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WORKING GROUP ON RINGED SEALS

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Online

REPORT

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NAMMCO

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EXECUTIVE SUMMARY

The NAMMCO Scientific Committee Working Group on Ringed Seals (RSWG) held its 2nd meeting online on the 16th and 27th of November 2023 (the 1st one being in 1996). The Working Group (WG) was chaired by Aqqalu Rosing-Asvid (Greenland).

The working group on Ringed Seals was convened to respond to request ***R-2.3.3*** "to convene a working group with the aim of conducting a thorough review of the existing data and to go ahead with the assessment of stocks for which it was possible. If the data required for a full assessment of (some of) the stocks were not available, the WGs and the SC should identify, and prioritize, which specific data essential to their assessments are still needed."

The focus of the meeting was given in the Terms of Reference (ToR):

a) *To define the management areas based on genetics and/or telemetry if possible.*
b) *To review which data (especially abundance, survey data and hunting statistics) are available in each management area.*
c) *To define whether there are any areas for which an assessment can be conducted.*
d) *To describe what kind of data that are lacking for management area with insufficient data.*
e) *To discuss whether there are alternative methods to carry out abundance surveys for assessing the stock status of ringed seals.*
f) *Recommend the suitable regularity of abundance surveys and assessments for each specific case (species/stock). [standard agenda points in all NAMMCO species WG]*

Definition of management areas in the North Atlantic

The WG used published genetic (item 4.1.) and movement data (item 4.2.) for the definition of management areas in the North Atlantic: (1) Svalbard, (2) East Greenland, (3) West Greenland and East Canadian waters, (4) Hudson Bay, (5) West Canada, Beaufort Sea, Chukchi and Bering Seas, and, last the Kangia ecotype (Figure 1). These areas are based on current knowledge have no or only insignificant overlap with neighbouring areas. Such conditions (i.e., no or insignificant overlap) were agreed to exist between all the suggested areas, except between area (3) and (5) where data were found inadequate for such a conclusion. This preliminary division makes it possible to allocate the available hunting statistics to an area, if the seal is caught in areas (1), (2), (4), or in the fjord system

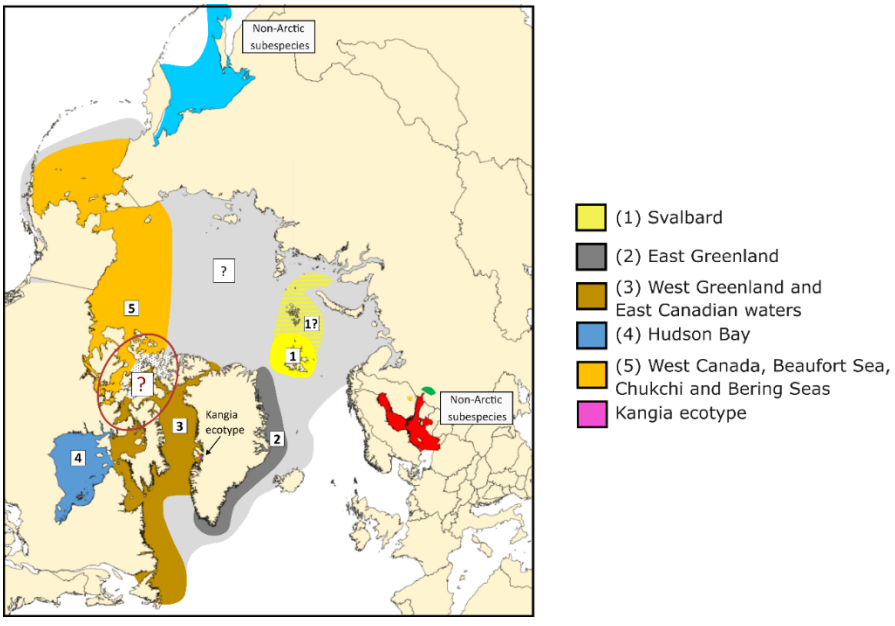

Figure 1. Map showing the five management areas for Arctic ringed seals, and the location of the ecotype from Kangia. The map also shows four non-Arctic subspecies.

that holds the newly recognized "ringed seal ecotype" living in the Kangia ecosystem. These four areas are under the jurisdiction of a single country (Norway, Greenland or Canada), whereas area (3) and (5) might have populations shared between Greenland, Canada and US. These management areas give a coarse division of the seals into area and jurisdiction, but within each management area there might be many complex population structures, which we still have not described yet.

Hunt and abundance estimates of ringed seals in the North Atlantic

Norway/Svalbard – management area 1

Hunting statistics for Svalbard are available since 2002 and they indicate fewer than 100 ringed seals hunted yearly. Preliminary findings from Isfjorden (harvested fjord) suggest that the harvest is reaching a concerning threshold, indicating potential issues with the current pace of harvesting activities. In Svalbard, drone surveys will be conducted to study ringed seal population trends in 2024.

Greenland – management areas 2 and 3

While there is no abundance data in East, nor West Greenland (which western boundaries are also not defined), new research demonstrated that the Kangia ringed seal, found in Ilulissat Ice fjord in West Greenland, appear to constitute a distinct ecotype, differing from other arctic ringed seals in size, coat colour and behaviour. This case is likely to be rare, but the large number of Arctic fjord systems as well as lakes, bifurcated archipelagos, and other environments across the entire Arctic, do that potentially more isolated ringed seals exists, and current research plans include testing the genetics of ringed seals in other fjord systems in Greenland, and across the Arctic region.

Long-term (200 years) ringed seal skin purchase and catch statistics in Greenland, indicate two periods of skin purchase and catch decline: one in the 1920s to 1940s and the period since 2006, both in East and West Greenland. The comparison between the two parameters and the temperature data indicate that climate influences the hunt too, with warmer temperatures coinciding with a decrease in the ringed seal catches in both periods.

The population of the Kangia ringed seal concentrates in Ilulissat Ice fjord, where there is a small but high-density population (abundance estimate of 1641 hauled-out animals or a total population of approximately 3000 in a survey from 2018). Indications of increased hunting activities in Ilulissat Ice fjord, due to changes in the ice-conditions, makes a new survey important to carry out in near future. No other ringed seal survey has been conducted in Greenland since the 1980s.

Other areas in the North Atlantic

Hudson Bay – management area 4

Eleven surveys have been conducted in Western Hudson Bay since 1995, more recently using infrared cameras, However, results have shown considerable year-to-year variation in abundance estimates likely related to uncertainties associated with availability variation (the fraction of the seals up on the ice).

Western Canada and Alaska – management area 5

Hunting statistics are rarely available in the Alaskan and Canadian Arctic, as there are no reporting regulations. However, this data exists for some specific communities.

Alaska

In Alaska, based on harvest data, the hunt is declining in Alaska. The reasons behind this decline are likely related to the lower interest of the newer generations for hunting, more unpredictable weather conditions and shorter winters. The harvest in Alaska is considered as sustainable, because the numbers are well below the PBR, even when it is calculated based on incomplete numbers.

An aerial survey, using planes equipped with cameras, was conducted in Spring 2023.

