

**Report on Special Independent Peer Review of the
Ringed Seal (*Phoca hispida*)
Status Review Report**

March 2012

National Marine Fisheries Service
Alaska Region
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Executive Summary

On December 10, 2010, the National Marine Fisheries Service (NMFS) made a 12-month finding on a petition to list the ringed seal as threatened or endangered under the Endangered Species Act (ESA) and proposed to list the Arctic, Okhotsk, Baltic, and Ladoga subspecies of the ringed seal as threatened (75 FR 77476). The proposal was informed by a status review report (Kelly et al., 2010) that compiled the best scientific and commercial data available concerning the status of the ringed seal, including the past, present, and future threats to this species. In consideration of substantial disagreement evident in peer review and public comments received on the proposed rule regarding the sufficiency or accuracy of the model projections and analysis of future sea ice habitat, in particular snow cover, for Arctic ringed seals, on December 13, 2011, we extended the deadline for the final listing determination by 6 months to June 10, 2012 (76 FR 77466).

To further ensure that our final determination is based on the best scientific and commercial data available and address the disagreement, we subsequently conducted special independent peer review of the sections of the status review report related to the disagreement. For this special peer review, we recruited two scientists with marine mammal expertise and specific knowledge of ringed seals, and two physical scientists with expertise in climate change and Arctic sea ice and snow to review these sections of the status review report and provide responses to specific review questions. We received comments from the two physical scientists and one of the marine mammal specialists. We have carefully reviewed these comments, and the primary points raised in response to the review questions are summarized below. We note that there were some points raised by one, but not both, of the reviewers. This should not be construed as disagreement or tacit agreement by the other reviewer, but rather the other reviewer made no comment on these points. The reviewers' comments are described in greater detail in the main body of this peer review report.

Climate Scientists

Question 1: Are the methods used to evaluate future sea ice conditions valid and appropriate?—One of the reviewers found the methods used to evaluate sea ice conditions valid and appropriate. The other reviewer expressed the view that the general circulation models (GCMs) used are not appropriate for directly linking to ringed seal habitat or for predicting snow on sea ice at a scale that is important for ringed seals, noting that the models: (1) do not capture precipitation adequately, particularly at the local scale; (2) do not capture openings in the ice that are large sources of moisture and heat to the atmosphere, thus making winter precipitation prediction problematic; and (3) do not account for ice surface roughness caused by deformation in the fall and through winter. This reviewer also identified the following concerns with the analysis: (1) fast ice conditions are not considered adequately in any of the GCMs used (he thought this was a key problem with the assessment because a significant amount of ringed seal habitat is related to fast ice, and he also suggested that fast ice would be less affected than marginal sea ice); (2) the status review report does not recognize that the loss of multiyear ice has translated into more first-year ice, which he argued could increase the amount of ringed seal habitat; and (3) the models are unable to predict surface deformation of the ice and seasonal availability of snow, which he noted are key to snow catchment and are key variables in ringed seal lair habitat. He also commented that basic physics suggest increased deformation can be expected as the ice forms later in the autumn and remains thinner throughout the winter, and that this could actually mean an improvement to ringed seal habitat. In addition, this reviewer thought that there was very uneven treatment of the regional sea ice predictions.

Question 2: Do you find that the uncertainties associated with the projections of changes in sea ice cover are reasonably identified and characterized?—One of the reviewers commented that the uncertainties associated with the sea ice projections were very clearly discussed.

Question 3: Is the output from the CCSM3 model the best available source to use as a basis for projecting snow cover on sea ice?—While noting there are still uncertainties, one of the reviewers expressed the opinion that the CCSM3 model is the best source available for snow cover projections. The other reviewer thought that the snow cover projections considered in the status review report are not sufficiently reliable in terms of assessing snow habitat for ringed seal lairs. This reviewer commented that the models used are not capable of capturing the physics of snow precipitation or the catchment of snow on sea ice and that such models do not yet exist.

Question 4: Do you find that the uncertainties associated with the projections of snow cover changes are reasonably identified and characterized?—One of the reviewers commented that projecting snow cover on sea ice is difficult and there remain uncertainties both in the projected depth and spatial distribution of depth. He thought that these uncertainties were identified and discussed in the status review report.

