Peer Review Report: Proposed Arctic Ringed Seal Critical Habitat Designation - Critical Habitat Evaluation

Introduction

On December 9, 2014, the National Marine Fisheries Service (NMFS) published a corrected proposed rule to designate critical habitat for the Arctic ringed seal and opened a 90-day public comment period on the proposal (79 FR 73010; December 9, 2014). Subsequently, on February 2, 2015, NMFS extended the public comment period through March 30, 2015 (80 FR 5498). During the comment period on the proposed designation, NMFS requested review of the evaluation of critical habitat contained in the proposed rule (specifically, sections titled "Background" through "Unoccupied Areas") by the following five independent peer reviewers with expertise in ringed seal biology and ecology:

- Steve Ferguson, Ph.D., Fisheries and Oceans Canada;
- Lois Harwood, Fisheries and Oceans Canada;
- John Iacozza, Ph.D., University of Manitoba;
- Brendan Kelly, Ph.D., Monterey Bay Aquarium; and
- Lori Quakenbush, Alaska Department of Fish and Game.

The reviewers were specifically asked to provide comments on the following topics:

1. The quality, thoroughness, and relevance of the scientific information considered; particularly whether there is any relevant information available that was not considered, but should be.
2. Whether scientific information is accurately presented and reasonably interpreted and applied.
3. Whether scientific uncertainties are adequately identified and characterized.
4. Whether the document provides a well-reasoned rationale for the proposed critical habitat based on the best scientific information available.

Responses submitted by each reviewer are included in the following section (in random order), with each reviewer identified by a number. Responses to substantive peer review comments and public comments will be provided in the final rule to designate Arctic ringed seal critical habitat, which will be published in the *Federal Register*.

Peer Review Comments

<u>Reviewer 1:</u>

Overall, I believe that the proposed rule accurately presented and interpreted the current scientific knowledge related to ringed seal habitat in the Arctic, while also identifying many of the scientific uncertainties in establishing habitat relationships between ringed seals and snow-covered sea ice parameters. As described below, more recent literature focusing on snow as an

important habitat characteristic has not been included (however I believe it may have been published after this report was written). I also believe that several limitations exist in the rationale for the proposed critical habitat, since snow cover and sea ice dynamics are not included in the estimation of the critical habitat (however are discussed as critical components in the report). Therefore a more thorough and relevant approach to estimating critical habitat for ringed seals may also include these considerations. It is unclear whether the proposed critical habitat outlined in the report would change as a consequence of the inclusion of snow and sea ice dynamics; however this would ultimately result in a more comprehensive evaluation, with potentially less uncertainties in the final designation.

Specific Comments

Page 73012: Seasonal Distribution and Habitat Use. The authors adequately discuss the relevance of snow cover thickness on sea ice to subnivean lair construction and implications for survival of ringed seals and their pups. However, recent research has suggested that the variability in snow on sea ice (both interannual and spatial variability) are important habitat considerations for ringed seals (Iacozza and Ferguson, 2014).

Iacozza, J. and S.H. Ferguson (2014). Spatio-temporal variability of snow over sea ice in western Hudson Bay, with reference to ringed seal pup survival. Polar Biology, volume 37(6): pp 81 7-832.

Page 73015: Specific Areas Containing Physical or Biological Features Essential to the Species. In the previous section, snow on sea ice was identified as an important habitat feature for the ringed seals during a significant portion of the life cycle of this mammal. However, under this section, snow cover or on-ice snow is not included as an essential feature. With no snow cover, the sea ice habitat would be essentially different than currently available to the ringed seal and thus should be included in this section. The authors discuss sea ice as a critical habitat feature; I would suggest a change to the terminology throughout this section to ‘snow-covered sea ice’. This may be a minor change, however would suggest to the audience that critical habitat for ringed seals includes not only the sea ice, but also the snow layer that accumulates on the sea ice.

Also in this section, I have some concern or reservation about the inclusion of only the ice edge from satellites. A number of sea ice characteristics, including concentration, ice type, surface roughness, thickness, etc. can be estimated directly or indirectly from satellite-based measurements that are now routinely collected for the Arctic region (especially the North American Arctic). While it is understood that many of these characteristics are require some form of processing of the imagery, their inclusion in this analysis would only strengthen the proposed delineation of critical habitat for the ringed seals.

The authors also mention on the bottom of page 73015 and top of page 73016 that while snow depth on sea ice is essential for ringed seal habitat (i.e. birth lairs), they are not aware any data on

this parameter. AMSR-E satellite imagery can accurately estimate snow depth on sea ice, especially for first-year ice. While this product is spatially limited (resolution of 12.5 km) and temporally limited (only available from 2002 to 2010), it may provide some guidance to the inclusion of this parameter into a model to delineate critical habitat for ringed seals.

