NAMMCO

Report of the NAMMCO Scientific Committee Working Group on Walrus

Greenland Representation
Copenhagen 23-25 October 2018

The NAMMCO Scientific Committee Working Group on Walrus met at the Greenland Representation in Copenhagen on 23-25 October 2018. The Working Group was convened by Mads Peter Heide-Jørgensen (Greenland, NAMMCO Scientific Committee) and Geneviève Desportes (NAMMCO Secretariat) and chaired by Robert Stewart (Canada, Invited Expert). A list of participants is contained in Appendix 1.

1 OPENING REMARKS

General Secretary Geneviève Desportes welcomed the delegates to the meeting on behalf of NAMMCO. Walrus has been a species of interest for NAMMCO since the beginning as it is a food resources for many Greenlandic communities both in West and East Greenland. Currently there are 3 stocks of walrus recognised in Greenland - Baffin Bay (BB), West Greenland-Southeast Baffin Islands (WGSBI) and East Greenland (EG), the two first being shared with Canada (BB and WGSBI). Therefore, she underlined how pleased NAMMCO was to welcome again representatives for Canada, indeed two at this meeting, Mike Hammill and Cory Matthews (DFO), as well as for the first time a representative from Nunavut, David Lee (NTI). NAMMCO was also pleased to note that the Canadian catch statistics, which have been difficult to obtain in the past, were presented to the Walrus Working Group (WWG) and thanked Canada for this. The last walrus assessments dated from 2013 (SC/25/14-WWG/FI01), with the assessment of the BB stock being updated in 2015 (SC/25/14-WWG/FI02).

The task of this meeting was to update the assessment of the three Greenlandic stocks, looking at new information on stock structure, life history parameters, catch statistics and abundance and trends. It was also to consider the impact of non-hunting human activities.

Chair Robert Stewart welcomed the participants to the 2018 Walrus Working Group meeting. After a presentation round, he reminded the participants of the ToRs of this meeting. The WWG should address two specific requests for advice from the Council of NAMMCO, as well as three active requests, as indicated below.

Specific Requests:

R-2.6.7: *provide assessments of, and advice on sustainable removals from, all stocks of walrus in Greenland covering the period from 2019 to 2023, with the advice for Qaanaaq starting in 2021.*

R-1.5.4: *advise on the best process to investigate the effects of non-hunting related anthropogenic stressors on marine mammal populations, including the cumulative impacts of global warming, by-catch, pollution and disturbance.*

Active Requests to be followed up:

R-2.6.3: *provide advice of the effects of human disturbance, including fishing and shipping activities, in particular scallop fishing, on the distribution, behaviour and conservation status of walrus in West Greenland.*

R-1.6.4: *provide advice on the best methods for collection of the desired statistics on losses*

R-1.6.5: *struck and lost rates should be subtracted from future advice on sustainable removals in Greenland, with the advice being given as total allowable landings.*

Regarding R-2.6.3, the SC 24 asked the WWG to discuss whether there was any new information to answer the request. The Disturbance Symposium held in 2015 provided some information, however the SC agreed to keep this request ongoing and to ask the WWG for further advice on this issue.

Regarding R-1.6.4, the SC agreed at its last meeting (SC 24, 2017) to ask the Working Groups to indicate when more reliable struck and lost (S&L) were a priority for improving assessments and would make the most significant difference in terms of quota allocation, so the collection of S&L data could be prioritised for these hunts. The Working Groups should then give recommendations on how to better obtain S&L data for the targeted hunts.

The WWG was therefore asked to specify for which walrus hunts, the collection of S&L data would significantly improve the reliability and precision of the assessment and to advise on the best way of collecting these S&L data.

2 ADOPTION OF AGENDA

The draft agenda (Appendix 2) was adopted without changes. The Chair specified that sub-headings under 9 were nor subheadings per se but more guidelines for the discussion.

3 APPOINTMENT OF RAPPORTEURS

Sam Smith (Intern) and Geneviève Desportes from the NAMMCO Secretariat were appointed as rapporteurs, with the help of participants when needed.

4 REVIEW OF AVAILABLE DOCUMENTS

Documents available for the meeting are listed in Appendix 3.

5 STOCK STRUCTURE

The Chair noted that no working documents concerning stock structure had been submitted to this meeting. Heide-Jørgensen presented document SC/25/14-WWG/FI15, which represented the final and published version of a document presented to the 2015 meeting of the NAMMCO Scientific Committee for the update of the BB stock. The findings were subsequently discussed.

Paper's abstract (ARCTIC, VOL. 70, NO. 3. P. 308 – 318)

Fifty of 58 walruses (*Odobenus rosmarus rosmarus*) instrumented with satellite-linked transmitters in four areas in eastern Smith Sound, Northwest Greenland, during May and June of 2010 – 13 and 2015 provided data for this study. These animals departed from the feeding banks along the Greenland coast in June – July (average 14th June), simultaneously with the disappearance of sea ice from these areas. Most of them moved to Canadian waters in western Smith Sound. The most frequently used summering grounds were along the coasts of Ellesmere Island: on the eastern coast, the area around Alexandra Fiord, Buchanan Bay, and Flagler Bay (west of Kane Basin) and Talbot Inlet farther south, and on the southern coast, Craig Harbour. This distribution of tagged walruses is consistent with prior understanding of walrus movements in summer. In addition, however, nine tracks of these tagged animals entered western Jones Sound and four entered the Penny Strait-Lancaster Sound area, crossing two putative stock boundaries. Since these 13 tracks were made by 12 animals, one walrus entered both areas. It is possible that some of the tracked walruses used terrestrial haul-out sites in the largely ice-free areas of Jones Sound and Lancaster Sound for short periods during the summer, though this cannot be confirmed with certainty. The return migration from western Smith Sound to the wintering area in eastern Smith Sound takes place in October. The tracked walrus showed high affinity to coastal areas, while walruses moving between Greenland and Canada also used offshore

areas in Smith Sound. This study demonstrates that the walrus population that winters along the north western coast of Greenland is shared more widely in Canada than previously thought and should be managed accordingly.

Discussion

There has been some debate as to whether walrus should be managed as multiple stocks within the high arctic. The paper showed that some walruses tagged in Baffin Bay (BB stock) moved further west into Canadian waters during summer than previously thought. Some animals wintering in Canada one year can be wintering in Greenland the following year. The stocks hunted in Greenland may be therefore also available for hunting in Canada to four communities, Grise fjord, Pond Inlet, Arctic Bay (Admiralty Inlet) and Resolute Bay.

Although there was some discussion as to how much mixing can be assumed from the movements of a relatively small number of individuals, it was also recognised that they represented a substantial proportion of the total number of tagged walrus and that the chance of detecting an animal moving very far west should be low unless these movements are fairly common. Therefore, the WWG agreed that there is not enough counter evidence to suggest discrete sub-stocks for high arctic walrus.

