

Management of Atlantic walrus (*Odobenus rosmarus rosmarus*) in the arctic Atlantic

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ABSTRACT

We review the management of Atlantic walruses (*Odobenus rosmarus rosmarus*) past and present in the four range states—Canada, Greenland, Norway and Russia—which have permanent populations of Atlantic walruses. Populations in all four countries have been depleted, although the extent of depletion is not well known. Inuit in Arctic Canada and Greenland hunt Atlantic walruses for subsistence while they have been protected at Svalbard (Norway) since 1952 and in the western Russian Arctic since 1956. Since the second half of the 20th Century Canada and Greenland have increased protection of their walrus. Generally the number of walruses landed in Canada is governed by the number of hunters and/or people in the settlement and not by stock-specific quotas. Although quotas have been set in few communities, it is not known if they are adequate to prevent overhunting. A quota system for walrus hunting in Greenland began in 2006. The current control system is largely effective in ensuring the quotas are applied and that reporting is correct. Greenland currently sets quotas based on recommendations from scientific assessments using recent population estimates to allow population growth from a depleted population. A challenge with respect to managing walrus hunting remains the variable and sometimes high rates of lost animals. Since the 1960s changes in socio-economics in hunting areas of Arctic Canada and Greenland (and the use of snowmobiles instead of dog sleds in Canada) have led to a general decrease in interest in hunting of walruses and reduced harvest on walrus stocks in these countries. Although there is an active ongoing cooperation between Canada and Greenland scientists regarding assessments of shared populations of walruses currently there is no formal agreement between the two range states on co-management of shared stocks. Protection of walrus from other anthropogenic impacts generally focusses on large-scale industrial activity. The level of protection afforded to walrus habitat in many areas depends entirely on the rigor with which the Environmental Impact Assessments are conducted. Basic information on walrus such as numbers and stock discreteness is often lacking and sufficient lead-time is required to collect baseline data. Moreover, although most environmental protection legislation considers ‘cumulative impacts’, practical application remains problematic. The effectiveness of environmental protection regulations depends on industry compliance and the management authorities’ ability to enforce compliance. Because walrus are found in remote locations, enforcement remains a challenge. Increased human activity allowed by the current change in distribution and quality of arctic sea ice poses new threats to walrus if not well regulated. International agreements have varying importance for management within and among member states. Regulations governing international trade serve to identify illegally obtained products and to encourage range states to have a sustainable quota system. International cooperation in information sharing has had clear benefits for management of walruses in the past. The maintenance and expansion of these international efforts will improve the management of Atlantic walruses in the future.

INTRODUCTION

The walrus (*Odobenus rosmarus*) has a circumpolar distribution in the Arctic. Two subspecies are commonly recognized, *O. r. rosmarus* from the North Atlantic and *O. r. divergens* from the North Pacific (Fay 1985). A third subspecies, *O. r. laptevi* from the Laptev Sea, was recognized by Chapskii (1940) but its taxonomic status was disputed. In a recent study based on genetic markers Lindqvist et al. (2009) indicated that the Laptev walrus is a subpopulation of the Pacific walrus and should not be regarded as a subspecies.

Walruses have a comparatively narrow ecological niche (Born et al. 1995). Their populations probably depend on: 1) the availability of large areas of shallow water (80 m or less) with suitable bottom substrate to support a productive bivalve community, 2) the presence of reliable open water over rich feeding areas, particularly in winter when access to many feeding areas is denied due to ice cover, and 3) the presence of haul-out areas in close proximity to feeding areas. Haul-out platforms are usually ice pans although terrestrial haul-out sites are used in the ice-free summer and autumn period. These animals' gregariousness and dependence on terrestrial haul-outs made it possible for European and American whalers and sealers to exploit them very intensively even before the development of mechanized transport and modern weapons. With modern hunting technology involving long-ranging boats and powerful firearms, hunters now have access to nearly the entire habitat that is still occupied by walruses. Adult females and males, with their comparatively high yields of ivory and meat, are hunted selectively. Furthermore, in all areas where walruses are hunted, struck-and-lost rates appear to be high. Their narrow ecological niche and restricted distribution make walruses relatively easy to hunt and vulnerable to environmental changes.

The walrus has a long history of exploitation. Walrus remains from archaeological sites have been used to speculate on the distribution of Atlantic walruses in Canada and Greenland through time (Dyke et al. 1999). In the later Paleo-eskimo period (2,500–1,000 BP) walrus remains are relatively common and occur in definite "diet-related" context. Remains tend to be more common from the periods ca. 2,500–2,300 BP and ca. 1,500–1,000 BP, than from the period in between. Apparently, Paleo-eskimos abandoned the High Arctic between 2,300–1,500 BP, perhaps due to a cooling climate, which also may have affected the distribution of walruses. Hunting by humans is considered to be the main cause of depletion of walruses during historic times (Born et al. 1995). The Norse hunted walruses in the Barents Sea and Greenland areas from sometime in the late 9th until the 15th century. Later and until the mid 20th century, European sealers and whalers tolled heavily on Atlantic walruses throughout their range until walrus were almost extirpated from several areas (e.g. Gjertz and Wiig 1995, Born et al. 1995 and references therein). Born (2005) found a positive correlation between the annual catches in West Greenland and annual mean temperature measured at Nuuk and suggested that climate warming and decreased ice cover made walruses in West Greenland more accessible to hunters who began using increasingly larger vessels and motorized boats during the 20th century.

The population size of Atlantic walruses is depleted relative to historical abundance due to over harvesting. For example, the number of walruses in Central West Greenland (a population shared with Canada) was reduced by about 80% between 1900 and 1960 (Born et al. 1995, Witting and Born 2014). The pre-harvest population size in the Barents Sea was probably more than 30,000 but is probably only around 5,000 animals today (Lydersen et al. 2008). There is a general lack of information on initial population sizes in Canada (COSEWIC 2006). However, European whalers and sealers also tolled heavily on walruses in certain parts of this jurisdiction during the 19th and early 20th Century (Ross and MacIver 1982, COSEWIC 2006) likely reducing some stocks severely.

The current total number of Atlantic walrus is still not known but is probably less than 20,000 (Born et al. 1995). Most are found in the eastern Canadian Arctic and Greenland. Furthermore, the range of Canadian walrus is greatly reduced from its early historic range which extended south at least to Sable Island, Nova Scotia (Mansfield 1958). Due to the severe reduction in number in most of its range caused by commercial hunting, regulations to protect Atlantic walrus were introduced in most jurisdictions during the 20th Century. Atlantic walrus are still hunted for subsistence purposes by Inuit living in Arctic Canada and Greenland, and are still important in the local hunting culture. They have been protected in Svalbard (Norway) since 1952 and in the western Russian Arctic since 1956 (Born et al. 1995 and references therein).

In the present paper we review the management of Atlantic walrus past and present. First we present management by jurisdictions. While walrus sometimes stray to southern parts of the North Atlantic (Born et al. 1995 and references therein, Born et al. 2014) and various national regulations in North America and Europe relate to such instances, describing this legislation is beyond the scope of the present review. Instead we emphasize management in the four range states—Canada, Greenland, Norway, and Russia—which have permanent populations of Atlantic walrus. We also discuss international bodies and agreements that are relevant to the management of walrus in the arctic Atlantic region. Based on the given information we discuss the future outlook for Atlantic walrus.

MANAGEMENT BY JURISDICTION

Canada

Stocks

The range of Atlantic walrus in the Canadian Arctic extended south to Sable Island and the Gulf of St. Lawrence in historic times (Mansfield 1958, Reeves 1978). Unrestricted commercial harvesting led to a serious decline in numbers and a contraction of walrus distribution to more northerly areas. The use of rifles by Inuit caused further reduction in the number of walrus (Mansfield 1958, Born et al. 1995 and references therein).