Question 5: Are there other scientific data available that could better inform our assessment of future snow conditions for Arctic ringed seal lairs?—Neither of the reviewers suggested any other data that could better inform the assessment of future snow conditions for

Arctic ringed seal lairs. One of the reviewers commented that models capable of capturing the physics of snow precipitation or the catchment of snow on sea ice do not yet exist and should be a high priority for development.

Marine Mammal Specialist

Question 1: Do you find that the uncertainties associated with the projections of snow cover changes are reasonably identified and characterized?—Reviewer 3 noted that some regional models are known to predict precipitation poorly, and thought that what is known about the performance of the CCSM3 model with respect to snow cover projections should be discussed. This reviewer also suggested that the status review report should provide additional details to address regional variation in projected freeze-up dates, and consider the relative degree of counteraction between snow accumulation and late ice formation in the different regions. In addition, she commented that the information on regional snow projections could be improved by including quantitative estimates of variance for each of the predicted snow depth ranges for each of the regions, noting that it is important to know if depth ranges were predicted equally well for all regions.

Question 2: Is the 20 cm minimum snow depth criterion for the formation and maintenance of ringed seal lairs, as a regional average depth measured on flat sea ice, reasonably supported by the best scientific data available?—Reviewer 3 noted that the presence and type of rough ice plays a critical role in determining the distribution and accumulation patterns of snow on the ice, and expressed the view that this is a complicating and highly variable factor that needs to be considered in interpreting snow cover thresholds and predicting subsequent impacts on ringed seals. This reviewer also pointed out that the minimum drift depth needed for birth lair formation and maintenance may be influenced by the ambient air temperatures and the primary predator in a particular region. She expressed the view that regional variation in the minimum snow depth required for lair construction is an important consideration, and noted that in some areas of the ringed seal's range birth lairs have been successfully constructed in drifts shallower than 45 cm, with corresponding snow depths on flat ice of less than 20 cm.

Question 3: Are there other scientific data available that could better inform our assessment of future snow conditions for Arctic ringed seal lairs?—Reviewer 3 did not identify any other data that could better inform the assessment of future snow conditions for Arctic ringed seals.

Question 4: Does the status review report adequately characterize the importance of snow cover and lairs for evaluation of risks to the persistence of the Arctic subspecies of ringed seals?—Reviewer 3 thought that the status review report made clear that there are significant latitudinal and regional differences in almost all aspects of ringed seal reproductive biology and behavior, and that this is indicative of a considerable degree of adaptive capacity. This reviewer commented that this adaptive capacity is a key reason why it is difficult to draw conclusions on

the nature and rate of climate changes impacts on ringed seals over broad geographic areas and moderately long periods of time, and expressed the opinion that these issues were not adequately addressed in the sections of the status review report that she reviewed.

Reviewer 3 also commented that while it is important to consider the observations reported of the effects of extreme weather events (e.g., extreme break-up freeze up years, heavy/light ice years, and spring rain) on Arctic ringed seals, those observations need to be considered in the proper geographic and temporal context and not overextended. This reviewer noted that these observations were for populations at the southern extent of the subspecies' range in the western Arctic, where ringed seals are expected to be more strongly affected by climate change, and that there are relatively few data on how these habitat effects are actually influencing longer-term reproductive potential and population dynamics.

In addition, Reviewer 3 commented that the link between “on-ice” predators and snow depth is strongly made in the status review report. However, she noted that the sections of the report that she reviewed did not comment on: the magnitude of the impact that increased predation might have relative to mortalities associated with other climate related factors like an early spring rain or an early break-up in a particular region; or, how the suite of predators in a particular region might change from predominantly “on-ice” species (e.g., polar bears) to “in-water” species (e.g., sharks and killer whales) and what impact that might have.

Introduction

On March 28, 2008, the National Marine Fisheries Service (NMFS) initiated status reviews of ringed (*Phoca hispida*), bearded (*Erignathus barbatus*), and spotted seals (*Phoca largha*) under the Endangered Species Act of 1973, as amended (ESA) (73 FR 16617). On May 28, 2008, we received a petition from the Center for Biological Diversity to list these three species of seals as threatened or endangered under the ESA, primarily due to concerns about threats to their habitat from climate warming and loss of sea ice. The Petitioner also requested that critical habitat be designated for these species concurrent with listing under the ESA. In response to the petition, we published a 90-day finding that the petition presented substantial scientific or commercial information indicating that the petitioned action may be warranted (73 FR 51615; September 4, 2008). Accordingly, we proceeded with the status reviews of ringed, bearded, and spotted seals and solicited information pertaining to them.