One critical component excluded from the analysis or delineation of critical habitat for ringed seal is the dynamics of sea ice. The proposed critical habitat is based primarily on sea ice thermodynamics (i.e. the location of the ice edge). Sea ice dynamics is essentially not included in this delineation. This sea ice process, controlled by the wind and ocean currents, is important for the formation of roughness elements and leads critical for the establishment of breathing holes, as well as thickness of sea ice critical for ringed seal molting, and has been discussed in previous sections in this report as a critical habitat process. A number of studies have been able to estimate sea ice dynamics in the Arctic (and the Beaufort Sea) using techniques such as ice floe tracking software. However I do not believe any work has already been done for the Bering Sea or Chukchi Sea, which may limit the ability to include this in the present report. This should be discussed as a potential limitation or uncertainty in the proposed critical habitat.

Page 73018: Special Management Considerations or Protection. As a minor point, I would suggest the inclusion of tourism as a potential threat to the ringed seal habitat. Transportation in relation to shipping is discussed as a potential threat, and I would recommend adding a few sentences on tourism (i.e. cruise ships) within this section.

<u>Reviewer 2:</u>

Subnivean Period: Although the subnivean period is reasonably considered as the most critical life history period, an argument can be made for the open-water hyperphagy period as also being very important. In particular, ringed seals near the edge of their southern distribution will likely be compromised by their ability to build up fat reserves during the open-water season necessary to survive and reproduce over winter.

Polar bears (and other predators) prey heavily on ringed seals particularly on pups while nursing. Therefore naïve and vulnerable seal pups are dependent on the ability to hide in a snow lair and escape into water if needed. This is considered the critical life history period, yet we have no real quantification of how real the risks of mortality at this time are. In particular, is there any literature on the relative density of ringed seal lairs in different ice types and geographic locations? Presumably, it would not be difficult to estimate from population survey estimates and using sex ratio, adult percentages, pregnancy rates and calculating the number of pups born each year and other metrics of age-specific fecundity.
Basking Period: For this period there are some estimates of the consequences of fasting during the moulting period (see Young and Ferguson (2014).

Open-Water Foraging Period: During this period when adult females need to regain their fat deposits and energy reserves, forage fish with relatively great fat/lipid deposits are necessary. Arctic cod is the primary fish but other species in the 3 to 10” size range can be utilized. Young et al. (2010) showed that juvenile seals will feed more on invertebrates during this period.

The seasons of the ringed seal can be better delineated so that specific critical habitat needs are outlined: (1) Late spring basking; (2) Early open-water; (3) Late open-water (major energy replenishment); (4) Early ice formation (adult territories); (5) Mid-winter maximum ice (pupping and nursing); (6) Early spring (mating). There is a need to identify the critical periods in the year and those less critical (i.e., prioritize).

1. Sea Ice habitat: a good description of the importance of seal preference for landfast ice that is stable with some deformation to allow snowdrifts for lairs. The authors need to describe the large amount of uncertainty on the relative importance of various ice characteristics and the limited research of moving pack ice as ringed seal habitat in winter.

3. Primary prey resources: Again emphasize the need for small forage fish that have relatively high lipid content and gravid females are available during the late open-water season pelagically. Changes in forage fish species abundance with distributional changes associated with warming waters may not provide the lipids needed for female ringed seal successful reproduction. The large shrimps and amphipods associated with arctic waters provide ringed seals with the energy needed for surviving the winter period when food is less available. Smaller invertebrate species with lower lipid content available with temperate waters will likely not provide the appropriate energetic equivalents.

A map of the region would be helpful when describing geographic boundaries of critical habitat.

Missing is a description of the seasonal cycle of Arctic cod (Boreogadus saida) and their use of deep water over winter that probably limits access by ringed seals due to extreme depths (e.g., Beaufort Sea research). In winter as the ice forms, Arctic cod aggregations develop with the largest fish remaining in the deepest layer. The smaller fish move down in daytime and up at night but never above a depth horizon threshold (e.g., 140 m). In winter, large adult cods have a very large, lipid-rich liver. Likely, diving seals target the large livers of these large, deep-depth cod. As a predation refugia, the depth limits the ability of seals having to dive to reach the largest fish. Also, Arctic cod spawn in winter and the buoyant eggs hatch into larvae near the surface from January to early July. References: Harter et al. 2013; Benoit et al. 2008; Geoffroy et al 2011.

Another uncertainty that should be described is our lack of knowledge of what ringed seals feed on while far offshore during the late open-water season. I know of no seal harvest in these

locations which would provide stomach contents. However, I suspect this is an important feeding period not only for juveniles but possibly adult females preparing for the energetic costs of pregnancy, birth, and lactation.

References:

Benoit D, Simard Y, Fortier L (2014) Pre-winter distribution and habitat characteristics of polar cod (Boreogadus saida) in southeastern Beaufort Sea. Polar Biol 37:149–163.)

Geoffroy, M., Robert, D., Darnis, G., Fortier, L., 2011. The aggregation of polar cod (Boreogadus saida) in the deep Atlantic layer of ice-covered Amundsen Gulf (Beaufort Sea) in winter. Polar Biology 34: 1959-1971.