Canada

In Canada, declining harvest in ringed seal, may indicate that the species is less prioritised for the community as a food resource.

Since 2018, seven surveys using infrared cameras in the Last Ice Area in Northern Canada have been conducted in spring and summer.

Alternative methods to obtain ringed seal abundance estimates

Alaska and Canada have conducted regular aerial surveys, outside the area shared with NAMMCO (Greenland). The WG agreed that the best way to estimate ringed seal abundances at present was to use aerial surveys, yet their high costs pose a significant challenge.

Impacts of other anthropogenic stressors on ringed seals

Although ringed seals are still abundant in the Arctic, the group expressed strong concerns over the cascading effects of climate change on the ringed seal, and in particular on the decrease of sea ice, which constitutes the most suitable breeding habitat for ringed seals. While pollution and noise disturbance may be important locally, these stressors may not cause a major impact on ringed seals. However, the WG agreed that it is crucial to monitor all the stressors comprehensively to understand their holistic impact.

Norway/Svalbard – management area 1

An ongoing project studying the impacts of global warming in ringed seals in Svalbard, has shown that due to rapid warming and its subsequent chain reactions, significant portions of these habitats are at risk of disappearing due to changes in snow and ice coverage caused by shifts from snowfall to rainfall.

By-catch and pollution are not considered problematic in Svalbard. Instead, noise might play a significant disturbance role during some periods of the year (summertime), when there is a continuous disturbance due to tourism and fisheries operating 24/7. However, conducting exclusive studies on noise disturbances is challenging due to the intricate intertwining of these disturbances with the effects of climate change. Trawling fisheries, which damage the benthic environment, may also pose an indirect threat to ringed seals in Northern Norway.

Greenland – management areas 2 and 3

The changing sea ice dynamics in different parts of West and South Greenland may have impacted ringed seal habitats. While some areas have seen a decrease in first year ice, others have experienced an increase in old ice (Northeast and Northwest Greenland), but the effects on seal habitats remain uncertain. In fjords where glaciers are retreating, the habitat for ringed seals might expand, as observed in Kangia, where seals now occupy areas once covered by glaciers.

By-catch and pollution are not seen as major threats to Greenland's ringed seals. Existing regulations that protect other sensitive animals (e.g., narwhals and belugas) from noise pollution likely offer similar protection to ringed seals.

Other areas in the North Atlantic

Hudson Bay, and Western Canada and Alaska – management areas 4 and 5

Alaska

Despite reduced ice cover in Alaska, seal pup harvesting continues, and the reproductive rates of ringed seals remain relatively stable. Incidents of by-caught ringed seals in Alaskan commercial fishing are rare, attributed to minimal overlap between fisheries and seal habitats.

Constant pollutant monitoring efforts in Alaska show lower metal and organic pollution levels compared to the broader Arctic.

Studies on ringed seals' sensitivity to noise show their adaptability to disturbances, provided noise levels are not consistently prolonged. Increased shipping activity, including icebreakers, in the Bering Strait poses concerns.

Canada

Studies modelling sea ice and ringed seal habitats in Canada reveal a concerning trend of habitat loss for ringed seals and this goes in line with decreasing harvest trends, which may be affected by many factors including sea ice loss.

Reporting by-catch is generally not mandatory in Canada. Instances reported, like in Cambridge Bay, show minimal by-catch, with hooded and harp seals being more affected than ringed seals in Canadian waters.

Except for localized pollution from specific sources, such as the US military radar station in Saglek Bay, Labrador, contaminant levels in Canadian ringed seals are relatively low and not of major concern.

Icebreaking activities during spring, potentially impact ringed seal breeding habitats. Icebreaking off Quebec occurs frequently during the critical mating and moulting season in spring, yet no regulations govern this activity.

Procedures to continue the assessment of ringed seal populations in the North Atlantic

Norway/Svalbard – management area 1

The primary objective is to gather more comprehensive data on the abundance, distribution, and boundaries of the ringed seal populations in Svalbard in critical fjords in which the harvest is concentrated.

Greenland – management areas 2 and 3

In East Greenland, with a well-defined management area, the WG prioritised the need to carry out estimate of ringed seal abundances. In West Greenland, where abundance estimates are also lacking research should first focus on defining the western boundary of the management area.

Regularity of abundance surveys and assessment for each species

In the lack of abundance estimates and trends in abundance in the NAMMCO management areas and clear definition of management areas, the WG did not have the elements necessary for estimating suitable regularity in obtaining abundance estimates and conducting assessments.

Recommendations for ringed seals

ALL COUNTRIES

Recommendations for research

- To only use genetic data from adult ringed seal sampled during the breeding season for population structure studies.
- To compile biological data of ringed seals for those instances in which it is reported along with catch data for a more comprehensive analysis on population trends.
- To monitor sea ice conditions to ensure an up-to-date assessment of ringed seal habitat status.

Recommendations for research with financial implications for member countries

- To carry out new studies to gain more insight on correction factors for ringed seals for abundance estimates.
- To study the sensitivity of ringed seals to noise, particularly in areas of high ship traffic or tourism activities.
- To conduct surveys of ringed seals, even partial surveys (as index), and to ensure that effort in determining population structure be continued.
- To increase the efforts in monitoring the different populations and assessing their status.

Recommendations for management and conservation

- To ensure the accuracy and authenticity of the reported by-catch data.

GREENLAND

Recommendations for research with financial implications for member countries

- To collect more telemetry and genetic data southwest of Baffin Island and in Lancaster Sound to delineate the boundary between the management areas west of Greenland.
- To carry out aerial surveys to estimate ringed seal abundances in East Greenland.
- To carry out a new survey of the Kangia seals in spring 2024 to get a new abundance estimate and secure every effort and funding for this new survey.

MAIN REPORT

The NAMMCO Scientific Committee Working Group on Ringed Seals (RSWG) held its 2nd meeting online on the 16th and 27th of November 2023 (the 1st one being in 1996). The Working Group (WG) was chaired by Aqqalu Rosing-Asvid (Greenland). The meeting agenda and list of participants are available in Appendix 1 and 2, respectively.

1. WELCOME FROM THE CHAIR AND OPENING REMARKS

Rosing-Asvid welcomed the participants and gave the background for the RSWG, namely the timely need to review the status of ringed seals in the Atlantic Arctic (the last review was in 1996) and within the Arctic at large.

The working group on Ringed Seals was convened to respond to request ***R-2.3.3*** *"*to convene a working group with the aim of conducting a thorough review of the existing data and to go ahead with the assessment of stocks for which it was possible. If the data required for a full assessment of (some of) the stocks were not available, the WGs and the SC should identify, and prioritize, which specific data essential to their assessments are still needed."

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k) *To discuss whether there are alternative methods to carry out abundance surveys for assessing the stock status of ringed seals.*

l) *Recommend the suitable regularity of abundance surveys and assessments for each specific case (species/stock). [standard agenda points in all NAMMCO species WG]*

The list of meeting documents is available in Appendix 3.

2. ADOPTION OF AGENDA

A recommendation section was added to the agenda (item 10). Otherwise, the agenda for both days (Appendix 1) was adopted without modification.