There are seven stocks of walrus within Canadian jurisdiction: the Baffin Bay stock, the Penny Strait-Lancaster Sound stock, the West Jones Sound stock, the North and the Central Foxe Basin stocks, the Hudson Bay-Davis Strait stock, and the South and East Hudson Bay stock (see Figure 1 of Andersen et al. 2014, Stewart REA 2008a, NAMMCO 2011). The Baffin Bay stock was considered a stock shared by Canada and Greenland (see also Stewart REA et al. 2014a for recent tagging results). Recent genetics studies (Shafer et al. 2014) suggest a link between the Penny Strait-Lancaster Sound stock and the Baffin Bay stock, albeit based on few samples from the latter, and it is conceivable that some part of the Penny Strait-Lancaster Sound stock also supports hunts in Greenland. Shafer et al. (2014) also concluded that the two Foxe Basin and Hudson Bay-Davis Strait stocks comprised a second population. Genetic and tagging studies (Andersen et al. 2014, Dietz et al. 2014) have also demonstrated a link between West Greenland and Southeast Baffin Island as well as influx from Hudson Strait to the West Greenland-Southeast Baffin Island area. While it is premature to identify a West Greenland-Southeast Baffin stock because the south and west boundaries in Canada are unknown, it is useful to recognize West Greenland-Southeast Baffin as a shared management unit (Andersen et al. 2014).

Management of harvest

Under the Fisheries Act (1867), Canada established regulations in 1928 banning commercial harvesting of walrus and limiting the killing of walrus to Inuit for their own food and clothing requirements (Mansfield 1973). In addition, exporting raw, unworked ivory was forbidden. In 1931, the regulations for the protection of walrus were revised and limited the number of

walrus taken annually to seven per Inuk with dependants and four per Inuk without dependants. Community quotas were enacted under the *Walrus Protection Regulations* of 1980 (SOR/80-338), as was the limit of four walrus per year per Inuk. In 1993, the Walrus Protect Regulations were replaced by the *Marine Mammal Regulations of the Fisheries Act*, which stipulate (subsection 6.(1)(c)) that an Inuk or land claims beneficiary may, without a license, hunt for food, social or ceremonial purposes up to four walrus in a year (Canada 2012). The Marine Mammal Regulations further stipulate requirements for hunting and (Section 26) established community quota levels for four communities in Nunavut. Non-beneficiaries may also kill walrus but they require a license under the Marine Mammal Regulations or Aboriginal Communal Fishing License Regulation to hunt walrus (COSEWIC 2006). Sport hunts are managed by limiting the number of licenses approved annually.

In Nunavut, the hunt is co-managed by the Nunavut Wildlife Management Board (NWMB), which is charged with making all decisions about wildlife management in Nunavut, Regional Wildlife Organizations (RWOs), and Hunter and Trapper Organizations (HTOs), in accordance with the Nunavut Land Claims Agreement (NLCA), the Fisheries Act and its regulations, as well as local hunting bylaws in some communities. Nunavut Tunngavik Incorporated (NTI) is the primary Designated Inuit Organization (DIO) under the NLCA and is responsible for ensuring that Inuit rights and obligations under the Agreement are implemented. Department of Fisheries and Oceans (DFO) collaborates with co-management partners, in Nunavik, the Nunavik Marine Region Wildlife Board, to develop approaches to walrus management that incorporate both traditional Inuit knowledge and scientific knowledge. While the wildlife boards are the main instrument of wildlife management and the main regulator of access to wildlife in the settlement areas, the Government of Canada retains the ultimate responsibility for wildlife management.

Theoretically, in many communities it is the number of Inuit rather than the number of walrus that limits the harvest (Stewart REA 2002). In practice, the number of walrus hunters in a community is much smaller than the total human population. However, the NWMB is considering new ways of managing the walrus hunt. Two aspects of these revisions are the development of management plans and DFO's application of the Precautionary Approach. Integrated Fisheries Management Plans (IFMPs), which identify the main management objectives and requirements, as well as the management measures to be used to achieve the objectives, develop common understanding of the basic "rules" for the sustainable management of walrus stocks. An IFMP is developed via stock-specific Working Groups comprised of all co-management partners (DFO, NTI, RWOs, HTOs, and Inuit elders), and establishes management goals, objectives, and measures for a particular stock. Co-management Working Groups established for walrus stocks in Foxe Basin and the Baffin Bay area (West Jones Sound, Penny Strait–Lancaster Sound, and Baffin Bay) have presented draft IFMPs to NWMB and DFO for approval (A. McPhee, DFO, pers. comm.).

DFO has applied the Precautionary Approach (see below) to domestic as well as straddling species, including walrus. For marine mammal species deemed data deficient, DFO uses the Potential Biological Removal (PBR) (Wade 1998, Wade and Angliss 1997) to estimate sustainable removal levels (Hammill and Stenson 2007, Stenson et al. 2012). NWMB has requested that DFO provide scientific advice on Total Allowable Removal (TAR) levels for all walrus stocks in Canada. While there were no data for the South and East Hudson Bay stock, advice has been provided for the other stocks (DFO 2013a) to be considered by both NWMB and the IFMP Working Groups.

Walrus harvest data in Nunavut are inconsistent and often based on estimates. The Marine Mammal Regulations and the Nunavut Land Claims Agreement require reporting but hunters are sometimes reluctant to provide information. For example, the non-response rate of hunters registered

for the Nunavut Wildlife Harvest Study varied from 0 to over 30% (Priest and Usher 2004). Recent efforts to increase compliance by both DFO and local authorities have not been entirely successful (DFO 2013b). Few data are available on struck and lost rates and the harvest data are therefore of limited scientific use (NAMMCO 2011). Improving this situation is a stated objective of the draft IFMPs. Harvest numbers for sport hunts are more reliable as provision of this information is a condition of the Marine Mammal Fishing License issued by DFO.

Live capture, biopsy collection, and tagging of walrus for scientific purposes are permitted only with a license and permit from an Animal Care Committee accredited by the Canadian Council on Animal Care (CCAC) and a DFO License to Fish for Scientific Purposes. The NWMB is currently developing a Live Capture Policy, in consultation with Nunavut hunters and their local and regional organizations (COSEWIC 2006).

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 (COSEWIC 2006) to assess the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk. The latest assessment of walrus in Canada was made in 2006 and the combined designation for all Atlantic walrus in Canada was Special Concern (COSEWIC 2006). It was further concluded (Page iii) that: *Better information is needed on population sizes and composition, seasonal movements, vital rates, and hunting mortality. The biggest threat is over-hunting, particularly on populations that inhabit the southern and northern ends of the species' current range. The species is near to qualifying for threatened status and requires an effective plan to manage hunting. No Management Plans are currently in place for the species. Although quotas have been set in few communities, it is not known if they are adequate to prevent overhunting.* COSEWIC initiated a re-assessment of walrus in Canada in 2012 (DFO 2013b).

Hunting regulations and regulations on international trade of walrus parts give limited protection of Atlantic walrus in Canada (COSEWIC 2006). A DFO Marine Mammal Transportation License is required to transport walrus or walrus parts from one province to another (Canada 2012). Walrus was listed by Canada in 1975 under Appendix III of the CITES in order to monitor international trade levels (Hall 2003) and an export permit from the Canadian CITES authorities is required to export walrus parts from Canada.

Habitat protection

Walrus habitat is protected under sections 34-37 of the *Fisheries Act* (Government of Canada 2014) which prohibits activities that result “in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery” (S35(1)) and the introduction of deleterious substances into waters frequented by fish, or in any place, under any conditions, that results in the deleterious substance possibly entering such water (S36(3)).