Harter, B.B., Elliott, K.H., Divoky, G.J., and Davoren, G.K. 2013. Arctic cod (Boreogadus saida) as prey: Fish length-energetics relationships in the Beaufort Sea and Hudson Bay. Arctic 66(2):191 – 196.

Young, B.G., L.L. Loseto, and S.H. Ferguson. 2010. Diet differences among age classes of Arctic seals: evidence from stable isotope and mercury biomarkers. Polar Biology 33: 153-162

Young, B.G., S.H. Ferguson. 2013. Seasons of the ringed seal: pelagic open-water hyperphagy, benthic feeding over winter and spring fasting during molt. Wildlife Research 40: 52-60.

<u>Reviewer 3:</u>

Comments are scientific in nature, and involve four main theme areas. Since the proposed critical habitat encompasses most known ringed seal habitat in US waters, in all seasons, references and rationale are included which could assist in a more refined determination of critical habitat areas. This would be prudent and possible for a more realistic designation given the abundance, wide distribution and plasticity of the species/population, as well as the variable nature of the environment.

1. Plasticity and Adaptability

As stated, throughout most of its range, the Arctic ringed seal relies on sea ice for pupping, lactation, molting, and resting. Ringed seal pups are normally born in snow caves (subnivean lairs) in the spring, and are very vulnerable to freezing and predation without these lairs (Smith, 1987). Timing of spring ice break-up (Smith and Harwood, 2001; Harwood et al., 2012a), snow depths on sea ice (Smith, 1987; Ferguson et al. 2005), and late-winter rain (Stirling and Smith 2004) can adversely affect lair formation and occupation. That the species produces only a single pup each year limits the ringed seal's ability to respond to environmental challenges such as diminishing ice and snow cover, and changes in prey. However, counter balancing all of this is that the species is the most abundant and widespread marine mammal species in the Arctic, is widely dispersed and highly adapted to environmental variability, and periodically undergoes dramatic changes in numbers and distribution (Stirling et al., 1977; Smith, 1987; Stirling, 2002;

Harwood et al., 2012a). Plasticity in life-history activities includes variability in timing of reproduction, and timing of moulting (Smith and Harwood, 2001) to adjust to seasonal changes in ice/snow cover seasons. In addition there is the ability of animals to survive slightly shortened nursing periods, to migrate over large distances (Crawford et al., 2012; Harwood et al., 2012b), to use alternative platforms to haul-out on, and also their tendency to feed opportunistically (Lowry et al., 1980) and use alternative food resources (Young et al., 2010; Crawford et al., in press). Along with annual variability, these attributes are important in counterbalancing the effects of a changing climate, ecosystem and sea ice, and it was not clear if these aspects were fully considered in the process of designation of critical habitat in the proposed rule.

2. Subnivean Period

The key habitat feature for ringed seals during the subnivean period is the *combination* of quality and quantity of sea ice (physical feature) and accessible, reliable, adequate food supply (biological feature) associated with that sea ice (Smith, 1987). Together these and other factors such as snow depth and ridging underpin the quality, quantity and suitability of habitat for ringed seals during the subnivean period. In the SE Beaufort/Amundsen region, adult females had failed ovulation, and this was linked to reduced body condition in years of severe ice conditions (Smith, 1987; Harwood et al., 2012a). Although ovulation rates recovered within 2-3 years of the events, this study underscores the importance of prey quality and quantity during the subnivean period. The winter 'prey' feature may not have been considered as an essential feature of the winter/spring habitat, and there is considerable scientific literature on this aspect which could assist with the refining of critical habitat areas, at least in the US portion of the populations' range.

It is also important to note that the scale of environmental factors that is relevant to ringed seals is very different from scale of factors examined in climate models, or broad groupings of ice type, duration and concentration. Further, climate models indicate that winter/spring ice conditions will not be compromised by a warming climate in the foreseeable future. Declines in multiyear ice, documented since 2012, may lead to the formation of more fast ice and a potentially increased amount of subnivean habitat.

In winter, ringed seals, especially adults, restrict their movements to localized home ranges, feed in these areas, and maintain 4 or 5 breathing holes within this home range. Offshore of the Alaskan North Slope, the fast ice/winter home ranges of 27 adult males ranged in size from <1 to 13.9 km^2 while the home ranges of 28 adult females ranged from <1 to 27.9 km^2 (Kelly et al., 2010). There was also evidence that adult seals return to the same specific areas in consecutive winters (Kelly et al., 2010), underscoring the attractiveness and importance of specific areas. The size of the winter home ranges used by adult males and adult females averaged 14 km^2 (Harwood et al., 2007). Also, Smith and Hammill (1981), Lydersen (1998), Smith and Lydersen (1992) provide important insights about the activity budgets, foraging distances and lair occupation of

adult females and pups during subnivean periods. Collectively, these studies reveal that in winter, ringed seals tend to be widely dispersed, occupying relatively localized areas, and restricted to areas within 10s of kms of the lairs as opposed to vast expanses of habitat.