3. APPOINTMENT OF RAPPORTEURS

NAMMCO Deputy Secretary Naima El bani Altuna was appointed as the primary rapporteur, with assistance from NAMMCO's General Secretary Geneviève Desportes. Participants were asked to submit written summaries of presentations, and interventions on agenda items as needed.

4. ESTABLISHMENT OF MANAGEMENT AREAS

4.1. GENETICS

Aimee Lang presented findings relating to the population structure of ringed seals in the Pacific Arctic (NAMMCO/SC/30/RSWG/08).

Summary:
NAMMCO/SC/30/RSWG/08 used a next-generation sequencing approach (DArTseq) to genotype ~5700 single nucleotide polymorphisms in 79 seals from 4 Pacific Arctic regions. Comparison of the 2 most geographically separated strata (Eastern Bering vs. Beaufort Seas) revealed a statistically significant level of genetic differentiation (FST = 0.001, p = 0.005) that, while small, was 1 to 2 orders of magnitude greater than expected based on divergence estimated for similarly sized populations connected by low (1% yr−1) dispersal. A relatively high proportion (72 to 88%) of individuals within these strata could be genetically assigned to their stratum of origin. These results indicate that demographically important structure may be present among Arctic ringed seals breeding in different areas and highlight the challenges associated with detecting population structure in highly abundant taxa.

Discussion:

Based on experience from Svalbard, Christian Lydersen highlighted the importance of sampling the animals at the right time of the year (i.e., breeding seasons) and at the right age (i.e., adult individuals). This is because young individuals tend to migrate much more than adults and it was mentioned that at least one study (Kelly et al., 2010) showed that adult seals subsequently returned to the breeding area where they were initially tagged. Lang clarified that they sampled both pups and adult specimens in the breeding season. However, the sample size for the study area remained small.

Morten Tange Olsen summarised the main findings of NAMMCO/SC/30/RSWG/07 about the Kangia seals.

Summary:
Research on ringed seals conducted to date (tagging, genetics, morphology) indicate no or only subtle population structure among Arctic ringed seals. However, Inuit recognise at least two ringed seal ecotypes, and body size variation in the species may be indicative of the existence of these ecotypes.

The Kangia ringed seal, found in a fjord in West Greenland, appear to constitute a distinct ecotype, differing from other arctic ringed seals in size, coat colour and behaviour. They stay primarily within the fjord, where there is a small (2000-3000), but high-density population. This Kangia ringed seal stands out as a distinct population in nuclear genome analysis, being distinct from all other ringed seals in the Atlantic Arctic (Eastern Canadian Arctic, Svalbard and East, Northwest and West Greenland). In addition, genetic differences in pigmentation (coat colour), growth factor genes and osmoregulation fit well the observations for Kangia seals: they are bigger, have different coloration and live in environments with freshwater coming from glaciers. It has been estimated that the Kangia seal split from other ringed seals 230,000 years ago, with signals of a recent contact (admixture). Interestingly, while pending future analyses, the genomic data in this study RSWG/07 based on Rosing-Asvid et al., 2023, point to low, but significant levels of genetic differentiation between Svalbard, Qaanaaq, Arviat and Ulukhaktok, suggesting the existence of substructure and/or isolation by distance within the Atlantic Arctic.

As the next steps, additional genomic data is currently being analysed from Kangia seals and selected Arctic populations to better understand the demographic history and genetic background of the Kangia seals local adaptations. In addition, through sample collection by DFO, GINR and ADFG, we are

currently generating 170 genomes from the Eastern Canadian Arctic and Greenland to help resolve the fine scale genetic structure of ringed seals in that region and identify other possible fjord ecotypes.

Discussion:

The case presented in RSWG/07 is likely to be rare, but the large number of Arctic fjord systems as well as lakes, bifurcated archipelagos, and other environments across the entire Arctic, do suggest that potentially more isolated ringed seals exist.

Lori Quakenbush informed that there is no similar fjord systems or lakes in Alaska. However, it has been noticed that there was a difference in size between pack ice ringed seals (smaller) and fast ice ringed seals (larger). Quakenbush and Lang also highlighted a project in collaboration with Tange Olsen to study the genetics of seal populations that might undergo the same phenomenon. Steve Ferguson informed the group that he is working on genetical analyses of resident ringed seals in two lakes of Baffin Island.

Kit Kovacs mentioned that the topography of Greenland was special, with such large glaciers cutting off entire fjord system. While Svalbard is topographically different to Greenland, similar genetic differentiation might also happen in Svalbard. Older studies showed a differentiation between seals of different fjords, with the differentiation increasing with increasing distances. Adult individuals do not move more than 5 km away in several months and come back to their natal fjord. Kovacs noted that the case of the Kangia seals was so interesting, by exhibiting such genetic and morphologic differences (size and skin colour) with their neighbour.

Charmain Hamilton had samples from Newfoundland and Labrador and Kovacs from Svalbard to contribute to Tange Olsen' study for expanding the sampling coverage.

Conclusion:

Genetic data is a valuable tool to evaluate the population structure, and the group **recommended** that sampling should be done in adult ringed seal during the breeding season, because juvenile seals migrate far away from their birthplace during fall and winter. Genetic studies have so far indicated that the Arctic ringed seals may be panmictic, but there are some structures and as presented in RSWG/08, Lang et al. (2021) found that a relatively high proportion (72 to 88%) of individuals from the geographically separated strata (Eastern Bering vs. Beaufort Seas) could be genetically assigned to their stratum of origin.

4.2. MOVEMENT DATA

Rosing-Asvid presented a compilation of published telemetry data, and based on this compilation, proposed potential management areas (NAMMCO/SC/30/RSWG/06).

Summary:

This document compiled published telemetry data (Figure 1) and suggest potential management borders (Figure 2), which separated areas with little or no exchange with neighbour areas.

Discussion:

Five areas (besides the Kangia ecotype) of Arctic ringed seals had little or no overlap in the tracking studies: (1) Svalbard, (2) East Greenland, (3) West Greenland and East Canadian waters, (4) Hudson Bay, and (5) West Canada, Beaufort Sea, Chukchi and Bering Seas (Figure 1 and 2).