Walrus will be exposed to new industrial activities (DFO 2013b), including greatly increased shipping associated with reduced ice and increased exploration and extraction of minerals and hydrocarbons in the Canadian Arctic. For example, the Baffinland Iron Mine proposal, which the Nunavut Impact Review Board’s environmental impact assessment concluded could proceed (see NIRB 2012), will greatly increase shipping traffic, both in frequency of passages and seasonal extent (12 months) through Hudson Strait and Foxe Basin (Baffinland 2012).

Greenland

Stocks

Three stocks of Atlantic walrus occur in Greenland: the Baffin Bay stock, the West Greenland–Southeast Baffin Island “component” of the Hudson Bay–Davis Strait stock, and the East Greenland stock. As previously noted, Baffin Bay and West Greenland–Southeast Baffin

Island walrus are shared between Canada and Greenland and are exploited in both jurisdictions. Although a single exchange between walrus in East Greenland and neighbouring Svalbard has been documented (Born and Gjertz 1993) there is likely little exchange between walrus in these two areas and walrus from East Greenland and Svalbard-Franz Josef Land differ genetically (e.g. Born et al. 2001). Hence, the East Greenland stock only resides in East Greenland and is hunted there (NAMMCO 2006, 2011, Witting and Born 2014).

Management of harvest

The three stocks have been subject to exploitation for centuries. Previous to the 19th century, walrus were caught by the Greenlanders (e.g. Rink 1877, Gad 1970), the Norse from 985 until the latter half of 15th century (e.g. Gad 1970, Roesdahl 1995), and European whalers and sealers from 17th century until 1923 (e.g. Gad 1973, Ross and MacIver 1982, Born et al. 1994 and references therein). From the beginning of the 20th Century, Inuit in Greenland and Canada hunted walrus with increasing efforts after the introduction of firearms and motorized vessels (Born et al. 1995, Born 2005).

Until 2006 the catch of walrus in West Greenland was regulated by limiting the hunting season and hunting methods (Born et al. 1995) with no quota system. Since 2006, regulations have been introduced at different times in the various regions where walrus are hunted.

The walrus hunt in Northwest Greenland (i.e. in the area formerly denoted “the Thule area” or “Avanersuaq” or “Qaanaaq municipality” between ca. 76° N and ca. 78° 30' N) from the Baffin Bay stock has been regulated since the beginning of the 20th Century up until the 1990s mainly by local decrees (Born et al. 1995). In the season with sea ice, shooting a walrus before it was harpooned was not permitted unless it was in a lead. In the open water season, shooting a walrus in the head before it was harpooned was prohibited.

Born et al. (1994) reviewed the development of the Greenlandic hunting regulations for the West Greenland–Southeast Baffin Island unit. In Central West Greenland, changes in walrus hunting practices and in particular the high catches in 1937, led to a discussion in the Local Political Council (*Landsrådet*) where it was proposed to regulate the walrus hunt. However, hunting regulations were not introduced until 1949 when walrus in the “West Ice” (i.e. the eastern edge of the Davis Strait pack ice that lies over the walrus feeding bank in Central West Greenland) were protected between 20 May and 31 December. New hunting regulations came into force for Central West Greenland in 1956. Originally it was not permitted to hunt walrus at the haul-outs of Kitsissut and Aarfiit in Kangaatsiaq municipality between 15 October and 31 January. This stipulation was, however, cancelled in 1959. The regulations were also amended in 1978 and 1994. According to the 1978 amendments, there were no restrictions on boats smaller than 40 tons but boats larger than 40 tons were limited to five walrus per year. By the 1994 amendments only boats smaller than 40 tons were allowed to catch walrus at all. According to the 1994 regulations the hunting of walrus in Greenland was only permitted for residents of Greenland who had a license as full time hunters. However, due to the importance of maritime hunting in Northwest and Central East Greenland, residents in these areas with a part-time hunting license were also allowed to hunt walrus. These regulations prohibited taking any walrus from 1 June to 31 December between 66°N and 75°N and females with young were protected from 1 April to 31 December in the same areas. Furthermore, all walrus were fully protected in western Greenland south of 66°N. Only vessels less than 40 tons and dog sleds could be used for hunting walrus. There were also restrictions concerning the types of weapons and bullet types that could be used and it was stated explicitly that wounded (“struck”) walrus must be harpooned before they were killed. Municipal councils could, if they desired, place further restrictions on walrus hunting. In 1994 it became mandatory that hunters report the catch by sex, age class, and date. Immobilization and scientific handling of walrus, export of walrus or parts

of walruses and keeping walruses in captivity needed special permission from the Greenland Government. Violation of the regulations might lead to a fine and the confiscation of the products from illegally killed walruses.

According to a special regulation from 1990, the hunting of walruses was allowed in the municipality of Kangaatsiaq (ca. 68° N) in Central West Greenland between 1 February and 14 October. This regulation was not included in the 1994 amendment (Born et al. 1994, 1995).

The walrus regulations were amended again in 1998 (Anonymous 1998), in part to better address management in Northwest Greenland (the Baffin Bay stock) and in East Greenland (the East Greenland stock). The amendments included: (1) Permanent residents of the Qaanaaq (Northwest Greenland) and Ittoqqortoormiit/Scoresby Sound (East Greenland) areas who had a license as part-time hunters were also allowed to hunt walruses (i.e. in addition to those licensed as full-time hunters); (2) hunting of walrus north of 70° 30' N in West Greenland and south of the border of the National Park in East Greenland (ca. 72° N) was permitted all year round, except in Zone I of the Melville Bay Nature Reserve where all wildlife was completely protected; (3) walruses were fully protected between 66° N and 70° 30' N in West Greenland between 1 May and 28 February; (4) only dog sleds and boats less than 32 GRT were allowed for transportation during walrus hunting (i.e. a restriction in size of boats allowed during walrus hunting); (5) it was made illegal to use explosives, harpoon cannon, shot guns and saloon rifles (i.e. calibre .22) for hunting walruses; and (6) the management authorities of the Government of Greenland were empowered, if deemed necessary, to make it mandatory for hunters to collect samples for scientific studies.

To protect wildlife, and in particular polar bears (*Ursus maritimus*), the Melville Bay Nature Reserve was created in June 1980. The reserve consists of an outer Zone I where hunting is permitted and an inner Zone II, in which all hunting is prohibited (Anonymous 1980) including the hunting of walrus. However, in the present context it is worth noting that walruses are not common in the Melville Bay Nature Reserve (Born et al. 1995).

The regulations for the catch of walruses in East Greenland were summarized in Born et al. (1997). In 1938 and 1939 some restrictions for the hunting of walruses for Danish hunters and trappers, but not Norwegians, operating in North East Greenland north of ca. 73° 30' N were introduced by the Danish hunting company "Nanok". The shooting of walruses at or near their haul-out sites and killing of females with calves was to be avoided.

Taking effect from 1 June 1951, a decree from the Danish Ministry of State Affairs gave complete protection to walruses north of 74° 24' N in North East Greenland. By the same decree, the island Sandøen in Young Sound, a well-known terrestrial walrus haul-out (Born et al. 1997), became a game reserve to which access was prohibited.