Therefore, the WWG **agreed** that the most precautionary approach was to consider a single Baffin Bay Management Unit, irrespective of stock boundaries, and that catches from the four Canadian communities should therefore be added to the Greenland catches when performing the assessment. Currently, removals in Canada are considered when generating advice for management of Greenlandic hunts.

While catches can be summed, abundance surveys in the two countries cannot be combined since walruses spent summer in Canada but winter in both Canada and Greenland. Greenlandic surveys in Baffin Bay are conducted in the winter, while Canadian Surveys are conducted in the summer. Winter surveys in Greenland cannot be added to Canadian numbers because they would be counted twice. Winter surveys in Greenland include only part of the population that is surveyed in Canada in the summer. It is not known if walruses from Greenland return each fall or if some individuals spend winter in Canada and/or some individuals that had wintered in Canada the previous year subsequently move to Greenland.

It was noted that there have been historic inconsistencies in the naming of stocks shared between Canadian and Western Greenland. There was a request to maintain stock names consistency, at least within NAMMCO, although there must be room for flexibility if further research challenges the stock boundaries. The WWG **agreed** to keep the following names for the Greenlandic stocks: Baffin Bay (BB), West Greenland-Southeast Baffin Island (WGSBI) and East Greenland (EG).

The existence of shared stocks between Canada and Greenland leads to a restating of the fact that a precautionary approach to management must be maintained given the absence of official joint-management of the populations. The WWG **recommended** that the possibility of joint-management process for shared stocks of walrus should be evaluated by Greenland and Canada.

6 LIFE HISTORY PARAMETERS

The WWG acknowledged that there was no new life history data that would inform recommendations and catch data.

7 CATCH STATISTICS

7.1 Reported Catch

7.1.1 Greenland

Garde presented SC/25/14-WWG04 on catch statistics and age structure of the three populations of walrus in Greenland. Since 1993, two hunting reporting systems have been introduced in Greenland. The first was Piniarneq (1993–2012) and the current system, Særmeldeskema (English: "special scheme") (2007 - 2018[1]). The catch data in Piniarneq are largely considered incomplete for the period of 2007-2012, when the Særmeldeskema was introduced. Information on the catch recorded in both reporting systems is provided by the hunters. The Særmeldeskema is filled out by hunters for hunted species subject to quota regulation.

Author's summary

There are three populations of Atlantic walrus (*Odobenus rosmarus rosmarus*) in Greenland: Baffin Bay, West Greenland-Southeast Baffin Island and East Greenland. Here, we present catch data and age structures, based on tusk lengths, for all three populations.

Since 1993, catches of walruses has been considerably reduced in the Qaanaaq area in North Greenland (Baffin Bay population) and also reduced in Upernavik in Northwest Greenland (West Greenland-Southeastern Baffin Island population). In the period 2007–2018, the overall catch trend in West Greenland has been slightly increasing. This is mainly due to increased catches at Store Hellefiske Bank, which account for most of the catches (68%; n = 372) while, catches at the localities West of Disko Island (9%; n = 48) and Upernavik (24%; n = 130) have been fairly constant or even slightly decreasing. In East Greenland, most catches are taken by hunters in Ittoqqortoormiit (82%; n = 63) and only a few are taken further south in the Tasiilaq area (0–3 year^{-1}). Overall in East Greenland catches have been fairly constant since 2007 with a mean of ~6 walrus year^{-1}. October is the month when most walruses are caught in the Qaanaaq area, while catches peak between March and May in West Greenland and May to June and August in East Greenland.

Throughout the years, more males than females have been caught with at ~2/3 of the catches being males in North and West Greenland while in East Greenland 90% of catches are males. In Qaanaaq, walruses in the catch are between 0 and more than 30 years with the majority being between 4 and 14 years. In West Greenland walruses are between 0 and 25 years, with most catches between 4 and 13 years and in East Greenland walruses are between 5 and 25 years with most in the ranges 9–11 and 18–21 years. Ages of walruses in the three populations were estimated using regression lines based on data on age from GLGs in walrus teeth and length of tusks from Born and Kristensen (GINR unpublished data). In the Qaanaaq area, 185 females that had age estimated were adult (=sexually mature) and of these 34 were pregnant (based on information from the hunt on 'presence of a foetus' in the reporting system Særmeldeskema) and also had an age estimate based on tusk length. This means that 18,4% of females from the Baffin Bay population were noted as having a fetus. This information was not available for the two other populations.

Discussion

The catch data for Baffin Bay shows a decreasing trend until the introduction of quotas. After 2007, the catch stabilises (SC/25/14-WWG04 - Fig. 2).

[1] Data from 2018 is preliminary as it covers the period from January to the end of September

For West Greenland-Southeast Baffin Island catch data were presented subdivided into three localities (Store Hellefiske Bank, West of Disko Island, and Upernavik). The WWG suggested that the catch data be pooled to cover the whole of this population and quotas were to be shown. This was subsequently done and presented for the WWG as SC/25/14-WWG04b.

It should be noted that for the hunts in West Greenland and East Greenland (not the Qaanaaq area), females with calves are not supposed to be taken. Further, in West Greenland the higher fraction of females in the catch data may be due to the hunt taking place during mating season. At this time, there is less segregation of the sexes, and therefore an increased likelihood that a female will be mistaken for a male.

The WWG commented on the apparent cyclical nature of the age distribution in BB and WGSBI within the catches from all populations. The discussion centred on the plausibility of this signal; whether it was due to synchronicity by part of the population within the 2-year reproductive cycle, or due to errors in the estimated age. A possible source of errors is the rounding error when measuring the tusks. It was also noted that the teeth of older animals were increasingly worn, yet this would not likely result in error for 7 or 8-year-old animals.

The WWG considered the importance of age structure data in each stock analysis (Section 9).

7.1.2 Canada

Matthews presented SC/25/14-WWG08 compiling catch data for Nunavut and Nunavik.

Author's summary

Atlantic walrus (*Odobenus rosmarus rosmarus*) occur throughout the eastern Canadian Arctic from southern Hudson Bay to northern Baffin Bay, where they are traditionally hunted by Inuit. Walrus are also hunted by non-Inuit in limited sport hunts. In Canada, walrus hunts are comanaged by Fisheries and Oceans Canada (DFO), the Nunavut Wildlife Management Board (NWMB), the Nunavik Marine Regional Wildlife Board (NMRWB), regional wildlife organisations, and local hunters and trappers organisations according to the Fisheries Act and the Nunavut Agreement. A small number of Nunavut communities (4 of 25) have annual quotas in place; in those that do not, regulations stipulate that individual Inuit may take up to four walruses annually. Some communities allow limited sports hunts in which a number of the walrus allotted to communities or individuals are transferred to non-Inuit hunters. Nunavik communities do not impose quotas, and sports hunts are rare. Inuit hunt statistics are reported by hunters to local hunters and trappers organisations and then relayed to DFO, while sport hunters are required as part of the licensing process to provide information to DFO directly. We present annual hunt statistics for Nunavut (from 1997-2017) and Nunavik (1994-2017) communities that hunt walrus from the two populations that occupy the eastern Canadian Arctic. These numbers do not include animals that were struck and lost. Annual hunt statistics were not reported for a large number of communities, which poses a challenge for effective management dependent on accurate records of removals relative to population abundance.