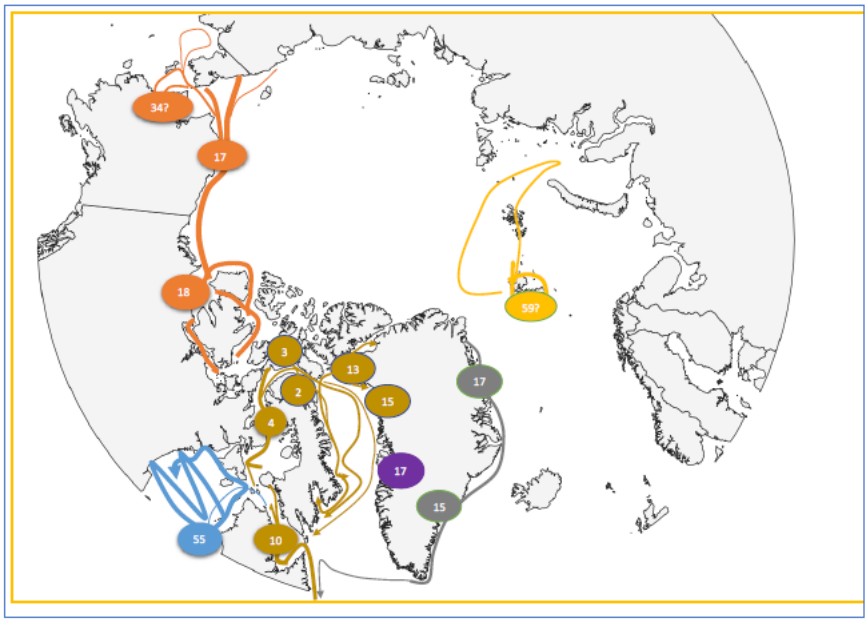

Figure 1. Ringed seal tracks based on published studies and ongoing studies in Greenland. Circles with numbers indicate the tagging sites and the number of seals that have been tracked for more than three months. The numbers for Svalbard and Kotzebue include all the tags (not only those that lasted more than 3 month). See NAMMCO/SC/30/RSWG/05 for references.

(1) Svalbard

Both genetic RSWG/07 and tagging data compiled in RSWG/06 indicate no contact between ringed seals from Svalbard and East Greenland. East of Svalbard the suggested management area was delineated based on Hamilton et al. (2015). However, Hamilton noted that this delineation was based on telemetry data of a single young individual. In the lack of more data to define the eastern boundary, the group decided to keep the eastern boundary open (Figure 2).

The lack of contact between Greenland and Svalbard might according to Lydersen be due to the bathymetric characteristics of the Fram Strait (i.e., very deep strait), only a few marine mammal species (like beluga and bowhead whales) cross the 0° meridian, which was suggested to be the line dividing the East Greenland and the Svalbard populations.

(2) East Greenland

A total of 47 ringed seals have been tracked in East Greenland including 20 in Northeast Greenland and 27 in Southeast Greenland RSWG/06. None of them have moved to West Greenland. One animal out of the 20 tagged in Northeast Greenland, a young of the year, moved south to the tip of Greenland and connected to Labrador and continued to Newfoundland (south of what normally is defined as the southern border for ringed seals).

(3) West Greenland and East Canadian waters

There are no natural boundaries to separate seals tagged in this area RSWG/06. Also, the group found the proposed border between (3) and (5) too weak (see below).

(4) Hudson Bay

Out of 55 seals tagged in Hudson Bay and lasting more than 3 months, only one moved out RSWG/06. A genetic study (presented by Morten Tange Olsen) Indicated a small but significant differentiation between seals sampled in Hudson Bay (Aviat) and in West Greenland. It was agreed that Hudson Bay work as a separate management area.

(5) West Canada, Beaufort Sea, Chukchi and Bering Seas.

Telemetry data indicate that the heavy ice-conditions around the Northwest Passage splits the seals in some that moves westward into area (5) and some that moves eastward towards Baffin Bay and West Greenland (area (3)). The group, however, considered the amount of data being too few to make any sharp boundary in that area (Figure 2).

The group therefore **recommended** that more telemetry and genetic data be collected in these areas, before decisions about management areas were made.

Conclusion:

It was agreed that (1) Svalbard based on both genetics and telemetry was different from (2) East Greenland. Svalbard and East Greenland was suggested to be separated at the 0° meridian. East Greenland was based on telemetry believed to have insignificant if any exchange with (3) West Greenland. The ecotype (Kangia ringed seal) was based on both telemetry and genetics shown almost completely isolated from the West Greenland ringed seals. (3) West Greenland and Eastern Canada had little contact with (4) Hudson Bay. The area west of the Northwest Passage to the Pacific Arctic, area (5) could not be separated from area (3) based on current data.

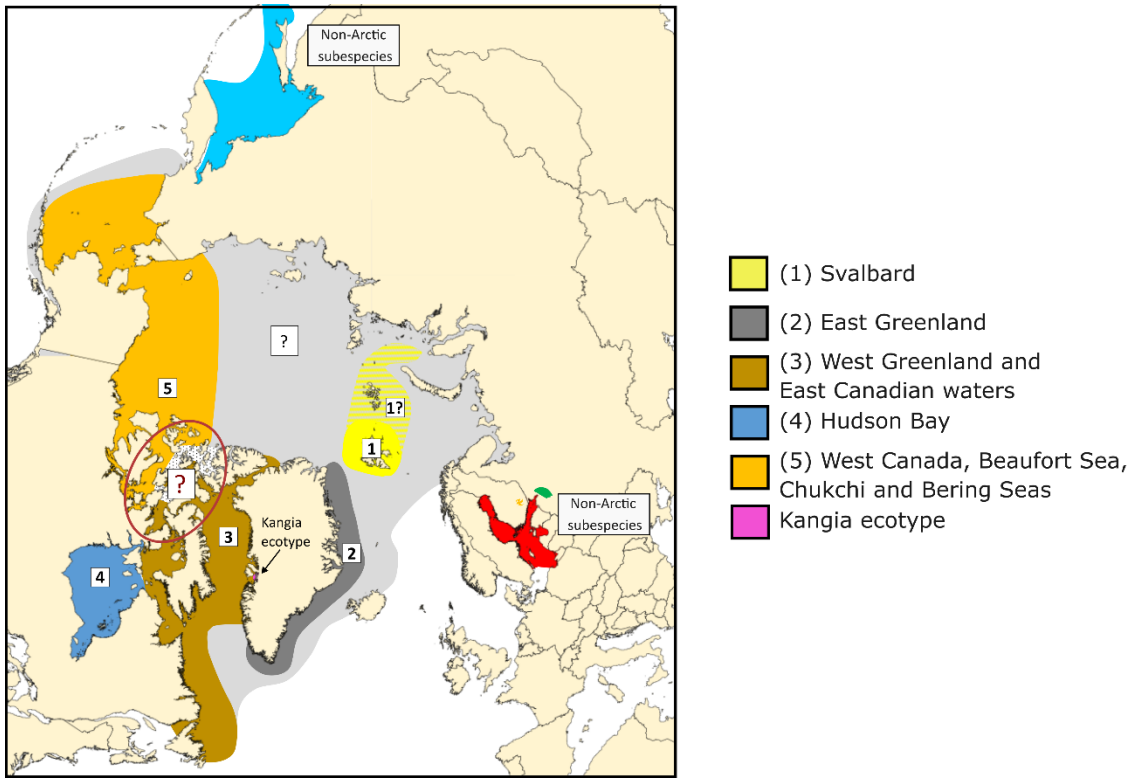

Figure 2. Map showing the five management areas for Arctic ringed seals, and the location of the ecotype from Kangia. The map also shows four non-Arctic subspecies.

A question was raised for why boundaries should be drawn, whether it was due to the conservation of genetic diversity or due to the isolation of independent demographic populations or the management

of the harvest. The group agreed that the important aspect to define the management boundary was the breeding dispersion, and this cannot be known when the seals are only tagged for a few months. Tagging data could help address this question, but long-time tagging is needed to delimit management areas. If using tagging data for delimiting management areas, uncertainties and caveats should be clearly expressed.

