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An Interview Survey about the Catch and the Climate

Museum Tusculanum Press

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Cover photo (front): A small skiff approaching a herd of walruses on an ice floe in dense fog in northern Ikeq/Smith Sound. The hunters are ready to shoot at short range to kill the animals instantly. Photo: E.W. Born
Cover photo (back): Two adult male walruses interacting in the water. Photo: E.W. Born

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# Abstract

The catch of Atlantic walrus (*Odobenus rosmarus rosmarus*) is an important element of the traditional marine hunting culture of West and Northwest Greenland where walruses have been caught for subsistence for millennia. However, quotas were only introduced in 2006 for the take of walruses in Greenland. Since the early 1990s the sea ice cover has decreased markedly on the walrus hunting grounds in West and Northwest Greenland. These changes have presented new circumstances for hunters who still rely upon the catch of walruses. In Greenland there is a tradition for collecting Local Ecological Knowledge (LEK) systematically and integrating LEK in the authorities' decisions on management of marine mammals. This study summarizes a LEK interview survey conducted in 2010 among experienced walrus hunters in West and Northwest Greenland. The main purpose was to systematically collect information on how the hunters had been affected by (1) introduction of walrus quotas, and (2) if the hunters had observed any effects on walruses from the decrease in sea ice. Information was also collected about hunting strategies, numbers and sex and age categories of walruses caught, hunting methods and "struck-but-lost", and many aspects of the general biology of walruses. A total of 76 experienced walrus hunters living in the "walrus hunting areas" between Maniitsoq (65° 25' N) in Central W Greenland and Siorapaluk (77° 47' N) in NW Greenland were asked 50 questions during standardized ("directed") interviews (two informants were interviewed together on the same occasion resulting in a total of 75 interviews). The results of this study demonstrate that the walrus is still an important species in the subsistence hunting culture in W and in particular NW Greenland (the Qaanaaq area). Edible walrus products are consumed by humans, and in the case of NW Greenland, are also important food for sled dogs. Products like meat, skin, and tusks are sold on local markets but are also shared among kin and relatives, thereby maintaining a traditional sharing culture. According to the interviewees, the catch of walruses decreased markedly after the introduction of quotas in 2006. However, analyses of walrus catches recorded in the official catch statistics showed a gradual decrease in the catch in all areas since the early 1990s, indicating that other mechanisms have influenced the trend in catches. The interviews indicate that a number of factors have contributed to the decrease in the catch of walrus. These include (1) the introduction of a quota on walrus (and also quotas for beluga, *Delphinapterus leucas*, narwhal, *Monodon monoceros*, and polar bear, *Ursus maritimus*, in those cases where hunting trips are mainly targeting these species with walrus as a

"secondary" species), (2) decrease in market demands for walrus products nationally and internationally, (3) a general decrease in number of full-time-hunters, (4) a general shift to alternative and more profitable sources of income (fishery and various wage earning jobs), and (5) climate changes resulting in walruses spending less time on the traditional hunting grounds and bad ice and weather conditions influencing the ability to access the walruses. Information from the informants on the number of walrus landed, or lost, in 2008 and 2009 was used to derive an estimate of a "struck-but-lost" ratio of 4.6% (*i.e.* 4.6% of all walruses struck were not retrieved) with some variation among areas. We caution that in several cases the numbers reported by individual hunters for 2008 and 2009 were uncertain. However, given the types of hunting methods used during the "open water hunt", an estimate of loss of <5% seems implausibly low. Climate change (including decreasing sea ice habitat and unpredictable weather conditions) was reported for all areas. A general shift in walrus distribution to the west (*i.e.* at the edge of the Baffin Bay-Davis Strait pack ice) has made the walruses occur farther offshore on their foraging banks. Furthermore, due to later formation of sea ice and earlier spring break-up, the walruses in W and NW Greenland now immigrate later in fall and emigrate earlier in spring and are therefore available for a shorter period of time in the hunting areas. Changes in ice and weather conditions have made hunting walruses more difficult and are, according to the informants, responsible for an overall decrease in hunting pressure and have therefore led to an increase in walrus abundance. The study confirmed that the principal food for walruses in N and NW Greenland are bivalve molluscs, but it did not result in information specific enough to determine if there has been any climate induced shift in benthic biodiversity and/or walrus food preferences. Overall, the study confirmed that systematically collected LEK can provide valuable information on hunting animals and their exploitation.

# Dedication

Dedicated to the Greenlandic subsistence hunters who boldly fight to maintain a long cultural tradition of making a livelihood for themselves and their families by harvesting the marine resources in a world of rapid environmental and social change.

## Eqikkaaneq

Aaffanniartarneq (*Odobenus rosmarus rosmarus*) Kalaallit Nunaata kitaani avannaanilu imaanit pissaqarniarnermut ukiuni tusindtilinni tapertaalluarsimavoq pingaarutilipilussuaq.Taamaattorli 2006-imi aatsaat aaffanniarnermut tunngatillugu pisassiisoqartalersimavoq. 1990-ikkunniit kitaata sikua aaffanniarfiusartoq allanngoriartupiloorsimavoq annikilliartorluni. Tamannalu aaffanniartartunut sunniuteqanngitsoorsimanngilaq. Kalaallit Nunaanni ukiorpassuarni ileqquusimavoq miluumasunik iluaquteqarnissamut aqutsinermi pisortaniit aalajangiiniarnermi atuisut ilisimasaasa ilanngunneqartarnerat, tamakkulu aamma katersorneqartuarnerat. Suliaq una 2010-mi aaffanniartartut misilittagaqarluartut uumassuseqassutsimullu ilisimasaqarluartut apersuiffigineqarneranneersuuvoq. Suliami paaserusunneqartut pingaarnerit tassaasimapput, (1) aarrit piniagaaneranni pisassiisoqartalernarata piniartunut sunniutai, aammalu (2) immap sikusarnerata annikilliartorsimasup aavernut sunniuteqarsimaneranik piniartut maluginiagaqarsimanerat. Piniariaatsimut, amerlassutsinut, suiaassutsimut pisarisartakkallu utoqqaassusiannut, piniarnermi atortunut, ikilereernerani annaasanut, allarpassuarnullu aarrit sananeqaataanut tunngasuteqartut katersorneqarput. "Aaffanniartarfiusuni" kitaani Maniitsumiit (65° 25' N) avanersuarmi Siorapaluk (77° 47' N) tikillugu aaffanniartartut misilittagaqarluartut katillugit 76-it aalajangersimasunik 50-inik apeqquteqarfiginerisigut misissuineq ingerlanneqarpoq (apersuineq ataaseq marlunnik inuttaqarmat apersuinerit ingerlanneqartut 75-iupput). Misissuinerup matuma ersersilluarpaa aaverniartarnerup nunatta kitaani pingaartumillu avanersuarmi (Qaanaakkunni) piniarnermut suli tapertaalluinnarnera. Neqaa inuit nerisarivaat nunattalu avannaani qimminut qimuttunut aamma nerukkaataalluartarluni. Neqaa amia tuugaavilu tuniniagaasarput aammalu ilaqutariit qanigisallu akunneranni ningerutigineqartarluni, taamaasilluni qangarsuummalli ileqqut attanneqarlutik. Apersorneqartut akissutaat malillugit 2006-imi pisassiisoqartalernerata kingunerisaanik pisarisartakkat ikileriarujussuarsimapput. 1990-ikkut aallarti-

laarnerannit pisaasartunut kisitsisaatigineqartut misissorneranni takuneqarsinnaavoq taamanili pisaasartut ikiliartorsimanerat, taamaammallu pisassiisalersimanerinnaq ikiliartornerannut tunngaviunngitsoq pissutsilli aamma allat peqqutaaqataasimassasut. Apersuillunilumi misissuinermit peqqutaasut assigiinngitsut taakkartorneqarput. Tamakkununnga ilaallutik nunatsinni nunanilu allani pisisartut ikiliartorsimanerat, piniartutut allagartallit ikiliartorsimanerat, allanullu isertitsissutaanerusinnaasunut saakkiartorsimaneq (aalisarneq akissarsiutigalugulu suliffeqarneq) aammalu silap pissusiata allanngoriartornerata kingunerisaanik aarrit tikikkuminarunnaarsimanerat.

2008-mi 2009-milu pisarisartakkat tikiunneqartartut pissatarisartakkallu apersuinermi akiss utigineqartut tunngavigalugit "kapigaluarlugit/aallaagaluarlugit annaasat" amerlassuserigunnagaat 4,6 %-imut tagginneqarpoq (tassa kapisanit 4,6% pissataasartutut), soorunami sumiiffikkaartumik kisitsit allanngorarluni. Ilisimatitsissutigissavarput 2008-mi 2009-milu pisanik nalunaarsuutit arlallit nalornissutigineqarmata. Sikuunngitsumi piniariaatsit eqqarsaatigalugit pissatarisartakkat 5%-iniit ikinnerutinnissaat piviusorsiunngitsumik appasippallaarsorinarpoq. Silap pissusiata allanngornera tamanit oqaatigineqarpoq (sikuusarnerata annikillinera silallu siulittuutigiuminaallinera). Baffin Bayip Davis Straitillu akornanni aarrit najortagaasa kimmut nikissimanerat avasinnerusumiilersimanerannik kinguneqarpoq, tasamani neriniartarfiinut. Sikuusarnerata kingusinnerusukkut pisalernera siusinnerusukkullu sikuertarnera pissutaalluni aarrit ingerlaartarnerat allanngorsimavoq, sivikinnerusumik piniarfigineqarsinnaanerannik sunniuteqarluni. Sikup silallu allanngornerisa aaverniartarneq siornatigorniit ajornarnerulersissimavaat, apersorneqartullu malillugit tamakku pissutaallutik piniagaanerat annikillisimavoq amerliartussutigiligaannik. Suliami matumani uppernarsineqarpoq nunatta avannaani kitaanilu uilukkunnik aarrit nerisannaaqarnerat, uppernarsineqanngilarli silap pissusiata allanngornerata immap naqqani uumassusillit assigiinngisitaarnerannut aammalu/ aarrit nerisannaavinut allannguisitsisimanera. Ataatsimut isigalugu misissuinermi uppernarseqqinneqarpoq piniartut piniakkat pillugit, tamakkulu atugaanerinut ilisimasaannik katersuineq paasissutissanik pissarsiffiulluarsinnaasoq; paasissutissanik piniakkat iluaqutigineqarnerisa aqutaanerannut ilaalluinnartariaqartunik.

## Pigititsineq

Naak avatangiisitigut inooqatigiinnikkullu allanngoriartupiloortoqaraluartoq ilungersorlutik qangarsuaaniillu ileqquusut malillugit piniakkanik inuussutissarsiuteqartunut ilaquttaminnullu pilersuisunut suliaq una pigitinneqarpoq.

# Contents

# Introduction

Atlantic walrus (*Odobenus rosmarus rosmarus*) has a long history of exploitation in West and Northwest Greenland. The Inuit and their predessors living in these areas have hunted walrus for millennia (*e.g.* Gulløv 2004). The Norse hunted walruses in West Greenland from sometime in the late 9th until the 15th century. From early 19th century until the mid-20th-century European sealers and whalers tolled heavily on Atlantic walruses in the Davis Strait-Baffin Bay region and adjacent areas of the eastern Canadian Arctic (Ross and MacIver 1982; Gulløv 2004; Wiig *et al.* 2014 and references therein). Traditionally the Inuit living in the Davis Strait-Baffin Bay region hunted walruses at a relatively limited scale but from early in the 20th century, they hunted walruses with increased efforts after the introduction of firearms and motorized vessels (Born *et al.* 1995; Born 2005a). During the first half of the 20th century, Greenlandic hunters in Central West Greenland (*i.e.* between ca. 66° N and ca. 70° 30'N) increasingly began to use larger vessels and motorized boats in their maritime hunting and fishing activities with the results that the catch of walruses increased markedly (Born *et al.* 1994; Witting and Born 2005, 2014). The social, economical and technological developments in NW Greenland north of 70° 30' N were more gradual, and in comparison with the situation in Central West Greenland, were delayed until after the mid-20th century (Witting and Born 2005). The catch of walruses has traditionally been a cornerstone in the subsistence hunting of Greenlanders living in NW Greenland north of ca. 76° N at the eastern coasts of the North Water (NOW) polynya (Vibe 1950,1956,1967; Born 1987a). Atlantic walruses are still hunted for subsistence purposes by Greenlanders living in West and Northwest Greenland (*e.g.* Witting and Born 2005, 2014; Hovelsrud *et al.* 2008; this study).

Two different subpopulations of walruses are exploited in West Greenland (*i.e.* south of ca. 70° 30' N) and in Northwest Greenland (*i.e.* north of ca. 76° N), respectively. The demographic affinity of the relatively few walruses caught in the Uummannaq-Upernavik area between ca. 70° 30' N and ca. 76° N remains undetermined. They may represent individuals from both subpopulations (Born *et al.* 1994, 1995; Born 2005a; Dietz *et al.* 2014) (See also: Materials and methods – Description of the survey area and its division into subareas).

The two subpopulations of walruses that are harvested in West and Northwest Greenland were depleted relative to historical abundance due to over-exploitation (Born *et al.* 1994; Witting and Born 2005, 2014). However, age and sex-structured

Bayesian modeling involving recent abundance estimates and historical removals has indicated signs of recovery in both subpopulations (Witting and Born 2014).

The distribution of walruses is basically confined to coastal shallow water banks with suitable food consisting mainly of benthic invertebrates. They can break up through a 15–20 cm thick layer of dense fast ice, but must retreat to areas with less dense ice if the ice becomes thicker than this. Hence, walruses are typically associated with drift ice ("broken pack ice") and polynyas (Vibe 1950; Fay 1982; Carleton Ray *et al.* 2016). These habitat preferences are also reflected in the distribution of

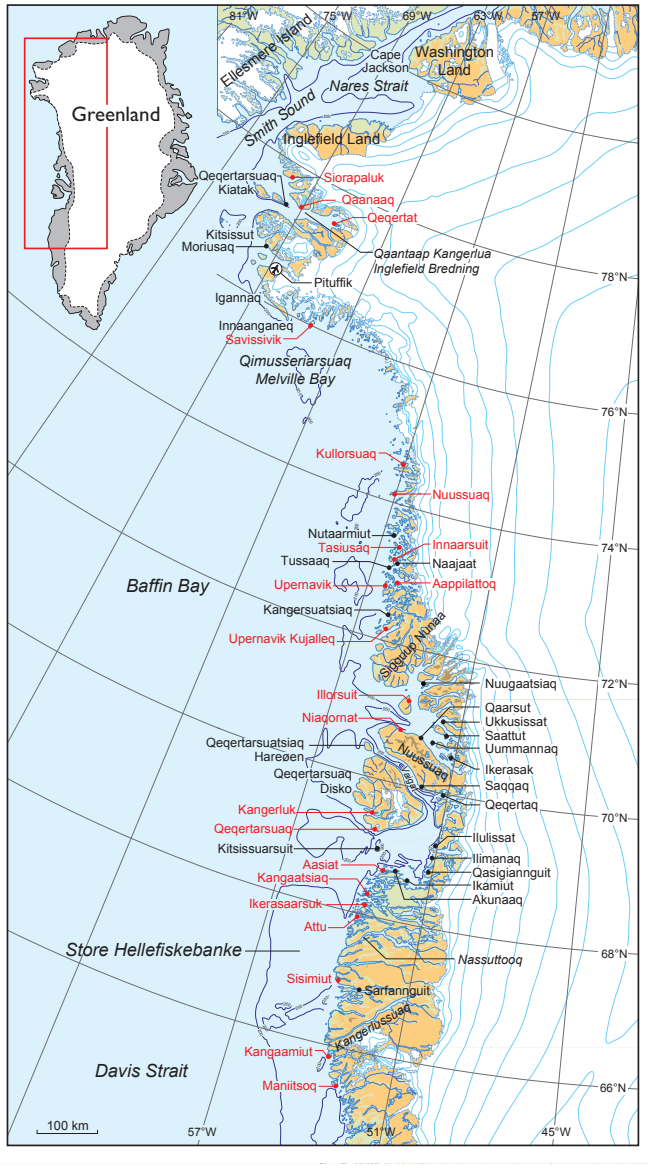



**FIG. 1.**
Map of the study area in West and Northwest Greenland. Towns and settlements visited between Maniitsoq and Siorapaluk during an interview survey among walrus hunters in 2010 are shown in red. The settlements Moriusaq and Qeqertarsuaq in Northwest Greenland were abandoned in the late 1990s and in 2010, respectively. The 200 m bathymetric curve is shown.

walruses in West and Northwest Greenland. In West Greenland south of ca. Qeqertarsuatsiaq/Hareøen (Fig. 1) the walruses are typically associated with the eastern edge of the Davis Strait-Baffin Bay pack ice (*i.e.* the "West Ice") overlying the shallow water banks during winter and spring (Born *et al.* 1994). Walruses belonging to the Baffin Bay subpopulation have their main distribution in the North Water ("NOW") polynya in Ikeq/Smith Sound (Vibe 1950; Born *et al.* 1995; Stewart *et al.* 2014a; Heide-Jørgensen *et al.* 2013, 2016). Sea ice conditions in NOW are generally "light" (*i.e.* non-consolidated and relatively thin drift ice) and the walruses occurring there have access to relatively large feeding banks on the eastern edges of the polynya (Vibe 1950). In the Uummannaq-Upernavik area, walruses occur from fall to spring in cracks and leads between the land-fast ice and the Baffin Bay pack ice (this study; Born *et al.* 1994).

Sea ice is a key factor in walrus distribution and population dynamics and is also the feature of polar marine ecosystems most subject to rapid climate change (Krupnik and Carleton Ray 2007 and references therein). The sea ice conditions have changed markedly in prime walrus habitat in West Greenland and Northwest Greenland during recent decades (Regehr *et al.* 2016). The sea ice concentration over the west Greenland continental shelf has decreased significantly since the beginning of the 1990s with an earlier spring break-up (Born 2005a; Heide-Jørgensen *et al.* 2010; Peacock *et al.* 2012; Dietz *et al.* 2014). During the same period, sea ice (Heide-Jørgensen *et al.* 2013; Gearheard *et al.* 2013) and weather conditions have deteriorated and become more unpredictable and variable in Northwest Greenland as also reported by subsistence hunters living in the Upernavik and Qanaaq regions (Born *et al.* 2011a). Among other things, these changes have negatively affected the walrus hunt in various ways (this study; Born *et al.* 2011a; Gearheard *et al.* 2013).

Prior to 2006, the walrus catch in Greenland was essentially regulated by limiting the hunting season and hunting methods (Born *et al.* 1995; Wiig *et al.* 2014); and without a quota system, no upper limit to the numbers killed was in place. However, in 2000 the Greenland Government decided that quotas should be introduced for the catch of walrus (Anon. 2006) and quotas for the take of walruses were introduced in 2006, taking effect on 1 August that year in NW Greenland and from 1 January 2007 in Central West Greenland (Wiig *et al.* 2014).

In NW Greenland (*i.e.* the Qaanaaq area) the quota represented a ca. 30% reduction of the average annual catch of walrus reported during the ten preceding years, whereas in areas south of 76° N the quotas represented a drop of ca. 20% in the average annual catch during the ten previous years.

The introduction of quotas inevitably represented a marked change, which in various ways influenced the walrus hunting activity of the subsistence hunters as docu-

mented in the present study. This happened during a period with a decrease in sea ice conditions and concentration, which likely affected both the hunting patterns and the distribution of walruses.

Information on abundance is a prerequisite for management of walruses. A series of aerial surveys to assess the number of walruses in West Greenland (including eastern Baffin Island) and Northwest Greenland have been conducted since 1981 (Born *et al.* 1994; NAMMCO 2013a,b; Heide-Jørgensen *et al.* 2013, 2014, 2016; Stewart *et al.* 2014a,b). These surveys have provided important information on the abundance of walruses that are exploited in West Greenland and in the North Water region.

However, information on the effects of quotas on hunting activity of Greenlanders still relying on catching walruses for subsistence purposes is a necessary tool, which may allow managers and stake holders to evaluate effects of the management system and make adjustments if necessary. Furthermore, effects of ongoing climate changes and reduction of sea ice on walrus populations and the maritime hunting activity in

The interviews revealed that in the Qaanaaq area in NW Greenland, a harpoon is used regularly during the walrus hunt. The subsistence hunters cooperated with the Greenland Institute of Natural Resources in attaching small satellite transmitters to walruses using the traditional method of harpooning (Stewart et al. 2014a). Photo: M. Villum Jensen

Greenland can be evaluated by collecting information and observations through LEK (Local Ecological Knowledge) from hunters who have a "hands on" perspective on the affected environment.

Local Ecological Knowledge (LEK) offers information and insight relevant to ecological management and research that cannot be obtained from other sources (*cf.* Huntington 1998, 2000). There is a growing recognition that LEK can be useful sources of information to complement "western scientific approaches" to resource management (Berkes *et al.* 2000; Berkes and Jolly 2001; Gilchrist *et al.* 2005 and references therein; Metcalf and Robards 2008). The governance and management of renewable natural resources encompass complex and multi-faceted problems that must be addressed by interdisciplinary research, planning, and management. Hence, Local Ecological Knowledge (LEK) has also become regarded as an obligatory source of information (Ruddle and Davis 2013; GINR 2013).

Collaboration between users and scientists is indispensable for a variety of reasons. Amongst these reasons being that collaboration gives natural resource and ecosystem scientists an unrivalled opportunity to study with people rich in local ecosystem experience and enables scientists to access and document new sorts of data and experiences required for more comprehensive understandings of ecosystems (Ruddle and Davis 2013 and references therein). Furthermore, integration of scientific and indigenous knowledge will lead to a better understanding of local to regional biological and ecological conditions, and a transition into more powerful decision-making on the part of indigenous peoples (Krupnik and Carleton Ray 2007).

According to Gilchrist and Mallory (2007) another purpose of collecting LEK in a wildlife management context is to seek out and apply any sources of reliable data, including information collected independently from western science, to help make more informed wildlife management decisions.

LEK may be defined in several ways. However, NOAA (2014) offers a strict definition of LEK: "LEK is similar to TEK (*i.e.* Traditional Ecological Knowledge) in that it is tied to place (*e.g.* specific hunting or fishing grounds) and is knowledge acquired through experience and observation. It can be acquired over a single lifetime or over many generations. LEK differs from TEK in that it does not require an ancient or even a multi-generational accumulation of knowledge, it does not require that the population be indigenous, and it does not require embedding in a broader shared culture. In other words, an individual can accumulate LEK over the course of one lifetime interacting with a local environment". We adopted this definition which in fact also to a large extent involves Local Fisheries Knowledge (LFK), which according to NOAA (2014), includes non-ecological knowledge related to fisheries, including but not limit-

ed to business aspects of fishing, economics, social dynamics, and local fishing culture. In the following we use the terms "LEK" and "LFK" synonymously.

Greenlandic subsistence hunters possess an intimate knowledge of the ecological conditions in their hunting areas and can provide a wealth of information on distribution as well as behavior and biology of their hunting animals. The first attempts to provide a comprehensive description of walruses and the walrus hunt in W and NW Greenland (Freuchen 1921; Vibe 1950) were to a large extent based on LEK and co-operation locally with hunters. Later studies of walrus in W and NW Greenland also relied upon a close co-operation between hunters and scientists (*e.g.* Born *et al.* 1981, 1982; Born 1987a; Born and Knutsen 1988, 1990; Knutsen and Born 1994; Andersen and Born 2000; Born 2005a; Stewart *et al.* 2014a; Dietz *et al.* 2014).

In Greenland there have been several studies that have systematically gathered local LEK regarding the occurrence and catch of a variety of animals (Born 1983, 1987a; Rosing-Asvid and Born 1990; Sandell and Sandell 1991, 1996; Petersen 1993a,b; Thom-

Abilanguaq Simigaq (aged 50 in 2010) from Qaanaaq studies one of the maps used during the interview survey, while the skipper of MV "*Iijaq*" Helge K. Lyberth has a local snack of dried narwhal meat. Photo: A. Heilmann

sen 1993; Hertz 1995; Glahder 1995, 2001, 2003; Dietz *et al.* 2001; Sandell *et al.* 2001; Rosing-Asvid 2002; Aastrup *et al.* 2005; Gilchrist *et al.* 2005; Born *et al.* 2011a). These LEK data have provided valuable information to scientists planning and making scientific studies of various Greenlandic wildlife and marine resources, and have also been used in various ways by authorities in their considerations of management and environmental impact assessments both nationally and internationally (see Section: Discussion – Evaluation of the interview survey method and conclusion).

In this study, experienced walrus hunters living in the "walrus hunting areas" between the town Maniitsoq (65° 25' N) in West Greenland and the settlement Siorapaluk (77° 47' N) in Northwest Greenland were interviewed. The purpose was to collect information from the hunters on hunting activity (timing and overall hunting strategies), numbers taken, selectivity for sexes, "struck-but-lost" walruses, hunting methods (boats used, use of harpoons and weapon), "head hunting" (*i.e.* the catch of a walrus where only head and tusks are secured), effects of quotas, distribution, effects of climate change, and aspects of general biology of walruses (pregnancy, birth period and foraging).

In this volume we present the results of this interview survey where a total of 76 experienced walrus hunters were interviewed in 2010. The 50 questions asked during "directed" interviews resulted in answers containing a wealth of information, which is summarized here. We hope that we have succeeded in finding the right balance between summarizing and generalizing this information, and presenting the hunters statements in as much detail as possible.

## Structure of the book

As indicated, the interviews resulted in a huge amount of detailed information on a variety of issues related to walruses and the walrus hunt. To avoid tiring the reader, this information has been distilled into a relatively short "Result" section followed by a "Discussion" section whereas the excessive details of the answers have been relegated to Appendix 2, 3, 4 and 5.

However, "The truth of the story lies in the details" (Paul Auster, *The Brooklyn Follies*, 2005), and it should therefore be noted that the quality of the LEK collected in this study, and the research undertaken to document it, can only be fully evaluated if reading the Appendix 2, 3, 4 and 5 which present hunter statements *verbatim*.

# Materials and methods

## Description of the survey area and its division into subareas

For descriptions of the walrus hunt based on interviews, the areas in which walruses are regularly hunted in West and Northwest Greenland (*i.e.* between the entrance to Kangerlussuaq/Søndre Strømfjord at ca. 66° N and the southern Ikersuaq/Nares Strait-Kane Basin region at ca. 78° 45' N; Born *et al.* 1994, 1995) were subdivided into three subareas based on information about occurrence of walrus and walrus foraging banks, general sea ice conditions, and hunting traditions (Born *et al.* 1994, 1995; Born 2005a):

Subarea 1 includes the coastal areas out to ca. 100 km offshore between ca. 66° N and ca. 70° 30' N (northern tip of Qeqertarsuatsiaq/Hareøen at the western entrance to Vaigat Sound), Fig. 1. This area encompasses the shallow water bank *"Store Hellefiskebanke"* and the banks along the west coast of Qeqertarsuaq/Disko Island. Walruses occur in this area usually in close association with pack ice between late fall and next spring (*e.g.* Born *et al.* 1994; Dietz *et al.* 2014).

Subarea 2 includes the Uummannaq and Upernavik region (*i.e.* the coastal areas between 70° 30' N north to the northern part Qimmusseriarsuaq/Melville Bay area at the settlement Savissivik at ca. 76° N out to ca. 100 km offshore), Fig. 1. Walruses occur mainly during spring and winter in the shear zone (*i.e.* the area with leads between land fast ice and offshore pack ice). They are believed to be in relatively few numbers in this area, and are mainly transient (Born *et al.* 1994, 1995). Generally, the continental shelf with shallow water and suitable walrus food is narrow in Subarea 2 and is covered with dense sea ice for a major part of the year (*e.g.* Buch 2001).

Subarea 3 is the North Water (NOW) polynya area (*e.g.* Smith and Rigby 1981) between ca. 76° N (Savissivik/Innaanganeq/Kap York area) and southern Ikersuaq/Kane Basin-Nares Strait at 78° 45' N; Fig. 1. The Greenland part of this area is sometimes referred to as *"Avanersuaq"* (*i.e.* "the great or far north") or the *"Thule area"*. In this paper we also refer to Subarea 3 as "the Qaanaaq area" after the main

town and administration center of the region. Walruses may occur year-round in the Qaanaaq area except during "the open water period", when they "summer" along eastern Umimmattooq/Ellesmere Island and along the coast in the Greenlandic parts of Ikersuaq/Kane Basin-Nares Strait (this study; Born *et al.* 1995; Stewart *et al.* 2014a). The duration of the absence period of walruses from the Qaanaaq area has apparently increased in recent years due to a decrease in sea ice (this study; Born *et al.* 2011a). In a walrus hunting context, the settlement of Savissivik situated in the southernmost part of Subarea 3 and Qeqertat in the bottom of Qaanaap Kangelua/Inglefield Bredning differ from the other settlements in the area (*i.e.* Moriusaq, Qeqertarsuaq/Herbert Ø, Qaanaaq and Siorapaluk; Fig. 1). The walruses are mainly transient in the Savissivik area, and Qeqertat is situated far from the walrus foraging banks at the entrances to Wolstenholme Fjord, Hvalsund and Murchison Fjord. Moriusaq was officially abandoned in 2010 but had become depopulated before that. Qeqertarsuaq was deserted after ca. 2000.

Walruses in the NOW area (Subarea 3) belong to the Baffin Bay stock (Andersen and Born 2000; Born *et al.* 2001, Andersen *et al.* 2014). The demographic identity of walruses occurring in Subarea 2 is basically undetermined.

It has been suggested that they represent migrants from Subarea 1, a southern extension of walruses from Subarea 3, or a mixture of both (Born *et al.* 1995; Born 2005a).

Walruses wintering in Subarea 1 south of ca. 70° 30' N (*i.e.* the Qeqertarsuatsiaq/Hareøen area; Fig. 1) belong to the West Greenland-Southeast Baffin Island "component" of the Hudson Bay-Davis Strait stock (Stewart 2008; NAMMCO 2010; Andersen *et al.* 2014; Dietz *et al.* 2014). This group of walruses is also subject to hunting by Inuit on the eastern Baffin Island region (*e.g.* Andersen *et al.* 2014). In Northwest Greenland north of ca. 76° N (*i.e.* north of the Innaanganeq/Kap York-Savissivik area), walruses from the Baffin Bay stock are taken by hunters living in the Qaanaaq area and also by hunters in Jones Sound at southern Ellesmere Island on a more limited scale (Born et al. 1995; Witting and Born 2005, 2014). Walruses are hunted throughout the year in the Qaanaaq region, except for a couple of months during summer when they are usually absent from their Greenlandic feeding grounds (Born 1987a; Born *et al.* 1995).

Due to the introduction of relatively large motorized boats in Central West Greenland at the beginning of the 20th century and an increased use of modern firearms, the history of walrus exploitation and the hunting tradition in Subarea 1 differs somewhat from that in Subarea 2 and 3 (Born 2005a and references therein). During the first half of the

20th century, walrus hunting became increasingly important in Subarea 1 until the 1940s when the annual reported catches dropped markedly, reflecting an apparent decrease in the exploited population (Born *et al.* 1994; Witting and Born 2005, 2014). This decrease happened concomitantly with an increased economic importance of fisheries, leading to a decrease in overall economic importance of walrus hunting in Subarea 1 (Born *et al.* 1994, 1995; Born 2005a). In the two other subareas, more modern hunting methods did not generally become used until after World War II and increased in use especially after the 1960s (Born 2005a). The hunt of walrus has always been (Vibe 1950; Born 1987a) – and still is (this study) – of great relative importance in Subarea 3, where products of walrus traditionally and presently supply the local community with important food for human beings and sled dogs, and supplement the income of hunters in the more traditional hunting community by selling of tusks, penis bones and figurines carved in ivory (Born 1987a; Gearheard *et al.* 2013; this study). Due to the relatively low abundance in Subarea 2, walruses have never been of great importance in the subsistence exploitation of marine resources in this area (Born *et al.* 1994).

The catch of walruses has a very long tradition in the town of Sisimiut. March 2006. Photo: E.W. Born

Hence, the history of walrus hunting as well as its past and contemporary importance in the subsistence economy differs in the three subareas. This is also reflected in differences among subareas in the number of walruses reported/hunter to the Greenland authorities (1993–2008) in the settlements and towns visited during our study (see: Results – Basic background data about the informants). Therefore, the extent of experience with walrus hunting of the informants generally differed among the three subareas.

Until 2009, Greenland was organized into 18 administrative units (municipalities). However, in January 2009 Greenland was re-organized into four major municipalities (Anon. 2008). According to the new organization, the towns Maniitsoq, Kangamiut and Sisimiut visited during this study belong to the *Qeqqata Kommunia* municipality. All other towns and settlements visited north of Sisimiut lie within another municipality – the *Qaasuitsup Kommunia*. The border between these two municipalities is at the entrance to the Nassuttooq fjord/Nordre Strømfjord (ca. 67° 28' N).

In the presentation of results the data and answers are presented in the order the areas were first visited (*i.e.* from south to north or from Subarea 1 to 3).

## Travels

Between 5 July and 9 September 2010 the interviewer (Anna Heilmann, AH) travelled north and south again along the coast of West and Northwest Greenland between Maniitsoq and Siorapaluk on a 28 foot fishing vessel (*"Iijaq"* of Maniitsoq) that was chartered for the purpose. The distance along the coast between Maniitsoq and Siorapaluk is ca. 1,700 km (Fig. 1). A total of 22 settlements and towns were visited en route (Subarea 1: 9; Subarea 2: 9; Subarea 3: 4) in order to interview walrus hunters (Table 1). Based on considerations on logistics, traveling routes, time and economic constraints, we decided to concentrate our visits to towns and settlements on the outer coast between Maniitsoq and Siorapaluk (*i.e.* those situated close to the walrus hunting grounds and where hunting of walrus is traditionally important); Fig. 1.

## Selection of interviewees

Prior to the study, unpublished information about who had reported the catch of walrus through the *Piniarneq* catch recording system (*cf.* Section: Catch statistics) from 1993 (the year when the *Piniarneq*-system was initiated) until 2008 (*i.e.* 16 years of reporting) was provided to the Greenland Institute of Natural Resources (GINR) by the Directorate of Fishery and Hunting and Agriculture (DFHA) in Nuuk (Greenland).

| Subarea | Town/Settlement | Number of potential informants[1] | Number interviewed[2] N | Pre-selected[3] | Peer recommended[4] | Number full-time hunters[5] | Total population (Greenlanders)[6] |
|---|---|---|---|---|---|---|---|
| 1 | Maniitsoq | 9 | 2 | 2 | 0 | 87 | 2612 |
| | Kangaamiut | 8 | 1 | 1 | 0 | 42 | 350 |
| | Sisimiut | 24 | 10 | 6 | 4 | 101 | 4969 |
| | Attu | 17 | 5 | 2 | 3 | 23 | 221 |
| | Ikerasaarsuk | 8 | 2 | 2 | 0 | 18 | 99 |
| | Kangaatsiaq | 3 | 2 | 2 | 0 | 31 | 568 |
| | Aasiaat | 3 | 2 | 1 | 1 | 46 | 2792 |
| | Qeqertarsuaq | 6 | 4 | 0 | 4 | 45 | 882 |
| | Kangerluk | 2 | 2 | 0 | 2 | 1 | 33 |
| Total | | 80 | 30 | 16 | 14 | 394 | 12526 |
| 2 | Niaqornat | 4 | 3 | 2 | 1 | 15 | 58 |
| | Illorsuit | 3 | 2 | 1 | 1 | 18 | 91 |
| | Upernavik Kujalleq | 9 | 2 | 2 | 0 | 27 | 204 |
| | Upernavik | 6 | 2[7] | 2 | 0 | 149 | 1071 |
| | Aappilattoq | 8 | 1 | 1 | 0 | 31 | 180 |
| | Innaarsuit | 4 | 1 | 1 | 0 | 22 | 157 |
| | Tasiusaq | 7 | 1 | 1 | 0 | 52 | 246 |
| | Nuussuaq | 3 | 1 | 1 | 0 | 34 | 204 |
| | Kullorsuaq | 11 | 2 | 1 | 1 | 61 | 430 |
| Total | | 55 | 15 | 12 | 3 | 409 | 2641 |
| 3 | Savissivik | 7 | 5 | 3 | 2 | 9 | 66 |
| | Qeqertat | 4 | 2 | 2 | 2 | 5 | 33 |
| | Qaanaaq | 30 | 11 | 9 | 0 | 46 | 595 |
| | Siorapaluk | 12 | 13 | 8 | 5 | 13 | 67 |
| Total | | 53 | 31 | 22 | 9 | 73 | 761 |

1: Number of potential informants who regurlarly had reported the catch of walrus to the catch reporting system during 1993–2008.
2: Number of hunters who actually were interviewed during 2010.
3: Number of interviewees in Column 4 who had reported the catch of walruses to the catch reporting system *Piniarneq*.
4: Number of interviewees in Column 4 who were selected based on local peer-recommendation.
5: Source: Statistics of Greenland, Nuuk (*in litt.*, 8 August 2014). Please note that all hunters with a license as a full-time hunter had not necessarily hunted walruses. Furthermore, in particular in Subarea 1 and 2 several hunters earn an income as fishermen, too.
6: In 2010 (Anon. 2015; Statistics of Greenland; www.stat.gl).
7: Two hunters were interviewed on the same occasion. Hence, the study reports results of a total of 75 interviews.

**Table 1.** Number of hunters interviewed in 2010 (N=76) by subarea and town/settlement in West and Northwest Greenland. The number of potential interviewees (number pre-selected and peer-recommended), number of registered fulltime hunters, and inhabitants (Greenlanders) per settlement and/or town in 2010 are also shown.

The motor vessel *"Iijaq"* (48 feet and 4.6 BRT) from Maniitsoq was the platform for the study. *Iijaq* made a roundtrip voyage of more than 3000 km between Maniitsoq and Siorapaluk during the walrus interview survey. Photo: A. Heilmann

For each settlement in the overall study area a number of hunters who had regularly reported the catch of walruses were "pre-selected" as suitable interviewees due to their experience in hunting walruses as documented through their reporting. A total of 248 hunters had reported their catch through the *Piniarneq* during the period in question (Subarea 1: 109, Subarea 2: 78, and Subarea 3: 61). Of these hunters, 188 were regarded as potential interviewees based on the fact that they had reported the catch of walrus regularly (ca. 52% of these had reported the catch of several walruses); Table 1.

Based on considerations of travel distances, travel time, and economic constraints, we decided *a priori* to interview 75 (ca. 40%) experienced walrus hunters among these 188 potential informants. Preferably, the interviewees should have experience with walrus hunting that covered the period prior to and after the marked decrease in sea ice (*i.e.* experience before and after the early 1990s).

The allocation of the number of interviews per settlement or town (Table 1) reflects the relative importance of walrus hunting in that particular subarea and settle-

Co-author Anna Heilmann who conducted the interviews with two interviewees from Upernavik Kujalleq. Left: Pele Karlsen (aged 43 in 2010) and right Thue Karlsen (aged 51 in 2010). Photo: A. Heilmann

ment/town. In particular, hunting of walruses is traditionally important in Sisimiut in Subarea 1 and in Siorapaluk and Qaanaaq in Subarea 3 (Vibe 1950; Born 1987a; Born *et al.* 1994), all of which are situated close to walrus wintering grounds (Vibe 1950; Born *et al.* 1994, 1995).

In some cases when a potential informant was not home or for other reasons was not available for being interviewed, other hunters with experience in hunting walruses were selected based on information obtained locally ("peer-recommendation"); Table 1.

## Information to the public

Prior to the survey we informed the head office of KNAPK (*Kalallit Nunaanni Aalisartut Piniartullu Kattuffiat*, *i.e.* the organization of fishermen and hunters in Greenland) in Nuuk about the survey, its purpose and methods and a list of the questions to be asked. KNAPK was encouraged to inform its local offices along the coast. Prior to departure from Sisimiut on 4 July and from Qeqertarsuaq on 15 July, AH was inter-

viewed by *Avannaata Radioa* (*i.e.* "The radio of northern Greenland"). Thereby the public and the hunters were informed about the interview survey.

## Interviewing method

It is preferred that a LEK/TEK research project has contributions of expertise from a well-resourced, interdisciplinary team (Armitage and Kilburn 2015). The team involved in the present study included marine mammalogists E.W. Born (EWB), M. Iversen (MI), and K.L. Laidre (KLL) who is also a spatial analyst, and social scientists Anna Heilmann (AH) and Lene Kielsen Holm (LKH). The team had previous experience from similar interview surveys in Greenland (*e.g.* Heilmann 2004; Born *et al.* 2011a; Gearheard *et al.* 2013).

All interviews were made by Anna Heilmann, who is from Maniitsoq and is fluent in Greenlandic, Danish and English. AH has extensive previous experience with interviewing hunters and local residents in Greenland (Heilmann 2004; Born *et al.* 2011a). The in-

Right: Qaernaaq Nielsen (aged 67 in 2010) was six years old when he participated in a walrus hunt for the first time. Left: The skipper of MV *"Iijaq"* Helge K. Lyberth. Photo: A. Heilmann

terviews were conducted in Greenlandic using a standardized ("directed" or "formal" or "structured") interviewing method (*cf.* Berg 2001) in a face-to-face interviewing process. The standardized interview involves the interviewer using an outline and asking predetermined specific questions within a certain time frame. Hence, the interviewer works from a checklist and takes notes. This type of interview seeks to reveal facts. Following the order in a printed questionnaire, the interviewees were asked a suite of questions on a variety of topics related to walrus hunting strategies and hunting methods, distribution, climate change effects, walrus biology etc. (Appendix 1).

The questions to be asked and the information to be sought were determined by EWB in consultance with AH and LKH. Prior to the study the list of questions was also reviewed by other biologists (Mads-Peter Heide-Jørgensen and Fernando Ugarte, GINR) who both have experience with various aspects of Greenland marine mammals.

Most of the questions were phrased so that they could be answered as "yes", "no" or "no opinion" (or informants were allowed to not answer), in order to not make the interview sessions too long with the risk of tiring the interviewees and also to allow for an easy *post hoc* categorization and summary of answers. However, if an informant wanted to supply additional information and provide more details to his answer, this was made possible and his statements were written on the questionnaire form. The hunters were also encouraged to make sketches on maps of, for example, walrus distribution, migration routes and hunting grounds. All interviews were recorded on a digital recorder. Usually an interview would last 1–3 hours. All of the informants received 600 DKK (ca. 100 US $; 1 US $ = ca. 6.0 DKK in July 2010) in accordance with the officially accepted rates as compensation for lost earnings, given the fact they were asked to stay home to be interviewed even if it was good hunting weather.

The answers were noted on the pre-printed question forms and more comprehensive interviews were recorded digitally during the interviews. The interviewees were guaranteed full anonymity.

A report on the travel was written shortly after the end of the field work (Heilmann 2010).

## Treatment of data

Since the informants were promised anonymity, names are not mentioned in the presentation of results. However, in cases where it is thought to be of relevance for the evaluation of an answer, the age and home settlement/town of the hunter offering a qualifying statement are given. Photos are shown of some of the interviewees. After

Before the introduction of strict hunting regulations it was permitted to hunt both sexes and all ages of walrus. A female and her newborn calf are about to be butchered in Sisimiut in the mid-1930s. Arctic Institute, Copenhagen

the interview survey these hunters specifically gave us permission to show photos of them and mention them by name.

As stated earlier some informants provided sketches of distribution etc. These sketches were of a highly variably clarity and precision. In several cases and particularly in Subarea 3 several of the hunters provided information in their sketches that was also provided by other informants in the area. In such cases we have attempted to summarize the information on maps (Appendix 2). However, to give the reader an idea about the number of individual hunters that were the basis for these "generalized maps", the hunters giving the information are presented by an ID number in the figure/map captions.

Information on name etc. of the interviewed hunters, the *post hoc* ID-numbering of them, the original data and a datafile are kept at the Greenland Institute of Natural Resources (P.O. Box 570, DK-3900 Nuuk).

Microsoft Office Excel 2007 and StatView® (version 5.0.1, SAS Institute Inc.) were used for statistical treatment of data. Where relevant, data were Ln-transformed for

analyses to meet the assumptions of normality and homoscedasticity (Zar 1999). Probability of significance was evaluated at the 5% level.

## Legislation and management of walruses

The interview survey had to take into account the existing restrictions and regulations for the catch of walruses in Greenland. Accordingly, the questionnaire was constructed based on knowledge of the legislation, which aims at regulating the hunting practice, hunting season and size of the catch. Therefore, hunting regulations will inevitably influence certain aspects of the answers and explanations given during the interview survey. To provide a context for the interview survey we summarize the Greenlandic walrus hunting regulations. The regulations were reviewed by Wiig *et al.* (2014), which the following summary is mainly based on (for detailed references *cf. ibid*.). We concentrate our review on those elements of the regulations that are of direct relevance for the interview survey.

Since 1929 until the 1990s, the walrus hunt in Northwest Greenland (*i.e.* in Subarea 3, the area between ca. 76° N and Kap Jackson on Qissuup Nunaat/Washington Land, in the area formerly denoted "Qaanaaq municipality") from the Baffin Bay stock has mainly been regulated by local decrees (Rasmussen 1929). In the season with sea ice, shooting a walrus before it was harpooned was not permitted unless it was in a lead in the sea ice. In the open water season, shooting a walrus in the head before it was harpooned was also prohibited (*ibid*.). In 1994 new legislations for the catch of walrus was introduced in Greenland (Anon. 1994a). By the revision of this legislation in 1998, (Anon. 1998a) the local regulations (*i.e. Vedtægt om hvalros fangst i Thule Kommune af 20. juli 1973*) for the catch of walrus in the former Qaanaaq municipality were canceled and from then on the general Greenland regulations for hunting walrus (Anon. 2006) also applied to this area (DFHA, *in litt.* 8 April 2016).

In West Greenland, hunting regulations were not introduced for the West Greenland-Southeast Baffin Island subpopulation until 1949 when walruses in the "West Ice" (*i.e.* the eastern edge of the Davis Strait pack ice) were protected between 20 May and 31 December. New hunting regulations came into force for West Greenland in 1956. The regulations have been amended several times since 1956.

The latest regulations from 27 October 2006 (Anon. 2006) introduced quotas and addressed the situations of the two different stocks exploited in West and Northwest Greenland, respectively.

The walrus hunting regulations from 2006 introduced further restrictions to the hunt of walruses in Greenland. Certain categories of walruses are protected: young

walruses of both sexes and of all ages accompanying their mother, and adult female walruses are completely protected (adult female being defined as females with an external tusk length of 15 cm or longer). However, in NW Greenland north of 76° N it is permitted to catch adult females with young. Furthermore, in anticipation of an increased number of walruses hauling out on land due to the reduction of sea ice, all walruses that are hauled out on land are completely protected throughout all of Greenland.

The regulations define hunting seasons. It is only permitted to hunt walruses occurring between 66° N (*i.e.* the tip of the south coast at the entrance to Kangerlussuaq/Søndre Strømfjord) and 70° 30' N (*i.e.* northern tip of Qeqertarsuatsiaq/Hareøen) between 1 March until 30 April (both days included). North of 70° 30' N (in NW Greenland) it is legal to hunt walruses between 1 October and 30 June (both days included) except in Zone I of the Melville Bay Nature Reserve where all wildlife is completely protected (Anon. 1989).

Only full-time hunters ("*erhvervsfangere*") living permanently in their respective municipality can get a license to hunt walrus. In addition to walrus, only full-time hunters can get a license to take beluga, narwhal and polar bears.

Furthermore, there are regulations for which equipment can be used when hunting walruses. It is not permitted to use aircrafts, helicopters and motor driven terrestrial vehicles including snow scooters and boats larger than 20 BRT/15 BT tons to catch walruses or for transportation to and from the hunting grounds. These protective measures were introduced in order to reduce the hunting pressure (*i.e.* reduce efficiency) and the number of walruses that can be taken during a hunting trip and brought home.

All meat, blubber, skin and other usable parts from each killed walrus must be brought back (or cached in the field for later use). Before leaving the hunting site, remains of the kill must be removed to the greatest extent possible.

There are also restrictions concerning the types of weapons (rifles with caliber 30.06 are minimum) and bullet types (full metal jacketed) that can be used, and it is stated explicitly that wounded ("struck") walruses must be harpooned before they are killed. Furthermore, it is specified that floats must be attached to the harpoon to prevent dead walruses from sinking.

Walrus products cannot be sold until the local authorities have registered the catch in question as legal. Traded skulls, tusks and bones of walruses must be accompanied by a certificate that is stamped by the authorities.

During an open hearing process, the "Hunters' Council" (*i.e.* "*Fangstrådet*") is asked for its opinion about the size of the annual quotas. The "Hunters' Council" is an advisory board that provides the Greenland Government with advice on matters con-

cerning hunting. The council consists of representatives of user groups, governmental management departments and the administration of the various municipalities. Thereafter, the Minister of Fishery, Hunting and Agriculture of Naalakkersuisut (the Greenland Government) makes a final decision on the size of the quotas. 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. For example, the quota for the catch of walruses in NW and W Greenland was reduced in 2010 due to overharvest in the previous year. 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.

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. After 2009 the quotas have included an assumed, but unknown, proportion of walruses that are mortally wounded or killed and not retrieved ("struck-but-lost"). Hence, the quotas for 2009 and later years were reduced 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 in this area are more specialized in hunting walrus and therefore have a low "struck-and-lost" rate (see Discussion – Losses ("struck-but-lost" ratio) and local abundance).

Since 2009 Greenland has aimed at regulating the removal of walruses based on advice given by The North Atlantic Marine Mammal Commission, NAMMCO (2010, 2013a,b) and the Greenland Institute of Natural Resources, GINR (Anon. 2015a), also taking into consideration catches in Nunavut from shared stocks, and estimates of loss.

Quotas for the catch of walrus in Greenland during 2007–2010 (*i.e.* prior to the interview survey) and for 2016 are shown in Appendix 2 (Table 9, p. 117).

Although not stated specifically in the regulations for the hunt of walruses (Anon. 2006), "sports trophy hunting" of walruses is not permitted in Greenland.

Hence reflected in several answers, the regulations from 2006 represented some important changes that affected walrus hunting activities: (1) Quotas were introduced for the two subpopulations in W and NW Greenland, respectively, (2) a hunting season (1 October to 30 June) was introduced for areas north of 70° 30' N in NW Greenland (according to the previous regulations from 1998 it was permitted to hunt walruses all year round in this region; Anon 1998a). In contrast, the hunting season in areas between 66° and 70° 30' N remained the same (1 March to 30 April) as in the 1998

regulations (Anon. 1998a), (3) adult females and females with calves became fully protected south of 70° 30' N, and (4) in all areas of Greenland, walruses hauled out on land became fully protected.

## Catch statistics

We present catch statistics from two catch recording systems: the *Piniarneq* and the *Special Reporting Forms* ("Særmeldingskemaer"). The *Piniarneq*-system was initiated in 1993 as a new system for recording the catch of wildlife and marine mammals in Greenland. Each year licensed hunters must report their catch of various species (birds, terrestrial and marine mammals) including walrus to the Department of Fishery and Hunting and Agriculture in Nuuk (Greenland). For a description of this recording system *cf. e.g.* Kapel and Rosing-Asvid (1996), Teilmann and Kapel (1998) and Born (2002). In 1994 it became mandatory to also report the catch of each walrus separately to the DFHA on *Special Reporting Forms* with detailed information including name of hunter, settlement, date and site of the catch, sex and approximate age of the walrus etc. (Anon. 1994a).

# Results

## Responses to the questions

**Basic background data about the informants (Appendix 1, Questions 1–3)**
A total of 76 walrus hunters were interviewed (Subarea 1: 30, Subarea 2: 15, and Subarea 3: 31). In one case (Upernavik town) two hunters were interviewed together resulting in a total of 75 interviews reported in this study (Table 1).

The interviewees represented ca. 8%, ca. 4% and ca. 43% of the hunters with a full-time hunting license in Subarea 1, 2 and 3, respectively (Table 1). Overall, they represented ca. 9% of all registered full-time hunters in the towns and settlements visited during the study.

About 66% (N=50) of the interviewed hunters were on our list of potential informants (*i.e.* they were "pre-selected") with experience in walrus hunting and therefore with knowledge about walruses in general. The remainder were "peer-recommended" by other hunters to be knowledgeable about these matters (Table 1).

Of the 76 informants, 66 (ca. 87%) had reported hunting walruses through the *Piniarneq* catch reporting system during 1993–2008. The average number of walruses reported/hunter/16 year period (1993–2008) were: Subarea 1: 15.2 (SD=15.5, range: 1–64 walruses, N=22 *i.e.* number of interviewees who had reported the catch of walrus); Subarea 2: 7.6 (SD=8.4, range: 1–34 walruses, N=14) and Subarea 3: 28.1 (SD=41.4, range: 1–174 walruses, N=30). The differences among average number of walruses reported reflect the difference in the relative importance of walrus in the marine subsistence hunting culture in the various subareas.

The interviewees were asked about their age when they (1) were interviewed, (2) for the first time participated in a walrus hunt, and (3) they themselves caught a walrus for the first time (Appendix 1, Questions 1–3).

The age distribution of the informants did not differ statistically significantly across areas (F=0.832, P=0.439, df: 73/2), Table 2. However, the average age at their first walrus hunt was significantly lower in Subarea 3 (the Qaanaaq area) than in the other two more southern areas (F=13.291, P<0.001, df: 67/2); Table 3, Fig. 2. It may, however, be noted that several hunters were only able to give an approximate age when they first participated in a walrus hunt. Nevertheless, 10 hunters (ca. 32%) in Subarea 3 reported that they were ≤10 years of age when they first participated. Hence, in this subarea the

informants had a significantly longer experience with walrus hunting compared to the other subareas.

**The catch of walruses, overall hunting "strategies", and the use of products (Appendix 1 and 2, Questions 4–9)**

We asked the hunters about how often they went walrus hunting during the year. The purpose was to find out how active the individual hunters were in hunting walruses, thereby providing information about the importance of walrus hunting in general.

Our study showed that hunting walrus is still an important element in the subsistence hunting culture in W and NW Greenland. In all subareas the answers indicated that hunters still go on hunting trips that are specifically dedicated to hunting walrus. However, it also became apparent that walruses are of relatively greater importance in Northwest Greenland (Subarea 3, the Qaanaaq area) where ca. 36% of the interviewees said that they go walrus hunting >5 times a year (Appendix 2, Table 4).

Overall: Among 41 informants who provided qualitative statements about how often they go walrus hunting, 15 (ca. 37%) stated that their hunting activity had decreased after the introduction of quotas (see also Section: Quotas). Another reason given for a decrease in walrus hunting activity was that the sea ice had deteriorated (see Section: Climate and walruses).