3. Open Water Foraging "Aggregations" & the Northern Boundary

The key habitat feature for ringed seals during open water foraging is access to offshore/open water locations where dense aggregations of prey form. The location, formation and development of these areas is linked to prevailing oceanographic and atmospheric features, only in some areas and age classes does this important fall feeding take place at ice edges. The offshore prey patches are realistic candidates for designation as critical habitat.

Prey patches develop offshore each summer/fall, in similar geographic areas among years, influenced by environmental conditions The specific locations where the prey patches form are influenced by bathymetry, wind-driven circulation, currents, and upwelling. Progress is being made with models which can predict where the prey patches will develop in a given year, under prevailing oceanographic and atmospheric conditions. Oceanographers could inform the designation of recurrent locations which are the most attractive to ringed seals (as candidates for critical habitat) in a given year and season.

The strategies used by ringed seals in the open water foraging period vary among regions to a greater extent than is implied by sections on this topic in the proposed rule. The model of 'some seals forage within 100 km of their land fast ice breeding habitat [resident], while others make extensive movements of hundreds or thousands of km to forage in highly productive areas and along pack ice edge" was observed by Freitas et al. (2008) near Svalbard, and in subadults in the Chukchi (Crawford et al., 2012). Different patterns have been observed in other areas, particularly in the range occupied by this same population of ringed seals in Canadian waters.

Harwood, Smith, Auld et al. (2015) observed ringed seals in eastern Amundsen Gulf made extensive feeding forays in summer, all to distant feeding areas, but not in association with sea ice. Harwood and Stirling (1992) found ringed seals in the SE Beaufort Sea formed large loose feeding aggregations offshore during late summer, again not in association with sea ice or sea ice edges. Seals were feeding in these aggregations, often coincidentally with seabirds and bowhead whales (Harwood, 1989), all using the same feeding areas. These prey patches/areas have oceanographic features which foster the production and concentration of planktonic prey, and important prey of ringed seals during open water (Lowry et al., 1980; Smith 1987; Smith and Harwood, 2001).

There are similar data becoming available for the Alaskan Beaufort Sea and Chukchi Sea. As noted in the proposed rule, [subadult] ringed seals tagged in 2001 and 2002 (Harwood et al., 2012b) migrated rapidly west over the continental shelf, offshore of the Alaskan North Slope

during September, but these were *migrating* animals. This was a sustained, westward migration, with timing and routing not indicative of feeding. Upon reaching the Point Barrow area, however, the seals changed their pattern of movement and began to aggregate in certain areas for feeding (see figure).

Herreman et al., 2012 (poster was used as the main source of information for the 'northern boundary designation' (page 73016) in the proposed rule. Of "many" seals tagged, "some" [2] migrated off shore >400 km to the edge of the pack ice, these being similar to that reported by Freitas et al. (2008) for the Svalbard area. The greatest proportion of tracks from Herreman's tagged seals was within 60 km of shore, and appeared 'clustered' in at least four distinct areas or patches. There are opportunities for detailed analysis of tracks of the tagged seals reported in Herreman et al. (2012), to reveal focussed areas particularly attractive to feeding seals in US waters and throughout its late summer/fall range (includes waters in Canada, Russia as well). From examination of Herreman et al. (2012), it appears there were at least four focal seal aggregation areas in the offshore, similar locations as locations used by ringed seals in 2001 and 2002.

It is also apparent that the patches in US waters that were used by ringed seals in late summer/fall (2001, 2002, 2011) overlap in time and space with feeding aggregation areas used by bowhead whales, also consumers of pelagic zooplankton (Harwood, 1989; Citta et al., 2014, Ashijan et al. 2010). A favorable feeding environment is produced when plankton are retained and concentrated on the shelf off Point Barrow, by the prevailing and converging currents. Further spatial analysis of these data sets offer opportunities to 'fine tune' the positioning of critical habitat boundaries, interannual variability and overlap among species.

4. Changes in the Marine Ecosystem & Responses of Ringed Seals to Date in the Chukchi Sea

It is almost important to note that there is emerging evidence that changes in the prey base of multiple species of marine mammals are already occurring in the Chukchi and Beaufort Seas (Harwood et al., 2012a; Harwood et al. in press; Crawford et al., in press). Stomach contents were collected from ringed seals at two harvest locations in the Chukchi Sea, collected between May and July, and analyses revealed a shift in prey between 1975-1984 and 2003-2012 (Crawford et al., in press). Despite this change in diet, the data show that the seals have apparently adjusted, growing faster and possibly weaning more pups in the recent compared to the historic period (Crawford et al., in press).

References

Ashjian, C.J., Braund, S.R., Campbell, R. G., George, J. C., Kruse J., Maslowski, W., Moore, S. E., Nicholson, C.R., Okkonen, S. R., Sherr, B. F., Sherr, E. B., and Spitz, Y. H. 2010. Climate Variability, Oceanography, Bowhead Whale Distribution, and Iñupiat Subsistence Whaling near Barrow, Alaska. Arctic 63 (2): 179–194

Citta, J., Quakenbush, L. T., Okkonen, S. R., Druckenmiller, M. L. Maslowski, W., Clement-Kinney J., George, J. C., Brower, H., Small, R. J., Ashijan, C. J., Harwood, L. A., and Heide-Jørgensen, M. P. 2014. Ecological characteristics of core-use areas used by Bering-Chukchi-Beaufort (BCB) bowhead whales, 2006-2012. Progress in Oceanography. In press.