4.3. GENERAL DISCUSSION: DO WE HAVE SUFFICIENT KNOWLEDGE TO DEFINE MANAGEMENT AREAS?

The kind of management areas revealed with this exercise can help defining which countries share ringed seals, such as young seals born in Eastern Canada which move to West Greenland waters and the other way around. Young ringed seals are known to stray much more than the adults, and a large fraction of management areas indicated by movement data are likely to reflect juvenile summer, fall and winter distribution.

The group discussed the importance of natal fidelity (return of seals to where they were born). This is known to occur, but data are scarce, and it is not possible to evaluate this phenomenon quantitatively. Genetic data could be collected in breeding areas during the moulting season from hair, whiskers or skins to study long-term site-fidelity. However, this comes with the complication of degradation of the material once the melting season starts and the need of very large sample sizes. The group agreed to mention, but not recommend, this technique as the study would require to be conducted over several years to get reliable data.

To define the management areas the group looked for natural boundaries that never or rarely are crossed. The management areas that emerge based on that, give a crude division into large areas, which likely contain several smaller stocks for which the WG does not have data to detect at present. The Kangia seal is a good example of that. It would have been included in the West Greenland and East Canadian population but is now defined as a new separate stock. The gradual improvement of genetics is likely to reveal more structures and that might break the large management areas into smaller areas. For the time being, however, this is the best the WG could do regarding subdivision. This preliminary division makes it possible at least to allocate the available hunting statistics to an area.

5. AVAILABLE HUNTING STATISTICS IN EACH MANAGEMENT AREAS

Quakenbush briefly presented the findings for the available harvest data in Alaska (NAMMCO/SC/30/RSWG/FI23 and FI25).

Summary FI23:

In 2012, climate-warming related decreases in sea ice led to listing ringed seals *Pusa hispida* as threatened under the United States Endangered Species Act (ESA) prior to evidence of population declines. Ringed seals are vital subsistence resources to coastal Alaska Native communities. ESA-related assessments concluded that subsistence removals (seals that were harvested as well as those that were struck and lost) were sustainable; however, limited data precluded a quantitative evaluation. Potential biological removal (PBR), defined as the maximum number of animals that can be removed from a stock while allowing the stock to reach or maintain its optimal sustainable size, is typically used to determine whether human-caused mortality is sustainable. Although developed to address commercial fisheries bycatch, PBR serves as a conservative measure of sustainability. In this work, Nelson et al. (2019) compiled annual subsistence removal of ringed seals and other ice seals in Alaska between 1992 and 2014 for 41 of 55 ice seal hunting communities and used per capita (based on the 2015 human population) removal estimates from surveyed communities to estimate regional and statewide average removals. They used average per capita values of harvest, combined with struck and lost, for surveyed communities (average removals) to extrapolate to unsurveyed communities. To account for underreported harvest, they also extrapolated using maximum harvest values, providing a

liberal estimate. Both the average and liberal estimates of removals were below PBR for all 4 species, including ringed seals. Thus, the best available data indicate that subsistence hunting is currently sustainable for all 4 species of ice seals.

Summary FI25:

This paper was referenced during the NAMMCO Review regarding the harvest of ringed seals in Alaska and is a summary of Olnes et al. (2022). Ringed seals (*Pusa hispida*) are harvested for subsistence purposes by many Alaska Native communities. Trends in the subsistence harvest of ringed seals for the Yukon-Kuskokwim Delta region of Alaska for more than 50 years using two types of data collected by the Alaska Department of Fish and Game: (1) bounty data collected from 1962 to 1972 for 16 communities, and (2) household survey data collected for seven of these communities from 1997 to 2018 were assessed. Both types of data include information on the number of ice seals harvested by each community annually. In addition, more detailed household surveys were conducted from 2008 to 2018 for Hooper Bay, Tununak, and Quinhagak, which collected data on the number of seals harvested by species, the percentage of households engaged in hunting or using seal products, and hunter perceptions. For the bounty period, we identified several years where most communities had above or below average harvests, suggesting regional drivers contributed to patterns in the ice seal harvest. For the seven communities with household survey data, the mean total harvest estimate during the household survey years was only slightly lower than during the bounty period, however, the human population doubled during this time, resulting in a substantial decline in the mean number of seals harvested per person. The more detailed surveys for Hooper Bay, Tununak, and Quinhagak also showed declines in seal harvests during the most recent decade. The declining harvest in some communities may be driven by reduced participation in hunting and less use of seal products. Ongoing sea ice loss is also likely contributing to the decline in harvest across the region. Current seal population estimates indicate all four species of ice seals harvested in Alaska are abundant in Alaskan waters, and most hunters have not observed changes in seal abundance.

Discussion:

Hunting statistics are rarely available in the Alaskan and Canadian Arctic, as there are no reporting regulations; it exists only for some specific communities.

However, Quakenbush informed the group that based on harvest data, the hunt is declining in Alaska. The reasons behind this decline are likely related to the lower interest of the newer generations for hunting, more unpredictable weather conditions and shorter winters. The harvest in Alaska is considered as sustainable, because the numbers are well below the PBR, even when it is calculated based on incomplete numbers.

The Nunavut Wildlife Study (Priest and Usher, 2004) was well done but should be updated. Lea mentioned that building on the Inuvialuit Harvest Study (1988-1997), subsistence harvest data continues to be collected in a couple of the communities in the Western Canadian Arctic.

Rosing-Asvid presented a 200-year long compilation of ringed seal skin purchase, catch statistics and temperature data. He also presented catch statistics for polar bears in East Greenland population.

Summary:

In Greenland, reporting hunt data is mandatory. Hunting statistics by species go back to the 1940s (with only a few years missing). Prior to that are skin purchase data, which together with the catch statistics give insights to the catch-level back for around 200 years. Similar to Canada, Greenland also recently experienced a decline in hunted ringed seals, both in West and East Greenland. The decline in both East and West Greenland has since 2006 been more than 50%. Several factors are likely candidates to contribute to this decline, including increased interest in fisheries, especially in West

Greenland, a reduction in the number of sledge dogs that in some areas traditionally are fed with seals, reproductive failure due to poor ice-conditions and maybe there is a rising population of polar bears, with an increased predation on ringed seals (the decline started around 2006 when the polar bear hunt became regulated with quotas).

Moreover, the 200-year long time-series of hunting data compared to the temperature data showed that climate influence the hunt too. Warmer temperatures coincided with a decrease in the ringed seal catches both between 1920s and 1940s, and since around 2006 and while the trends in polar bear catches and ringed seal catches normally follow one another, this trend is discontinued during warm periods.

Discussion:

When available, monitoring the biological aspects from subsistence harvests, such as the number of pups and age at maturity, can provide valuable insights into the population's "health" status. However, the group agreed that this data should not solely be relied upon to estimate abundances; instead, it should be used in conjunction with other abundance estimate methods. The group **recommended** that biological data should also be studied for those instances in which it is reported along with catch data for a more comprehensive analysis on population trends.