In all subareas it is still common to go on hunting trips where the primary target is walrus. When asked the question *"Do you sometimes go hunting only for walrus"*, ca. 44% of the informants said that this was the case (Appendix 2, Table 5). However,

| Question 1 | | | | | |
|---|---|---|---|---|---|
| Subarea | Mean age (years) | SD | Median age (years) | Min-Max. (years) | N (interviewees) |
| 1 | 52.9 | 9.2 | 53.5 | 33–79 | 30 |
| 2 | 49.6 | 9.2 | 47.0 | 33–74 | 15[1] |
| 3 | 50.3 | 12.6 | 51.0 | 22–71 | 31 |
| 1: 15 hunters were interviewed. However, two were interviewed on the same occasion resulting in a total of 75 interviews. | | | | | |

**Table 2.** Ages of walrus hunters (by subarea) when interviewed in 2010.

| Question 2 and 3 | | | | | |
|---|---|---|---|---|---|
| Subarea | Mean age (years) | SD | Median age (years) | Min-Max. (years) | N[1] (interviewees) |
| 1 | 20.6 | 7.5 | 20.0 | 7–38 | 28 |
| 2 | 23.4 | 10.3 | 20.0 | 12–52 | 12 |
| 3 | 13.3 | 5.6 | 13.0 | 4–29 | 30 |
| 1: Some were not able to answer this question because they did not remember exactly. | | | | | |

**Table 3.** Ages of interviewees (by subarea) when they caught walrus for the first time.

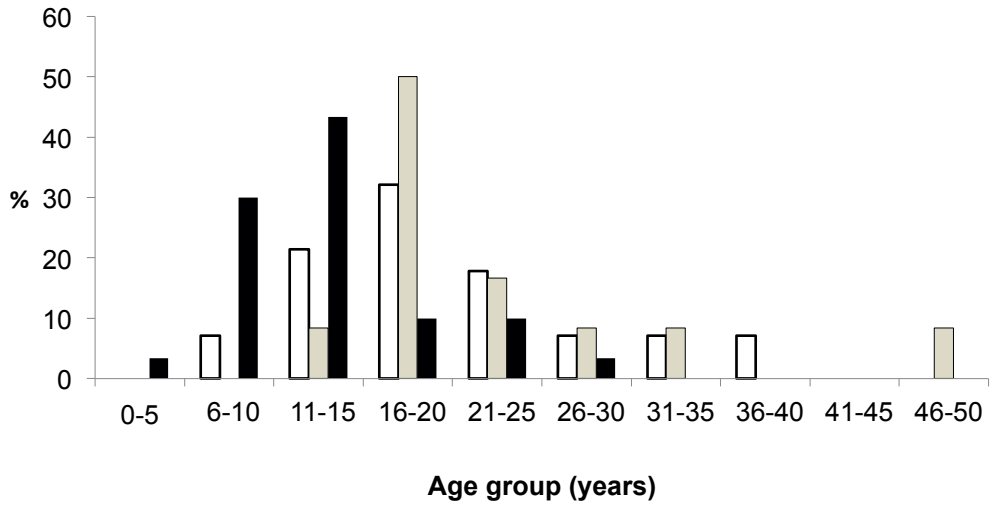



**Fig. 2.** Age distributions of the informants at their first participation in a walrus hunt. White: Subarea 1, N=28 walrus hunters. Grey: Subarea 2, N=12. Black: Subarea 3, N=30. Some hunters could not remember when they participated in their first walrus hunt.

when asked if they only hunt walrus if they encounter them by coincidence ca. 80 % of the interviewees answered in the affirmative (Appendix 2, Table 6). It became clear from the answers to both questions that walruses are often taken during hunting trips targeting also other species like beluga (*Delphinapterus leucas*), narwhal (*Monodon monoceros*) and polar bears (*Ursus maritimus*).

The hunters were asked in which months they hunt walrus. The distribution of months in which walruses are caught (Appendix 1, Question 6) differed significantly among subareas ($P<0.0001$, $\chi^2=93.544$, $df=22$), reflecting differences in a combination of availability of walruses, sea ice conditions and hunting regulations in the various areas.

In Subarea 1 there is a clear peak in March–April which reflects that the hunting season starts 1 March (Fig. 3). The answers from the informants indicated that the reason fewer walruses are taken in April compared to March is that the local market is saturated early and/or that walruses have started to emigrate from the hunting grounds maybe as a result of the combined effect of the westward retreat of the "West Ice" and disturbance from the hunt. Despite the fact that walruses are protected in January–February in Subarea 1, some hunters indicated that they had taken walrus during these months. Hence, the introduction of a hunting season has limited the catch of walruses during February when they are otherwise available closer to the coast as mentioned by some informants.

According to the latest hunting regulations (Anon. 2006), walruses can be taken year-round in Subarea 2 and 3 except during July-September. The apparent lack of

Nielsen Olsen (aged 61 in 2010) from Sisimiut said that walruses are often taken during hunting trips where the hunters also hunt for beluga and narwhal. Photo: A. Heilmann

walrus hunting in Subarea 2 in December may reflect that the annual quota has been used up in months previous to December (Fig. 4). The interview study indicated that in Subarea 2 the relatively small quota is used up quickly; hunters living in the northern settlements of Subarea 2 mentioned that the quota was used up by hunters living further south in the subarea before they themselves could get access to the walruses.

In Subarea 3 the interviews showed that walruses are taken at all times of the year, but the hunt is concentrated during January–June with a peak in May, and October–November (Fig. 5).

There is still some hunting in January–March on the thin ice but according to the interviews this has become increasingly difficult and dangerous due to deteriorating ice conditions. The "thin-ice hunt" for walrus is traditionally practiced during winter and early spring. A newly formed layer of thin sea ice covers the walrus feeding grounds during this period and walruses may continue foraging because they are able to break through the thin ice to breathe. When the weather is stable and the new ice has not been covered with snow the hunters are able to walk out on the thin ice to catch walruses by harpooning them when they break through the ice. The primary area for the "thin-ice hunting" is at the entrance to Murchison Fjord (Vibe 1950; Born 1987a).

Nowadays the hunt in the spring peaks in May (Fig. 5), which according to the informants is caused by the sea ice breaking up and the walruses leaving the hunting grounds earlier than before. Although the interviews indicated that there are still some catches in September, the fall catch takes place in October–November due to a

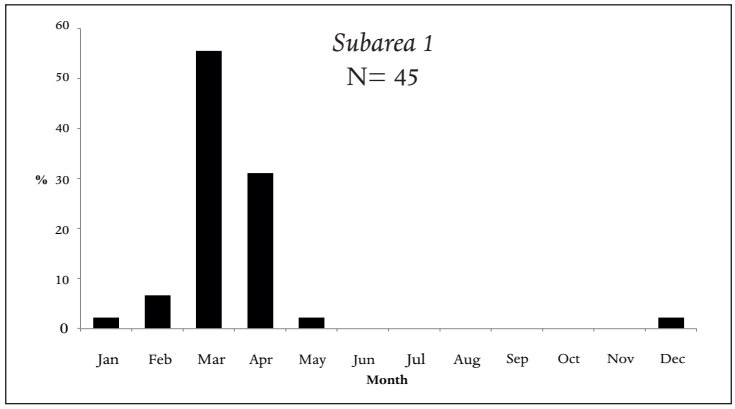



**Fig. 3.** Distribution of months in which walruses are caught in Subarea 1 according to hunters who were interviewed in 2010. N=Number of months specified by 28 informants.

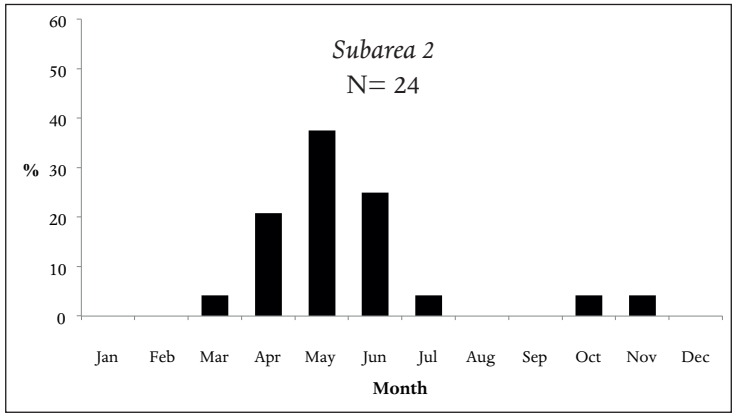



**Fig. 4.** Distribution of months in which walruses are caught in Subarea 2 according to hunters who were interviewed in 2010. N=Number of months specified by 13 informants.

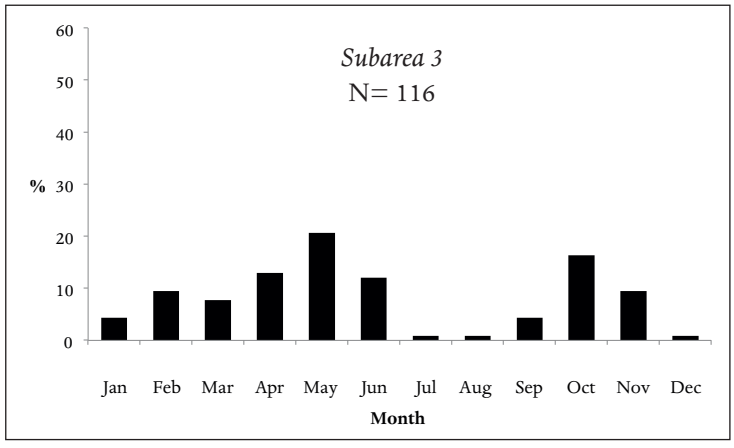



**Fig. 5.** Distribution of months in which walruses are caught in Subarea 3 according to hunters who were interviewed in 2010. N=Number of months specified by 30 hunters.

later formation of sea ice and therefore later arrival of walruses from other areas (*i.e.* Ellesmere Island and the Kane Basin region).

Several informants said the catch of walruses is often combined with hunting for other marine mammals. In Subarea 1 the answers indicated that walruses are often taken during hunting trips that are mainly targeting beluga and/or narwhal. In Subarea 2 hunting walrus is combined with hunting for polar bears. Beluga, narwhal and polar bears are highly praised hunting animals, which occur in the same areas as walruses during winter and spring. Furthermore, in Greenland the products from these three species are more economically valuable than that of walrus (this study; Sejersen 2001). Some informants indicated that restrictions to hunting narwhal, beluga and polar bears have also influenced the walrus hunt to some extent. The reason given was that when the quotas for these more valuable species have been used, the hunting pressure on walruses decreases because they are often taken as a "secondary" species during hunting trips mainly for narwhal, beluga and polar bears.

The interviews showed that edible walrus products (skin, blubber, meat, liver, heart) are still used for human consumption or are fed to sled dogs (Appendix 2, Table 7).


Meat from various marine mammals including walrus is sold at the open air market ("*brædtet*") in Sisimiut. March 2006. Photo: E.W. Born

In all subareas the edible walrus products are shared among kin and friends (Appendix 2, Table 7), keeping a traditional sharing culture alive as also described for beluga (Sejersen 1998, 2001 and references therein).

Traditionally, walrus hide, blubber and meat were stable food items for sled dogs (Vibe 1950; Born 1987a), and according to our study, this is still the case in Subarea 3 (and to some extent also in Subarea 2). However, due to decreasing stable sea ice, and a shift in occupation from hunting to fishing, the number of sled dogs in Subarea 1 has decreased substantially (this study; Anon. 2014a), which was given as one explanation for the decrease in demand for walrus in this area.

In West Greenland it is not permitted to have dogs for a dog team south of 66°N in the Sisimiut area (Anon. 1998b; Anon 2010a). Hence, the incentive for the hunters in Kangaamiut and the areas south of this village to hunt walrus is not to provide food for their own dogs, but to acquire meat for human consumption (or to obtain edibles that can be sold as dog food in areas farther north).

The selling of walrus products represents a source of cash income for the hunters. Skulls, tusks and penis bones are sold to provide cash income necessary in a modern

Walrus hide and meat are staple food items for the sled dogs, especially in the Qaanaaq area in NW Greenland. Several interviewees in this area complained that a decrease in the catch of walruses has made it difficult to provide enough food for their sled dogs. Photo: E.W. Born

hunting culture to cover expenses, for example fuel and loans to buy boats, etc. In particular, the selling of tusks (sometimes still imbedded in the skull and sometimes loose) has a relatively high economic value. We were therefore interested in knowing how it was decided among the participants in a walrus hunt who would get the tusks and the subsequent income received from selling them.

In all subareas it is common practice that the owner of the boat gets the income from selling the skull and tusks. However, sharing the income among the participants in the hunt is also common (Appendix 2, Table 8).

## Trends in the catch of walruses (Appendix 1 and 2, Questions 10–16)

To serve as background for the presentation of trends in the walrus catch, the regional quotas for the years 2007–2010 (and 2016) are shown in Table 9 (Appendix 2).

The hunters were asked how many walruses they themselves had caught during 2008 and 2009. In all subareas the number of walruses caught per hunter who had caught walrus in 2008 and 2009 varied between 2.4 and 2.8 walrus, respectively (Appendix 2, Table 10).

The estimates provided by the interviewees when asked about how many walruses had been landed in their settlement/town in 2008 and 2009 varied considerably, and in many cases the estimated number differed from numbers reported to the management authorities via the catch reporting systems *Piniarneq* and *Special Forms* (Appendix 2, Tables 11, 12 and 13).

Of 71 interviewees who answered the question of whether there had been a change in the number of walruses taken in their settlement/town (Appendix 2, Question 14), ca. 76% said "yes" and the remainder said "no". Among the 54 hunters who also expressed an opinion about the direction of the change, ca. 93% indicated a general decrease in the catch of walruses whereas ca. 7% said that the catch had increased. The fraction of answers indicating a decrease was particularly high in Subarea 3 (Appendix 2, Table 14).

The hunters who said that the catch of walrus had decreased gave several reasons for this trend: (1) the introduction of a quota on walrus (and also quotas for beluga, narwhal and polar bear in the case of hunting trips mainly targeting these species with walrus as a "secondary" species), (2) decrease in market demands, (3) a general decrease in number of hunters, and (4) climate changes resulting in walruses spending less time on the traditional hunting grounds and bad ice and weather conditions influencing the ability of hunters to access the walruses.

Several hunters expressed that the introduction of quotas had resulted in a general decrease in the catch of walruses (see also Section: Quotas). To further explore if the introduction of quotas had caused a marked decrease in walruses caught (and reported), we extracted data on walrus catches reported to the *Piniarneq* between 1993 (year

of introduction of this reporting system) and 2012 from the settlements and town visited during this study. In all areas the reported catch of walrus in *Piniarneq* showed a negative trend with a gradual decrease during 1993–2012 (tests for correlation catch/year were all statistically significant, P≤ 0.01, data not shown) with no marked decrease in catches after 2006 (Figs. 6–9).

To further detect tendencies in individual catches over time we also looked at the number of walrus reported annually during 1993–2010 by six experienced hunters living in Siorapaluk and Qaanaaq in Subarea 3. These hunters (average age in 2010: 53.5 years; range: 43–63 years) were selected because they had regularly reported walrus catches (*i.e.* in 13 to 17 years during 1993–2010). The annual catch fluctuated for all six hunters but for unknown reasons there was a peak in their annual catches during 2000–2003 (this peak is also apparent in the total catches reported from these communities, Fig. 9). Overall however, their catch dropped markedly in 2004 and not after 2006 (data not shown).

Hence, sources other than the interviews indicate that several factors may have led to a general decrease in the catch of walruses. Since the early to mid-1990s, sea ice extent in West Greenland has decreased markedly with earlier spring break-up and later fall formation (Born 2005a; Stirling and Parkinson 2006; Heide-Jørgensen *et al.* 2010; Peacock *et al.* 2012; Dietz *et al.* 2014; Laidre *et al.* 2015). An increase in temperature

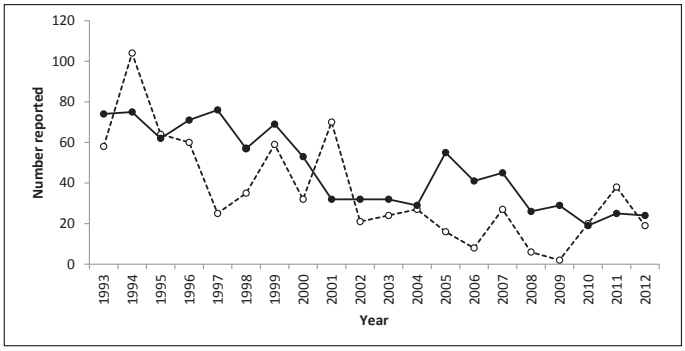



**Fig. 6.** Trends in the catch of walruses (1993–2012) reported to *Piniarneq* (see Material and Methods) in Subarea 1 from Sisimiut (black line) and seven other towns and settlements (stippled line) that were visited during an interview survey in 2010. Traditionally Sisimiut is the most import "walrus town" in this area and is therefore shown separately.

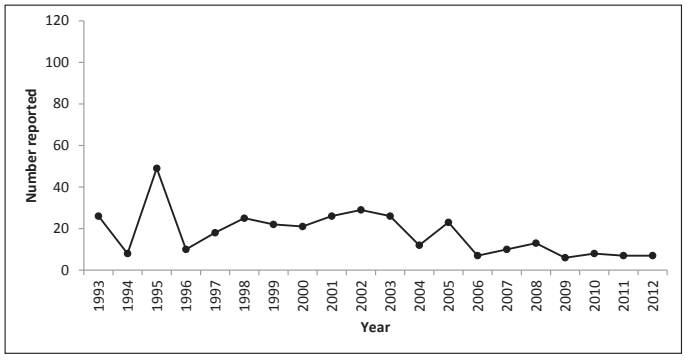



**Fig. 7.** Trend in the catch of walruses (1993–2012) reported to *Piniarneq* (see Material and Methods) in Subarea 2 from nine towns and settlements that were visited during an interview survey in 2010.

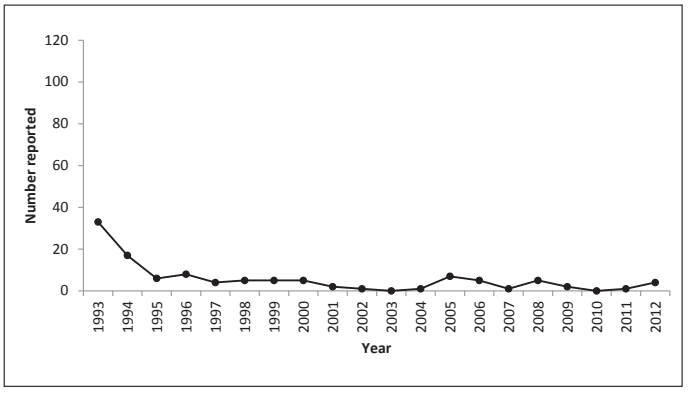



**Fig. 8.** Trend in the catch of walruses (1993–2012) reported *to Piniarneq* (see Material and Methods) from Savissisivik and Qeqertat in Subarea 3.

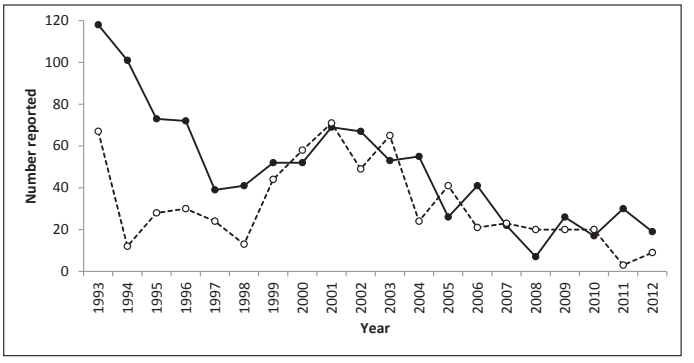



**Fig. 9.** Trends in the catch of walruses (1993–2012) reported to *Piniarneq* (see Material and Methods) from Qaanaaq (black line) and Siorapaluk (stippled line) in Subarea 3.

and decrease in sea ice cover have also been documented for NW Greenland since the 1990s (Born *et al.* 2011a; Heide-Jørgensen *et al.* 2013; Gearheard *et al.* 2013). The interview survey clearly showed that the climate changes with worse sea ice conditions and unpredictable weather have made walrus hunting more difficult in all subareas. This has particularly been the case with the traditionally important "thin-ice hunt" in the Qaanaaq area, which nowadays is only rarely practiced because the thin ice does not form or is broken up unexpectedly due to strong winds from the south (This study; Born *et al.* 2011a). Furthermore, the interviews indicated that accumulation of more snow on the surface of the thin ice nowadays makes it difficult to walk softly and silently when sneaking up on walruses as they surface through the ice (This study; Born *et al.* 2011a). Vibe (1950) mentioned that the "thin-ice hunt" stopped when snow had accumulated on the thin ice.

Hence, both the interview survey and other sources indicate that climate change has been a major factor responsible for a general decrease in the catch of walruses during the last two decades (see also Section: Climate and walruses).

An additional factor causing the decrease in catches, as mentioned by hunters in Subarea 3 is that it is possible to launch skiffs at the ice edge and go walrus hunting

relatively early in the season due to lighter ice conditions. It was suggested by some informants that this "disturbance" (*i.e.* hunt) induces an escape response in walruses. Therefore, soon after the hunt has commenced, the walruses migrate to the eastern coast of Ellesmere Island where they are not hunted (This study; Born *et al.* 1995).

Finally, it should be mentioned that the walrus quotas in Greenland were designed for a gradual reduction of the catch (NAMMCO 2006a: 166). In later years however, the quotas for the Greenlanders' take of walruses from the E. Baffin Island-W Greenland and the N Baffin Bay stocks have been raised slightly (Appendix 2, Table 9) due to new scientific advice about abundance. However, the quotas still only represent ca. 70% of pre-quota catches reported in W and NW Greenland.

### Categories of walruses caught (Appendix 1 and 2, Questions 17–20)

We were interested in information about whether walrus hunters selectively hunt for either gender and/or specific age groups of walrus. The reason being that the sex and age composition of the catch influences productivity of the population and conse-

Five walrus hunters were interviewed in Attu (population: 221 Greenlanders in 2010) where traditionally hunting of walrus is important. March 2006. Photo: E.W. Born

quently determines the level of sustainable removals (NAMMCO 2010; Witting and Born 2005, 2014).

Although the interview study showed that both genders are caught, it also indicated that the catch is skewed towards males to an unknown extent (Appendix 2, Table 15). It appeared from the answers in all three subareas that if given the choice (*i.e.* in a group of walruses) the hunters would target certain walruses specifically (Appendix 2, Table 16). In such cases they tend to hunt selectively for big walruses and particularly big males. The motivation is a wish to get animals with a lot of meat and with big tusks. Some informants indicated that the quota system with restrictions on numbers is a further incentive for targeting big walruses (authors' note: Which also means for older and sexually mature walruses). However, other informants said that they prefer younger walruses and/or adult females because they have more tender meat.

We asked the hunters if they had ever caught pregnant walruses (Appendix 1, Question 20). The purpose was to gain further insight into the extent to which adult females are taken. Peak mating season in walruses is January–February (Fay 1982; Born 2001). Implantation occurs in June–July (Fay 1982), and the peak birth period is late May–June–early July (This study; Vibe 1950; Born 2001).

In Subareas 1 and 3 where the hunters generally have more experience with walruses and walrus hunting than in Subarea 2, the majority of interviewees said that they had caught pregnant walruses (Appendix 2, Table 17). This was particularly the case during March–April. In Subarea 3, however, observations of pregnant walruses were made during February–June as well as at other times of the year (Appendix 2, Table 18).

## Hunting methods (Appendix 1 and 2, Questions 21–28)

Basically, there are four hunting methods when hunting walrus: (1) on or among pack ice from boat, (2) in open water, (3) at a breathing hole (*e.g.* during the "thin-ice hunt" as practiced in Subarea 3), and (4) on or at haulout sites. These hunting methods are similar in all areas of the range of walruses (Russia, Alaska, Canada and Greenland; NAMMCO 2006b), except for the fact that in Greenland it is no longer permitted to hunt walruses hauling out on land (Anon. 2006).

Walruses are large and dangerous animals to hunt, and in almost all cases several hunters (or skiffs) participate in the hunt in order to minimize risks and to bring back the products, which can amount to several hundred kilos per walrus (*e.g.* Born 1987a; Knutsen and Born 1994). The number of walruses that can be taken during a hunting trip and in turn the amount of edible products (skin, blubber, muscle etc.) that can be transported home depends on vessel size.

The hunters were asked which type of boat or other means of transportation (*e.g.* sled) they use when hunting walrus.

Piitannguaq Platou (aged 58 in 2010) from Sisimiut said that if given the chance, the hunters will select the biggest walruses with big nice-looking tusks. Some of the other informants preferred smaller animals with more tender meat. Photo: A. Heilmann

Hunting methods in W and NW Greenland differed among subareas, and was largely related to equipment (vessel type *i.e.* skiff vs. cutter and use of dog sleds or not).

We defined a skiff as a boat up to 20 feet long. A boat larger than this was defined as a cutter (*i.e.* a <20 BRT/15 BT fishing vessel made of wood, fibre glass or steel with an inboard engine). Some hunters specified which type of boat they owned. They were typically "Poca 400–600" or "Nuumiit 19" skiffs. Among types of cutters, "AWI 27" was mentioned.

Generally, the type of vessel used during the walrus hunts varied among the three subareas. This reflects a combination of regional differences in environmental conditions (in particular in sea ice), hunting and fishing practices, seasonal occurrence of walruses, and to a certain extent social and economic conditions in the communities.

The interviews showed that cutters are primarily used during walrus hunts in Subarea 1, whereas in the other subareas the hunters predominantly use skiffs (Appendix 2, Table 19). This difference reflects both environmental and socio-economical factors. The majority of interviewees in Subarea 2 said they mainly use skiffs when hunting walruses, whereas in Subarea 3 about 26% of the answers showed that "skiff and sled" are used in combination. Hunters in this area in particular use dog sleds for transport-

In Subarea 3 the hunters go by dog sled to the ice edge in spring where they camp and hunt for walrus, narwhal and seals. Photo: E.W. Born

ing the skiff (or a kayak in case of hunting narwhals) to the ice edge from where it is launched. This emphasizes the importance of the dog sled as a means of transportation, and in Subarea 3 it was stressed how important the walrus hunt is because it provides the hunter with products necessary for feeding his dog team.

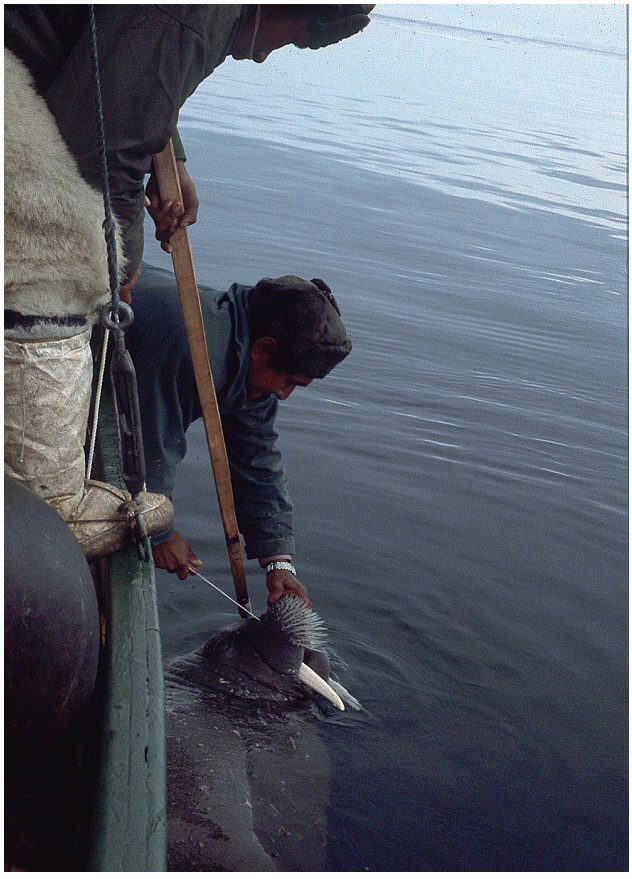
Due to the presence of a longer period of open water in Subarea 1, cutters can operate for longer periods of the year. Furthermore, in Subarea 1 the cutters are used for other resource uses like dredging for scallops (*Chlamys islandica*) and Greenland (snow) crabs (*Chionoecetes opilio*), and trawling shrimp (*Pandalus borealis*) and Greenland halibut (*Reinhardtius hippoglossoides*), and are also used for hunting other marine mammals like beluga and narwhal (This study; Siegstad *et al.* 2001; Rasmussen *et al.* 2005, 2010). Our study indicated that the hunters in Subarea 1 who use cutters for hunting walrus have certain advantages compared to those who only have skiffs. Cutters can go further offshore than skiffs to the eastern edge of the Baffin Bay-Davis Strait pack ice where walruses occur (and apparently occuring farther offshore nowadays according to this study). Cutters can navigate more easily among this ice, and they are also able to bring back more walrus products than the skiffs. Some hunters in Subarea 3 commented upon the higher efficiency of cutters and/or skiffs with large and powerful engines in contrast to that of skiffs with less powerful engines. It was suggested that there should be a limit to how many walruses can be taken during a single hunting

trip and/or that hunters with relatively slow skiffs should be given priority when allocating the local quota.

Walruses are relatively big animals. Adult male Atlantic walruses reach an average total body mass (TBM) of 1100–1200 kg (Knutsen and Born 1994; Garlich-Miller and Stewart 1998), but some may reach a TMB of ca. 1600 kg (Born and Acquarone 2007). Adult females reach an average TBM of 700–800 kg (Knutsen and Born 1994; Garlich-Miller and Stewart 1998). Hence in terms of the ability to kill a walrus within a short time, the firing distance is of interest – as well as the type of ammunition and the caliber of the firearm. Firing distance is also relevant to the question of losses because a long firing range with a heavy caliber rifle may increase the risk that walruses get seriously wounded and escape before being retrieved.

Hence, the interviewees were asked at which distance they would start shooting to hit a walrus and which weapon they were using (Appendix 1 and 2, Questions 22 and 23).

In all subareas the hunters explained that they use heavy caliber rifles and a harpoon when hunting walruses.



A walrus being prepared so that it can be towed to a place where it can be butchered. A cut is made in the upper lip and the towing line is put through the hole. Photo: E.W. Born

According to the information from the hunters, they fire at walruses at an average distance of ca. 50 to ca. 70 m. Mean of estimates of maximum distance for shooting at walruses was ca. 72 m in Subarea 1, ca. 56 m in Subarea 2 and ca. 48 m in Subarea 3 (Appendix 2, Table 20). The mean of firing distances differed statistically significantly among subareas (P=0.010, F=4.896, df: 70/2) and was significantly higher in Subarea 1 than in Subarea 3 (Tukey-Kramer *post hoc* test). According to some informants, shots may be fired from a distance up to 200–300 m. However, it must be mentioned that in all subareas the estimates of the distance at which one would fire at a walrus had a very broad range (Table 20), and in many cases were given as "approximately" or "less than". In addition, several of the informants explained how the distance depends on the circumstances and on the behavior of the walruses in particular.

According to the interviews the hunters aim at the body of swimming walruses. The purpose of hitting the body of a swimming walrus is to avoid killing it instantly in order to catch up with the severely wounded animal before it can be harpooned and killed.

In contrast to what happens when walruses are in the water, the study revealed that when walruses are hauled out on ice the hunters aim at the neck region to kill the walruses instantly, hoping they remain on the ice. This is similar to the method reported in Alaska (NAMMCO 2006b).

Hunters are ready to shoot at a herd of walruses hauled out on the southern edge of the pack ice in Ikersuaq (Nares Strait-Kane Basin). In such a case the hunters attempt to kill the walrus instantly with a shot fired to its neck region Photo: E.W. Born

A dead walrus with no air trapped in its lungs has negative buoyancy and will quickly sink if it has not been harpooned and anchored to a float (Vibe 1950; Fay *et al.* 1994; Born *et al.* 1995; NAMMCO 2006b). To prevent or reduce loss, regulations for the catch of walruses in Greenland explicitly specify that wounded ("struck") walruses must be harpooned before they are killed (Anon. 2006).

The interviews showed that wounded (or dead) walruses are harpooned and fastened to a float to avoid them from sinking and being lost.

However, the answers indicated an apparent regional difference in the timing of when the harpoon is thrown during the sequence of hunting events. In Subarea 1 and 2 the vast majority of informants said that the harpoon is thrown before the walrus is fired at, whereas in Subarea 3 the answers indicated that the harpoon may be thrown either before or after the shooting depending on the type of hunt. During the "thin-ice hunt" which is practiced in Subarea 3 the harpoon is thrown when the walrus surfaces through the thin ice before it is shot at whereas during the boat hunt the walrus is shot at before a float is attached to it using the harpoon (Appendix 2, Table 21).

According to the informants the harpoon is thrown at a maximum distance of ca. 10 m but usually at 2–3 m (Appendix 2, Table 22).

### Losses ("struck-but-lost" ratio) (Appendix 1 and 2, Questions 29, 30 and 31)

The number of walruses potentially lost during the walrus hunt is largely related to hunting practice and methods. Exact knowledge of loss rates is important for a variety of reasons. For example, information on "struck-but-lost" rates must be included in modeling of population trends and calculations of sustainable catch levels (*e.g* Witting and Born 2005, 2014). For obvious reasons the "struck-but-lost" rate is a controversial issue because any estimate of a high loss rate may indicate the use of unsuitable and wasteful hunting methods.

To get information on loss rate we asked each hunter whether he had lost any walruses during his 2008 and 2009 hunting activities.

Although the interviews indicated that some walruses are lost during the hunt, the estimates of loss rate for the years 2008 and 2009 were relatively low. Information obtained from the hunters indicated that the overall loss rate in 2008 and 2009 averaged ca. 4.6% (13 lost of 285 struck). However, the estimates of loss rate ranged between 1.8% (Subarea 1; 2009) and 12.5% (Subarea 2; 2009); Appendix 2, Table 23.

### "Head hunting" (Appendix 1 and 2, Questions 32 and 33)

The question of "head hunting" (defined as only bringing back head and tusks from a walrus) is sometimes subject to international debate (*e.g.* New York Times 1992; NBC 2007; Vice News 2016) and is from time to time raised as an issue by non-gov-

During the winter hunt on thin ice in the Qaanaaq area, the walruses are harpooned first and then killed by a shot to the head. Iganaq/Dalrymple Rock in the Qaanaaq area. Photo: T. Kristensen

ernmental conservationist organizations (*e.g.* Sea Shepherd 2007; Seal Conservation Society 2016).

According to the Greenlandic hunting regulations, all edible walrus products must be brought back to town or should alternatively be securely cached in a meat depot (Anon. 2006). Hence, head hunting is illegal. However, tusk ivory (and/or whole skulls with tusks) represent a relatively high economic value because these products can be sold nationally or internationally, and can be used for producing local handicraft. Depending on its size and condition, a whole skull with tusks may be sold for at least 4000 DKK in Greenland (ca. 667 US $; July 2010 exchange rate); (this study).

Although the head hunting phenomenon seems to be an issue discussed particularly in regards to the hunting of walruses in Alaska (*e.g.* New York Times 1992; NBC 2007; Vice News 2016), we wanted to explore if head hunting is practiced in West and Northwest Greenland despite its illegality. We did so by asking the informants if they had ever brought back only the head and tusks of a walrus (Question 32) or knew of anybody who had done this (Question 33; Appendix 1).

When asked about whether they themselves had ever brought only the head back from a walrus hunt, ca. 20% of the informants in Subarea 1 answered "yes" whereas all informants in the two other subareas said "no" (Appendix 2, Table 24). Interest-

ingly, when asked whether they had heard or knew about others bringing back only the head, ca. 48% of the informants answered "yes"(ca. 44% answered "no" and the remainder had no opinion on the matter; Appendix 2, Table 25). There was a tendency for informants to have heard about head hunting practiced by hunters from settlements or areas other than from where they themselves lived, which may indicate that the answers to this question were perhaps based on rumors in certain cases.

According to some interviewees, bringing only the head back may sometimes happen if the hunters suspect the walrus is sick or infested with *trichinae* (authors' note: *Trichinella* sp. is an internal parasite that can be transferred to humans if eating infested walrus meat that has not been cooked sufficiently. An average of ca. 2% of walruses may harbor *trichinae*; *e.g.* Fay 1982 and references therein; Born *et al.* 1982). Or, it may happen if the ice or weather conditions become so rough that it is dangerous or impossible to navigate back safely with a fully loaded skiff or cutter. However, the answers also indicated that bringing back only the head was a relatively more common practice when ivory and other products could be traded to the trade companies. It was also mentioned that the introduction of a quota had made the hunters more careful about bringing all products back home. All in all, the interviews indicated that directed head hunting is very rare in Greenland.

## Quotas (Appendix 2, 3 and 4, Questions 34 and 35)

Quotas for the catch of walrus in Greenland were introduced in 2006 (Anon. 2006). The quotas are allocated on a regional basis to the three different walrus subpopulations in Greenland (*i.e.* The West Greenland part of the Hudson Bay-Davis Strait and the Baffin Bay subpopulations, and the East Greenland subpopulation). The regional quotas for West and Northwest Greenland are shown in Table 9 (Appendix 2).

The quotas represented a marked decrease in the catch of walruses. The reported annual catch of walruses in Subarea 3 averaged 114 (SD=36.5, range: 72–171 walrus/year; DFHA *in litt.* 2014) during the ten years (1996–2005) prior to introduction of quotas. The annual quota for 2006 (the year when they took effect in Subarea 3) was 80 walruses. Hence, the quota represented a ca. 30% reduction of the average annual catch. In Subarea 1 and 2 together the annually reported catch during the ten years prior to quotas (*i.e.* 1997–2006) averaged 146 walruses (SD=39.0, range: 72–191 walrus/year; DFHA *in litt.* 2014). The total annual quota for 2007 in Subarea 1 and 2 was 90 walruses. Therefore, in these areas quotas represented a drop of ca. 38% in the annual reported catch.

By asking the question whether quotas are necessary or unnecessary (Question 34), we wanted to explore what the general attitude among the hunters was to the fact that

quotas had been introduced for the walruses hunt. Quotas on this species represented a very new scenario for the subsistence hunters.

Overall, 44% of the 75 interviews indicated that the walrus hunters thought quotas are necessary, whereas 52% of the answers indicated that quotas were considered unnecessary (4% had no opinion about this subject). In Subarea 3 there were comparatively more hunters than in the other subareas who thought that quotas were unnecessary (Appendix 2, Table 26).

In Subarea 1 several hunters mentioned that when the hunting season opens on 1 March the walruses have already moved farther offshore following the retreat of the edge of the Davis Strait-Baffin Bay pack ice which, in their opinion, limits the hunting pressure on walruses in itself. It was also mentioned that frequent harsh weather and difficult sea ice conditions limit the hunting intensity. It was indicated by a couple of interviewees that fishing vessels (shrimp trawlers) operating in areas where walruses occur contribute to walruses moving farther offshore relatively early in spring.

Some informants in Subarea 1 suggested that instead of having a bulk quota, there should be a quota or limit to what a single vessel or hunter should be allowed to catch annually.

In Subarea 2 several informants mentioned that the quota for the entire subarea is generally too small. Some hunters living in the northern parts of Subarea 2 (*i.e.* in the settlements Nuussuaq/Kraulshavn and Kullorsuaq) suggested that there should be a separate quota for the northern areas because walruses become available in this area later in the season than farther south. According to these informants, when walruses can be hunted in the northern area in spring, hunters living further south in Subarea 2 have already used the quota. Some informants expressed that the (small) quotas affect the hunters in an economically negative way, and that the catch of walruses in Subarea 2 has always been modest anyway.

When answering these questions, several interviewees in Subarea 3 were of the opinion that walruses are abundant in the northern Baffin Bay-Smith Sound-Nares Strait-Kane Basin area (*i.e.* the North Water) and that "nature itself" protects the walruses because they are inaccessible during periods with difficult sea ice conditions and strong winds, similar to what some informants in other subareas noted. In Subarea 3 it was also suggested that perhaps a quota of one to two walruses per hunting trip would work (*i.e.* instead of a bulk quota for the area; see Discussion). Lastly, it was mentioned that the quota has made it difficult to sustain a dog team.

By asking the question about the effects brought about by the introduction of quotas (Question 35), we sought information on how, or if for example, the hunting strategies, the catch level, or income of the individual hunter had been affected by the introduction of walrus quotas.

Overall, 64% of the 75 interviews indicated that their catch of walrus decreased after 2006 whereas 28% indicated that the introduction of quotas had had no noticeable

An adult male walrus on Store Hellefiskebanke, April 2008. If given the chance, the hunters target adult male walruses with nice tusks and which also provide a large amount of meat. Photo: R. Dietz

effect on them (the remainder had different explanations, or no opinion on the matter; Appendix 2, Table 27).

The opinion that quotas had caused a reduction in the catch of walruses was most pronounced in Subarea 2 and 3 (Table 27) where the hunting of walruses and other marine mammals is still, to a large extent, important in the local subsistence economy (*cf.* Rasmussen *et al.* 2010).

More detailed information provided by the hunters on this issue is presented in Appendix 2, 3 and 4.

## Distribution, seasonal occurrence and local abundance (Appendix 2, Questions 36–41)

Several explanations were provided on distribution and occurrence of walruses.

The information on distribution of walruses obtained from hunters living in the southern part of Subarea 1 (*i.e.* Maniitsoq to Aasiaat area) indicated that the distribution to some degree reflects variations in seasonal occurrence, extent and density of the pack ice (*i.e.* the "West Ice"). If the pack ice is dense the walruses tend to occur closer to the coast. Walruses may appear in (*i.e.* immigrate to) the area from sometime in December–January. During January–April their general distribution is between ca. 66°

N (*i.e.* west of the entrance to Kangerlussuaq/Søndre Strømfjord) and ca. 68° N (*i.e.* west of Attu) and between 54° and 56° W (*i.e.* on Store Hellefiskebanke; Appendix 2, Map 1). During April–May the walruses have progressively moved farther offshore as the sea ice melts and the edge of the "West Ice" retreats westward towards Baffin Island in Canada. Although the two sexes may occur in the same areas, several answers indicated that on Store Hellefiskebanke, male walruses are distributed farther offshore (*i.e.* at deeper waters) than females and young (Appendix 2, Map 1). According to information from hunters living in the northern parts of Subarea 1 (*i.e.* in Qeqertarsuaq and Kangerluk on Qeqertarsuaq/Disko Island), the walruses occur along the western coast of Qeqertarsuaq/Disko Island when there is sea ice. Apparently their distribution has changed in that they no longer occur as close to the town of Qeqertarsuaq as they used to. During January–April the walruses occur in shallow water areas south of Eqaluit/Nordre Laksebugt (69° 37' N/54° 49' W) and at Akulleq (Mellemfjord) and at Qasigissat (69° 53' N/54° 51' W) north of Akulleq. However, in March–April they move with the sea ice offshore in a northwesterly direction (Appendix 2, Map 2).

According to the informants in Subarea 2 (*i.e.* between the Nuussuaq peninsula in the Uummannaq area and the settlement Savissivik) walruses occur in relatively small,

A group of male walruses on Store Hellefiskebanke northwest of Sisimiut, April 2008. Photo: R. Dietz

specific shallow water areas (polynyas) close to the coast. For example, the tips of the Nuussuaq and Sigguup Nunaa/Svartenhuk peninsulas in the Uummannaq area and the Nuussuaq/Kraulshavn peninsula farther north were mentioned as areas where walruses may occur regularly during spring (Appendix 2, Maps 3–6). However, during this time of the year walruses can also be seen 75–100 km offshore among the pack ice in the Upernavik town area (Map 5). Information from the hunters living in Subarea 2 indicated that walruses are not generally abundant and are primarily transient during spring (and fall) in this area, which is in accordance with previous information (Born *et al.* 1994, 1995). According to the interviews walruses are observed travelling north in spring and south in the fall although some answers also indicated that some (probably few) walruses might winter in the area.

The interviews indicated that the walruses are transient in the Savissisvik area (Subarea 3) where they migrate north along the edge of the fast ice in late April–June (Appendix 2, Map 6). Although none of the informants from Savissivik specifically mentioned a fall migration in the other direction, this was mentioned by a hunter from Siorapaluk. In fall the walruses re-appear in the eastern parts of the North Water polynya (*i.e.* to the Qaanaaq area or central parts of Subarea 3), usually in September–November (peak: October) and winter there until next May–June when they migrate north to summer along eastern Umimmattooq/Ellesmere Island. Some migrate north along the coast of Qaqqaatsut/Inglefield Land in Greenland to summer in the eastern parts of the Ikersuaq/Nares Strait-Kane Basin area (Appendix 2, Maps 7–12). Hence, the central parts of Subarea 3 are usually devoid of walruses during summer except for a few stragglers and occasional occurrence of small herds. During fall, winter and spring there is a segregation of the two sexes in this subarea: adult males occurring farther south than females and young. The interviews indicated that walruses may occur year round along eastern Ellesmere Island where large numbers have been observed in the Buchanan Bay area (78° 55'N and 74° 50'W) during summer. In recent years walruses have apparently shown a tendency to occur closer to land during the open water season and there were several observations of walruses in Qaanaap Kangerlua/Inglefield Bredning where the waters are deep (Appendix 2, Maps 7 and 9). Walruses were not previously common in this area (Vibe 1950), and the reason for this increased occurrence was not clear. While some hunters took it as a sign of walruses generally having become more abundant, others suggested that it reflected changes in the sea ice conditions.

More details on distribution of walruses in Subarea 3 are presented in Appendix 2 and in Maps 6–12.

Sometimes large groups of walrus can be encountered in spring on the pack ice in southern Ikersuaq (Nares Strait-Kane Basin), such as those shown in this photo taken in June 1990. In the background: Anoretooq/Kap Inglefield (Greenland; left) and Ellesmere Island (Canada; right). Photo: E.W. Born

## Walruses hauled on land (Question 37)

In several places within their Arctic range walruses regularly haul out on land during the period with minimum ice conditions, or the open-water season (*e.g.* Fay 1982; Born *et al.* 1995 and references therein). Historically, walruses hauled out regularly on terrestrial haulouts in several places in Subarea 1 between ca. 64° and ca. 70° 30' N. In particular, there were several haulouts at the entrance to the Nassuttooq fjord (Born *et al.* 1994, 1995). However, due to hunting at the haulouts the walruses no longer frequented these sites after the 1940s (Born *et al.* 1994). Further north, in Subarea 2 and 3, only a few places had been identified where walruses occasionally hauled out until perhaps sometime in the beginning of the 20th century (Born *et al.* 1995 and references therein).

We were interested in information on observations of walruses hauling out on land. In a rapidly warming Arctic with reduced sea ice cover (*e.g.* Laidre *et al.* 2015) it may be expected that Atlantic walruses will be forced to spend more time hauling out on land (Born 2005a and references therein; Laidre *et al.* 2008 and references therein). This behavior has already been observed in the Pacific subspecies (*O. r. divergens*) since 2000 in the Chukchi Sea-Bering Strait region (MacCracken 2012).

The interviews indicated that walruses do not use terrestrial haul-outs (*"uglit"*) in West Greenland. Walruses from the West Greenland-SE Baffin Island stock only use haul-outs on SE Baffin Island during summer such as the one pictured on Angijak Island (Cumberland Peninsula) where 745 walruses were hauled out on 26 August 2005 (Stewart *et al.* 2014b). Photo: E.W. Born

In Subarea 1, ca. 33% of the hunters said that they had seen walruses on land. In contrast, only ca. 10% of the informants in Subarea 3 and none in Subarea 2 had observed this (Appendix 2, Table 28). In Subarea 2 an informant had heard about another hunter who had shot a walrus on land at Illorsuit in the 1990s (Map 4, Obs. 22). Generally, the few observations of walruses on land were sporadic, and in each case only a single or a couple of animals were noted. The exception was a large herd of both sexes observed near Inuarfissuaq on the northern coast of Inglefield Land in 1967?–1969? (Appendix 2, Map 9, Obs. 58).

## Change in distribution (Questions 38 and 39)

The hunters were also asked if they had observed any changes in distribution of walruses during the last 10–15 years.

Overall, 56% of the informants had noted some changes in recent years whereas 35% said they had not (the remainder expressed no opinion on this matter; Appendix 2, Table 29).

In Subarea 1 walruses were reported to occur farther offshore than before due to the reduction of sea ice, which according to the hunters has resulted in ice break-up occurring earlier and the eastern edge of the Davis Strait pack ice being positioned farther to the west. A general shift in distribution farther offshore was also noted in Subarea 2.

It was mentioned that nowadays walruses in Subarea 1 arrive later in fall and emigrate ("disappear") earlier in spring (see also section: Climate and walruses). In Subarea 3 the informants also mentioned how the walruses in recent years leave the hunting grounds (*i.e.* the banks in the eastern parts of the NOW vis-a-vis the Qaanaaq area) earlier in spring (nowadays in May–June as opposed to June–early July previously) and arrive to these areas later in the fall (in October–November as opposed to September–October previously). The hunters ascribed this change to be a result of the decrease in sea ice.

Walruses may be affected by noise and fishery activity (*cf.* Born *et al.* 1995; NAMMCO 2006a). Some hunters in Subarea 1 mentioned that walruses may also have changed distribution due to noise and other impacts from fisheries (trawling for shrimp and dredging for scallop). The adverse effects were thought to be due to underwater noise and competition between walruses and fisheries for benthic resources. In Subarea 1 there is substantial fishing activity on and especially at the banks' edges where walruses occur (Born 2005a: 38).

Our study indicated that walruses have begun to occur farther inshore (*i.e.* farther to the east and also farther into fjords with deeper waters) in Subarea 3 during the open water season. Hence, walruses have come closer to populated areas where they were not seen earlier. The Qaanaaq and Appat/Pituffik (North Star Bay) areas were mentioned specifically.

## Local abundance (Questions 40 and 41)

We asked the hunters if they had observed any changes in abundance on the walrus hunting grounds in recent years, and if so, if they had an explanation for the change.

Overall, ca. 44% of the informants were of the opinion that walruses have become more abundant on the hunting grounds in W and NW Greenland during later years, whereas ca. 35% thought that the abundance was unchanged (ca. 7% thought that walrus numbers had decreased and the remainder had no opinion about this matter); Appendix 2, Table 30. Several hunters had observed more walruses within the hunting areas and deduced that this was a sign of a population increase, which was attributed to a reduction in level of exploitation due to (1) quotas, (2) a reduced demand of walrus products, (3) a decrease in the number of active hunters, and (4) a general shift to a more profitable fishery and other occupations.

According to the interviewees in Niaqornat in Subarea 2, walruses are often found in spring in a small polynya at the tip of the Nuussuaq peninsula at the entrance to Uummannaq Fjord. However, this adult male was observed in dense pack ice at 70° 54' N and 56° 09' W (*i.e.* ca. 60 km NW of the tip of Nuussuaq) on 16 April 2009 during a polar bear survey. Photo: Ø. Wiig

## Climate and walruses (Questions 42 and 43)

In general, effects of climate change on walruses were reviewed in *e.g.* Born (2005a), Laidre *et al.* (2008), MacCracken (2012) and Kovacs *et al.* (2015). Born (2005a) reviewed and discussed historical and contemporary climate change effects on Greenland's walruses, in particular.

In Subarea 1 and 3 where walruses occur regularly and for a greater part of the year, about 66% of the interviewees said that walruses are influenced by climate change. In contrast, only ca. 29% of informants were of this opinion in Subarea 2, where walruses are generally few and mainly transient (Appendix 2, Table 31).

About 84% of the interviewees from all three subareas who thought that climate changes had affected walruses mentioned a change in geographical distribution and a change in the time of arrival to and disappearance from the hunting areas (or a combination of a change in distribution as well as in timing of immigration and emigration; Appendix 2, Table 32).

Informants in Subarea 1 mentioned that walruses are nowadays distributed farther offshore due to the decrease in sea ice (*i.e.* the edge of the Baffin Bay-Davis Strait pack

ice is located farther west). It was also commented on how the variable and unpredictable sea ice conditions had made it increasingly more difficult to hunt walruses. Some informants expressed the opinion that the fact that walruses tend to occur farther offshore and emigrate earlier due to changing sea ice conditions had reduced the hunting pressure which had resulted in an increase in local abundance.

The interview survey indicated that for hunters who use skiffs, it is difficult and dangerous to reach walruses far offshore, let alone less profitable because of an increased use of fuel, and the fact that skiffs can only bring back a relatively small load of edible products from a walrus hunt. Hence, generally the climate changes favor hunters with larger boats. During the interview survey several informants also complained about instances where a single boat had brought back several walruses, saturating the market and taking an "unfair share" of the quota. Furthermore, with a hunting season

If the pack ice is "open" (less dense) it is easier to reach the walruses. However, in these cases they may be farther offshore and more difficult to reach for small skiffs. Because cutters can operate farther offshore than skiffs, they have the advantage during the walrus hunt. Store Hellefiskebanke, March 2006. Photo: E.W. Born

restricted to March–April in Subarea 1, the walruses may have already initiated their emigration from the hunting areas in the later part of the hunting season.

In Subarea 1 and 3 the informants reported that the walruses arrive later in fall to their main feeding grounds (and hunting grounds), and disappear from these grounds earlier in spring. In particular, this was noted now to be the case in Subarea 3.

Some informants in Subarea 3 ascribed the earlier emigration from the hunting areas in spring to a combination of earlier ice break-up and an escape response due to an early (earlier) start of the walrus hunt with skiffs (and cutters).

Several informants referred to "good" or "bad" sea ice conditions. This not only related to whether the relatively dense sea ice usually preferred by walruses is present in any given year, but also to whether the ice conditions allow the hunters to hunt walrus. The interview survey indicated that this was not a simple relationship. "Good" sea ice (*i.e.* stable and dense pack ice over banks) close to the coast may mean easier access to walruses. However, if the ice becomes too dense it may no longer be navigable for small boats and skiffs. "Bad" ice conditions in the Qaanaaq area particularly refer to the fact that unstable weather and sea ice conditions have almost eliminated the "thin-ice hunt" (described on p. 39) during late winter (This study; Born *et al.* 2011a). The unstable and unpredictable climate and sea ice conditions that negatively interfere with the hunting activity was mentioned as an additional factor (apart from quotas) for eased hunting pressure and the consequent apparent increase in walrus abundance.

## Biology (Questions 44–48)

### Period of birth (Question 44)

The peak birth period in Atlantic walrus is late May–early July (this study; Vibe 1950; Born 2001). However, the mating season in walruses is prolonged, and extra-seasonal births are not uncommon (Vibe 1950; Fay 1982; Born 2001). The calf is ca. 110 cm long at birth (Garlich-Miller and Stewart 1999; Born 2001).

Recorded observations of newborn walruses in West Greenland (Subareas 1 and 2) in recent times are very scarce (Born *et al.* 1994). In contrast, some information on period of birth and observations of newborn walruses exist from the Baffin Bay subpopulation in Subarea 3 (Born 2001).

By asking the question about observations of newborns to hunters who regularly visit walrus grounds, we wanted to explore if observations of newborns are more regular occurences than previously indicated by written records (see also Section: Categories of walruses caught).

An opened sand gaper (*Mya truncata*) eaten by a walrus. The sand gaper is one of the preferred food items of walruses. The soft parts have been sucked out by the walrus, leaving only the shells and the siphon sheath. Photo: S. Rysgaard

The answers to the question whether the hunters had observed newborn walruses indicated that this does not happen often in Subarea 1 and 2 (Appendix 2, Table 33). However, the few observations of newborns reported by the interviewees in these areas had been made between March and July. In contrast, about 77% of the informants in the Qaanaaq area (Subarea 3) had seen newborn. According to these observations, peak birth period is May–July but extra-seasonal births had also been observed (Appendix 2).

## Food (Questions 45–48)

A decrease in sea ice will influence marine productivity and benthic biodiversity. Information on potential positive and/or negative effects of a decrease in sea ice on primary production, benthic productivity, and biodiversity is still conflicting and open for debate, while effects may differ among different Arctic seas (*cf.* Josefson *et al.* 2013; Michel *et al.* 2013).

We asked the hunters whether they inspect the stomachs to see what walruses eat, and whether they had noted any changes in what the walruses eat. We were interested in obtaining general information on food types and changes to food types in order to potentially reflect benthic biodiversity changes on walrus feeding banks, perhaps induced by local warming in recent decades.

Overall, ca. 84% of the informants said that they inspect the stomach contents while the walrus is being butchered which usually is shortly after it has been killed. All interviewees in Subarea 3 answered that they do inspect the stomach (Appendix 2, Table 34). This is to a large extent due to the fact that certain stomach contents (*i.e.* the fresh foot of especially *Serripes* sp.) are considered delicacies that are eaten either raw or boiled (This study; Born 2005b: 28).