By 1 July 1974, the national park of North and Northeast Greenland was established. Although hunting in this park is generally prohibited, residents of the Ittoqqortoormiit/Scoresby Sound area with a hunting license are allowed to conduct traditional hunting inside the national park and it is not explicitly stated that walruses cannot be taken during such hunting activity. Hence, during the second half of the 20th Century the catch of walruses in West Greenland was basically regulated by limiting the hunting season and hunting methods (Born et al. 1995) with no quota system; therefore there was no upper limit to the numbers killed. However, in 2000 the Greenland Government decided that quotas should be introduced for the catch of walrus (as well as polar bear, beluga *Delphinapterus leucas* and narwhal *Monodon monoceros*; Anonymous 2006a) and quotas for the take of walruses were introduced in 2006 taking effect on 1 August that year (Anonymous 2006a,b).

To a certain extent the delay in introduction of walrus quotas was caused by the great uncertainty about the actual size of the three subpopulations of walrus. The initial quotas for the three stocks that are exploited in Greenland were based on considerations on international agreements, biological advice, user knowledge, hearings with the “*Fangstrådet*” (i.e. an advisory body consisting of various Greenlandic stakeholders including KNAPK the organization of Greenlandic Fishermen and Hunters) and reports on annual takes (Anonymous 2006a).

The executive order on walrus hunting (Anonymous 2006d) is still valid at the time of this publication. According to this order, adult females are protected except in the Qaanaaq area (Northwest Greenland) where walrus hunting traditionally has been, and still is, of great importance to the hunting community. In anticipation of an increased number of walruses hauling out on land due to the reduction of sea ice, walruses that are hauled out on land are completely protected (Anonymous 2006c). The first version of the 2006-regulations made it mandatory that all walruses must be harpooned before being shot to prevent losses (Anonymous 2006b). However, after hearings with KNAPK this restriction was modified (L. Fontain, now former head of KNAPK, pers. comm. 2007) and instead the regulations specify walruses must be harpooned before receiving the finishing shot. Furthermore, it is specified that floats must be attached to the harpoon to prevent dead walruses from sinking (Anonymous 2006c).

During an open hearing process, the “*Fangstrådet*”, KANUKOKA (i.e. the organization of municipalities), GINR, and other stakeholders are asked for their opinion about the size of the quotas (e.g. Lyberth 2012). Thereafter, Greenland’s Department of Fishery, Hunting, and Agriculture (DFHA) propose the quotas and their regional apportioning whereafter Naalakkersuisut (the cabinet) takes the final decision (e.g. Anonymous 2012). The municipality councils are responsible for the regional administration of the quota system. The minister has the right to reduce the regional quota for the current or subsequent year in case of illegal catches or overharvest (Anonymous 2006c). For example the quota for the catch of walruses in Northwest and West Greenland was reduced in 2011 due to overharvest in the previous year (Anonymous 2010). Quotas are usually given in blocks of 2 or 3 years. Regional game officers and the police authorities are responsible for reporting any violation of the walrus regulations to the DFHA.

Prior to the introduction of quotas for all three stocks/units that are exploited in Greenland (i.e. Baffin Bay, West Greenland-Southeast Baffin Island and East Greenland) the average annual reported landed catch according to the “*Piniarneq*” reporting system during 1993–2006 was 126, 170 and 18 (GINR 2011), respectively. Annual quotas issued for the Greenland catch of walruses for the years 2010–2012 were 64 (Baffin Bay), 61 (West Greenland-Southeast Baffin Island), and 18 (East Greenland) or a total of 143 walruses per year (GINR 2011). This represents a reduction in the exploitation of walruses in Greenland of ca. 55% since 2006 (Ibid.). Prior to 2009 the quotas addressed reported landed catches and did not compensate for struck-and-lost. In order to incorporate an assumed, but unknown, proportion of walruses that are mortally wounded or killed but not retrieved during the hunt, the quotas for 2009 and later years were reduced by 30% to include an estimate of unreported struck-and-lost for the West Greenland-Southeast Baffin Island and the East Greenland areas. Quotas for the catch in Northwest Greenland from the Baffin Bay stock were not reduced because DFHA assumed that the hunters there are more specialized in hunting walrus and have a low struck-and-loss rate (Anonymous 2010).

The management authorities receive advice on sustainable use of walruses from the Greenland Institute of Natural Resources (GINR). Since 2009 Greenland has aimed at regulating the removal of walruses based on the advice given by the North Atlantic Marine Mammal Commission (NAMMCO 2011) and the Greenland Institute of Natural Resources (GINR 2011) taking also into consideration catches in Nunavut from the shared stocks, and estimates of loss.

To determine the extent to which harvesting walrus in Greenland aimed at international trade is potentially negatively impacting natural populations, the GINR (which is also Greenland's CITES Scientific Authority) assessed the status of the three stocks in Greenland. This assessment was based on recent data on size of the various stocks and on information on catch and trade. It was concluded that the current exploitation of walruses in Greenland and the current export of walrus products from Greenland are not detrimental to the three subpopulations that range in Greenland (GINR 2011). The current exploitation from the two stocks shared with Canada is sustainable because in none of the cases did total removals exceed the estimated annual replacement yield (GINR 2011).

The three stocks of walrus ranging in Greenland are listed in the Greenland Red List (Boertmann 2007). It must however be noted that the Red List assessment (Boertmann 2007) was carried out before reliable estimates of stock sizes became available and before the 2006 management scheme for walruses had any effect on the stocks.

In particular, the Baffin Bay stock (part of what formerly was denoted "The North Water stock") was listed as *Critically Endangered*. In the Red List assessment this stock was estimated to have decreased by more than 85% during the last 45 years due to heavy hunting. The Greenlandic quota for 2012 for the Baffin Bay walrus stock was 64 (GINR 2011). If this quota is all landed, and additionally 4 walruses are landed in Nunavut plus an assumed 15% loss rate, the projected removals for 2012 would be 78 walruses. Such level of removals would result in a probability of population increase lower than the one recommended by NAMMCO in 2009 (NAMMCO 2011). A total removal of 78 walruses per year will, however, still be lower than the estimated annual average replacement yield of 84 for this stock (GINR 2011). Modelling of population dynamics indicates that the Baffin Bay stock has decreased by 40% between 1960 and 2005 but is now increasing due to a recent decrease in harvest level (Witting and Born 2014).

In the Red List assessment the West Greenland–Southeast Baffin Island unit was assumed to have decreased by more than 75% in three generations (45 years). However, due to the possibility of immigrations from Hudson Strait, which might mitigate the effect of local apparent over-exploitation, the population was listed as *Endangered*. Studies of movement (Dietz et al. 2014) and genetics (Andersen et al. 2014) conducted since the Red List assessment have demonstrated that walruses that occur and are exploited in West Greenland are a part of a West Greenland–Southeast Baffin Island unit. It may presently number ca. 3,000 walruses (Heide-Jørgensen et al. 2014; Stewart REA et al. 2014b) and is judged not to be subject to over-exploitation during the current Canadian and Greenlandic management scheme (GINR 2011) and is increasing (Witting and Born 2014). The assessment made in 2011 by the Greenland CITES authority concluded that the combined West Greenland–Nunavut/Canada removal of ca. 89 walruses per year from the West Greenland–Southeast Baffin Island unit is well below (68%) the estimate of the annual replacement yield of 130 animals. Furthermore, it is in accordance with the NAMMCO recommended protection level indicating that a total of 89 walruses can be removed (landed catch and struck-and-lost) annually from the West Greenland–Southeast Baffin Island area while there is a 70% probability that the stock will increase (GINR 2011).

The Northeast Greenland population was listed as *Near Threatened*. Although the population size at the time of the Red List assessment was assumed to be lower than 1,000 and therefore according to the Red List criteria should warrant for listing as *Vulnerable*, it was assumed to be increasing and the hunting was assumed to be sustainable.

