their mothers, and foetuses (e.g., the overall pregnancy rate of narwhal killed from 2005–2019 was 18 percent) (NAMMCO-JCNB Joint Working Group, 2020), will influence the sustainability of the hunts.

Under-reporting and non-reporting
Accurate reporting is important to assess the sustainability of the hunts. NAMMCO SC identified underreporting to be an issue as far back as 1994, due to hunting loss, which is never included, and infrequent catch reporting (Heide-Jørgensen, 1994).

In 2019, NAMMCO SC identified a discrepancy between harbour porpoise catches reported in the official database (Piniarneq), which was set up in 1993, and those reported by hunters during interviews, revealing both under- and non-reporting and a tendency for hunters to reduce takes reported to the Piniarneq system. The discrepancy in the numbers of individuals hunted and those reported was significant. For example, one hunter reported a catch of 200 harbour porpoises during an interview but recorded zero catches to the Piniarneq system. According to NAMMCO, there were four other hunters who also reported zero catches in the Piniarneq database despite conceding, when interviewed, that they had successfully taken beluga and/or narwhal. Ten additional hunters who were interviewed completely failed to submit reports to the Piniarneq system (NAMMCO, 2019b).

Between 2006-2022 125 entries of northern bottlenose whales (*hyperoodon ampullatus*) were made in the NAMMCO catch database. However, validation of these catches determined that they were harbour porpoises that had been incorrectly reported on the catch data form. Bottlenose whales are not normally hunted in Greenland (NAMMCO 2015).[11]

Struck and lost small cetaceans
Rates for small cetaceans killed but lost during hunts is regionally different and varies based on hunting methods, techniques, experience as well as species behaviour, time of year and weather conditions. For example, in 1980, the IWC SC estimated total loss rates of 25 percent (1 of 4) of beluga and narwhal landed in winter-spring hunts in West Greenland. In winter, 50 percent (1 of 2) of landed beluga and narwhal were lost while 10 percent (1 of 10) landed during the open water hunt in the summer were lost. In Thule, summer hunts of narwhals resulted in a five percent loss rate while, for belugas, the rate was 10 percent (IWC, 1980).

The scarcity of reports containing struck and lost data reveals an underreporting of struck and lost animals for both beluga and narwhal (NAMMCO, 2015). Official catch records only include data on landed animals and do not include whales that were struck and lost. For narwhal, the average annual struck and lost rate is an additional 15-20 percent of the number of landed animals (Garde *et al.,* 2019). According to GINR, narwhals are more likely to be struck and lost in hunts where they are shot from boats whereas loss rates in nets are minimal although net-whaling raises other welfare issues. For example, in three open-water hunts in Ittoqqortoormiit in August 2015 and 2017 an average of 36 percent of whales shot were struck and lost. It is not known if these whales were mortally wounded.

[11] Northern Bottlenose Whale - NAMMCO; Fritidsjagtbevis (sullissivik.gl)

An analysis of historical narwhal catch data from 1993–2017 found that a variation in struck and lost whales could be attributed, in part, to local hunting rules (Garde *et al.,* 2019). For example, where hunters are required to strike narwhal with hand-held harpoons before they can be shot, the loss rate is significantly reduced (Garde *et al.,* 2019), although the use of a harpoon raises other welfare issues. In West Greenland, a loss rate of 5 percent is arbitrarily applied to the catches in Inglefield Bredning to account for both narwhal that are struck and lost and calves that are separated from mothers. Recently, a struck and loss rate of 7.6 percent was estimated for narwhals in Melville Bay from 2017 -2019 (Garde *et al.,* 2019).

In 2015, the Greenland progress report to NAMMCO reported that legislation requires that any struck and lost monodontids should be reported and will be counted against the quota (NAMMCO, 2015). It's unclear from the NAMMCO catch database whether this has occurred. Since 2017, NAMMCO SC has stated that management advice should be based on total allowable landings rather than total removals. Therefore, the number of struck and lost animals should be deducted from the calculation of a sustainable number of landed animals (NAMMCO, 2021a). This is consistent with the Revised Management Plan.