Following completion of a status review report and 12-month finding for spotted seals in October 2009 (74 FR 53683, October 20, 2009; see also, 75 FR 65239; October 22, 2010), we established Biological Review Teams (BRT) to prepare status review reports for ringed and bearded seals. The status review report of the ringed seal is a compilation of the best scientific and commercial data available concerning the status of the species, including the past, present, and future threats to this species. After the status review report was completed by the BRT (Kelly et al., 2010), on December 10, 2010, we made a 12-month finding and proposed to list the

Arctic (*Phoca hispida hispida*), Baltic (*Phoca hispida botnica*), Okhotsk (*Phoca hispida ochotensis*), and Ladoga (*Phoca hispida ladogensis*) subspecies of ringed seals as threatened (75 FR 77476). Long-term model projections of diminished sea ice and, in particular, snow cover on sea ice during the 21st century were a primary determinant in this listing proposal. We published our 12-month finding for bearded seals as a separate notification concurrently with this finding (75 FR 77496; December 10, 2010).

The proposed rule announced a 60-day comment period to close on February 8, 2011. On February 8, 2011, we extended the comment period 45 days to March 25, 2011 (76 FR 6754). Three public hearings were held in Alaska in Anchorage, Barrow, and Nome (76 FR 9733, February 22, 2011; 76 FR 14882, March 18, 2011).

In accordance with our July 1, 1994, Interagency Cooperative Policy on Peer Review (59 FR 34270), we requested the expert opinion of four independent scientists with expertise in seal biology and/or Arctic sea ice and climate change regarding the pertinent scientific data and assumptions concerning the biological and ecological information used in the proposed rule. The purpose of the review was to ensure that the best biological and commercial information was used in the decision-making process, including input of appropriate experts and specialists. We received comments from three of the reviewers.

Two of the reviewers questioned the magnitude and immediacy of the threats posed to Arctic ringed seals by the projected changes in sea ice habitat, in particular on-ice snow cover; whereas, the third reviewer found that the information used in the proposed rule adequately supported the determination. This disagreement was also evident in public comments received. In consideration of the disagreement regarding the sufficiency or accuracy of the model projections and analysis of future sea ice habitat, in particular snow cover, for Arctic ringed seals, on December 13, 2011, we extended the deadline for the final listing determination by 6 months to June 10, 2012, (76 FR 77466).

To further ensure that our final determination is based on the best scientific and commercial data available and address the disagreement, we subsequently conducted special independent peer review of the sections of the status review report (Kelly et al., 2010) related to the disagreement. For this special peer review, we recruited two scientists with marine mammal expertise and specific knowledge of ringed seals, and two physical scientists with expertise in climate change and Arctic sea ice and snow to review these sections of the status review report and to provide responses to specific review questions (Appendices A and B).

We received comments from the two climate scientists and one of the marine mammal specialists. We carefully reviewed these comments, and have consolidated them in this report. Where individual reviewers offered conflicting comments, this report includes the viewpoints of both reviewers. There were some points raised by one, but not both, of the reviewers. This should not be construed as disagreement or tacit agreement by the other reviewer, but rather the other reviewer made no comment on these points.

Issues Raised in the Special Independent Peer Review Comments

Climate Scientists

Question 1: Are the methods used to evaluate future sea ice conditions valid and appropriate?