A survey in 2009 to determine the size of the East Greenland stock indicated that it numbers at least 1,500 individuals (NAMMCO 2011). According to the stock assessment made by NAMMCO in 2009 (NAMMCO 2011) total annual removals between 12 and 26 walruses would have an

estimated probability between 50 and 95% of being sustainable given a female fraction in the removals of 10%. NAMMCO recommended that quotas for future total removals be set for an acceptable protection level larger than or equal to 70% probability of being sustainable which corresponds to a total annual removal of 20 walrus in East Greenland. In addition, the GINR (2011) noted that the estimate of 1,500 for the total East Greenland stock is considered to be an underestimate, and that the reported annual catches for the later years have been much lower than 18.

Habitat protection

According to the Greenland Government Executive Order on Nature Protection (No. 29) of 18 December 2003 (Anonymous 2003), § 1 “*the purpose of this executive order is to assist in the protection of the nature in Greenland. The protection must be based on ecological sustainability in accordance with the **precautionary principle** (authors’ emphasis) and in respect of the living conditions of human beings and the protection of fauna and flora*”. The Order’s Section 2 states that the intention is to: (1) protect the biological diversity including genes, species, habitats, and ecosystems; (2) ensure that the exploitation of the living resources is ecologically sustainable; and (3) ensure that international agreements about nature conservation to the extent possible are being implemented by Greenlandic law (E.W. Born translation, 7 February 2010).

The probability for future large-scale hydrocarbon exploration in Greenland is high. Such activities might affect walrus. The Greenland Mineral Resources Act and other rules, regulations, and guidelines (Anonymous 2009a), stipulate a range of measures aimed at environmental protection, climate protection, and nature protection (Government of Greenland 2014). Applications submitted to the Bureau of Minerals and Petroleum to conduct offshore hydrocarbon exploration activities must be accompanied by an environmental impact assessment. Prior to opening new areas for hydrocarbon exploration and exploitation licensing rounds, a Strategic Environmental Impact Assessments for the region is prepared. Such assessments have been developed for Northeast Greenland (Boertmann et al. 2009a), Northwest Greenland (Boertmann et al. 2009b), Central West Greenland (Mosbech et al. 2007, Merkel et al. 2012), and Southwest Greenland (Frederiksen et al. 2012). It is concluded that all three populations of walrus in Greenland in various ways might be negatively affected by future hydrocarbon exploration.

As indicated in the previous section the Melville Bay Nature Reserve and the national park of North and Northeast Greenland offers some habitat protection that will also benefit walrus. However, the above-mentioned Nature Reserve and National Park have coastal boundaries and do not extend to offshore waters. However, protection zones for walrus in relation to seismic activity have been designated in Northwest and Northeast Greenland (Kyhne et al. 2011)

Norway

Stocks

Information on distribution (Born 1984, Gjertz and Wiig 1994) and studies of movement (Wiig et al. 1996) and genetics (Andersen et al. 1998, Born et al. 2001) have shown that there is a common stock of walrus that range over the Svalbard and the Franz Josef Land archipelagos in which most of the males summer in Svalbard and most females and calves remain in north-eastern parts of Svalbard and the Franz Josef Land area. Walrus from this stock are thought to have negligible contact with the East Greenland stock (see previous section). However, the relation between the Svalbard-Franz Josef Land stock and walrus found around Novaya Zemlya, and in the Laptev, south-eastern Barents, Pechora and White Seas is uncertain (Born et al. 1995, NAMMCO 2006, Boltunov et al. 2010).

Management of harvest

In 1604 the first recorded hunt of Atlantic walrus occurred in Svalbard (Gjertz and Wiig 1995), marking the beginning of the onslaught on the walrus population in this archipelago. By the mid-

dle of the 19th Century the stock showed clear signs of decrease. The centuries of walrus hunting brought the reportedly large herds to the verge of extinction (Norderhaug 1969), until they finally were given total protection in 1952 (Anonymous 1952). It is difficult to assess the size of the original populations prior to hunting, but the Svalbard population must have been very large (Reeves 1978, Gjertz et al. 1998). Lydersen et al. (2008) estimated the number of walrus- es in 2006 as about 2,600. They further assumed that the total population including Franz Josef Land was about 5,000.

In the late 1940s and early 1950s, concerns the large catches by Norwegians in Northwest Greenland were discussed by Denmark and Norway. It was concluded that walrus- es were so depleted that they could not sustain the Norwegian harvest and, in 1952, a Royal Decree, in accordance to the Norwegian Sealing Law of 1951, gave a complete protection to walrus- es (Anonymous 1952, Rasmussen 1952, Øritsland 1973). This law applied to “sealing inside the Norwegian fishery limit, and to sealing carried out by Norwegian citizens, inhabitants of the country or by Norwegian companies and other organizations outside the Norwegian fisheries limit”.

The Norwegian-Russian Sealing Agreement of 1958, which applies to northeast Atlantic waters east of Kap Farvel, Greenland, also includes a provision that the catching of walrus is forbidden throughout the year. The Agreement thus confirmed both the Soviet total prohibition of walrus hunting in the western Soviet Arctic since 1956 and the ship-based hunting since 1934, and the Norwegian total prohibition since 1952 (Øritsland 1973).

Habitat protection

Today there is considerable focus on management of the Barents Sea ecosystem. An integrated management plan for the Barents Sea was finalized in 2006 (Anonymous 2006d, Olsen et al. 2007) with the stated purpose: “...to provide a framework for the sustainable use of natural resources and goods derived from the Barents Sea–Lofoten area and at the same time maintain the structure, functioning and productivity of the ecosystems of the area.”

Svalbard and the northern part of the Barents Sea (north of Bear Island) have not yet seen much industrial activity and petroleum related activities are still not allowed. The main activity with relevance to walrus- es is tourism, e.g. cruise ship traffic. The Norwegian Government released a White Paper outlining status and intentions for management of environment and human activities in Svalbard in April 2009 (Anonymous 2009b). The only issue discussed in this document with direct relevance to walrus- es is the potential impact of cruise traffic on resources and wildlife in the two large nature reserves in the eastern part of Svalbard. Since parts of the objectives of these nature reserves are to serve as reference areas for research, new initiatives are taken to strengthen the regulation of traffic in the protected areas.

The environmental authorities have also signalled that more restrictive measures will be implemented in the dispensation practices for activities in protected areas. In 2008 the regulations for the two large nature reserves in the eastern parts of Svalbard, Northeast Svalbard and Southeast Svalbard nature reserves, were adjusted to prohibit access by tourist ships with more than 200 passengers. However, the most important new adjustment was the prohibition of all heavy ship fuels: no ship can use or bring fuels other than light diesel fuel, class DMA (ISO 8217 Fuel Standard) into the areas. This will reduce the risk for oil fouling from accidental spills of heavy bunker fuel oils in these areas.

The haul-out sites of walrus- es at Svalbard are well documented (Gjertz and Wiig 1994, Lydersen et al. 2008) and most are within protected areas. Although field data are missing that document effects on oil fouling on walrus- es, they are likely sensitive to oiling in addition to direct disturbance at haul-out sites (Hansson et al. 1988, Born et al. 1995, Isaksen et al. 1998).

The walrus in Svalbard are listed as *Vulnerable* in the Norwegian Red List (Swenson et al. 2010). The listing is based on an assumed very low number of reproducing individuals (< 250) within their Norwegian distribution area.

Russia (and the former USSR)

Stocks

As noted above, the walrus at Svalbard and at Franz Josef Land in the western Russian Arctic comprise one common population. Lydersen et al. (2008) concluded that the total population including Svalbard and Franz Josef Land was about 5000 animals. The relation between these walrus and those found around Novaya Zemlya in the Laptev, in the south-eastern Barents, Pechora and White Seas remains uncertain (Born et al. 1995, NAMMCO 2006, Boltunov et al. 2010). The present number in the Pechora Sea is estimated to be about 4000 (Lydersen et al. 2012).