Crawford, J.A., Frost, K.J., Quakenbush, L.T., and Whiting, A., 2012. Different habitat use strategies by subadult and adult ringed seals (*Phoca hispida*) in the Bering and Chukchi seas. Polar Biology 35 (2), 241–255. doi: 10.1007/s00300-011-1067-1.

Crawford, J. A., Quakenbush, L. T., and Citta, J. J. in press. A comparison of ringed and bearded seal diet, condition and productivity between historical (1975–1984) and recent (2003–2012) periods in the Alaskan Bering and Chukchi seas. Progress in Oceanography. Special Issue, Synthesis of Arctic Research (SOAR) 2015.

Ferguson, S. H., I. Stirling and P. McLoughlin. 2005. Climate change and ringed seal (*Phoca hispida*) recruitment in western Hudson Bay. Marine Mammal Science 21:1): 121-135

Harwood, L.A. 1989. Distribution of ringed seals in the southeast Beaufort Sea during the open water period. M.Sc. Thesis, University of Alberta, Dept. of Zoology.

Harwood, L.A. and Stirling, I. 1992. Distribution of ringed seals in the southeastern Beaufort Sea during late summer. Canadian Journal of Zoology 70(5):891-900.

Harwood, L. A., Smith, T. G., and Auld, J. C. 2012b. Fall migration of ringed seals (*Phoca hispida*) through the Beaufort and Chukchi seas, 2001-2002. Arctic 65(1): 35-44.

Harwood, L. A., Smith, T. G., Auld, J. C., Melling, H. and Yurkowski, D. 2015. Seasonal movements and diving of ringed seals, *Pusa hispida*, in the western Canadian Arctic, 1999-2002 and 2010-2011. Arctic 68(2).

Harwood, L. A., Smith, T.G., George, J.C., Sandstrom, S.J., Wojciech, W., and Divoky, G. J. in press. Changes in the Beaufort Sea ecosystem: diverging trends in the body condition of marine mammals, seabirds and anadromous char revealed through long- term monitoring. Progress in Oceanography. Special Issue, Synthesis of Arctic Research (SOAR).

Harwood, L. A., Smith, T. G., and Melling, H. 2007. Assessing the potential effects of near shore hydrocarbon exploration on ringed seals in the Beaufort Sea Region 2003-2006. Environmental Studies Research Funds 162: 103 p.

Harwood, L. A., Smith, T. G., Melling, H., Alikamik, J., and Kingsley, M.C.S. 2012a. Ringed seals and sea ice in Canada's Western Arctic: harvest-based monitoring 1992-2011. Arctic 65(4): 377-390.

Freitas C, Kovacs, K. M., Ims, R.A., Fedak, M.A., and Lydersen, C. 2008a. Ringed seal post-moulting movement tactics and habitat selection. Oecologia 155: 193-204. http://dx.doi.org/10.1007/s00442-007-0894-9

Kelly, B.P., Badajos, O.H., Kunnasranta, M., Moran, J.R., Martinez-Baker, M., Wartzok, D., and Boveng, P. 2010. Seasonal home ranges and fidelity to breeding sites among ringed seals. Polar Biology. doi 10.1007/s00300-010-0796-x

Lowry, L.F., Frost, K.J., and Burns, J.J., 1980. Variability in the diet of ringed seals, *Phoca hispida*, in Alaska. Canadian Journal of Fisheries and Aquatic Sciences 37, 2254–2261.

Lydersen, C. 1998. Behaviour and energetics of ice-breeding north Atlantic phocid seals during the lactation period. Polar Institute.

Smith, T. G. 1987. The ringed seal, (*Phoca hispida*), of the Canadian western Arctic. Canadian Bulletin of Fisheries and Aquatic Sciences 216. 81pp.

Smith, T.G. and L.A. Harwood. 2001. Observations of neonate ringed seals, *Phoca hispida*, after early break-up of the sea ice in Prince Albert Sound, N.T. Canada, spring 1998. Polar Biology 24: 215-219.

Smith, T. G. and Hammill, M.O. 1981. Ecology of the ringed seal, *Phoca hisida*, in its fast ice breeding habitat. Canadian Journal of Zoology 59: 966-981. http://dx.doi.org/10.1139/z81-135

Smith, T. G. and Lydersen, C. 1991. Availability of suitable land-fast ice and predation as factors limiting ringed seal populations, *Phoca hispida*, in Svalbard. Polar Research 10: 585-594. http://dx.doi.org/10.1111/j.1751-8369.1991.tb00676.x

Stirling, I. 2002. Polar bears and seals in the eastern Beaufort Sea and Amundsen Gulf: a synthesis of population trends and ecological relationships over three decades. Arctic 55 (supp.1): 59-76.