Although various food items were reported by the interviewees (*e.g.* fish, sand eel, *Ammodytes* sp., and Polar cod, *Boreogadus saida*, and ringed seal, *Phoca hispida*, and harp seal, *Pagophilus groenlandicus*), the information confirmed that walruses in West and Northwest Greenland mainly consume bivalve mollusks (Appendix 2, Table 35). The description of parts of bivalves found in the stomachs indicated that *Mya* sp., *Serripes* sp. and *Hiatella* sp. are common food items.

In Subarea 1 some hunters mentioned Icelandic scallop, which is exploited in commercial fishery (*e.g.* Garcia 2006) and it was therefore indicated there may be competition for this bivalve species between the walruses and the fishery.

During the interviews Icelandic scallop was also reported as walrus food in the Qaanaaq area (Subarea 3). The Icelandic scallop is mainly distributed in SW and W Greenland but has also been reported from the Qaanaaq area (Pedersen 1994; Glahder *et al.* 2003).

The information provided by the informants indicated that seal eating is a more common habit of walruses in Subarea 2 and 3 compared to Subarea 1 (Appendix 2, Table 35).

Our study also indicated that walruses living in Subarea 3 have a broader diet than those occurring farther south (Table 35).

Only three hunters (Subarea 3) mentioned observations of changes in walrus food (Appendix 2, Table 36). All three had noticed instances where the size of the bivalves consumed had decreased. One of the informants ascribed this change to a density dependent effect with more walruses impacting the bivalve stock. Another mentioned a time effect, with the apparent change happening around 2000.

## Recovery of tagged walruses (Question 49)

During 1989 and 2009 (*i.e.* prior to the interview survey) a total of 68 walruses had been tagged either with flipper tags, satellite radio transmitters, or both, in W or NW Greenland or adjacent areas (Subarea 3, N=11; Born *et al.* 1995; Stewart *et al.* 2014a. Eastern Canadian High Arctic, N=18, Stewart 2008. Eastern Baffin Island, N=8, and in Central West Greenland off Sisimiut, N=31, Dietz *et al.* 2014). Some of these wal-

ruses were later recovered by Greenlandic hunters, and their recaptures were reported to the authorities (Born 2005a; Dietz *et al.* 2014). However, by asking the question whether the interviewee had ever caught a walrus which was marked or carried a transmitter we wanted to detect if for whatever reason some hunter recoveries of tagged walruses had not been reported.

Three hunters answered that they had recovered tagged walruses (Appendix 2, Table 37). In each of these three cases, the recapture was reported and tags delivered (Dietz *et al.* 2014; Born, unpublished information).

However, interestingly there were two (perhaps three?) reports of observations in Subarea 2 and 3 of walruses fitted with satellite transmitters. These walruses were not caught. A hunter from Niaqornat in Subarea 2 mentioned that in 2003 (year uncertain), he saw a walrus with a satellite tag on the tusk at the tip of the Nuussuaq peninsula in the Uummannaq area. This walrus was in a herd of walruses and was not hunted. It is unclear if this is the same instance that another hunter from Niaqornat referred to. According to him he saw a tagged walrus at the Nuussuaq peninsula in 2007, and in this case they also did not catch the walrus.

Finally, a hunter from Qaanaaq in Subarea 3 said they saw a big male walrus in October 2008 (site not stated). When they were about to shoot it, they realized it had a radio transmitter (no information on type; *i.e.* whether a tusk transmitter or a transmitter attached to the skin) and therefore they did not hunt it.

## Other comments/final statements (Question 50)

At the end of an interview, each hunter was asked if he had other information or comments that he would like to offer. The informants were free to comment on whatever subject they wanted. The purpose was to enhance the interviewees to provide comments on matters that were not necessarily captured by the pre-determined questionnaire. A total of 46 "summary" comments were offered (Appendix 5). One informant provided his "summary" comments while drawing on a map (information no. 35, Map. 6).

Several of these comments were a recapitulation of comments offered when answering previous questions. The final comments fit into these overall categories: (1) Quotas and abundance of walruses, (2) the timing of the hunting season, (3) potential future trophy hunting of walruses and tourism, (4) climate and walruses, 5) effects of noise, and (6) miscellaneous other comments.

The various "final" comments are summarized in Appendix 2, and individual statements are presented in Appendix 5.

# Discussion

## Study purpose, design, selection of informants, and evaluation of the interview survey method

The purpose of our study was to collect factual information from the users about walruses and the walrus hunt (*cf.* Houde 2007). Hence, we sought LEK (Local Ecological Knowledge) and/or LFK (Local Fisheries Knowledge) information, the majority of which can only be supplied by the walrus hunters, and which supplements information collected via scientific studies.

Several factors may inevitably influence a LEK study like the one we made. Both LEK and data derived by expert-based science vary temporally and spatially. As pointed out by Brook and McLachlan (2005, and references therein) it is clear that the areas that hunters frequent and the degree of familiarity may vary among individuals. Furthermore, the responses received by researchers when interviewing local people also vary because of many other factors, which include the context for the interviews, the level of familiarity with the interviewees and local culture as a whole, and how the resulting data are interpreted. Thus, the commonality among all studies, whether based upon scientific data on wildlife populations, documenting LEK, or incorporation of the two, is that the approach taken, the methods used, and the scale of consideration all fundamentally influence the study results (*ibid.*).

Armitage and Kilburn (2015) list several considerations to make when planning and conducting a LEK interview study including (1) scope/objectives of the study, (2) research team and the role of the principal investigator (PI), (3) research design, (4) commitment to data quality check, and (5) confidentiality.

### Purpose

We were seeking LEK information from the users themselves about several issues related to evaluation of the status of two walrus subpopulations exploited by Greenlanders. The background for initiating the interview survey was the premise that the users possess a wealth of knowledge about walruses acquired through their hunting activities. This information in many cases is almost impossible or very difficult to obtain in any other way (*e.g.* information on hunting strategies and methods, observations of walruses on land, reaction of walruses to different sea ice conditions,

observations of newborns), and is thus important to collect and include in the overall evaluation of walrus exploitation in Greenland.

Hence, the main purpose was to specifically inform the Greenland Institute of Natural Resources, GINR (as well as managers and the general public both nationally and internationally) about LEK aspects of an important Greenlandic renewable resource.

## The research team

Formal interview methods are best deployed where researchers already have a good grounding in the culture of the interviewees and know how to craft meaningful questions well (Armitage and Kilburn 2015).

Our study benefitted from the fact that both Anna Heilmann and Lene Kielsen Holm have Greenlandic as their native tongue, are fluent in both Danish and English, and have conducted interview surveys before in the areas in question. Hence, a difference in language was not a barrier between the interviewer and the interviewees. The biologists involved in the study all have extensive experience from studies of marine

Otto Simigaq (aged 48 in 2010) from Siorapaluk in Subarea 3 was 11 years old when he participated in his first walrus hunt. He said the bivalves eaten by walruses have become smaller since ca. 2000. Photo: A. Heilmann

mammals in Arctic and Boreal areas. Furthermore they (EWB and KLL) have conducted several field studies working together with hunters in the areas covered by this study and have previous experience with LEK/TEK studies.

According to Armitage and Kilburn (2015) the PI (principal investigator) has a special role to play in the design and execution of a LEK/TEK research study, particularly if the PI is also responsible for data processing and report writing, which was the case for the present study. Hence, the PI needs to have a good understanding of the history and culture of the people whose TEK is being studied (*ibid.*). Since 1977 the PI of the present study (EWB) has spent more than two years in total in several of the hunting communities between Sisimiut and Siorapaluk studying walrus and other key marine mammals in cooperation with the hunters. In several cases he accompanied the hunters to collect biological material during their walrus hunts, thereby learning about walrus hunting practice (*e.g.* Born *et al.* 1982, Born 2001, 2003; Born 2005a).

We are therefore convinced that the team behind the study and the study design ensure that the questions were relevant to both the study purpose as well as the interviewees, and were readily understood by them.

## Selection of informants

According to Davis and Wagner (2003) it is essential to design and conduct LEK research in a manner most likely to produce results that will thoroughly represent breadth, depth, and comparability of LEK, while positioning the research outcomes to withstand rigorous public inspection. Furthermore, the quality and impact of data assembled during LEK research depends largely on who is identified as "knowledgeable", and whether information is gathered systematically from a large enough group of knowledgeable individuals. Consequently, the first step in conducting LEK research must involve some means to identify the knowledgeable persons (*ibid.*).

Overall, the interviewees represented ca. 9% of all registered full-time hunters in the towns and settlements visited. However, being licensed as a full-time hunter in Greenland does not necessarily mean that one is experienced in walrus hunting, or for that sake is still an active walrus hunter. For example, in 2010 a total of 46 persons were registered as full-time hunters in Aasiaat (source: Department of Fishery, Hunting and Agriculture, DFHA, Nuuk), but the interviews revealed that in this town apparently only one hunter was actually still an active walrus hunter. Before the survey we identified 188 potential informants who had reported the catch of walruses to the DFHA regularly. Basing the survey on previous knowledge of who demonstrably had experience in hunting walrus (based on their reporting to the official catch reporting system), and on peer-recommendations obtained in villages visited *en route* make us believe that the informants were all "knowledgeable" as also demonstrated by their answers.

The fact that in several cases a potential informant on the pre-selection list was not available and instead others were interviewed because they were recommended locally as "knowledgeable" means the survey had a certain degree of *de facto* randomness in selection of LEK experts among the walrus hunters. This ensured a higher degree of representativeness of the entire group of experienced walrus hunters with up-dated knowledge.

Where LEK is required concerning specific living entities (*e.g.*, walruses), the LEK-holders must be selected from a population of individuals who have direct experience with these entities. These are usually people who have harvested and observed them over a lengthy period of time (Armitage and Kilburn 2015). We were therefore interested in interviewing hunters who had relatively much experience with hunting walruses, because we were interested in long term perspectives on potential changes. The mean and median age of the informants was ca. 50 years and the vast majority had 20–40 years of experience with hunting walruses. This guaranteed that they had long enough experience with walrus hunting to detect changes over time, for example, changes related to decrease in sea ice for the last two to three decades. Although several hunters were only able to provide an approximate year (age) for their first walrus hunt (or participation in a walrus hunt) because it happened so long ago, it became apparent that the hunters in the Qaanaaq area generally started very early because it historically and presently is still a tradition that they accompany older hunters at a much younger age compared to hunters in the other two subareas. This reflects that hunting traditions in the Qaanaaq area, and also to a degree in Subarea 2, were (and to some extent still are) more deeply rooted than in the other areas where fishing and other means of occupation are more common (Siegstad *et al.* 2001; Rasmussen *et al.* 2010).

Hence, the majority of the interviewees represented a group of hunters with long term experience in hunting walruses.

## Interviewing methods

The informants were all systematically asked the same suite of questions, which ensured consistency in the interview process.

To increase the level of mutual understanding between interviewer and interviewees, the interviews were made in Greenlandic without an interpreter. An interview usually lasted 1–2 hours and we attempted to apply to Tobias' (2009) THROT (*i.e.* the Two-Hour Rule Of Thumb – guideline stipulating that a map biography interview should not exceed two hours of recorded interviewing time) to ensure the research experience for participants is respectful and is not tiring of the interviewee (Armitage and Kilburn 2015).

The late Peter Hansen (aged 52 in 2010) from Savissivik in Subarea 3 explained how decreasing sea ice conditions had negatively influenced the walrus hunt. Photo: A. Heilmann

## Evaluation of the interview survey method and conclusion

It is our experience that sometimes the Greenlandic public and users wrongly believe that the Greenland Institute of Natural Resources, GINR, (*i.e.* "the biologists") sets the quotas. In Greenland, quotas are determined by the Greenland government (*i.e.* the Minister for Fishery, Hunting and Agriculture) based on input from science, users, management authorities and other stakeholders after a formalized hearing process.

Nevertheless, one may speculate that when answering in a GINR interview survey, some interviewees might think their answers directly or indirectly influence the setting of quotas for walrus hunting. However, it must be kept in mind that the vast majority of questions asked in this interview were not about quotas, but were instead about collecting important biological observations from users.

The interview survey was initiated, planned and conducted by GINR, which is a Greenlandic based center for natural science studies of Greenland's living resources. The main purpose of GINR's activities is to conduct scientific studies on Greenland's renewable resources and provide the scientific basis for a sustainable exploitation of the living resources in an around Greenland (Anon. 1994b: § 1). However, in order to fulfill

its role, GINR not only collects information using quantitative biological science but in many cases also incorporates LEK/TEK in the description of the status of a living resource. According to the chapter "Local knowledge" in the strategic work plan of GINR for 2013–2017 (GINR 2013: p. 7) "it shall be attempted to include the knowledge of fishermen, hunters and other groups in the scientific work of the institute. It is important that all information that can assist in the work of the institute is collected, analyzed and included". Hence, GINR may include LEK/TEK obtained via various sources including through interview surveys conducted in a systematic fashion.

In the case of advice on sustainable catch levels of walrus, the various information and data collected and analyzed by GINR are submitted to an international advisory body (*i.e.* the North Atlantic Marine Mammal Commission's Scientific Working Group). Following evaluation by the Scientific Committee, NAMMCO's Commission (of which Greenland is a member), provides the Greenland management and political authorities with advice related to the management of three walrus stocks that are exploited by Greenland (NAMMCO 2010).

The Greenland management authorities and political system (*i.e*. The Minister for Fishery, Hunting and Agriculture) determine annual quotas after having consulted with user groups and stakeholders. According to § 4 of the legislation for the catch of walruses in Greenland (Anon. 2006): "The Hunters' Council" (HC, *Piniarnermut Siunnersuisoqatigiit*, "Fangstrådet") must be consulted regarding the total size of the walrus quota".

Of course, it cannot entirely be ruled out that the contents (or the flavor) of an answer in some cases were influenced by the particular interviewee's concern that his answer would be used out of context or in an unintended way by GINR. However, the independent interviewer (AH) participating in the study as an external consultant not affiliated with GINR conducted the interviews, which in our opinion reduced the risk that answers were influenced by an apparent "conflict between hunters and biologists".

Several of the questions were related to walrus biology and climate effects, whereas others concerned hunting methods. Our personal experience from having worked for several years together with Greenlandic hunters is that they are willing to openly share their knowledge and experience with matters related to the hunting of animals and to the hunt itself, and often do this in a clear and objective way. This is also the experience from interview studies conducted with indigenous walrus hunters in the Bering Strait region (Krupnik and Carleton Ray 2007). Nevertheless, one may suspect that answers to more politically and economically infectious questions such as, for example "struck-but-lost", would have a tendency to be more influenced by the hunters' speculations about the potential consequences of an answer. The surprisingly – at least to us – low estimate of "struck-but-lost" ratio resulting from the interviews indicates that this was perhaps the case.

Our study also resulted in a variety of information types, which to an unknown degree may vary in quality depending on factors mentioned by Brook and McLachlan (2005). We have attempted to summarize the information as rigorously as possible to reflect overall tendencies in the answers. In our opinion, however, there is merit in also reflecting the diversity of individual opinions expressed and answers given during a LEK study. This allows the reader to gain insight into the fact that there is quite often not only one single opinion or consensus. For that reason, in several places we present individual statements to allow the hunters to "speak for themselves" (Appendix 2, 3, 4, and 5).

Born *et al.* (2011a) recommended that "local" observations (LEK/TEK) be collected systematically through a long-term monitoring system established locally, involving that hunters and other users of a resource *themselves* collect and present the LEK/TEK. Although LEK collected and summarized by the users themselves would inevitably also be influenced by various factors influencing interpretation, there would likely be less risk that certain aspects of the LEK information gets "lost in translation" as it may when LEK is summarized by scientists.

The interviewees in Subarea 3 were younger than those in the other two subareas when they first participated in a walrus hunt. A walrus is butchered in Subarea 3 in the late 1970s. Photo: T. Kristensen

Information on a renewable resource and the environment generated by indigenous hunters and scientists has many similarities (Krupnik and Carleton Ray 2007). However, it should be kept in mind that there may be fundamental differences between scientific and indigenous knowledge in scaling (*i.e.* in ways of interpreting natural phenomena at different spatial and temporal levels). Indigenous hunters' knowledge is usually drawn from local observations. This attention to detail and hunters's localized perspective contrast with the the scientists' usual focus on larger scale phenomena (*ibid.*).

However, despite whatever limitations LEK/LFK interview surveys may have, by conducting a systematic directed interview survey among a representative fraction of experienced walrus hunters, we suggest we have gathered and presented information that is representative of the current situation of walrus hunting activity in West and Northwest Greenland.

## The catch of walruses, overall hunting "strategies", and season

It became apparent from the interviews that walruses and walrus hunting are still of greater relative importance in Subarea 3 compared to the other areas. Based on an estimate of 250 total walruses landed per year in Subarea 3, Born (1987a) estimated that walruses in the early 1980s provided the hunters' households with ca. 25% of the meat and other edible products obtained from hunting on an annual basis.

There was an apparent contradiction between the answers to Question 5: "Do you sometimes go hunting only for walrus?" and Question 7: "Do you only hunt walrus if you encounter them by coincidence?" Overall, ca. 44% answered yes to the first question whereas ca. 80% answered yes to the second question. Apart from the fact that the answers to Question 7 confirm that walruses are also taken during hunting trips where several species are targeted, a simple explanation for the apparent contradiction is that perhaps some interviewees did not understand that the questions implied an "either/or" situation. Our suspicion that these questions gave rise to some confusion among interviewees is supported by the fact that in Subarea 3 where walrus hunting is still very important, ca. 50% of the informants answered that they still go on hunts which only target walrus whereas ca. 97% answered "yes" to the question whether they only hunt walrus when they encounter them by coincidence.

It became clear from the interviews that in all three subareas the catch of walruses is often combined with hunting for other marine mammals such as beluga and narwhal. However, it must be mentioned that when talking about narwhals and belugas, it is common for Greenlandic hunters to simply refer to their common generic term *"qilaluaq"* without distinguishing between the two species linguistically. During several of the in-

terviews, informants used the term *qilaluaq* without specifying whether it was *"qilaluaq qaqortoq"* (the "white" *qilaluaq*) or *"qilaluaq qernertaq"* (the "black" *qilaluaq*). Both species occur and are hunted in all three subareas. In Subarea 1 and 2, however, it is much more common to catch beluga than narwhal (Heide-Jørgensen *et al.* 2003). Hence, when informants mentioned *qilaluaq* in these two subareas, we have translated the term to beluga. However, in Subarea 3, narwhal is more common and is a more integrated element in the marine hunting culture (*e.g.* Born 1987b). Hence, when *qilaluaq* was refered to in Subarea 3 without further specification we have translated the term to narwhal.

The hunters were asked about which months they hunt walruses. The seasonal distribution of the walrus catch in Subareas 2 as revealed by the interview survey did not differ from that presented in Born (2011) based on the reporting via the *Piniarneq* system during 1993–2006 of a larger sample (N=477). An exception is that the interview survey did not report the catch of walruses in January and February, whereas the reporting via *Piniarneq* did.

The seasonal distribution of catches in Subarea 3 as indicated by the interview survey does not differ from that based on the reporting via the *Piniarneq* (1993–2006) of a much larger sample (N=1753; Born 2011).

The answers did indicate that the season of catch has changed somewhat compared to the situation prior to quotas and climate changes.

The catch of walrus in Subarea 1 showed a clear peak in March, which is in contrast to previous years. During 1950–1983 (*i.e.* before quotas and the decrease in sea ice), walruses were mainly caught during March–May in the southern parts of Subarea 1 (*i.e.* Aasiaat and south) and during February–May in the northern part (*i.e.* at Qeqertarsuaq/Disko Island); Born *et al.* (1994). Several hunters explained that the change in period reflects how the hunting season opens the 1st of March, and that the quota is used up quickly before the walruses start migrating away from the West Greenland hunting grounds.

The interviews indicated that in Subarea 2 walruses are mainly taken during April–June, with a peak in May. Compared to earlier years (1950–1983; Born *et al.* 1994) the catch in Subarea 2 is now more concentrated during spring, probably reflecting that walruses are mainly caught nowadays during spring hunts targeting polar bears, narwhal and beluga. Compared to 1950–1983 (Born *et al.* 1994), there was a lack of records in December–February. For January and February, this lack may indicate that the interest in hunting walruses during the dark and cold winter months has decreased and/or that the sea ice situation has made the walrus hunt more difficult. The lack of catches in December may reflect that the relatively small quota for the entire subarea (Appendix 2, Table 9) has been used up by then.

In Subarea 3 the interviews indicated that walruses are taken at all times of the year, but that the hunt is concentrated during January–June with a peak in May, and in Octo-

ber–November. The seasons for the walrus hunt in Subarea 3 have not changed markedly since earlier years (Born 1987a). However, it was indicated by several informants that the traditional "thin-ice hunt" in late winter has become relatively less important because of unstable sea ice conditions caused by warming. According to Born (1987a) and Born *et al.* (1995 and references therein) the "thin-ice hunt" was performed during November to mid-May with a peak in March–April. The "open-water" or boat hunt period peaked in June–July and in October when the walruses reappeared in the hunting grounds.

According to the interviews, there is still some hunting in January–April on the thin ice, but this has become increasingly difficult and dangerous due to deteriorating ice conditions. During an interview survey about polar bears and the polar bear hunt in NW Greenland (Born et al. 2011a) the hunters mentioned that heavy snowfall early in the year also complicates the walrus hunt on the newly formed ice because the snow squeaks when the hunters walk softly on the thin ice towards walruses in order to harpoon them. It was also told that the ice is no longer as thick as it used to be and is easily broken up by the southerly wind. In the 1970s and the early 1980s, hunters used to go walrus hunting on the thin ice when there was a southerly breeze because that was when it was least dangerous. However, nowadays it has become hazardous to hunt on the thin ice when the wind comes from the south because the wind causes the ice to break up (*ibid.*).

The "thin-ice hunt" was quantitatively the most important of the hunting forms in Subarea 3 according to Vibe (1950). However, according to Born (1987a), the hunting from boats during late spring and fall became quantitatively more important, reflecting the socio-economical development resulting in an increased use of cutters and skiffs with outboard engines (*i.e.* increased effort and efficiency). Nowadays the hunt in the spring peaks in May, which is earlier in the season than before (Born 1987a). The interviews indicated that the later fall catch (now October–November compared to September–October; this study; Born 1987a; Born *et al.* 1995) is primarily due to a later formation of sea ice and therefore later arrival of walruses from their summering areas farther north and along eastern Ellesmere Island (this study; Born and Knutsen 1988, 1990; Stewart *et al.* 2014a).

## Trends in the catch of walruses

When the hunters were asked how many walruses they had caught during 2008 and 2009, the numbers in several cases were given with uncertainty and with a range, and in other cases the informant was not able to remember the exact number. Furthermore, it was in some cases not quite clear from the answer whether the interviewee specifically referred to the number of walruses of which he was considered the primary hunter (*i.e.*

he personally had the license to catch a walrus, or had either harpooned the animal or fired the first bullet that hit or finished it off) or whether he gave the number of walruses he had participated in taking (*i.e.* as one of several participants). This was despite the fact that we had specified that the number sought was to be based on walruses he had a license for, or walruses he had harpooned or finished off. Furthermore, the estimates provided on how many walruses had been landed in their settlement/town in 2008 and 2009 varied considerably. Generally, the answers to this question indicated that keeping track of total numbers landed in the settlement/town was not something the individual hunter was paying much attention to – or, perhaps, did not want to comment upon the topic for whatever reason. We therefore caution that these uncertainties influence the numbers reported here to an unknown extent. In contrast, the numbers reported to the management authority (*i.e.* DFHA) – and which are summarized by DFHA annually – are reported by the individual hunter who, according to the legislation, must report every single walrus he catches with a license. Nevertheless, our study demonstrated the difficulties in collecting precise catch statistics, especially in cases like walrus hunting where typically several hunters participate in the hunt of a single animal.

The interviewees gave several reasons for a decreasing trend in number of walruses caught: (1) the introduction of a quota on walrus (and also quotas for beluga, narwhal

It became clear from the interviews that in West Greenland walruses are often taken during hunting trips mainly targeting beluga, narwhal and polar bears. Photo: E.W. Born

and polar bears in case of hunting trips mainly targeting these species with walrus as a "secondary" species), (2) decrease in market demands for walrus products nationally and internationally, (3) a general decrease in number of full-time-hunters, (4) a general shift to alternative and more profitable sources of income (fishery and various wage earning jobs), and (5) climate changes resulting in walruses spending less time on the traditional hunting grounds and bad ice and weather conditions influencing the ability to access the walruses.

Our study showed that walruses are often taken during hunting trips that mainly target the economically more attractive beluga, narwhal and polar bear. The highly valued skin (mattak/muktuk) of beluga and narwhal is sold at relatively high prices in Greenland. According to this study beluga and narwhal mattak could be sold for 250 DKK per kilo (ca. 42 US $, July 2010 exchange rate) in the bigger towns in Subarea 1, whereas walrus meat could only be sold for 65 DKK/kg (ca. 11 US $). The mattak price has continued to increase. In 2014, one kilo of mattak was sold for ca. 450 DKK/kg (ca. 82 US $ in 2014) to consumers in the towns of Greenland (*e.g.* Anon. 2014c). This tendency toward an increased preference for catching economically more valuable narwhals at the expense of other marine mammals was already noted in the Qaanaaq area by the 1980s (Born 1987a). Some interviewees mentioned that restrictions to the catch of these other species were an additional cause for the decrease in the catch of walrus. Quotas for the catch of beluga and narwhal in W and NW Greenland were introduced in 2004 and came into effect the same year (Anon. 2004), whereas quotas for the catch of polar bears in entire Greenland were introduced in 2005, taking effect on 1 January 2006 (Anon. 2005). Only licensed full-time hunters are allowed to catch walrus, beluga, narwhal and polar bears. Hence, the interviews indicated that for these hunters who make a living from multi-species "fishery/hunting", restrictions to hunting one species may affect the impact on other species too.

The interviews also indicated that there has been and still is a decreased demand for walrus products both nationally and internationally. Walrus meat etc. as a food source for humans has decreased at least in Subarea 1, and it was mentioned that young people have become less interested in eating walrus products. This is in accordance with information in Hansen et al. (2008) and Jeppesen (2008, 2012) who showed that the proportion of people who eat traditional food on a weekly basis decreased between 1993 and 2010. This tendency was most pronounced in the southern parts of W Greenland (*i.e.* Subarea 1 compared with Subareas 2 and 3), and in particular there has been a decrease in meals containing pinnipeds (Jeppesen 2012).

Traditionally the tough walrus skin is used as stable food for sled dogs (Vibe 1950). The interviews revealed that nowadays the walrus skin is either sold (to dog owners) or used by the hunters for feeding their own sled dogs, or given away to others who still have a dog team. However, a general decrease in the number of sled dogs in Subarea 1 has led to decreasing demand for walrus products (skin and meat) for feeding

sled dogs in this area. According to Anon. (2014a) the number of sled dogs in the municipality of Qeqqata decreased by ca. 50% during 1993–2013.

The international market for walrus products (*e.g.* tusks and artifacts made of walrus ivory) is regulated by international legislation for trade in these products. Restrictions to export walrus products from Greenland were introduced in 2008. Walruses in Greenland are on List III under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 2016). Products from species on List III can only be exported commercially from Greenland provided the existence of a "Non Detriment Finding" (NDF)-status assessment (*cf.* Anon. 2016), which must be able to document that exploitation and commercial trade is not detrimental to the population or subpopulations in question. In 2008 a negative NDF for Atlantic walrus in Greenland was issued because there was insufficient data to conclude that exploitation was not detrimental to the three walrus subpopulations harvested in Greenland. However, after a series of new scientific studies that allowed NAMMCO to provide management advice for all stocks, a positive NDF was issued in 2009 by Greenland. Subsequently, the Government of Greenland implemented sustainable catch limits that were in accordance with the advice from NAMMCO. However, the catch limits were still much lower than the reported annual catches prior to 2006. Following new data on subpopulation sizes and harvest and a re-evaluation by NAMMCO, a new "Non Detriment Finding" in 2014 was also positive (Anon. 2015a). Nevertheless, because catches (including estimated losses) in NW Greenland for the entire period 2013–2015 exceeded the biological recommendation for total allowable harvest, the Greenland Institute of Natural Resources issued a negative "Non Detriment Finding" in 2016 (GINR 2016).

In addition, a general decrease in the number of full-time hunters was mentioned as a reason for the decrease in number of walruses taken. During the last decade there has been a general decrease in the number of hunters licensed to take walrus in all of Greenland. This trend has been most pronounced in Subarea 1 compared to the more northern areas. The average age of the hunters has increased during the same period (Rasmussen *et al.* 2010; Anon. 2015b). Furthermore, in all subareas and again most pronounced in Subarea 1, other means of getting an income (fishery and wage jobs) have increasingly become more important (*ibid.*).

## Categories of walruses caught

The study indicated that in all subareas the overall sex ratio in the walrus catch is skewed towards males to an unknown extent.

In West Greenland (Subarea 1), the proportion of female walruses in the landed catch was estimated at 0.55 (*i.e.* the catch skewed towards females) based on biological samples from 1988–1997 ($N_{tot}$=33) and 2004–2007 ($N_{tot}$=103; Andersen *et al.* 2014).

In contrast, females constituted 0.47 (*i.e.* the catch skewed toward males) in a sample ($N_{tot}$=439) from the catch in NW Greenland, 1987–1991 (Subarea 3; NAMMCO 2013b; Andersen *et al.* 2014) and 0.39 in the reporting through the *Special Reporting Forms* during 2007–2013 ($N_{tot}$=408; NAMMCO 2013b).

However, the information on sex ratio in the catch obtained from the interview survey cannot readily be compared to information in the other sources, a reason being that the responses reflect the individual interviewee's personal preference to a certain extent, depending on whether he prefers to catch adult males for their higher yield of meat and larger tusks or females and young for their more tender meat.

Our survey indicated that most hunters, when possible, will target adult males, which is likely a result of two factors: (1) the hunting regulations (Anon. 2006) offered increased protection to adult females, and (2) as mentioned by some informants: in certain situations when only a single or few walruses can be taken by a hunter because of the quota he may, when given the choice, prefer to target adult males which provide the largest amount of edible products and have the largest tusks.

The idea that hunters generally target larger walruses with more yield of meat and tusks has also been reported from Greenland, Arctic Canada and the Bering Strait region (Born *et al.* 1994; Born *et al.* 1995 and references therein).

## Hunting methods

In order to avoid or minimize losses, the hunting regulations (Anon. 2006: § 9) state that the walrus must be harpooned (*i.e.* with a harpoon with one or more floats attached) before the shot that finishes it off is fired.

We asked the hunters about the timing of when the harpoon is thrown in the sequence of a walrus hunt (*i.e.* whether before or after the walrus has been hit by a shot). In Subarea 1 and 2 ca. 95% of the hunters answering this question said "before"; one (2%) said that it could be both "before and after", and one expressed no opinion on the matter. In contrast, ca. 74% of the informants in Subarea 3 said that the harpoon might be thrown either before or after the walrus had been hit by bullets depending on the circumstances (Appendix 2, Table 21).

In a summary of occurrence of walrus and the walrus hunt in the Qaanaaq area (*i.e.* Subarea 3) mainly based on pre-1950 written sources, Hastrup (2015) refers to local catch legislations that date back to 1929 (Rasmussen 1929). According to these regulations, walruses must be harpooned before being shot at (*ibid.*). Hastrup (*ibid.*: 216) indicated that it is not clear how this legislation is dealt with in practice and adds that

A harpoon is also used when walruses are hunted from a cutter in Subarea 3. Photo: E.W. Born

"sometimes people could be skeptical to the letter of the law". However, as mentioned in the section "Legislation and management of walruses" this regulation was canceled and has not been in force in Subarea 3 since 1998.

However, there seems to be a contradiction in the answers received during the interviews, at least in Subarea 1 and 2, that on one hand (1) before shots are fired at a swimming walrus, a harpoon is thrown at it with a distance of less than 10 m, and (2) that often the shots are fired at the body of the walrus at a distance of 50 m and more.

By firing long range at swimming walruses and hitting in the body when they are diving (or hitting the water surface close to them), the hunters prevent them from getting enough air to escape underwater (by for example changing direction underwater). The skiff powered with a 40–100 HP outboard engine then catches up with the walruses, which are short of breath or wounded, and have to surface with short intervals. When the skiff has caught up with the walrus, shots are fired to wound it mortally and then a harpoon with a float is fastened to the animal before one or more finishing shots are fired (E.W. Born personal observation in the Qaanaaq area in 1977, 1978 and 1990). This practice of targeting the body (lungs and/or spinal cord) of swimming walruses before

they can be harpooned and killed is also common in other parts of the walrus' range (NAMMCO 2006a). Losses may inevitably occur sometimes if hunters wound a walrus with bullets from heavy caliber rifles before harpooning it with a float securely fastened.

It should, however, be noted that several hunters mentioned that walruses can be dangerous and may attack when they are hunted. This is in accordance with other observations (*e.g.* Hansen 1995; E.W. Born personal observation). We speculate whether the fact that walruses may attack skiffs and boats during a hunt may perhaps in itself encourage the hunters to make sure that the walruses are severely wounded and *moribund* before they are approached at close quarters and the harpoon is thrown.

## Losses ("struck-but-lost" ratio)

The estimate on loss rate for the years 2008 and 2009 averaged <5% (range: 2–13%) based on the information given by the informants. These loss rates are low compared to information from other sources on "struck-but-lost" rates in the walrus hunt.

However, it must be cautioned that attempts to quantify the loss rates based on hunters' information on numbers caught and numbers struck-but-lost are influenced by the fact that in several cases, numbers of lost and/or landed given by the hunter were uncertain. Furthermore, in some cases it was not entirely clear from the answers how many walruses the hunter reported as taken by him in contrast to how many walruses he had participated in taking. For example, a hunter from Niaqornat said that he had taken about 10 walruses in 2008 and 2009. However, his answer to how many he thought had been taken in the settlement in total indicated that he had participated in taking those 10 walruses.

Relatively few reports based on observations of struck-but-lost in walrus hunts exist and several of these observations were made during hunting trips several years ago (Born *et al.* 1995 and references therein). However, the observations indicated that in some types of walrus hunts, losses may be substantial. A loss ratio of up to ca. 20% (*i.e.* 1/5 of every walrus struck is lost) has been recorded for the walrus hunt in Chukotka (NAMMCO 2006b). According to NAMMCO (2006a), losses range from less than 10% to more than 50% for modern walrus hunting practices – the highest being during the open-water hunt which is also when most walruses are caught.

Only few earlier records of loss exist from Greenland, and none exist from West Greenland to our knowledge (*i.e.* in this context Subareas 1 and 2). In the Qaanaaq area (Subarea 3) estimates of loss in walrus hunts during the open-water season ranged between 15% and 25% (based on 34 hunting trips, in which 112 animals were retrieved in 1977 and 1978). The highest figure included animals that escaped during the hunt (newborn young and wounded animals) and whose fate was unknown (Born and Kristensen 1981; Born *et al.* 1995). Presumably, the majority of the injured animals eventu-

During the 1960s and 1970, small wooden cutters (20 ft so-called *"nummerbåde"* with a 10–20 hp diesel engine) were increasingly used in the Qaanaaq area. Our study showed that cutters are more efficient than skiffs in the walrus hunt because they can go farther offshore, penetrate denser pack ice and also bring back more edible walrus products. Photo: E.W. Born

ally die from their wounds (Fay *et al.* 1994). The interviews indicated that the methods used during the open-water hunt in the Qaanaaq area nowadays are essentially similar to those used in the late 1970s and early 1990s (E.W. Born, pers. observation).

Since the 2006 introduction of quotas in Greenland, it has been mandatory to report each struck-but-lost walrus to the Greenlandic management authorities. During 2006–2008 only one walrus was reported struck-and-lost to the Greenland management authorities (Anon. 2011). However, the management authorities considered this to be an implausibly low rate for struck-but-lost, and decided to reduce the walrus quota for 2009 in West Greenland by ca. 25% to incorporate potential loss in total allowable catch (TAC). Quotas for the catch in NW Greenland (*i.e.* Subarea 3) from the Baffin Bay stock were not reduced because the Greenlandic management authorities assumed that the hunters in the Qaanaaq area are more specialized in hunting walruses and therefore have a low struck-but-lost rate (Anon. 2009, 2011).

Recently, the Greenland management authorities assumed an overall loss rate of 3% in all types of walrus hunting without giving any basis for their estimate (*i.e.* "thin-ice hunt" and hunting from boats *during* the "open-water hunt") in Subarea 3; Anon. (2014b,c, 2016).

Due to the similarity in hunting practice between Greenland and Canada where losses from 20% to 50% have been reported (Born *et al.* 1995 and references therein), an overall loss rate (proportion of all animals killed or mortally wounded that are not retrieved) of 30% was suggested by Born *et al.* (1995) for the kills in West Greenland. However, for modeling of trends in Greenlandic walrus subpopulations, Witting and Born (2014) assumed an overall loss rate in West and Northwest Greenland of ca. 15%.

The interview survey indicated that during the open-water hunt, hunters use heavy caliber rifles and fire bullets at the body of swimming walruses at a relatively far distance in order to prevent them from escaping. Inevitably, such a hunting method must result in some walruses either getting away mortally wounded or dying and sinking before they can be retrieved. With reference to the fact that loss rates of ca. 20% have been reported for similar types of hunts in Chukotka (NAMMCO 2005, 2006a), and given the uncertainty of answers (numbers landed and numbers lost) during the interviews, we suggest that the overall loss rate in the walrus hunt in West and Northwest Greenland is higher than the ca. 5% suggested by the present study.

## Distribution, seasonal occurrence and local abundance

### Distribution and seasonal occurrence

The general distribution and pattern of seasonal immigration and emigration from the shallow water banks in West and Northwest Greenland described by the informants were essentially similar to that described in other sources (*cf.* Vibe 1950, 1956, 1967; Born *et al.* 1994, 1995 and references therein; Born 2005a).

The hunters in Subarea 1 described how adult males tend to occur farther west (at deeper waters and in denser ice) than females on the shallow water banks. This is in accordance with information on distribution in Born *et al.* (1994), and with Dietz *et al.* (2014), who used satellite telemetry for tracking walruses in West Greenland. The interviewees in Subarea 3 also reported segregation by sex, with females and young generally occurring farther north than adult males during fall, winter and spring, which is in accordance with Vibe (1950) and Born *et al.* (1995).

In Subarea 1 walruses were reported to occur farther offshore than before due to the reduction of sea ice, which according to the hunters, has resulted in ice break up occurring earlier and the eastern edge of the Davis Strait pack ice being positioned far-

ther to the west. These changes in the sea ice have also been recorded through remote sensing (*e.g.* Peacock *et al.* 2012; Dietz *et al.* 2014).

It was also mentioned that nowadays walruses in Subarea 1 arrive later in fall and emigrate (disappear) earlier in spring.

Dietz *et al.* (2014) found that the timing of the spring dispersal and migration towards Canada was closely linked to the extent and retreat of the eastern edge of the Baffin Bay-Davis Strait pack ice edge.

The interviewees living in the northern parts of Subarea 2 noted that walruses can only be accessed later in the spring compared to the areas farther south. The general scarcity of walruses in Subarea 2 and their more southerly distribution during early spring was corroborated with aerial surveys conducted in March–April 2009–2013, when a helicopter searching for polar bears on the fast ice and the offshore pack ice covered the area between 70° 22' N and 76° 15' N (*i.e.* between Vaigat and Savissivik, Fig. 1). All observations of marine mammals from the coast to 150 km offshore were recorded (Born and Laidre 2010; Born *et al.* 2009, 2011b, 2012, 2013). During a total of ca. 245 hours "on effort" search, a total of only eight walruses were observed. These

An adult male walrus was observed on the pack ice about 50 km west of the entrance to the Uummannaq Fjord (Subarea 2) during an aerial survey for polar bears in April 2012. Blood stains on the ice from recent wounds indicate that the walrus had recently engaged in fights with other males for mates. Photo: K. Laidre

walruses were all seen in shallow waters in the southern parts of Subarea 2 south of 72° N (*i.e.* between Upernavik Kujalleq and the Nuussuaq pensinsula in the Uummannaq area) in 2009 and 2012 (*Ibid.*, Born and Laidre unpublished data).

Some informants living in Subarea 1 mentioned that dredging for scallop and trawling for shrimp negatively influenced the distribution of walruses, making them occur farther offshore. The adverse effects were thought to be due to both competition for scallop between walruses and fisheries and underwater noise from fishery activities.

In this study, scallop was reported as a walrus food item, particularly in Subarea 1.

In West Greenland, commercial scallop dredging began in 1983 (Pedersen 1994). Since then, there has been a relatively small-scale regulated fishery for scallop with annual catches ranging from 1200 to 2600 tonnes since 1995 (Garcia 2006). There are indications that each scallop bed is extensively dredged before the fleet moves on to new areas (Garcia 2006). The main fishing area was around Nuuk (Pedersen 1994) but the scallop fishery has successively moved farther and farther north. The fishery is confined to the open-water season and the scallop beds are mainly in inshore areas (Pedersen 1994; Garcia 2006) where walruses rarely occur (this study).

Information about intensity of trawling for shrimp, Atlantic cod (*Gadus morhua*) and Greenland halibut and dredging for Icelandic scallop in West Greenland for ca. 20 years prior to 2005 did indicate relatively much fishing activity *around* but not *on* the walrus foraging banks *per se* (read: walrus wintering areas) in West Greenland (Born 2005a: 38). This geographical distribution of the fishery does not of course preclude that noise from shipping and fishery activity may impact the distribution of walruses in the shallow water areas. In 2005 the NAMMCO Working Group on Walruses was not able to reach a conclusion about whether fishery and ship traffic is a problem for walruses in West Greenland due to a general lack of information (NAMMCO 2006a). However, in connection with a Strategical Environmental Impact Assessments, it was concluded that walruses hauled out on drift ice are generally sensitive to noise, and that ship noise (*i.e.* underwater noise and ice breaking) may potentially displace walruses in W and NW Greenland (Mosbech *et al.* 2007; Boertmann and Mosbech 2011; Merkel *et al.* 2012).

Nevertheless, although the information obtained during the interview survey did not provide a clear picture of whether or not (or to what extent) fishery activity displaces (or has displaced) walruses on or from their feeding banks, some informants were of the opinion that fisheries have a negative impact on the distribution of walruses.

Our study indicated that walruses have begun to occur farther inshore (*i.e.* farther to the east) in Subarea 3 during the open water season. Historical sources indicate that walruses were abundant in Murchison Sound, and they also occurred farther east in

Wolstenholme Sound (*i.e.* close to Pituffik/Thule Air Base) and appeared in McCormick Fjord between Siorapaluk and Qaanaaq during the open-water season (Sverdrup 1903; Peary 1917; Vibe 1950). The reason for the recent increased occurrence of walruses farther inshore during the open water period nowadays was not clear. According to some interviewees it may represent a reduced hunting pressure or a climatically induced change in distribution – or a combination of such factors.

The hunters' observations of walruses on land indicated that observing single or few walruses that are hauled out on land is perhaps a little more common nowadays than indicated in Born *et al.* (1994, 1995), where none were reported in recent time. However, during the interviews there were no observations indicating that walruses in West and Northwest Greenland have resumed their habit of using their traditional terrestrial haulouts (*"uglit"*). Hence, the few observations reported during the interview survey did not indicate a noticeable shift in haul-out behavior induced, for example by climate change and reduction in sea ice.

**Local abundance**

According to the interviewees there has been an increase in walrus abundance on the walrus hunting grounds, perhaps reflecting an increase in the subpopulations exploited in W and NW Greenland, and it was suggested that this potential increase was also a result of quotas being introduced.

Obviously, the introduction of quotas in 2006 (taking effect in Subarea 3 from summer 2006 and in Subarea 1 from spring 2007) represented an intentional decrease in level of exploitation (p. 54). Since 2007, the walrus quotas for the areas mentioned were gradually reduced even further (Appendix 2, Table 9) until new estimates of the size of subpopulations became available.

During 2006 and 2012, aerial surveys resulted in estimates of the number of walruses on the West Greenland wintering grounds (*i.e.* a component from the West Greenland-Southeast Baffin Island – part of the Hudson Bay-Davis Strait stock) of 1105 (95% CI: 610–2002) and 1408 (95% CI: 922–2150) walruses, respectively (Heide-Jørgensen *et al.* 2014). The aerial survey average estimate of abundance for the Baffin Bay subpopulation in the NOW area in late winter and spring of 2009 and 2010 was 1499 walruses (95% CI: 1077–2087; Heide-Jørgensen *et al.* 2013). The estimate of abundance in the NOW area during summer 2009 was in the same range (*i.e.* 1250 walruses; Stewart *et al.* 2014a). Because not all potential walrus areas were surveyed, Stewart *et al.* (2014a) suggested that their estimate was negatively biased. An aerial survey in April 2014 resulted in an abundance estimate of 2544 walruses (95% CI: 1513–4279) in the North Water area (Heide-Jørgensen *et al.* 2016). Although all these estimates have a relatively high coefficient of variation, they may indicate an increase in number of walruses on

West Greenland wintering grounds and in the North Water area. However, the number of walruses in the NOW area likely fluctuates both seasonally and annually as the estimates in Heide-Jørgensen *et al.* (2013, 2016) may indicate. Based on a variety of previous observations and aerial surveys, Born *et al.* (1995) concluded that approximately 1700–2000 and perhaps as many as 3000 walruses were present in the entire NOW area during the open-water season.

Until ca. 2006/2007 the walrus subpopulations in West Greenland and the North Water area were assumed to be in decline due to over-exploitation (Witting and Born 2005, 2014). Even assuming a maximum population growth rate (up to 7–8% per year; Witting and Born 2005, 2014 and references therein; Kovacs *et al.* 2014), the increase between the year of introduction of effective quotas (2007) and when the interview survey was conducted (2010) would theoretically only amount to a couple hundred walruses in each of the two subpopulations. Given seasonal and inter-annual variations in occurrence, a change of this magnitude would probably not easily be detected in the hunting areas. Nevertheless, the observation of an increase in abundance in the walrus hunting areas by the informants is in accordance with other information on population trends (Witting and Born 2014; Heide-Jørgensen *et al.* 2016).

## Climate and walruses

Informants in Subarea 1 mentioned that walruses are nowadays distributed farther offshore due to the decrease in sea ice (*i.e.* the edge of the Baffin Bay-Davis Strait pack ice is located farther west). The sea ice conditions along the coast of West, and also to some extent Northwest Greenland, are influenced by the relatively warm northbound West Greenland Current (Buch *et al.* 2004), reaching as far north as Smith Sound (Melling *et al.* 2001) in the Qaanaaq area. In contrast, the coasts on the western side of Smith Sound, Baffin Bay and Davis Strait are influenced by the Labrador Current, which brings relatively cold waters south along Ellesmere and Baffin Island. Hence, sea ice prevails for longer time in the western parts of Smith Sound, Baffin Bay and Davis Strait (*e.g.* Taylor *et al.* 2001 and references therein), and it therefore may be expected that effects of changing ice conditions on walruses will first be experienced in West and Northwest Greenland. During 1979–2010 ice break-up in Central West Greenland has advanced an average of ca. one week per decade, though with large inter-annual variation (Dietz *et al.* 2014).

Beluga, another Arctic shallow water marine mammal, is sympatric with walruses in Subarea 1 during winter and spring (Heide-Jørgensen and Reeves 1996; Heide-Jørgensen and Acquarone 2002; Heide-Jørgensen *et al.* 2010). Heide-Jørgensen *et al.* (2010)

A young female walrus in northern Ikeq/Smith Sound, August 1988 (note the small satellite transmitters on its back). Interviewees in Subarea 3 mentioned that female walruses with calves occur in this area (Appendix 2, Maps 8, 10, 12). Photo: M. Villum Jensen

found a clear relationship during 1981–2008 between a decrease in sea ice cover and an increased distance of beluga occurrence from the coast (*i.e.* less sea ice farther offshore).

A study of the movement of walruses in West Greenland involving satellite telemetry found that the timing of the spring dispersal and migration towards Canada was closely linked to the extent and timing of retreat of the Davis Strait pack ice edge (Dietz *et al.* 2014). However, although walruses prefer areas with >50–70% ice cover in West Greenland (Born *et al.* 1994; Dietz *et al.* 2014), some may remain on the feeding grounds some time after the ice has gone (Dietz *et al.* 2014), which is also indicated by the interview survey.

Some informants suggested that the earlier emigration from the hunting areas in Subarea 3 in spring could also be an escape response due to an early (earlier) start of the walrus hunt with skiffs (and cutters). During an interview survey in 2006 (Born *et al.* 2011a) it was also indicated that the walruses leave the area (*i.e.* the entrance to Murchison Sound) because of noise from outboard motors. Furthermore, it was reported that when the hunters go out to walruses in May, the animals disappear off in

a northerly direction soon afterwards because they have grown more timid. This did not happen in the 1980s (*ibid.*).

Similarly, Dietz *et al.* (2014) suggested that the hunt itself could be an additional factor triggering walruses to migrate from Subarea 1 to Baffin Island (Canada).

Information on sea ice cover (or indices of sea ice cover) and reported catches have been used to establish simple relationships between fluctuation in sea ice and the catch of marine mammals in Greenland. The reported catches were regarded as a proxy for the actual size of the exploited populations (Vibe 1967; Rosing-Asvid 2006). However, relevant to the present study, Heide-Jørgensen *et al.* (2010) found a significant positive correlation between mid-winter sea ice extent and reported catch of beluga (1954–2006) in West Greenland. The highest catches of beluga (1954–2006) were made in years with dense ice cover, likely resulting in the belugas occurring closer to the coast (*ibid.*). Born (2005a) found a positive correlation between temperature and catch of walruses in West Greenland (1900–2002). High catches were reported during a warm period (ca. 1930–ca. 1960). He suggested that a combination of relatively light ice conditions along the coast and the increasing use of larger boats with longer range and cargo capacity led to increased catches of walruses during this period. The boats were bought for an engagement in a multi-species exploitation (*i.e.* fishery and catch of marine mammals). Fisheries increasingly became the main source of income at the same time as the international market for walrus products decreased (*ibid.*). Apparently the population segment wintering in West Greenland was subject to overexploitation until the 1960s (Witting and Born 2005, 2014). The interview survey confirmed how the catch of walruses in Greenland (and in fact also other marine mammals) is governed by a complex number of factors including (1) availability and accessibility (relative abundance of walruses related to sea ice conditions and equipment used *i.e.* size of boats), (2) socio-economical factors (*e.g.* other renewable sources being more economically profitable, *e.g.* fish and shrimp, narwhal and beluga), (3) change in occupations (*i.e.* a decrease in number of hunters and more people becoming engaged in fisheries or other more profitable occupations), (4) international and national market demands (international regulations in trade and change in local human food preferences), (5) and national restrictions, not only for the catch of walrus but also narwhal and beluga in particular. Several hunters in Subarea 1 mentioned how walruses are caught during hunting trips that are primarily dedicated to the catch of the more profitable narwhal and beluga. It was also said that if the quota for these small cetaceans is used up, the interest in walrus hunting is smaller.

In a study of Pacific walruses, Carleton Ray *et al.* (2016) also mention how social factors often override effects of environmental conditions on the hunting pattern. In case


A walrus is brought on to a small fishing vessel off Sisimiut in Subarea 1 on 12 April 2007. Photo: M. Villum Jensen

of the Pacific walrus hunt sky-rocketing gasoline prices transform into fewer trips, fewer boats hunting and shorter distances over which hunters can hunt.

Hence, our interview study exemplifies that there is no simple relationship between environmental factors (*i.e. e.g.* the spatial and seasonal extent of sea ice) and the reported catch (as a proxy for abundance) of marine mammals in Greenland as otherwise suggested in Vibe (1967) and Rosing-Asvid (2006).

Clearly, local abundance (or density) of Atlantic walrus may be affected by the sea ice conditions as indicated by the present study. However, the conditions in Svalbard (Norway) are an example that there is no general and/or simple relationship between decrease in sea ice and abundance of walrus. The number of Atlantic walruses at Svalbard is growing almost exponentially (Kovacs *et al.* 2014, 2015; Regehr *et al.* 2016) despite a dramatic decrease in sea ice in the area (*e.g.* Laidre *et al.* 2015).

The adverse effects of changing sea ice and weather conditions on the catch of walrus become evident from this study. This is an example of how an interview survey can assist in obtaining information on an important parameter such as reduced effort caused by environmental conditions – information that can best be obtained by asking the hunters themselves.

# Biology

## Period of birth

The questions about whether the hunters had ever caught pregnant walruses (Question 20) or had observed newborns (Question 44) were somewhat overlapping because they both sought information on the reproductive cycle of walruses. To a large extent, the answers about pregnant walruses most likely reflected the fact that a fetus has to be a certain size in order for the hunters to readily detect it in the uterus during butchering. In January–February when some informants reported that they had taken pregnant walruses, the fetus is ca. 70–80 cm long. In March–April when the majority reported observing pregnant walruses, the fetus is 90–100 cm, and in May–June it is 110–120 cm long. Some reported having shot pregnant walruses in October–November when, according to Fay (1982) and Born (2001), the fetus is 30–40 cm long.

In Subarea 1 and 2, a relatively small number of informants reported having seen newborn walruses. This is in accordance with Born *et al.* (1994) who, based on various sources, reported the observation of very few newborns in West Greenland after 1975. The reason that relatively few informants in this subarea had observed newborn walruses nowadays is likely due to the hunting season being confined to March–April, and that walruses nowadays usually emigrate from their West Greenland wintering grounds prior to the peak birth period. This suggestion is supported by information from the 1930s in Central West Greenland that the first calves were born in late May, and most calves were born in late May and early June (Hansen 1937; Anon. 1938). It is also worth noting that in the 1930s walruses were still present in West Greenland as late as June (*ibid.), w*hich is in marked contrast to nowadays.

Several of the interviewees in Subarea 3 have seen newborn walruses, and according to their observations, peak birth period is May–July. However, extra-seasonal births had also been observed. This is in accordance with Born (2001), who described reproduction in female Atlantic walruses based on a biological material sampled in Subarea 3 by subsistence hunters and scientists. The period for catching walrus in this area is longer than farther south, which likely explains why more birth observations were reported in Subarea 3.

## Food

According to some authors (*cf.* Josefson *et al.* 2013: 302; Michel *et al.* 2013: 509), due to less ice cover, production will primarily increase in areas such as the Barents Sea, and will consequently have the potential to support higher biodiversity. In other areas such as the Beaufort Sea, however, ice retreat will occur from shallow to deep sea areas, and

During the interviews the hunters reported their observation of newborn walruses. This was most common in Subarea 3 (the Qaanaaq area). Photo of a ca. 2-month-old walrus calf on a terrestrial haul-out in NE Greenland. Photo: E.W. Born

less sympagic-pelagic production will reach the benthos there. The continental shelf along W and NW Greenland is a highly productive shallow water area, similar to the Barents Sea.

A longer open-water period would be expected to increase marine primary production (Rysgaard *et al.* 1999). Considering the close coupling of benthic and pelagic productivity (*e.g.* Sejr *et al.* 2000, 2002), primary and secondary production in many Arctic marine areas may increase with reduced ice cover due to global warming (Rysgaard *et al.* 1999). Furthermore, benthic productivity increases with water temperature (Brey and Gerdes 1998). Improved food availability may stimulate bivalve growth and production, which could compensate for increased predation by walruses. Climate change has resulted in increased growth rates of mollusc species (including the walrus food item *Clinocardium ciliatum*) on the coast of NE Greenland (Sejr *et al.* 2009).