Other species of small cetacean are also subject to high struck and lost rates. Based on the numbers reported by hunters, in 2019, NAMMCO SC and the IWC SC reported struck and lost rates for harbour porpoises of approximately 10 (NAMMCO, 2019b) and 8 (IWC, 2014) percent, respectively. As white-beaked dolphins and white-sided dolphins are shot by rifle, the struck-and-lost rate might be extremely high (NAMMCO, 2022a). Killer whales also have a high struck and lost rate. During three hunting events where the number of killer whales that died and sank was reported, four whales were landed and nine sank (NAMMCO, 2022a). Another report calculated a 50 percent struck and lost rate (Ugarte *et al.,* 2020). No estimates of struck and lost rates for long-finned pilot whales are available (NAMMCO, 2022b).

The IWC Working Group on Whale Killing Methods and Welfare Issues has encouraged the incorporation of data collection and the reduction of struck and lost rates in Greenland's management of its beluga and narwhal hunts.[12]

As a component of accurate reporting, understanding and accurately accounting for struck and lost individuals is important for sustainability of the hunt and for the hunted populations. Struck and lost rates specific to different hunting regions, populations, and species would allow incorporation of uncertainty into hunt structure, monitoring, and management (Watt *et al.,* 2019). Consistent efforts to collect reliable data should be required and enforced.

The fate of struck and lost individuals is unknown. Some will succumb to their wounds and others may survive. When a harbour porpoise is struck and lost, hunters look for an accumulation of birds as their occurrence often indicates where the wounded animal is located (NAMMCO, 2011). However, the majority of struck and lost individuals will not be recovered, nor will their death be officially recorded.

TIME TO DEATH

Recording time to death, as well as struck and lost rates, provides an understanding of the level of suffering endured by cetaceans, with a view to implementing measures that reduce time to death and, by so doing, minimise suffering to address welfare concerns.

A NAMMCO manual for small cetacean hunting in Greenland recommends measures to address welfare and hunter safety, including equipment and hunting areas for different species (NAMMCO, 2014). The manual was published 10 years ago. As a result, the manual does not reflect the current science and understanding of welfare considerations relevant to all hunted species.

[12] The Working Group on Whale Killing Methods and Welfare Issues (iwc.int)

NAMMCO's manual also states "*The overriding principle pertaining to any killing is that it is carried out as quickly and painlessly as possible with due respect to the safety of the hunters. However, the killing method should also entail considerations whether the animal is for human consumption or not*." NAMMCO also provides detailed guidance on how time to death should be recorded (NAMMCO, 2011).

Although data are collected on time to death for baleen whales hunted in Greenland (Government of Greenland, 2018), it is unknown if there are similar requirements for small cetaceans. This is despite advice from NAMMCO's Expert Group in 2011 recommending that small cetacean hunt efficiency be assessed by documenting struck and lost rates and time to death. It also recommended that data are gathered in a standardised manner to facilitate comparison between hunts. The Expert Group noted that netting, although resulting in a lower struck and lost rate, is likely to cause significant stress and a prolonged time to death for captured animals. Noting that under Greenlandic law nets can be left for upwards of 24 hours between inspections, it recommended that every attempt should be made to develop alternative catching methods (NAMMCO, 2011).

IMPLICATIONS OF HUNT DISRUPTION TO BEHAVIOUR AND SOCIAL SYSTEMS

The unknown impacts of stress and social disruption linked to hunts are likely to reduce survivorship, reproductive success and impeded recovery of the remnant populations (EIA, 2013). This exacerbates a low baseline rate of recovery given small cetaceans' life history, social and behavioural characteristics (Wade *et al.,* 2012). For example, some beluga populations show no evidence of recovery despite cessation of hunting, perhaps because exploitation rates do not explicitly incorporate consideration of social, behavioural, or cultural factors (Wade *et al.,* 2012).

In areas of heavy exploitation, as with belugas and some other small cetaceans, not only the numbers but also the social structure of narwhal populations have been affected by hunting (Wade *et al.,* 2012). Besides the potentially disruptive effects on reproduction, takes of older individuals may have wider implications. In addition to the impact of direct exploitations on population dynamics, it can indirectly effect odontocetes, including belugas and narwhals, by causing a loss of cultural knowledge (for example, types of alternative prey, areas where prey can be found, and capture methods for different types of prey under varying circumstances, increased risk of ice entrapment) (Wade *et al.,* 2012).