Management of harvest

Walrus hunting in Franz Josef Land first became a significant mortality factor around 1900 (Gjertz et al. 1992). From then until the late 1920s Norwegian sealers harvested a considerable number of walrus in Franz Josef Land (Lønø 1972): the total registered catch in the period 1880 to 1950 was estimated to about 5,900 by Gjertz et al. (1992). Gjertz et al. (1998) estimated the original population size of walrus in Franz Josef Land in 1897 to be 6,000–12,000 walrus.

In the USSR, harvesting of Atlantic walrus was first limited in 1921 (Bychkov 1973). In 1935 the state harvest from sealing vessels ceased and in 1949 the killing of walrus by any fishing or sealing industry was prohibited. The hunting of walrus was prohibited for any Soviet citizens in 1956, except for a subsistence harvest by some native people and expeditions (Bychkov 1985). The Novaya Zemlya population of walrus was included in the list of Rare Animals of the USSR in 1971. In 1975 regulations for protecting and harvesting of marine mammals prohibited sport hunting of walrus as well as any landing on or the littering of shore haul-outs at any time. It also prohibited possession, manufacture, buying, selling, storage, and transportation of hides and tusks from walrus.

Habitat protection

The Atlantic walrus is now classified as Category 2 in the Red Data Book of the Russian Federation (Boltunov et al. 2010). According to the Federal Law No 52 “On the Wildlife” from 1995, no activities that may result in mortality, decline in numbers or disturbance of the habitat of the species listed in the Red Data Book are to be permitted. The threats to these walrus today are mainly related to the economic development in the region, and in particular to the development of oil and gas fields in the south-eastern Barents Sea (Boltunov et al. 2010).

INTERNATIONAL AGREEMENTS

Several international agreements relevant for the management of Atlantic walrus are presented here alphabetically.

Bern Convention

The walrus is listed on Appendix II (“Strictly protected fauna species”) of the Bern Convention. According to Article 6 of the convention: *Each Contracting Party shall take appropriate and necessary legislative and administrative measures to ensure the special protection of the wild fauna species specified in Appendix II.*

The Bern Convention relates to the European Council and other countries that have signed the convention. The only signing nation where walrus are normally distributed within its jurisdic-

tion is Norway, with walrus occurring in Svalbard and Jan Mayen waters, areas that are not included under the convention. In addition, walrus is not listed by Norway as a species under the convention (Miljødirektoratet 2013a). While Norway has committed to having a policy on nature protection consistent with The Bern Convention for these areas (Miljødirektoratet 2013b), the relation of the Bern Convention to the management of Atlantic walrus is unclear.

CITES (Washington Convention)

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), also known as the Washington Convention, is an international agreement among governments which aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival (CITES 2014a). Under CITES all import, export, re-export, and introduction from the sea of species covered by the Convention must be authorized through a licensing system. Each Party to the Convention must designate one or more Management Authorities in charge of administering that licensing system and one or more Scientific Authorities to advise Managing Authorities on the effects of trade on the status of the species. The species covered by CITES are listed in three Appendices (CITES 2014b), according to the degree of protection they need. Appendix III contains species that are protected in at least one country, which has asked other CITES Parties for assistance in controlling the trade. The walrus is listed on Appendix III based on the request from Canada in 1975. CITES reviewed the Appendix III status in 1987 and concluded that international trade levels did not warrant an increased level of protection of walrus (Hall 2003).

The European Union Wildlife Trade Regulation

The European Union Wildlife Trade Regulation No. 338/97 allowing trade to be regulated by quotas or other restrictions came into effect on 1 June 1997 (EC 2014). The regulation includes the CITES regulations but also includes provisions that are more restrictive than those by CITES. For example, import permits are not only required for species listed in Annex A (which broadly corresponds to Appendix I of CITES) but also for species listed in Annex B (which broadly corresponds to Appendix II of CITES).

A Scientific Review Group can form opinions on whether or not imports of certain species from a particular country of origin comply with the following conditions:

- 1) Trade does not have a harmful effect on the conservation status of the species or on the extent of the territory occupied by the relevant population of the Annex A or B species;
- 2) The Management Authority is satisfied, following consultation with the competent Scientific Authority, that there are no other factors relating to the conservation of the Annex A or B species which militate against issuance of the import permit.

If the Scientific Review Group determines that these conditions are met, a positive opinion is formed and import into the EU can take place. If the Scientific Review Group forms a negative opinion, imports of the species from the country under consideration are temporarily suspended and EU Management Authorities will reject all EU import permit applications for the relevant species-country combination.

The walrus is listed on Annex B which contains CITES Appendix II species, (except where an EU Member State has entered a reservation), some CITES Appendix III species and some non-CITES species. In 2006 the Scientific Review Group formed a negative opinion on the commercial import of walrus products from Greenland (EC 2006). Since September 2008 the European Union has suspended the import to EU of walrus products from Greenland (EC 2008). A ban on marketing seal products, including walrus, within EU countries was adopted by the EU Council on 27 July 2009, and came into effect on 20 August 2010 (EU 2009). However, Article 3 pro-

vides conditions under which walrus products could be placed on the market, including products from Inuit subsistence hunts. Importing personal items, including tourist items, was not banned.

The International Union for Conservation of Nature (IUCN)

The International Union for Conservation of Nature brings governments, non-government organizations, United Nations agencies, companies, and local communities together to develop and implement policy, laws, and best practices on pressing environment and development challenges (<http://www.iucn.org/about/>). IUCN is the world's oldest and largest global environmental network.

One important goal of IUCN is to produce The IUCN Red List of Threatened Species based on a scientific approach for evaluating risk of extinction. The walrus as a species was assessed in 2008 and was listed as Data Deficient (Lowry et al. 2008). The justification was: *“Although the global population is undoubtedly still quite large, there is evidence of declining populations in two of the subspecies. Climate change is expected to have negative consequences for Walruses, and particularly severe consequences for the Pacific subspecies. Additionally, little recent information is available regarding current population sizes and trends throughout much of the Walrus’s range. At this time, this species must be classified as Data Deficient.”*

IUCN opinions and decisions have no enforcement on the management within member states.

NAMMCO

The North Atlantic Marine Mammal Commission (NAMMCO) is an international body formed by agreement among Faroe Islands, Greenland, Iceland, and Norway in 1992. It is to foster cooperation on the conservation, management, and study of marine mammals in the North Atlantic (<http://www.nammco.no/>) and focus on modern approaches to the study of the marine ecosystem as a whole, to understand better the role of marine mammals in this system.

NAMMCO provides a mechanism for cooperation on conservation and management for all species of cetaceans and pinnipeds in the region, many of which have not before been covered by such an international agreement. The Council is the decision-making body of the Commission and meets annually to review advice requested from specific committees. The Scientific Committee provides scientific advice in response to requests from the Council. The Scientific Committee has established a Working Group on Walrus for giving such advice. The Working Group invites specialists to participate in the meetings depending on the questions being addressed. These specialists are invited independently of their nationality. As a consequence scientists from USA, Canada, Russia, and other countries have participated in meetings in addition to scientists from the member countries.

For many species, there are shared stocks between NAMMCO member country Greenland and non-member country Canada. To facilitate the information flow of new scientific knowledge, and recommendations and decisions made at the different levels of the NAMMCO system, representatives from Canada are invited to participate in meetings at all levels in the organization. Canadian scientists participate in the work of the Scientific Committee Working Group on walrus (e.g. NAMMCO 2011).