Based on a study in two fjords at Svalbard and at Franz Josef Land, Wlodarska-Kowalczuk and Weslawski (2001) suggested that one consequence of climate warming for Arctic marine near-shore ecosystems will be a decline in benthic biodiversity due to increased turbidity and mineral sedimentation from melt waters. However, in W and

Several of the interviewees reported finding pieces of seal in walrus stomachs. The photo shows pieces of seal skin found in the feces of an adult male walrus in NE Greenland, August 2001. Photo: M. Acquarone

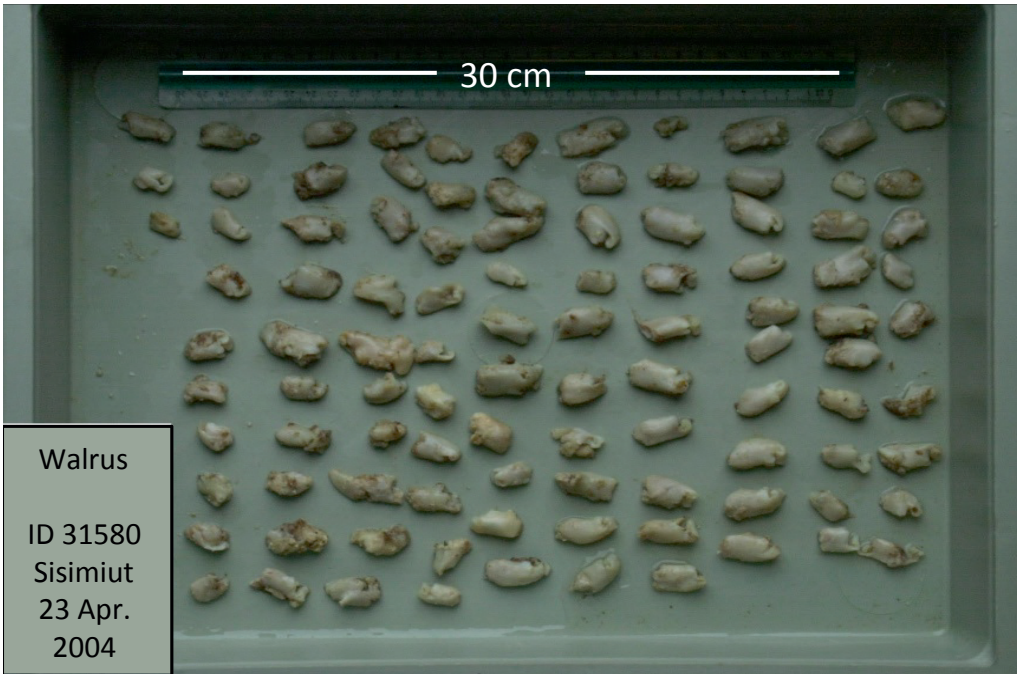
NW Greenland, and in many other areas of the Arctic, walrus feeding banks are not located at the entrance to fjords, but are instead found along the outer mainland coasts or even farther offshore. Being relatively far away from glaciers, turbidity caused by outflow of melt water might be less of a problem in such areas. Hence, it is likely that increased sedimentation from increased melting of glaciers will not negatively affect benthos and/or walruses to any noticeable degree on their West and Northwest Greenland foraging banks.

Although walruses have a relatively broad menu consisting of various benthic invertebrates and also occasionally taking vertebrates (fish, birds and marine mammals), their main prey is bivalve mollusks (*e.g.* Vibe 1950; Fay 1982; Born *et al.* 2003). Very few of the mollusks found in walrus stomachs can be identified to species, since the shell usually is absent and it is common to find only the foot and siphon of bivalves (Fay 1982; Sheffield and Grebmeier 2009). The remains of bivalves found in walrus stomachs are typically the feet of *Serripes groenlandicus* (synonym: *Cardium groenlandicum*), *Ciliatocardium ciliatum* (synonym: *Cardium ciliatum, Clinocardium ciliatum*), *Astarte borealis* and *Macoma calcarea,* and the siphons of *Mya truncata* and *Hiatella arctica* (synonym: *Saxicava arctica*); Vibe (1950) and Fay (1982 and references therein).

The interviews confirmed that walruses in West and Northwest Greenland mainly consume bivalve molluscs. This is in accordance with Vibe (1950) and Born *et al.* (1994). Other walrus food items like cockles, bottom dwelling worms, fish and seals (*e.g.* Born *et al.* 1994; Fay 1982) were also reported by the hunters. However, the information on stomach contents did not allow for an identification of species ingested except perhaps in the case of the relatively large feet of *Serripes* and siphons of *Mya,* both of which are common walrus food items (Vibe 1950; Fay 1982; Born *et al.* 2003).

Our study indicated that seal predation is a more common habit of walruses in Subarea 2 and 3 compared to Subarea 1. An explanation for this apparent difference is perhaps that walruses occurring in Subarea 2 and 3 are more often excluded from their feeding banks by formation of a denser and more persistent layer of sea ice. During exclusion from the mollusk banks the walruses may be forced to predate on seals. In contrast walruses in Subarea 1 have access to larger foraging banks which usually have less dense sea ice conditions.

The information from the hunters also indicated that walruses living in Subarea 3 have a broader diet than those occurring farther south. This may reflect that in this area it is still common for humans to eat the stomach contents, and the hunters also




A sample of stomach contents from a male walrus shot on 23 April 2004 at Store Hellefiskebanke west of Sisimiut. The photo shows 102 siphons of the bivalve *Mya truncata*. Photo: E.W. Born

have the opportunity to study walrus food preferences for a larger part of the year. The walrus diet may change somewhat during the year (Fay 1982).

Overall, the information collected during the interviews about walrus food were relatively unspecific and did not lend support to further speculations about whether walruses in W and NW Greenland have changed diet during the last decades.

## Recovery of tagged walruses

The interviews provided information on three observations of tagged walruses that were not shot and/or reported. Only in the case of an observation in the NOW area (2008) was it specified that it was a male walrus with a tusk satellite-radio. The other two observations (2003 and 2007) which both were made at the tip of the Nuussuaq peninsula in the Uummannaq area in Subarea 2 did not specify transmitter type or sex of the walrus, and none of the three observations involved information on the time of year.

Generally, the information was a little too scanty to allow for exact identifion of where these walruses came from. The observation in the NOW area may have been of one of four male walruses that were furnished with tusk satellite-radios on SE Baffin Island in fall 2007 (Dietz *et al.* 2014). Alternatively, it may have been one of three adult male walruses that were fitted with tusk satellite-radios in Jones Sound vis-à-vis NOW during 1998–2004 (Stewart 2008). The observation in 2007 at Nuussuaq could have been one of six walruses (four males, two females) that were tagged with puck or matchbox satellite-radios at Store Hellefiskebanke during spring 2007 (Dietz *et al.* 2014). The 2003 observation at Nuussuaq is a little more mysterious. It could have been from High Arctic Canada where 15 walruses (13 males, three females) were fitted with tusk satellite-radios during 1993–2001 (Stewart 2008) or, much more unlikely, one of 15 male walruses that were furnished with tusk satellite-radios in NE Greenland during 1999–2001 (only tusk radio-transmitters were attached to walruses prior to 2005); Born 2005a.

# Appendix 1 – List of questions

Questions asked during 75 interviews of 76 walrus hunters in West and Northwest Greenland, 2010.

## Basic background data about the informants

Name (given and family name), address and telephone number.
1: *How old are you?*
2: *How old were you when you for the first time participated in a walrus hunt?*
3: *How old were you when you caught a walrus for the first time?*

## The catch of walruses, overall hunting "strategies" and use of products

4: *How often do you go walrus hunting?* (*i.e.* number of times per year)
5: *Do you sometimes go hunting only for walrus?* (*i.e.* because you go particularly for walruses)
6: *At which time of the year do you hunt walrus?* (*i.e.* during which months)
7: *Do you only hunt walrus if you encounter them by coincidence?*
8: *What do you do with the meat, skin, skull/tusks and the penis bone?* (please explain).
9: *Who gets the skull and the tusks?*

## Trends in the catch of walruses

10: *How many walruses did you catch in 2009?* (*i.e.* How many did you finish off/harpoon or report to the authorities?)
11: *How many walruses did you catch in 2008?*
12: *How many walruses do you think were landed in total in your settlement/town in 2009?*
13: *And in 2008?*
14: *Has the number of walrus caught in your settlement/town changed during the last 10–15 years?*

15: *Which change?*
16: *Why have these changes happened?*

## Categories of walruses caught

17: *Do you catch both male and female walruses?*
18: *How many of each sex on an annual basis*?
19: *Do you specifically target some types of walruses if you have the chance?*
20: *Have you ever caught pregnant walruses?*

## Hunting methods

21: *Which type of boat are you using?* (when you are hunting walrus).
22: *At which distance are you firing? (i.e. the greatest distance at which you would fire at a walrus; in m).*
23: *Which caliber is the rifle you are using (i.e.* when hunting walrus*)?*
24: *Where do you aim at the walrus when it is hauled out on the ice?*
25: *Where do you aim at the walrus when it is in the water?*
26: *Do you use a harpoon*?
27: *When do you throw the harpoon*? *Before or after the walrus has been hit by a shot*?
28: *At which distance do you throw the harpoon?* (*i.e.* estimate of minimum and maximum distance in m).
29: *Did you hit walruses that you did not retrieve and which were lost in 2009?*
30: *In 2008?*
31: *In 2007?*
32: *Have you ever brought back only the head and tusks of a walrus?*
33: *Do you know if there is anybody who brings back only the head and tusks?*

## Quotas

34: *Are quotas necessary or unnecessary*?
35: *What effects did it have for you that quotas were introduced in 2006*?

## Distribution, seasonal occurrence and local abundance

Question 36: *Where do walruses occur at different times of the year?* (time, place, gender, ice type, distance from the coast etc.).
37: *Have you seen walruses that were hauled out on land?* (when?, where?).
38: *Have you observed any changes in the distribution of walruses during the last 10–15 years?*
39: *Which changes have you observed?*
40: *Have there been any changes during the later years in abundance of walruses in areas where you are hunting them?*
41: *Why have these changes happened?*

## Climate and walruses

42: *Do climate changes influence walruses?*
43: *How do climate changes affect walruses?*

## Biology

### Period of birth

44: *Have you seen newborn walruses?* Where? When?

### Food

45: *Do you inspect the stomach to see what the walrus has eaten?*
46: *What do they eat?*
47: *Have you noticed any changes to what the walruses are eating?*
48: (If the answer was *yes* to question 47) *Which changes have you seen?*

## Recovery of tagged walruses

49: *Have you ever caught a walrus which was marked or carried a transmitter?*

## Other comments/final statement

50: *Is there something else you would like to tell/explain?*

# Appendix 2 – Detailed summaries of responses with individual statements by informants

## The catch of walruses, overall hunting "strategies" and hunting seasons (Questions 4–9)

### Question 4

*How often do you go walrus hunting?* (*i.e.* number of times per year).

The purpose of this question was to find out how active the individual hunters were hunting walruses and thereby providing information about the importance of walrus hunting in general.

The number of times during a year that the hunters went walrus hunting differed statistically significantly among the subareas ($P<0.0001$, $\chi^2=31.445$, $df=6$). In Subarea 1 and 2 a high proportion of the hunters (ca. 97% and ca. 86%, respectively) answered that they hunt walrus ≤2 times per year. In contrast, the proportion of interviewees in Subarea 3 who said that they hunt walrus this infrequently was only ca. 39%, and in

| Question 4 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subarea | < 1 time per year | % | 1–2 times per year | % | 2–5 times per year | % | > 5 times per year | % | No opinion[1] | % | No answer | % | N[2] |
| 1 | 9 | 30.0 | 20 | 66.7 | 1 | 3.3 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 30 (30) |
| 2 | 7 | 50.0 | 5 | 35.7 | 0 | 0.0 | 0 | 0.0 | 2 | 14.3 | 0 | 0.0 | 14 (14) |
| 3 | 5 | 16.1 | 7 | 22.6 | 5 | 16.1 | 11 | 35.5 | 3 | 9.7 | 0 | 0.0 | 31 (31) |
| 1: Answers included other statements, *e.g.* that the hunter for various reasons had stopped hunting walrus.<br>2: N=Interviewees. In parentheses: Number of answers to this specific question. | | | | | | | | | | | | | |

**Table 4.** Number of answers (by subarea) to Question 4: "How often do you go walrus hunting?"

this area ca. 36% mentioned that they go walrus hunting more than five times a year (Table 4).

Of 15 informants in Subarea 1 who gave further explanations, 13 (ca. 87%) said that they used to go walrus hunting more often. Several reasons for a decrease in walrus hunting activity were given: eight (ca. 53 %) stated the reason was the introduction of quotas. Among the hunters providing this explanation a 46-year-old said that prior to the introduction of quotas, he used to hunt walruses every year – also from shrimp trawlers.

Other reasons for a decrease in walrus hunting activity were given. A 54-year-old hunter mentioned that he had not hunted walrus for the previous three years because the quota on beluga (white whale) had become so small. He used to hunt walrus during hunting trips primarily dedicated beluga. A 61-year-old hunter explained that walrus meat could previously be sold for seven Danish kroner per kg (ca. 1.2 US $ in 2010/kg) to the *Sipineq* (*i.e.* a co-op based in Sisimiut that bought and sold hunting and fishing products locally and nationally, established in 1967 and closed down in the late 1980s; Winter 2002). However, when this was no longer possible he had become less interested in hunting walrus. A 63-year-old informant stated that in general the number of walrus hunts that he does depends on the sea ice conditions, and that in some years he did not go walrus hunting at all. A hunter (aged 33) said a reason for a reduction in his walrus hunting activity was because he had gotten a permanent job. Finally, a 66-year-old informant said during the 1980s he had a vessel and was hunting walrus every year. However, in 1988 a walrus attacked him when he was using the harpoon during the hunt and since then he has hunted walrus less than once a year.

In Subarea 2 (*i.e.* the Uummannaq-Upernavik area), 11 of the 14 interviewees provided some additional information. Eight (ca. 73%) stated that their walrus hunting activity had decreased and five of these interviewees stated specifically that this was a result of introduction of a quota system. In contrast, two hunters said their interest in going walrus hunting had increased during the years. One (49 years old) said that this happened around the mid-1990s, and the other explained that this was due to the fact that he had gotten a bigger boat (type: AWI 39) and had had a regular "crew" since 2005.

In Subarea 3 (the Qaanaaq area), 15 hunters also provided some additional information when answering this question. Eleven remarks (ca. 73%) indicated a reduction in walrus hunting activity and individual explanations for this development included (1) the introduction of quotas, (2) the ice conditions had deteriorated due to a change in currents (authors' comment: this apparently referred to the traditional hunting on thin ice during winter and early spring), (3) walrus ivory could no longer be sold to the trade company (*i.e. KNI*, *Kalaallit Niuerfiat* "Greenland Trade Company" which

replaced the Royal Danish Trade Company, *KGH*, in 1986), (4) walrus was only hunted in connection with hunting narwhal (at the ice edge), and (5) one said that he now only hunts walruses when he encounters them by coincidence. Remarks from five hunters aged between 52 and 69 years indicated that their hunting activity had decreased simply because they had grown older and were no longer that active.

## Question 5

*Do you sometimes go hunting only for walrus?* (*i.e.* because you go particularly for walruses)

The purpose of this question was to explore to what extent the hunters go on a hunting trip particularly dedicated to catching walrus.

Overall, ca. 44.0% (N=33) answered "yes" and 54.7% (41) "no" ($N_{total}$=75 answers) to the question (one hunter, 1.3%, had no opinion about the matter), Table 5. The proportion of "no" and "yes" answers did not differ statistically among subareas ($P<0.526$, $\chi^2=1.283$, df=2). The apparent tendency in Subarea 1 to a higher proportion of interviewees answering "no" than "yes"(Table 5) was not statistically significant ($P=0.297$, $\chi^2=1.283$, df=1).

| Question 5 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subarea | "Yes" | % | "No" | % | No opinion | % | No answer | % | N[1] |
| 1 | 11 | 36.7 | 19 | 63.3 | 0 | 0.0 | 0 | 0.0 | 30 (30) |
| 2 | 7 | 50.0 | 7 | 50.0 | 0 | 0.0 | 0 | 0.0 | 14 (14) |
| 3 | 15 | 48.4 | 15 | 48.4 | 1 | 3.2 | 0 | 0.0 | 31 (31) |
| 1: N=Interviewees. In parentheses: Number of answers to this specific question. | | | | | | | | | |

**Table 5.** Answers to Question 5: "Do you sometimes go hunting only for walrus?" (*i.e.* because you go particularly for walruses)

Some hunters gave further explanation to their answer. Of the 19 in Subarea 1 who indicated that they did not engage in hunts specifically dedicated to hunting walrus, 14 (ca. 74%) stated that the hunting of walrus was usually combined with the hunt for other species, particularly beluga and narwhal (13 answers). Three specified that also polar bears and seals were targeted during such hunts.

Among the hunters who answered in the affirmative, four qualified their answer. One hunter mentioned that walrus is hunted because it provides good food for sled dogs whereas another interviewee told that the local market gets saturated if too many walruses are caught (*i.e.* during the hunting season). The answer given by a

52-year-old informant from Kangerluk on Qeqertarsuaq/Disko Island indicated that he hunted specifically for walrus when he needed food for his dog team:

> When there was sea ice we went hunting specifically for walrus. I do not have a dog team when there is no sea ice.

In Subarea 2, two interviewees answering "no" explained that walruses are hunted during hunting trips during which narwhal, beluga and polar bears are also taken. Three hunters who answered "yes" also stated that other species were taken when walruses were hunted, and among these interviewees one mentioned that walruses were specifically targeted when the polar bear quota had been fulfilled during spring.

In Subarea 3 only few hunters added comments when answering Question 5. A hunter who answered "no" said that:

> Walruses are caught in April–May when they migrate north.

According to Jørn (Juulut) Kruse (aged 48 when interviewed) living in Niaqornat, the hunt for walruses in Subarea 2 in the spring is usually combined with the hunt for narwhal and polar bear. Photo: A. Heilmann

whereas another said that they take whatever marine mammal species they encounter when they are hunting. One hunter who responded with a "yes" specified that they hunt specifically for walrus during winter.

## Question 6

*At which time of the year do you hunt walrus?*

The hunters were asked in which months they hunt walrus. The distribution of months in which walruses are caught (Results, Figs. 3–5, p. 40) differed significantly among subareas ($P<0.0001$, $\chi^2=93.544$, $df=22$). Also when seasonal distributions were tested pairwise against each other, all tests resulted in statistically significant differences (data not shown).

In Subarea 1, 25 hunters (ca. 83%) said March and of these, 11 (37%) also said April (Results, Fig. 3). Overall, March and April constituted ca. 87% of the months mentioned. Eighteen interviewees noted that the timing was related to the opening of the hunting season on 1 March. Information from four of the hunters indicated that they had hunted walrus prior to this date (*i.e.* January–February). It was mentioned by eight hunters that prior to the introduction of quotas (and hunting season?) they would usually hunt walrus in January–February. One hunter mentioned that he once (year not stated) caught walrus in December.

A 60-year-old hunter from Attu stated that:

> We wait patiently for March 1st. Otherwise we would hunt in February when the walruses occur closer to the coast.

He also mentioned that:

> Walruses are sensitive and move west when there are trawlers nearby.

A total of 13 of the 14 interviewees in Subarea 2 mentioned months during which walruses are hunted. Compared to Subarea 1 the walrus catch takes place later in the spring in Subarea 2. The months April, May and June constituted ca. 83% of the months mentioned (Results, Fig. 4).

Some of the hunters offered further explanations. A hunter from the settlement Niaqornat said that they hunt walrus in April or in March at the edge of the fast ice at the entrance to the Uummannaq fjord if the fjord ice is stable.

A 46-year-old hunter from Nuussuaq/Kraulshavn in the northern part of the Upernavik area (Subarea 2) stated that they hunt walruses:

The settlement Niaqornat (population: 58 Greenlanders in 2010) is situated at the entrance to the Uummannaq fjord in the southern part of Subarea 2. Three experienced hunters living there were interviewed about walruses and the walrus hunt. April, 2009. Photo: E.W. Born

> If there is still some of the quota left we go walrus hunting in May when they are migrating north and are eating in shallow waters and are hauling out on the ice, and in the fall, in November, when the walruses move south.

Two interviewees from the Upernavik area mentioned that nowadays they do not hunt walruses during the fall because by then the quota for the entire area has been used. One of these hunters complained about the fact that the total quota for the entire Upernavik area was only four walruses per year (authors' note: it was five; Table 9 later).

A 63-year-old hunter from the settlement of Kullorsuaq was in line with this statement and said:

> There is never any quota left so it is quite many years ago since we hunted at the ice edge during spring even though we still see walruses. It is just sad to observe them now when we cannot hunt them

> anymore. The southern settlements (authors' note: in Subarea 2) catch the entire quota.

Although walruses can be caught year round in Subarea 3 (except July–August), the catch is concentrated in the period January–June (ca. 67% of the months mentioned) with a peak in May. Walruses are also caught during fall (*i.e.* September–November; ca. 30% of the months mentioned) with a peak in October (Results, Fig. 5).

Some informants in Subarea 3 provided additional information. Three hunters from Savissivik where walruses are mainly transient (this study) mentioned that they go to the floe edge (*i.e.* the edge of the land-fast ice) in April to hunt walrus when the walruses are on their way north. An interviewee (aged 63) from Qaanaaq said that he hunts walrus in the fall when he usually takes two walruses in order to get enough food for his sled dogs. Another hunter mentioned that they hunt walruses during fall from skiffs, whereas in the spring they go by sled to the edge of the fast ice to hunt them. It was also stated by a hunter that they hunt walrus during January–March depending on the ice conditions (authors' note: at this time of the year the walruses are hunted during the "thin-ice hunt"; this study, Vibe 1950; Born 1987a). This was also commented upon by a 46-year-old hunter from Siorapaluk, according to whom they used to hunt walrus on thin ice during January–March, whereas nowadays the "thin-ice hunt" is no longer possible due to the deterioration of the ice conditions (*i.e.* the thin fast ice has become unstable and breaks up unexpectedly or does not form at all; this study; Born *et al.* 2011a; Gearheard *et al.* 2013). The same man also explained that that they mainly use skiffs for hunting walrus in May–June and in October–November.

## Question 7

*Do you only hunt walrus if you encounter them by coincidence?*

By asking this question we wanted to discover to what extent hunters took walruses opportunistically when they encounter them on hunting trips dedicated to catching other marine species, in contrast to hunting trips specifically targeting walrus. Hence, this question was related to Question 5.

In Subarea 1 more informants answered "yes" (N=19) than "no" (11) to this question. However, the difference was not statistically significant (P=0.297, $\chi^2$=1.086, df=1); Table 6.

| Question 7 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subarea | "Yes" | % | "No" | % | No opinion | % | No answer | % | N[1] |
| 1 | 19 | 63.3 | 11 | 36.7 | 0 | 0.0 | 0 | 0.0 | 30 (30) |
| 2 | 11 | 78.6 | 2 | 14.3 | 1 | 7.1 | 0 | 0.0 | 14 (14) |
| 3 | 30 | 96.8 | 1 | 3.2 | 0 | 0.0 | 0 | 0.0 | 31 (31) |
| 1: N=Interviewees. In parentheses: Number of answers to this specific question. | | | | | | | | | |

**Table 6.** Answers to Question 7: "Do you only hunt walrus if you encounter them by coincidence?"

Among 12 hunters who offered supplementary comments, six said they prioritize hunting narwhal and beluga but will also catch walrus if they encounter them during a hunt for these cetaceans. One of these interviewees explained that this prioritization is because narwhal/beluga products are more valuable trade commodities. Another hunter (60 years old from Attu) ascertained that they love walrus meat; whereas a hunter from Maniitsoq stated that he only catches walrus if he is sure he can sell all the meat in Maniitsoq and Kangamiut. An interviewee who answered "yes" explained that when on a hunting trip, he will first hunt for walrus and then go for seals. A 49-year-old hunter from Sisimiut indicated that to a certain extent, his interest in hunting walrus depended on the type of walrus, and that if it was a big male he was unlikely to catch it. An interviewee who answered "no" stated that "there is always walrus". Finally, a 66-year-old informant from Qeqertarsuaq explained that before the regulations he would hunt walrus if he encountered them coincidentally when going in his 43 BRT/GRT shrimp trawler.

In Subarea 2 more interviewees answered "yes" (N=11) than "no" (2) to this question. However the difference in numbers given the two answers was not statistically significant at the 5% level (P=0.064, $\chi^2$=3.436, df=1). One hunter had no opinion on this matter; Table 6.

A 44-year-old hunter from Illorsuit who answered "no" stated that it depends on how much walrus meat they already have and how much they expect to hunt. Three hunters (from Upernavik Kujalleq, Nuussuaq and Kullorsuaq, respectively) said that they would take walruses if any of the quota was left.

One of these informants (Nuussuaq) added that:

> Nowadays the quota opens in January and then the hunters from Upernavik town catch the whole quota. Hence, for the last years I have not hunted walrus since the quota has already been used.


In spring dog sleds are used to bring skiffs to the edge of the land-fast ice in Subarea 3 to hunt walrus. Photo: M. Villum Jensen

A 35-year-old interviewee from Niaqornat said that he used to hunt the walruses he encountered, but that now he checks the size of its tusks before he decides whether to kill it or not. A hunter (aged 55) from Tasiusaq said that it depended on which vessel they were using that particular day and its cargo capacity. If there was still space in the cargo hold, they would go for a walrus if they saw one.

In Subarea 3, 30 interviewees responded "yes" and only one said "no" to this question; Table 6. The difference between the number of hunters answering "yes" or "no" was statistically significant ($P<0.001$, $\chi^2=17.485$, $df=1$).

Some informants gave further explanation. A 37-year-old hunter from Savissivik said:

> Because walrus is rare (in this area) we try to catch the ones we see. But only if we bring a skiff with (*i.e.* skiffs are transported on the dog sled to the ice edge). Hunting walrus from qajaq (kayak) is dangerous. In 1984, my brother got killed, 29 years old, by a walrus during a narwhal hunt. He was the older in the family. The narwhal was caught but not dead yet. The walrus attacked when my brother was in his qajaq. His body was never found, only his qajaq. They were two hunting together.

Another hunter (aged 53) from Savissivik who answered "no" to the question stated that they catch narwhals, seals and walrus during the same hunting trips. A 67-year-old informant from the same village indicated that the annual take of walrus may vary, and said that in that area walrus is a rare animal that they sometimes encounter coincidentally, but some years they may get five in total. A 53-year-old hunter, also from Savissivik, mentioned that they take walruses if there is any of the quota left and if the skiff can load them. Similarly, a hunter from Qaanaaq also alluded to the loading capacity, stating that he would only kill two walruses because the products of two is what can be transported in a skiff and on a dog sled back to the settlement. A fellow villager also stated that his catch of walrus depended on whether he would be able to transport the products back. A 43-year-old informant also from Qaanaaq said that the catch depended on whether there was any quota left. In Siorapaluk a 63-year-old hunter said that during spring, bearded seal (*Erignathus barbatus*) is alternative game whereas in the fall the catch of walrus is prioritized. Finally, a 34-year-old hunter from the same village mentioned that they mainly catch walrus from September onward.

| | | | Question 8 | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Meat | | | | | | | Skin | | | | | | | Skull/Tusks | | | | | | Penis bone | | | | | |
| Sub-area | | | Sold | For own use | Given to family | Given to other [1] | Used as dog food | Discarded | No opinion | Sold | For own use | Given to family | Given to other | Used as dog food | Discarded | No opinion | Sold | For own use | Given to family | Given to other | Used as dog food | Discarded | No opinion | Sold | For own use | Given to family | Given to other | Used as dog food | Discarded | No opinion | Ntotal (hunters) |
| 1 | N | 28 | 27 | 22 | 3 | 4 | 0 | 0 | 11 | 3 | 1 | 7 | 14 | 9 | 0 | 24 | 14 | 0 | 4 | 0 | 0 | 2 | 6 | 3 | 0 | 1 | 0 | 3 | 19 | 30 |
| | % [2] | 93.3 | 90.0 | 73.3 | 10.0 | 13.3 | 0.0 | 0.0 | 36.7 | 10.0 | 3.3 | 23.3 | 46.7 | 30.0 | 0.0 | 80.0 | 46.7 | 0.0 | 13.3 | 0.0 | 0.0 | 6.7 | 20.0 | 10.0 | 0.0 | 3.3 | 0.0 | 10.0 | 63.3 | |
| 2 | N | 5 | 12 | 1 | 5 | 9 | 0 | 0 | 1 | 14 | 4 | 3 | 11 | 0 | 0 | 9 | 6 | 0 | 3 | 0 | 0 | 0 | 5 | 7 | 0 | 0 | 0 | 0 | 2 | 14 |
| | % | 35.7 | 85.7 | 7.1 | 35.7 | 64.3 | 0.0 | 0.0 | 7.1 | 100.0 | 28.6 | 21.4 | 78.6 | 0.0 | 0.0 | 64.3 | 42.9 | 0.0 | 21.4 | 0.0 | 0.0 | 0.0 | 35.7 | 50.0 | 0.0 | 0.0 | 0.0 | 14.3 | 14.3 | |
| 3 | N | 11 | 31 | 1 | 2 | 28 | 0 | 0 | 2 | 16 | 0 | 1 | 31 | 0 | 0 | 23 | 13 | 0 | 0 | 0 | 0 | 1 | 18 | 11 | 0 | 2 | 0 | 0 | 5 | 31 |
| | % | 35.5 | 100.0 | 3.2 | 6.5 | 90.3 | 0.0 | 0.0 | 6.5 | 51.6 | 0.0 | 3.2 | 100.0 | 0.0 | 0.0 | 74.2 | 41.9 | 0.0 | 0.0 | 0.0 | 0.0 | 3.2 | 58.1 | 35.5 | 0.0 | 6.5 | 0.0 | 0.0 | 16.1 | |

1: Given as present to other than family; *i.e.* to some who still have a dog team

2: Percentage of hunters giving this answer

**Table 7.** Answers to Question 8: "What do you do with the meat, skin, skull/tusks and penis bone?"

The fractions of hunters answering "yes" or "no", respectively, to this question differed significantly among the three subareas ($P=0.004$, $\chi^2=11.243$, $df=1$).

## Question 8

*What do you do with the meat, skin, skull/tusks and the penis bone?*

In Subarea 1 the majority of the answers indicated that the meat is sold (*i.e.* either at the local market or privately) or consumed by the hunter and his relatives or given to kin for consumption (Table 7). The individual informants gave a combination of answers but few mentioned that some of the meat is also fed to the sled dogs. A 47-year-old hunter from Maniitsoq said that he, after having had the meat analyzed for *trichinae* at the local hospital, immediately sold the meat. He would sell it cheap to owners of sled dog teams in Sisimiut and Kangaatsiaq. A 79-year-old hunter from Kangaamiut mentioned that until 1965, walrus products (meat, skin, tusks) could be traded to the Royal Danish Trade Company (*KGH*, *Den Kongelige Grønlandske Handel*). An informant (aged 61 years) from Sisimiut said that in previous years they could

Anders Lundblad (aged 57 when interviewed in 2010) from Sisimiut (Subarea 1) explained that food preferences of people have changed, leading to a decreased demand of walrus meat. This has also resulted in less hunting of walrus. Photo: A. Heilmann

trade the meat to the local trade co-op. *Sipineq* (authors' note: *i.e.* until the late 1980s). A 53-year-old hunter from the same town mentioned that they kept the most tender and delicious meat for their own consumption or gave it away to kin and friend, and then sold the remainder.

Three hunters (aged 47, 47 and 79 years from Kangaatsiaq, Aasiaat and Kangaamiut, respectively), said that after being cooked, the skin (*"kaava"*) is also eaten. The informant from Aasiaat also said that earlier, walrus skin was used for making ropes (*"kigaaqut"="kigaallisaatit"*) that were laid around the sled runners as a brake to reduce speed when running the dog sled downhill.

It became obvious from the answers that the tradition of sharing edible walrus products with family and others in the settlement/town is still practiced to a large extent.

The majority of answers indicated that the skull/tusks are either sold or kept for own use (*e.g.* carving or decoration). Two hunters from Sisimiut (aged 49 and 58, respectively) said they used to sell the skulls/tusks, but after the introduction of a quota these items have become more valuable and therefore they keep them themselves. A 54-year-old hunter from Kangaatsiaq mentioned that walrus tusks/ivory could be sold to *KNI* trade company for ca. 800 DKK/kg (ca. 133 US $ in 2010) in the 1980s and 1990s. A 47-year-old hunter from Maniitsoq says that he sells penis bones and tusks to local artists/figurine carvers, or gives them to friends as presents. A hunter (53 years) from Sisimiut mentioned that he gives the skull/tusks to an old craftsman in the town. Similarly, a 60-year-old informant from Kangaatsiaq mentioned that he sells the ivory to artists/figurine carvers but they do not buy much anymore. A 47-year-old hunter from the same village said he would sell skull with tusks for ca. 500 DKK/kg (ca. 83 US $, July 2010 exchange rate).

The penis bone (*os penis*) is either sold or the hunter keeps it himself (Table 7). A 51-year-old interviewee from Kangaatsiaq mentioned that he used to be able to sell the penis bones for ca. 200 DKK/kg (ca. 33 US $), but that he now keeps them himself.

A 46-year-old hunter from Qeqertarsuaq said:

> The penis bones seem to have become more popular nowadays.

According to the 14 informants in Subarea 2, the vast majority of walrus meat and skin is consumed by humans and/or fed to the sled dogs (Table 7). Three hunters (from Aappilattoq, Nuussuaq and Kullorsuaq, respectively) said they eat the skin (*"kaava"*) boiled, or in case of a 63-year-old hunter from Kullorsuaq, fermented and cold. A 44-year-old hunter from Innaarsuit mentioned that he serves walrus as a special treat

for Christmas. Similar to the situation in Subarea 1 the skull with tusks or tusk ivory are either sold, kept for decoration at home, or are given to others. Three informants stated that they sell the tusks to local artists. One of these hunters, a 37-year-old from Upernavik Kujalleq mentioned that he would charge at least 4000 DKK for a skull with tusks (ca. 667 US $). A 46-year-old interviewee from Nuussuaq said that he himself makes figurines, whereas a 63-year-old hunter from Kullorsuaq explained that he uses the ivory for hunting tools and implements (*"naalikkamut napasoq"*, *i.e.* the tusk ivory is for example used for making the knob on the harpoon shaft to which the throwing board is attached when throwing the hapoon). Three hunters (Niaqornat, Upernavik Kujalleq and Kullorsuaq, respectively) said that they sell the penis bones to artists (figurine carvers) for 1000 or 1500 DKK a piece (ca. 167–250 US $). A hunter from Nuussuaq said he would usually discard the small penis bones but use the larger ones as the tip of a harpoon (*"igimaq"*; *i.e.* the harpoon's flexible tip on which the harpoon head is attached). Similarly, a hunter from Kullorsuaq also used the bones for harpoon tips. Finally, an informant from Aappilattoq mentioned that he uses the penis bones as parts of hunting tools (*"avataq pullaffia" i.e.* mouthpiece used to inflate the *avataq*/ float; *"puappik"* the local dialect for a *"pulaffik"*).

In Subarea 3 all informants said the meat is used for human consumption. The meat (skin and blubber) is also fed to the sled dogs, and some interviewees mentioned that the meat can also be sold locally if they have a surplus and if anyone is interested in buying it (Table 7).

Some hunters provided details about the use of walrus meat. A 37-year-old hunter from Savissivik told that:

> The walrus meat is hidden under stones. The meat is kept there for three to four months or longer during winter – under big stones. The meat under the stones gets covered with snow. We then will cut it up and serve it slightly fermented for festive occasions.

A 67-year-old informant from the same village also mentioned that the older hunters prepare fresh walrus meat (*"ungerlaaq"*) and know the "recipe" and methods for fermenting it. He added that the dish is "smelly and delicious". A hunter aged 62 from Qaanaaq explained how the meat is covered by stones in June and picked up again in October and eaten as a delicacy. However, after the climate change (*i.e.* warming) it has been more difficult to prepare because the meat rots quickly and therefore has to be prepared more carefully (*i.e.* during the fermentation process). It is therefore seldom nowadays that walrus meat is prepared in this manner. The habit of preparing fermented walrus meat was also mentioned by others. A 46-year-old hunter from

Walrus bone is used for making parts of hunting tools and artifacts. The traditional hunting stool from NW Greenland had legs made of walrus bacula (*i.e.* penis bones) and a seat made of a walrus scapula. The legs were tufted with polar bear skin to dampen the sounds when the stool was used by the hunter while waiting at seal breathing holes in the fast ice. Photo: T. Kristensen

Siorapaluk also commented upon the effect of climate warming and said that in the 1990s they kept the meat under stones from May until October but this has become a rare event because the meat becomes unedible (authors' note: higher ambient temperatures and climatic instability make the fermentation process less controllable). A 48-year-old informant from Qaanaaq mentioned that the meat may also be cached for the winter, covered with stones for provision (*"qinnillugu"*; caching meat under stones and let it ferment; this is a preparation method not only used with walrus meat but also several other hunting products). The 62-year-old hunter from Qaanaaq mentioned that he eats the *"sakiai najungusilu"* (*i.e.* the meat at the chest and the ribs) and the liver, and feeds the rest of the meat/tissues to his sled dogs. Another interviewee (aged 69) from the same town similarly specified that the meat from the ribs (and the neck) is the preferred food for humans.

Traditionally tough and up to several centimetres thick, walrus skin is solid dog food that goes a long way. All informants in Subarea 3 mentioned that the skin of the walrus is used as food for the sled dogs (Table 7). However, 16 hunters (ca. 52%) said that the skin is also eaten by humans and that they prefer the skin of young walruses. The skin

is usually boiled, although a 59-year-old hunter from Siorapaluk said that he would also eat it fresh.

The tusks (ivory) often still attached to the maxilla, or the entire skull with tusks still imbedded, are either sold or used by the hunter himself. Of the 23 hunters who said that they sell the tusks, 8 (ca. 35%) stated that they were sold to local artists/figurine carvers. All 14 informants that did not sell the ivory said that they use it for making parts of their hunting equipment/tools (for example dog leash toggles), or figurines etc. However, a very experienced 69-year-old walrus hunter said he sells the tusks because the walrus ivory often has cracks and may therefore break. Thus when making hunting tools, he has replaced the ivory with "plastic" (*i.e.* a PVC type plastic).

The penis bones are either sold, used for making parts of hunting tools, or used for arts and craft. Eight of the 11 interviewees who said they keep these bones use them for hunting tools (*"uunaaq"*, *i.e.* the shaft of the harpoon) or for making figurines or *"saaqqutit"* (*i.e.* qajaq/kayak tools). A hunter mentioned that he would sell a penis bone to tourists for 300–500 DKK (ca. 50–83 US $, July 2010 exchange rate), and another interviewee said about the penis bones:

> They are very popular among Danes.

| Question 9 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Subarea | | The owner of the boat/skiff | Decided after "negotiation" | The income is shared | Who sees the walrus first | Who shoots first or kills the walrus | Whoever harpoons the walrus first | Other answers | No opinion | $N_{total}$ (hunters) |
| 1 | N | 13 | 7 | 9 | 1 | 2 | 1 | 2 | 0 | 30 |
| | %[1] | 43.3 | 23.3 | 30.0 | 3.3 | 6.7 | 3.3 | 6.7 | 0.0 | |
| 2 | N | 5 | 4 | 3 | 2 | 6 | 0 | 2 | 0 | 14 |
| | % | 35.7 | 28.6 | 21.4 | 14.3 | 42.9 | 0.0 | 14.3 | 0.0 | |
| 3 | N | 18 | 1 | 11 | 0 | 9 | 11 | 0 | 0 | 31 |
| | % | 58.1 | 3.2 | 35.5 | 0.0 | 29.0 | 35.5 | 0.0 | 0.0 | |
| 1: Percentage of hunters given this answer | | | | | | | | | | |

**Table 8.** Answers to Question 9: "Who gets the skull and the tusks?"

## Question 9

*Who gets the skull and the tusks?*

We were interested in knowing how it was decided among the participants in a walrus hunt who would get the tusks and therefore decided who would get the income from selling the tusks.

In Subarea 1, 13 (ca. 43%) of the informants answered that the owner of the boat used during the hunt gets the skull and tusks (Table 8). In this region they often use cutters when hunting walrus among the offshore pack ice. Some informants explained that the selling of the tusks helps cover the owner's expenses for fuel and equipment, and/or covers interest rate connected with the loan raised for his acquiring of the vessel. Under the category "Other answers" (Table 8) was a statement by a 53-year-old hunter from Sisimiut who said that in some cases the owner of the boat may give away the tusks to a favorite crew member. A 46-year-old informant from Qeqertarsuaq said that when he used to hunt with another hunter, he himself would get the tusks while


The cabinet in a hunter's home in Niaqornat (Subarea 2). Nowadays many of the hunters keep the skull and tusks for themselves. Photo: A. Heilmann

the other who did not own the skiff would get the penis bone. Several explained (ca. 23% of answers) that the decision about who will get the tusks is reached in accordance to internal agreement among the participants in the hunt, whereas other answers (ca. 30% of answers) indicated that the income from selling the tusks is shared among all participants (Table 8). Several answers indicated that the decision about what happens with the tusks varies according to circumstances and who participates in the hunt.

The answers from the 14 hunters interviewed in Subarea 2 also indicated that the skull/tusks belong to the owner of the vessel used (ca. 36% of answers), or it is decided according to internal agreement among participants (ca. 29%), or the income from selling the tusks is shared among them (ca. 21%), Table 8. Six of the 14 informants (ca. 43%) answered that the skull and the tusk belong to the hunter who hits the walrus first, or finishes it off (Table 8).

In the category "Other answers" was a statement by a 44-year-old hunter from Innaarsuit,

> If the others want it, I will give it to them,

and a remark from a 55-year-old informant from Tasiusaq:

| Subpopulation | Settlement/Town | Year | | | | |
|---|---|---|---|---|---|---|
| | | 2007 | 2008 | 2009 | 2010 | 2016[5] |
| E Baffin Isl.-W Greenland[1] | Maniitsoq | 3 | 2 | 2 | 4 | |
| | Sisimiut | 29 | 27 | 17 | 22 | 30 |
| | Kangaatsiaq | 14 | 13 | 7 | 8 | |
| | Uummannaq-Aasiaat area | 25 | 23 | 12 | 12 | |
| | Upernavik | - | - | - | 8(-1)[3] | 39 |
| Total | | 71 | 65 | 38 | 54(53) | 69 |
| N Baffin Bay[2] | Upernavik | 19 | 10 | 5 | - | - |
| | Qaanaaq | 80 | 80 | 70 | 64(-16)[4] | 86 |
| Total | | 99 | 90 | 75 | 64 (48) | 86 |

1: Earlier denoted the West Greenland subpopulation (cf. NAMMCO 2010)
2: Earlier denoted the Northwater population (*ibid.*).
3: From 2010 the catch in Upernavik has been regarded as being taken from the West Greenland subpopulation. The demographic identity of walruses in the Upernavik area remains uncertain (*cf.* Materials and methods).
4: A certain number is subtracted if the catch in the previous year exceeded the local quota.
5: The quotas for 2016 were based on new advice from NAMMCO and the Greenland Institute of Natural Resources (GINR).

**Table 9.** Regional annual quotas for the catch of walrus in West and Northwest Greenland in 2007–2010, and 2016 (Source: Anon. 2007, 2009, 2010b, 2014b, 2016).

> I seldom hunt with others but when I do and the other is hunting walrus for the first time he will get it (*i.e.* the skull with tusks).

Also in Subarea 3 did the answers reveal that it is often the owner of the boat (skiff or cutter) who gets the skull and tusks (ca. 58% of the informants gave this answer); Table 8. However, six who gave this answer added that if the boat owner sells the tusks, the net income (after expenditures like fuel etc. have been subtracted) is shared among the participants in the hunt. A 67-year-old hunter from Savissivik mentioned that if several are hunting together, the hunter who shoots/hits first will get the tusks, however if one puts a harpoon into the walrus, it is "his" walrus and he will get the tusks. Another hunter who said the one who shoots/harpoons first will get the tusks emphasized that they all share the meat (edibles). In Subarea 3, 11 interviewees (ca. 36%) answered that the one who is harpooning the walrus gets the tusks.

## Trends in the catch of walruses (Questions 10–16)

To serve as a background for the following, the regional walrus quotas in the years 2007–2010 (and 2016) are shown in Table 9.

### Question 10 and 11

Q 10: *How many walruses did you catch in 2009* (How many did you finish off/harpoon or report to the authorities?

Q 11: *And in 2008?*

The purpose of these questions was to get an idea from the informants about the magnitude of their catch (and losses).

In Subarea 1, 20 of the 30 informants (ca. 67%) had hunted walrus in 2009. The average number was 2.8 walrus per hunter. The total number of walruses landed by 20 hunters in Subarea 1 in 2009 was 56 (Table 10). Two hunters gave the number taken with some uncertainty (3–4 and ca. 5 walrus, respectively). However, ten hunters (mean age: 51.4 years, SD=9.2, range: 33–66 years; median age: 54 years) said that they had not hunted walrus in 2009 and some of them gave an explanation for this: (1) a 54-year-old hunter from Maniitsoq said that because the narwhal and beluga quotas had become so small, he did not hunt either narwhal/beluga or walrus in 2009, (2) two hunters had lived in other parts of Greenland in 2009, (3) a 33-year-old hunter from Ikerasaarsuk had had a wage job in 2009, and (4) a hunter from Sisimiut said he had not hunted walrus in 2009 (and 2008) because during spring he prefers to guide

trophy hunters during muskox (*Ovibos moschatus*) hunts in the Kangerlussuaq area. Among those who had caught relatively many walruses in 2009, three (two from Sisimiut and one from Qeqertarsuaq) had caught them from cutters (9, 4 and 7 walruses, respectively). The hunter from Qeqertarsuaq had taken his seven walruses during one hunting trip. A 60-year-old interviewee from Attu mentioned that he had caught 10 walruses in 2009 together with other hunters (and ca. 10 in 2008 and seven in 2010, also together with others). However, from his answer it was not entirely clear whether he was considered the main hunter responsible for having caught these walruses.

In 2008, 15 informants (50%) in Subarea 1 had hunted walrus and landed an average of 2.7 walrus per hunter. The total catch landed by the 15 interviewees in this year was 40 walruses (Table 10). Thirteen hunters (mean age: 51.0 years, SD=9.1, range: 33–66 years; median age: 49 years) did not go walrus hunting in 2008. Eight of these hunters also did not hunt walrus in 2009. A 46-year-old hunter from Sisimiut gave as an explanation for not hunting walruses in 2008, saying the quota had already been taken so he went muskox hunting instead.

| Question 10 and 11 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subarea | Year | N[1] (%) | Not hunting walrus | Did not remember | Walrus/ Hunter Mean | SD | Range | Total[2] | N[3] |
| 1 | 2008 | 15 (50.0) | 13 (43.3) | 2 (6.7) | 2.7 | 3.6 | 0–11 | 40 | 30 |
| | 2009 | 20 (66.7) | 10 (33.3) | 0 (0.0) | 2.8 | 3.2 | 0–10 | 56 | 30 |
| 2 | 2008 | 8 (57.1) | 4 (28.6) | 2 (14.3) | 2.4 | 3.5 | 0–10 | 19 | 14 |
| | 2009 | 8 (57.1) | 6 (42.9) | 0 (0.0) | 2.6 | 3.8 | 0–10 | 21 | 14 |
| 3 | 2008 | 25 (80.7) | 1 (3.2) | 5 (16.1) | 2.8 | 3.2 | 0–10 | 66 | 31 |
| | 2009 | 26 (83.9) | 4 (12.9) | 1 (3.2) | 2.8 | 3.2 | 0–10 | 70 | 31 |

1: Number of hunters who had been hunting walrus during that particular year. (%) = percentage of all informants in the area.
2: Total number of walruses landed by the informants in that particular year.
3: Total number of informants in the subarea.

**Table 10.** Answers to Questions 10 and 11: "How many walruses did you catch in 2009", and Question 11 "... in 2008?" (*i.e.* how many did you finish off and report to the authorities?).

In Subarea 2, eight of the 14 informants (ca. 57%) had hunted walrus in 2009. The total number landed was 21 with an average of 2.6 walrus per hunter (Table 10). A hunter from Niaqornat gave the number of walruses he had caught with some uncertainty (ca. 10 in 2009 and ca. 10 in 2008). Furthermore, he explained that he had caught these walruses together with other hunters from his settlement and also from the settle-

ment of Saattut in the Uummannaq area and the town of Ilulissat in the Disko Bay area (Fig. 1). Therefore, it was unclear from his answer whether all these walruses had been reported as caught only by him, or were alternatively reported by several hunters participating in these hunts. Six hunters (ca. 43%), five of whom were living in settlements in the northern parts of Subarea 2 (*i.e.* in Aappilattoq, Tasiusaq, Nuussuaq and Kullorsuaq), said that they did not hunt walrus in 2009 because the quota had already been used up. For the same reason, four hunters did not hunt walrus in 2008. The total landed catch reported by eight hunters in Subarea 2 for 2008 was 19 (average 2.4 walrus per hunter). Two informants did not remember their catch of walrus in 2008 (Table 10).

The fraction of informants in Subarea 3 that had hunted walrus in 2008 and 2009 was relatively high (ca. 81% and ca. 84%, respectively) and was higher than in the other two subareas, reflecting the importance of walruses in this area. In both years the mean number of walrus caught per hunter was 2.8. The total number caught in 2008 by 25 of the interviewees was 66 walruses, and in 2009 the total landed by 26 informants numbered 70 (Table 10). In 2009 four of the informants did not hunt walrus, one of whom also did not hunt walrus in 2008. A 52-year-old hunter from Savissivik explained that he did not hunt walrus in 2009 (and 2010) because of bad sea ice conditions. A 48-year-old hunter from the town of Qaanaaq also gave this as reason for why he did not catch any walrus in 2008. A 62-year-old interviewee from the same town said he only caught 2–3 walruses per year after the introduction of quotas. Two hunters clarified that they had caught more walruses together with other hunters than what they reported during the interviews as taken specifically by themselves.

It must be noted that several of the hunters did not remember how many walruses they had taken, and in nine cases (ca. 36% of the hunters who had caught walrus in 2009) and 10 cases (ca. 38% of the hunters who had caught walrus in 2008), the number they gave for their catch was approximate and with a range. In such cases we chose the highest value for the summary statistics in Table 10. In cases where a number was given as a "circa", the face value was used.

## Question 12 and 13

Q 12: *How many walruses do you think were landed in total in your settlement/town in 2009?*
Q13: *And in 2008?*

The purpose of these questions was to explore if the individual hunter either had a general idea of the total number of walruses caught in his home town or perhaps kept track of and noted the actual number.

| | Question 12 | | | | Question 13 | | | |
|---|---|---|---|---|---|---|---|---|
| Subarea 1 | 2009 | | *Pin* | *Spec* | 2008 | | *Pin* | *Spec* |
| Settlement/ Town | Estimate (total catch/yr) (N)[1] | No opinion/ other answer (N) | Reported[2] | Reported[3] | Estimate (total catch/ yr) (N)[1] | No opinion/ other answer (N) | Reported[2] | Reported[3] |
| Maniitsoq | 4 (1) | 1 | 0 | 2 | - | 2 | 1 | 1 |
| Kangaamiut | - | 1 | 0 | no[4] | - | 1 | 0 | no |
| Sisimiut | 30–40 (1), 22 (1), ca. 20 (1) | 7 | 29 | 15 | 30–40 (1), >22 (1), ca. 20 (1) | 7 | 26 | 22 |
| Attu | 10 (1) | 4 | 2 | no | 1 (1) | 4 | 0 | 3 |
| Ikerasaarsuk | - | 2 | 0 | no | - | 2 | 0 | no |
| Kangaatsiaq | - | 2 | 0 | 2 | - | 2 | 2 | 2 |
| Aasiaat | 0 (1) | 1 | 0 | no | 3 (1) | 1 | 3 | 3 |
| Qeqertarsuaq | 0 (1), 2 (2), 7 (1) | 2 | 0 | 2 | 0 (1), 2 (1) | 4 | 0 | no |

1: In parentheses = number of informants providing this particular estimate.
2: *Pin* – reported to *"Piniarneq"* in that year (Source: DFHA, Nuuk, 2013).
3: *Spec* – reported through the *"Særmeldingskemaer"* (*i.e. Special Reporting Forms*; Source: DFHA, Nuuk, 2013).
4: "no" = no reporting forms received.

**Table 11.** Estimates given by 30 informants in Subarea 1 of the total catch of walrus in 2008 and 2009 in the respective settlements and towns.

The majority of the 30 informants in Subarea 1 did not offer an estimate of total catches of walrus in any of the two years (Table 11). However, there were others who provided estimates for 2009. A 47-year-old hunter mentioned that four were caught in the town of Maniitsoq (none in 2008). Six informants in Sisimiut said that the whole quota was taken (regional quotas are shown in Table 9). Another of these informants said the quota was fulfilled and that:

> The rest of the hunters had their catches confiscated.

He thereby indicated that in 2009 some walruses were taken in excess of the quota. Among direct estimates from hunters in Sisimiut was "22 caught", which was the total quota according to this informant. Without giving further explanation, an interviewee (aged 55) from Sisimiut estimated that the annual landed catch in this town was 30–40 walruses in 2009 (and also in 2008). A 65-year-old hunter who had no opinion of the catch in 2009 and 2008 in Sisimiut said that in 2010 the quota was exceeded and that there were some "confiscations". The hunters in Attu did not provide any specific comments except for a 60-year-old who estimated that ca. 10 walruses had been

Steen Zeeb (aged 49 in 2010) from the town Qeqertarsuaq/Godhavn said that mainly hunters from Kangerluk/Diskofjord hunt walruses, however hunters from Qeqertarsuaq often join them. Photo: A. Heilmann

caught in 2009 in the settlement. According to him, very few walruses were caught there because the regional quota had already been used. Another hunter from Attu said there were probably not many that were landed, and gave as an explanation that there are now only skiffs in the settlement (*i.e.* no cutters). A hunter (aged 37) estimated "0" caught in 2009 in Aasiaat and added that he was the only walrus hunter in that town. One hunter estimated a total of seven landed in Qeqertarsuaq, which had been taken by one vessel only. However, another informant from this town said that 2–3 were caught by another vessel bringing the total estimate for Qeqertarsuaq up to at least 9–10 walruses in 2009.

Similarly, only a few estimates of total landings in 2008 were provided. The estimates for Sisimiut resembled those for 2009, except that a 57-year-old hunter who estimated "22 in 2009" said "a bit more than 22 because that quota was higher in 2008". A hunter (aged 47) from Kangaatsiaq mentioned that they only take the walruses they happen to encounter, and that "there were no more walrus hunters left in that settlement". The aforementioned walrus hunter in Aasiaat said that three were caught (by him) in the town in 2008. According to a 49-year-old hunter from the town of Qeqer-

| | Question 12 | | | | Question 13 | | | |
|---|---|---|---|---|---|---|---|---|
| Subarea 2 | 2009 | | *Pin* | *Spec* | 2008 | | *Pin* | *Spec* |
| Settlement/Town | Estimate (total catch/yr) (N)[1] | No opinion/ other answer (N) | Reported[2] | Reported[3] | Estimate (total catch/yr) (N)[1] | No opinion/ other answer (N) | Reported[2] | Reported[3] |
| Niaqornat | 10 (1) | 2 | 4 | 4 | <10 (1) | 2 | 4 | no |
| Illorsuit | 2 (1) | 1 | 0 | no[4] | 0 (2) | | 0 | no |
| Upernavik kujalleq | 3 (1), 3–4 (1) | | 2 | 4 | | 2 | 7 | 8 |
| Upernavik town | 0 (2)5 | | 0 | no | 1 (2)2 | | 2 | 1 |
| Aappilattoq | - | 1 | 0 | no | 2 (1) | | 0 | 1 |
| Innaarsuit | 0 (1) | | 0 | no | 1 (1) | | 0 | no |
| Tasiusaq | - | 1 | 0 | no | 1 (1) | | 0 | 1 |
| Nuussuaq | 0 (1) | | 0 | no | 0 (1) | | 0 | no |
| Kullorsuaq | 0 (2) | | 0 | no | 0 (2) | | 0 | no |

1: In parentheses = number of informants providing this particular estimate.
2: *Pin* – reported to *"Piniarneq"* in that year (Source: DFHA, Nuuk, 2013).
3: *Spec* – reported through the *"Særmeldingskemaer"* (*i.e. Special Reporting Forms*; Source: DFHA, Nuuk, 2013).
4: "no" = no reporting forms received.
5: Double interview. Two hunters were interviewed at the same time (*cf.* Material and Methods).