Discussion

The WWG thanked Canada for the catch data, while also noting that there are gaps in the catch history.

The WWG noted that the reliance on self-reporting of catch data in Canada, results in gaps in the catch history for individual hunters and communities. This will hamper management initiatives, particularly when some communities do not supply data at all. The WWG **encourages** Canada to take action to provide more complete catch data.

The WG also noted that there is a scheme already in place using biological samples provided by hunters to test for the presence of *Trichinella* in walrus meat. The program has support within the communities. The samples provided could also be used to inform catch statistics, with the agreement of the communities. However, it was noted that this will not be a complete accounting as walrus taken for meat to be given to dogs is not sent for testing. A similar scheme was in place in Greenland but has been discontinued.

Table 1. Catch statistics for Atlantic walrus compiled from both Greenlandic and Canadian sources.

Year	Fiscal Year**	Baffin Bay (CA)	Qaanaaq Area	Grise Fjord	West Greenland (CA)	West Greenland	Qikiqtarjuaq	Clyde River	Iqaluit	Pangnirtung	East Greenland
1993			265	12		241	0	0	29	0	15
1994			156	24		270	5	0	26	40	10
1995			128	5		265	16	0	25	8	11
1996			122	8		176	0	1	9	2	7
1997	1997/1998	12	74	12	19	155	3	0	0	16	1
1998	1998/1999	14*	72	11	32	139	0	1	27	4	7
1999	1999/2000	8	101	5	18	184	0	0	15	3	10
2000	2000/2001	11	126	4	34	196	0	0	19	15	7
2001	2001/2002	7*	171	2	28	162	1	1	7	19	10
2002	2002/2003	4	147	3	43	150	33	0	1	9	34
2003	2003/2004	14	160	7	17	113	1	0	1	15	11
2004	2004/2005	10	90	5	2*	100	0	2	NR	NR	4
2005	2005/2006	4*	78	2	10*	158	NR	NR	10	NR	16
2006	2006/2007	5	67	5	34*	73	9	1	9	15	5
2007	2007/2008	6	80	4	17*	43	6	0	11	NR	10
2008	2008/2009	0*	66	NR	10*	28	NR	NR	NR	10	9
2009	2009/2010	9*	90	7	24*	33	NR	NR	14	NR	4
2010	2010/2011	9	60	2	20*	40	6	NR	14	NR	7
2011	2011/2012	9	42	4	19*	50	5	0	14	NR	5
2012	2012/2013	2*	76	NA	36	34	NA	NA	NA	NA	4
2013	2013/2014	0	62	NA	6	NA	NA	NA	NA	NA	NA
	2014/2015	17			7						
	2015/2016	2			21*						
	2016/2017	1			39						

*Totals are incomplete because some communities did not report subsistence and/or sport hunt statistics for that year.

**Canadian hunt statistics span calendar years as data is compiled for fiscal years running from April to March

7.2 Struck and Lost

The NAMMCO SC has repeatedly recommended that catch statistics include data for struck and lost (S&L) animals for different seasons, areas, and catch operations and the WWG was therefore requested to provide advice on the best method for collecting them for the different types of hunt. The SC 24 has also noted that better S&L rate data may not always be the priority parameter for improving assessments, given the difficulty of obtaining such data. However, given the importance of identifying S&L rates for some hunts more than others, it was **agreed** that one way forward was to direct WGs to indicate when more reliable S&L were a priority for improving the assessment and would make the most significant difference in terms of quota allocation, so the collection of S&L data could be prioritised for these hunts. (SC 24, 5.3.1)

Accordingly, the WWG discussed at length the benefits expected from getting accurate reports of S&L animals. There are many problems with S&L reporting, both through self-reporting and through the use of independent observers. The WWG **agreed** that much of the error associated with underreported S&L may be offset by regular population surveys. Although the WWG acknowledges that improved S&L data would improve the accuracy of the models used, it also agreed that in some cases assessment models are somewhat insensitive to variation in S&L rates. Without the exact data on S&L the assessment models compensate through the adjustment of abundance and population growth parameters as discussed in section 9. The models' estimates of total removals in the one example considered showed little sensitivity to changes in S&L rates but better accuracy of losses would influence the advice on landed catches and provide more accurate accounting of removals.

The WWG discussed ways of getting better S&L data from the hunters. Noting that the benefit of getting more accurate S&L rates was similar for walrus, narwhal and beluga harvests, the WWG **recommended** that managers engage in a dialog with the hunters to find the best way of collecting the data. As full actors in the project planning, the hunters would be able to help determine the method with the least intrusion in to their hunting practices and more willing to contribute data as a result.

The WWG discussed a method to improve S&L reporting in Greenland, and **recommended** that strikes and losses be reported in the Særmeldeskema, the current system for reporting catches.

Considering the likely difficulties and cost involved in getting a reliable, observed, S&L rate, the WWG **agreed** that the cost-benefit of an independent S&L observer program did not make it a priority.

8 ABUNDANCE AND TRENDS

Heide-Jørgensen presented (SC/25/14-WWG05). This paper discussed the distribution of walrus around Store Hellefiske Bank with respect to changing sea ice coverage in Western Greenland.

Author's summary

Aerial surveys of the occurrence and abundance of walrus in late winter in West Greenland have been conducted at irregular intervals since 1981. We constructed a time series of walrus positions and sighting rates from the surveys covering the same area in West Greenland. Annual catches of walrus since 1952 and positions of catches after 2006 were compiled and satellite-based sensing of sea ice was used to estimate sea ice extension in eastern Baffin Bay after 1978. There was a general decline in sea ice concentration from 1952 through 2017 with large variability in the period after 1982 and a minimum concentration in 2005 and 2006. The mean western position of the walruses on the banks did not vary with the sea ice concentration indicating that the walrus chose the same winter-feeding area even in years where there was a major lack of sea ice that could be used for haul-out. The coastal area along West Greenland (<10 km from shore) previously had several terrestrial haul-out sites used by walruses during fall, but we found no tendency in neither sightings nor catch reporting of walrus within the coastal area. All catches were taken in spring and nothing suggests that the walruses are presently using their abandoned terrestrial haul-outs. The relative abundance of walrus, indicated as sightings per linear kilometre, showed an increasing trend in abundance from 1981 through 2017 ($p=0.06$).

Discussion

This paper found that, regardless of ice coverage, walrus largely remained within the same longitude range for the period studied. This suggested that they had a strong affinity for the feeding area, regardless of ice extent. Furthermore, many of the historic terrestrial haul-out sites had been abandoned, suggesting a preference for ice and less affinity for land. Interestingly, the year with the lowest sea ice coverage, 2006, corresponded to the westernmost average sightings of walrus.