The NAMMCO Scientific Committee Working Group on walruses chaired by Greenland met in 2005 and 2009 to determine the status of various stocks of Atlantic walruses. During both meetings information of Pacific walrus was also considered. Based on recommendations from its latest meeting (November 2009) the NAMMCO Management Committee for Seals and Walruses endorsed the following recommendations from the Scientific Committee (NAMMCO 2010) related to Atlantic walrus:

1. Mechanisms for validating reporting of catch and loss both from Greenland and from Canada be designed and enforced.
2. For the West Greenland-Southeast Baffin Island, East Greenland and Baffin Bay stocks, the catches and losses (including the Canadian ones) and the future development of the population to be monitored in light of total removals, as well as in light of climate change and planned industrial development.
3. The removals for all areas should be set under consideration of a probability of stock increase that is higher than or equal to 70%.
4. Managers consider establishing a more robust system for monitoring the sex and age composition of catch.
5. A common management regime is established between Greenland and Canada on shared stocks of walrus.

The members of the committee also all agreed that Canada should be encouraged to join NAMMCO in order to improve management of shared stocks.

United Nations

Although not walrus-specific, the United Nations *Agreement on Straddling and Highly Migratory Fish Stocks*, which came into force in 2001, requires signatory nations to apply the Precautionary Approach (PA) to straddling and highly migratory fish stocks. In 2009, Canada outlined how the precautionary approach would be applied to both straddling and domestic stocks (DFO 2009). Subsequently a conceptual framework was developed for seals off Canada's east coast (Hammill and Stenson 2007). It recognized data-rich and data-poor species based on the number of recent abundance estimates and current information on fecundity and/or mortality. It noted that the PBR approach is appropriate for data-poor species in that it can use generic estimates of reproductive rates and a single abundance estimate; however it does not necessarily use all the information available and may constrain harvest to very low levels (Hammill and Stenson 2007). The application of this framework for walrus is ongoing in Canada. The agreement has also been signed by Denmark and Norway (see UN 2013) but has no implication for the management of walrus within their jurisdictions.

DISCUSSION

Although colloquially termed 'walrus management', management practices are in fact aimed at controlling human activities. For walrus, these fall into two main categories: hunting and industrial development, of which developing tourism and climate change are sub-categories. Approaches to managing these activities have varied through time and among jurisdictions. The number of Atlantic walrus was clearly depleted in many parts of their range due to overharvesting, and the first management steps were therefore to address direct removals. By the mid-20th Century, all walrus range states had some regulations in place to reduce the numbers of walrus killed and the number struck-and-lost. Norway banned all hunting of walrus by Norwegian citizens in 1952 and Russia (USSR) banned all hunting of walrus in 1956 with some exceptions. Hunting was banned in North East Greenland in 1956. Throughout Greenland, stock-specific quotas were introduced in 2006. Catches in Canada are, in most places, personal and community quotas.

The lack of quantitative information on stock size and removals prevent firm conclusions being reached about the present status of the stocks especially in some parts of Canada and the western Russian Arctic. In Canada, large harvests in the 1800s apparently contributed to a population decline, indicated by a reduction in the area occupied by walrus (COSEWIC 2006, Stewart DB et al. 2014). Stewart REA et al. (2014c) found no statistical trend in numbers of the West Jones Sound and the Penny Strait-Lancaster Sound stocks between 1977 and 2009. Although current management allows, in general, four walrus/Inuk/year, annual removals are well below this level.

Since the mid-2000s Greenland has intensified its research on walrus and conducted comprehensive studies to determine the size of the three stocks ranging in Greenland. In the case of the Baffin Bay stock and West Greenland-Southeast Baffin Island walrus the Greenland/Denmark economical and logistic involvement also involved their Canadian range. This resulted in up-to-date information on numbers of walrus in Greenland and some parts of neighbouring Canada (Dietz et al. 2014, Andersen et al. 2014, Stewart REA et al. 2014a,b,c). Similar efforts in Canada are found elsewhere in this volume. In North East Greenland, regulations and the establishment of the national park where the majority of the East Greenland stock lives have led to a slow increase in the population (Born et al. 1997; Witting and Born 2014).

Bans on walrus hunting have been in effect in Svalbard and Russia for over 50 years. The number of walrus present at Svalbard before and after the historical peak in hunting is unknown, but the population was considered to be initially large (Reeves 1978). As this was estimated to be about 2,600 animals in 2006 (Lydersen et al. 2008), it is clear that while full protection has prevented extirpation, it has not yet allowed recovery to 'large' numbers. The relationships among walrus at Svalbard, and Franz Josef Land and the Barents, Pechora, and White seas in Russia are unclear (Born et al. 1995, Boltunov et al. 2010). Again, complete protection has prevented extirpation but there is little indication numbers have recovered to historical levels. Clearly direct removals have in the past had a large impact on walrus populations (Reeves 1978, Born et al. 1995, Gjertz et al. 1998, COSEWIC 2006, Stewart DB et al. 2014). Also clear is the slow rebuilding of completely protected walrus populations and the consequent need to ensure that current walrus populations are not further reduced.

Currently walrus hunting in Canada and Greenland continues. In Canada, generally the number of walrus landed is governed by the number of hunters and not stock-specific quotas (Stewart REA 2002). Although quotas have been set in few communities, it is not known if they are adequate to prevent overhunting. Such a system of management is clearly contrary to sound population management practices, as it does not consider the ability of the population to sustain the potential kill. This has been recognized and NWMB has requested information on stock-specific allowable harvest levels (DFO 2013a). Stock-specific walrus management plans are also being developed. Recent estimates of PBR suggest Canadian harvests are sustainable in the high Arctic population. The range of PBR estimates for Foxe Basin are based on preliminary population estimates and are somewhat lower than recent reported harvest levels (Stewart REA and Hamilton 2013). Better data are required for both parameters.

The quota system for walrus hunting in Greenland began in 2006 and hunters are instructed to report details on their hunting. The current control system to a large extent ensures that the quotas are applied and that the reporting is correct. As a consequence, there are cases when an annual quota was reduced following a year when the quotas were exceeded. Quotas are based on recommendations from scientific assessments using available population estimates and catch statistics. The importance of good population estimates was illustrated by Witting and Born (2014). The historic catch statistics for the Greenland stocks are uncertain and present assessments were based on several assumptions related to these statistics. Introduction of quotas in Greenland resulted in a substantial reduction in the overall take and after information of stock sizes became available in 2009 the quotas have aimed at sustainability and increase in the stock size (NAMMCO 2011, GINR 2011). Furthermore, Greenland introduced almost complete protection of females and their calves and for walrus on land, both important protective measures. Introduction of quotas also meant a great improvement in collection of catch statistics. Hence, Greenland now has a management scheme for walrus which is in accordance with sound management practice and which aims at sustainability.

There is currently no formal agreement between Canada and Greenland on the management of

shared stocks. The Canadian-Greenland Joint Commission on Beluga and Narwhal (JCNB) has discussed adding walrus to its mandate but has not yet done so, although scientists meet under the umbrella of NAMMCO (see below) to discuss the management of Atlantic walruses. Greenland and Canada continue to use different approaches to determining allowable harvest levels. In Canada, sustainable TAR estimates are based on PBR due to a lack of a series of population abundance estimates and local fecundity and mortality schedules. In Greenland, also without a series of population abundance estimates and local fecundity and mortality schedules, risk-based assessment methods incorporate recent estimates of population size (i.e. counts adjusted for walruses that were not at the surface on land during the surveys), estimates of vital parameters, recent catches, and historical trends in population size (NAMMCO 2011, Witting and Born 2014). Partly as a result of the different approaches and partly due to the use of different periods of harvest data, the estimates of sustainable harvest levels differ for the shared stocks in Baffin Bay and West Greenland-Baffin Island (Stewart REA and Hamilton 2013). As also stated in Andersen et al. (2014), the fact that Canada and Greenland harvest from shared walrus populations under different management schemes, calls for coordination of management by the two jurisdictions.