**Table 12.** Estimates given during 14 interviews in Subarea 2 of the total catch of walrus in 2008 and 2009 in the respective settlements and towns.

tarsuaq, it is mainly hunters living in the settlement Kangerluk who hunt walruses in the Disko Island area. Hunters from Qeqertarsuaq would go to Kangerluk and join the hunters there when going walrus hunting.

The catch of walrus is a less usual event in Subarea 2 compared to the two other subareas. Consequently, a higher proportion of the hunters were able to offer an estimate of the total number of walruses taken in their home town (Table 12). Six of seven informants living in Upernavik town and the settlements farther north who said that no walruses were taken in their settlement in 2009 explained that this was because the quota for the entire area had already been taken elsewhere in the administrative entity. This was also given as a reason for "0" catches in 2008 by the three hunters interviewed in Nuussuaq and Kullorsuaq. As mentioned under "Question 10 and 11", ca. 10 landed in Niaqornat in 2008 and 2009, respectively, were reported by a hunter. This informant also reported these numbers when asked how many he himself had caught, adding however that they were caught together with other hunters.

In Subarea 3 the estimates given for the total number of walrus taken in Savissivik ranged between one and seven in 2009, and two to three in 2008. According to the catch reporting systems only few were taken in these years (Table 13). Traditionally only few walruses are taken each year in the Savissivik area, primarily in May–June

(Born *et al.* 1995 and references therein). A 67-year-old and very experienced hunter living in Savissivik explained that they do not go specifically for walrus because they do not encounter them very often. He added that walruses are also dangerous and aggressive, particularly those which are drifting on the ice floes (migrating? Authors' note: perhaps because they have not eaten during the migration?).

According to the interviewees only a few walruses were taken by hunters in Qeqertat. However, hunters living in Qeqertat at the bottom of Qaanaap Kangerlua/Inglefield Bredning go walrus hunting at the entrance to Murchison Sound and Whale Sound (*i.e.* in the areas where hunters also from other parts of the area hunt walrus; this study).

In Qaanaaq only four of 11 informants provideded estimates of the total catch in 2009. The estimates ranged between one and ca. 70 walruses. The estimates differed markedly from the total 2009-catch reported for Qaanaaq via both the *Piniarneq* and the *Særmeldingskemaer/Special Reporting Form System* (Table 13). Furthermore, the numbers given by the two reporting systems also differ to a large degree. Two informants from Qaanaaq who did not offer an estimate of numbers landed said that in 2009 the total quota was used. Another hunter from this town stated that they probably took more than the quota because the game officer did not keep the list of total

| | Question 12 | | | | Question 13 | | | |
|---|---|---|---|---|---|---|---|---|
| Subarea 3 | 2009 | | *Pin* | *Spec* | 2008 | | *Pin* | *Spec* |
| Settlement/Town | Estimate (total catch/yr) (N)[1] | No opinion/other answer (N) | Reported[2] | Reported[3] | Estimate (total catch/yr) (N)[1] | No opinion/other answer (N) | Reported[2] | Reported[3] |
| Savissivik | 3–4 (1), 6–7 (1), 2–3 (1), 1–2 (1) | 1 | 2 | 2 | 2–3 (1) | 4 | 5 | 5 |
| Qeqertat | 2 (1), 1 (1) | - | 0 | no[4] | 2 (1) | 1 | 0 | no |
| Qaanaaq | 1 (2), ca. 70 (1), 50–60 (1) | 7 | 26 | 47 | ca. 70 (1) | 10 | 7 | 23 |
| Siorapaluk | ca. 60 (1), 70 (1), 15–20 (1), 6 (1), >30 (1), ca. 30 (1) | 7 | 20 | 37 | ca. 60 (1), >7 (1), 15–20 (1), 6 (1), ca. 20 (1) | 8 | 20 | 13 |

1: In parentheses = number of informants providing this particular estimate
2: *Pin* – reported to "Piniarneq" in that year (Source: DFHA, Nuuk, 2013)
3: *Spec* – reported through the "*Særmeldingskemaer*" (*i.e. Special Reporting Forms*; Source: DFHA, Nuuk, 2013)
4: "no" = no reporting forms received

**Table 13.** Estimates given during 31 interviews in Subarea 3 of the total catch of walrus in 2008 and 2009 in the respective settlements and towns.

numbers updated. Apparently, two informants who did provide estimates may have misunderstood the question and mentioned the number they themselves had landed whereas the other likely gave an estimate for the entire area (*i.e.* including what was landed in Siorapaluk because the hunters from Qaanaaq and Siorapaluk hunt walrus at the same hunting grounds).

The estimates given by a few hunters living in Siorapaluk for the total catch of walrus landed in this settlement in 2009 differed widely (*i.e.* between six and 70; Table 13). However, three informants estimated 15–20 walrus and ca. 30, which is not far from what was reported to the official management authorities through the reporting systems (Table 13). A hunter (aged 48) living in Siorapaluk complained that the quota given to Siorapaluk was used by hunters from Qaanaaq. The estimates for 2008 also had a large range (six to ca. 60). However, also in this case did a couple of hunters provide estimates (15–20 and ca. 20, respectively), which were not far from the catch reported to the management authorities. A 44-year-old hunter who estimated a total of ca. 20 for 2008 added that the weather conditions during winter and summer were bad, and therefore 2008 was "a tough year".

## Questions 14, 15 and 16

Q 14: *Has the number of walrus caught in your settlement/town changed during the last 10–15 years?*

Q 15: *Which change?*

Q 16: *Why have these changes happened?*

These questions were interrelated and the answers are therefore treated together.

In Subarea 1 almost 67% of the informants (N=20) said that there had been a change in number of walrus landed in their home town. About 30% (N=9) stated "no change"or "no opinion" (N=1); Table 14. About 63% (N=19) were of the opinion that there had been a decrease, whereas ca. 33% (N=10) gave no answer to the direction

| | Question 14 | | | | | | | | | Question 15 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subarea | "Yes" | | "No" | | No opinion | | No answer | | | Fewer | | More | | No opinion | | No answer | | |
| | N | % | N | % | N | % | N | % | N1 | N | % | N | % | N | % | N | % | N[1] |
| 1 | 20 | 66.7 | 9 | 30.0 | 1 | 3.3 | 0 | 0.0 | 30 (30) | 19 | 63.3 | 1 | 3.3 | 0 | 0.0 | 10 | 33.3 | 30 (20) |
| 2 | 8 | 57.1 | 6 | 42.9 | 0 | 0.0 | 0 | 0.0 | 14 (14) | 6 | 42.9 | 2 | 14.3 | 0 | 0.0 | 6 | 42.9 | 14 (8) |
| 3 | 26 | 83.9 | 2 | 6.5 | 3 | 9.7 | 0 | 0.0 | 31 (31) | 25 | 80.7 | 1 | 3.2 | 0 | 0.0 | 5 | 16.1 | 31 (26) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | | | | | | | | | | |

**Table 14.** Answers to Question 14: "Has the number of walrus caught in your settlement/town changed during the last 10–15 years?", and Question 15: "Which change?"

of change (*i.e.* Question 16; the aforementioned nine who had not observed any change plus another hunter who gave no answer to this question). A single interviewee thought that the catch had *increased* (Table 14).

Nearly 50% of the informants (14 hunters) in Subarea 1 stated that fewer walruses are caught nowadays because of the introduction of quotas. However, several reasons for the decrease were given. A hunter (aged 47) from Maniitsoq explained that previously, they would perhaps catch seven walruses in total but after the quota they would only catch two to three. He added that he does not hunt "illegally" outside the quota since he is afraid of losing his vessel (*i.e.* confiscation). Another hunter from this town said that the hunters from Maniitsoq catch walrus during the hunts for beluga and narwhal. Because the quotas for these cetaceans are small they do not hunt them so much anymore and therefore also catch less walruses. Two informants from Sisimiut stated that there are plenty of walrus, but fewer are taken due to the quotas, and the whole quota is always taken. Another hunter from Sisimiut said that walrus meat was always sold at the local market ("*brædtet*", *i.e.* "the board") and they also used to go to Maniitsoq and farther south to sell it. He added that in previous years "larger" boats were also allowed to hunt walrus which is no longer the case, resulting in an overall decrease in the catch (authors' note: by the 1994 amendments of the walrus hunting regulations boats above 40 tons were no longer allowed to catch walruses; Anon. 1994a). Among the informants in Attu, a 54-year-old hunter said that much fewer walruses are caught not only because of the quota but also because less people own a vessel in this settlement nowadays. According to him there was only one vessel left (in 2010); otherwise the hunters have only skiffs. When answering these questions another hunter from this settlement felt a need to explain that in the 1990s he was reported to the police by a Danish nurse because he had 24 walrus skulls with tusks lying outside his house. However, the charge (authors' note: likely of "head hunting") was dropped and he was "totally acquitted". An explanation of how the management system affects the walrus hunt was provided by a 60-year-old hunter living in Attu. According to him they would usually catch walrus in January–February when they occur closer to the coast. Nowadays, they "watch the walruses in January–April" but are only allowed to hunt them during March–April when they are too far away (too far offshore). Hence they are difficult to hunt, and reaching them is more expensive in fuel (authors' note: during winter the walruses occur at the eastern edge of the Baffin Bay-Davis Strait pack ice. During spring when this ice dissolves and the ice edge moves westward the walruses follow the retreating sea ice and therefore get farther offshore; Born *et al.* 1994; Dietz *et al.* 2014). A hunter from Kangaatsiaq and two from Qeqertarsuaq also gave the relatively late opening of the walrus hunting season (*i.e.* 1 March) as an additional explanation for a decrease in the catch.

Five of the responses to Question 16 indicated that the decrease in the catch is also related to the changing sea ice conditions. A hunter (aged 79) from Kangaamiut said that walruses are no longer landed in this settlement because the sea ice conditions prevent it. A 58-year-old informant from Sisimiut stated that:

> If there has been any change it is due to the climate. The sea ice has changed – it arrives (forms) later and has become more unstable.

Three other interviewees (Sisimiut, Attu and Kangaatsiaq, respectively) explained how the ice conditions in any given year influences the numbers caught. The pack ice conditions determine how easy, or difficult, it is to reach the walruses.

Several informants indicated that to a certain extent economical and cultural mechanisms also influence the number of walruses taken. The 79-year-old hunter from Kangaamiut said that:

> Now when people concentrate on fishery, walrus hunting is no longer economically profitable.

An informant (aged 55) from Sisimiut explained that:

> The young do not eat the same food as people did 20 years ago. The food habits have changed. The catch of walrus ceases when the local market has become saturated.

Another interviewee from Sisimiut also mentioned this change in peoples' food habits.

A 66-year-old hunter from Qeqertarsuaq also mentioned that the younger generations eat less walrus and therefore the market's demand for walrus has decreased.

A 42-year-old hunter from Qeqertarsuaq who specifically answered that the catch of walrus had *increased* said that:

> It seems like that the walrus never arrives in some years, but there have been more walruses for the last two years (authors' note: in 2008 and 2009 there was more Baffin Bay-Davis Strait pack ice in Subarea 1 than in the preceding several years; *cf.* Dietz *et al.* 2014).

This was supported by a 49-year-old informant from the same village who said:

> Now, in 2010, the walruses are easy to hunt. They are more visible (*"takussaaneruppu"*, *i.e.* seen more often); occurring in pairs and in groups. In 2010, probably the most walruses were taken from skiffs in 10 years.

An informant from the same village said they used to catch walruses close to Uiffaq (Blåfjeld) a little west of Qeqertarsuaq town on Disko Island. Nowadays, they usually do not see them this close. However, it seems like they are getting closer again. The aforementioned 66-year-old hunter from Qeqertarsuaq said that the walruses now rarely get close to Uiffaq and indicated that this is because the vessels dredging for scallop take the food of the walrus.

Finally, a 37-year-old informant living in Aasiaat said that before he got his vessel in 2003 none of the local people were hunting walrus or selling the meat in Aasiaat. Only people from other places came and sold walrus meat. When he got his vessel they started to hunt walrus and sell the products locally.

About 57% of the interviewees (N=8) in Subarea 2 said that there had been a change in the number of walrus landed in their home town. The remainder thought that there had been no change. About 43% (N=6) said that fewer were caught and ca. 14% (N=2) stated "more" (Table 14).

The informants gave various explanations in support of their response. A hunter living in Niaqornat said that the catch of walrus had increased in this settlement, and said the reason is because hunters are "learning" (the habits of) the walrus. According to him they see a lot of walruses and now know where to find them. Earlier they would only take walruses if they bumped into them, but now they hunt them actively. In this village another informant – also an active hunter – had observed no change. However, he specified that the numbers taken in any year is more a question of when the sea ice melts and disappears because then the walruses also disappear. But like the aforementioned hunter he also emphasized that one has to know where the walruses are, and also know when and where they can be hunted. He added that there are now many walruses in herds on the ice. The other informant in Subarea 2 (44 years old living in Illorsuit), who was of the opinion that the catch has increased, stated that they only catch walrus if they meet them by coincidence. But he went on to say that in later years they have bumped into more, and that they catch more walruses nowadays compared to when he was a child.

Six hunters (Upernavik Kujalleq, Upernavik town, Innaarsuit, Nuussuaq, and Kullorsuaq, N=2) who said that fewer walruses have been landed in their settlement said this is because the quota for the entire area is small. Three informants living in the northern settlements Innaarsuit (N=1) and Kullorsuaq (N=2), explained that the area

in which they live becomes free of sea ice relatively late in the spring, which means that the quota is already used when they get a chance to go walrus hunting. As stated by a 50-year-old from Kullorsuaq:

> Kullorsuaq becomes free of sea ice later than the more southern settlements (*i.e.* in the Uummannaq-Upernavik area) which means that the quota is used before the hunters from Kullorsuaq can go walrus hunting. I do not even remember when we last caught walrus in this village. The quota is used when we finally begin to see walruses.

About 84% of the hunters (N=26) in Subarea 3 answered to Question 14 that there has been a change in the number of walruses landed in their home town; and only few were of the opinion that there had been no change. Of those 26 who had observed a change, 25 (ca. 96%) said that the catch had decreased, adding up to about 81% of all answers given by Subarea 3 for Question 15 (Table 14).

The explanations provided by the informants for the observed trends differed somewhat depending on where they lived in the Qaanaaq area. Walruses that appear in

The village Savissivik (population: 66 in 2010) where walruses are mainly transient is the southernmost settlement in the Qaanaaq area (Subarea 3), September 2013. Photo: E. W. Born

the southernmost part of Subarea 3 where the settlement of Savissivik is located are migratory (this study). The five informants from Savissivik thought that the catch of walrus had decreased in this settlement, and they indicated that changing sea ice conditions and the fact that walruses generally had become more rare in the area probably explained the decrease in the numbers caught. However, one of these informants (aged 71) mentioned that from October and throughout winter, walruses are foraging in the Innaanganeq/Kap York area (Fig. 1) but are not hunted there because it is relatively far from Savissivik. Another hunter (aged 67) said that now the sea ice breaks up much earlier in spring, and he speculated that the walruses perhaps have changed their migration route and travel north further offshore than they did earlier. According to this informant the winds have also become stronger and there is open sea more often and for longer periods of time nowadays. However, he added that there are more walruses at Innaanganeq nowadays. In this area there is an ice-free shallow water area (*i.e.* a local current and wind driven polynya) where there are always walruses. According to a 52-year-old hunter from the settlement, the sea ice conditions have become worse during the later years with the result that they can no longer go hunting for walrus in May. Finally, an interviewee (aged 53) from Savissivik also pointed to the fact that there is no longer a market for walrus products, which is why they do not hunt them as much anymore. He added: "Walrus is not much worth".

Hence, overall the answers given by the informants in Savissivik indicated that the reduction in the catch of walrus in this area mainly reflects a combination of deterioration of sea ice conditions making it more difficult to hunt walrus, the fact that fewer walruses occur close to this settlement, and a general decrease in demand of walrus products.

The two informants from Qeqertat both said that the catch has remained unchanged and that they seldom see walruses in that area anyway.

Generally the informants from Qaanaaq and Siorapaluk thought that the decrease in catches was due to the introduction of quotas and a general worsening of sea ice and weather conditions.

About 46% (N=11) of the 24 informants living in Qaanaaq and Siorapaluk said that the catch had decreased because of the quotas. A 46-year-old hunter from Qaanaaq added that walrus is used for dog food and the number of sled dogs has decreased because they have less to eat (*i.e.* of walrus). An informant (aged 51) from the same town, who also thought that the decrease in the catch was due to the quota, added:

> Otherwise God's creatures are not diminished in a population. Nature takes care of them.

However, a total of ca. 33% of the informants from Siorapaluk and Qaanaaq were of the opinion that the decrease in catches was due to a general change in sea ice and weather conditions. Among these eight interviewees, two thought that the decrease was a result of a combination of climate change and the introduction of a quota system. A hunter from Qaanaaq stated that the sea ice forms later and breaks up more often and faster, which makes it harder to hunt walrus. A very experienced 63-year-old walrus hunter living in Siorapaluk mentioned how walruses arrive later and are therefore harder to catch (authors' note: he probably meant later in the fall. Because the ice nowadays forms later and during late fall it is darker and more unstable weather for walrus hunting). Another hunter from this settlement mentioned that it has become stormier during winter; and another said that it is now impossible to hunt during winter (January–March) because of the climate change (authors' note: traditionally the walrus was hunted on thin ice forming during winter over their foraging banks for example at the entrance to Murchison Sound, see p. 39). Hence, these informants indicated that the relatively late formation of sea ice and it's increasing instability have made it too dangerous and often impossible to hunt walrus on the thin fjord ice during winter.

Other remarks were given by five hunters from Siorapaluk and Qaanaaq when answering whether the landed catch of walrus had changed. A 53-year-old hunter from Qaanaaq was the only informant who said that the catch had increased. He mentioned that he had caught a lot of walruses in the pack ice during a single month right after he aquired his vessel in the beginning of the 1990s (authors' note: an AWI 27). However, then he added:

> Walruses are not seen so much anymore.

A 22-year-old hunter from Siorapaluk said the number of inhabitants in Siorapaluk had decreased because people move to Qaanaaq and therefore fewer walruses are landed by hunters in Siorapaluk.

## Categories of walruses caught (Questions 17–20)

### Questions 17 and 18

Q 17: *Do you catch both male and female walruses?*
Q 18: *How many of each sex on an annual basis?*

The purpose of these questions was to explore if there was a bias towards either of the sexes in the catch. These questions were interrelated and the answers are therefore treated together.

Overall, the number of informants answering either "yes" or "no" to Question 17 differed statistically significantly among subareas ($P<0.003$, $\chi^2=12.016$, df=2). Significantly more answered in the affirmative in Subareas 1 and 3 compared with Subarea 2 (Table 15, p. 134). However, taken together, the answers indicate that the Greenlanders' catch of walruses from the West Greenland-Southeast Baffin Island "component" of the Hudson Bay-Davis Strait and the Baffin Bay subpopulations is skewed towards males to an unknown extent.

Although 22 (ca. 73%) of the hunters in Subarea 1 answered "yes" when asked the question whether they hunt both males and females and the remaining eight answered "no" (Table 15), the difference in number of informants giving either of the two answers was not statistically significant ($P=0.063$, $\chi^2=3.455$, df=1).

In Subarea 1, ca. 40% (N=12) of the hunters answered that they take fewer female than male walruses. Fifty percent (N=15) said that males and females make up the same proportion in the catch whereas 10% (N=3) thought that they take more females than males on average (Table 15). However, the numbers in each category of answers were not statistically significantly different ($P=0.084$, $\chi^2=4.951$, df=1).

A hunter (aged 61) from Sisimiut said that he tries not to hunt females with calves (*"piaralik"*, *i.e.* walrus cow with a calf) and added *"piniaqqusaannginnamik"* ("it is not permitted to catch them"). A 60-year-old hunter from Attu explained that it can be difficult to tell their gender if there are many walruses in a group; females may look like males. A 54-year-old informant living in Maniitsoq said that they prefer to hunt smaller walruses because their meat is easier to sell in the town. An interviewee from Sisimiut said that pregnant females are fat (*i.e.* rich in blubber), and they catch them in March. For example, in March 2010 they caught two pregnant walruses with very big fetuses that were probably going to be born soon. Another hunter (aged 60) from the same town explained that the sex of the walruses they catch depends on where they hunt. If they are hunting "out in the west" at ca. 68° N they mainly catch males, and if they go more to the south they mainly get female walruses. An interviewee from Kangaatsiaq said that he mainly targeted male walruses before the introduction of quotas. On the contrary, a hunter from Aasiaat mentioned that they mainly caught females previously, but they now take mainly male walruses, thereby following the regulations after a quota system has been installed (authors' note: which protects adult females).

Regarding terminology informants in Attu and Kangerluk said that a young walrus calf is called *"nukalloq"* and a female with a young calf is referred to as a *"nukallulik"*.

In Subarea 2, almost the same number of hunters answered "yes" (N=6) than "no" (N=7) to Question 17 ($P=0.842$, $\chi^2=0.040$, df=1), and one informant did not have an opinion on this matter (Table 15).

About 86% (N=12) of the informants in Subarea 2 were of the opinion that they take fewer female than male walruses. One informant (ca. 7%) said that males and females make up the same proportion in the catch, and no hunters thought there is a surplus of females in the catch (one hunter did not give an answer); Table 15. Significantly more informants thought that they take relatively few female walruses ($P=0.005$, $\chi^2=10.460$, $df=1$); Table 15.

Some hunters provided additional comments. An interviewee from Niaqornat said that earlier they would target both sexes, but after the introduction of quotas they only go for male walruses. This was supported by another informant from the village who said that they tend to select big males. However, in this village another hunter told that:

> We go for the fattest walruses with tender meat.

A hunter living in Innaarsuit gave a clue about the sex composition in the catch in that area by saying that it is mainly the big male walruses that migrate by Innaarsuit. In Tasiusaq, an informant said they prefer to hunt walruses that occur closest to the coast (*i.e.* irrespective of their sex) because they only use skiffs and therefore cannot transport a large load of hunting products back; and he added:

> We do not see walruses very often.

In Kullorsuaq a hunter (aged 63) who answered that the catch consists of less females than males mentioned that they earlier only caught the walruses that were passing through the area on their way north (authors' note: his comment indicates that they caught what was available without being able to hunt selectively for special sex or age groups). However, another hunter (aged 50) from this village said they mainly caught male walruses in previous years.

Twenty-nine (ca. 94%) of the hunters in Subarea 3 answered "yes" to whether they take both male and female walruses, and only two (ca. 6%) answered "no". The difference in the number of informants giving the two answers was statistically significant ($P<0.001$, $\chi^2=14.383$, $df=1$); Table 15.

In this subarea, ca. 48% (N=15) of the informants mentioned that they take fewer female than male walruses. About 39% (N=12) said that males and females constitute the same proportion in the catch whereas ca. 13% (N= 4) thought that they generally catch more female than male walruses (Table 15). The difference in the numbers in the various answer categories was not statistically significant ($P=0.154$, $\chi^2=3.738$, $df=1$); Table 15.

| | Question 17 | | | | | | | | | Question 18 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sub-area | "Yes" | | "No" | | No opinion | | No answer | | | Fewer F[2] than M[3] | | F=M | | More F than M | | No opinion | | No answer | |
| | N | % | N | % | N | % | N | % | N[1] | N | % | N | % | N | % | N | % | N | % | N[1] |
| 1 | 22 | 73.3 | 8 | 26.7 | 0 | 0.0 | 0 | 0.0 | 30 (30) | 12 | 40.0 | 15 | 50.0 | 3 | 10.0 | 0 | 0.0 | 0 | 0.0 | 30 (30) |
| 2 | 6 | 42.9 | 7 | 50.0 | 1 | 7.1 | 0 | 0.0 | 14 (14) | 12 | 85.8 | 1 | 7.1 | 0 | 0.0 | 0 | 0.0 | 1 | 7.1 | 14 (14) |
| 3 | 29 | 93.5 | 2 | 6.5 | 0 | 0.0 | 0 | 0.0 | 31 (31) | 15 | 48.4 | 12 | 38.7 | 4 | 12.9 | 0 | 0.0 | 0 | 0.0 | 31 (30) |

1: N=Informants. In parentheses: Number of answers to this specific question.
2: F=Females.
3: M=Males.

**Table 15.** Answers to Question 17: "Do you catch both male and female walruses?" and Question 18:"How many of each sex on an annual basis?"

Generally, the hunters in Subarea 3 provided few additional explanations when answering Questions 17 and 18. A 37-year-old interviewee from Savissivik said the sex composition of the catch simply reflects the sex composition of walruses that pass through the area. However, an informant (aged 71) from the same village said that the male walruses migrate through the area from the beginning of April until June, and females with calves come through the area in mid-June ("when the little auks are breeding"; *i.e.* little auk, *Alle alle*). Hence, they mainly take males because the large males arrive first. Without providing further details, a 55-year-old hunter from Qeqertat said he only hunts female walruses. A very experienced walrus hunter from Qaanaaq said that: "In the fall it does not matter" (authors' note: likely implying that at this time of the year walruses of both sexes are targeted). An experienced walrus hunter living in Siorapaluk mentioned that there are more female walruses, but it is more desirable to catch males (authors' note: according to Vibe 1950 and this study females are in surplus at the foraging banks at the entrance to Murchison Sund). Another informant from this settlement explained that during the fall hunt it is difficult to determine the walruses'gender (authors' note: probably because of the darkness and that the walruses are mainly in the water at this time of the year). In contrast, in the spring they can tell females and males apart, and during this time it is mainly the males that are caught (authors' note: during spring walruses bask on floes of sea ice and then it is easier to get a view of them and determine their sex before they are shot at).

Hence, overall ca. 53% (N=39) of the responses ($N_{tot}$=74, one informant did not provide an answer; Question 18, Table 15) indicated that the catch consists of a surplus of male walruses. About 28% (N=28) indicated a 1:1 male:female sex com-

position, and only 9% (N=7) suggested that the catch is skewed towards females. The differences among types of answers were statistically significant (P=0.001, $\chi^2$=13.351, df=12).

## Question 19

*Do you specifically target some types of walruses if you have the chance?*

The purpose of this question was to explore to what extent the hunt is selective for special types of walruses – for example, big males with big tusks and a large amount of meat for eating.

| Question 19 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subarea | "Yes" | | "No" | | No opinion | | No answer | | |
| | N | % | N | % | N | % | N | % | N[1] |
| 1 | 29 | 96.7 | 1 | 3.3 | 0 | 0.0 | 0 | 0.0 | 30 (30) |
| 2 | 11 | 78.6 | 2 | 14.3 | 1 | 7.1 | 0 | 0.0 | 14 (14) |
| 3 | 30 | 96.8 | 0 | 0.0 | 1 | 3.2 | 0 | 0.0 | 31 (31) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | |

**Table 16.** Answers to Question 19: "Do you specifically target some types of walruses if you have the chance?"

In Subarea 1, 29 (ca. 97%) of the hunters answered "yes" to this question, and only one said "no" (ca. 3%); Table 16. Twenty-nine of the informants explained their hunting strategy. Thirteen (ca. 45%) of these informants representing all villages and towns visited in Subarea 1 said that if they have the chance they target large animals with big tusks (eight indicated that in such cases old males are targeted because they are biggest). A 47-year-old hunter from Maniitsoq said that sometimes an order on tusks has been placed by somebody before they go hunting. In such cases, he would try to select large males, but ideally he would catch one male and one female. An informant (aged 53) in Sisimiut said that he would usually target males but hoped to get at least one female. They would look for animals with nice tusks and avoid the ones with only one tusk. Usually, he only catches two to three walruses and therefore wants to make sure that they have nice tusks and are not *too* old (authors' note: these two statements indicate that the quality of the meat is also a criterion for selection because smaller walruses have more tender meat). He added that they mainly hunt to the south of Sisimiut in an area which is not the most frequented site by large males. Two interviewees pointed to the fact that large walruses are also selected because they provide more meat.

A hunter from Kangerluk on Disko Island explained that the loading capacity of the skiff determines which walrus is taken:

> If possible we take just one big walrus. If that is not possible we may catch two small. We cannot take 50 walruses because they are big animals and they occur far away.

Fourteen of the hunters (ca. 48%) said that they hunt selectively for walruses based on the *quality* of their meat. These informants also represented the entire Subarea 1. Thirteen of these interviewees specified that they would select small or medium-sized walruses because their meat is more delicious and thus easier to sell locally. It was mentioned that the meat of adult males is more lean compared to the meat of young walruses and females. A hunter from Sisimiut specified that if there are many walruses they hunt small males selectively because their meat is better. However, an informant from the same town stated that he mainly hunts adult females and younger walruses, which have the better meat. A hunter (aged 55) from Attu also said that he prefers to hunt the females since they are fatter (*i.e.* have relatively more blubber; *cf.* Knutsen and Born 1994). Interestingly, he added that females also do not have *trichinae*. He also said that there are seldom any males nowadays and that earlier they would mainly catch male walruses. Another hunter from this settlement explained that female walruses with calves are called *"nukallulik"* (plural: *"nukallut"* or *"nukallullit"*). Finally, two informants said that they (1) only hunted medium-sized walruses, and (2) take the walruses that they happen to encounter (*i.e.* they hunt non-selectively), respectively.

Eleven (ca. 79%) of the hunters in Subarea 2 answered "yes", thereby confirming that if given the chance they would hunt selectively, two said "no" (ca. 14%), and one had no opinion (ca. 7%); Table 16. Of the 14 informants, 12 gave further explanation to their answer. In nine cases (75% of 12) informants representing all villages visited (except Tasiusaq and Nuussuaq/Kraulshavn) stated that big walruses are selected – and preferably big males. Three of these comments also indicated that apart from the size of the tusks, the fact that big walruses provide more meat is an additional criterion for selectivity. Two hunters living in Nuussuaq and Kullorsuaq, respectively, said they did not target any size or sex category of walruses. However, the hunter from Nuussuaq said that they simply go to the area with walruses that is closest to the settlement so that they are able to transport them back home (*i.e.* with skiffs). The hunter from Kullorsuaq mentioned that they catch walruses that travel along the ice edge, and added that it is not many.

In Subarea 3, 30 (ca. 97%) of the hunters answered "yes" to this question, and one had no opinion on the matter (Table 16).

Thirty informants gave further details. Twenty (ca. 67%) of the answers revealed that they target big animals with large tusks, and in 22 of these cases it was mentioned that they hunt specifically for big males. Eleven answers (ca. 37%) specified that they select the large walruses to get the most meat (for humans and sled dogs). Some answers were a combination (both much meat and big tusks). Four hunters (ca. 13%) specified that they prefer the big walruses because they need to get as much out of the hunt as possible due to the limit set by the quota.

Two hunters from Siorapaluk provided explanations that included other information. One of these informants (aged 63) said:

> We take large animals because of the quota. Large walruses also provide more meat. The area near Siorapaluk is the area for the female walruses. We have more females here. Siorapaluk is also an area where walruses give births. The area around Moriusaq is an area for males.

The other hunter from this village said that:

> We prefer to hunt large animals of both gender with large tusks. It pays off better. The skin cannot be sold. It is the tusks that are valuable.

Overall, although the number of hunters who answered "yes" versus the number who answered "no" to Question 19 differed among subareas, this difference was not statistically significant at the 5% level ($P=0.06$, $\chi^2=5.525$, $df=2$). It appeared from the answers in all three subareas that if given the chance, the hunters would hunt selectively for big walruses and in particular for big males.

## Question 20

*Have you ever caught pregnant walruses?*

By asking this question we sought more detailed information on the occurrence of adult and reproductive females, and details on gestation and period of birth. If a hunter answered in the affirmative to this question we also asked him at which time of the year and where he had caught pregnant walruses, and how big the fetus was.

The majority (N=20; ca. 67%) of hunters interviewed in Subarea 1 confirmed that they had caught pregnant walruses; seven (ca. 23%) said "no" and three (10%) had no opinion on the matter (Table 17). Eighteen of the informants mentioned in which months they had caught pregnant females (Table 18). A 46-year-old informant from

Sisimiut said that before the quota he caught females in January with up to 0.5 meter long fetuses. However, he did not remember catching any pregnant females in later years. A 60-year-old hunter from Attu who mentioned that he had caught a pregnant walrus only once (in February or March in the 1970s), said:

> It had a big and fat fetus. Bigger than an *"allattooq"*, maybe 1.5 m long; (authors' note: an *allattooq* is a subadult harp seal).

Ten interviewees said that they had taken pregnant female walruses in March (Table 18). One of these hunters (from Aasiaat) who had once caught a pregnant female specified that the fetus was smaller than 1 meter. A hunter from Sisimiut said that in March 2010 they caught two pregnant walruses with very big fetuses that probably would have been born soon after. A 54-year-old interviewee from Attu said that when he catches pregnant walruses, it is by mistake because when walruses are in a herd, one cannot judge from their appearance whether they are pregnant or not. He added that the fetuses are quite big in March and as big as a subadult harp seal. Three hunters (living in Sisimiut, Attu and Aasiaat, respectively) estimated that the fetuses they had seen in March were about 1.5 meters long.

| Question 20 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subarea | "Yes" | | "No" | | No opinion | | No answer | | |
| | N | % | N | % | N | % | N | % | N[1] |
| 1 | 20 | 66.7 | 7 | 23.3 | 3 | 10.0 | 0 | 0.0 | 30 (30) |
| 2 | 5 | 35.7 | 8 | 57.1 | 1 | 7.1 | 0 | 0.0 | 14 (14) |
| 3 | 23 | 74.2 | 7 | 25.8 | 0 | 0.0 | 0 | 0.0 | 31 (31) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | |

**Table 17.** Answers to Question 20: "Have you ever caught pregnant walruses?"

| Question 20 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sub- | Jan | | Feb | | Mar | | Apr | | May | | Jun | | Oct | | Nov | | |
| area | N | %[1] | N | % | N | % | N | % | N | % | N | % | N | % | N | % | N[2] |
| 1 | 1 | 4.3 | 1 | 4.3 | 10 | 43.5 | 10 | 43.5 | 1 | 4.3 | - | - | - | - | - | - | 18 (23) |
| 2 | - | - | - | - | 1 | 16.7 | 2 | 33.3 | 1 | 16.7 | - | - | 1 | 16.7 | 1 | 16.7 | 4 (6) |
| 3 | 1 | 3.6 | 4 | 14.3 | 7 | 25.0 | 4 | 14.3 | 2 | 7.1 | 3 | 10.7 | 5 | 17.9 | 2 | 7.1 | 20 (28) |
| All | 2 | 3.5 | 4 | 7.0 | 18 | 31.6 | 16 | 28.1 | 4 | 7.0 | 3 | 5.3 | 6 | 10.5 | 3 | 5.3 | 42 (57) |
| 1: Percentage of number of months mentioned.<br>2: N=Informants giving details on months in which they had caught pregnant walruses (in parentheses: Number of months mentioned). | | | | | | | | | | | | | | | | | |

**Table 18.** Months mentioned by informants when asked Question 20:"Have you ever caught pregnant walruses?"

Ten hunters stated that they had caught pregnant walruses in April (however, three of these informants said "March–April"), Table 18. Of these informants four said that by then the fetus is about 1 m long, two said 1.5 m and three said "little more than 1 m", "less than 2 m" and "1.2 m long", respectively (one gave no estimate of size). An interviewee (aged 58) from Sisimiut mentioned that before the quota system was introduced he had also caught pregnant walruses in May at which time "the fetus is the size of a little seal".

Only two hunters, both from Maniitsoq, specified the area in which they had caught pregnant females: "West of Kangaatsiaq and Attu" and "West of Sisimiut", respectively (authors' note: In both cases it means on Store Hellefiskebanke).

In Subarea 2, five interviewees (ca. 36%) answered "yes" and eight (ca. 57%) "no" to Question 20, and one (ca. 7%) had no opinion on this subject (Table 17). Only four informants specified months in which they had caught pregnant walruses. This had happened during March–May and in October–November (Table 18). Five hunters provided information on the body length of the fetuses they had seen. Four of these informants emphasized that they had only caught a pregnant female once. A hunter from Aappilattoq said that the fetus was 1.2 m in March, whereas a hunter from Niaqornat said that fetuses are 1.3–1.4 m long at the end of April. A hunter living in Upernavik Kujalleq said 1.5 m in April–May. An informant from Kullorsuaq who, in the 1980s, caught a pregnant walrus during October or November said that the fetus was more than 1.5 meter long or "the same size as a small seal". An interviewee, who did not remember in which month he had caught a pregnant walrus, estimated its fetus to have been ca. 1.5 m long.

Only one informant in Subarea 2 gave information on site of catch of pregnant walruses. He had only caught one pregnant walrus which was "west of Nutaarmiut", but he could not remember in which month this had happened.

In Subarea 3, 23 (ca. 74%) of the 31 informants answered that they had caught pregnant walruses and the remainder said "no" (Table 17). March–April constituted ca. 39% of the months given as the months in which pregnant walruses are caught, but pregnant females had also been caught during January–June. The interviewees had also observed that some of the walruses caught in October–November were pregnant (Table 18).

Twenty-two of the informants provided estimates of the body length of the fetuses at different times of the year. Month/body length in meter (N=informants): Jan., 1 m (1). Feb., 1.5 (1). Feb.–Mar., 0.5 (1), 0.2–1.5 (1). Mar., 1 (2), 1.5 (2). Apr., 0.7 (1), 1.5 (3). Jun., 1.5 (3). Oct., 0.3–0.5 (5), 0.7 (1). Nov., 1.5 (1). A hunter (aged 63) from Siorapaluk mentioned that in May the females may have fetuses that are ca. 1.5 m long and weigh ca. 60 kg.

These estimates of fetus lengths indicate that the birth period of walruses is protracted, as also indicated by the remarks of two hunters (from Qaanaaq and Siorapaluk, respectively) who stated that fetuses of different sizes can be found at all times of the year because according to them walruses may give birth at all times of the year.

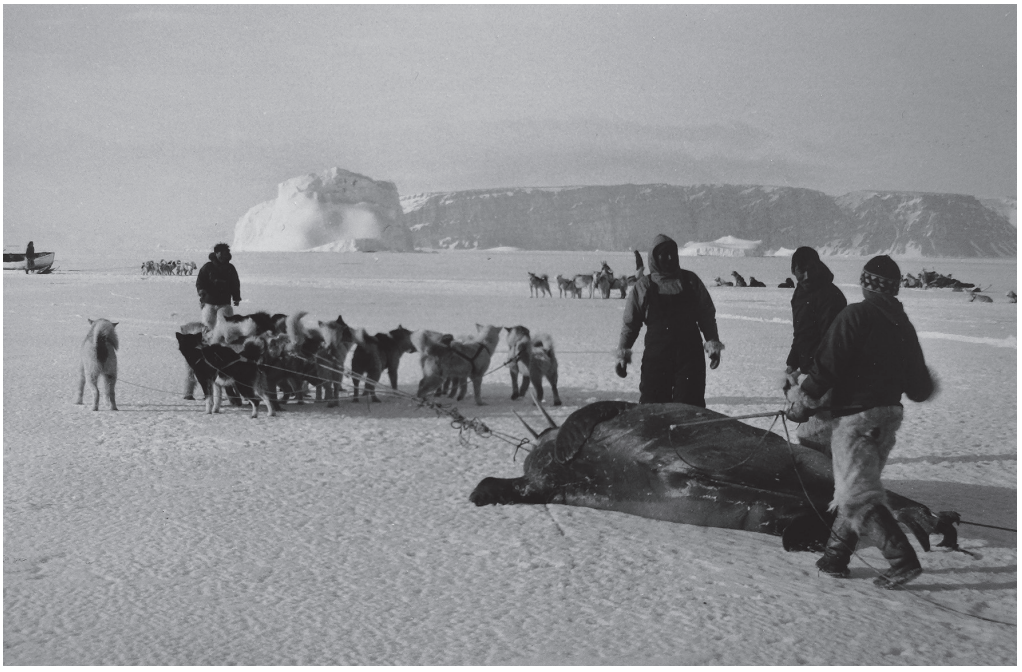
Two interviewees reported having caught walruses with twin fetuses. In April in the 1990s, a 51-year-old interviewee from Qaanaaq found ca. 1.5 m long twins in the womb of a walrus at Etah/Foulke Fjord. The other informants (aged 53) living in the same town had found twins in the first walrus he had ever caught. This was in May sometime in the 1960s.

See also Question 44: "Have you seen newborn walruses?", p. 197.

## Hunting methods (Questions 21–33)

### Question 21

*Which type of boat are you using?* (*i.e.* when you are hunting walrus).



A walrus hauled onto the ice by a dog team near Appat/Saunders Island, May 1977. The interviews documented that the use of dog sleds is still an important part of the marine resource exploitation in Subarea 2 and 3. Photo: T. Kristensen

The hunters were asked which type of boat or means of transportation they use when hunting walrus.

We defined a skiff as a boat up to 20 feet long. A boat larger than this was defined as a cutter. Some hunters specified which type of boat they owned. They were typically Poca 400–600 or Nuumiit 19 skiffs. Among types of cutters AWI 27 was mentioned.

Generally, the type of vessel used during the walrus hunts varied among the three subareas. This reflects a combination of regional differences in environmental conditions (in particular in sea ice), hunting and fishing practices, seasonal occurrence of walruses – and to a certain extent also social and economic conditions in the communities.

According to the answers in Subarea 1, cutters were used in ca. 60% and skiffs in ca. 30% of the cases for hunting walrus. Two hunters used both a cutter and skiff (ca. 7%). A single hunter (ca. 3%) living in Qeqertarsuaq said that he used his dog sled for transporting his skiff to the ice edge when going on a walrus hunt (Table 19). Fourteen of 15 informants (ca. 93%) living in the towns (*i.e.* Maniitsoq, Sisimiut and Aasiaat) in Subarea 1 said that they hunt walruses using cutters whereas only four of 15 interviewees (ca. 27%) from the settlements use cutters. Some of the hunters gave details about the size of the cutters used. On average they were 40.1 feet long (SD=5.5, range: 30–52 feet; N=12) with a mean BRT/GRT of 18.7 tonnes (SD=2.4, range: 14.0–19.9 tonnes; N=8).

The majority (ca. 71%) of the informants in Subarea 2 said that they use skiffs for hunting walruses (Table 19). A 50-year-old hunter from Kullorsuaq said they go by dog sled to the edge of the fast ice to hunt walrus. The only informant in Subarea 2 who said that he used a cutter added "back then", indicating that he was no longer actively hunting.

| Question 21 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subarea | Cutter | | Skiff | | Cutter and skiff | | Cutter, skiff and sled | | Cutter and sled | | Skiff and sled | | Sled | | |
| | N | % | N | % | N | % | N | % | N | % | N | % | N | % | N[1] |
| 1 | 18 | 60.0 | 9 | 30.0 | 2 | 6.7 | 0 | 0.0 | 0 | 0.0 | 1 | 3.3 | 0 | 0.0 | 30 (30) |
| 2 | 1 | 7.1 | 10 | 71.4 | 2 | 14.3 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 1 | 7.1 | 14 (14) |
| 3 | 2 | 6.5 | 14 | 45.2 | 3 | 9.7 | 1 | 3.2 | 1 | 3.2 | 8 | 25.8 | 2 | 6.5 | 31 (31) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | | | | | | | |

**Table 19.** Answers to Question 21: "Which type of boat (or means of transportation) are you using?" (*i.e.* when you are hunting walrus).

Generally, the answers in Subarea 3 reflected that the dog sled is used as a means of transportation to the hunting grounds in January–March (authors' note: *i.e.* when walruses are hunted on thin ice), whereas during spring (May–June) it is usual practice to bring a dinghy on a sled to the ice edge for hunting walruses. Only two informants mentioned that they use a cutter when hunting walruses (a 27 feet AWI 27 type), reflecting the scarcity of cutters in this area where the majority of hunters use skiffs (Table 19). A hunter (aged 67) from Savissivik specifically mentioned that walruses are no longer hunted from kayak because it is too dangerous.

## Question 22

*At which distance are you firing*? (*i.e.* the greatest distance at which you would fire at a walrus; in m).

In terms of the ability to kill a walrus within a short time, the firing distance is of interest, as well as the type of ammunition and the caliber of the firearm used (see Question 23).

The maximum distances at which the hunters would fire at walruses in the three subareas are shown in Table 20. Mean distances were ca. 72, ca. 56 and ca. 48 meters in Subarea 1, 2 and 3, respectively. The mean of firing distances differed statistically significantly among subareas (P=0.010, F=4.896, df: 70/2) and was significantly higher in Subarea 1 than in Subarea 3 (Tukey-Kramer *post hoc* test). However, it must be cautioned that in all subareas the estimates of the distance at which one would fire at walruses had a very broad range (Table 20), and in many cases were given as "approximately" or "less than". In addition, several of the informants explained how the distance depends on the circumstances and particularly on the behavior of the walruses.

| Question 22 | | | | |
|---|---|---|---|---|
| Subarea | Distance Mean (m) | SD | Min.-Max. (m) | N[1] |
| 1 | 71.7 | 52.8 | 8–200 | 30 (29) |
| 2 | 56.0 | 88.1 | 4–300 | 14 (14) |
| 3 | 48.2 | 65.5 | 5–200 | 31 (30) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | |

**Table 20.** Answers to Question 22: "At which distance are you firing?" (*i.e.* the greatest distance at which you would fire at a walrus; in m).

In Subarea 1 some informants said that if the walruses were hauled out and calm, they would get closer before shooting. In such case they may get as close as 10–50 m before shooting, according to four of the informants. A 61-year-old hunter from Sisimiut said that maximum firing distance is ca. 2 m if the walruses are sleeping (authors' note: this estimate of maximum distance seems implausibly short and is therefore not included in the summary statistics in Table 20. A walrus which is not killed instantly at this short distance may constitute an immediate danger to people in a tiny dinghy) and that the firing distance otherwise depends on how shy the walruses are. An interviewee (aged 46) from the same town said that if the walruses are in the water, the firing distance is a maximum of 200 m, but most of the time it is less. According to him they would aim at the body when the walruses are about to dive. A 54-year-old informant from Attu explained that the maximum distance for a shot was ca. 100 meters or 30–50 meters depending on whether the walruses were fleeing.

In Subarea 2 the estimates of maximum firing distance averaged ca. 56 m (Table 20). Three hunters provided a range with their estimate: 3–4 (N=1) and 30–40 m (N=2), but no further explanations were offered by the informants in this area.

The estimates of maximum firing distance averaged ca. 48 m in Subarea 3. Seven hunters provided a range to their estimates of distance, spanning from 2–4 m to 5–200 m. The latter estimates were provided by a 63-year-old hunter (Siorapaluk) who explained that they would first shoot at ca. 200 m at swimming walruses with the intention of scaring them. Then when they catch up with the walruses, they would shoot at ca. 5 m distance to hit (and wound them mortally). This hunting method was also explained by a 53-year-old hunter from Savissivik who said they would shoot first avoiding to hit (*i.e.* the particular walrus or any in the herd) in order to make the walruses dive and get short of breath. Then they can get closer and shoot at ca. 5 m distance. Another informant (aged 71) also living in Savissivik said that they would fire at ca. 5 m distance *after* harpooning the walrus.

A 34-year-old hunter from Siorapaluk said that when hunting walruses that are hauled out on ice floes, they fire at ca. 20 m distance to kill instantly (see front cover photo).

## Question 23

*Which caliber is the rifle you are using (i.e.* when hunting walrus*)?*

According to § 5 in the Greenlandic regulations for the catch of walruses, the smallest permitted bullet diameter is 7.62 mm (30.06) when shooting walruses. However, 5.64 mm (caliber .222) may be used for finishing off walruses that are harpooned or in other ways secured (Anon. 2006).

In Subarea 1, 25 hunters (ca. 83% of the 30 informants) said that they use "30.06" rifles when hunting walrus (the 30–06 Springfield rifle has a bullet diameter of 7.62 mm; *S. Andersen pers. comm.* 2014). The remaining five informants mentioned "300 Magnum" (*i.e.* caliber .300 Winchester Magnum; diameter: 7.62 mm), or "375 Magnum" (*i.e.* caliber .375 Holland & Holland; diameter: 9.53 mm). One of these interviewees (51 years old from Ikeraarsarsuk) answered a "Carl Gustav" (*i.e.* an old Swedish military rifle caliber 6.5 x 55 SM).

Eight of the 14 informants in Subarea 2 (ca. 57%) also said that they would use a 30.06 rifle when hunting walruses. Four interviewees mentioned "375 Magnum" (N=3) or a caliber "458" (N=1; the caliber .458 Winchester Magnum has a bullet diameter of 11.63 mm). However, two informants said that they use a "Sako" (74 years, Illorsuit) and a ".222" (63 years, Kullorsuaq), respectively (the caliber .222 SAKO rifle produced in Finland is a commonly used weapon when hunting pinnipeds, other than walrus; "the Sako" has a bullet caliber of 5.64 mm).

In Subarea 3, 29 (ca. 94% of the 31 informants) mentioned that they use a 30.06 rifle when shooting at walruses (one of these hunters also uses a 300 Winchester Magnum; and one also a "243", *i.e.* a caliber .243 Winchester with a bullet diameter of 6.17 mm). One of the remaining two hunters said that he uses an "89" (*i.e.* an old German military rifle with a bullet diameter of 7.93 mm) and the other that he uses a "Parker-Hale 308" (bullet diameter: 7.62 mm).

## Question 24

*Where do you aim at the walrus when it is hauled out on the ice?*

Where the hunter aims at a walrus depends on the circumstances and in particular whether it is hauled out on ice or is swimming when it is fired at.

Twenty-four of the 30 informants (ca. 80%) in Subarea 1 answered that they aim at the neck. Of these, eight added that they aim at the neck in order "to kill" (*i.e.* instantly). Four (ca. 13%) said that they aim at the head and two of these hunters added "to kill". Two hunters (ca. 7%) gave other answers: A hunter (aged 37) from Aasiaat said he aims at the body or at neck depending on the position of the walrus on the ice and whether it is about to go into the sea or not. A 49-year-old informant from Qeqertarsuaq mentioned that he aims at the shoulders (author's note: Probably meaning in the upper thorax region).

In Subarea 2, 12 of 14 informants (ca. 86%) said that they aim at the neck; three added: "To kill". One hunter said he aims at the head and another said: "Either at the neck or the head".

Ten of the hunters in Subarea 3 (ca. 32% of 31) answered that they aim at the neck and two specified that they did this after having harpooned the walrus. Twelve (ca. 39%) said: "At the head" and two mentioned: "After having harpooned". One hunter (ca. 3%) said he aims either at the head or the neck. Eight (ca. 26%) interviewees gave other answers: One of these informants said that he first aims for the heart and then the neck, whereas another said he shoots at the body, then throws the harpoon before shooting at the neck to kill. Four mentioned that they harpoon the animal first without stating where they aim. Finally, two hunters answered that they have never killed a walrus that was hauled out on the ice.

Hence, the answers indicated that a preferred method to kill a hauled out walrus is a shot to the neck region. Although only mentioned by three informants, the hunters apparently avoid firing the lethal shot directly into the head in order not to spoil the skull and the tusks.

## Question 25

*Where do you aim at the walrus when it is in the water?*

Two of the informants in Subarea 1 did not answer this question. However, the remaining 28 (ca. 93%) said that they attempt to hit swimming walruses in the body first. Some of the interviewees who specified which part of the body they would hit mentioned "shoulders", "lungs", "in the side in the stomach region" or "the abdomen". A 61-year-old informant from Sisimiut said that they would shoot a swimming walrus in the body so it does not sink, and then fasten a harpoon to it (before it is killed). This method was also described by a hunter (aged 51) from Ikerasaarsuk. A 40-year-old hunter from Qeqertarsuaq described how he shoots the walrus in the abdomen in order to prevent it from fleeing and then when it surfaces again, he harpoons and kills it.

Similar to the situation in Subarea 1, the majority (ca. 79% of 14) of informants in Subarea 2 answered that they aim at the body of swimming walruses. A 49-year-old hunter from Niaqornat explained that this is done in order to not kill them instantly (authors' note: a dead walrus with no air trapped in its lungs has a negative buoyancy and will quickly sink if it has not been harpooned and thereby anchored to a float; Vibe (1950), Fay *et al.* (1994), NAMMCO (2006a), E.W. Born personal observations). Hence, the walrus is first wounded with shots to the body from a distance, which allows the hunter to catch up with it. A hunter (aged 55) from Tasiusaq similarly explained how he would first shoot at the body and then harpoon the walrus before killing it. A 46-year-old hunter from Nuussuaq/Kraulshavn said that he shoots when the walrus arches its back before it dives (*i.e.* at *"kujaatigut"*, *i.e.* in the loin region, in the

lumbar region). In contrast a 51-year-old from Upernavik Kujalleq said that he aims at the neck of swimming walruses. A 63-year-old informant from Kullorsuaq explained that they (authors' note: in this village?) do not hunt walruses when they are in the water ("at sea"). An informant from Illorsuit did not answer the question.

About 81% of the 31 interviewees in Subarea 3 answered that if the walrus is in the water, they aim at the body. Seven of these informants explained that this is to prevent the walrus from sinking (before it can be retrieved). Fourteen (ca. 45%) specifically mentioned that they secure the walrus by harpooning it before killing it.

An informant (aged 48) from Qaanaaq explained the hunting method like this:

> First we fire at the body. Then we harpoon the walrus and thereafter shoot at the head or neck to kill it.

Five informants did not answer the question directly but explained that they use the harpoon before firing the deadly shot(s) to either the head or neck.

Hence it became apparent from the answers that in all subareas the hunters purposely do not aim at head or neck of swimming walruses in order to avoid killing them instantly with the risk that they sink before they can be retrieved. The answers also revealed that the bullets are usually fired to the body (thorax or abdomen) region when the walrus arches its back for diving. The shots are fired to the body in order to wound the walrus and prevent it from getting enough air to dive and escape. This allows the hunters to catch up with the walrus to harpoon it and subsequently finish it off.

## Question 26

*Do you use a harpoon*?

In all three subareas the answers indicated that the harpoon is regularly used during walrus hunts.

Twenty-nine of the 30 interviewees (ca. 97%) in Subarea 1 answered "yes" to this question, and a 49-year-old hunter from Qeqertarsuaq was the only who said "no". Only a few extra explanations were provided. A hunter (aged 49) from Sisimiut added that he uses the harpoon when the walruses are in the water and sometimes also when they are hauled out.

A 66-year-old informant from Qeqertarsuaq told this story:

> A male walrus with 20 cm long tusks was at the harbor in August 1988. An older man explained that it had lost a (its?) female (partner?) and therefore it attacked. He and his son went out in a skiff and the

> walrus attacked their skiff. They hit it with the harpoon before they shot it. Another man killed it with a single shot. It is said that it is the medium sized males that are the most aggressive.

All informants in Subarea 2 (N=14) and Subarea 3 (N=31) answered that they use the harpoon during walrus hunting. In Subarea 3, a 62-year-old hunter from Qaanaaq added that he always has more than one harpoon ready for throwing.