Stirling, I. and Smith, T. G. Smith. 2004. Implications of warm temperatures and an unusual rain event for the survival of ringed seals on the coast of southeastern Baffin Island. Arctic 57(1): 59-67.

Stirling, I., Archibald, W.R., and DeMaster, D. 1977. Distribution and abundance of seals in the eastern Beaufort Sea. Journal of the Fisheries Research Board of Canada 34: 976-988.

Young, B. G., Loseto, L. L., and Ferguson, S. H. 2010. Diet differences among age classes of Arctic seals: evidence from stable isotope and mercury biomarkers. Polar Biology 33: 153-162. DOI 10.10007/s00300-009-0693-3

Reviewer 4:

The quality, thoroughness, and relevance of the scientific information considered; particularly whether there is any relevant information available that was not considered, but should be.

Subnivean Period: The scientific information considered in this section was thorough, however, its relevance is less certain, and habitat important to subadults was not considered. It is true that subnivean lairs have been important for protection from extreme cold in the past. The importance of subnivean lairs for protection of pups from the cold, however, may decrease as spring air and water temperatures increase. The smaller size of ringed seal pups relative to other ice seal species make it more difficult for these pups to stay warm during the short period in early April between birth and acquiring a blubber layer, however the dependence on lairs for thermal protection is likely to decrease in importance as temperatures warm. Internal temperatures of unoccupied lairs ranged from -0.1 to 0.3 ºC while ambient temperatures ranged from -34.6 to 7.8 ºC (Kelly 1983). If ambient temperatures warm enough to melt lairs in April, the thermal advantage of the lair is no longer necessary. Unless temperatures drop well below freezing after the melt event, which is

less likely under current conditions, ringed seal pups may now be able to survive on top of the ice. All other ice seal species give birth and rear their pups on top of the ice without lairs and without defenses against predators. Arctic foxes tunnel into lairs and prey on pups regardless of snow depth, it is more likely that the presence of the female protects the pup from foxes. A decreasing Beaufort Sea polar bear population could result in lower pup predation in that region. Lairs are not required in all regions for successful ringed seal pup production indicating that lairs are not a requirement for the species. Ringed seals in the Sea of Okhotsk have been pupping on the ice without the protection of lairs since the early 1900s (Smirnov 1911 in Heptner et al. 1976, p 237). The Sea of Okhotsk population was estimated to be between 676,000 and 855,000 in the 1970s and 1980s, indicating that this population is abundant and viable. Although polar bears are not present in the Sea of Okhotsk, neither are they a significant source of pup mortality in much of the southern and central Bering Sea; therefore it is unlikely that polar bears will cause significant pup mortality throughout the entire range of the Arctic subspecies of ringed seal, annually if lairs are not used for rearing pups.

The "subnivean period" as used in the proposed rule focuses on the breeding adult component of the ringed seal population. Although it is mentioned that "…subadult Arctic ringed seals have been observed to travel relatively long distances in winter to near the ice edge in the Bering Sea (Crawford et al. 2012)", the potential importance of the southern ice edge habitat to subadult ringed seals is not considered in the determination of the southern boundary of proposed critical habitat.

Basking Period: The scientific information considered in this section was thorough and relevant.

Open-Water Foraging Period: The scientific information considered in this section was less thorough, but relevant. Satellite telemetry evidence from ringed seals tagged in Kotzebue Sound indicated ringed seals that wintered, and likely bred, in the pack ice also moved north during the open-water period to the ice edge (Crawford et al. 2012). Analysis of blubber thickness measurements from our biomonitoring data show that ringed seals are fattest in the winter (November–February) and thinnest in summer (June–August) (see Fig. 13, Quakenbush et al. 2011). Johnson et al. (1966) also reported the fattest ringed seals in winter, indicating that significant foraging occurs outside the open-water period.

Diet: Our analysis of diet from stomach contents of subsistence harvested ringed seals shows that diet has changed between the past period of more ice (1975–1984) and the recent period of less ice (2003–2012). Ringed seals are eating more fish now and fewer invertebrates (Quakenbush et al. 2011, Crawford et al. *In press*). This change in diet has been accompanied by thicker blubber in the recent period indicating the change has not been negative (Quakenbush et al. 2011, Crawford et al. *In press*).

Relevant information that is available and not considered in the proposed rule includes information from Alaska Native subsistence seal hunters and the Alaska Native co-management body (the Ice Seal Committee). Seals are of major importance to coastal Native people of Alaska and provide a reliable and valued supply of fresh meat and oil to more than 60 coastal villages in western and northern Alaska. The hunters know a great deal about the biology, ecology, behavior, health, and movements of ringed seals. They also know how the environment is changing and are watching how it is affecting ringed seals. For example, information is available from recent Ice Seal Committee meeting minutes (January 2013, January 2014, and March 2015) where representatives of the ice seal hunting regions give their regional hunter reports. Those reports indicate that ringed seal numbers are high, seals are in good health, and although ice and weather conditions shorten the hunting season and make hunting more difficult, hunters are getting what they need. A letter to NMFS from the Ice Seal Committee (25 March 2011) during the comment period for the listing of ringed seals also says *"subsistence users have not yet seen signs that ringed and bearded seals are experiencing the ill effects related to climate change."* In this letter the Ice Seal Committee recommended that NMFS do a review of available traditional/local knowledge to better understand what hunters know about the status of ringed seals.