NAMMCO has tentatively scheduled a Dolphins Working Group (DWG) meeting for 2023 and all member countries have been recommended to compile a detailed review of the available information on the species to be discussed. The NAMMCO SC agreed this was important in light of the unusually large hunt of *Lagenorhynchus sp*. in the Faroe Islands in 2021. It has been recommended that the Terms of Reference of this DWG include the potential effect of removing complete groups/family groups on genetic diversity and social knowledge (NAMMCO, 2022a).

OTHER THREATS FACED

Consideration of climate change, noise pollution, bycatch and other threats are also relevant to address questions of sustainability and welfare considerations.

The observed long-distance migrations of West Greenland porpoises and known travelling distances of some other odontocete species, such as killer whales, means that they are likely to be vulnerable to these impacts both in Greenlandic waters and on the high seas. Consequently, not only must hunt quotas be set for these species but they must be based on consideration of the myriad environmental threats faced by cetaceans.

Climate change

Arctic marine mammals have a close association with, and are dependent on, sea ice. Measurable sea ice declines in the Arctic, including Greenland, showed statistically significant trends for 1979–2013 toward earlier

spring sea ice retreat, later fall sea ice advance and, consequently, longer summers (Laidre *et al.,* 2015). Continued unprecedented changes in Arctic marine mammal habitats are inevitable, and will influence cetacean reproduction, feeding and life history events, but are inadequately monitored and reported (Laidre *et al.,* 2015). The threat to Arctic marine mammals posed by climate change has been documented (Kovacs *et al.,* 2011; Laidre *et al.,* 2008) and continues to be a priority concern.

Narwhals are considered to be among the most sensitive of Arctic endemic marine mammals to climate change (Hauser *et al.,* 2018). Their range is being restricted by warming oceans (Louis *et al.,* 2020) and since they primarily lose heat through the dorsal ridge and tail fluke, their ability to adapt to these warming temperatures is limited (NAMMCO, 2019a). They rely on limited prey selection, strict migratory patterns and high site fidelity (Chambault *et al.,* 2020). Different populations of narwhals employ specialised foraging strategies, which have repercussions for their potential ability to adapt to ecosystem changes (Watt *et al.,* 2015). In addition, the daily rate of successful feeding events was particularly low for narwhals in summer, suggesting that narwhals rely on body reserves accumulated in winter to sustain them year-round. Consequently, the expected changes or disappearance of narwhal wintering habitats in response to climate change may have severe fitness consequences (Chambault *et al.,* 2023).

Research on climate change effects on the narwhal populations in West Greenland and the Canadian Arctic Archipelago indicate that although narwhals may be able to adapt their migration patterns in response to warming oceans, there is an overall predicted loss of suitable habitat, as climate change is likely causing increased habitat fragmentation and a drastic reduction of their winter ranges (NAMMCO, 2022a). Narwhals are remaining longer in their summer areas at a rate of 10 days per decade, a similar rate to observed sea ice loss (Shuert *et al.,* 2022). The consequences of these changes to narwhal populations are not entirely understood but they will result in greater exposure of animals to increasing anthropogenic activities in their summering areas (Shuert *et al.,* 2022).

While there have been several recent sightings of narwhals in areas north of their traditional range (e.g. Dove Bay, Northeast Greenland), evidence suggests that a combination of hunting and climate change is negatively impacting the long-term viability of populations in Southeast Greenland (NAMMCO, 2019a). These most southerly populations of narwhals are most exposed to negative effects from climate change (NAMMCO, 2019).

Warming ocean waters will also restrict the range of narwhals. Narwhals from East and Southeast Greenland may be under pressure to abandon their traditional habitats due to ocean warming and either migrate further north or face local extirpation (Chambault *et al.,* 2020). Adapting to new environments may result in changes in reproductive and survival parameters and understanding the effect of ocean warming on life history parameters requires large sample sizes and long-term data collection, as it is probably causing habitat fragmentation and a drastic reduction in their winter ranges (NAMMCO, 2022a).