## Question 27

*When do you throw the harpoon? Before or after the walrus has been hit by a shot?*

| Question 27 | | | | | |
|---|---|---|---|---|---|
| Subarea | Before | After | Before or after | No answer | N[1] |
| | N (%) | N (%) | N (%) | N (%) | |
| 1 | 27 (93.2) | 0 (0.0) | 1 (3.4) | 1 (3.4) | 30 (29) |
| 2 | 14 (100) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 14 (14) |
| 3 | 5 (16.1) | 3 (9.7) | 23 (74.2) | 0 (0.0) | 31 (31) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | |

**Table 21.** Answers to Question 27: "When do you throw the harpoon? Before or after the walrus has been hit by a shot?"

In Subarea 1, ca. 93% (27 of 29 hunters who responded) answered that they throw the harpoon after the walrus has been wounded by rifle shots (Table 21). A 61-year-old hunter from Sisimiut who said "after" added that he throws the harpoon when the walrus has become exhausted. A hunter (aged 66) from Qeqertarsuaq explained that he either throws it before or after having hit the animal. An informant (aged 53) from the same town said that he has only once used the harpoon on a walrus that was sleeping on the ice before he shot at it. A 51-year-old from Ikerasaarsuk explained:

> The walrus is really agile (fast) – the most agile among seals. Therefore, we have to shoot them in the body first.

That hunting walrus can be dangerous is exemplified by a story told by a 52-year-old hunter from the same settlement:

> Once a walrus almost got into our skiff when it attacked. The harpoon broke into three pieces.

All informants in Subarea 2 said they throw the harpoon after the walrus has been hit by a shot (Table 21). However, a hunter from Kullorsuaq added: "Mainly after".

In this subarea a hunter (aged 35) from Niaqornat said:

> Walruses are incredibly agile. They defend themselves a lot and may attack. It is impossible to harpoon first (*i.e.* before shooting) when they are that aggressive.

The answers to this question in Subarea 3 were more diverse. About 16% (N=5) answered "before", slightly fewer than 10% (N=3) said "after", whereas about 74% (N=23) answered "before or after" (Table 21).

In this area, 21 informants gave further explanation when answering the question. Of these, 16 said that they attach a harpoon before shooting when they are hunting walruses that are either hauled out on ice or are at the surface to breathe through the thin fast ice ("thin-ice hunt"). Nine of these 16 hunters specifically mentioned that they harpoon the walruses first when hunting them on thin ice during January–April. Of the three who answered that they would harpoon the walrus after shooting when targeting swimming walruses, one said that he throws the harpoon "when the walruses get slower/become less agile" ("*pitsorlukkaangat*", *i.e.* when it "walks" slower), while the others specifically mentioned that they throw the harpoon after shooting in such situations. A 52-year-old hunter from Savissivik emphasized that he always harpoons the walrus before shooting. His big brother was killed by a walrus. Two hunters gave answers that deviated somewhat from those of the others. An informant (aged 62) from Qaanaaq said that when he is hunting walruses on the ice during spring he throws the harpoon after having fired, whereas during fall when hunting swimming walruses he would attach the harpoon before shooting. A 31-year-old hunter from Qaanaaq said that during January–March he throws the harpoons before hitting the walrus with shots if it is in the water, whereas in May–June when they are hauled out on the drift ice he will shoot to kill them before harpooning.

| Question 28 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Subarea | Minimum | | Min.-Max. | N[1] | Maximum | | Min.-Max. | N[1] |
| | Mean (m) | SD | (m) | | Mean (m) | SD | (m) | |
| 1 | 2.5 | 1.3 | 1–5 | 13 | 4.4 | 2.7 | 1–10 | 28 |
| 2 | 1.8 | 0.4 | 1–2 | 8 | 3.8 | 2.9 | 1–10 | 14 |
| 3 | 2.2 | 1.1 | 0.5-3 | 13 | 3.6 | 1.5 | 1–7 | 31 |
| 1: N=Number of answers to this specific question. | | | | | | | | |

**Table 22.** Answers to Question 28: "At which distance do you throw the harpoon?" (*i.e.* estimate of minimum and maximum distance in m).

## Question 28

*At which distance do you throw the harpoon?* (*i.e.* estimate of minimum and maximum distance in m)

The answers to this question indicated that in all three subareas the harpoon is thrown at an average distance between 2 to 4 m (range: 0.5 to 10 m) from the walrus depending on the circumstances (Table 22). The estimates of maximum throwing distance did not differ between subareas (P=0.644, F=0.528, df: 70/2, Tukey-Kramer *post hoc* test).

Several of the estimates of distance when throwing the harpoon were approximate and some informants explained how the distance varied according to the circumstances. For example, in Subarea 1, a 56-year-old hunter from Attu whose estimate of distance was 2–3 meters said that if the walruses are aggressive, he would throw the harpoon from a greater distance (*i.e.* 4+ m). Several remarks indicated that it can be dangerous to hunt walruses. A hunter (aged 61) from Sisimiut explained that when the walruses are tired they sometimes try to hit the boat with their tusks when the hunters get really close. A 55-year-old informant from the same settlement said that once a walrus attacked with a roar, and on another occasion an animal tried to hit the boat with its tusks. According to a 51-year-old hunter from Ikerasaarsuk, the young male walruses are the most aggressive. A hunter living in Subarea 2 also mentioned that he throws the harpoon at a relatively greater distance if the walrus is aggressive. A hunter living in Qaanaaq in Subarea 3 where walruses are hunted in winter during the "thin-ice hunt" stated that the harpoon is thrown at a distance of ca. 1 meter when the walrus comes up through the sea ice to breathe.

## Losses ("struck-but-lost" ratio) (Questions 29–31)

Q 29: *"Did you hit walruses that you did not retrieve and which were lost in 2009?"*
Q 30: *"In 2008?"*
Q 31: *"In 2007?"*

We asked each hunter if he had hit walruses that he did not retrieve and which were lost in 2007, 2008 and 2009, respectively.

As stated in a previous section walruses that have been hit by bullets and are not harpooned and securely fastened to a float may disappear mortally wounded, or sink, before they are retrieved (Vibe 1950, Fay *et al.* 1994, Born *et al.* 1995 and references therein). Various estimates of loss during walrus hunts (*i.e.* number lost as fraction of all hit/struck; the "struck-but-lost" ratio) are substantial and range between 10% and more than 50%. The fraction of walruses that are lost during the subsistence hunt is an integrated part of the calculations of total sustainable removal levels (*e.g.* Witting and Born 2005, 2014; NAMMCO 2013b) and setting quotas (Anon. 2014b, 2016).

| Questions 29–31 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Subarea | "Yes" | | "No" | | Did not hunt | | No opinion | | % lost[1] | |
| | | N | % | N | % | N | % | N | % | % | N[2] |
| 2009 | 1 | 1 | 3.3 | 19 | 63.4 | 10 | 33.3 | 0 | 0.0 | 1.8 | 30 (30) |
| | 2 | 1 | 7.1 | 7 | 50.0 | 6 | 42.9 | 0 | 0.0 | 12.5 | 14 (14) |
| | 3 | 4 | 12.9 | 24 | 77.4 | 2 | 6.5 | 1 | 3.2 | 5.4 | 31 (31) |
| 2008 | 1 | 1 | 3.3 | 16 | 53.4 | 13 | 43.3 | 0 | 0.0 | 2.4 | 30 (30) |
| | 2 | 1 | 7.1 | 7 | 50,0 | 5 | 35,8 | 1 | 7.1 | 5.0 | 14 (14) |
| | 3 | 3 | 9.7 | 25 | 80.6 | 1 | 3.2 | 2 | 6.5 | 4.3 | 31 (31) |
| 2007 | 1 | 1 | 3.3 | 22 | 73.4 | 6 | 20.0 | 1 | 3.3 | * | 30 (30) |
| | 2 | 1 | 7.1 | 8 | 57.1 | 3 | 21.1 | 2 | 14.3 | * | 14 (14) |
| | 3 | 4 | 12.9 | 23 | 74.2 | 1 | 3.2 | 3 | 9.7 | * | 31 (31) |

1: Number of walruses lost (*i.e.* lost as percentage of total lost plus total landed, *cf.* Table 10).
2: N=Informants. In parentheses: Number of answers to this specific question.
*: No estimates from hunters in this study for 2007 of total landed.

**Table 23.** Answers to Questions 29–31: "Did you hit a walrus (walruses) that you did not retrieve and was (were) lost?" (in 2009, 2008 and 2007).

Questions 29–31 were asked in order to develop an estimate of loss based on the hunters' own experiences.

Information obtained from the hunters during the interview survey indicated that the overall loss rate in 2008 and 2009 averaged 4.6% (13 lost of 285 struck). However, estimates of loss rate ranged between 1.8% (Subarea 1; 2009) and 12.5% (Subarea 2; 2009), Table 23.

Twenty hunters in Subarea 1 said they had landed a total of 56 walruses in 2009 (*cf.* Table 10). However, only one hunter from Aasiaat mentioned that he had lost (*i.e.* not retrieved) a walrus in 2009. Hence, the estimate of total loss was 1.8% in 2009 (*i.e.* 1 lost of 57 struck; Table 10). Fifteen hunters reported having landed a total of 40 walruses in 2008 (Table 10). The same hunter from Aasiaat said that he had lost one walrus that year, which brings the estimate of total loss in Subarea 1 to 2.4% for 2008 (1 of 41 walruses struck; Table 10). Of the 23 hunters who answered whether or not they had lost a walrus in 2007, one from Maniitsoq said that he had lost one animal that year (our survey did not provide hunter-based estimates of total landed catches in 2007).

Among those who answered that they did not lose any walruses in 2007–2009, or did not have a specific opinion on this, 12 explained that they had lost walruses earlier, but this happened very rarely.

A 54-year-old informant from Attu said:

> I have lost some earlier. It depends on the distance to the walrus when the first shot is fired.

A hunter (aged 55) from the same settlement stated he had lost some. This happened in cases where the walruses either sank or escaped (authors' note: likely meaning after they had been hit by shots). This informant added: "It can probably not completely be avoided".

In comments to their answers to questions 27–29, 13 of the informants in Subarea 1 assured that they had never lost a walrus. One of these (a 61-year-old hunter from Sisimiut) said:

"We hunt carefully".

In Subarea 2, eight hunters reported landing a total of 21 walruses in 2009 (*cf.* Table 10). Of these eight informants, one (an active hunter from Niaqornat who reported having landed ca. 10 walruses himself in 2009) said that he had lost three walruses in 2009, bringing the estimate of total loss to 12.5% (*i.e.* 3 lost of 24 struck); Table 23. Eight hunters reported that they landed a total of 19 walruses in 2008 (Table 10). Among these was a hunter from the same settlement (he reported that he landed 5 walruses in 2008) who mentioned that he had lost one walrus in 2008. This brings the estimate of total loss in Subarea 2 to ca. 5.0% for 2008 (1 of 20 walruses struck); Table 23. Among the nine hunters who answered whether or not they had lost a walrus in 2007, one said that he had lost one animal that year (our study did not provide an estimate for 2007 of total landed catch in Subarea 2).

Among 12 hunters in Subarea 2 who said that they had lost walruses in 2007–2009 (or had no opinion on the matter), nine offered further comments. Two hunters who used to hunt together and were interviewed together in Upernavik town said that they had only lost one walrus by mistake (authors' note: *i.e.* in their entire hunting career). This was because one of them thought that the other had already harpooned the animal. A 63-year-old hunter from Kullorsuaq said he has lost a walrus now and then. Seven informants in this subarea stated that they had *never* lost a walrus.

Twenty-four informants in Subarea 3 said they did not lose any walruses during 2009 (Table 23) when a total of 70 landed walruses were recorded during the interviews (Table 10). However, four hunters answered that they had lost a walrus. Hence, according to the information from the hunters the loss rate in this subarea was ca. 5.4% (4 lost of 74 struck). The corresponding data for 2008 were: 25 did not have any losses but 3 had (loss rate: 4.3%; 3 lost of 69 struck). Twenty-three informants said they had had no losses in 2007 whereas four said that they had (Table 23).

In Subarea 3 four experienced walrus hunters who had lost walruses during 2007–2009 provided some additional comments on the topic. A hunter (aged 67) from Savissivik assured that it is very seldom that they lose a walrus. However, a 46-year-old informant from Qaanaaq mentioned that he loses walrus(es) almost every year. This may for example happen when other walruses push "the half dead walrus away so

that they lose it" (authors' note: this refers to hunting walruses that are hauled out on an ice floe). A 50-year-old informant from Qaanaaq estimated that he loses one or two walruses per year. A hunter (aged 48) from Siorapaluk voiced how under special circumstances in 2009, a walrus escaped into the drift ice and another sank. He added that they are otherwise careful not to lose any walrus. Fourteen other informants who had not lost any walrus during 2007–2009 mentioned that it has happened that they lose a walrus but this is very rare. It was mentioned that this may happen if the sea is too rough, if the sea ice is in poor condition, or if a dead walrus is pushed off the ice floe when the other walruses in the herd escape into the sea. Eleven of the informants in this subarea said that they had never lost a walrus.

## "Head hunting" (Questions 32 and 33)

Q 32: *"Have you ever brought back only the head and tusks of a walrus?"*
Q 33: *"Do you know if there is anybody who brings back only the head and tusks?"*

By asking Question 32 and Question 33 we wanted to explore if head hunting is practiced in West and Northwest Greenland despite its illegality.

Eighty percent of the 30 informants in Subarea 1 answered "no" to Question 32, and in the other two subareas all interviewees answered "no" (Table 24).

Some of the hunters in Subarea 1 who answered "yes" gave further explanations to why they had secured only the head in some cases. A 55-year-old informant from Sisimiut said that if the walrus is so skinny that it has *trichinae* (see p. 54), then they bring back only the head. A 55-year-old hunter from Attu said that he brought back only the head of a walrus once. This was because the walrus was so thin that its bones were visible and its tusks were broken. They dumped the carcass and left all meat behind. He also explained that the local medical doctors analyze the meat for *trichinae* and once they had to discard a walrus due to *trichinae*. A hunter (aged 47) from Aasiaat also said that he had dumped the body of a walrus because it was very thin and thus

| Question 32 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subarea | "Yes" | | "No" | | No opinion | | No answer | | |
| | N | % | N | % | N | % | N | % | N[1] |
| 1 | 6 | 20.0 | 24 | 80.0 | 0 | 0.0 | 0 | 0.0 | 30 (30) |
| 2 | 0 | 0.0 | 14 | 100 | 0 | 0.0 | 0 | 0.0 | 14 (14) |
| 3 | 0 | 0.0 | 31 | 100 | 0 | 0.0 | 0 | 0.0 | 31 (31) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | |

**Table 24.** Answers to Question 32: "Have you ever brought back only the head and tusks of a walrus?"

it was suspected that it was infested with *trichinae*. A hunter from Ikerasaarsuk also mentioned a case where only the head was secured because the walrus was very thin and had a lot of tubercles. A hunter from Attu explained that he once could not bring back the meat from a walrus hunt because there was too much sea ice and it was a tough trip back. Finally, a 53-year-old interviewee from Sisimiut said that earlier – in the 1980s – when the ivory was traded to the trade company *KGH/KNI,* some were hunting only for the tusks.

Despite the fact that the informants had not themselves practised head hunting they may have heard about others doing it; and the responses to Question 33 indicated that this was the case.

In Subarea 1, 16 (ca. 53%) of the 30 informants answered "yes" to this question confirming that they had heard about some who had brought back only the head and tusks from a walrus hunt. About 27% answered "no", and another ca. 20% had no opinion on the matter (Table 25).

The answers given by eight of the informants who answered "yes" indicated that apparently head hunting was more common previously, and various reasons were given for this to be the case. A 55-year-old informant from Sisimiut said that head hunting might have been practiced earlier when tusks and ivory could be traded to the trade companies (*KGH/KNI/Sipineq*). According to him some were only hunting for the tusks in the late 1980s. That this was a more common practice earlier was supported by a statement by a 46-year-old hunter from the same town:

> It is not heard about so much anymore. However, in the 1980s it was practiced commonly by certain people. We know their names.

An informant (aged 56) from Attu who actually answered "no" to the question nevertheless explained that:

| Question 33 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subarea | "Yes" | | "No" | | No opinion | | No answer | | |
| | N | % | N | % | N | % | N | % | N[1] |
| 1 | 16 | 53.3 | 8 | 26.7 | 6 | 20.0 | 0 | 0.0 | 30 (30) |
| 2 | 5 | 35.7 | 9 | 64.3 | 0 | 0.0 | 0 | 0.0 | 14 (14) |
| 3 | 15 | 48.4 | 16 | 51.6 | 0 | 0.0 | 0 | 0.0 | 31 (31) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | |

**Table 25.** Answers to Question 33: "Do you know if there is anybody who brings back only the head and tusks?"

> Before the introduction of quotas (*i.e.* before 2006) it happened (*i.e.* that only head and ivory were brought back). However, since the introduction of quotas the whole animal must be brought back home. In order to bring the whole walrus back we prefer to hunt several skiffs together.

This statement indicates that sometimes the relatively small loading capacity of a skiff determines whether all products of a walrus are transported home. This is supported by a statement by a hunter (aged 54) from Attu who said that he had not heard of any cases of head hunting and he himself hunted only from vessel and not a skiff. A 52-year-old informant from Ikerasaarsuk also said that before the introduction of a quota, he had heard about somebody head hunting.

A hunter from Ikerasaarsuk mentioned that he had heard about lots of walrus bodies (left) near Upernavik. He suspected that they had been left due to the suspicion that they were infested with *trichinae*. An interviewee from Qeqertarsuaq said that he had heard about head hunting, but not in Qeqertarsuaq because in this town "there is a use for meat and skin – everything". Another informant from the same town also assured that in Qeqertarsuaq:

> We always need the whole animal. And anyway we do not take many walrus at a time.

In Subarea 2, five of the 14 informants (ca. 36%) answered "yes" to this question and the remainder answered "no" (Table 25).

An interviewee from Niaqornat said that head hunting does not happen in his settlement but he has previously heard about somebody who saw it happen. Another hunter from the same settlement who answered "no" added that they had heard rumors about it from Ilulissat (Fig. 1), but he did not know if they were true. An interviewee, also from Niaqornat, mentioned that he had heard about it from the settlement of Saattut in the Uummaannaq area (Fig. 1). A 44-year-old hunter from Illorsuit said that in 1994 they found a stinking walrus body without head but they did know who had killed it. During an interview in Upernavik town, it was mentioned that they had been told that in 2008 some hunters from Upernavik Kujalleq had left walrus bodies behind.

On the other hand, an informant from Upernavik Kujalleq said that they take all of the walrus with them back because it is considered precious food for humans. In the same settlement another hunter explained that they hunt for the largest walrus to get the most meat now that the local quota is so small. Informants from Aappilattoq, Innaarsuit, Tasiusaq, Nuussuaq and Kullorsuaq assured that they bring back all products from the walrus partially because it is precious food and partially because they catch walrus so rarely.

In Subarea 3, 15 of the 31 informants (about 48%) answered "yes" to question 31, and about 52% answered "no" (Table 25).

Four of the five informants from Savissivik answered "no" and three of these hunters explained that they bring back all products from the walruses because they need the meat and other edible products, and also for feeding their sled dogs.

The fifth informant from this settlement answered "yes" and added:

> It is said that those from Qaanaaq only bring back head and tusks and leave the body behind when they go walrus hunting in Canadian waters.

A hunter from Qeqertat said that he had heard about cases of head hunting. He explained that sometimes drift ice with walrus bodies without heads drift into the fjord. In ca. 2003 he had seen three walrus bodies on the sea ice without heads. He speculated that the hunters involved probably had caught too many walruses (authors' note: the explanation implies that some hunters had killed too many walruses on one occasion and were not able to bring back all products from the kill. In such case they had cut off and only brought back the economically valuable heads of three of the walruses).

Among the 13 hunters from Qaanaaq and Siorapaluk who said that they had heard about cases where only the head and tusks were brought back, a hunter said that he himself had witnessed it in 2007. Five others said that it happens very rarely. However, the remaining seven who answered "yes" explained that if the meat was left behind, it would only happen because of bad weather preventing the hunters from bringing it back in the first place. In such cases they would cache the meat under big stones and pick it up later. It was emphasized that the meat is important food for humans and sled dogs.

## Quotas (Questions 34 and 35)

Q 34: *"Are quotas necessary or unnecessary?"*
Q 35: *"What effects did it have for you that quotas were introduced in 2006?"*

By asking the question whether quotas are necessary or unnecessary we wanted to explore what the general attitude among the hunters was to the fact that quotas had been introduced for the walrus hunt.

Overall, 44% of the 75 interviews indicated that the hunters thought that quotas are necessary whereas 52% of the answers indicated that quotas were not considered necessary (4% had no opinion about this subject). In Subarea 3 there were comparatively more hunters than in the other subareas who thought that quotas were not necessary (Table 26).

Several hunters elaborated on their answer. Their explanations contain interesting information and we present them *in extenso* in Appendix 3.

However, some main themes became apparent from the explanations provided both by interviewees who thought that quotas are necessary and by those who thought that they are *not*.

In Subarea 1 several hunters mentioned that the distribution of walruses in itself sets a natural limit to how intensively they can be hunted. It was told that when the season opens on 1 March the walruses have already moved farther offshore following the retreat of the edge of the Davis Strait-Baffin Bay pack ice (*i.e.* the "West Ice"). This makes it difficult for the relatively small cutters (up to 20 BRT/GRT) and skiffs to access the walruses offshore among the relatively heavy pack ice. Some of the interviewees suggested that the hunting season should be earlier when walruses occur closer to land. Some also mentioned that frequent harsh weather and difficult sea ice conditions limit the hunting intensity. It was indicated by a couple of hunters that fishing vessels (shrimp trawlers) operating in areas where walruses occur contribute to walruses moving farther offshore relatively early in spring.

It was suggested by some informants that instead of having a bulk quota there should be a quota or limit to what a single vessel or hunter should be allowed to catch annually.

Walrus skin, blubber, meat and skulls brought back by a cutter ("*nummerbåd*") to the settlement of Siorapaluk in Subarea 3 after a hunt in northern Ikeq/Smith Sound, July 1978. Photo: E.W. Born

| Question 34 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subarea | "Yes" | | "No" | | No opinion | | No answer | | |
| | N | % | N | % | N | % | N | % | N[1] |
| 1 | 15 | 50.0 | 14 | 46.7 | 1 | 3.3 | 0 | 0.0 | 30 (30) |
| 2 | 7 | 50.0 | 7 | 50.0 | 0 | 0.0 | 0 | 0.0 | 14 (14) |
| 3 | 11 | 35.5 | 18 | 58.1 | 2 | 6.5 | 0 | 0.0 | 31 (31) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | |

**Table 26.** Answers to Question 34: "Are quotas necessary or unnecessary?"

Some interviewees noted that socio-economical changes have affected the walrus hunt and has led to a general decrease in the interest in hunting walruses. It was mentioned that people's food habits have changed so that there is no longer a big market for walrus meat, and also that previously, there was a greater incentive for hunting walruses when blubber and other walrus products could be traded to the trade company.

Several informants in Subarea 2 who thought that quotas are necessary also mentioned that the quota for the entire subarea is too small. In the southern part of this subarea walrus hunting is combined with polar bear hunting. When the bear quota is

The dog sled is still an integrated part of the maritime hunting practice in Northwest Greenland. Dog sleds are used for transporting kayaks, skiff and cutters to the ice edge and for bringing back hunting products to the village. Photo: E.W. Born

used up the hunters no longer hunt walrus. A hunter from Kullorsuaq thought that it would be good if the hunters from that area were allowed to hunt walruses later than those living in the southern parts of the Upernavik-Uummannaq area. The reason for this suggestion was a combination of later spring break-up of sea ice and the walruses' migration pattern. Walruses become available to hunters in Kullorsuaq later in the season than those hunters farther south. Hunters who thought that quotas are not necessary expressed that the (small) quotas affect the hunters in an economically negative way, and that the catch of walrus in the area always has been modest.

The explanations given in Subarea 3 confirmed that walruses are transient in the Savissivik area. Several of the informants in Subarea 3 emphasized that the walrus stock in the northern Baffin Bay-Smith Sound-Kane Basin-Nares Strait area is abundant. Furthermore, several interviewees were of the opinion that "nature" itself protects the walruses because they are inaccessible during periods with bad sea ice and strong winds, similar to what informants in other subareas noted. When answering this question some hunters mentioned that if a boat happens to catch several walruses during a hunting trip the catch is shared among the hunters who made up the "crew" during the trip (*i.e.* it is not the owner of the boat that keeps the catch products for himself). In Subarea 3 it was also suggested that perhaps a quota of one to two walruses per hunting trip would work (*i.e.* instead of a bulk quota for the area). Finally, it was mentioned that the catch of walrus is essential for providing food for human consumption and for feeding the sled dogs, and that the quota has made it difficult to sustain a dog team – and buying dog food in the local store is too expensive.

By asking question 35 we sought information on how the individual hunter had been affected by the introduction of walrus quotas.

Several informants answered that the introduction of quotas had resulted in a reduction in their catch of walruses. Overall, ca. 64% of the 75 interviews indicated that their catch of walrus decreased after 2006, whereas ca. 28% indicated that the introduction of quotas had had no noticeable effect on them (the remainder had a different explanation, or no opinion on the matter); Table 27.

A reduction in the catch of walruses by the individual hunter was most apparent in Subarea 2 and 3 (Table 27) where hunting of walrus and other marine mammals is still important to a large extent in the local subsistence economy (Rasmussen *et al.* 2010).

The more detailed explanations offered by interviewees in connection with answering Question 35 are listed in Appendix 4.

However, some main themes that became apparent from answers are mentioned here. Some of the informants in Subarea 1 who said that they had been affected by the introduction of quotas mentioned that a decrease in catch had led to a reduced monetary income. It was also mentioned by one hunter that they had to switch to other species (in his case to muskox, *Ovibos moschatus*) to compensate for the decrease in

| Question 35 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Subarea | Catch less | | No effect | | Other answer | | No opinion | | No answer | | |
| | N | % | N | % | N | % | N | % | N | % | N[1] |
| 1 | 13 | 43.3 | 14 | 46.7 | 0 | 0.0 | 3 | 10.0 | 0 | 0.0 | 30 (30) |
| 2 | 11 | 78.6 | 2 | 14.3 | 1 | 7.1 | 0 | 0.0 | 0 | 0.0 | 14 (14) |
| 3 | 24 | 77.4 | 5 | 16.1 | 1 | 3.2 | 1 | 3.2 | 0 | 0.0 | 31 (31) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | | | |

**Table 27.** Answers to Question 35: "What effects did it have for you that quotas were introduced in 2006?"

the take of walrus. As was the case with answers to Question 34, several hunters said that the opening of the walrus hunting season on 1 March made it difficult to catch walruses. The reason given was that by then the walruses are relatively far offshore and therefore less accessible. The answers indicated that this tendency to move farther west relatively early was a result of decreased sea ice and it was suggested that the walrus hunting season should be changed to January–February.

The settlement Kullorsuaq (population: 430 in 2010) which is situated in the northern part of Subarea 2 depends on the catch of various marine mammals and fishing for Greenland halibut, April 2012. Photo: E. W. Born

Of the hunters who expressed the opinion that their walrus hunting activities had not been influenced by the introduction of quotas, several said that the sea ice conditions determine whether walruses can be hunted or not. It was mentioned that walrus hunting activity was limited anyway partially because the products from walruses are now mainly used in the household economy and also because fishing represents an important alternative source of income. Furthermore, a hunter from Ikerasaarsuk noted that there were now generally fewer walrus hunters in that settlement.

The majority of the informants in Subarea 2 said that they catch fewer walruses after 2006 and they complained that the quota for the entire Uummannaq-Upernavik area is too small. The result is that when they get a chance to hunt walrus, the quota is often used up. This is particularly a problem in the northern parts of the area. In this area only two hunters said the quotas had not affected them (Table 27).

Similar to the situation in the two other subareas, the interviews in Subarea 3 revealed that walrus meat and edibles are consumed by humans, and other products like tusks, lower jaw and penis bones are used for making tools, handicraft or is sold. However, in Subarea 3 dogs sleds were traditionally (*e.g.* Vibe 1950) and still are widely used for travelling (this study). Using dog sleds for transportation to and from the marine hunting grounds (*e.g.* ice edges) is still an integrated part of the hunting activity (this is in fact also the case in Subarea 2). However, in contrast to the situation in Subarea 2 where walruses are mainly transient (Born *et al.* 1994, 1995) walruses belonging to the Baffin Bay subpopulation occur almost year round in most of Subarea 3 (Vibe 1950; Born 1987a; Born *et al.* 1995; Heide-Jørgensen *et al.* 2013, 2016). Traditionally walruses have been a very important element in the subsistence catch by the people living in this area (Vibe 1950; Born 1987a), which is still the case today (this study; Rasmussen *et al.* 2010; Witting and Born 2005, 2014).

In Subarea 3 as well, the majority of informants said they had experienced a decrease in their catch of walrus. It was mentioned several times by interviewees that a very important reason for catching walruses in this subarea is to provide stable meat, skin and blubber for feeding the sled dogs. Many of the informants said the reduction in their catch of walruses due to the quotas made it difficult to provide enough food for the sled dogs; according to the interviewees the alternative of buying food for the dogs (*i.e.* imported dog food pellets) in the local stores is prohibitively expensive for the hunters. Some said they had had to reduce the number of dogs in their team. It was mentioned that selling walrus meat and skin to other hunters used to be a source of income and also that it is no longer possible to sell walrus products to the *KNI* (*i.e.* the trade company). This has led to a reduction in income. In this area it was also mentioned that the worsening sea ice conditions have made it even more difficult to catch (enough) walruses (see also section: Climate and walruses).

A statement by a hunter from Siorapaluk captured the sentiment of several of the informants in Subarea 3:

> (The quotas) are way too bad. In 1999 when there was good ice we were able to hunt on the ice in January–February. Already then, before the quota, the catches were decreasing due to worsening of the sea ice conditions in the 1990s. Those with small skiffs caught fewer walruses already by then. In 2006 we got punished even more with the introduction of a quota and could also no longer hunt during the summer. This is a "multiple punishment". It becomes impossible to follow the regulations. It may have consequences and lead to punishment. We thereby become "criminals". Even though Avanersuamiut (authors' note: "People of the North", expression for people living in the area) obey the law.

Another hunter from the same settlement indicated that the reduction in the number of walruses that can be taken is part of a more profound process leading to reduced income from hunting. This is because the hunt for other mammals has also become restricted and the selling of hunting products increasingly difficult:

> I have really lost a lot since 2006. My income decreased with 73% after the quota. It is the narwhal hunt, fox fur, falling prizes, seal skin etc. For example, the settlement Moriusaq closed down (was abandoned) because of these conditions.

There were also complaints about the administration of the hunting license system, which makes it difficult to hunt walrus because the process of issuing licenses was/is relatively slow. In some cases this has hindered the hunters in going walrus hunting when the conditions were otherwise good.

The answers from hunters who did not think that the quotas had changed their situation were all given by hunters living in Savissivik. They mainly confirmed earlier statements that walruses are rare and mainly transient in this area.

## Distribution, seasonal occurrence and local abundance (Questions 36–41)

### Question 36

*Where do walruses occur at different times of the year?* (time, place, gender, ice type, distance from the coast etc.).

The various explanations provided by several of the interviewees are presented in the following.

Informants from Maniitsoq and Kangaamiut said that in April the walruses are found "in the west" in an area that stretches from southwest of Sisimiut north to Aasiaat.

A 79-year-old hunter from Kangaamiut said:

> When hunting walrus we go northwest from Itilleq. To *Nassuttuup paavani* (i.e the entrance to Nassuttoq/Nordre Strømfjord at 67° 29' N), sioraani (in that area), and *Attup sioraani* (off Attu) The walruses are not distributed along the coast but in the shallow water areas to the west. The closest to Kangaamiut where I have caught walruses is west of Kangerlussuaq.

Nine hunters from Sisimiut provided information on the overall distribution of walruses in Subarea 1. It was mentioned by four interviewees that walruses concentrate where there is sea ice and therefore the general distribution depends on the sea ice cover. A 53-year-old hunter said that the ice "arrives" in January (*i.e.* the "West Ice" gets closer to the West Greenland coast). If the pack ice is dense the walruses occur closer to the coast. There is a tendency for female walruses and calves to occur closer to the coast (*i.e.* in less dense ice and at shallower waters) than the males. However, two informants from Maniitsoq and Kangaamiut, respectively, were of the opinion that the general distribution of male and female walruses does not differ. During April the walruses move west-northwest north of Attu as the sea ice melts and the eastern edge of the "West Ice" retreats towards Baffin Island.

According to a hunter (aged 63) from Sisimiut the walruses are mainly found west of 55° W at *Aarrit/Aarfiit karra* (67° 39' N/53° 45' W; *"karra"* meaning "promontory"). They are distributed between *Siorarleralaap/Sujorardlît karra* (66° 42' N/53° 38' W) at Sisimiut north to *Qeqertarsuup karra* (*i.e.* the western promontories of Qeqertarsuaq/Disko Island). Another informant (aged 61) said that in February females and calves are at the entrance to Amerloq at Sisimiut, near the coast west of Ukiivik and at the entrance to Kangerlussuaq. According to a 53-year-old interviewee there are many

females at *Kangaarsup karra* during January–April when the large males gather at *Attup uummannaata karrani* (*i.e.* the promontory of Uummannaq at Attu; unclear location and maybe referring to Uummanaarssuk at 67° 42' N/53° 47' W), and west of Qeqertarsuaq/Disko Island. Another informant said that the walruses are distributed between 54° and 55° W early in the season, but can later be found at ca. 56° W. Their northern distribution is between the entrance to Nassuttooq (Nordre Strømfjord) and Aarrit south of Attu. It was also mentioned that old male walruses occur west of Disko Island in May.

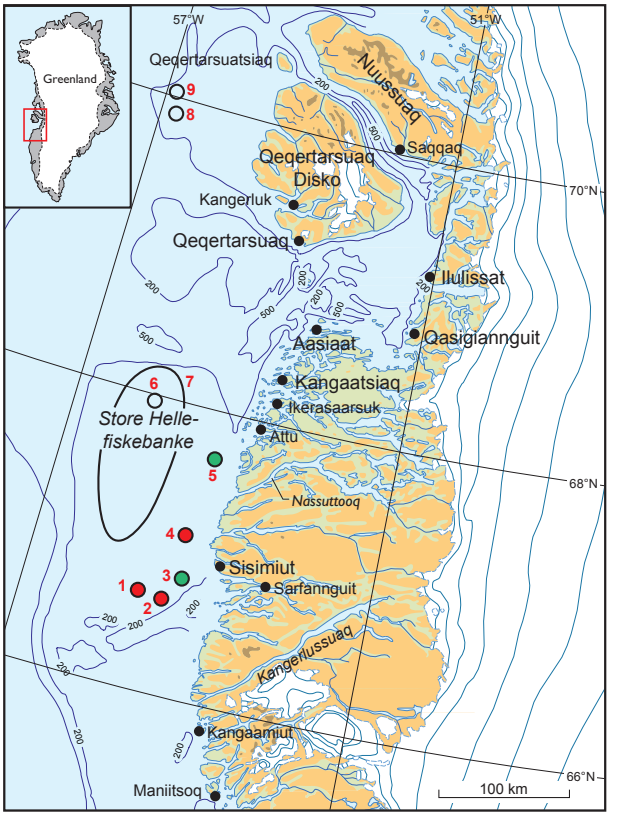
Eleven informants living farther north in Subarea 1 (*i.e.* in the Attu-Aasiaat area) also provided information on the distribution of walruses. A hunter from Attu mentioned that both sexes can be found at ca. 55° W in April–May. According to him they often occur west of the entrance to the Nassuttooq fjord, and he confirmed information from Sisimiut that the walruses generally move west and north during spring (April–May). Another informant from Attu stated that the walruses are at 54°–55° W and a little south of 68° N during January–March. However, according to him they move west when there is noise. He said that females and males are generally separate but can be found on the ice together. Another interviewee from the same settlement described the same distribution area and added that they are eating in this shallow water area. He also said that in January the females are 5–7 nautical miles (9–12 km) from shore before they move west. The females move west in February whereas the males move towards west and north in March (authors' note: this may reflect a combination of different geographical distribution of females and males and timing of the retreat of sea ice where the two sexes are distributed).

A 60-year-old informant from Attu described the situation like this:

> Walruses are at 55° W in March – close to 56° W. The males are more towards the west (*i.e.* farther offshore at deeper waters) and males and females are seldom together. Earlier we hunted walruses far to the west in the pack ice in April–May, about 17 hours going by cutter towards the west far into the ice. Walrus hide was also traded back then in the 1950s. Half a hide was worth about 150 Danish kroner (ca. 25 US $, July 2010 exchange rate) and a whole hide approximately twice as much. In April–May they are mainly farther offshore to the west. They are far away.

An interviewee (aged 56) from Attu was quite specific and stated that in the later years the walruses have been at 67° 59' N and 54° 50' W in March. According to him herds consisting of males and females may be found at 67° 47' N and 55° 16' W at the end of March.

A hunter from Ikerasaarsuk said that the walruses occur really close to land in December–January. When the ice arrives in December they can be met west of Attu. In January they are northwest of Sisimiut and in March off *Ukiiviup karra* (Sydbay, 67° 13'N and 53° 54'W). Their distribution generally depends on the currents and the winds. In April–May the walruses are at *Alanngorsua*'s shallow water banks (*i.e.* at the banks to the west of the peninsula Alanngorssua, ca. 68° 09' N and 53° 20' W, on which the settlement Ikerasaarsuk is located). Plenty of male walruses concentrate in May–beginning of June offshore at about 56° W.




**Map 1.** Subarea 1. Information on distribution of walruses and hunting areas provided on maps by informants in the southern parts of Subarea 1 (four hunters from Sisimiut and two from Attu) during an interview survey, 2010. The text below is that which was noted on the maps during the interviews. Numbers in parentheses are the IDs of the hunters providing the specific information.

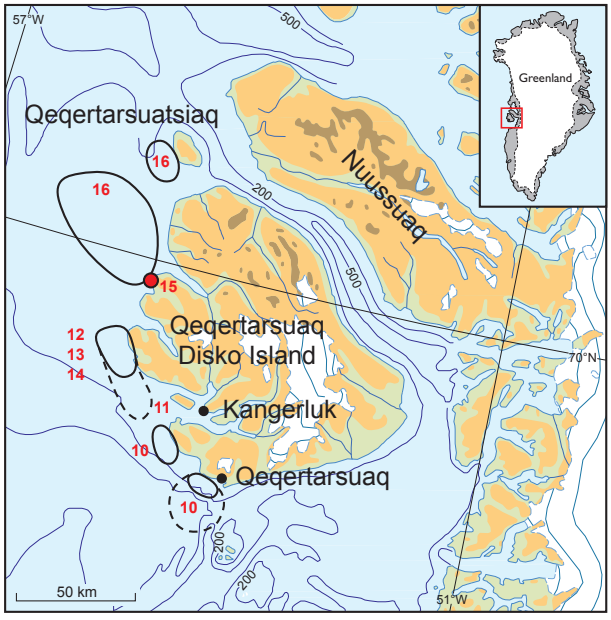
1) Mainly females in January (4).
2) Females and young in February–March (8).
3) Young "aggressive" males in February–March (8).
4) Females with young in March–April (8).
5) The older males are always farthest to the west (*i.e.* farther offshore) (8).
6) Both sexes in April. The males are distributed farther west than the females (4).
7) General distribution area. The "exact" location depends on the sea ice conditions. The males are generally distributed farther to the west than the females (11, 13, 14, 17).
8) The walruses are mainly at Qeqertarsuaq/Disko Island during May. In May the males are more "detectable" than the females (4).
9) Distribution area in April–May. Mainly older males occur in this area but also big females with large tusks (11).

That walruses occur to the northwest of Sisimiut from January, and the fact that they move more and more in a northwesterly direction off Attu during April, was also mentioned by another informant from Ikerasaarsuk. He added that the walruses are closer to Qeqertarsuaq (Disko Island) when approaching summertime although he was not sure about when.

A hunter from Kangaatsiaq said that he mainly hunted walruses west of Kangaatsiaq, a little to the south of the entrance to Nassuttooq. The catch of walrus depends on the sea ice conditions between ca. 20 to ca. 40 nautical miles (ca. 37 to ca. 74 km) offshore, which is where they hunt walrus in March.

An informant from Aasiaat said that the further west they go the more male walruses they see. But he also stated that the two sexes may occur in the same areas.

Some of the hunters living in the southern parts of Subarea 1 made sketches of the occurrence of walruses (Map 1).




**Map 2.** Subarea 1. Information on occurrence of walruses and hunting areas at Qeqertarsuaq/Disko Island provided on maps by four hunters from Qeqertarsuaq town, two from Kangerluk and two from Aasiaat during an interview survey, 2010. The text below is that which was noted on the maps during the interviews. Numbers in parentheses are the IDs of the hunters providing the specific information.

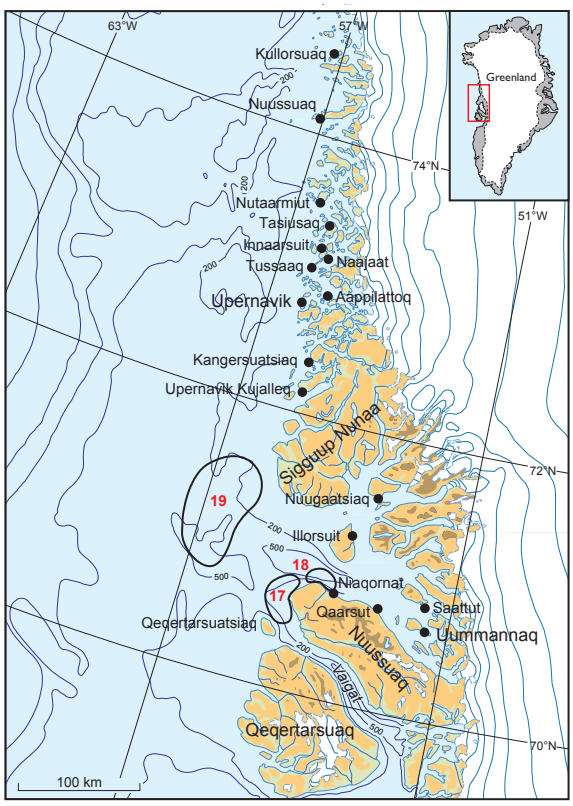
10) Previously they occurred in this area (27, 28).
11) They occur here in March (30).
12) They have occurred here in later years (27).
13) If there is (dense) sea ice the walruses also occur in this area (25). They are here in March–May (26, 28). They may occur here close to the coast in shallow waters in January and February (28).
14) Female walruses with young occur here in January–February (29).
15) We go by dogsled to this area to hunt walruses. Previously we hunted here in January–February, but now we hunt in March–April. It is mainly single male walruses (29).
16) Shallow water areas that are preferred by walruses in March–April (23, 24, 25, 26, 27).

Hunters that were interviewed in Qeqertarsuaq and Kangerluk on Qeqertarsuaq/Disko Island said that walruses occur along the western coast of Qeqertarsuaq/Disko Island when there is sea ice. Apparently their distribution has changed, as they no longer occur regularly close to the southwestern parts of the island (Map 2).

A 42-year-old informant from the town of Qeqertarsuaq mentioned that if they observe walruses close to the coast one day they have moved farther west the next day. According to him this is because the walruses become alarmed and therefore move farther offshore.

A hunter (aged 66) from the same town stated that:

> Not many walruses have come close to Qeqertarsuaq town since I became adult. Only a few have arrived so I cannot say anything about this (*i.e.* distribution). Many years ago they were very close to Qeqertarsuaq. Not many go hunting all the way out there nowadays.

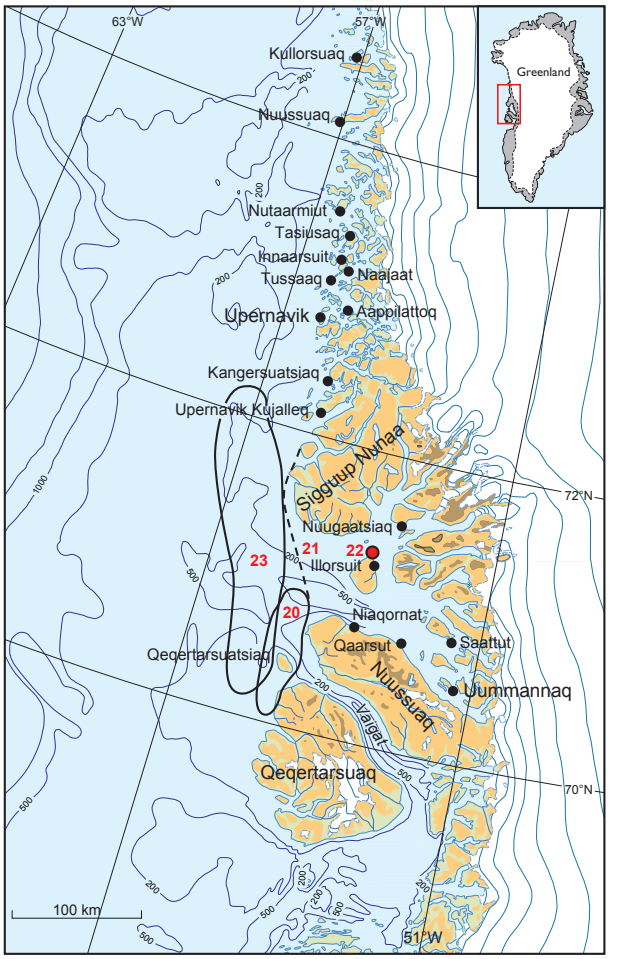



**Map 3.** Southern part of Subarea 2. Information on walruses and hunting areas provided on maps by two hunters from Niaqornat during an interview survey, 2010. The text below is that which was noted on the maps during the interviews. Numbers in parentheses are the IDs of the hunters providing the specific information.

17) This is an area with currents that create an open water area (*i.e.* polynya) where walruses occur (31) in February–March/April (33).
18) Walruses may occur here in December–January (31).
19) The walruses occur here during May in a shallow water area (31).

A 52-year-old interviewee living in Kangerluk explained that during the period January–April the walruses occur in shallow water areas south of Eqaluit, at Akulleq (Mellemfjord), and at Qasigissat north of Akulleq. However, in March–April they move with the sea ice offshore in a northwesterly direction. The walruses are more to the south in December–January.

According to two experienced hunters living in Niaqornat there is an open water area (polynya) at the tip of the peninsula Nuussuaq. During February–April walruses may occur in this polynya, which is created by a strong current passing some small islands. According to one of these informants, both genders occur in this area and



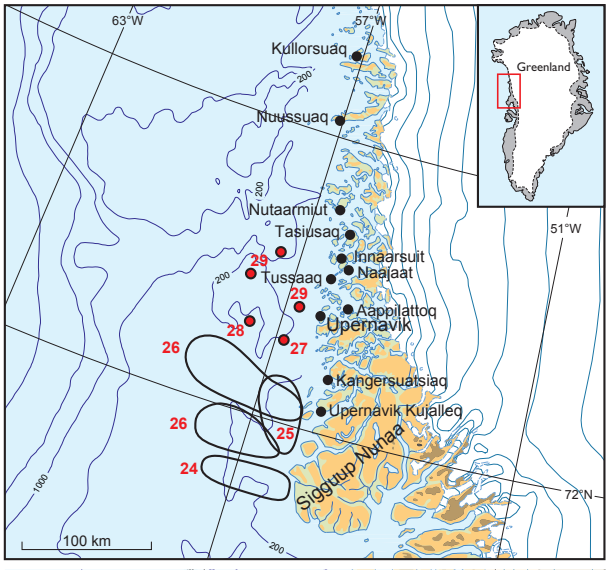

**Map 4.** Southern part of Subarea 2. Information on walruses and hunting areas provided on maps by two hunters from Niaqornat during an interview survey, 2010. The text below is that which was noted on the maps during the interviews. Numbers in parentheses are the IDs of the hunters providing the specific information.

20) In February–March they are along the west coast of Nuussuaq, around Qeqertarsuatsiaq/Hareøen and at the NW part of Qeqertarsuaq/Disko Island (32).
21) In the 1980s and 1990s the walruses were here at the edge of the fast ice in April (32).
22) The catch by hunter "P.Z." of a walrus on land (author's note: no further information) (34).
23) The walruses occur here during May (32).

sometimes females with suckling calves can be found at the shallow waters a little farther north (Map 3 and 4). A hunter from Illorsuit said that he had seen groups of walruses (with up to 10–15 individuals) hauled out on the sea ice in this area in April–May (and also at the tip of Sigguup Nunaa / Svartenhuk peninsula and at Qeqertarsuatsiaq / Hareøen farther south). Another informant from this settlement confirmed the occurrence of walruses at the Nuussuaq peninsula and Sigguup Nunaa / Svartenhuk, and added that walruses only rarely come close to Illorsuit.

A hunter living in Upernavik Kujalleq said that walruses are closer to land when the sea ice freezes from January to March. When the pack ice melts and the ice edge moves towards the west, he noted the walruses also move west. He also noted that there are scallop trawlers close to Upernavik Kujalleq in the summer, but he did not know if this has an effect on the distribution of walruses.

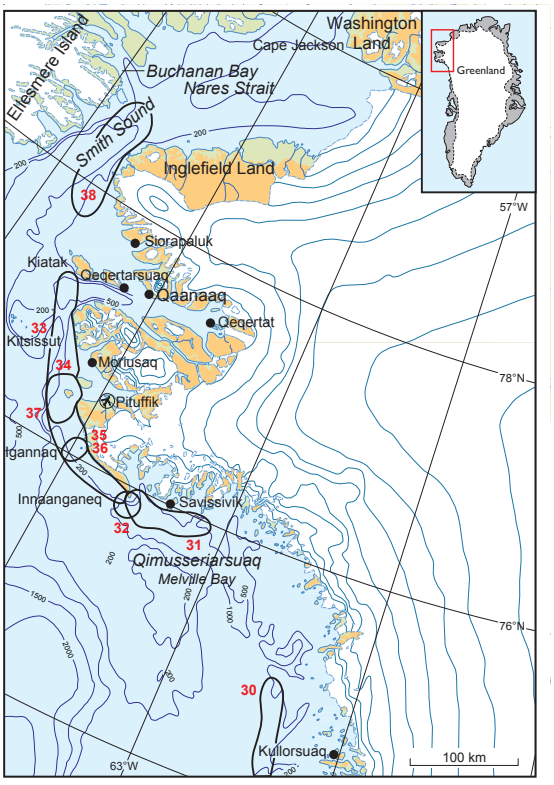
Informants in Upernavik town said that there are walruses west of the town and west of the Illutalik island (72° 48' N and 56° 30' W), west of Upernavik in December–January. They mentioned that there are walruses at the shallow waters at ca. 58° 30 ' W (authors' note: *i.e.* ca. 75 km offshore from Upernavik town). An informant from Aappilattoq said that there is an area ca. 100 km west of Upernavik town where




**Map 5.** Northern part of Subarea 2. Information on walruses and hunting areas provided on maps by two hunters from Upernavik Kujalleq, one from Upernavik town and one from Aappilattoq during an interview survey, 2010. The text below is that which was noted on the maps during the interviews. Numbers in parentheses are the IDs of the hunters providing the specific information.

24) They are foraging in this area in November–December (36).
25) Walruses occur here from January until April. The majority is females but there are also a few male walruses (37).
26) In December–January they are here when the sea ice begins to form (36).
27) Walruses may occur here (39).
28) This is a place where female walruses with calves may occur in May (38).
29) Walruses occur here in January (38).

**Map 6.** Northern part of Subarea 2, and Subarea 3. Information on walruses and hunting areas provided on maps by six hunters during an interview survey, 2010 (except ID 44, who was from Kullorsuaq in Subarea 2, the other informants were from Savissivik, or had lived in Savissivik). The text below is that which was noted on the maps during the interviews. Numbers in parentheses are the IDs of the hunters providing the specific information.

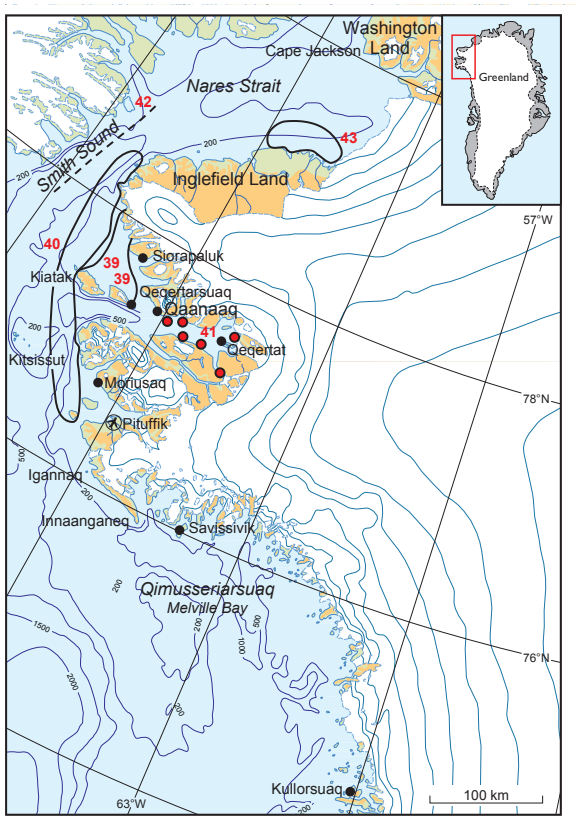



30) We hunt walruses in this area during April–June (44 from Kullorsuaq).
31) Walruses occur at the ice edge in this area from late April until late June (45, 46, 47, 55). In May–June the walruses migrate along this ice edge on their way north (48).
32) The walruses are here in November–December in an open water area ("polynya") at Innaanganeq/Kap York (48).
33) This is the area with big males with big tusks. From December through the winter they occupy this entire area (46).
34) There are walruses here from November–December (47, 48, 55).
35) The Igannaq area is said to have been "a walrus area in the old days" but they have "disappeared" in later years. In May–June 2009 and 2010 two hunters (49 and hunter "M.E.") saw many walruses in this area (48).
36) They are at Igannaq in June (45, 46, 47).
37) In April 2010 some hunters from Qaanaaq saw many walruses hauled out on the drift ice in this area (48).
38) Females and young are found in this area (46).

he searches for walruses in April–May. He also mentioned west of Sigguup Nunaa/Svartenhuk peninsula as an area where walruses can be found, and explained that the walruses in the area are on their way north in the spring, and south in the fall (Map 5). According to him walruses are transient in the Upernavik area. The notion that walruses are transient and migrate north in spring and south in fall was also expressed by a hunter from Innaarsuit.

An informant from Tasiusaq said that they encounter walruses by coincidence, and that the most northern place that he has hunted walrus was west of Tuttulissuaq (Kap Seddon, 75° 20' N and 58° 38' W) in Qimusseriarsuaq/Melville Bay (Map 6).

According to a hunter from Nuussuaq/Kraulshavn, walruses can occur in May near some islands at the leads at Kitsissorsuit (Ederfugleøer, 74° 02' N and 57° 46' W). They may also be seen in the shallow water areas at the Nuussuaq peninsula. At this time of the year the walruses are travelling north. However, when the light disappears in November they are in the shallow waters between Kiatassuaq (Holms Ø, 74° 29' N and 57° 30' W) and Nuussuaq/Kraulshavn.