The WWG noted that these findings indicated that there was still sufficient ice cover within or adjacent to the feeding area. However, the WWG speculated that there may be a threshold of ice coverage below which, the ice is insufficient or too distant from the feeding area, and the population declines or relocates to land haul outs. A change in abundance or distribution could reduce the number of walrus available to hunters.

The WWG **recommended** that the relationship between the present findings, and hunting and non-hunting impacts be explored. Non-hunting impacts on Atlantic Walrus are discussed in Section 10, and Store Hellefiske Bank, as an important foraging area for walrus, was noted as an area that should be monitored for detrimental anthropogenic disturbance.

The WWG **stressed** the general importance of shallow waters as feeding areas for walrus.

Hansen presented SC/25/14-WWG 06 and SC/25/14-WWG07.

Author's summary SC/25/14-WWG 06

An aerial survey covering the eastern part of the North Water/Smith Sound area was conducted in April 2018 with the purpose of generating an abundance estimate that is compatible with a survey in 2014. A total of 74 observations of 26 groups of walrus detected in water and 48 groups hauled out on the ice were collected allowing for Distance Sampling analysis. Pooling these data with observations from two aerial surveys conducted in East Greenland 2017 with the same observer crew (3/4) increased the number of walrus groups detected in water to 40 and to 56 groups hauled out on ice in NW Greenland. The abundance of walrus on ice was 447 (cv=0.35; 95% CI= 223-893) and the abundance in the water was 832 (cv=0.16; 95% CI= 613-1130). The total abundance of walrus on both ice and in water was 1279 (cv=0.16, 95% CI= 938-1744) individuals. This is lower than a previous estimate from 2014 and the main difference seems to be the larger extent of fast ice in 2018 that prevented the walrus from entering some of their traditional feeding grounds in the shallow coastal areas, i.e. Wolstenholme Fiord. The shallow water habitat that was available for walrus in 2018 was smaller than in 2014 for the same area of Northwest Greenland. In 2014 the fiord was not completely ice-covered, and more observations were made of walrus in water. Since the' walrus in water' part of the estimate is corrected for availability at the surface (factor 2.74), this part-estimate has a large impact on the total estimate depending on the proportion of walrus seen in water.

Author's summary SC/25/14-WWG07

A subpopulation of Atlantic walrus (*Odobenus rosmarus rosmarus*) is found in East Greenland. This population is hunted for subsistence purpose in two communities in Southeast Greenland, but it has its main distribution in Northeast Greenland (north of 73°N). An aerial survey was conducted in August 2017. Due to the low number of observations (n=10), observations from two aerial surveys conducted in winter in the Northeast Water in 2017 and in the North Water in 2018 with the same observer crew was added. This increased the number of walrus groups available for strengthening the detection function and perception bias. The summer survey of the Northeast Water provided a fully corrected estimate of 177 walrus (cv=0.18, 95% CI 124-252) walrus. A second aerial survey of the shallow areas of the Greenland Sea along the coast of Greenland provided only two walrus sightings and no abundance estimates were developed from this effort. Surveys of walrus at their terrestrial haul-out sites in August 2017 revealed that 3 out of 26 known haul-out sites were used by walrus and one new haul-out site was discovered. Assuming random movement, the average number of walrus present on each haul-out site was used. One option for correcting the number present at the haul-out sites is to use an estimate from satellite tagged walrus from 2009 where ~40% of the walrus on land were present at any time of the counts, increasing the number of walrus at the terrestrial haul-outs to 102 walruses (cv=0.17). Adding this estimate to the line transect survey in the Northeast Water gives a total abundance in Northeast Greenland in 2017 of 279 walrus (cv=0.11, 95% CI 226-345). A reanalysis of a walrus survey conducted in East Greenland in August 2009 gave a fully corrected abundance estimate of 559 (cv=0.23, 95% CI:357-875) walrus, which is lower than previous estimates of 1429 (cv=0.45, 90% CI 705-2896). None of the surveys covered all the haul-out sites simultaneous with offshore areas and correction factors for undetected walrus seems inadequate for both surveys. Both abundance estimates are likely negatively biased due to survey coverage and correction factors.

Discussion:

There was a greater sea ice extent in 2018 than in 2014 in West Greenland, which was exemplified by a greater proportion of walrus observed in the water in the first survey. The correction factor applied to observations of walrus in the water would therefore have a greater, and perhaps disproportionate, impact upon final abundance estimates. Furthermore, walrus' feeding grounds in Wolstenholme Fjord were more accessible in 2014, increasing the number of walrus observed in this area.

The WWG suggested that more covariates such as sea ice characteristics could be incorporated into the detection function, however noting that the small data set may preclude a significant improvement of the results.

With few observations of walrus obtained by the survey in East Greenland, the WWG agreed that the data from all three surveys be pooled together for calculating a common detection probability, as the same methods (observers, protocols, planes) were used on all surveys. Then walrus abundance should be calculated per area using this common detection probability, using a Chapman estimator within a strip transect when sample size is too low. There was also some discussion on the best truncation distance for walrus in water and, considering the plots of perpendicular distances, the WWG agreed that a truncation distance of between 100m and 500m should be used. Hansen carried out the modifications recommended by the WWG and produced SC/25/14-WWG06b. The final abundance estimate endorsed by the WWG for the three surveys are presented in Table 2 below.

Averaging counts of walrus at haul-outs within and among sites could be a better method of estimating total number than using a maximum number of animals that are hauled-out. This could compensate for variation in haul-out behaviour at each site and is amenable for adjustment by average attendance data. This reanalysis was completed (SC/25/14-WWG07b).

Table 2. Atlantic walrus abundance estimates from aerial surveys conducted in the Northeast Water (NEW) and North Water (NOW).

	Abundance estimate (cv)		
	NEW Summer 2017	**NEW Summer 2009**	**NOW Winter 2018**
Walrus in water	142 (0.17)	147 (0.68)	832 (0.16)
Walrus on ice	35 (0.59)	260 (0.30)	447 (0.35)
Walrus terrestrial haul out	102 (0.17)	152 (0.17)	
Total	**279 (0.11)**	**559 (0.23)**	**1279 (0.16)**

9 ASSESSMENT BY STOCKS

Witting Presented SC/25/14-WWG09-rev, SC/25/14-WWG10, SC/25/14-WWG11-rev and SC/25/14-WWG12-rev[2]

9.1 Assessments

The assessments for walrus in Baffin Bay, West Greenland/Southeast Baffin Island, and East Greenland were updated with new data. A new abundance estimate, and data on the age-structure of walruses caught in Greenland from 2007 to 2018, were available for all areas. In previous assessments

[2] Working Papers 09, 11, and 12 were subject to revisions after discussion during the meeting. Current versions reflect changes made to the model priors as recommended by the WWG.

there was only a rather old (from 1987 to 1991) age-structure for Baffin Bay, so the data for this assessment were significantly improved for all areas.