Environmental changes that negatively impact body condition may hinder the ability of belugas to reach preferred prey sources, evade predators and escape ice entrapments (Choy *et al.,* 2019). The JWG reviewed available research on climate change effects on beluga in West Greenland and the North Water, projecting loss of habitat in Cumberland Sound. Similar to narwhals, the mechanism connecting climate change and beluga population dynamics are unknown, and new beluga movement should be monitored for early detection of distribution changes (NAMMCO-JCNB, 2021).

A lack of pack ice in summer and increasing sea temperatures are major oceanographic changes recently observed in coastal areas of Southeast Greenland. The resulting cascading effects on the marine ecosystem have included changes in the composition of pelagic fish species and the presence of a large number of boreal cetaceans not previously documented in the area or now occurring in surprisingly large numbers for example,

humpback (*Megaptera novaengliae*), fin (*Balaenoptera physalus*), killer and pilot whales as well as white-beaked dolphins (Heide-Jørgensen et al., 2022). These changes may result in increased takes of species for which population data is absent or scant and for whom no quotas have been set. For example, increasing catches of pilot whales, killer whales and white-beaked dolphins have been reported, probably due to a reduction of summer sea ice making the animals more accessible to hunters.

Harbour porpoises in West Greenland may also be particularly sensitive to ecosystem level changes, as the number of prey species seems to be limited compared to other parts of the North Atlantic and since waters in West Greenland are subject to more extreme fluctuations in productivity (NAMMCO, 2019b).

Given the fast pace of ecological change in the Arctic and uncertainty in how populations will respond, flexible and adaptive management is critical (Laidre *et al.,* 2015).

Noise pollution

The reduction in sea ice and resulting extended open water season has contributed to expansion in industrial development in Arctic waters and to the increased use of Arctic international shipping routes (Reeves *et al.,* 2014) including off Greenland, making these waters more crowded, noisier and hazardous for marine wildlife. Belugas and narwhals in particular demonstrate extreme sensitivity to noise and disturbance (Kyhn *et al.,* 2019).

NAMMCO SC recently reviewed disturbance impacts on these species, including from shipping, ice breaking, and mining and made research and management recommendations (NAMMCO, 2022d). Oil and gas development and increases in shipping activities result in noise pollution, ship strikes, displacement from critical habitat, and the risk of accidental or illegal discharge of oil. Areas currently open for leasing or that are already leased for hydrocarbon exploration and development overlap portions of the annual and main summer ranges of beluga and narwhal (Reeves *et al.,* 2014). Even in high Arctic areas, local seismic surveys are a concern for endemic marine mammal populations (Heide-Jørgensen et al., 2021). During seismic survey trials, narwhals were clearly affected not only by the noise produced by airgun arrays but also by the ships alone (Heide-Jørgensen et al., 2021). Due to these impacts, NAMMCO SC has recommended that shipping activities from large vessels in East Greenland should be regulated to avoid further negative impacts on the declining narwhal populations (NAMMCO, 2022a).

Extensive studies of narwhal reactions to disturbance from vessels and seismic operations indicate that narwhals are clearly not adapted to frequent disturbance; their freeze or flee response have severe physiological and energetic consequences. The long-term effects of continued disturbance on narwhal populations is unknown as such large-scale industrial activities over extended periods of time have not yet been undertaken in narwhal habitat (NAMMCO, 2019a).

With routine vessel transits of the Arctic expected by mid-century (Hauser *et al.,* 2018), there is a need to consider long-term exposure from industrial-scale seismic surveys and continued ship traffic (Heide-Jørgensen et al., 2021). Greenland does not currently contribute data to the International Council for the Exploration of the Seas (ICES) Impulsive Noise Register (INR) (NAMMCO and NIMR, 2019).

It is already known that belugas are easily scared towards the coast where they are more likely to face hunters and also that the migration patterns of belugas are potentially affected by seismic activities (NAMMCO and JCNB, 2015).

Bycatch

Greenland does not currently report bycatch data separate from cetaceans killed in hunts. In 2022, however, it proposed to launch a mobile App for hunters in 2024 to increase reporting and distinguish bycatch and hunt data (NAMMCO, 2022b). Greenland has never provided data to the International Council for the Exploration of

the Seas (ICES) Bycatch Working Group (NAMMCO, 2022c) and no species-specific bycatch estimates are available for any cetacean species (NAMMCO, 2022a).