Lydersen told that hunting statistics for Svalbard (sport hunt in a limited area) are available since 2002, they indicate fewer than 100 ringed seals hunted yearly.

Conclusion:

Ringed seals hunting statistics from Canada and Greenland both showed declines, and in Greenland the decline was quite severe. Several possible reasons for this decline were mentioned. The group, however, raised concerns that the declining hunt reflected a decline in ringed seal numbers.

6. AVAILABLE ABUNDANCE DATA IN EACH MANAGEMENT AREA

Alaska:

Surveys are conducted in planes equipped with cameras and the results of the first round are close to being published. In Alaska, where there are no fjord systems, surveying ringed seals is possible, but expensive as it requires large planes for several weeks (approximately six weeks). However, thanks to faster planes, a second round of aerial surveys will be started in the Bering Sea in spring 2024 for 3 weeks.

Canada:

While aerial survey coverage for ringed seals has been sporadic and remains outdated in many regions of the Canadian Arctic, some areas have been surveyed in recent years. Eleven surveys have been conducted in Western Hudson Bay since 1995, more recently using infrared cameras. However, results have shown considerable year-to-year variation in density estimates likely related to uncertainties associated with availability variation (the fraction of the seals up on the ice). In 2016 and 2017, ringed seal aerial surveys using photographic and infrared camera technology were performed in Eclipse Sound, Navy Board Inlet and Milne Inlet in Northern Baffin Island, Canada (see Young et al., 2019a and Yurkowski et al., 2019b). Since 2018, seven surveys using infrared cameras in the Last Ice Area in Northern Canada have been conducted in spring and summer (see Carlyle et al., 2021).

Greenland:

No ringed seal survey has been conducted in Greenland since the 1980s except in the Ilulissat Ice fjord where the Kangia population was surveyed in 2018. The survey resulted in an abundance estimate of 1641 hauled-out animals or a total population of approximately 3000, using a factor-2 conversion to account for animals submerged during the survey. However, due to unusual and favourable sea ice conditions for the hunters (i.e., large icebergs are not blocking the entrance of the fjord in periods) the hunt seems to have increased in that area in the last years and the 2018 abundance might not correspond to the present abundance due to the increased hunting. Rosing-Asvid will try to raise funding to conduct a new survey in Spring 2024.

Considering that the Kangia seal constitutes a small but unique ecotype, the group **strongly recommended** a new survey of Kangia seals be carried out in spring 2024 get a new abundance estimate, and every effort be made and to secure funding for this new survey.

Norway:

In Svalbard, drone surveys will be conducted for looking at trends.

Conclusion:

Alaska and Canada have conducted regular aerial surveys but not in the area shared with NAMMCO (Greenland). No regular abundance estimate is available for NAMMCO areas.

7. ARE THERE ALTERNATIVE WAYS TO EVALUATING ABUNDANCE AND STATUS?

While aerial surveys seem to be the only method in use at present to estimate ringed seal abundances, the costs of aerial surveys are elevated and usually unaffordable. Using drones and satellite images are expected to decrease the cost of surveys, but this field is under development. Despite new developments in the field of surveys, issues steaming from the uncertainty related to the fraction of seals submerged (i.e., the correction factor) remain. Therefore, the group **recommended** carrying out new studies to gain more insight on correction factors for ringed seals abundance estimates.

Based on Kingsley (1998) and Stirling and Øritsland (1995), Rosing-Asvid referred to an alternative way to estimate ringed seal abundances using polar bear estimates and polar bear diet composition.

Summary:

Kingsley (1998) and Stirling and Øritsland (1995) both used polar bear numbers to come up with estimates of the number of ringed seals needed to support them. Their assumption was that polar bears almost exclusively were eating ringed seals. Nowadays polar bear diet is often estimated based on “quantitative fatty acid signature analysis”, often supported by a model that includes pollutants (e.g., mercury) and isotopes. This should give a better insight to polar bear diet composition and thereby improve these kinds of estimates.

Discussion:

This method is controversial and, Lydersen and Boveng expressed scepticism about this method due to numerous necessary assumptions, resulting in considerable uncertainties. Rosing-Asvid had earlier shared this scepticism, but now believes that the method is developing and is likely to improve further.

Based on the discussion in item 5, Desportes, seconded by Kovacs, remarked that people considered the population of ringed seals not of being of concern because of the decreased harvest. However, such interpretation could be challenged. Decreased catch statistics could also be the sign that the seals are less abundant and less available to the hunters as well as the to the polar bears. This would in turn explain the latter shift in their diet towards hooded seals. In addition to this, poorer ice conditions impair reproductive success by making the young individuals more available to predators. Kovacs mentioned that certainly in Svalbard the population of ringed seal is decreasing, while the population of polar bear is increasing.

The group also highlighted the complexity of estimating the proportion of ringed seals from fatty acids, since changes in this data might indicate shifting dietary patterns rather than actual variations in the prey population's abundance.

Conclusion:

The group did not find a proven better alternative for estimating ringed seal abundances than aerial surveys, yet their high costs pose a significant challenge.

Estimating ringed seal abundances via polar bear estimates and the contribution of ringed seal to their diet involves numerous uncertainties.

8. OTHER ANTHROPOGENIC STRESSORS

8.1 CLIMATE CHANGE

Alaska

Despite observing a reduction in ice cover across Alaska, there is still a considerable number of seal pups being harvested, and the reproductive rates of ringed seals remain relatively stable. The concern in Alaska is not centred around less ice but rather the potential impact of heavy ice conditions on the seal population.

Canada

Studies modelling sea ice and ringed seal habitats in Canada reveal a concerning trend of habitat loss for ringed seals, which typically favour residing in the continental shelf region. These models incorporate crucial environmental factors to assess these changes: (1) spring sea ice, which is the time in which breeding and moulting happen, (2) the duration of opens water, from which seals get food, (3) bathymetry, to account for benthic food sources.

Hamilton informed the group that community members in Labrador are also reporting less harvested seals, although the reason is unclear. However, less ice and snow in some regions are indications that this might be related to less favourable habitats. The same trends are observed in East Canada and across Nunavut.

David Yurkowski also noted that communities were reporting shifts in distribution and habitats. In Northern Ellesmere Island ringed seals were only observed hauling out on first year ice amongst the mosaic of different age stages (i.e. first year ice to multiyear ice).

Greenland

The shifting dynamics of sea ice, with decrease of both first-year sea ice and multiyear ice, in Southeast, West, and South Greenland might have impacted the habitats of ringed seals. Conversely, both Northwest and Northeast Greenland have experienced an increase in older sea ice, but how that influenced the ringed seal habitat is unknown. In some fjords, the retreat of marine-terminating glaciers leads to an “elongation” of the fjord, which often increases the ringed seal habitat. This is

observed in Ilulissat Ice fjord, where high concentrations of Kangia seals now occupy areas that not long ago would be occupied by the glacier.

Older ice due to its stability and greater snow accumulation, is a much more favourable habitat for ringed seal reproduction and breeding. For instance, Yurkowski noted that no ringed seals have been observed in first year ice in Ellesmere Island.