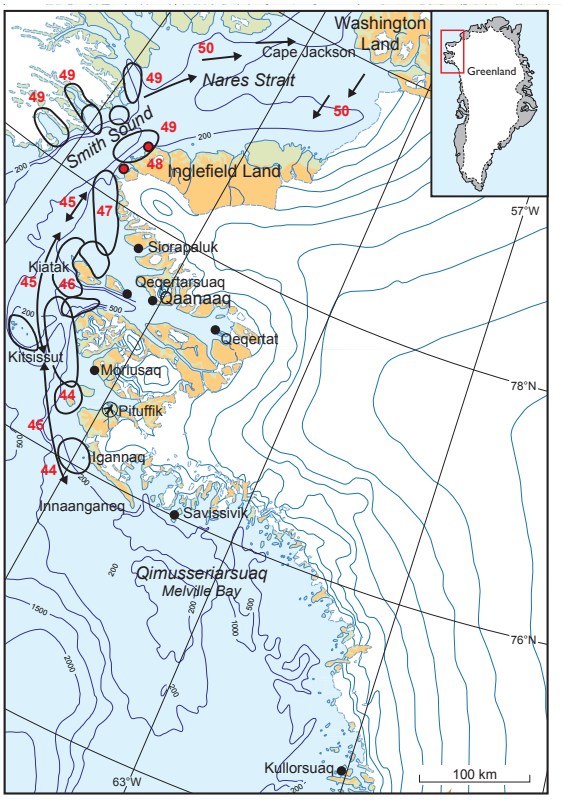



**Map 7.** Subarea 3. Information on walruses and hunting areas drawn on maps by four hunters from Qeqertat (except for 66 who lived in Siorapaluk) during an interview survey, 2010. The text below is that which was noted on the maps during the interviews. Numbers in parentheses are the IDs of the hunters providing the specific information.

39) Earlier the walruses occurred here and were hunted in this area (*i.e.* on the thin ice east of the ice edge shown) during February–April. Nowadays the ice edge is situated farther east (51; the position of the edge of the fast ice before and now is shown).
40) General distribution of walruses (no further explanation) (52).
41) Places (red dots) where a hunter from Qeqertat had seen walruses in the fjord Qaanaaq Kangerlua/Inglefield Bredning (53).
42) During spring the walruses migrate through Smith Sound (52).
43) In June–July 1987 we were here, and there were plenty of walruses (52). A hunter from Siorapaluk said they hunted walruses in this area in the 1990s (66).

According to two informants from Kullorsuaq, walruses are travelling north at the edge of the fast ice west of Kiatassuaq and farther north during April–June. In fall they are seen migrating south at the western islands west of Kullorsuaq. Single walruses may be encountered in the Qimusseriarsuaq/Melville Bay during the narwhal hunt in July.

The majority (ca. 80%) of the hunters who were interviewed in Subarea 3 made sketches on maps when answering this question (Map 6–12). However, several also provided more detailed explanations.




**Map 8.** Subarea 3. Information on walruses and hunting areas drawn on maps by six hunters from Qaanaaq (except for ID 68 and 69 who lived in Siorapaluk) during an interview survey, 2010. The text below is that which was noted on the maps during the interviews. Numbers in parentheses are the IDs of the hunters providing the specific information.

44) Areas with walrus in October (he thought that some walruses also may occur here year-round) (55). It is an area where big males occur (68).
45) The general migration route both south and north in Smith Sound (54).
46) We hunt walruses here both in the spring (May–June) and in the fall (October) (55, 69). The hunters from Qaanaaq hunt walruses in this area (69).
47) In spring the majority of walruses in this area (*i.e.* entrance to Murchison Fjord) are females with young (67). This is a shallow water area (69).
48) In July they can be caught here along the coast (55, 69).
49) The hunter saw female walruses with calves in these fjords in July 2008 (55). Females with calves occur in these areas (59).
50) During June the walruses migrate north (54; in June–July according to informant 55). In October they drift south again on the Greenlandic side of Nares Strait (54).

According to four of the five informants in Savissivik the walruses migrate north in spring along the edge of the fast ice between Savissivik and Innaanganeq/Kap York (Map 6 and 7). The timing of this migration is late April–June, apparently peaking in May. According to one of the hunters there is always open water at Innaanganeq, which is why the walruses have their migration route there. Another who said there is a migration north in May also said that the females with young migrate through the area in June on their way north, whereas the older males follow in July.

A fifth interviewee in Savissivik mentioned a specific observation:

> We saw lots of walruses on the drift ice at Igannaq/Conical Rock when we went by skiff to Pituffik/North Star Bay (*i.e.* where the Thule Air Base is located) in June 2009; more than a 100 walruses.

Apparently there is a general northward migration in spring along the outer coast of the Qaanaaq area (Map 8). A 66-year-old hunter from Siorapaluk said that the old males arrive first on their way north in spring and then the females gradually mix in, generally arriving later on their migration north.

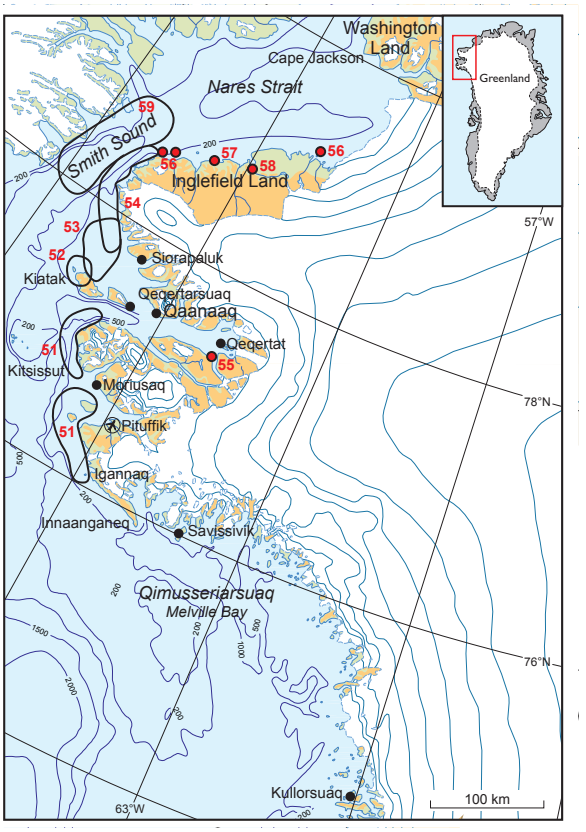
Information from the hunters indicates that walruses return to the subarea in October (one informant said September–October) and stay in their shallow water feeding grounds until the following May (some interviewees said June/July) when there is a general migration out of Subarea 3 north to eastern Umimmattooq/Ellesmere Island in Canada, and northern Qaqqaatsut/Inglefield Land in Greenland. During winter there is a segregation of sexes, with adult males occurring farther south (*i.e.* in the Kiatak/Northumberland Island area and around Appat/Saunders Island and Qeqertarsuaq/Wolstenholme Island) and adult females and young occupying the entrance to Murchison Sound in the Neqe (Kap Suamarez)/Pitoraafik (Kap Chalon) area and farther north (Maps 8–12).

However, according to a statement by a 46-year-old hunter from Qaanaaq, this spatial segregation seems to develop during winter. This informant said:

> We mainly see males west of Siorapaluk (*i.e.* at the entrance to Murchison Fjord) in the fall and in the spring we mostly see females with calves in the same place.

An informant (aged 69) from Siorapaluk explained that the females generally occur on the drift ice closer to land than the males, indicating an east-west distribution related to water depths similar to that in Subarea 1.

Some of the hunters told about their observations of walruses along eastern Ellesmere Island. A 44-year-old informant from Siorapaluk said that there are walruses year round in Canada (*i.e.* along eastern Ellesmere Island). He was there in the 1990s (apparently during summer in the Buchanan Bay area) when they saw walruses all over on the drift ice (Map 10). In summer 2009 he also observed plenty of walruses along eastern Ellesmere Island. An informant (aged 62) from Qaanaaq said that they were in Canada at the ice edge (authors' note: likely meaning the "ice bridge" across southern Nares Strait-Kane Basin usually going from Anoritooq/Kap Inglefield in

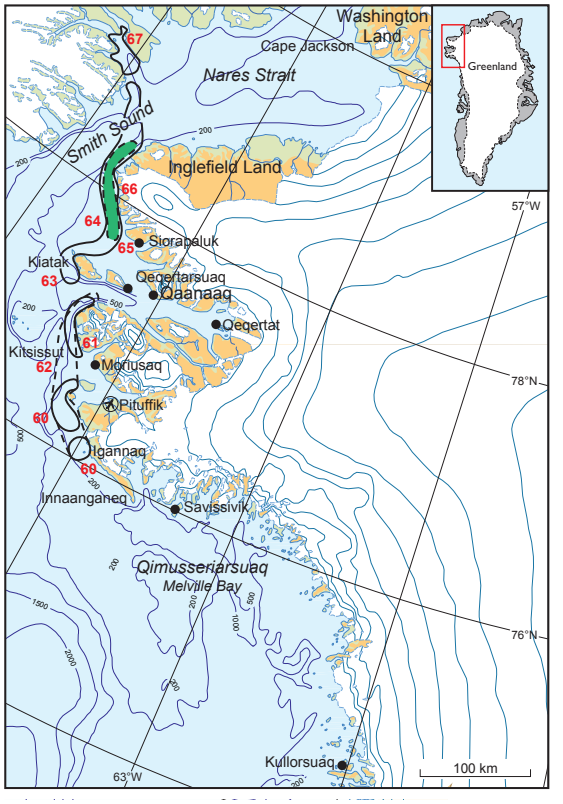



**Map 9.** Subarea 3. Information on walruses and hunting areas drawn on maps by one hunter from Qaanaaq and two from Siorapaluk during an interview survey, 2010. The text below is that which was noted on the maps during the interviews. Numbers in parentheses are the IDs of the hunters providing the specific information.

51) Places with big male walruses with long tusks. They are not there during summer (*i.e.* the open water season) (57, 58).
52) The majority of walruses in this area are males (58).
53) Smaller walruses (females with young) occur here during spring and fall (57); in June–July and October (68).
54) Area with female walruses and young in February–March and May (58).
55) In July 2003 the informant saw a walrus in this place (58).
56) Places where males occur (58).
57) Place where both gender of walrus occur (58).
58) Walruses had been observed hauled out on land in this place in May (?) ca. 1967–1969. It was a large herd with both sexes (58).
59) Plenty of walrus in this area (68).

Greenland to Pikiuliusarsuaq/Pim Island on eastern Ellesmere Island) in July 2008 where there were many females with calves. According to him lots of walruses passed by, they all moved northward, and none were swimming towards the south. He added that in July the walruses also migrate north of Etah/Foulke Fjord on the Greenlandic coast. A 63-year-old hunter from Siorapaluk said that the last time he caught walruses along the Canadian coast was during a dog sled trip in February–April in the 1990s when they saw plenty of walruses.

The concentrated occurrence of walruses during summer (primarily females with young) in the Buchanan Bay area on eastern Ellesmere Island was also reported by Born and Knutsen (1988) and Stewart *et al.* (2014a).



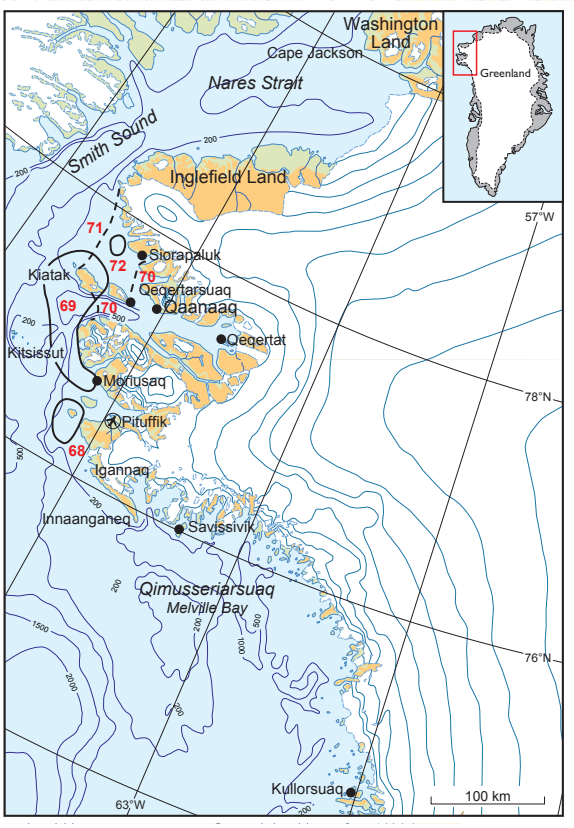

**Map 10.** Subarea 3. Information on walruses and hunting areas indicated on maps by two hunters from Qaanaaq during an interview survey, 2010. The text below is that which was noted on the maps during the interviews. Numbers in parentheses are the IDs of the hunters providing the specific information.

60) Area with both gender of walrus (60).
61) Area with big male walruses ("very big and heavy males") (60).
62) Male walruses occur in this area during October–June (61).
63) There are walruses in this area in January–April and in October–November (61).
64) Females with young occur in this area (60).
65) Female walruses with young occur in this area in May (61).
66) Area (green) with both sexes of walrus (60).
67) Area (*i.e.* Buchanan Bay) with walruses (no further explanation given by the informant) (61).

An informant from Siorapaluk said that the females give birth in the area west of Siorapaluk, whereas a hunter from Qaanaaq mentioned that they give birth in June–July in Canada and at Etah/Foulke Fjord. He has seen many females with calves in these places (Map 8).

Walrus stragglers have been observed during summer in Qaanaap Kangerlua/Inglefield Bredning where the waters are deep (*i.e.* east of their shallow water feeding banks at the entrance to Murchison Sound); Map 7). A hunter from Qaanaaq explained:

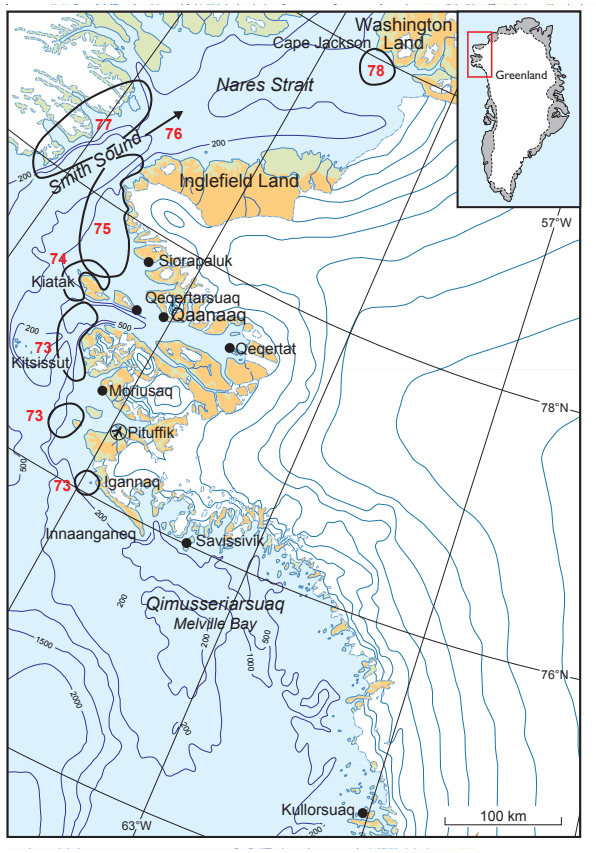
> At a meeting with the Hunters' and Fishermens' Organization (KNAPK) it was decided to kill all the walrus that are seen in the




**Map 11.** Subarea 3. Information on walruses and hunting areas indicated on maps by two hunters from Qaanaaq and one from Siorapaluk during an interview survey, 2010. The text below is that which was noted on the maps during the interviews. Numbers in parentheses are the IDs of the hunters providing the specific information.

68) The "red walruses, the very big males" are in this area during January–June (62).
69) Area where (big) male walruses predominant (62, 63).
70) The position of the ice edge nowadays (62). During October–December walruses occur west of this place (66).
71) The edge of the fast ice was in this position during January–April until 1998–2000 (62). In June we catch them on the drift ice in this area (66).
72) Female walruses with calves are in this area (62, 63).

**Map 12.** Subarea 3. Information on walruses and hunting areas indicated on maps by one hunter from Qaanaaq and six from Siorapaluk during an interview survey, 2010. The text below is that which was noted on the maps during the interviews. Numbers in parentheses are the IDs of the hunters providing the specific information.




73) Areas where males predominant (71, 72, 73); big males (68).
74) Earlier there were always walruses in this area during summer (71).
75) The walruses are in this area until June. They migrate north in June–July (70). This is an area with females with young (66, 68, 72, 73).
76) The walruses migrate north here during spring (73).
77) There are walruses in this area all year round (74).
78) It is thought that walruses can be found in this area during winter (*i.e.* at Cape Jackson on Washington Land) (71).

fjord towards Qeqertat (*i.e.* Qaanaap Kangerlua/Inglefield Bredning) where we hunt narwhal from qajaqs/kayaks because walruses are dangerous and may attack a qajaq.

Finally, a hunter (aged 50) from Qaanaaq said he thought there were different types of walrus at Siorapaluk and at Etah, respectively. Some are red, brownish and some are dark purple. According to him, the dark purple walruses are very large. He has seen this several times.

| Question 37 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subarea | "Yes" | | "No" | | No opinion | | No answer | | |
| | N | % | N | % | N | % | N | % | N[1] |
| 1 | 10 | 33.3 | 20 | 67.7 | 0 | 0.0 | 0 | 0.0 | 30 (30) |
| 2 | 0 | 0.0 | 14 | 100 | 0 | 0.0 | 0 | 0.0 | 14 (14) |
| 3 | 3 | 9.7 | 28 | 90,3 | 0 | 0.0 | 0 | 0.0 | 31 (31) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | |

**Table 28.** Answers to Question 37: "Have you seen walruses that were hauled out on land?"

## Question 37

*Have you seen walruses that were hauled out on land?* (when?, where?)

The sea ice over the continental shelf in eastern Davis Strait and Baffin Bay has decreased markedly since the early 1990s (*e.g.* Peacock *et al.* 2012; Dietz *et al.* 2014). Our goal by asking Question 37 was to detect if walruses had resumed (or are in the process of resuming) the habit of hauling out on land in W and NW Greenland as a consequence of a decrease in the sea ice.

Ten (33%) of the informants in Subarea 1 had observed walruses resting on land in recent time. The corresponding figures for Subarea 2 and 3 were 0% and ca. 10%, respectively (Table 28).

Several of the hunters who had seen walruses on land in Subarea 1 provided details about their observations. These observations are listed with information of the home town and age of the hunter in the following:

> Maniitsoq (aged 47): Yes, three times in my life. One day in June 2006 I saw a live walrus on a skerry at the island named Aluusat which is situated a little west of the Maniitsoq Airport. Later the same day I saw a walrus carcass flensed on the beach of the island called Uummannassuaq (65° 27' N – 53° 05' W) close to Maniitsoq. And once, in June (July?), I saw a live nukalloq (*i.e.* young walrus) south of Itilleq (65° 43' N – 53° 17' W) on an island with a lighthouse.
>
> Sisimiut (49): Yes, once on an island north of Attu during spring (April or May); about 10 years ago.
>
> Sisimiut (58): Yes, north of Ukiivik at *aataarniarfiup Ikerasaa* (exact location unclear) about 5 years ago in June (July?). It was a female

with a calf with 5 cm long tusks. They were on the beach and looked really nice and healthy.

Sisimiut (46): In August around 1987 I saw a female with a large calf with 5–10 cm long tusks on a skerry a bit north of Kangerluarssuk (66° 43' N – 53° 37' W). In September 1990 I saw a large male on a skerry at the mouth of Kangerluarsuk. And "NN" saw a walrus at open sea in the fall (October) 1999. In the past an older man observed walrus at Ukiivik/Sydbay (67° 17' N – 53° 54' W) at Nassuttooq/Nordre Strømfjord several times.

Attu (54): When I was approximately 10 years old (*i.e.* ca. 1966) I saw a walrus sleeping on a little island a little south of Aqisserniaq (67° 51' N – 53° 35' W). My father and I were tending fishing nets. I think it was in October. I was young and I do not remember the gender of the walrus.

Attu (55): Yes. I have seen this once at Uummannaq on an island west of and close to Attu in the 1980s. This island is visible from Attu. It was early in the fall – around September. It was a small walrus which was alone and awake.

Attu (60): Several times. In November or December 2004. A relatively big aggressive male was in the harbour. The kids threw stones at it. It was lean and aggressive. It got caught. I have seen walrus one land several times. In 2009, I saw a large male at Taateraaq (Tikeraq Ø?).

Ikerasaarsuk (51): Yes, twice. In December 2009 west of Ikerasaarsuk close to a small strait. It lay on the beach and was big and fat; and around April in 2008 on the beach at *Niaqornap karra*.

Qeqertarsuaq (66): In July 2009 together with "NN" and five other skiffs" (authors' note: This instance was also mentioned by two other interviewees who specified that it was a young walrus which hauled out at Maligissat at Uiffaq/Blåfjeld in July 2009).

Walruses no longer use terrestrial haul-outs (*"uglit"*) in West and Northwest Greenland. Uglit are only found in Northeast Greenland. Adult male walruses on Sandøen in Young Sound, August 2002. Photo: E.W. Born

In Subarea 1 some of the informants who answered that they had never seen a walrus on land provided additional statements. A hunter from Sisimiut (aged 63) had heard that, previously, the walruses hauled out on land at Nassuttooq at *Aarrit karra* (*i.e.* at a point at Aarrit). He had not seen it himself because he was "not in time" (*i.e.* too young) to experience it. A 61-year-old hunter from Sisimiut said that walruses are almost never seen close to land because of increased (boat) traffic. An interviewee from Ikerasaarsuk mentioned that he caught a walrus inshore on his way to Attu in July 2002. Finally, an informant from Kangaatsiaq said that he has sometimes heard about observations of lone calves that have been weaned recently. They are called *tammartajaartut* = the lost ones and are "puberty kids" – *sukorsiaqqat*.

None of the interviewees in Subarea 2 had seen walruses on land. However, a 49-year-old hunter from Niaqornat mentioned that at Nuussuaq peninsula at the entrance to Uummannaq fjord, he had seen walruses in the water at the beach in November and March; and also close to Niaqornat around June–July. An informant (aged 74) from Illorsuit talked about a hunter who had encountered a walrus basking in the sun on land in the 1990s. This walrus was caught at the tip of the Illorsuit island.

Only three informants in Subarea 3 had seen walruses that were hauled out on land.

> Qaanaaq (aged 50): Yes, when I was 8–9 years old (*i.e.* 1967–1969?). Many walruses of both gender. I think it was in May (Map 9 observation 58).
>
> Siorapaluk (48): Yes. In October around 1976–1978? This was an approximately three-year-old walrus that escaped during the hunt a little south of Etah/Foulke Fjord.
>
> Siorapaluk (63): Yes. I saw them in October close to the coast north of Siorapaluk.

Several of the informants who answered "no" reported having seen walruses close to the beach but not exactly hauled out. This had been observed in June in the 1970s near Etah and in the fall at Kiatak/Northumberland Island. A hunter from Qaanaaq referred to a story told by an old relative who had lived on Ellesmere Island and who had seen walruses hauling out on land there (site not stated).

When asked the question about walruses on land a 59-year-old hunter from Siorapaluk told a remarkable story:

> In 1989 I saw a narwhal on land. The sea gulls had begun eating off it. When I wanted to attach a rope to it, it was still breathing. It had no wounds. I killed it and took the kill with me home. It was good and fresh.

## Question 38 and 39

Q 38: *Have you observed any changes in the distribution of walruses during the last 10–15 years?*
Q 39: *Which changes have you observed?*

Overall, ca. 56% of the 75 interviews reported various changes in distribution of walruses in recent years. About 35% did not report any changes and ca. 9% had no opinion on the matter. Changes had been observed in all subareas. When answering these questions some informants also referred to a change in local abundance (see Questions 40 and 41).

Of the 15 hunters (50% of the interviewees) in Subarea 1 who had observed changes in distribution (Table 29), four said that the walruses now occur farther offshore to the west-northwest, and they thought that this was related to changes in the ice conditions. Eight said the number of walruses had increased, whereas two

thought that fishing activity had affected the distribution. The last informant gave a different explanation.

| Question 38 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subarea | "Yes" | | "No" | | No opinion | | No answer | | |
| | N | % | N | % | N | % | N | % | N[1] |
| 1 | 15 | 50.0 | 13 | 43.3 | 2 | 6.7 | 0 | 0.0 | 30 (30) |
| 2 | 6 | 42.9 | 7 | 50.0 | 1 | 7.1 | 0 | 0.0 | 14 (14) |
| 3 | 21 | 67.7 | 6 | 19.4 | 4 | 12.9 | 0 | 0.0 | 31 (31) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | |

**Table 29.** Answers to Question 38: "Have you observed any changes in the distribution of walruses during the last 10–15 years?"

There were remarks about the relationship between the distribution of walruses and sea ice. According to a 47-year-old informant from Maniitsoq (the town located southernmost in Subarea 1), the walruses are nowadays distributed a little more to the north. Previously, they mainly hunted walruses west of Itilleq (66° 35' N – 53° 30' W) but now they hunt them off Attu and Kangaatsiaq. He added that the distribution probably depends on the ice conditions. This was also the opinion expressed by a 54-year-old hunter living in the same town. This interviewee mentioned that the sea ice has become thinner (authors' note: likely also meaning less dense pack ice), which is why the walruses occur farther to the west.

A hunter (aged 61) from Sisimiut went into more detail about segregation by size and stated:

> The big walruses are not seen so often in later years. Nowadays they probably occur more to the west. Otherwise, the walruses are seen closer to land in recent years. Earlier we hunted walruses more out west (authors' note: "big walruses" probably refering to adult males).

When answering this question, eight informants said that the number of walruses had increased.

A 58-year-old informant from Sisimiut said:

> There are now more walruses. They mainly stay at 55° W but off Attu they may stay at 54° 20' W. There are always walruses at 66° 20' N.

Another hunter (aged 58) from the same town said that the walruses now get closer to Sisimiut.

According to a 61-year-old informant also from Sisimiut, there are more walruses now because walrus products are not traded as before to the local the co-op *Sipineq* or to the fish factory plant in Maniitsoq. Therefore, they are not exploited as rigorously anymore because of a reduced demand from the market.

A hunter from Attu thought that there are more walruses now because of the strict quotas and an informant living in Ikerasaarsuk told that there are many "small walruses" west of 56° W. According to him there are:

> Incredibly many northwest of Sisimiut at *Ukiiviup karra* (*i.e.* at the Ukiivik promontory).

Farther north in Subarea 1, some informants had also noted that walruses had become more abundant. A 49-year-old informant from Qeqertarsuaq, who during spring 2010 saw more walruses than ever during the last 10 years, thought that it could be because the pack ice was close to land in 2010.

An informant (aged 42) from the same town who had also observed an increased occurrence of walruses explained:

> Many years ago the walruses came very close to Qeqertarsuaq but then they disappeared somewhat but now it seems as if they are again seen more often…

Two hunters thought that the distribution of walruses had changed due to noise. A 79-year-old informant from Kangaamiut said that the distribution has shifted farther west "because there are so many boats". According to a hunter (aged 52) from Kangerluk on Qeqertarsuaq the scallop fishing vessels, which operate in shallow waters, negatively affect the walrus population. He previously hunted more to the south, and scallop vessels were fishing in the same places where the walrus used to occur and forage. That resulted in a decrease in observations of walruses. However, nowadays there are not as many scallop vessels and the walruses are again being seen more often in those areas.

A 52-year-old hunter from Ikerasaarsuk said that he thought there are fewer walruses after quotas were introduced (authors' note: this might be a misunderstanding of the question). Perhaps the informant meant that the catch has decreased after quotas were introduced?).

Some of the informants who had *not* observed any changes in the distribution of walruses also provided additional explanations. Three hunters (from Sisimiut, Kangaatsiaq and Qeqertarsuaq, respectively) stated that the walruses have always been closely linked to the sea ice. If the sea ice is "bad" they do not see many walruses, whereas if the ice is "good" (*i.e.* more sea ice and closer to land?), walruses are observed more frequently. When the pack ice retreats offshore the walruses follow west. Two hunters from Attu thought that there had generally been an increase in walruses.

One of these hunters gave an explanation that indicates prices paid for different hunting products have led to reduced hunting for walrus:

> I am mainly hunting narwhal and beluga but there are plenty of walruses west of Attu. Narwhal and beluga mattak (muktuk, *i.e.* the skin) is always highly appreciated but not so much the narwhal and beluga meat. The mattak is more expensive. However, walrus meat is also appreciated and even more than narwhal and beluga meat. Narwhal and beluga mattak can be sold for 250 Danish kroner per kg (ca. 42 US $, July 2010 exchange rate) in Sisimiut-Nuuk whereas walrus meat is sold for 65 kroner per kg (ca. 11 US $) in Sisimiut. Because of the prices I mainly hunt narwhal and beluga.

Of those answering "no" there were also some who thought that fishing activity has a negative impact on the distribution of walruses. A 60-year-old hunter from Attu said:

> Walruses do not feel safe about the trawling vessels and they flee more than seals. They flee to the west. However if the ice comes back they will come back to the area in higher numbers than before.

An informant (aged 46) living in Kangerluk on Qeqertarsuaq/Disko Island mentioned that the trawlers operating in the Disko Bay make the walruses flee.

A 40-year-old interviewee from Qeqertarsuaq said they used to observe walruses in January–February, but now they see them in March–April (authors' note: due to the hunting season not starting until 1 March?). Then they are harder to catch because they have moved farther west by then.

Finally, an informant from Attu who said he had no opinion on the matter nevertheless expressed the thought that there has been an increase in numbers after quotas were introduced.

Six hunters (ca. 43%) in Subarea 2 reported that they had seen changes in the distribution of walruses. Five of these informants mentioned an increase in numbers, whereas one had noted a shift in distribution. Seven informants (50%) had not noted any changes and one (ca. 7%) had no opinion on the subject (Table 29).

Walruses are seen more often in recent years according to a 35-year-old informant from Niaqornat. He thought that this could be due to the ice conditions having become "better" (authors' note: no further explanation but likely meaning that the pack ice has become less dense in this area?), and therefore the hunters have easier access to the areas where walruses occur. A hunter (aged 49) from the same village thought the introduction of quotas had caused an increase in the number of walruses. He added that walruses are very shy and move away when they are disturbed. A hunter from Upernavik Kujalleq added that "nature" determines how many walruses there are. Another hunter from this village and one from Kullorsuaq had also noted an increase in the number of walruses.

A 44-year-old informant from Innaarsuit mentioned that the walruses now occur more to the west than previously.

The majority (ca. 68%) of the 31 informants in Subarea 3 had noted a change in distribution of walruses during the last 10–15 years. Six (ca. 19%) had not seen any change, and four (ca. 13%) had no opinion on this matter (Table 29).

Of the 21 informants who had observed changes, eight mentioned changes in distribution and timing of occurrence of walruses in the area. Eleven thought the number of walruses had increased, whereas two were of the opinion that there were now fewer.

In this context we present the answers provided by informants in Savissivik separately because walruses are transient in this area, contrasting the situation farther north. Three of the five informants in Savissivik thought that nowadays fewer walruses are observed in the Savissivik area in spring. One of these hunters (aged 67) said that the sea to the west and south of Savissivik is now covered with ice for a shorter period of time than before, and he speculated that walruses may have therefore changed their migration routes so they do not get as close to Savissivik as they did previously. However, two hunters from the same village said that there were now more walruses. One of these informants explained that since Moriusaq (which was situated in Wolstenholme Fjord (Fig. 1) close to the walrus feeding grounds at Appat/Saunders Island) was abandoned (in 2010), the number of walruses has increased because the people living in that settlement caught many walruses (authors' note: This settlement was officially abandoned in 2010 but several years before that the number of inhabitants had decreased markedly). The other informant stated that the walruses nowadays are even caught in areas where narwhals are caught (authors' note: It is unclear which areas are referred to but it is likely Qaanaap Kangerlua/Inglefield Bredning which is an import-

A couple of male walruses being butchered on a small ice floe after a successful hunting trip at Qeqertarsuaq/Wolstenholme Island (Subarea 3), which is an area with a surplus of male walruses according to the interviewees (*cf.* Maps 8, 9, 11, 12). Photo: E.W. Born

ant area for the narwhal hunt, *e.g.* Born (1986, 1987b), and where walruses have been observed in recent years; Map 7). Hence, the answers from these two hunters do not likely refer to their own direct observations in the Savissivik area. When answering Question 38 affirmatively, a hunter from Qaanaaq and one from Siorapaluk stated that walruses had begun to enter Qaanaap Kangerlua/Inglefield Bredning where they very rarely appeared before.

Two hunters from Qaanaaq and three from Siorapaluk had also noted changes in walrus distribution and in the timing of their appearance in the area.

A 50-year-old informant from Qaanaaq said that because of climate warming, the sea ice situation, and the winds, the walruses are now further away from land in October–November and are instead more out in the open sea. A hunter (aged 63) from Siorapaluk stated that the migration routes have also changed. In the 1990s the walruses moved along the coast, but nowadays they migrate farther from the coast. A 34-year-old interviewee from Siorapaluk also mentioned that the walruses used to occur closer to the coast but now are "more out in the west". In contrast, a 59-year-old informant from the same settlement said that the walruses used to be more to the west but now get closer to land and disturb the seals. This

makes the seals disappear. He speculated that maybe the walruses get closer to land because the sea ice forms later. A 62-year-old informant from Qaanaaq mentioned that the walruses now re-appear later in the area during the fall. They used to arrive in October but now they arrive a little later – in November. When it is dark they are therefore harder to see (and hunt) in November during *"kaperlak"* (*i.e.* the time of darkness). Without giving further explanation he added that: "It is also harder in spring".

Four informants from Qaanaaq and five from Siorapaluk were of the opinion that walruses have become more abundant.

A 63-year-old hunter from Siorapaluk said:

> There were fewer walruses earlier and there are more now. A lot of walruses were observed in June 2010 on the drift ice north of Siorapaluk. There is really a lot.

Finally, a hunter (aged 53) from Qaanaaq who otherwise had no opinion on the matter stated that the distribution of walruses depends on the movement of the sea ice.

### Questions 40 and 41

Q 40: *Have there been any changes during the later years in abundance of walruses in areas where you are hunting them?*
Q 41: *Why have these changes happened?*

Although by asking the previous two questions we specifically sought information on observations of changes in distribution, several of the informants reported the observation of changes in abundance (*i.e.* apparent number of walruses or local density). Hence there is some overlap in the answers to Questions 38 and 39 and the answers to the questions in the present section.

Overall, only 5 (ca. 7%) of the interviews indicated that walruses had become less abundant whereas 33 (ca. 44%) indicated that they had become more abundant. However, according to 26 (about 34%) of the interviews the situation was unchanged and 11 (ca. 15%) expressed no opinion on this matter.

About 3% of the 30 informants in Subarea 1 said that there were now fewer walruses. About ca. 27% answered that they had become more abundant. However, ca. 43% thought that there had been no change in abundance, and ca. 27% had no opinion on this matter (Table 30).

| Question 40 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Subarea | Fewer | | More | | Unchanged | | No opinion | | No answer | | |
| | N | % | N | % | N | % | N | % | N | % | N[1] |
| 1 | 1 | 3.3 | 8 | 26.7 | 13 | 43.3 | 8 | 26.7 | 0 | 0.0 | 30 (30) |
| 2 | 0 | 0.0 | 7 | 50.0 | 6 | 42.9 | 1 | 7.1 | 0 | 0.0 | 14 (14) |
| 3 | 4 | 12.9 | 18 | 58.1 | 7 | 22.6 | 2 | 6.5 | 0 | 0.0 | 31 (31) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | | | |

**Table 30.** Answers to Question 40: "Have there been any changes during the later years in abundance of walruses in areas where you are hunting them?"

Eight hunters mentioned that walruses had become more abundant. An informant from Sisimiut and one from Qeqertarsuaq explained that this was because of the quotas (*i.e.* walruses are hunted less intensively and therefore their number has increased). The informant (aged 58) from Sisimiut also speculated about the effects of changes in sea ice conditions:

> Earlier some walruses probably drowned when the sea ice was pressed together (authors' note: crushing them or preventing them from surfacing to breathe?). Nowadays they have easier access to air ("breathing holes") which leads to increased survival.

Another informant from Sisimiut and one from Ikerasaarsuk had noted that a lot of females with calves are seen nowadays. According to another informant from Qeqertarsuaq there were more walruses than ever in March 2010 west of Kingittoq, situated at the southern part of the entrance to Akulliit/Mellemfjord (69° 42' N – 54° 58' W) on the west coast of Disko Island.

A 56-year-old informant living in Attu was the only one who thought that the number of walruses had decreased. According to him:

> The areas where walruses were found previously are not used by them so much anymore. Instead there are a lot of trawlers that force the walruses out to the west. The result is that they occur farther west of the hunting grounds used earlier.

Thirteen hunters were of the opinion that the number of walruses in their hunting area in Subarea 1 was unchanged, and some of these informants offered additional explanations.

Five hunters (Maniitsoq, Sisimiut N=2, Kangaatsiaq, Aasiaat) explained that the abundance of walruses in the area depends on the ice conditions, which may change within seasons and from year to year. One of these informants (aged 46) from Sisimiut said:

> It is only a question of the sea ice conditions. During this winter (*i.e.* 2009–2010) the sea ice conditions have been good and walruses have often been observed. We observe them as soon as we go hunting. We do not have to search for them when the ice is good.

However, according to the other hunter from Sisimiut and the hunter from Aasiaat, the walrus distribution has shifted to the west. According to them, walrus numbers are probably the same but they now occur farther offshore. The informant from Kangaatsiaq who also thought the relative abundance is governed by sea ice conditions added that walruses are sensitive to trawlers and flee when they hear noise. The opinion that walruses are displaced by the activity of ships was also expressed by a 79-year-old hunter from Kangaamiut.

Other explanations were offered by hunters who found the situation unchanged. A 33-year-old informant from Ikerasaarsuk mentioned that if they were hunting walruses like previous years in January–February, they would see many more near the coast among the ice. An interviewee (aged 52) living in Kangerluk on Qeqertarsuaq/Disko Island stated that it has become more difficult to observe walruses because of the ice conditions. According to him the sea ice hardly reaches the coast anymore (authors' note: this statement probably also refers to the fact that during the hunting season which opens 1 March the sea ice retreats offshore and fewer walruses are observed close to the coast). In contrast, a 40-year-old hunter from Qeqertarsuaq said that the number of walruses has apparently increased and they occur closer to the coast.

Among the hunters who had no specific opinion about the matter was a 61-year-old from Sisimiut who said that the walruses occur closer to Sisimiut. He speculated that this is perhaps because there are more shrimp trawlers in the Attu area, which is why they see walruses more often at Sisimiut (authors' note: meaning an avoidance response to disturbance). Finally, a 66-year-old from Qeqertarsuaq who otherwise had no opinion on this subject stated like several others that the relative abundance is basically a question of the ice conditions.

None of the informants in Subarea 2 thought that the abundance of walruses in their hunting areas had decreased. Fifty percent (N=7) answered that walruses had become more abundant. However, ca. 43% (N=6) answered that there had been no change, and one (ca. 7%) had no opinion about the subject (Table 30).

Among those who had observed an increase was a 49-year-old hunter from Niaqornat who said:

> It is a question of searching for them. Walruses are associated with the sea ice and they have a good sense of smell which makes them go to other places if they are alerted. We see many at the ice edge in June when the ice is moving (authors' note: breaking up and retreating?).

A hunter living in Illorsuit said that walruses are now seen more often, but complained that the quota is used up so fast in their area so there is very little left for the hunters in Illorsuit.

In Nuussuaq/Kraulshavn in the Upernavik area, a 46-year-old informant said that he has seen more and more walruses at the shallow waters west of Nuussuaq in November when the skiffs are not as active anymore (authors' note: due to formation of sea ice and darkness). According to him more walruses are observed in large groups during fall. He also mentioned that they do not specifically search for walruses in the spring because the quota has been used, and he thought the increase in observations is due to the quotas resulting in walruses being hunted less rigorously now. The opinion that the occurrence of walruses has increased after the quota introduction was shared by a 50-year-old hunter living in Kullorsuaq.

Some of the six hunters who found the situation unchanged also commented on the situation. It was mentioned that the number of walruses varies between years according to weather conditions. In Tasiusaq a 55-year-old informant said that he does not see them in large numbers. The largest number of walruses that he has seen was at the tip of Nuussuaq/Kraulshavn in November 1989 when they were migrating south.

Four (ca. 13%) of the 31 informants in Subarea 3 thought that the abundance of walruses had decreased whereas 18 (ca. 58%) said that there had been an increase. Seven informants (ca. 23%) answered that there had been no change, and two (ca.6%) had no opinion on this matter (Table 30).

Three of the five interviewees in Savissivik thought that the abundance of walruses had decreased in this area. One said he did not know why, whereas a 71-year-old hunter mentioned that the area south of Savissivik has become an open water area and the number of walruses has therefore decreased. He added that in the "walrus areas to the west" there are always many walruses in the winter (authors' note: probably meaning west at Innaanganeq/Kap York and west and northwest of this area). A 67-year-old informant from the same settlement agreed that the decrease in local occurrence is because of the change in sea ice conditions. There is open sea almost all year round nowadays, so the walruses migrate further away from Savissivik than they did before.

In contrast, two other hunters living in Savissivik thought walruses had become more abundant. According to one of these informants the reasons were that the settlement Moriusaq became deserted and the introduction of quotas, meaning walruses were no longer hunted as rigorously. The other (aged 52 years) speculated that the increase was perhaps a result of the climate getting warmer. According to him, this makes the walruses go farther to the north because they are attracted to cold areas.

Among informants in Subarea 3, a fourth interviewee (apart from three in Savissvik) thought that the abundance had decreased (Table 30). According to this 31-year-old hunter living in Qaanaaq, fewer walruses are now observed because of the sea ice conditions. He added that there are likely plenty of walruses in January–February but they cannot see them due to the darkness.

Sixteen hunters living in parts of Subarea 3 other than Savissivik were of the opinion that the abundance of walruses had increased. Among these informants, 13 (81%) explained that they thought the abundance had increased because of the introduction of quotas. A 50-year-old informant from Qaanaaq mentioned that there were fewer walruses in the 1970s and had moved to other places. Apart from the quotas, other reasons for an increase were mentioned. In Qaanaaq a 69-year-old informant said that walruses have become more abundant because they have become better at escaping (*i.e.* avoid the hunters and get away). An informant (aged 48) from the same town pointed to the fact that the hunting pressure has also likely decreased because the number of hunters had decreased. According to him the younger hunters do not know how to hunt walruses. A hunter (aged 69) living in Siorapaluk explained that the hunting pressure on walruses has decreased because the market for walrus products has become smaller. He also added that there are plenty of walruses along eastern Ellesmere Island where they are not hunted – as also mentioned by another hunter from the village.

A 44-year-old hunter from Siorapaluk said:

> We do not know how many walruses there are in Canada in June–July. Go count them in Canada and do not assess the population size while the walruses are passing through when migrating south and north (*i.e.* in Subarea 3) (authors' note: the number of the Baffin Bay subpopulation walruses in the North Water polynya area was assessed in 2009, 2010 and 2014. See: Discussion – local abundance).

Two hunters from Qaanaaq who said that walruses have increased in abundance mentioned the effects of changing ice conditions on the movement of walruses. According to one of these informants:

> The small and younger walruses and the females with calves now arrive later. They arrive in October–November as opposed to September–October earlier. Their numbers have increased and they get closer to Qaanaaq due to the ice conditions. The pack ice comes closer and becomes denser.

The other hunter mentioned that the sea ice has become thinner and that the walruses arrive later (authors' note: probably meaning later in fall).

Some of the seven hunters who had not observed any changes also offered comments when answering the question.

A 62-year-old informant from Qaanaaq mentioned that the abundance changes from year to year:

> Not the later years but otherwise it changes from year to year. Some years there are many and some years there are fewer. In years when there are fewer it is mainly because they arrive later when it has become dark and we cannot hunt them because of the polar night.

Another hunter (aged 53) also from Qaanaaq said the walruses now arrive later because the sea ice arrives (forms) later in fall. A 63-year-old hunter from Siorapaluk was also of the opinion that there had been no change because he had seen plenty of walrus on the sea ice. He said that they occur in herds with only males and other herds with only females. He had seen this several times during spring.

## Climate and walruses (Questions 42 and 43)

Q 42: *Do climate changes influence walruses?*
Q 43: *How do climate changes affect walruses?*

In all subareas but most noticeably in Subareas 1 and 3, the hunters had observed effects of climate changes.

Overall, 44 of the 75 (ca. 59%) answers to Question 42 indicated that the walruses in West and Northwest Greenland are influenced by the ongoing climate changes. However, 14 (about 19%) of the informants thought that this was not the case, and 17 (ca. 22%) did not have an opinion about the subject (Table 31).

| Question 42 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subarea | "Yes" | | "No" | | No opinion | | No answer | | |
| | N | % | N | % | N | % | N | % | N[1] |
| 1 | 20 | 66.7 | 2 | 6.7 | 8 | 26.7 | 0 | 0.0 | 30 (30) |
| 2 | 4 | 28.6 | 7 | 50.0 | 3 | 21.4 | 0 | 0.0 | 14 (14) |
| 3 | 20 | 64.5 | 5 | 16.1 | 6 | 19.4 | 0 | 0.0 | 31 (31) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | |

**Table 31.** Answers to Question 42: "Do climate changes influence walruses?"

Several reported that the sea ice cover had decreased (the ice becoming thinner and less dense and the eastern edge of the Baffin Bay and Davis Strait pack ice (the West Ice) had become located farther from land). Furthermore, the timing of sea ice formation in fall occurs later and the break-up in spring is earlier than before. Many informants mentioned how walruses are closely associated with the drift ice and thus their distribution, appearance and disappearance in the hunting areas have also changed.

Overall: Among the 44 informants who said that climate changes have influenced walruses, 50% noted a change in walrus distribution, ca. 21% mentioned changes in arrival and disappearance of walruses in the hunting areas, and ca. 13% mentioned a combination of these effects. Furthermore, ca. 11% said that the variable and unpredictable ice conditions had influenced the hunters' ability to get to the walruses to hunt them, and ca. 5% were of the opinion that the number of walruses had increased because the reduced accessibility had reduced hunting pressure (Table 32).

Of the 20 hunters in Subarea 1 who answered that climate changes have affected the walruses, 11 living in the Maniitsoq-Aasiaat area said the sea ice in this area forms later, has become thinner and more unstable, breaks up earlier, and is generally located farther from the coast. They stressed that walruses are associated with the pack ice and as a consequence of this recent environmental change, the walruses are now distributed farther to the west and to the north.

| Question 43 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Subarea | Distribution 1 | | Timing 2 | | 1 and 2 | | Effect on hunting | | Increase in number | | |
| | | % | N | % | N | % | N | % | N | % | N[1] |
| 1 | 15 | 75.0 | 1 | 5.0 | 2 | 10.0 | 2 | 10.0 | 0 | 0.0 | 30 (20) |
| 2 | 2 | 50.0 | 0 | 0.0 | 2 | 50.0 | 0 | 0.0 | 0 | 0.0 | 14 (4) |
| 3 | 5 | 25.0 | 8 | 40.0 | 2 | 10.0 | 3 | 15.0 | 2 | 10.0 | 31 (20) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | | | |

**Table 32.** Answers to Question 43: "How do climate changes affect walruses?"

This is captured in a statement by a hunter from Maniitsoq:

> Walruses are associated with the sea ice. Now when the ice is more northerly distributed walruses are no longer seen so much west of Sisimiut. There is less sea ice now.

The change in the sea ice has also had an effect on the hunting season for walruses in that it is shorter, and the hunters must go farther offshore to hunt them. A hunter from Sisimiut said:

> Walruses are seen further west due to bad ice. The hunters hunt further away than before.

A 55-year-old informant from Attu mentioned:

> The sea ice is more fragile (*i.e.* thin and unstable) and arrives later and disappears earlier. The walrus occurs more to the west. When the sea ice was better (*i.e.* thicker and more stable and dense) they came closer to the coast.

Another hunter (aged 56) from the same town specified:

> Previously the walruses were found at 54° 16' W but now they are at 55° 16' W (authors' note: this indicates a 40–50 km displacement offshore).

In the Qeqertarsuaq/Disko Island area the sea ice conditions generally differ from those farther south (*i.e.* usually the edge of the Baffin Bay pack ice lies closer to the coast along western Disko Island than south of the entrance to Disko Bay; *e.g.* Buch 2001). Four informants living on Disko Island explained how the hunt is influenced by the changing ice conditions.

A 52-year-old hunter from Kangerluk said:

> Walruses are associated with sea ice and it is harder to find them if there is less ice.

An informant (aged 40) from Qeqertarsuaq explained:

> The changing and variable ice conditions make it difficult for the hunters to decide whether to go hunting or not.

A 49-year-old hunter from the same town speculated about the effects of different types of sea ice on the distribution of walruses and the accessibility to the sea ice, saying:

> Maybe we saw more walruses this year than ever because there was more large fields of pack ice this year. The ice was worse (close to land) so maybe that is why the hunters could get close to the places with walruses where the pack ice is.

Two hunters living in Ikerasaarsuk and Kangerluk, respectively, thought that climate change has no effect on walruses. The informant from Ikerasaarsuk explained:

> Walruses are amazing animals which can occur anywhere. However, it may become problematic if it becomes too warm and if the sea ice they are on gets too thin. But they can also haul out on land.

Among the eight informants living in Subarea 1 who were noted for having no specific opinion on the subject, four (Sisimiut, N=2, Attu, 1 and Qeqertarsuaq, N=1) nevertheless mentioned that walruses are associated with the sea ice, which has become thinner and more unstable; and furthermore the winters have become milder. The 60-year-old hunter from Attu said that:

> In the period 2004–2008 there was almost no sea ice. Most of the time we therefore saw the walruses in the water. Walruses will not live in places without sea ice.

The informant from Qeqertarsuaq (aged 66 years) speculated about fluctuations in the sea ice cover:

> The ice conditions have changed. The sea ice conditions have become worse. ... This probably happens every 30 to 40 years. Hence, the sea ice will probably come back.

A 54-year-old hunter from Attu thought that the walruses will not leave the area completely because they must stay near their food resources:

> Walruses adapt to the climate, to nature. I do not think that they will "abandon" the banks west of Attu even if the sea ice disappears. They have been eating there for so long.

Finally, a 55-year-old informant from Attu explained:

> I do not think so (*i.e.* that climate change has an effect). I have heard that even before the sea ice arrives the walruses come to the coast close to Attu and wait for the ice to arrive.

Four of the 14 interviewees (ca. 29%) in Subarea 2 thought that climate change influences the walruses. Seven (50%) did not think so, and three (ca. 21%) had no specific opinion on this matter (Table 31).

An informant (aged 46) from Niaqornat, who answered "yes" to Question 42, said that the walruses begin their migration north earlier than before because the sea ice has decreased. He also thought that their general distribution area has increased (authors' note: likely meaning that the walruses are more dispersed because the ice cover is less dense). A hunter from Illorsuit mentioned that the winds have become stronger and that nowadays it is more difficult to find the animals. The sea ice is situated farther from the coast and consequently the walruses are farther away, which makes it more difficult to hunt them. A hunter living in Upernavik Kujalleq also mentioned that the walruses occur farther offshore because the sea ice conditions closer to the coast have become bad. He added that the walruses arrive later in the season (authors' note: he did not specify whether this was in spring or fall or both).

Of the seven informants who mentioned that climate change does not have an influence on walruses, a 46-year-old from Nuussuaq explained:

> Walruses have a good sense of smell and flee easily no matter what the climatic conditions are. In the fall when the skiffs are no longer active (*i.e.* the ice has formed and has become too thick) the walruses concentrate more now than before.

Twenty of the 31 informants (ca. 65%) in Subarea 3 said that climate changes are affecting walruses, whereas five (ca. 16%) said that this is not the case, and six (ca. 19%) had no opinion (Table 31). The majority (13 of 20 answers) had noted changes to distribution and in the timing of the seasonal appearance and disappearance of walruses (Table 32).

Of the five interviewees in Savissivik, three thought that climate changes have affected the walruses in the area and two had no opinion on the matter. They said that sea ice conditions have generally worsened, there is now more open water, and the spring ice break-up now occurs earlier than before. One of these hunters, who also mentioned that the currents have become stronger, said that a consequence of all these changes is that the walruses migrate farther offshore than they did before.

Farther north in this subarea, seven informants said that the sea ice conditions have deteriorated, and the ice has become thinner and less dense. Ten interviewees said the ice forms later in fall and breaks up earlier in spring, and that this has resulted in walruses arriving later to the area in fall and leaving earlier in spring. A hunter from Qeqertat explained how they used to hunt walruses on the fast ice (*i.e.* the "thin-ice hunt") in March. This type of hunt is no longer practiced very often because the sea ice has become thinner (authors' note: the new and thin sea ice at the walrus foraging banks has become unstable and breaks up unpredictably). As an example of the fast ice instability, an informant said that in December 2009 the ice broke up and they could not hunt.

A hunter from Qaanaaq stated that the walruses are hunted in a less intensive fashion because the ice has become thinner and therefore cannot support the dog sled used for transportation to and from the hunting grounds during the period of fast ice cover. Another hunter from the same town mentioned that walruses are now father away and spend much of their time along eastern Ellesmere Island. Because hunters from Subarea 3 do not hunt them there, he thought that the population has increased.

An interviewee from Siorapaluk said that, previously, walruses would come back to the area in September, but now that the sea ice forms later they do not arrive to the hunting grounds until the end of September and in October.

According to two informants (Qaanaaq and Siorapaluk) the later formation of sea ice in fall and the generally worsened sea ice situation have had the consequence of walruses coming closer to populated areas where they were not seen earlier. The Qaanaaq and Appat/Pituffik (North Star Bay) areas were mentioned specifically.

Of the five informants in Subarea 3 who did not think that climate change has influenced walruses, two informants from Qaanaaq provided additional comments. A 43-year-old hunter said:

> The climate changes have not influenced walruses. But climate changes have influenced the hunters, the hunting periods and the hunting areas. The edge of the fast ice in the fjords has changed position and is now located more to the east, and the sea ice conditions have become worse. I mainly hunt in the fall to provide food for sled dogs but earlier I hunted a lot in the spring to get meat for humans.

When answering this question, a 69-year-old hunter provided a relatively emotional and vivid comment:

> I would like to accuse the Zoological gardens in Denmark for keeping polar bears and musk oxen in captivity. They are torturing the animals. It is getting warmer in Greenland but the walruses sleep through it all lying in all their feces on the ice.

Finally, a hunter from Qaanaaq and one from Siorapaluk who both said that they had no opinion about the question provided comments. The hunter from Qaanaaq said that the ice has become worse and there is more open sea now. According to him it has therefore become impossible to drive the dog sled to Canada in the later years (authors' note: *i.e.* across the "ice brigde" in southern Nares Strait-Kane Basin). This informant said:

> Of course walruses move farther north while the sea is getting warmer.

## Biology (Questions 44–48)

### Period of birth (Question 44)

*Have you seen newborn walruses?* (Where? When?)

By asking this question to experienced walrus hunters we wanted to explore if observations of newborns are more regular events than previously indicated by written records.

In Subarea 1 and 2, only seven (ca. 23%) and four (ca. 29%), respectively, of the interviewees said that they had seen newborn walruses. In contrast, 24 (ca. 77%) of the informants *in* Subarea 3 reported having seen newborns (Table 33).

| Question 44 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subarea | "Yes" | | "No" | | No opinion | | No answer | | |
| | N | % | N | % | N | % | N | % | N[1] |
| 1 | 7 | 23.3 | 23 | 76.7 | 0 | 0.0 | 0 | 0.0 | 30 (30) |
| 2 | 4 | 28.6 | 10 | 71.4 | 0 | 0.0 | 0 | 0.0 | 14 (14) |
| 3 | 24 | 77.4 | 7 | 22.6 | 0 | 0.0 | 0 | 0.0 | 31 (31) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | |

**Table 33.** Answers to Question 44: "Have you seen newborn walruses? Where? When?"

A newborn walrus on the back of its mother in northern Smith Sound (Subarea 3), June 2008. According to Greenlandic legislation for walrus catch, adult females accompanied with calves and young are totally protected except in Subarea 3, reflecting the particular importance of the walrus hunt in this area. Photo: M. Villum Jensen

Seven informants in Subarea 1 provided some details about their observations of newborn walruses. The earliest observation was made in March by a hunter from Attu who had seen a newborn walrus at 68° N and 56° W. Three observations were from April–May. An informant living in Maniitsoq said they had often seen ice floes with blood and "slime" (*i.e.* the afterbirth; the placenta and fetal membranes expelled from the uterus after birth) in April, and newborn walruses in April–May. A hunter from Ikerasaarsuk reported having seen a newborn at the end of April 2008 at 56° W northwest of Sisimiut, and an interviewee from Aasiaat had observed a newborn slightly west of Qeqertarsuatsiaq/Hareøen in the beginning of April 1981. According to him:

> It was both cute and ugly at the same time and looked like its mother, only without tusks.