Not only the data, but also the priors, were improved for all areas. Most of the priors were uniform in the past. These were changed to semi-informative priors with a humped beta distribution around an expected value for adult survival (expected 0.97; range 0.95 to 0.99) and the age of reproduction (expected 7 years; range 5 to 9). The birth rate was fixed at an expected maximum value of 0.5, with a uniform prior on age-class zero survival (from 50% to 100% of adult survival) capturing the joint uncertainty on the two parameters. This reduced the total number of parameter estimates for each model by one.

One of the estimated parameters is the proportion of hunted animals that are struck and lost. A field study in 1977/78 estimated loss rates up to 25% above landed catch for 34 hunts in the Qaanaaq area with a total of 112 landed animals (Born *et al*., 1995). More recent estimates by hunters indicate much lower loss rates, and therefore all assessments used a uniform prior from 5% to 25% above landed catch on the loss rate.

All models were age-structured with an even sex ratio. While the real catches are known to be male biased, this choice was made to avoid potential interactions between the sex ratio and growth rate that would be difficult to interpret. The current dynamics of the three stocks were approximated by exponential and density regulated models, in order to have at least two independent estimates to compare for each stock.

Baffin Bay, SC/25/14-WWG09-rev

Walrus in Baffin Bay are harvested in the Qaanaaq area in Northwest Greenland, and in Western Jones Sound, Penny Strait and Lancaster Sound in Canada.

The fit of the models to the new and an older age-structure shows an underrepresentation of animals younger than seven to ten years, in agreement with a hunt that takes mainly adult animals. The estimated selectivity is steep and convex, characteristic of strong selection even against animals that are almost but not yet fully grown.

An overall decline in the Baffin Bay stock is unclear due to incomplete catch histories, but both the exponential and density regulated model estimated a decline from 1960 to about 2007, and an increasing population thereafter. This reflect a decline in the annual catches from about 150 from 1999 to 2003, to about 80 from 2004 to 2008. Both models show a clear updating of the current growth rate to an average estimate of 6.6% (90% CI:5.7% - 7.8%) in the absence of catches.

West Greenland-Southeast Baffin Islands, SC/25/14-WWG10

This assessment assumes that walruses off West Greenland and Southeast Baffin Island comprise a single stock, with the production of the whole population supporting the hunt in both areas. The stock is harvested in West Greenland up to and including Upernavik, and along Southeast Baffin Island in Canada, including Clyde River, Qikiqtarjuaq, Pangnirtung and Iqaluit.

The fit to the age-structure showed a linear under-representation of animals younger than nine years, in agreement with a hunt that takes mainly adult animals. The age-structure generated growth rate estimates that were higher than the expected plausible range, and it was considered precautionary to adopt models with no age-structured data. These updated the current annual growth rate to an average estimate of 6.3% (90% CI:3.7% - 9.1%) in the absence of harvest, and they estimated a small increase in abundance from 1977 to 1994, followed by a decline to 2007, and an increase thereafter; in direct response to changes in the annual catches.

West Greenland, SC/25/14-WWG11-rev

This assessment is the precautionary version for West Greenland/Southeast Baffin Island walrus. It assumes that walruses that overwinter in West Greenland are a well-define sub-component of a larger joint population off West Greenland and Southeast Baffin Island. It is the West Greenland component that supports the harvest in West Greenland, and this component is also exploited off Southeast Baffin Island. The Canadian catches from the two stock-components are determined by their relative abundance, with 49% of the catches in Clyde River, Qikiqtarjuaq, Pangnirtung and Iqaluit being taken from the West Greenland component.

The fit to the age-structure showed a linear under-representation of animals younger than nine years, in agreement with a hunt that takes mainly adult animals. The age-structure generated growth rate estimates that were higher than the expected plausible range, and it was considered precautionary to adopt models with no age-structured data. These updated the current annual growth rate to an average estimate of 7.2% (90% CI:4.9% - 9.4%) in the absence of harvest, and they estimated a small increase in abundance from 1977 to 1994, followed by a decline to 2007, and an increase thereafter; in direct response to changes in the annual catches.

East Greenland, SC/25/14-WWG12-rev

Walrus in East Greenland are harvested around Tasiilaq and Ittoqqortoormiit, where 90% of the takes are of adult males, while females and calves are found further to the North, especially in the Northeast Water.

The fit of the model to the age-structure is rather rough, but it shows an under-representation of animals younger than about 10 years, in agreement with a hunt that takes mainly adult animals. The estimated selectivity appears to be steep and convex, as expected for strong selection even against animals that are almost but not yet fully grown.

In agreement with the earlier assessment for East Greenland, the density-regulated model estimates a stable or slightly increasing population that is close to carrying capacity (depletion ratio of 95%). The current abundance is estimated at 540 (90% CI:300 - 1600) animals, with an estimated annual growth rate of 1.7% (90% CI:0.5% - 5.7%), assuming no catches.

Discussion

The two assessment models for West Greenland differed in the absolute abundance estimates that were used to calibrate the index surveys: SC/25/14-WWG10 used a single abundance estimate from Baffin Island in 2007 of 2500 walrus and SC/25/14-WWG11-rev used three estimates from West Greenland, averaging 1217 walrus. The estimate from East Baffin is more than twice the average of the three West Greenland surveys and occurred in summer when the survey area is thought to include animals from other stocks. The estimates from West Greenland are from surveys during the spring when the animals are near the hunting grounds in Greenland. Thus, the WWG determined that the assessment in SC/25/14-WWG11-rev should be used. The WWG also noted that the mixture of stocks in East Baffin likely varies from year to year and that further data on the distribution and mixture of stocks in the survey area would be required to use East Baffin survey results.

Several of the population models include an age-structure from animals that were landed. The additional information provided by these data help the models estimate parameters and population trajectories. For the Baffin Bay and the East Greenland populations, it is therefore recommended to include the age-structure of the catch in the assessments when feasible. However, for West Greenland, models with age-structured data (SC/25/14-WWG11-rev) estimates substantially higher growth rates than the versions without age information. The West Greenland model is also heavily influenced by the last survey index in the time series, which drives the population trajectory upwards and interacts with the age structure, resulting in growth rates that are above what is supported by the literature. The influence of this abundance index was reduced by the use of an additional variance parameter, but there is no such option for the age-structure data at this time. Incorporating uncertainty around the age-structure will likely improve all models, but until this option is available, it is precautionary to not include it for West Greenland.

Assessment models with density-regulated growth provide a more realistic representation of population dynamics but require more data to be reliable and involve estimation of additional parameters which can result in additional uncertainty. At low population levels (high depletion), there is little difference between the five-year projections of exponential and density regulated versions of the model and therefore little incentive to use the latter. However, for populations near to or greater than the MSYN, density-dependent mechanisms act upon population dynamics and slow down their growth rate. In that case, the advice generated by the exponential models could lead to unsustainable harvest levels. It is for this reason that the WWG has **recommended** using the density-regulated models in the management advice.

Since all the walrus hunts in Greenland take predominantly males, the WWG considered that sex-specific models might be beneficial. The present modelling assumes an equal removal of males and females, yet the populations might tolerate a slightly larger take of males. This is especially true for East Greenland where 90% of the catches are males, with females and juveniles found predominately in the North, where there is no hunt. The East Greenland hunt may therefore have little effect on the growth of the population. The WWG **recommended** that the applicability of using two-sex models for walrus populations be investigated.