Svalbard

Kovacs informed the group of an ongoing project to study the impact of global warming in Svalbard to understand the effects on ringed seal habitats. They have observed that rapid warming and its subsequent chain reactions (e.g., shifts from snowfall to rainfall), are causing the disappearing of significant portions of these habitats due to changes in snow and ice coverage. This loss poses a severe threat to the ringed seal population, impacting their habitats and breeding grounds.

Harvest data shows that pups are not any longer being harvested, giving an indication of a decrease in pup production and survival rates possibly due to factors such as increased vulnerability to predators in less favourable snow coverage and habitats. This has consequences for adult seals as well, both female and male seals. Females are experiencing a trend toward larger sizes, which is attributed to their inability to raise pups successfully, thus avoiding the cost of lactation and the subsequent loss in fat.

Conclusions:

While some areas are experiencing a loss of habitats, there are instances of habitat gains in certain regions (e.g., some fjords in Greenland). Concerning declining trends in ringed seal populations (as deduced from declining catch statistics and harvest data) are observed in Svalbard, Greenland and Hudson Bay, wh.ile Alaska shows signs of potential stability.

The group expressed strong concerns over the overall circumpolar projections in sea ice decline and changes in precipitation pattern (i.e., increased rain and winds instead of snowfall) for the upcoming years that may cause a dramatic loss of ringed seal habitat. The group therefore **recommended** monitoring sea ice conditions to ensure an up-to-date assessment of ringed seal habitat status.

8.2 BY-CATCH

Alaska

Almost no by-caught ringed seals are reported in Alaska in commercial fishing, even when observers are onboard. In Alaska there was little overlap in fisheries and ringed seal habitats.

Canada

Some by-catches are reported in Arctic char fisheries. Reported by-catch in the Cambridge Bay area is minimal. In Labrador there is no obligation to report by-caught animals. Shelley Lang mentioned that there is not good data on by-catch in Canada because it is not required to report. However, it was mentioned that by-catch was largely most important for hooded and harp seals.

Greenland

It is mandatory to report by-catch in lumpfish fishery in Greenland and the average reported catch of ringed seals during 2016–2023 was 22 (ranging from 2 to 51).

Svalbard

There is no recorded mortality of ringed seals in any of the fishing activities.

Conclusions:

The relatively low incidence of by-catch motivated the group to question the accuracy of the reported numbers, considering the wide recognition of a general major issue of under reporting of by-catch events by fishers. Acknowledging this, the group **agreed that further investigation of ringed seal by-catch rate was warranted,** both validating the reported by-catch figures and using independent ways of getting such data, so to guarantee their precision and credibility.

8.3 POLLUTION

Alaska

Pollutants are constantly monitored in Alaska and metal and organic pollution levels remain generally lower than in the rest of the Arctic, and consequently also the levels of contaminants in ringed seals.

Canada

Except for local pollution from contaminant sources (e.g., a US military radar station in Saglek Bay, Labrador) in localized areas, levels of contaminants are not a big concern in Canada.

Greenland

Rosing-Asvid informed the group that pollution in ringed seals is not a big issue in Greenland.

Svalbard

In Svalbard, organic pollution levels are under control, and they are not considered problematic.

Conclusions:

Overall, the group did not see pollution as a key anthropogenic stressor for ringed seals in the Arctic.

8.4 DISTURBANCE

The discussion about disturbance focused on noise disturbance from shipping and from the tourism industry.

Alaska

There is a growing concern over the increased number of Russian shipping and icebreakers navigating north through the Bering Strait. However, the group discussed their lack of authority to establish effective regulations in response to this issue.

Regarding the sensitivity of marine mammals to noise pollution, some investigations have been conducted in Alaska. Findings suggest that these animals can adapt relatively quickly to noise disturbances as long as the noise levels are not long-term or constant. Ringed seals are silent animals, so monitoring changes in behaviour or displacement due to disturbance through studying seals' acoustic activities is not feasible.

Canada

In Canada, the iron ore mining project on Baffin Island generates ice breaking when the ice is forming in spring and could affect ringed seals trying to find adequate habitat for breeding. Off Quebec icebreaking occurs often, but no regulations exist for icebreaking which mainly takes place in the mating and moulting season in spring. Ferguson informed the group about an ongoing study, focusing on analysing telemetry data and vessel tracks, that reveals how deeply seals are affected by vessel noise, leading to their displacement, especially for seals in the south.

Greenland

Although there are no studies on the tolerance of ringed seals to noise, several studies have addressed this issue with narwhal and beluga, which have lower tolerance thresholds for disturbances. Regulations provided for narwhal and beluga should therefore also protect ringed seal.

Svalbard

In Svalbard, restrictions have been implemented to avoid people from driving snowmobiles on ice or breaking ice without a permit, aimed at reducing disturbances to the environment. During some periods of the year (summertime) there is a continuous disturbance due to tourism and fisheries operating 24/7. Kovacs noted that conducting exclusive studies on noise disturbances is challenging due to the intricate intertwining of these disturbances with the effects of climate change.

Conclusions:

Although ship disturbance may not cause a major impact on ringed seals, it is crucial to monitor all the stressors comprehensively to understand their holistic impact. The group therefore **recommended** to study the sensitivity of ringed seals to noise, particularly in areas of high ship traffic or tourism activities.

8.5 OTHER

Kovacs noted that trawling fisheries may pose an indirect threat to ringed seals in Northern Norway. This is because trawling efforts damage the benthic environment, which causes in turn the decrease of polar cod and therefore loss of a major food source for ringed seals.

8.6 OVERALL CONCLUSION

Although ringed seals are still abundant in the Arctic, the group expressed strong concerns over the cascading effects of climate change on the ringed seal, and in particular on the decrease of suitable breeding habitat. The group therefore strongly **recommended** that efforts in monitoring the different populations and assessing their status be increasing.

9. HOW TO PROCEED IN ASSESSING THE STATUS

9.1 SVALBARD

Given the logistic difficulties in conducting routine surveys of the entire archipelago due to the absence of sea ice during their moulting period and the possibility for counting moulting seals, the strategy is to focus surveys on specific fjords instead. These partial surveys can then be used as indices, which combined with demographics in the harvest, could potentially reveal changes in population dynamics. The primary objective is to gather more comprehensive data on the abundance, distribution, and boundaries of the ringed seal population.

Preliminary findings from Isfjorden (harvested fjord) suggest that the harvest is reaching a concerning threshold, indicating potential issues with the current pace of harvesting activities. These findings are yet to be published but underline the urgency of the situation.

9.2 EAST GREENLAND

Although the management area is well defined, there are no available abundance estimates in this area. The group **recommended** carrying out aerial surveys to estimate ringed seal abundances in this area.

9.3 WEST GREENLAND

There are no abundance estimates for ringed seals. Additionally, the western boundary of the management area for ringed seals in West Greenland is poorly defined. Consequently, the group

recommended prioritising further telemetry and genetic research focused on ringed seals in this area to define the precise boundaries between the management areas. This will also allow to gather crucial information regarding the distribution and in return where to focus effort for determining abundance.