Critical Habitat Identification

Ringed seals in Alaska are known to occupy all waters of the U.S. Exclusive Economic Zone extending from the northern and western coasts of Alaska to a southern limit near Bristol Bay. Except for the southern boundary, most of ringed seal range in Alaska is included in the area proposed as critical habitat. How to define the southern boundary could be done in many ways. The way that was chosen is reasonable except that it focused on habitat where whelping conditions may occur and did not consider the southern ice edge area that we found to be important for subadults in winter (Crawford et al. 2012).

Most of the subadult ringed seals tagged near Kotzebue during (2007 and 2008) traveled to the unconsolidated ice edge for the winter and did not use fast ice or more stable pack ice. The number of tagged subadults is small relative to the overall number of subadults in the population, therefore the high proportion that used the ice edge in winter could mean this habitat is important to this age class. Thus, habitat important to this age class was not included in the scientific information considered and some of that area may have been left out of the proposed designation of critical habitat by the way the southern limit was drawn. Specifically, compare the southern boundary of the proposed critical habitat and Fig. 1b from Crawford et al. (2012).

Features essential to the conservation of the Arctic ringed seal in the United States include:

> (1) Sea ice habitat suitable for the formation and maintenance of subnivean birth lairs... This is defined as fast ice or stable pack ice with snow at least 54 cm deep. *"…because without the protection of lairs, ringed seal pups are more vulnerable to freezing and predation"*. I

agree that sea ice suitable for whelping and nursing pups to weaning is an essential feature, however, whether a snow depth of 54 cm at birth lairs is currently a requirement is not known, as was discussed above.

In addition to habitat for subnivean lairs, southern ice edge as habitat for wintering subadults should also be evaluated for consideration as essential to the conservation of the Arctic ringed seal in the United States.

(2) Sea ice habitat suitable as a platform for basking and molting of at least 15% concentration. I agree that this is a reasonable interpretation of the best information available.

(3) Primary prey resources include arctic cod, saffron cod, shrimp and amphipods. Agree.

Whether scientific information is accurately presented and reasonably interpreted and applied.

Scientific information is accurately presented and in most cases reasonably interpreted and applied, however, as stated above, some interpretations may be overemphasized under current temperature conditions and trends.

Whether scientific uncertainties are adequately identified and characterized.

Scientific uncertainties are not adequately identified and characterized. This was the weakest part of the proposed rule for listing and also for the proposed designation of critical habitat. The science reviewed does not help us understand how ringed seals will respond to less ice and related conditions because it was collected during times of more ice. Genetic information has shown that ringed seals have survived warm periods with low ice in the past (O'Corry-Crowe 2008) providing evidence of some resilience to environmental change, however, the ESA listing of Arctic ringed seals as threatened in 2012 occurred before any signs of population stress (e.g., decreased body condition, lower pregnancy rate, higher age at maturity) were observed. There has been no sign of population decline to date under the current sea ice conditions for the Arctic ringed seal in Alaskan waters (Quakenbush et al. 2011b, Crawford et al. *In press*, reports from subsistence hunters). Therefore the entire rationale behind the listing as threatened and the subsequent need to designate critical habitat is based on interpretations of how ringed seal have used ice and snow during colder conditions. There is very little information on how seals will respond to less ice and snow in warmer conditions. The few examples that are cited may not be representative of current conditions. For example, less than 54 cm of snow over lairs was important when temperatures in April were colder. If lairs melted early in the past, due to an unusual warm spell, pups could become hypothermic when temperatures dropped well below freezing again. If lairs melt now due to warm April temperatures it is less likely temperatures will drop to those that cause hypothermia. It is likely that predation may be higher in some areas with less snow or melted lairs, but predation is not likely to take the majority of pups produced each year given the vast area of ringed seal range. The point is, there is much to learn about how ringed seals, as a species, will respond to the changes that are coming and the above examples are as likely, or more likely, to occur than those presented in the proposed rule for listing or the

proposed designation of critical habitat. Arctic ringed seal distribution over multiple seas and regions ensures that conditions will vary considerably and conditions in at least some of those areas will likely continue to be suitable for ringed seals to pup, molt, and feed. While conditions may result in a reduction in pup survival in some years it will not likely result in a population reduction for more than a decade given that females are reproductively active for ~20 years of their life and pup annually.

Whether the document provides a well-reasoned rationale for the proposed critical habitat based on the best scientific information available.