There is on-going cooperation between scientists in Canada and Greenland on assessments of shared populations of walruses. The need for updated population estimates and reliable catch statistics for proper assessments of populations have been underlined by NAMMCO (2011). The minimum population sizes of several populations harvested in Canada have been estimated recently (Stewart REA et al. 2013a,b,c) whereas hunting statistics remain problematic. The lack of data was partly due to lack of tagging system for walruses caught and also because the hunters are concerned about the imposition of harvesting limits in the future (NAMMCO 2010). The management plans being developed by co-management partners help to address these issues. Similar co-management plans with Greenland, for example through NAMMCO on a formal basis, are needed for shared stocks.

The greatest challenge with respect to managing walrus hunting remains the variable and sometimes high rates of struck and lost animals. Reducing losses means hunters can benefit from a greater proportion of the total allowable removals. Such loss rates vary with hunting conditions but might be high (Born et al. 1995) as most walruses that are struck and lost likely die (Fay et al. 1994). Greenland decided to reduce the walrus quota for West Greenland to account for assumed losses (NAMMCO 2011). In the most recent assessment of Greenland walruses, Witting and Born (2014) used a hunting loss rate of up to 30% in recent years. Similarly, in assessing the use of PBR to estimate total allowable removals, Stewart REA (2008b) used 30% to calculate to allowable landed harvest levels. Loss rates are being addressed by the IFMP in Canada and Stewart REA and Hamilton (2013) did not apply any adjustment for losses or under-reporting in estimating Total Allowable Removal.

Losses can be minimized by making it mandatory to harpoon and fasten a buoy (“*avataq*”, “*fangstblære*”) to the walrus *before* any shot is fired at it. This hunting method, which in fact is in accordance with old Inuit hunting practice, should apply to all areas where walruses are hunted. It would reduce losses substantially and thereby increase the outcome of the hunt, which in turn would result in a reduction in overall removals. In Greenland, the hunting regulations for walruses require harpooning the walrus before the mortal shot is delivered (Anonymous 2006c). Some hunters in Greenland oppose this because they feel in most cases it is not feasible to approach walruses close enough to harpoon them. Therefore, one can speculate that in practice there is not complete compliance and that, in some cases, loss rates remain high. The shortcomings of the hunting practices and the hunting report system have been pointed out by NAMMCO on several occasions (NAMMCO 2007, 2011, also see above) and still require improvement. The walrus management plans being developed in Canada rely on local by-laws developed and enforced by each community to reduce hunting losses and improve reporting.

In light of continued catches, continued decrease in sea ice and changes in the marine habitats of which walrus are a part it is necessary to monitor the size of the walrus stocks regularly. Determination of stock size in walrus is very difficult due to their sparse but clumped distribution and the remoteness of their range areas. Therefore, management authorities should make a cost-benefit analysis to determine how often walrus stocks should be monitored.

The other main source of impacts on walrus populations is the development of commercial enterprises such as the extraction of non-renewable resources, which may harm walrus and their habitat, and tourism, which depends on the presence, and abundance of walrus themselves. Several mines are being developed in Canada which would result in great increases in shipping, including the introduction of all-season shipping activity through walrus habitat in Foxe Basin and Hudson Strait (e.g. Baffinland 2012). Hydrocarbon and mineral exploration are increasing in Greenland (Boertmann et al. 2009b). There are plans to develop the huge oil and gas fields in the south-eastern Barents Sea with possible impacts on walrus (Boltunov et al. 2010). Such developments generally require an Environmental Impact Assessment (EIA) although the terms of such assessments vary among nations.

In Canada, an EIA can be conducted under federal legislation, the Canadian Environmental Assessment Act, or Provincial and territorial legislation. For example, the Baffinland Iron Mine EIA was recently conducted by the Nunavut Impact Review Board (NIRB 2014). National regulations in Greenland require EIA studies to accompany applications for hydrocarbon exploration (Government of Greenland 2014). Thorough preliminary strategic impact assessments have been performed (Boertmann et al. 2009a,b). Part of the Dietz et al. (2014) study on movement and habitat occupancy of walrus in Central West Greenland was conducted to provide background information in relation to evaluation of the effect of oil activities. In Norwegian waters there is a strong focus on environmental protection and existing legislation appears well suited to protect walrus in the near future both in relation to industrial development and in relation to tourism. The responsible authorities charged with conducting EIAs in Russia are the Federal Service for Monitoring the use of Natural Resources and the Federal Service for Ecological, Technological and Nuclear Control. The main legislation relevant to EIA appears to be the Federal Law 'On Ecological Expertise, 1995'. While the act provides for detailed studies over an array of pre-development stages (Govorushko 1997) and any economic activity must be managed and conducted in the way to avoid negative impact to species listed in the Red Data Book of Russia, such as Atlantic walrus, and their key habitats (A. Boltunov, All Russian Research Institute for Nature Protection, in email), we are not aware of the nature of impact studies required before the area is developed.

In all cases, the level of protection afforded to walrus and their habitat in most areas depends entirely on the rigor with which the EIA is conducted. Basic information on walrus is often lacking and sufficient lead-time is required to collect the required baseline data. Moreover, although most environmental protection legislation considers 'cumulative impacts', the practical application of the term remains problematic (e.g. Cooper and Sheate 2002, Wärnbäck and Hilding-Rydevik 2009, DFO 2012).

In some jurisdictions tourism developments tend not to receive impact assessments and are not thoroughly monitored. For example, in Canada, there is no readily accessible database of the numbers and routes of tour ships operating in the Arctic. In other areas, the number of cruise ships visiting walrus habitat have increased. In the period 2001–2008 the number of landing sites of tourists in protected areas in eastern Svalbard varied between 34 (2008) and 75 (2005) depending on ice conditions. The number of persons landed in the same period varied between 8,000 (2001) and 13,000 (2006) (Anonymous 2009b). Information from Greenland and Russia is lacking. Some jurisdictions have regulations to regulate the 'closest approach' distances for non-

hunting interactions with walrus. In Canada, the relevant regulations, the Marine Mammal Regulations are under revision.

The effectiveness of these regulations depends on industry compliance and the authorities' ability to enforce compliance. Because walrus are found in remote locations, enforcement remains a challenge. Better tracking of tourist vessels and flights, the placement of Marine Mammal Observers on tour ships, and automatic cameras on important haul-out sites are some possible approaches to monitoring impact and contribute in reducing walrus disturbance.

International agreements have varying importance for management within member states and for the trade between them. Regulations governing international trade serve two functions to protect walrus populations. When sustainable quotas are in place, monitoring international trade allows illegally obtained products in excess of those quotas to be identified. Second, international trade agreements can be used to encourage range states to ensure that their quota systems are sustainable; that current populations are not reduced in the future.

We believe that the present change in distribution and quality of Arctic sea ice imposes new threats to Atlantic walrus through increased human activity if not regulated in the habitat of walrus. The increased activity will be related to the development of petroleum and mineral resources as well as general ship traffic and tourism. International cooperation in information sharing has had clear benefits for management of walrus in the past. From the initiation of a working-level agreement among individuals of range states (Walrus International Technical and Scientific Committee (WITS) in 1990 (Fay et al. 1990) to the inclusion of most range states in NAMMCO, discussions among resource-users and researchers, and between the two groups has fostered international collaboration as witnessed by this NAMMCO publication. The authors encourage the maintenance and expansion of this international sharing to the best for the management of Atlantic walrus.

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