Harbour porpoise bycatch has been documented in the Greenlandic halibut gillnet fisheries (NAMMCO, 2021a). These data are not included in the US National Oceanographic and Atmospheric Administration (NOAA) List of Foreign Fisheries. High numbers of harbour porpoises are taken in the hunt, and concern has been raised by NAMMCO SC and the IWC SC (IWC, 2022) regarding the persistence of the local population(s). Given questions about the sustainability of the harbour porpoise population(s) due to hunting alone, should Greenland export fish products to the US, there might need to be zero bycatch for Greenland to meet the legal requirements of the US Marine Mammal Protection Act Import Provision Rule.

Chemical pollutants

Studies have found persistent organic pollutants (POPs), such as polychlorinated biphenyls (PCBs), Polybrominated diphenyl ethers (PBDEs) and Per- and polyfluoroalkyl substances (PFASs) in bowhead whale blubber (Letcher *et al.,* 2010), and in the liver of pilot whale, harbour porpoise and Atlantic white-sided dolphin (Rotander *et al.,* 2012). Studies have assessed pollutant levels of Arctic small cetaceans (Butt *et al.,* 2010) including maternal transfer of PFASs in killer whales in Greenlandic waters (Gebbink *et al.,* 2016). Long chain perfluoroalkylsulfonic acids (PFSAs) and perfluoroalkylcarboxylic acids (PFCAs) are persistent and bioaccumulative chemicals used in industrial and commercial applications and have been reported at elevated concentrations in remote Arctic wildlife (Butt *et al.,* 2010). Marine mammal eating killer whales in southeast Greenland face a high risk of decline due to POPs contamination (NAMMCO, 2018).

Increasing levels of highly neurotoxic mercury have been found in narwhals, likely as a product of their feeding on higher trophic-level prey (Dietz *et al.,* 2021). Concentrations of mercury were high in pilot and killer whales (up to 15,9 mg/kg wet weight (ww)). In Japan, the maximum limit of methyl mercury in whale meat for human consumption is 0,3 mg/kg ww. All pilot (9) and killer whales (2) and 70 percent of the white beaked dolphins (n=10) had concentrations above 0,3 mg/kg ww.[13]

Health authorities in several countries warn pregnant women and other vulnerable population groups to limit or even stop their consumption of odontocete products due to the negative impacts of eating contaminated meat. In 2020, the Greenland progress report to NAMMCO reported that the Government of Greenland took notice of scientific reports showing high level of contaminants in killer whales and the subsequent recommendation by the Greenlandic Health Authority not to use killer whales for human consumption or animal feed. As a result, the Government of Greenland is considering using an executive order to prohibit the catching of killer whales (NAMMCO, 2020).

CUMULATIVE EFFECTS OF MULTIPLE STRESSORS

Considering the stress endured by small cetacean populations subject to hunting, stress associated with other anthropogenic threats, most of which are increasing in frequency and severity, may be additive. Multiple threats, such as contaminants and climate change, may act adversely and cumulatively impact some populations of Arctic biota (Borgå *et al.,* 2022) yet little is known about the cumulative effects of multiple stressors on Arctic marine mammals (Laidre *et al.,* 2015).

To assess the impacts of such threats, there must be reliable long-term monitoring of cetacean population abundance relative to the rate of removals by hunting and other pressures. Robust estimates of absolute abundance do not exist for Greenlandic small cetaceans and long-term data series that can be used for trend analysis are not available (Heide-Jørgensen et al., 2016).

[13] World Marine Mammal Conference (xcdsystem.com) Abstract of poster presented on Tuesday Dec. 10th in Pollutants and Toxicology – Group B.

Acknowledging that halting all hunting of a population may not be sufficient to promote their recovery where depleted or small, NAMMCO and the JCNB Joint Working Group have advocated for additional management actions such as establishing protected areas of critical habitat, e.g., closing areas to hunting, fishing and vessel traffic (NAMMCO and JCNB, 2021).