9.2 Management recommendations

9.2.1 Sustainable harvest levels

Baffin Bay

It is estimated that there is a 70% chance of increase in Baffin Bay walruses after 5 years with a total annual removal of 94 individuals (Table 3). With an estimated struck and lost rate of 12% and an assumed annual Canadian catch of 5 individuals (based on the average from 2012 to 2016), this results in a recommended annual catch (landed animals) of no more than 84 walruses, with 79 being caught in Greenland.

Table 3. The estimated probability of an increasing stock after 5 years for a total removal between 79 and 103 walruses from Baffin Bay. Based on the density-regulated model with age-data.

Removal	79	82	85	88	91	94	97	100	103
Probability	0.95	0.93	0.89	0.83	0.76	0.70	0.60	0.49	0.43

West Greenland – Southeast Baffin Island

For this recommendation, the WWG makes the precautionary assumption that walruses that summer off Southeast Baffin Island and winter off West Greenland might be a subcomponent of the whole West Greenland – Southeast Baffin Island population. A 70% chance of increase in the subcomponent after 5 years is estimated for a total annual removal of 97 walruses (Table 4). With an estimated struck and lost rate of 13% and an assumed annual Canadian catch of 12 individuals from the subcomponent (based on the average from 2012 to 2016), this results in a recommended annual catch (landed animals) of no more than 86 walruses, with 74 being caught in West Greenland.

Table 4. The estimated probability of an increasing stock after 5 years for a total removal between 72 and 112 walruses from the West Greenland components of the West Greenland – Southeast Baffin Island stock. Based on the density-regulated model with no age-data.

Removal	72	77	82	87	92	97	102	107	112
Probability	0.89	0.86	0.83	0.78	0.74	0.70	0.64	0.59	0.54

East Greenland

Relating to a sustainable catch of walruses in East Greenland, it is worth noting that the geographical segregation of individuals is providing a large degree of self-protection against overexploitation. Females and juveniles are found predominately in the North where these is no hunt, while animals around Tasiilaq and Ittoqqortoormiit are predominantly adult males, with about 90% of the catches being males. For these reasons the East Greenland stock is of least concern of the three walrus populations in Greenland.

Notwithstanding this geographical degree of self-protection, the WWG estimates and recommends a sustainable level of takes. A revised estimate of the 2009 survey was presented (old estimate: N=1429; 95% CI: 705-2896; New: N=559; 95% CI: 357-875), and the revised numbers changed the assessment of the stock compared to the last assessment in 2013.

The preferred assessment model estimates a 70% chance of an increasing stock after 5 years for an annual total removal of 19 individuals (Table 5), with a struck and lost rate of 14%. This results in a recommended annual catch (landed animals) of no more than 17 walruses.

Table 5. With a population that is estimated to be close to the carrying capacity, the inferred management objective is an increase for depletion levels below the maximum sustainable yield level (MSYL), and a total removal below 90% of the maximum sustainable yield for depletions above MSYL. The estimated probability of fulfilling the objective after 5 years is shown for a total removal of 17 to 22 walruses in East Greenland. Based on the density-regulated model with age-data.

Removal	17	18	19	20	21	22
Probability	0.83	0.77	0.73	0.67	0.64	0.59

9.2.2 Carryover of quotas to new period

NAMMCO 21 (2012) requested the SC to investigate the possibility to include a carryover for quotas in order to include this possibility in the next hearing for the new quota block period. At its following meeting, the SC (SC 20, 2013) concluded, on the basis of the conclusion of the WWG (Nov 2013), that there is no biological argument against carryover of unused quotas within an assessment period. A problem arises if carryovers accumulate over time and/or across assessments. Carrying over within an assessment period was implemented in Greenland in 2014.

The WWG **agreed** that no new information has been presented that would counter the use of carry-over quotas for Atlantic Walrus. The WWG did not see any reasons to changes its conclusion from 2013.

10 NON-HUNTING HUMAN IMPACTS

The WWG had two requests to consider.

R-1.5.4*: advise on the best process to investigate the effects of non-hunting related anthropogenic stressors on marine mammal populations, including the cumulative impacts of global warming, by-catch, pollution and disturbance.*
R-2.6.3*: provide advice of the effects of human disturbance, including fishing and shipping activities, in particular scallop fishing, on the distribution, behaviour and conservation status of walrus in West Greenland.*

The Disturbance Symposium held in 2015 provided some information in relation to both requests, however the SC asked the WWG for further advice in relation to non-hunting human impacts.

There were no working documents tabled to address R-1.5.4 but document SC/25/14-WWG/FI18 was considered. The WWG **agreed** with the SC report in its identification of shipping, seismic exploration, fisheries interactions and tourism as major stressors on walrus populations. It added to that list habitat destruction through direct mining activities which will not only disturb walrus by the mining activities but also by the destruction of the banks that support walrus food populations (bivalves) through the sucking and release of sand and sediment, loss of ice habitat from shipping and climate change and ballast water discharge which may alter the water chemistry over feeding areas.

Two projects were particularly of concerns. First is the Black Sand Mining operation in the Northern Waters area, near Qaanaaq (Bluejay mining project). The sand extraction is both land-based and offshore based at depth going to 10-20m, i.e., few hundred meters offshore. The disturbance will be both direct on the walrus but also indirect but disturbing/destroying the bivalve community, which is the food resource for the walrus, through sand sucking on the banks where the walrus feed. Ships will be present year-round. The Baffin Land or Mary River Project was the second large extraction project of concerns, with shipping all year across the walrus banks. Summer shipping is not the major problem for the walrus, but winter shipping in the pack ice is very problematic for walrus. Also, the construction of a railway to Steensby Inlet and a port by the Baffinland Iron Ore Mary River Project is currently being reviewed by the Nunavut Impact Review Board. If permitted, this is expected to generate increased shipping activity through Hudson Strait.

Environmental Impact Assessments (EIAs) are presently conducted on a national basis, are sometimes project specific (local), and do not consider cross border impact. This is in agreement with document SC/25/14-WWG/FI18, in which EIAs are noted for the lack of transboundary concerns. The lack of broad-scale assessment was a cause of great concern to the WWG. Document SC/25/14-WWG/FI18 concluded that the best process to investigate the effects of non-hunting stressors on walrus populations is to officially facilitate and encourage international studies and meetings directed at answering the specific information gaps associated with specific projects, in a manner that makes the results applicable to other projects.

The WWG noted that there is an agreement between The Kingdom of Denmark and Canada for cooperation in the marine environment (Treaty no. E101887 http://www.treaty-accord.gc.ca/text-texte.aspx?id=101887). The agreement covers pollution (which extends to sound pollution), vessel traffic, and compensation in respect of damage to the marine environment. It also encourages scientific cooperation between nations in the form of joint research programmes and marine resource management. The WWG views the shared stocks of walrus as a good opportunity to apply the terms of the treaty. The WWG **recommended** increased bi-lateral cooperation between Canada and Denmark/Greenland in agreement with the treaty (for example, see articles VI & VII).