Reviewer 1 found the methods used to evaluate sea ice conditions were valid and appropriate, and he noted that the authors made good use of the literature to select the Intergovernmental Panel on Climate Change's (IPCC) model runs that best represented sea ice conditions in the regions of interest. Reviewer 2 similarly commented that he liked the way that a subset of the models was chosen to best match the observed changes in sea ice in recent times. However, this reviewer discussed the following concerns with the analysis:

- (1) He expressed the view that the circulation models (GCMs) are not appropriate for directly linking to ringed seal habitat or for predicting snow on sea ice that is at a scale that is important to ringed seals, noting that for example, the models do not: (a) capture precipitation adequately, as the hydrological cycle is very hard to model (particularly at the local scale); (b) capture the openings in the ice in winter that are large sources of moisture and heat to the atmosphere, thus making prediction of winter precipitation problematic; and (c) account for ice surface roughness caused by deformation in the fall and through winter.
- (2) He commented that fast ice conditions are not considered adequately in any of the GCMs used because these models are unable to deal with the physics of this type of ice. Reviewer 2 thought this was a key problem with the status review assessment since a significant amount of ringed seal habitat is related to fast ice. He noted that recent results from his lab indicate fast ice timing around the Canadian Arctic is changing somewhat, but much slower than in marginal ice areas, which is related to the fact that continents cool quickly in autumn while open water in the ocean delays freeze-up in the marginal ice zone. Thus, he suggested the fast ice habitat of ringed seals would be less affected than marginal ice habitat.
- (3) He noted that the status review report did not recognize that the loss of multiyear ice has translated into more first-year sea ice (as an aerial average over the northern hemisphere), which he argued could increase the amount of ringed seal habitat. For example, Reviewer 2 noted ringed seals were observed to 88° N latitude during a 2010 icebreaker expedition, and have also been observed well into the center of the Beaufort Sea ice gyre in first-year ice when only 20 years ago this would have been dominated by multiyear ice that ringed seals would not have used.
- (4) He pointed out that the models are unable to predict surface deformation of the ice and the seasonal availability of snow, which he noted are key to snow catchment hydrology within the icescape and are key variables in ringed seal lair habitat. He commented that basic physics suggest increased ice deformation can be expected as the ice forms later in

the autumn and remains thinner throughout the winter, and that this could actually mean an improvement to ringed seal habitat in the short term.

Regarding the regional sea ice predictions in the status review report, Reviewer 2 thought that there was very uneven treatment of the problem being addressed. He reiterated his view that the GCMs are appropriate for hemispheric or global scale projections, noting that they do not capture sea ice deformation in the marginal sea ice zone or fast ice formation and deformation, and that the analysis does not recognize that in regions where multiyear sea ice has dominated, it has now been replaced by first-year ice. Reviewer 2 also commented that the models show how much the duration of open water can be expected to increase in each of the regions considered, which he finds compelling. He suggested that this would create problems for polar bears as they try to return to the sea ice in autumn, and may also affect ringed seal habitat. However, he discussed that a direct effect on ringed seal lair development would not be expected because the model projections indicate the open water season would be largely dominated by later autumn rather than earlier spring.

Question 2: Do you find that the uncertainties associated with the projections of changes in sea ice cover are reasonably identified and characterized?

Reviewer 1 found that the uncertainties associated with the sea ice projections were very clearly discussed. He also noted that a nice explanation was provided for the divergence in AOGCM climate projections, and that the discussion of possible future ice conditions for different regions of the Arctic was “excellent.”

Question 3: Is the output from the CCSM3 model the best available source to use as a basis for projecting snow cover on sea ice?

While noting there are still uncertainties, Reviewer 1 commented that the CCSM3 model is the best source available for snow cover projections. Reviewer 2 expressed the view that the snow cover projections considered in the status review report are not sufficiently reliable in terms of assessing snow habitat for ringed seal lairs, noting that: (1) it is well known that the GCMs do not adequately predict precipitation; and (2) as discussed regarding the sea ice projections, the models do not capture sea ice deformation processes, and are thus not adequate to predict snow catchment topography, which is a key variable in lair development. This reviewer commented that these types of processes require much different types of models than the GCMs considered, but such models do not yet exist and should be a high priority for development. He also noted that snow catchment on sea ice is not well understood (nor modeled), and that blowing snow models are in development in several labs that will eventually be useful in ringed seal habitat assessment. In addition, he suggested that regional models that adequately capture Arctic precipitation (such as the GEM-LAM model in Canada) should be used to estimate changes in precipitation.

Question 4: Do you find that the uncertainties associated with the projections of snow cover changes are reasonably identified and characterized?

Reviewer 1 commented that projecting snow cover on sea ice is difficult and there remain uncertainties both in the projected average depth and spatial distribution of depth. He found that these uncertainties were identified and discussed in the status review report.