CONCLUSION AND RECOMMENDATIONS

A robust small cetacean monitoring programme is required to understand the status and trends of local populations. This is essential to inform quotas, particularly given the impact of climate change and other associated threats on the populations (Laidre *et al*., 2015). In recent years, the pressure on small cetaceans in Greenland from anthropogenic threats has intensified. Technological advancements (predominantly the introduction of motorboats), improved hunting efficiency (the increase in the use of rifles as opposed to harpoons and nets) and the increase in sea-temperature, have not been considered or reflected in the management advice given for small cetacean populations.

The following recommendation is addressed to Greenland:

To ensure the protection of small cetaceans in Greenland, the government should urgently implement measures for all small cetacean hunts consistent with international conservation management recommendations, ensuring sustainability and taking into account other causes of mortality including stuck and lost, bycatch and other anthropogenic threats. Such measures must be precautionary, based upon up-to-date knowledge of population status and trends, and account for recovery rates.

To the IWC SC:

- Evaluate population status and trends of small cetaceans targeted in Greenlandic hunts.

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Table 1. Population status and trends of small cetacean populations of Greenland (for more detail, see Ugarte *et al.,* 2020)

Species	**Population / 'stock' / Management Unit**	**Region**	**Status**	**Trend**	**Quota?**
Beluga	West Greenland winter	NW	Reduced	Stable	Y
	North Water Polynya winter	NW	Reduced	Unknown	
	SW Greenland winter	SW	Extirpated	Extirpated	-
Narwhal	W Greenland winter aggregation	NW	Reduced	Stable	Y
	Smith Sound	N	Not Reduced	Unknown	
	Inglefield Bredning	N	Reduced	Stable	
	Melville Bay	NW	Reduced	Decreasing	
	Scoresby Sund	SE	Reduced	Decreasing	
	Kangerlussuaq	SE	Reduced	Decreasing	
	Tasiilaq	SE	Reduced	Decreasing	
	Dove Bugt Summer	NE	Not Reduced	Unknown	
Harbour porpoise	West Greenland	SW	Unknown	Unknown	N
	West Greenland	SE	Unknown	Unknown	N
Killer whale	Unknown	NW, SW, SE	Unknown	Unknown	N
Pilot whale	West Greenland	SW, NW	Unknown	Unknown	N
	East Greenland	SE	Unknown	Unknown	N
White beaked dolphin	West Greenland	SW, NW	Unknown	Unknown	N
	East Greenland	SE	Unknown	Unknown	N
Atlantic white-sided dolphin	Unknown	SW	Unknown	Unknown	N
Northern bottlenose whale	Unknown	NW, SW, SE	Unknown	Unknown	N

Figure 1. Map of Greenland and small cetacean hunting locations

Figure 2. Number of belugas recorded as hunted in annual Greenland hunt, 1993-2022 (data from NAMMCO online catch database)

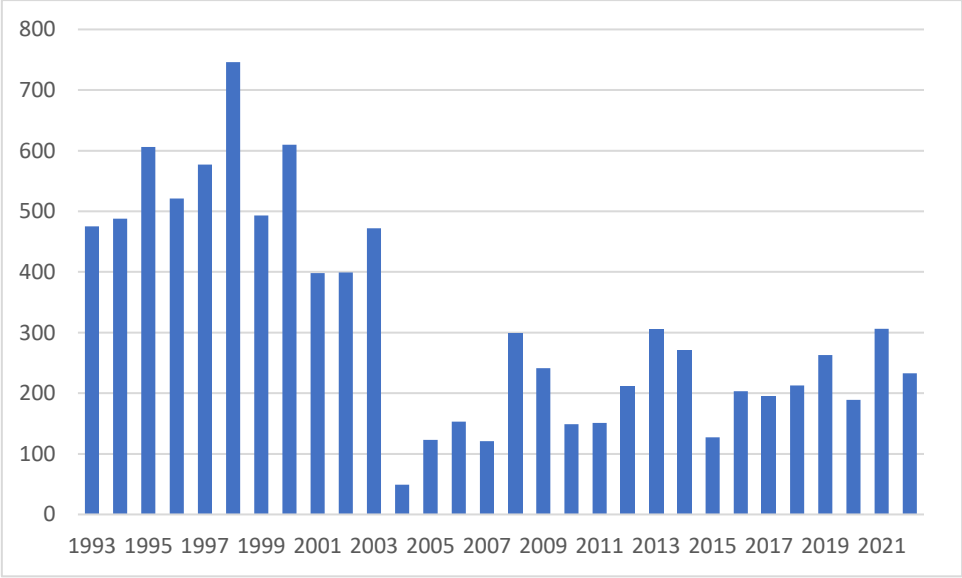

Figure 3. Number of narwhal recorded as hunted in annual Greenland hunt, 1993-2022 (data from NAMMCO online catch database)