9.4 KANGIA RINGED SEAL

The group **recommended** timely getting a new abundance estimate of the Kangia seal (see item 6 for background and justification).

9.5 REGULARITY OF ABUNDANCE SURVEYS AND ASSESSMENTS FOR EACH SPECIFIC CASE (SPECIES/STOCK)

In the lack of abundance estimates and trends in abundance in the NAMMCO management areas and clear definition of management areas, the group did not have the elements necessary for estimating suitable regularity in obtaining abundance estimates and conducting assessments. Due to the critical need for these data to properly assess the status of the different populations, the group **recommended** that efforts in conducting surveys of ringed seals even partial surveys (as index) be increased and that effort in determining population structure be continued, as indicated in the items above.

10. RECOMMENDATIONS

10.1 RECOMMENDATIONS FOR RESEARCH

All countries

Recommendations for research

- To only use genetic data from adult ringed seal sampled during the breeding season for population structure studies.
- To compile biological data of ringed seals for those instances in which it is reported along with catch data for a more comprehensive analysis on population trends.
- To monitor sea ice conditions to ensure an up-to-date assessment of ringed seal habitat status.

Recommendations for research with financial implications for member countries

- To carry out new studies to gain more insight on correction factors for ringed seals for abundance estimates.
- To study the sensitivity of ringed seals to noise, particularly in areas of high ship traffic or tourism activities.
- To conduct surveys of ringed seals, even partial surveys (as index), and to ensure that effort in determining population structure be continued.
- To increase the efforts in monitoring the different populations and assessing their status.

Greenland

Recommendations for research with financial implications for member countries

- To collect more telemetry and genetic data Southwest of Baffin Island and in Lancaster Sound to delineate the boundary between the management areas west of Greenland.
- To carry out aerial surveys to estimate ringed seal abundances in East Greenland.
- To carry out a new survey of the Kangia seals in spring 2024 to get a new abundance estimate and secure every effort and funding for this new survey.

10.2 RECOMMENDATIONS FOR CONSERVATION & MANAGEMENT

- To ensure the accuracy and authenticity of the reported by-catch data.

11. ACCEPTANCE OF REPORT

A preliminary draft of the report was approved by the WG on December the 8th. The final report was recirculated and accepted by the group on December the 11th.

12. CLOSING REMARKS

The Chair thanked the WG members for their contributions to a fruitful discussion, providing a good review of the status of ringed seal around the arctic. The group thanked Rosing-Asvid for his chairing, as well as the rapporteurs for ably documenting the deliberations.

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APPENDIX 1: AGENDA

Agenda 1st meeting

16 November 2023, 16:00–19:00 CET, Video conference

1. **Welcome and Opening Remarks from the Chair**
2. **Adoption of agenda**
3. **Appointment of rapporteurs**
4. **Establishment of management areas**

   4.1. Genetics

   4.2. Movement data

   4.3. General discussion: Do we have sufficient knowledge to define management areas?
5. **Available hunting statistics in each management areas**
6. **Available abundance data in each management area**
7. **Are there alternative ways of evaluating abundance and status?**
8. **How to proceed in assessing the status**
9. **Recommendation**
10. **Next meeting?**

For information:

This meeting has been convened to contribute to answering **request R-2.3.3.** from the NAMMCO Council: ***"****to convene a working group with the aim of conducting a thorough review of the existing data and to go ahead with the assessment of stocks for which it was possible. If the data required for a full assessment of (some of) the stocks were not available, the WGs and the SC should identify, and prioritize, which specific data essential to their assessments are still needed."*

Terms of Reference of the Working Group on Ringed Seals are:

1. To define the management areas based on genetics and/or telemetry if possible.
2. To review which data (especially abundance, survey data and hunting statistics) are available in each management area.
3. To define whether there any areas for which an assessment can be conducted.
4. To describe what kind of data that are lacking for management area with insufficient data.
5. To discuss whether there are alternative methods to carry out abundance surveys for assessing the stock status of ringed seals.

Agenda 2nd meeting

27 November 2023, 16:00–19:00 CET, Video conference

11. Are there alternative ways to evaluating abundance and status? (item 7 in original agenda)

12. How to proceed in assessing the status (item 8 in original agenda)

12.1. Approval of the updated management areas based on previous discussion
12.2. Svalbard
12.3. East Greenland
12.4. West Greenland
12.5. Kangia ringed seal
12.6. Regularity of abundance surveys and assessments for each specific case (species/stock)

13. Other anthropogenic stressors
3.1. Global warming
3.2. By-catch
3.3. Pollution
3.4. Disturbance
3.5. Others

4. Review of the recommendations

Other business and closing remarks

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APPENDIX 3: LIST OF DOCUMENTS

Working Documents

Doc. No.	Title	Agenda item
SC/30/RSWG/01	Agenda	2
SC/30/RSWG/02	List of Participants	1
SC/30/RSWG/03	List of Documents	
SC/30/RSWG/04	Map with ringed seal surveys – Schiøtt, S.	6
SC/30/RSWG/05	References to map with ringed seal surveys – Schiøtt, S.	6
SC/30/RSWG/06	Delineation of management units for the Arctic ringed seals (*Pusa hispida hispida*) – Rosing-Asvid, A.	4.2. & 4.3.
SC/30/RSWG/07	Rosing-Asvid, A., Löytynoja, A., Momiglaino, P., Hansen, R. G., Hjorth Scharff-Olsen, C., Valtonen, M., Kammonen, J., Dietz, R., Farsø Rigét, F., Ferguson, S., Lydersen, C., Kovacs, K. M., Holland, D. M., Jernvall, J., Auvinen, P., & Tange Olsen, M. (2023). An evolutionarily distinct ringed seal in the Ilulissat Icefjord. *Molecular Ecology*, *00*, 1–12. https://doi.org/10.1111/mec.17163	4.1
SC/30/RSWG/08	Lang, A., Boveng, P., Quakenbush, L., Robertson, K., Lauf, M., Rode, K., Ziel, H., & Taylor, B. (2021). Re-examination of population structure in Arctic ringed seals using DArTseq genotyping. *Endangered Species Research*, *44*, 11–31. https://doi.org/10.3354/esr01087	4.1.

For Information Documents

Doc. No.	Title	Agenda item
SC/30/RSWG/FI01	NAMMCO–North Atlantic Marine Mammal Commission. (1996). *Report of NAMMCO scientific committee* Ad hoc *working group on ringed seals* (p. 18). NAMMCO.	Several
SC/30/RSWG/FI02	Kovacs, K. M. (2014). *Circumpolar ringed seal (*Pusa hispida*) monitoring—CAFF´s ringed seal monitoring network* (43 Rapportserie Norsk Polarinstitutt, p. 48). Norsk Polarinstitutt.	Several
SC/30/RSWG/FI03	Quakenbush, L. T., Crawford, J. A., Nelson, M. A., & Olnes, J. R. (2019). *Pinniped movements and foraging: Village-based satellite tracking and collection of traditional ecological knowledge regarding ringed and bearded seals.* (OCS Study BOEM 2019-079; p. 131). U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Alaska Outer Continental Shelf Region.	4

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