As pointed out in the above comments, in some cases the document includes well-reasoned rationale for the proposed critical habitat and in other cases it does not. In most cases the best scientific information available was used although some of the interpretations may be inaccurate.

Recommendations for critical habitat:

The activities that are most likely to occur in ringed seal habitat that may require special management considerations are related to oil and gas, shipping, and commercial fishing and these are most likely to occur during the open-water season. Shore-fast ice known to be used by ringed seals is decreasing in extent and persistence, and its proximity to shore makes it more accessible for many human activities, thus elevating its need for special management considerations over larger areas of pack ice where less human activities are likely to occur. Using this information, an alternative approach for the northern boundary of critical habitat would be to include the area from shore out to ~35 km in the Beaufort Sea, and across the Chukchi Sea to the U.S. EEZ boundary. This nearshore zone would include all of the shorefast ice and some pack ice in the Beaufort Sea. The southern boundary may require revision to include the winter locations of subadult ringed seals as indicated by tagged subadults (Crawford et al. 2012) as this area could be important for many wintering subadult Arctic ringed seals and may require special management considerations if the area becomes more important for commercial fishing, such as for winter pot fisheries for crab and cod (Citta et al. 2014).

Literature Cited

Citta, J. J., J. J. Burns, L. T. Quakenbush, V. Vanek, J. C. George, R. J. Small, M. P. Heide-Jørgensen, and H. Brower. 2014. Interactions of bowhead whales and winter pot fisheries in the Bering Sea. Marine Mammal Science 30:445–459. DOI: 10.1111/mms.12047.

Crawford, J. A., K. J. Frost, L. T. Quakenbush, and A. Whiting. 2012. Different habitat use strategies by subadult and adult ringed seals (*Phoca hispida*) in the Bering and Chukchi seas. Polar Biology 35:241–255. DOI: 10.1007/s00300-011-1067-1

Crawford, J. A., L. T. Quakenbush, and J. J. Citta. *In press*. A comparison of ringed and bearded seal diet, condition and productivity between historical (1975–1984) and recent (2003–2012) periods in the Alaskan Bering and Chukchi seas. Progress in Oceanography.

Heptner, L. V. G., K. K. Chapskii, V. A. Arsen'ev, and V. T. Sokolov. 1976. Ringed seal. *Phoca (Pusa) hispida* Schreber, 1775. Pages 218–260 *in* L. V. G. Heptner, N. P. Naumov, and J. Mead, editors. Mammals of the Soviet Union. Volume II, Part 3--Pinnipeds and Toothed Whales, Pinnipedia and Odontoceti. Vysshaya Shkola Publishers, Moscow, Russia. (Translated from Russian by P. M. Rao, 1996, Science Publishers, Inc., Lebanon, NH).

Johnson, M. L., C. H. Fiscus, B. T. Ostensen, and M. L. Barbour. 1966. Marine mammals. Pages 897–924 *in*: Environment of the Cape Thompson Region, Alaska. N.J. Wilimovsky and J.N. Wolfe, eds. U.S. Atomic Energy Commission, Oak Ridge, TE.

Kelly, B. P. 1983. Ringed seal snow lairs: use patterns and thermal significance. 5th Biennial Conference on the Biology of Marine Mammals, Boston, 27 November–1 December.

O'Corry-Crowe, G. 2008. Climate change and the molecular ecology of Arctic marine mammals. Ecological Applications, 18(2) Supplement S56-S76.

Ognev, S. I. 1935. Mammals of U.S.S.R. and adjacent countries. Volume 3. Carnivora. Glavpushnina NKVT, Moscow, Russia. 641 p. (Translated from Russian by the Israel Program for Scientific Translations, Jerusalem 1962, 741 p.).

Quakenbush, L., J. Citta, and J. Crawford. 2011. Biology of the ringed seal (*Phoca hispida*) in Alaska, 1960–2010. Final Report to the National Marine Fisheries Service from the Alaska Department of Fish and Game. 72 p.

Reviewer 5:

Based on my own extensive research of the species and its habitat as well as a thorough knowledge of the scientific literature pertaining to ringed seals, I find the proposed rule to be well considered and documented and likely to enhance protection of this threatened species as called for under the Endangered Species Act.

The Proposed Rule thoroughly and accurately reviews, interprets, and applies the relevant scientific information on the species, and I am not aware of any relevant information that is left out. The Proposed Rule also appropriately considers economic and national security impacts.

Inevitably, there are uncertainties that must be addressed, and the Proposed Rule identifies those and makes balanced determinations based on the best available information. For example, the minimal depth of snow drift necessary for sheltering new born ringed seals is not known precisely, and the Proposed Rule designates 54 cm (less than the midpoint of published estimates) based on a careful reading of the literature, consideration of regional variation, and consideration of sample sizes. The Proposed rule also clearly lays out benefits of the rule that extend beyond those that can be monetized. Similarly, the consideration of the economic impacts of the proposed rule was careful and thorough.

In summary, the Proposed Rule presents a well-reasoned rationale for the designation of critical habitat that is based on thorough and accurate reading of the scientific literature and other available information.