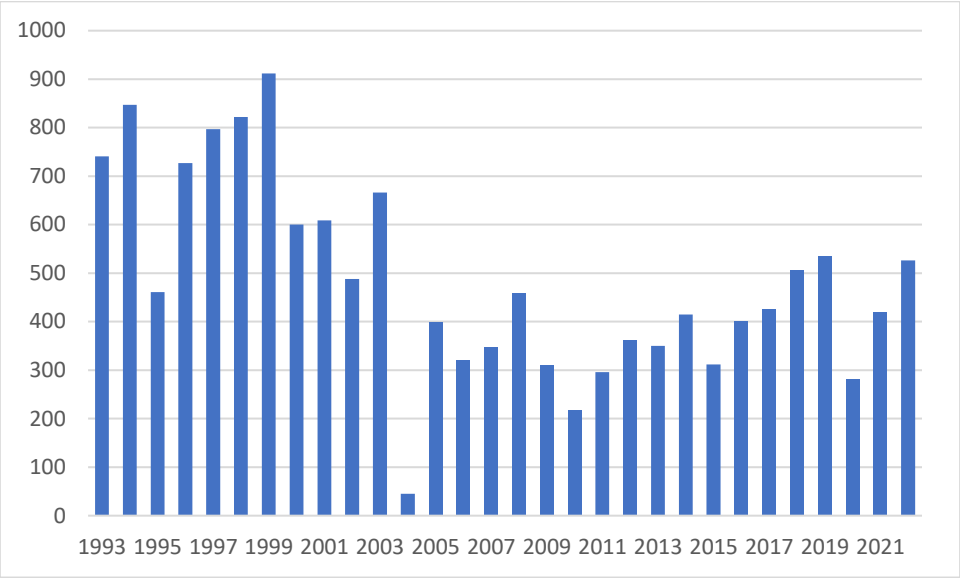

Figure 4. Number of Atlantic white-sided/white beaked dolphins recorded as hunted in annual Greenland hunt, 2003-2022 (data from NAMMCO online catch database)

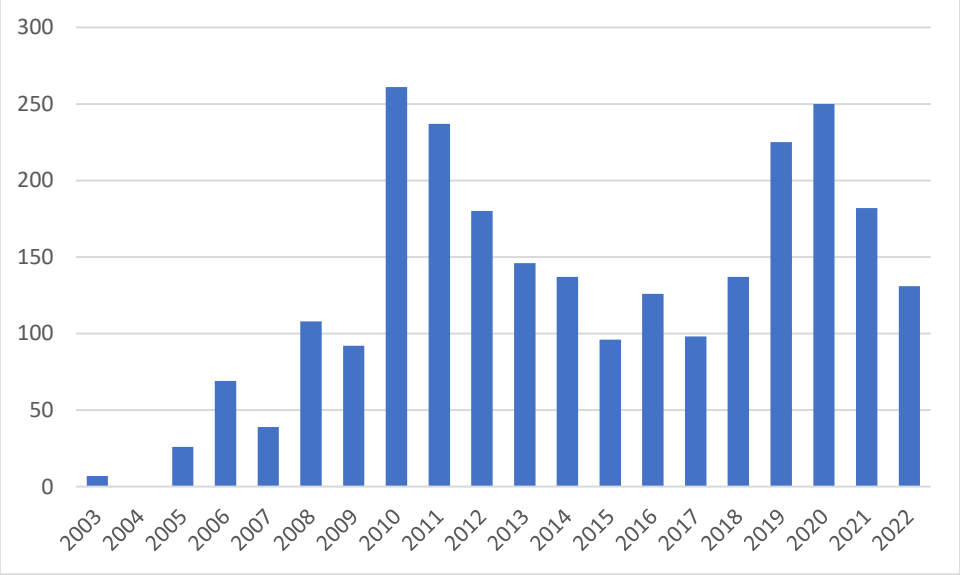

Figure 5. Number of harbour porpoise recorded as hunted in annual Greenland hunt, 1993-2022 (data from NAMMCO online catch database)