Question 5: Are there other scientific data available that could better inform our assessment of future snow conditions for Arctic ringed seal lairs?

Reviewer 1 stated that he is not aware of any other available data that could be used to assess future snow conditions. Reviewer 2 commented that models capable of capturing the physics of snow precipitation or the catchment of snow on sea ice do not yet exist and should be a high priority for development.

Other points raised by the reviewers

Reviewer 1 agreed with the status review report statement (p. 82) that most snow falls in autumn. However, this reviewer noted that it is not as clear whether this is due to local moisture or autumn storms bringing moisture up from lower latitudes, and suggested adding references and clarifying this point with J. Overland or M. Serreze. He also commented that Fig. 28 in the status review report appeared to show a linear increase in snow depth from October through March, which seemed to disagree with: (1) a statement in the report that “Progressively later formation of sea ice will result in less snow accumulation as most snow falls on sea ice in autumn” (p. 82); and (2) snow observations discussed on pages 108-109.

Reviewer 2 pointed out that the projections of future snow cover were discussed in terms of current climatology of snow over sea ice (i.e., increased precipitation in autumn and spring and less in winter). However, he suggested snow climatology would be expected to change due to more open water later into the winter, which would provide a moisture source for increasing pulses of snow on sea ice in the autumn and perhaps through the winter if the atmosphere remained warmer. For example, he noted that during recent field work in the southern Beaufort Sea during winter, this process was evident as snow accumulated through the winter period in Amundsen Gulf, complete with increased numbers and intensity of cyclones delivering that precipitation. Nevertheless, this reviewer commented that he remains concerned about ringed seal habitat and in particular the increasing probability of spring precipitation coming in the form of rain during the critical birth lair period (i.e., April). He thought that it is important to remain vigilant about ringed seal habitat and that we make it a priority to understand the salient physics, particularly with prediction of snow precipitation and snow catchment, and then develop models designed for this type of assessment at the regional scale.

Marine Mammal Specialist

Question 1: Do you find that the uncertainties associated with the projections of snow cover changes are reasonably identified and characterized?

Reviewer 3 thought that given the importance of snowfall predictions to assessing the quality of future ringed seal habitat, there should be discussion of what is known about the performance of the CCSM3 model with respect to snow cover projections, noting that not all models predict decreased precipitation in all Arctic areas, and that in some regional models, precipitation is one of the variables that is often poorly predicted. Regarding the observation that progressively later ice formation will result in less snow accumulation (e.g., p. 82), this reviewer thought that more details should be provided to identify in which geographic areas this would apply and address the variation in freeze-up dates for different regions. She suggested that given the projections of increased precipitation reported for some other models discussed in the status review report, the degree of counteraction between snow accumulation and late ice formation could be important, particularly in regions not experiencing significantly late ice formation relative to autumn snow accumulation. She also commented that the information on regional snow cover projections could be improved by including more quantitative estimates of variances for each of the predicted snow depth ranges for each of the regions, noting that it is important to know if depth ranges were predicted equally well in each region.

Question 2: Is the 20 cm minimum snow depth criterion for the formation and maintenance of ringed seal lairs, as a regional average depth measured on flat sea ice, reasonably supported by the best scientific data available?

Reviewer 3 commented that in evaluating the impacts of the predicted changes in snow fall throughout the range of the species, regional variation in the minimum snow depth required for lair construction is an important consideration and requires further study. This reviewer pointed out that the minimum drift depth for a lair where a pup is successfully reared may be influenced by the regional ambient air temperatures and the primary predator; thus at more southern latitudes, lairs may be found in shallower drift depths due to milder temperatures and the reduced number of polar bears. She also noted that the presence and type of rough ice plays a critical role in determining the distribution and accumulation patterns of snow on the ice, and expressed the view that this is a complicating and highly variable factor that needs to be considered in interpreting snow cover thresholds and predicting subsequent impacts on ringed seals. Reviewer 3 commented that although the status review report considered snow drifts of 45 cm or more (with corresponding snow depths on flat ice of 20 cm) as necessary for lair formation, in some areas of the ringed seal's range lairs have been constructed in shallower drifts that provided protection for successful rearing of a pup. For example, Reviewer 3 noted that based on observations in coastal Labrador, as long as the appropriate rough ice is present, 10 cm of snow cover could still provide adequate snow drift development for successful lair construction, depending on ice deformation in the area.