A 55-year-old informant from Sisimiut said he had seen newborns many years ago on the walruses' offshore feeding banks, and a hunter from Attu mentioned that in the same area he had seen calves that were probably born too early. He added:

> They are so cute. Almost all black. If you want to see something really cute then it is a newborn walrus. When I was a kid we had one as a pet that we bottle-fed.

Finally, an informant (aged 33 years) from Ikerasaarsuk said he caught a newborn walrus that was swimming alone in July 2002 ("It tasted great").

In Subarea 2 four of the 14 informants had observed newborns. An informant (aged 35) from Niaqornat said that many years ago he had caught an adult female in May with a calf that still had its umbilical cord attached. Another hunter from the same village had observed a ca. 1.5 meter long suckling newborn in June. Another informant (aged 46) from Niaqornat mentioned an observation of a newborn in May 2008, whereas an interviewee (aged 51) from Upernavik Kujalleq had observed newborn walruses in April, May and June.

In Subarea 3, several informants had seen newborn walruses (Table 33).

Three hunters living in Savissivik reported sightings of newborns. A 71-year-old said they used to catch females with very small calves in June, whereas a 67-year-old hunter said:

> Back when walruses occurred closer (to Savissivik) they gave birth on the ice on their way north. I saw them often in the 1980s and 1990s on the ice in May and June still with umbilical cord. Now walruses and their newborn are seen very rarely.

However, the third informant (aged 52) from this village said that the females with newborn pass through the Savissivik area on their way north in June.

Twenty of the hunters living north of Savissivik provided details on their observations of newborn walruses and some hunters specified the months for these observations. Newborns still with an umbilical cord had been observed during May–July. However, a 30-year-old hunter from Siorapaluk said that newborns could be seen from October until spring but also that they mainly see newborns in May–June. Among 21 months mentioned 5% (N=1) was October, 29% (6) was May, 47% (10) June and 19% (4) July. This information indicates that the birth period is protracted but peaks in June.

According to four very experienced walrus hunters between 48 and 67 years of age, walruses may give birth in April–May (1), May (1), May–June (1), and June (1).

| Question 45 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subarea | "Yes" | | "No" | | No opinion | | No answer | | |
| | N | % | N | % | N | % | N | % | N[1] |
| 1 | 23 | 76.7 | 7 | 23.3 | 0 | 0.0 | 0 | 0.0 | 30 (30) |
| 2 | 9 | 64.3 | 5 | 35.7 | 0 | 0.0 | 0 | 0.0 | 14 (14) |
| 3 | 31 | 100 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 31 (31) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | |

**Table 34.** Answers to Question 45: "Do you inspect the stomach to see what the walrus has eaten?"

| Question 46 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subarea | | Bivalves[1] | Scallops | Snails | Worms | Shrimps | Fish | Seal | Other | Pebbles | Shells | N[2] |
| 1 | N | 22 | 4 | 1 | 0 | 0 | 2 | 2 | 0 | 3 | 1 | 30 (23) |
| | %[3] | 95.7 | 17.4 | 4.3 | 0.0 | 0.0 | 8.7 | 8.7 | 0.0 | 13.0 | 4.3 | |
| 2 | N | 6 | 0 | 2 | 0 | 0 | 1 | 6 | 0 | 0 | 0 | 14 (9) |
| | % | 66.7 | 0.0 | 22.1 | 0.0 | 0.0 | 11.1 | 66.7 | 0.0 | 0.0 | 0.0 | |
| 3 | N | 30 | 2[4] | 1 | 2 | 2 | 2 | 27 | 3[5] | 1 | 0 | 31 (31) |
| | % | 96.8 | 6.5 | 3.2 | 6.5 | 6.5 | 6.5 | 87.1 | 9.7 | 3.2 | 0.0 | |
| 1: Icelandic scallop, *Chlamys islandica*, is also included in this column but some hunters also mentioned scallop specifically.<br>2: N=Informants. In parentheses: Number of hunters specifying food items. Several answers included more than one group of food items.<br>3: Percentage of hunters specifying food items.<br>4: One of these informants expressed uncertainty about his identification.<br>5: Narwhal (N=2), sea urchins and sea anemones (N=1). | | | | | | | | | | | | |

**Table 35.** Answers to Question 46: "What do walruses eat?"

Of 16 hunters who mentioned the areas in which females with newborn are seen, 15 mentioned the entrance to Murchison Sound (*i.e.* W and NW of Siorapaluk) north along the coast to the Etah/Foulke Fjord-/Anoritooq/Kap Inglefield region (see also Maps 8–11). However, a 62-year-old informant from Qaanaaq said there are lots of newborns in late June and early July along eastern Ellesmere Island.

## Food (Question 45 and 46)

Q 45: *Do you inspect the stomach to see what the walrus has eaten?*

Q 46: *What do they eat?*

The vast majority of hunters (ca. 84%) in all three subareas answered that they do check the stomach contents of the walruses they catch and in Subarea 3 all the hunters replied "yes" (Table 34).

In most of the cases the informants categorized the food items found in the stomachs (Table 35).

In all subareas the majority of hunters mentioned bivalves. However, some differences among subareas became apparent. In Subarea 1 several interviewees specifically mentioned scallop (*i.e.* Icelandic scallop, *Chlamys islandica*) and pebbles. Whereas in Subareas 2 and 3, many of the informants had found remnants of seal (ringed seal and harp seal) in walrus stomachs. This was regularly observed particularly Subarea 3, where pieces of narwhal had also been seen in stomachs. Furthermore, it is remarkable that the variety of food items reported in Subarea 3 was greater than in the other two subareas (Table 35).

Some details from the hunters' observations of food items are highlighted in the following.

In Subarea 1 several of the hunters who said they find bivalves in the stomachs used the term "elongated mussels" or "*ussunngujuit*" (or "*usunngusat*"; *i.e.* "the penis-like"),

The full stomach of a freshly killed walrus lies on the ice. The hunter indulges in a pair of fresh clam "feet" which are a tasty delicacy. Photo: E.W. Born

perhaps referring to finding siphons of the common walrus food items, the sand gaper *Mya truncata*, and wrinckled rock borer, *Hiatella (Saxicava) arctica* (*cf. e.g.* Vibe 1950; Fay 1982; Born *et al.* 2003). A hunter from Qeqertarsuaq specified that he had found "*tikerusat*" (*i.e.* "index finger-like"), most likely referring to the feet of Greenland cockle, *Serripes groenlandicus* (*Cardium groenlandicum*; *cf.* Vibe 1950; Fay 1982; *i.e. foot* = a fleshy organ extending from between the bivalve's shells and used for anchoring it in the sediment). The *Serripes* foot may look like a finger. A hunter from Maniitsoq described how the stomach can be full of bivalves.

> Once we caught a female with a young. The food in the stomachs was enough to fill several buckets. There was about 20 kg of food in the mother's stomach and about 10 kg in the stomach of the young.

Some of the informants said how the fresh bivalves in the stomach are eaten as a delicacy either raw or cooked.

Two hunters had seen fish in stomachs. One of these informants who was from Ikerasaarsuk had found "*putooruttut*" (*i.e.* sand eel, *Ammodytes* sp.), while the other living in Sisimiut only mentioned having seen small fish in walrus stomachs.

Only two informants in Subarea 1 reported finding pieces of seals in stomachs. One of these hunters (aged 46) from Sisimiut, who also mentioned he had seen snails in walrus stomach contents caught at Nassuttooq/Nordre Strømfjord, added:

> I have seen (parts of) ringed seals more than once in the stomach of walruses caught west of Qeqertarsuaq/Disko Island in March–April–May. I have also observed snails and mussels together with ringed seal. I have probably seen ringed seal in the stomach of older male walruses three times.

A 46-year-old hunter from Kangerluk said:

> We caught a "*terittoq*" (*i.e.* young walrus) with 15–17 cm long tusks which had eaten "*natseq*" (*i.e.* ringed seal) including its skin. When we are hunting ringed seals we usually say that there are walruses in the area if there are no seals.

In Subarea 2 the majority of informants also reported finding bivalves in walrus stomachs (Table 35). Some reported having found "long elongated mussel (parts)" in stomachs, likely referring to siphons *Mya*. Another term mentioned was "*tikiusat*"

(*"tikiisat"*) which is the local dialect for *Serripes* feet (see previous section). A hunter (aged 51) from Upernavik Kujalleq had found *"kiliitat"* (*i.e. killuttat/kiliutat* or scallop, *Chlamys islandica*) in stomach contents. Also in this subarea did some informants mention how stomach contents consisting of fresh bivalve parts are eaten as a delicacy.

A 46-year-old hunter from Niaqornat told a remarkable story:

> We caught a walrus in February 2005 which had only gills of cod (authors' note: *i.e. Gadus* sp., perhaps Greenland cod, *G. ogac* or perhaps Atlantic cod, *G. morhua*?) in its stomach. The walrus was not thin but fat.

A relatively large fraction of the hunters in Subarea 2 had seen pieces of seals in walrus stomachs (Table 35).

A hunter from Niaqornat who answered that walruses eat different bivalve species and snails said that he once caught a walrus which:

> had eaten a whole seal. The only parts that I did not find were the head and the tail. It was a very full walrus so I just had to inspect its stomach. The seal's skin was in small triangular pieces.

An informant living in Kullorsuaq mentioned:

> The walruses are hungry when they migrate north. When at the ice edge the hunters' seal skins get stolen by the walruses (authors' note: probably referring to the situations where the skins of newly flensed ringed seals are immersed in sea water at the ice edge to let gammarids clean off the blubber). I have seen it several of times. The walruses are dangerous, hungry and aggressive when they migrate through the area.

Another hunter from the same village said:

> I collect the best *tikiisat* (*i.e.* bivalve feet) and boil them and eat them. They taste good. Sometimes we see seal in the stomachs. When the walruses migrate they eat seal. Several times we have seen a walrus with a seal between the front flippers (embraced) as if carrying a "lunchbox" (sandwich). They swim while they hold the seals with their flippers. The medium-sized walruses are aggressive when they

> migrate north. Those with approximately 10 cm long tusks attack more than other walruses.

In Subarea 3 walruses are generally hunted for a larger part of the year (*i.e.* October–June) compared to Subareas 2 and 3 (this study). Maybe this is why the hunters in Subarea 3 described a broader walrus menu (Table 35). Furthermore, the majority of informants who reported seeing stomachs with parts of seals and other marine mammals were in this subarea (Table 35).

The reported majority of bivalves as a main food item included *"imaneq"* (*i.e. Mya* sp.) and *"tikequsit"* / *"tikaasat"* (*i.e.* "index finger look-a-likes", *i.e.* feet of *Serripes*).

Many of the informants in Subarea 3 mentioned how fresh bits of mussel from the stomach are eaten either raw or boiled.

Two hunters (from Qaanaaq and Siorapaluk, respectively) mentioned scallop *"kissiviussaq"* / *"kissivaasaq"* (*Chlamys islandica*), although one expressed uncertainty about his identification. Other invertebrate food for walruses included snails, shrimp, sea urchins, sea anemones and worms living in areas with muddy sediments (Table 35).

A 50-year-old hunter told of a time they were "thin-ice hunting" for walrus in winter and had found Polar cod, *Boreogadus saida*, that apparently had been preyed upon by walrus:

> We have seen *eqalukkat tingui* (*i.e.* liver of *eqalukkat* meaning the liver of Polar cod). I have seen eqalukkat on the thin ice where only the liver was eaten. In 1979 when we went hunting (*i.e.* walking on the thin ice) in February–March and April we often saw *eqalukkat* without liver.

Twenty-seven of the informants (ca. 87%) in Subarea 3 reported having found remains of seals in walrus stomachs (Table 35). Four out of the five informants in Savissivik said that walruses on their spring migration north along the ice edge often preyed on seals. One hunter explained:

> Walruses that migrate north often have seals in their stomach. However, those that have regular eating places have *tikaasat* (*i.e.* bivalve feet) in their stomach. When walruses eat a seal they suck its skin and meat into small pieces.

Two hunters from Qaanaaq also mentioned how walruses on their migration north in June may prey on seals.

Some of the informants living north of Savissivik also told some fascinating stories about walruses eating other marine mammals.

A 69-year-old hunter from Qaanaaq told:

> On the other side of the fjord – opposite Qaanaaq – in ultimo June/July I once saw a walrus sleeping on an ice floe with its "prey": An *aataaq* (*i.e.* adult harp seal) with only the skin left. One of the elders once told that he saw a seal trying to escape from a walrus. The seal escaped onto the sea ice but the walrus followed and caught the seal on the ice. The walrus only ate the liver and a little blubber and then left the rest. Imiina Imiina from Siorapaluk told this.

A hunter (aged 63) from Siorapaluk said:

> I have twice caught a seal with wounds in the side and on the fore and back of its body. The elders say that they have been in a fight with a walrus. I have also seen narwhal mattak (skin) in walrus stomachs.

A 48-year-old informant from Qaanaaq mentioned:

> Sometimes there is seal in the stomach. I have also seen walruses that had eaten narwhal. Walruses can easily also eat humans. They can do everything.

According to a Qeqertat-based hunter who had not found seal in walrus stomachs:

> It is known that the aggressive walruses with brown tusks eat seals.

## Question 47 and 48

Q 47: *Have you noticed any changes to what the walruses are eating?*
Q 48: *In such case, which changes have you seen?*

Overall the vast majority of informants had not noticed any changes in what the walruses eat (Table 36). However, only three hunters in Subarea 3 mentioned that they had noticed a change. All three had noticed a decrease in size of the bivalves consumed by walruses.

| Question 47 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subarea | "Yes" | | "No" | | No opinion | | No answer | | |
| | N | % | N | % | N | % | N | % | N[1] |
| 1 | 0 | 0.0 | 18 | 60.0 | 11 | 36.7 | 1 | 3.3 | 30 (30) |
| 2 | 0 | 0.0 | 10 | 71.4 | 3 | 21.4 | 1 | 7.1 | 14 (14) |
| 3 | 3 | 9.7 | 27 | 87.1 | 1 | 3.2 | 0 | 0.0 | 31 (31) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | |

**Table 36.** Answers to Question 47: "Have you noticed any changes to what the walruses are eating?"

A 43-year-old informant from Qaanaaq said:

> In October 2009 we caught four walruses which had unusually small *imaneq* (*i.e.* bivalves, mainly *Mya* sp.) in their stomachs (authors' note: At Pikiuleq/Littleton Islands near Etah/Foulke Fjord according to his drawing).

A hunter (aged 48) from Siorapaluk explained:

> A change happened at the end of the 1990s or beginning of the 2000s. Earlier the walruses had large *imanerit* (pl. of bivalves; sing. *imaneq* = bivalve) in their stomachs but now they are very small. This is probably due to the low hunting pressure. Walruses come closer and therefore also eat small *imanerit*. In the 1980s when the sea ice was good they had nice big *imanerit* in their stomachs.

A third informant (aged 30) from Siorapaluk had also observed that the bivalves consumed by walruses had become smaller, but did not know when this happened.

## Recovery of tagged walruses (Question 49)

*Have you ever caught a walrus which was marked or carried a transmitter?*

Three hunters answered that they had recovered tagged walruses (Table 37). However, interestingly enough there were two (perhaps three?) reports of observations in Subarea 2 and 3 of tagged walruses that were not caught.

| Question 49 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subarea | "Yes" | | "No" | | No opinion | | No answer | | |
| | N | % | N | % | N | % | N | % | N[1] |
| 1 | 1 | 3.3 | 29 | 96.7 | 0 | 0.0 | 0 | 0.0 | 30 (30) |
| 2 | 0 | 0.0 | 17 | 100.0 | 0 | 0.0 | 0 | 0.0 | 14 (14) |
| 3 | 2 | 6.5 | 29 | 93.5 | 0 | 0.0 | 0 | 0.0 | 31 (31) |
| 1: N=Informants. In parentheses: Number of answers to this specific question. | | | | | | | | | |

**Table 37.** Answers to Question 49: "Have you ever caught a walrus which was marked or carried a transmitter?"

Without giving further details, a hunter from Maniitsoq said that he once caught a walrus with a tag and that he notified the authorities.

In Subarea 3 a hunter said he caught a walrus (with a transmitter) in 2009 and sent it to the Greenland Institute of Natural Resources. Another hunter said that many years ago he caught a walrus with a tag but could not remember if he delivered the tag or not.

In these three cases the recapture was reported and tags were delivered (Born *et al.* 1995; Dietz *et al.* 2014).

There were three reports of tagged walruses that were not shot. A hunter from Niaqornat in Subarea 2 mentioned that in 2003 (year uncertain) he saw a walrus with a satellite tag on the tusk at the tip of Nuussuaq. This walrus was together with other walruses and was not hunted. It is unclear if this is the same instance that another hunter from Niaqornat referred to. According to him, he saw a tagged walrus at Nuussuaq in 2007 and in this case as well they did not catch the walrus.

Finally, a hunter from Qaanaaq in Subarea 3 said they saw a big male walrus in October 2008. When they were about to shoot it they realized that it had a radio transmitter and they therefore did not hunt it.

## Other comments/Final statements (Question 50)

*Is there something else you would like to tell/explain?*

At the end of an interview the hunter was asked if he had other information or comments that he would like to offer. The informants were free to comment on whatever subject they wanted. The purpose was to encourage the interviewees to provide comments on matters that were not necessarily captured by the pre-determined questionnaire.

A total of 46 "summary" comments were offered (Appendix 5). A 47th informant provided his "summary" comments while drawing on a map (information no. 35, Map. 6).

Several of these comments were a recapitulation of comments offered when answering previous questions. The final comments fit into these overall categories: (1)

quotas and abundance of walruses, (2) the timing of the hunting season, (3) a potential future trophy hunting of walruses and tourism, (4) climate and walruses, 5) effects of noise, and (6) miscellaneous other comments.

The various "final" comments can be summarized as follows:

## Quotas and abundance of walruses

The majority of comments addressed the quota system and the apparent abundance of walruses (Subarea 1: 5 comments; Subarea 2: 8 and Subarea 3: 7). In Subarea 1 it was suggested to change the quota system so that there was a limit to the number of walruses that could be taken per hunter/boat. According to the informants, such a system would be more flexible than a "bulk quota system" in meeting the requirements of the local market, and would prevent a single boat (or few boats) from taking too many walruses during a single hunting trip. In Subarea 2 it was commented that the total quota for the entire area was/is too small and that the quota is already used when hunters in the northern areas get a chance to hunt walruses. For both Subarea 1 and 2 there were comments that walruses are abundant and that there have been no signs of a decrease. In Subarea 3 there were also statements about the quota for the region being too small, which among other things results in the hunters having difficulty getting enough food for their sled dogs. Furthermore, it was mentioned that the sea ice conditions had deteriorated and that walruses have changed distribution so that they now occur closer to populated places than before. There were some who also requested a quantitative assessment of the size of the walrus subpopulation in the region (see: Discussion – local abundance).

## Timing of the hunting season

Six comments addressed the timing of the hunting season (Subarea 1: 5 comments; Subarea 2: 1 comment). It was stated that the hunting season opens too late and ideally should open earlier when walruses occur closer to land. These comments were related to the fact that the sea ice conditions have changed. In Subarea 2 there was also a request for a second start date of the hunting season. Furthermore, it was mentioned that the northern part of the Upernavik area should have a separate quota because the quota for the entire region is used up early by hunters living in the southern part of the region.

## Potential walrus trophy hunting and guiding of tourists

Statements about trophy hunting for walrus or guiding tourists to see walruses were only provided by hunters in Subarea 1. Four informants from Sisimiut suggested in-

troducing walrus trophy hunting, and one living in Qeqertarsuaq said that he would be happy to guide tourists to places with walruses.

### Climate and walruses

Four comments concerned the relationship between walruses and climatic changes (Subarea 1: 2 comments, and Subarea 3: 2). In Subarea 1, an informant expressed the opinion that walruses will go elsewhere if the sea ice disappears completely, whereas another informant who did not "believe in climate changes" mentioned an observation of dead redfish (*Sebastes* sp.) at Attu in January 2000 and a "strange" current in that area in 2003–2004. Two informants living in Subarea 3 commented upon the change in distribution: Walruses are occurring closer to the coast and populated areas and arriving later to the area in fall.

### Effects of noise

According to two hunters in Subarea 1 (living in Sisimiut and Attu, respectively) fishing activity and other vessel traffic had scared walruses away from certain areas, and had generally displaced them farther west.

### Other comments

Ten comments addressed miscellaneous other subjects (Subarea 1: 2 comments, and Subarea 3: 8). In Subarea 1 there were statements about how walruses were hunted on land at the entrance to the Nassuttooq fiord at the beginning of the 20th century, and of numerous walruses that had been observed in the offshore pack ice in April 2008. In Subarea 3 there were three informants who commented on the management of walruses. It was suggested that walruses should be managed locally. Another statement was a complaint about the Greenland government's overall politics regarding hunting as a means of providing for a living. A hunter talked about a local competition between hunters with low engine powered skiffs and hunters who can go faster in skiffs with stronger engines and can get to the walrus areas first. He suggested that there should be a way to prioritize "poor" hunters with low engine powered skiffs. Three informants mentioned how walruses migrate to Canada (*i.e.* eastern Ellesmere Island) or Qissuup Nunaat/Washington Land in Greenland, and one of these hunters suggested that in fall the walruses pass Savissivik on their southward migration to the Sisimiut area. Finally, an informant commented on his specific observations of lean walruses at Kiatak/Northumberland Island in Greenland and near Apparsuit (Appauhat in the local dialect = Bache Peninsula at Buchanan Bay) on eastern Ellesmere Island, and speculated that this could be a result of local depletion of walrus food items.

# Appendix 3 – Necessity of quotas (additional comments)

Comments given by hunters in three subareas in West and Northwest Greenland when answering Question 34 (*"Are quotas necessary or unnecessary?"*).

The home town of the informant (and his age in 2010) is presented first.

## Subarea 1

### Statements by hunters who thought that quotas are necessary

Maniitsoq (54): Walruses are not that important to the hunters from Maniitsoq. We only catch walrus during narwhal and beluga hunts when we encounter the walruses coincidentally. Walrus is not a source of income for us. We would like to catch the narwhals and belugas and walruses in January/February. The size of the quota is of no importance. However, there is a wish to be allowed to catch during other months (and preferably also with a higher quota) so it becomes profitable to hunt walruses.

Sisimiut (49): On one side it is fine with quotas. The society is monitoring the status of the stock and has an interest in it ... there are questionnaires etc. (On the other side) I had hoped that walrus trophy hunting for tourists could have created a source of income. The community would get an income and the meat would be used in Greenland.

Sisimiut (61): It is fine with a quota to secure that the exploitation is sustainable.

Sisimiut (53):Regulations are necessary when talking about size of the boats that are allowed to hunt – and only for the (licensed) hunters. It is by nature difficult to hunt walrus. Or there could be a limit to the numbers taken per trip. This year a boat came back with 10 walruses from a hunt. This is regrettable and the meat was not used well. I suggest 5 animals per trip.

Sisimiut (46): Quotas are necessary but they do not have to be so small. It is important with some control. The quota is too small. Perhaps a maximum of two walruses per

hunter would be fine. The quota should be larger – and more animals in total per year but only few for each hunter. There is a lot of walruses, but it is distasteful when one hunter got 10.

Attu (55): The hunting season should be earlier than March because at that time the walruses have moved far west – far offshore. The hunting season should begin in January.

Ikerasaarsuk (33): We have to think about the future generations.

Ikerasaarsuk (52): As the sea ice conditions have become worse the walruses occur farther away (offshore).

Ikerasaarsuk (51): (Quotas are necessary) so there will not become too few (walruses). Our descendants should also be able to hunt walrus. Walruses should not be "money machines" because of their tusks.

Kangaatsiaq (47): Walruses are difficult to hunt. The most difficult time to hunt them is during March–April when the hunting season is open and it is allowed to hunt them. This is a limiting factor in itself.

Qeqertarsuaq (49): Walruses should not be hunted only for their tusks – or the like. They should be hunted for their meat and skin – also for food for the sled dogs.

Qeqertarsuaq (42): I do not like that it is not allowed to hunt walrus until 1 March. It would be better if we were allowed to hunt them from 1 January. The walruses arrive in the wintertime. Otherwise, I think that it is fine with the quotas.

Kangerluk (52): Quotas are fine and also that only licensed hunters are allowed to hunt walrus.

### Statements by hunters who thought that quotas are not necessary

Sisimiut (58): In March when the hunting season opens the quota is soon used up. Walruses are mainly seen in May when the sea 'opens' and the sea ice is melting. They are intelligent. When the sea ice melts the walruses move farther into the pack ice in the west. We do not hunt from May and onwards since the ice is melting and the walruses disappear and the hunters start fishing cod instead. The walruses are too far away (offshore) in June.

Sisimiut (55): Quotas are not necessary because the boats that are allowed to hunt walrus are so small.

Sisimiut (58): There was a massive hunt earlier when blubber was traded. Today the food habits of people have changed. They eat less walrus and therefore walruses are hunted less intensively. We only hunt when there is a (local) market for it. Quotas are not necessary nowadays.

Sisimiut (63): The sea ice sets a limit (to the hunt) in itself. The walruses are among the pack ice and they are hard enough to hunt as it is.

Sisimiut (61): After all the walruses protect themselves when they are far into the pack ice. They are difficult to hunt.

Sisimiut (63): There are not fewer walruses. They have only moved farther west. There are now more vessels – more noisy vessels – that have scared the walrus more to the west (offshore).

Attu (54): Nature itself takes care of the population. The quota is so small and we never know whether it becomes stormy during March or the sea ice becomes bad, in which case we cannot catch walruses.

Attu (56): There are more and more walruses. There are also more and more fishing vessels (trawlers) so the walruses flee far west to 55° 16' W. Earlier they were at 54° 50' W.

Attu (55): Before the introduction of quotas we did not catch many either. There is not a big market (for walrus) around Attu.

Attu (60): The trawlers now operate at (from?) 68° N which is where the walrus are and the walruses move away when the trawlers arrive. However, the walruses protect themselves and stay far away (offshore).

Aasiaat (37): Walruses are not hunted much. They are difficult to hunt under difficult sea ice conditions and hard to transport back. It is sufficient when one has got five walruses.

Aasiaat (47): Not many hunters in Aasiaat are hunting walrus. There is not a market for walrus products.

Qeqertarsuaq (66): There are not many walruses that come to Qeqertarsuaq nowadays. If there was no quota the hunters would probably not catch more. It is true that unlimited hunt makes the population decrease.

## Subarea 2

### Statements by hunters who thought that quotas are necessary

Niaqornat (35): I do not think that the hunters have ever used up their quota in Uummannaq. We combine hunting for bear and walrus and if the bear quota has been used up we do not longer hunt for walruses. Free hunting without a quota could lead to ruthless exploitation. Hence the population should be protected. Walruses are aggressive. They can sustain being hunted in the Greenlandic way.

Niaqornat (46): With a strict quota the population will increase. However, I think that if the quota is not too small – it is fine.

Illorsuit (74): The quotas are too strict. Back when "NN" caught two in 2009 the village got a letter saying that the quota was used. It would be fine if the quota could be increased a bit.

Upernavik Kujalleq (43): I think that quotas are necessary but the quota is too small. There is plenty of walrus. I have seen *so* many walrus in later years. Some females are accompanied by a large calf from the previous birth cycle as well as by a newborn. I have seen so many females with calves and many walruses.

Aappilattoq (53): The quota is too small. When the walruses arrive the local quota has already been used up. In 2010 the quota was only 4 walruses (authors' note: official quotas are presented in Table 9. 117).

Innaarsuit (44): The quota is too small. We do not see many walruses anyway.

Kullorsuaq (50): Quotas are necessary to ensure sustainable use. However, it would be good if it could be arranged so that the hunters in Kullorsuaq were allowed to hunt walruses a little later than the others (authors' note: *i.e.* farther south).

### Statements by hunters who thought that quotas are not necessary

Niaqornat (49): There is a lot of walruses (and polar bears) in large groups. It is a question of the sea ice conditions. I have seen a lot of walruses. The quotas are too strict.

Illorsuit (44): Nobody is hunting walrus ruthlessly.

Upernavik Kujalleq (51): The sea ice protects the animals. It is very difficult to catch walrus.

Upernavik (double interview: Ages 45 and 47 years, respectively): For the sake of the hunters the quotas are unnecessary. There are plenty of walruses.

Tasiusaq (55): Earlier (authors' note: *i.e.* before the introduction of quotas) we only hunted the walruses that we encountered coincidentally. We did not catch much. There is no ruthless exploitation of walrus.

Nuussuaq (46): The quotas are bad for the people that earn their living from hunting.

Kullorsuaq (63): We only catch the walruses that migrate through this area and they are not many.

## Subarea 3

### Statements by hunters who thought that quotas are necessary

Qaanaaq (46): The quota is too small and ought to be larger because we do not hunt ruthlessly and the weather already sets a limit to how much we can catch.

Qaanaaq (69): It is necessary with a quota but it is too small. It appears as if "xx" (*i.e.* the minister for fishery in 2010) does not believe the hunters. The owner of a cutter reports the catch but the other hunters do not report them (*i.e.* the crew); only the owner. The minister thinks that we catch more than 10 and do not share the catch. But on a cutter with a "crew" of five they share the catch among all five hunters that participated in the hunt.

Qaanaaq (53): The quota makes it difficult to have a dog team. The quota is too small.

Qaanaaq (43): The walruses should be counted before the quotas are set. I hear that there are many walruses and the quota is too small. In October we mainly hunt walruses to get food for our dogs.

Siorapaluk (69): Having quotas is reasonable if they were not that small.

Siorapaluk (63): The quota is too small. I have a license for two walruses now. We are not allowed to hunt in the summer either. I also know that some catch 30 walrus per year outside the quota. It was drastic to go from 200 to two walrus a year in 2006 (authors' note: probably meaning going from an unlimited catch of an average of ca. 200 walruses for the entire area to two licenses/hunter/year). Some hunters take only tusks and leave the meat behind. I have seen this happen until recently. Some hunters catch walrus outside the quota and others are punished for it.

Siorapaluk (46): The whole quota was used in 2009. Quotas are necessary but the quota should be larger because there are plenty of walrus (authors' note: apparently the quota was exceeded in 2009; Table 9).

Siorapaluk (52): Off course quotas are necessary. But there is a lot of walrus and the quota is too small.

### Statements by hunters who thought that quotas are not necessary

Savissivik (37): The quota is too strict because it is said that there are plenty of walrus on the walrus grounds. Savissivik is only at the migration route for walruses. They are not here permanently.

Savissivik (71): Savissivik is not a walrus area. Hence, we only catch those that migrate through the area. Quotas do not make sense here and are not considered necessary. Walruses are rare in Savissivik.

Savissivik (53): There are so many walruses nowadays that the quota is not necessary anymore.

Savissivik (52): The animals that we hunt have become more abundant.

Qaanaaq (53): There is no ruthless exploitation. (We hunt walruses to get) dog food, hunting tools, for our own use – it is all valuable (to us).

Qaanaaq (62): Quotas are not necessary now when only licensed hunters can hunt. Earlier when everybody could hunt walrus quotas were necessary.

Qaanaaq (31): Not here (*i.e.* quotas are not necessary here).

Siorapaluk (48): I disapprove of the quota. We use the meat for dog food and cannot afford to buy dog food in the local store.

Siorapaluk (63): It would be good if a hunter was allowed to catch only 1–2 walruses per hunting trip.

Siorapaluk (34): Walruses protect themselves. Siorapaluk is not a fishing area – this means that we hunt mostly bearded seal and walrus for dog food. We do not have so much else for dog food. Fish is too lean for dog food.

Siorapaluk (66): Walruses protect themselves because there are constantly storms coming during fall and it is dark in the winter.

Siorapaluk (59): The walrus takes care of itself.

Siorapaluk (44): There are not many hunters in Qaanaaq (*i.e.* Subarea 3) and they do not over-exploit the walrus. By the introduction of quotas the hunters were promised that it would not affect them too much. But that was not true. Nature sets a "quota" for the walrus hunt anyway. The hunters in Qaanaaq are few and do not have alternatives like for example Greenland halibut and shrimps. When the seals are moulting the hunters do not have any possibilities left for obtaining an income.

### Statement by a hunter who had no opinion about question 34

Savissivik (67): We do not live in a "walrus area". Hence I do not have an opinion about this. I have a license for two walruses for 2010 but I do not think that I will see any.

# Appendix 4 – Effects of quotas (additional comments)

Explanations given by the hunters in three subareas in West and Northwest Greenland when answering Question 35: "What effects did the introduction of quotas in 2006 have on you?"

The home town of the informant (and his age in 2010) is presented first.

## Subarea 1

### Statements by individual hunters who now catch less walruses than before

Maniitsoq (47): Now I catch less walruses per year. Now I catch only 1–2 per year.

Maniitsoq (54): I have lost income. I catch less walruses and therefore have a smaller income.

Kangaamiut (79): Last time I caught walrus was in 1985 but people in Kangamiut have not taken any walrus since 2006.

Sisimiut (58): I catch fewer. Before the 2006 quotas I caught eight walruses (per year) typically during two to three hunting trips. After 2006 I catch less because (I think) of the other hunters. There need to be some (walruses) for everybody. One time some hunters caught 10 walruses during one trip. This does not make sense since the market is too small. You learn to consider the market and pay attention to the other hunters. Too large catches mean that meat is wasted because the market is small and there are few buyers.

Sisimiut (58): I did not get part of the quota because I had a relatively small boat. With a larger vessel I am (would have been) able to hunt walrus while there is still some left of the quota.

Sisimiut (46): We have to catch other species. Because of the quota there are limits to how much we can catch. So I decided to go musk ox hunting instead. The permitted hunting period is so short and there are so few animals (in the quota). I wish for a longer hunting period and more animals (in the quota).

Sisimiut (63): It is not good. It would be better if the hunting season could be changed to January. Walruses are not over-exploited.

Attu (54): For everybody the quota has meant that in some years they do not get to taste walrus. There is only one vessel left in Attu. The hunting season should be changed from March to January like it was before since the sea ice is gone in March – moved far west. The hunting season should be when there is sea ice. In Kangaatsiaq the quota is 5 (authors' note: the quota was 8; Table 9). It should be like with caribou: Hunt in January–February and then (permission to) catch everything you can catch during this time without a quota.

Ikerasaarsuk (52): Previously I was hunting more walruses. It is harder to make a living from hunting walruses after the quota so I do not hunt them so much anymore.

Ikerasaarsuk (51): As a vessel owner I had to let the crew go because of the small quota. It does not pay to have a lot of men (crew). Accidentally we caught a small walrus in the net in December. Its tusks were approximately seven cm long.

Aasiaat (37): Problematic. It is hard just to hunt males. Not many are hunting in Aasiaat.

Qeqertarsuaq (40): The hunting season opens too late. After the introduction of quotas in 2006 we catch fewer walruses because they are already far away when the season opens in March.

Kangerluk (52): (The effects of) the change of the hunting season from January–February to 1 March has been noticeable. The hunting ground is more remote in March/April because the period with a cover of sea ice has become shorter.

## Statements by individual hunters who had not been affected by introduction of quotas

Sisimiut (61): It did not have any effect since we always hunted carefully.

Sisimiut (53): Not much. We mainly hunt to get meat for our freezers. I do not sell much. We mainly fish.

Sisimiut (63): It is mainly the sea ice (conditions) that sets a limit to the hunt.

Sisimiut (61): It was not of any significance. I do not catch fewer.

Attu (56): No importance. What matters to me are the sea ice conditions. That is what determines whether it is possible to hunt (walruses) or not.

Attu (55): No importance. We did not catch much earlier either.

Ikerasaarsuk (33): I did not feel it much (was not much affected). There are now fewer walrus hunters in Ikerasaarsuk.

Kangaatsiaq (47): I did not catch many (walruses) before the quota either.

## Subarea 2

### Statements by individual hunters who now catch fewer walruses than before

Niaqornat (49): I used to catch more walrus. Now I catch fewer.

Illorsuit (44): We would have liked to go hunting in 2006–2007 and 2008, but then the quota was already used so we did not even go walrus hunting.

Upernavik Kujalleq (51): Even though there is a lot of walrus the quota is used fast and there is no walrus left for us to hunt. I used to catch one to two walrus a year before 2006; enough for my own use. After 2006, there are some years where we do not get to hunt because the quota is already used.

Upernavik Kujalleq (43): Earlier I caught walrus every year. Now the quota is used fast and some years we do not get to hunt before the quota is used.

Upernavik (double interview: 45 and 47): A lot. Families have also been affected a lot by the reduction of food. When others have used the quota there is no walrus left for them and their families. They used to catch more walrus before 2006 – every year.

Hunters from Upernavik Kujalleq and Innaarsuit most often take the entire quota. The quota should be bigger.

Aappilattoq (53): It is noticeable when one has hunted walrus previously. Earlier I could catch three walruses during spring. Now we only observe the walruses because the quota is used up.

Innaarsuit (44): Now we just look the other way when we see a walrus and the quota is used. Before (quotas) we could catch the walruses that we encountered coincidentally. I caught more back then.

Tasiusaq (55): Yes. It had an effect. Now, when I see walrus and there is not anything left of the quota I just watch them. I caught one per year before 2006. We encounter them by chance in the spring.

Nuussuaq (46): Since the (introduction of) quotas I have not caught any walrus because the quota is used. The quota is small and is used by hunters from Upernavik town and Upernavik Kujalleq.

Kullorsuaq (63): It has affected us enormously. Now we only look at the walruses by the ice edge without being able to do anything. We do not hunt walrus anymore. Before, I hunted them every year.

Kullorsuaq (50): Prior to 2006 I caught walrus every year. Since 2006 I have not caught any because the quota has (already) been used every year.

## Statements by individual hunters who had not been affected by introduction of quotas

Niaqornat (46): None.

Illorsuit (74): None.

## Statement by a hunter who had another opinion

Niaqornat (35): The quotas have changed. Combined with bear hunting there has been an increase in hunting for walrus. However, 2006 has not changed anything for me. Now we know (the habits of) the walrus and can probably not avoid catching them every year.

## Subarea 3

### Statements by individual hunters who now catch fewer walruses than before

Savissivik (71): I have not hunted (walrus) after 2006.

Savissivik (53): I do not hunt them so much more. We can only catch one walrus now after the quota and we cannot sell the tusks anywhere anymore. I caught more before 2006. There was a possibility to trade walrus products to KNI (*i.e.* the trade company).

Savissivik (52): I caught more walrus before 2006. It is tough with the quota.

Qeqertat (34): The quotas are too much. It has been hard. You cannot hunt anything without a license and a license is something you can wait a long time for. It is tough to catch less than before. I caught more walrus before 2006.

Qaanaaq (46): Some hunters do not get a part of the quota if it is used up and therefore they do not get food for their sled dogs. Before 2006 I caught much more. The quota is way too small. It is tough for an owner of a dog team.

Qaanaaq (53): The good hunting opportunity, the chance for obtaining dog food and hunting tools is lost so we have to buy dog food in the store. I caught more before 2006. The hunting season opens when the weather has become bad. In effect the walrus hunt has been closed for people in Qeqertat after the introduction of quotas.

Qaanaaq (69): It is a problem for us sometimes. We are in lack of dog food. (I wish that) the quota could be 100 walruses in the entire Qaanaaq area minus Savissivik. I think the walruses should be counted again. There are lots of walrus in Canada and plenty of them at the islands there. Count them properly and find out how many there are.

Qaanaaq (62): It has been hard to bear. I used to catch many more walruses before 2006. It was used for dog food. I could even catch 12 walruses to ensure food for the sled dogs for the winter. We also had many more dogs back then. We now have fewer dogs after 2006. I also have fewer dogs now; also because of the weather.

Qaanaaq (31): Yes. The hunting certificate (authors' note: permission issued annually by the management authorities in Nuuk for full time licensed hunters) comes late and the (local) license (to take walrus) cannot be obtained before the certificate has arrived. I caught more walrus before 2006.

Qaanaaq (41): The sled dogs have lost food. I caught many more walruses before 2006. Therefore, I have fewer sled dogs now because dog food is more expensive to buy.

Qaanaaq (50): I am really angry because of the quotas. Due to this we have lost a lot of food for the sled dogs. I have lost dogs due to the quota because the sled dogs do not have so much to eat as before. Sometimes the dogs have to starve. I caught more walrus before 2006 and after 2006 a lot fewer. Dog food in the shop is very expensive for the hunters.

Qaanaaq (51): Of course my catch (of walrus) has decreased.

Qaanaaq (53): It has been problematic in relation to keeping sled dogs. I caught more walrus before 2006. It is not only for me it has been tough.

Qaanaaq (43): I caught more walrus before 2006. Now I catch fewer. Dog food is seen in the shop more after 2006. Before 2006 the owners of sled dogs bought walrus meat.

Siorapaluk (48): It has been tough. With regard to the dog food it has been problematic and also regarding food for our own consumption. I hunted more (walruses) before 2006.

Siorapaluk (30): There is almost nothing of the quota left for us when the weather finally becomes good enough to go hunting. The sea ice has also become so bad. I caught more before 2006.

Siorapaluk (69): I have always respected and do respect the quota. The younger do not (respect them). I caught more walruses before 2006.

Siorapaluk (48): Yes off course. I caught more walrus before 2006. I caught 50 walrus one year before 2006. I support and respect the quota.

Siorapaluk (63): (The quotas) are way too bad. In 1999 when there was good sea ice we were able to hunt on the ice in January–February. Already then before the quota the catches were decreasing due to worsening of the sea ice conditions in the 1990s. Those with small skiffs caught fewer walruses already by then. In 2006 we got punished even more with the quota and could not hunt during the summer. This is a "multiple punishment". It becomes impossible to follow the regulations. It may have consequences and lead to punishment. We thereby become "criminals". Even though Avanersuamiut (authors' note: "People of the North", an expression for people living in the area) obey the law.

Siorapaluk (34): It has affected us a lot. Now we only look at the walruses because of the tough restrictions even though we do not have a (local) game officer (*"jagtbetjent"*). I caught more before 2006 after I got my Q17 (skiff) in approximately 2000.

Siorapaluk (46): It has been tough and the quota has been used up before we can catch walrus. I caught more walrus before 2006.

Siorapaluk (59): Yes, I did catch more walruses.

Siorapaluk (44): I have really lost a lot since 2006. My income decreased with 73% after the quota. It is the narwhal hunt, fox fur, falling prizes, seal skin etc. For example, (the settlement) Moriusaq closed down (was abandoned) because of these conditions.

Siorapaluk (22): I have caught fewer after 2006.

## Statements by individual hunters who said that they had not been affected by introduction of quotas

Savissivik (37): Savissivik is not a walrus place. I did not catch many before 2006 either. We catch the ones we see. So it did not have an impact.

Savissivik (67): Nothing. The walruses visit Savissivik so rarely that it is not a question of quota here.

Qeqertat (55): Not much because I am from (live in) Qeqertat.

Siorapaluk (63): Not much. It is unchanged.

Siorapaluk (66): I am not happy with it. But it has not influenced on my hunting. I am thinking of the "real" hunters that were influenced by it. I got a pension when I was 63 and became a part time hunter. I would like to go hunting again and therefore got a "hunting license for full time hunters" in 2010.

## Statement by a hunter who expressed that he had another opinion on the matter

Qaanaaq (48): The quotas did not affect me so much. It has been tough for some.

# Appendix 5 – Additional comments

Comments offered by the hunters in three subareas in West Greenland when addressing Question 50 ("Is there something else you would like to tell/explain?").

The home town of the informant (and his age in 2010) is presented first.

## Subarea 1

### Statements by hunters about quotas and abundance of walruses

Maniitsoq (47): I wish that the walrus quota could be increased. (An increase of only) two more walruses per year. We have not noticed that there are fewer walruses now.

Sisimiut (58): The quota system makes no sense. Since walruses are hunted constantly. I suggest: Allow for example three walruses per hunter. If 10 walruses are caught (on one occasion) the market becomes saturated. The meat gets old fast. Hence in order not to waste the meat only three should be caught at a time.

Sisimiut (53): We caught only one walrus this year since the quota got used up. One boat caught five walruses without a license. The five walruses were confiscated. I disapprove of one boat catching 10 animals during one trip. The meat gets rotten and the other hunters lose their part of the quota. It could be good if there was a place to trade meat and hide. It could be distributed better in the country for selling. The skin could be used for dog food in the "dog districts".

Sisimiut (61): It seems as if there are more walruses in the later years. When we have caught what we need we just leave the walruses (in peace).

Kangaatsiaq (47): Kangaatsiaq had an agreement with KNAPK (*i.e.* the fishermen and hunters' organization) about hunting. During one hunting trip four walruses can be caught which is the same as (fulfilling) the quota in Kangaatsiaq (authors' note: the quota in 2009 for Kangaatsiaq was 7; Table 9, p. 117).

## Timing of the hunting season

Sisimiut (49): Concerning climate change: The sea ice is melting faster so the hunting season should be adjusted to the ice conditions. It should be permitted to hunt walruses earlier in the season before the sea ice melts.

Attu (55): Hunters from Sisimiut and Attu complained about the hunt not starting until March. But now they are used to it. They probably wished to eat walrus earlier in the season.

Qeqertarsuaq (49): We could catch more walruses in Qeqertarsuaq if for example the hunting season was in January. We need the walrus in Qeqertarsuaq for example. The owners of dog sleds would really like to buy walrus and Qeqertarsuarmiut (*i.e.* people living on Disko Island) also enjoy eating the meat.

Kangerluk (52): The hunting season is too late. I wish that it could be changed to January–February as it was before.

Kangerluk (46): I think that the hunting season opens too late. (It opens) when the walruses are gone. This is not good.

## Potential walrus trophy hunting and guiding of tourists

Sisimiut (49): I hope that trophy hunting of walruses can be established. The tourists often ask if walruses can be hunted as trophies. The meat will be used in Greenland and is not lost but will provide a profit.

Sisimiut (55): Walrus could be used for trophy hunt in which case the trophy hunt must be carefully monitored and controlled by game officers. And there could be guides assisting the tourists.

Sisimiut (46): My wish is that there could be walrus trophy hunting. I already arrange trophy hunting for musk ox. The millionaires ask for walrus trophy hunting. After the musk ox trophy hunt they would then be able to go on to the walrus hunt.

Qeqertarsuaq (40): I have thought a lot about bringing tourists to the places where the walruses are because scientists are always so interested and make interviews. I would like to show people from the Greenland Institute of Natural Resources the "walrus areas" while we hunt.

### Climate and walruses

Sisimiut (61): The walruses are still in their traditional places. If the sea ice continues to decrease they will probably move elsewhere. In the summer of 2009 a female was seen in open water swimming with her young. They had no ice to rest on. I have seen the photo of them but do not have it myself. Their skin was pale and whitish due to the long swim and they were exhausted.

Attu (60): I do not believe in climate change. Ultimo (ca.) January 2000 dead redfish (*Sebastes* sp.) were floating around west of Attu. After that there was not so much sea ice on our seas anymore. In 2003?–2004? there was a strange current in the sea west of Attu.

### Effects of noise

Sisimiut (63): It is not so strange that there apparently are no longer any walruses west of Nuuk. There are so many noisy vessels now that the walruses have been scared away. I do not believe the scientists who say that there are fewer walruses now. I also think that the scallop fishing vessels over-exploit the walrus food source.

Attu (56): Trawlers and other vessels scare the walrus further to the west.

### Other comments

Sisimiut (58): Our grandparents caught walruses on land, and used qajaq, and sold blubber and skin. They caught them at the entrance to Nassuttooq in November. Killed them and cached the products on the coast to pick them up next spring in April–May when the ice and snow melted and the bodies appeared again on the beach. It was provision for the spring period. The meat was not rotten due to the cold. They had no freezers then. My grandparent lived in Aqissermiormiut (abandoned in 1969) at Attu.

Ikerasaarsuk (51): I regret that I did not have a camera with me when we were in the pack ice in April 2008. There were so many walrus and they smelled. The walruses did not care about the hunters going around them in boats. Once we saw a small ice floe with 30 walruses on it and they smelled. There were lots of males. And their feces was greenish and stank.

## Subarea 2

During eight of the interviews in this subarea, comments were offered relating to the quota system and abundance.

## Statements by hunters about quotas and abundance of walruses

Niaqornat (35): The walrus quota is too strict. I can accept quotas but it is hard to accept quotas that strict. A slightly larger quota would be acceptable. When we hunt walrus they are found in great numbers.

Illorsuit (74): The quota is too strict in comparison with how many walruses we see. The quota always gets used up before we get a chance. We now see more walruses.

Illorsuit (44): The quota is not satisfying. There are only four walruses for the Upernavik area (authors' note: the quota was 5 for this area; Table 9). When the season opens all will fight to become the first to catch walrus because we love to eat walrus. In later years it happens that some do not even get a chance to taste walrus because the quota is used. This year we went hunting just as the season opened but did not get a walrus before the quota was used by others. It is very annoying.

Upernavik Kujalleq (51): With these quotas it is like the history about the reindeer (caribou; *Rangifer tarandus*) in the south where the biologists did not believe the hunters. In the end it turned out that there were plenty of reindeer. I also think that there are lots of walruses now which reproduce these years when the quota is that small. Sometimes it seems like there is a majority of small walruses and calves – and we are not permitted to hunt them, and we do not. What is the consequence? There will be more and more walruses. It is also said in southern areas in Greenland – the Sisimuit area – that there are more and more walruses there. So I think we are right.

Upernavik Kujalleq (43): Quotas are probably not necessary this far north. Make limitations and regulations so that only full time hunters are allowed to catch walrus. Increase the quota in a way that does not affect the population in a negative way.

Upernavik (45 and 47): The number of walruses is unchanged. It would be super if the quota could be increased with 2–3 animals. In Aappilattoq when the ice breaks up before the quota is used they barely reach to catch some of walruses before the quota has been fulfilled for the year.

Tasiusaq (55): It is tough now that we cannot hunt walruses because the people south of here use up the entire quota.

Nuussuaq (46): The quota is too small. The people in Kullorsuaq do not hunt walruses much anyway. But we would like to get a chance to eat the meat and use the tusks and

the bones. We need the whole walrus. Hungry walruses may also attack hunters when they pick up the the seals that they have caught at the ice edge. They are aggressive and dangerous but cannot be hunted. That is frustrating.

### Timing of the hunting season

Kullorsuaq (63): In Kullorsuaq the sea ice breaks up later than at the more southern settlements. It is therefore wrong that Kullorsuaq is part of the same quota as those settlements. We would like to have another starting day for the hunting season so that we get a chance to hunt walrus. We also need walruses.

## Subarea 3

### Statements about quotas and abundance

Qaanaaq (46): The quota is too small. The quota is used up before some hunters even can get their share of it. Even though I support and respect the quotas I think that it is too small. The walrus population is increasing so it would be responsible to increase the quota.

Qaanaaq (53): There are not fewer walruses now, but the ice conditions have become worse. If anyone says the opposite it is not true. It is the sea ice that has become worse. Therefore quotas are not necessary. Here we only hunt walruses for our own use and to provide food for our dogs. We do not overexploit the walruses. There are no trade possibilities; neither for skin nor tusks or meat. The Inughuit ("people of Avanersuaq") can administer their hunt on their own.

Qaanaaq (62): The quota is not good or useful for the hunters because the hunters in Qaanaaq are so few and they can regulate the catch themselves. I wish for an "open" (*i.e.* not restricted by a quota) hunt only for full time hunters using the regulations we have in Qaanaaq. For example, permit hunting only in May.

Siorapaluk (48): Now when walruses are not hunted so much they move closer to the settlements in the fall. I see many walrus on the drift ice in winter.

Siorapaluk (46): Revisit the quotas and the quota in the fall. Count the hunters. Increase the quota a little. The climate is changing. Walruses are increasing in numbers and they are anyway difficult to hunt.

Siorapaluk (59): Since quotas were introduced we have had severe problems getting enough dog food even though we hunt all the time. I am not a full time hunter but have hunted with the full time hunters to help them.

Siorapaluk (44): Quotas have shortcomings. Count the walrus where they are for one or two months in Canada. Do not count them while they are migrating. If they are counted properly the quota will be increased. Nature already puts a limit to the hunting pressure.

## Climate and walruses

Qaanaaq (53): Walruses are more often observed close to Qaanaaq (town) in November.

Siorapaluk (52): The sea ice arrives later in fall nowadays and it appears as if the walruses have come closer (authors' note: to the coast and populated areas).

## Other comments

Savissivik (67): [This hunter told stories about many walruses seen at the island Igannaq a little north of Kap York in 2009 and 2010; Map 6].

Savissivik (52): We Greenlanders should make the regulations for the catch ourselves and not let other countries decide. We protect our hunting animals ourselves. We use the qajaq when we hunt.

Qeqertat (34): The hunters have been hit by the effects of quota and the climate change. The Greenland government says that the hunters should have labor jobs and wants to get rid of hunters. Unemployment is increasing while the hunters are having a hard time.

Qaanaaq (69): In the winter ca. 1965 I noticed that the walruses had become thinner in April when there was *sassat* (*i.e.* narwhals trapped in a hole in the fast ice) at Kiatak/Northumberland Ø. When we hunted polar bears at Apparsuit (*i.e.* in Buchanan Bay) on eastern Ellesmere Island we saw walruses with a very thin layer of blubber and they were very weak. This was probably because their food was scarce where they were. This was in May or in the beginning of April at the end of the 1960s.

Qaanaaq (31): When we hunt in the north (*i.e.* north of Ullersuaq/Kap Alexander) we see how the walruses move north to Canada. They escape to Canada (*i.e.* eastern Ellesmere Island).

Qaanaaq (50): The walruses migrate to Canada on the drift ice and there are really many walruses that move north. I have seen them on the drift ice in large groups. They migrate from Savissivik towards Canada.

Siorapaluk (48): Regarding the hunters who use skiffs the quota gets used by those having the fastest skiffs. Skiffs with 100 HP catch the entire quota. The "poor" hunters with 40 HP do not get a share of the quota because it is already used up. Skiff owners with engines with less power should have priority.

Siorapaluk (66): The walruses migrate north in April–May along the coast to the northern areas. I have heard that they wintered at Nuussuaq (*i.e.* Kap Calhoun/Qissuup Nunaat/Washington Land). I once saw them migrate past Etah all day and night. They were very many. In the autumn they move along the coast of Canada to the south. I think that they migrate to the coast in the Sisimiut area – passing by Savissivik.

# Authors

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This volume presents the results of an interview survey among Greenland subsistence hunters on walruses and the catch of walruses in West and Northwest Greenland, where the catch of walruses is still an important part of the traditional subsistence hunting culture.

The Greenland walrus hunting grounds have experienced marked environmental changes due to climate change and quotas were introduced for the catch across all of Greenland in 2006. Thus, by setting out to explore how these changes have affected the local communities, the authors have interviewed seventy-six experienced walrus hunters living in twenty-two settlements and towns along the ca. 1,700 km coast from Maniitsoq in the south to Siorapaluk in the north, yielding a wealth of detailed information about how climate changes and introduction of quotas have affected walruses and walrus hunting practice.

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