The WWG also **endorsed** the common thread in "Knowledge Gaps" identified in document SC/25/14-WWG/FI18 inasmuch as detection and quantification of effects are poorly known. Filling those knowledge gaps requires a broader expertise encompassing many specialties such as acoustics, behaviour, bivalve biology, ice and climate dynamics, to be able to identify the impacts on bivalves and other ecosystem components which in turn will affect walrus. The development of these activities, by displacing the walrus from feeding areas, may also affect the availability of the walrus to the hunters.

11 RECOMMENDATIONS

11.1 Review of past recommendations

The WWG reviewed shortly the responses to the recommendations made by the 2013 WWG, which were subsequently adopted by the NAMMCO Scientific Committee and forwarded to the Management Committees.

The 2013 WWG **recommends** that:

- New estimates of sex and age structure of the catch for West Greenland are obtained. The sex determination that is reported by the hunters should be validated using genetics.

Response: this was not carried out. The 2018 WWG recommended replacing this recommendation with **SC/2018/*WWG2018/GL/RR1 and GL/RR3*** below under point 11.2.

- The fraction of the catches and abundances in Canada that belong to the West Greenland/Baffin Island population are clarified.

Response: This proportion was not clarified per se, but the 2018 WWG used catches scaled to the relative ratio of abundance estimates.

- Complete catch statistics from Canada are collated.

Response: the as complete as possible Canadian walrus statistics were collated and presented to this meeting. There are still missing data, but these older data will likely not become available. The 2018 WWG recommended replacing this recommendation **SC/2018/*WWG2018/GL/OR2*** below under point 11.2**.**

- Reliable reports of struck and lost are obtained for the entire range of the stocks in Greenland and Canada.

Response: there was no progress with this request and the 2018 WWG recommended replacing this recommendation with **SC/2018/*WWG2018/GL/OR1*** below under point 11.2**.**

- Regular abundance estimates (5-10 years) from Baffin Bay, West Greenland, and the southeast coast of Baffin Island are obtained.

Response: several new abundance estimates have been obtained. The 2018 WWG recommended replacing this recommendation with **SC/2018/*WWG2018/ALL/RR2*** below under point 11.2.

11.2 Recommendations for research

The recommendations listed were expressed during the meeting (copied from the body of the report, as indicated by the reference to the agenda point) or further formulated by the WWG, when, on the basis of the assumptions underlying the current assessments, it agreed that further research would support the use of these assumptions.

Recommendations are not listed in order of priority but following their appearance in the text of the report.

SC/2018/*WWG2018/All/RR1* – Improve information on stock structure and seasonal movements of walruses between summering grounds in East Canada and wintering grounds in West Greenland.

SC/2018/*WWG2018/All/RR2* – Maintain regular schedule of surveys of all Greenlandic stocks, ideally coordinated and synchronised with Canadian surveys in the same areas.

SC/2018/*WWG2018/All/RR3* – Explore the relationship between the present findings, and hunting and non-hunting impacts [See Agenda point 9.1].

SC/2018/*WWG2018/GL/RR1* – Update age-tusk relationships for all walrus populations in Greenland.

SC/2018/*WWG2018/GL/RR2* – Incorporate uncertainty around the age structures into the assessment models.

SC/2018/*WWG2018/GL/RR3* – Investigate the applicability of using two-sex models for walrus populations [See Agenda point 9.1].

11.3 Other recommendations

SC/2018/*WWG2018/ALL/OR1* – The possibility of joint-management process for shared stocks of walrus should be evaluated by Greenland and Canada [See Agenda point 5].

SC/2018/*WWG2018/ALL/OR2* – Canada was encouraged to take action to continue provide more complete catch data [See Agenda point 7.1.2].

SC/2018/*WWG2018/GL/OR1* – A dialog between managers and hunters should be established in order to discuss the best method of recovering struck and lost data [See Agenda point 8].

SC/2018/*WWG2018/GL/OR2* – In Greenland, struck and lost individuals should be reported in the Særmeldeskema [See Agenda point 7.2].

SC/2018/*WWG2018/GL/OR3* – Bi-lateral cooperation between Canada and Denmark/Greenland in agreement with the bilateral treaty regarding activities that affects resources in the other country, Treaty no. E101887. The shared stocks of walrus represent a good opportunity to apply the treaty (for example, see articles VI & VII) [See Agenda point 10].

12 OTHER BUSINESS

There was no other business.

13 ADOPTION OF REPORT

Report was provisionally adopted by the WWG on 25 October 2018, 18:00, pending editorial revisions. The final report was adopted by correspondence on 7 November 2018, 16:00.

The Chair thanked everyone for their contribution and the re-running of some of the analysis during the meeting, and the in-depth discussions. He also thanked the rapporteurs for their work. Desportes thanked everyone on behalf of NAMMCO, and the chair for his able chairing of the meeting. Special thanks went to Sam Smith, intern at the Secretariat, for his great contribution to the reporting.

Appendix 1

NAMMCO SCIENTIFIC COMMITTEE
WORKING GROUP ON WALRUS
23-25 October 2018
Greenland representation, Copenhagen

AGENDA

1. OPENING REMARKS

2. ADOPTION OF AGENDA

3. APPOINTMENT OF RAPPORTEURS

4. REVIEW OF AVAILABLE DOCUMENTS

5. STOCK STRUCTURE

6. LIFE HISTORY PARAMETERS

7. CATCH STATISTICS
7.1 Reported catch
7.2 Struck and lost (R-1.6.4)

8. ABUNDANCE AND TRENDS

9. ASSESSMENT BY STOCK (R-2.6.7, R-1.6.5)
9.1 Present status
9.2 Management recommendations
9.2.1 Sustainable harvest levels
9.2.2 Carryover of quotas to new period

10. NON-HUNTING HUMAN IMPACTS (R-1.5.4, R-2.6.3)

11. RECOMMENDATIONS FOR RESEARCH

12. OTHER BUSINESS

13. ADOPTION OF REPORT

Appendix 2

NAMMCO SCIENTIFIC COMMITTEE
WORKING GROUP ON WALRUS
23-25 October 2018
Greenland Representation, Copenhagen

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Appendix 3

NAMMCO SCIENTIFIC COMMITTEE
WORKING GROUP ON WALRUS
23-25 October 2018
Greenland Representation, Copenhagen