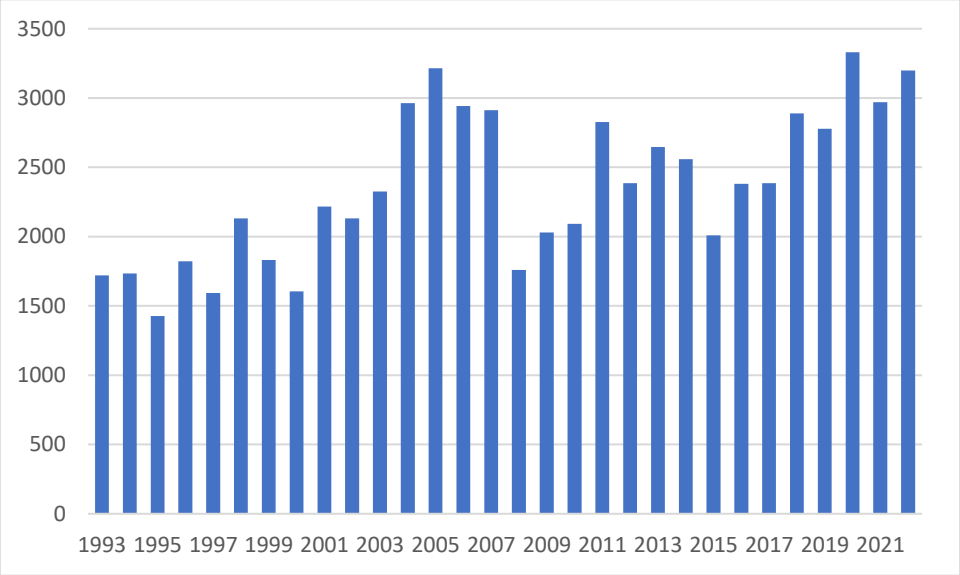

Figure 6. Number of killer whales recorded as hunted in Greenland, 1996-2022 (data from NAMMCO online catch database)

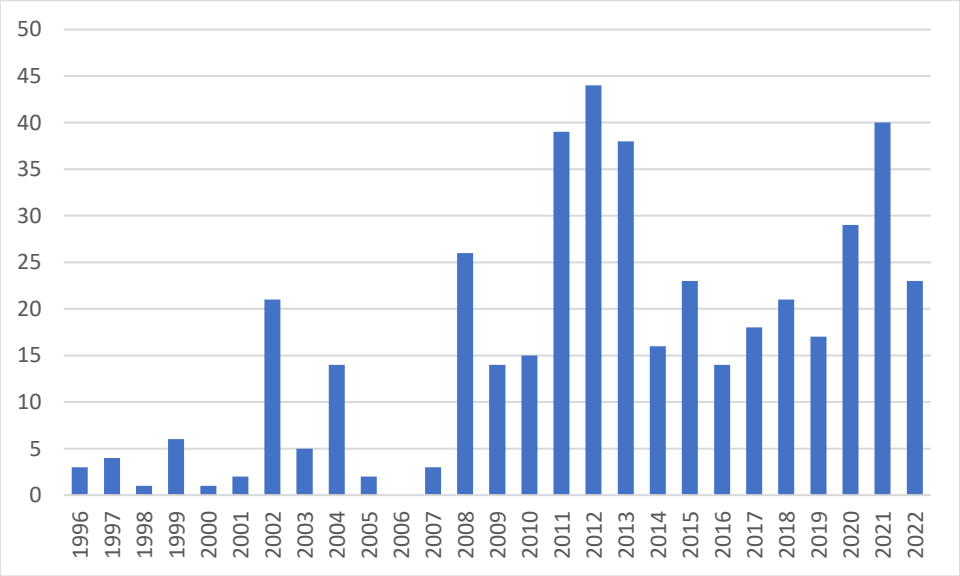

Figure 7. Number of long-finned pilot whales recorded as hunted in annual Greenland hunt, 1995-2022 (data from NAMMCO online catch database)