Reviewer 3 also commented that there has been very little modeling work done to establish the relationship between snow cover and snow drift height in the different regions of the seal's range. In addition this reviewer suggested that it should be noted how difficult it is to measure snow cover and how poor the available data are across various parts of the species' range. She also expressed the opinion that the Iacozza and Barber (1999) study linking thinner first year ice conditions with increased deformation is potentially very important and warrants further discussion and interpretation in the status review report.

Finally, Reviewer 3 suggested that the statement in the status review report that average snow depths already appear to be below levels necessary for lair formation in much of Hudson Bay (p. 111) should be reviewed by Hudson Bay researchers. She commented that although there is evidence of a decline in the western Hudson Bay population of seals (or perhaps decadal cycles) this is not consistent with the longer term reproductive failure implied by this statement.

Question 3: Are there other scientific data available that could better inform our assessment of future snow conditions for Arctic ringed seal lairs?

Reviewer 3 did not identify any other data that could better inform the assessment of future snow conditions for Arctic ringed seal lairs.

Question 4: Does the status review report adequately characterize the importance of snow cover and lairs for evaluation of risks to the persistence of the Arctic subspecies of ringed seals?

Reviewer 3 thought that the status review report made clear that there are significant latitudinal and regional differences in almost all aspects of ringed seal reproductive biology and behavior. This reviewer commented that these data indicate ringed seals exhibit a considerable degree of adaptive capacity relative to climate related changes, noting that this adaptive capacity and the associated variation in reproductive life history characteristics of ringed seals are key reasons why it is so difficult to draw conclusions on the nature and rate of climate change impacts on ringed seals over broad geographic areas and over moderately long periods of time. This reviewer expressed the opinion that these issues and how to deal with them were not adequately addressed in the sections of the status review she reviewed, nor was enough consideration given to these related issues from the perspective of overall interpretation of the data presented or the conclusions made.

Reviewer 3 also commented that while it is very important to consider the observations reported for Arctic ringed seals in extreme break-up/freeze-up years, heavy and light ice years, and spring rain events, there are relatively few data on how these habitat effects are actually influencing longer-term reproductive potential and population dynamics. This reviewer also noted that the information presented is for populations at the southern extent of the subspecies' range and in the western Arctic, where ringed seals are expected to be more strongly affected by climate change compared to other regions in the Canadian Arctic. While again acknowledging that these findings are extremely important, this reviewer cautioned that they need to be

considered in the proper geographic and temporal context and not overextended. She also suggested that the related reproductive and/or abundance data should be considered in more detail in terms of the time scale of the changes noted, the biological significance of the changes, and the variations associated with the data. In addition, she noted that it should be acknowledged that for many other areas in Canadian waters there are no current population estimates, little information on reproductive productivity, and very limited habitat monitoring.

Finally, Reviewer 3 commented that the link between “on-ice” predators and snow depth was strongly made in the status review report; a lack of adequate snow cover/drift development clearly correlates with decreased survival of ringed seal pups due to inadequate lair formation. Therefore, this reviewer believed it is likely that the impact of predation will increase in regions where there are predictions for significant decreases in snow cover. She noted that the sections of the status review report that she reviewed did not comment on the magnitude of the impact that increased predation might have relative to mortalities associated with other climate related factors like an early spring rain or an early break-up in a particular region. This reviewer also commented that the status review report did not discuss how the suite of predators in a particular region might change from predominantly “on-ice” species to “in-water” species and what impact this might have. For example, she noted that there is some new information on shark and killer whale predation becoming available that may be important for some regions.

Other points raised by the reviewers

Reviewer 3 thought that there should be more focus on the seasonal thresholds and types of ice that are thought to be important for ringed seals, noting that some thresholds are likely to be more critical than others. For example, a change in ice thickness in core Arctic habitat may be less significant than a change in freeze-up dynamics that affects ice roughness and subsequent snow drift development in the medium and long-term. This reviewer suggested that this type of data synthesis is needed to evaluate how important changing ice extent, thickness, and presence of multiyear ice actually will be in the future, and found it lacking in the sections of the report that she reviewed. She also noted that there are few data on what proportion of available “suitable” habitat is actually used by ringed seals in most areas of the species’ range. She thought that without this information it is difficult to evaluate the impacts of ice loss. This reviewer suggested that in core Arctic areas, availability of ice habitat may not be a limiting factor even with the predicted changing conditions in the short and medium term.