LIST OF DOCUMENTS

MEETING DOCUMENTS

Doc. No.	**Title**	**Agenda item**
SC/25/14-WWG/01	Draft Agenda	2
SC/25/14-WWG/02	Draft List of Participants	1
SC/25/14-WWG/03	Draft List of Documents	4
SC/25/14-WWG/04	Garde, E. *et al.*, Catch Statistics and age structures for Atlantic walrus in Greenland 1993 to 2018	7
SC/25/14-WWG/04b	Garde, E., Updates to Working Paper 04	7
SC/25/14-WWG/05	Heide-Jørgensen, M.P. *et al.*, The ice recedes but the walrus just stay.	8
SC/25/14-WWG/06	Hansen, R. & Heide-Jørgensen, M.P., Abundance of walrus in the North Water 2018.	8
SC/25/14-WWG/06b	Hansen, R., Recalculations for North Water Survey 2018	8
SC/25/14-WWG/07	Hansen, R. *et al.*, Current and past abundance of walrus in East Greenland.	8
SC/25/14-WWG/07b	Hansen, R., Recalculations for Summer Survey in East Greenland	8
SC/25/14-WWG/08	Matthews, C. *et al.*, Hunt statistics for walrus (*Odobenus rosmarus rosmarus*) in Canada from 1994-2017.	7
SC/25/14-WWG/09-rev	Witting, L., Assessment of Baffin Bay (North Water) walrus - 2018	9
SC/25/14-WWG/10	Witting, L., Assessment of West Greenland East Baffin walrus - 2018	9
SC/25/14-WWG/11-rev	Witting, L., Assessment of West Greenland walrus - 2018	9
SC/25/14-WWG/12-rev	Witting, L., Assessment of East Greenland walrus - 2018	9

*Working Papers 09, 11, and 12 were subject to revisions after discussion during the meeting. Current versions reflect changes made to the model priors as recommended by the WWG.

FOR INFORMATION DOCUMENTS

Doc. No.	Title	Agenda item
SC/25/14-WWG/FI01	Report of the 2013 Walrus Working Group meeting	4, many
SC/25/14-WWG/FI02	Extract of the SC22 (2015) report – 7.7. Walrus, including assessment of Baffin Bay stock	4, many
SC/25/14-WWG/FI03	Higdon, J.W., and D.B. Stewart. 2018. State of circumpolar walrus (*Odobenus rosmarus*) populations. Prepared by Higdon Wildlife Consulting and Arctic Biological Consultants, Winnipeg, MB for WWF Arctic Programme, Ottawa, ON.	, many
SC/25/14-WWG/FI04	Shadbolt, T., Arnbom, T. and Cooper, E.W.T. 2014. *Hauling Out: International Trade and Management of Walrus.* TRAFFIC and WWF-Canada. Vancouver, B.C.	4, many
SC/25/14-WWG/FI05	Gotfredsen, A. B., Appelt, M., & Hastrup, K. (2018). Walrus history around the North Water: Human–animal relations in a long-term perspective. *Ambio*, *47*(S2), 193–212. https://doi.org/10.1007/s13280-018-1027-x	4, many
SC/25/14-WWG/FI06	Haug, T., Bogstad, B., Chierici, M., Gjøsæter, H., Hallfredsson, E.H., Høines, Å.S., Hoel, A.H., Ingvaldsen, R.B., Jørgensen, L.L., Knutsen, T. and Loeng, H., 2017. Future harvest of living resources in the Arctic Ocean north of the Nordic and Barents Seas: a review of possibilities and constraints. *Fisheries research*, *188*, pp.38-57.	4, many
SC/25/14-WWG/FI07	Ølberg, R.A., Kovacs, K.M., Bertelsen, M.F., Semenova, V. and Lydersen, C., 2017. Short Duration Immobilization of Atlantic walrus (*Odobenus rosmarus rosmarus*) with etorphine, and reversal with Naltrexone. *Journal of Zoo and Wildlife Medicine*, *48*(4), pp.972-978.	4
SC/25/14-WWG/FI08	Lindqvist, C., Roy, T., Lydersen, C., Kovacs, K.M., Aars, J., Wiig, Ø. and Bachmann, L., 2016. Genetic diversity of historical Atlantic walruses (*Odobenus rosmarus rosmarus*) from Bjørnøya and Håøya (Tusenøyane), Svalbard, Norway. *BMC research notes*, *9*(1), p.112.	4,5,8
SC/25/14-WWG/FI09	Kovacs, K.M., Aars, J. and Lydersen, C., 2014. Walruses recovering after 60+ years of protection in Svalbard, Norway. *Polar Research*, *33*(1), p.26034.	4,5,8
SC/25/14-WWG/FI10	Andersen, A.O., Heide-Jørgensen, M.P. and Flora, J., 2018. Is sustainable resource utilisation a relevant concept in Avanersuaq? The walrus case. *Ambio*, *47*(2), pp.265-280.	4
SC/25/14-WWG/FI11	Wiig, Ø., Born, E.W. and Stewart, R.E., 2014. Management of Atlantic walrus (*Odobenus rosmarus rosmarus*) in the arctic Atlantic. *NAMMCO Scientific Publications*, *9*, pp.315-341.	4,5,8,9

SC/25/14-WWG/FI12	Andersen, L.W., Jacobsen, M.W., Lydersen, C., Semenova, V., Boltunov, A., Born, E.W., Wiig, Ø. and Kovacs, K.M., 2017. Walruses (*Odobenus rosmarus rosmarus*) in the Pechora Sea in the context of contemporary population structure of Northeast Atlantic walruses. *Biological Journal of the Linnean Society*, *122*(4), pp.897-915.	4,5
SC/25/14-WWG/FI13	Ugarte, F. 2015. Third standing non-detriment findings for exports from Greenland of products derived from Atlantic walrus (*Odobenus rosmarus rosmarus*). Greenland Institute of Natural Resources, CITES Scientific Authority Greenland, 1 July 2015. Letter to the Ministry of Domestic Affairs, Nature and Environment, Nuuk, Greenland. J. nr. 40.00.01.01.45-1/14: 7 pp.	4, many
SC/25/14-WWG/FI14	Kovacs, K.M., 2016. *Odobenus rosmarus ssp. rosmarus*. The IUCN Red List of Threatened Species 2016: e. T15108A66992323.	4, many
SC/25/14-WWG/FI15	Heide-Jørgensen, M.P., Flora, J., Andersen, A.O., Stewart, R.E., Nielsen, N.H. and Hansen, R.G., 2017. Walrus Movements in Smith Sound: A Canada-Greenland Shared Stock. *Arctic*, *70*(3).	4,5,6
SC/25/14-WWG/FI16	Garde, E., Jung-Madsen, S., Ditlevsen, S., Hansen, R.G., Zinglersen, K.B. and Heide-Jørgensen, M.P., 2018. Diving behavior of the Atlantic walrus in high Arctic Greenland and Canada. *Journal of Experimental Marine Biology and Ecology*, *500*, pp.89-99.	4
SC/25/14-WWG/FI17	Stewart, R.E. and Stewart, B.E., 2005. Comparison of between-tooth age estimates of Atlantic walrus (*Odobenus rosmarus rosmarus*). *Marine mammal science*, *21*(2), pp.346-354.	5,6
SC/25/14-WWG/FI18	NAMMCO Impacts of Human Disturbance on Arctic marine mammals, with a focus on Belugas, Narwhals & Walrus, Report - 2015	4, many