Reviewer 3 also commented that two points raised in the status review report—that loss of sea ice varies on a regional basis, and that the early loss of summer sea ice cannot be extrapolated to the seasonal ice zones—emphasize why it is so difficult to draw conclusions about climate related impacts on Arctic ringed seals over broad geographic regions and time scales. She expressed the opinion that this was not adequately reflected in the overall interpretation of results and development of conclusions in the sections of the report that she reviewed.

Regarding the question of whether ringed seals will move north with retreating ice cover into deeper, less productive waters and whether the forage fish they prey on will also move,

Reviewer 3 commented that it is difficult to predict how quickly the distribution of seals might change in some regions given what is known about the relatively diverse diet of ringed seals in different regions and the potential for new species of forage fish (and other prey species) to shift northward. She thought that this point needed to be acknowledged, as it likely to be highly variable and makes drawing conclusions over broad geographic regions difficult.

Finally, Reviewer 3 expressed the opinion that given what is known about how the reproductive behavior of Ladoga and Saimaa ringed seals has changed in recent history (i.e., increased use of shorelines for lair construction, etc.), the statement in the status review report that the projected sea ice changes by the end of this century will be rapid relative to ringed seal generation time and thus limit adaptive responses (p. 105) should be considered more carefully. This reviewer also commented that the section of the status review report that provides background information on the importance of ice as a basking platform in the Arctic (section 2.4.3) should include information on what happens in areas of the range (e.g. Ladoga and Saimaa ringed seals) where ice currently does not remain intact long enough for seals to use it for the whole period. She noted that there is discussion in the report of limited evidence suggesting that the lack of a suitable ice platform may lead to a delayed molt, and suggested the longer term impact of this from a survival aspect should be addressed or noted as a data gap.

Citations

- Iacoza, J., and D. G. Barber. 1999. An examination of the distribution of snow on sea-ice. *Atmosphere-Ocean* 37:21–51.
- Kelly, B. P., J. L. Bengtson, P. L. Boveng, M. F. Cameron, S. P. Dahle, J. K. Jansen, E. A. Logerwell, J. E. Overland, C. L. Sabine, G. T. Waring, and J. M. Wilder. 2010. Status review of the ringed seal (*Phoca hispida*). U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-212. 250 p. Available at <http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-212.pdf>.

**Appendix A: Peer Review Request to Climate Scientists
for Special Independent Peer Review of the
Ringed Seal Status Review Report**

The National Marine Fisheries Service (NMFS) has proposed to list the Arctic subspecies of the ringed seal as threatened under the U.S. Endangered Species Act (ESA), primarily due to the threat posed by projected decreases in sea ice, and especially, snow cover (75 FR 77476, 2010). The ESA status review was conducted by a Biological Review Team, who prepared a review of the best scientific and commercial data available concerning the status of the ringed seal, including the past, present, and future threats to these species (Kelly et al., 2010; Enclosure 1).

We requested the expert opinion of four independent scientists with expertise in seal biology and/or Arctic sea ice and climate change regarding the pertinent scientific data and assumptions concerning the biological and ecological information used in the proposed listing rule. We received comments from three of the reviewers.

There was significant disagreement among these reviewers and among members of the public who commented on the proposed listing, concerning the sufficiency or accuracy of the analysis of model projections of future on-ice snow cover, and the magnitude and immediacy of the threats posed to this population by the projected changes in sea ice habitat. An acknowledged limitation to the projections is that they are from a single model that has snow data available.

To address the disagreement and further ensure that our decision process is based upon the best scientific and commercial data available, we are conducting additional peer review of the abovementioned aspects of the status review report. This special peer review will involve individual review by several experts, and will be limited to the relevant sections of the status review report (see below). A report summarizing the special peer review comments received will be made available for public comment. It should be noted that if NMFS receives a Freedom of Information Act request, anonymity of comments cannot be guaranteed.

You have been identified as an independent specialist with appropriate expertise to contribute to the special peer review. Your participation would greatly assist our determinations on this listing action. We request your review of the sections of the status review report identified in the enclosed outline (Enclosure 2), and your specific responses to the following questions. Please also feel free to consult other sections of the report in conducting this review.

- (1) Are the methods used to evaluate future sea ice conditions valid and appropriate?
- (2) Do you find that the uncertainties associated with the projections of changes in sea ice cover are reasonably identified and characterized?
- (3) Is the output from the CCSM3 model the best available source to use as a basis for projecting snow cover on sea ice?
- (4) Do you find that the uncertainties associated with the projections of snow cover changes are reasonably identified and characterized?
- (5) Are there other scientific or commercial data available that could better inform our assessment of future snow conditions for Arctic ringed seal lairs?

Your inclusion in this special peer review is very important to the listing process. We appreciate your assistance in this special peer review and request that you submit written comments...

Enclosures

- 1) Status review of the ringed seal
- 2) Outline of ringed seal status review report sections for review

Enclosure 1

Kelly, B. P., J. L. Bengston, P. L. Boveng, M. F. Cameron, S. P. Dahle, J. K. Jansen, E. A. Logerwell, J. E. Overland, C. L. Sabine, G. T. Waring, and J. M. Wilder. 2010. Status review of the ringed seal (*Phoca hispida*). U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-212. 250 p. Available at <http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-212.pdf>.

Enclosure 2

Ringed seal status review report sections for review

Highlighted sections contain information pertaining to observations or projections of sea ice and snow cover on sea ice, particularly in the Arctic.

Section	Pages
Executive Summary	xii
4.2.1.1.1 Effects of climate change on the annual formation of ringed seals' habitat	46-49
4.2.1.1.1.1 IPCC model projections	49-51
4.2.1.1.1.2 Northern Hemisphere	51-59
4.2.1.1.1.3 Sub-regions	59-86
4.2.1.2.1 Impacts related to changes in ice and snow cover	108-109, 110-112

**Appendix B: Peer Review Request to Marine Mammal Specialists
for Special Independent Peer Review of the
Ringed Seal Status Review Report**

The National Marine Fisheries Service (NMFS) has proposed to list the Arctic subspecies of the ringed seal as threatened under the U.S. Endangered Species Act (ESA), primarily due to the threat posed by projected decreases in sea ice, and especially, snow cover (75 FR 77476; December 10, 2010). The ESA status review was conducted by a Biological Review Team, who prepared a review of the best scientific and commercial data available concerning the status of the ringed seal, including the past, present, and future threats to this species (Kelly et al., 2010; Enclosure 1).

We requested the expert opinion of four independent scientists with expertise in seal biology and/or Arctic sea ice and climate change regarding the pertinent scientific data and assumptions concerning the biological and ecological information used in the proposed listing rule. We received comments from three of the reviewers.

There was significant disagreement among these reviewers and among members of the public who commented on the proposed listing, concerning the sufficiency or accuracy of the analysis of model projections of future on-ice snow cover, and the magnitude and immediacy of the threats posed to Arctic ringed seals by the projected changes in sea ice habitat. An acknowledged limitation to the projections is that they are from a single model that has snow data available.

To address the disagreement and further ensure that our decision process is based upon the best scientific and commercial data available, we are conducting additional peer review of the abovementioned aspects of the status review report. This special peer review will involve individual review by several experts, and will be limited to the relevant sections of the status review report (see below). A report summarizing the special peer review comments received will be made available for public comment. It should be noted that if NMFS receives a Freedom of Information Act request, anonymity of comments cannot be guaranteed.

You have been identified as an independent specialist with appropriate expertise to contribute to the special peer review. Your participation would greatly assist our determination on this listing action. We request your review of the sections of the status review report identified in the enclosed outline (Enclosure 2), and your specific responses to the following questions. Please also feel free to consult other sections of the report in conducting this review.

- (1) Do you find that the uncertainties associated with the projections of snow cover changes are reasonably identified and characterized?
- (2) Is the 20 cm minimum snow depth criterion for the formation and maintenance of ringed seal lairs, as a regional average depth measured on flat sea ice, reasonably supported by the best scientific data available?
- (3) Are there other scientific or commercial data available that could better inform our assessment of future snow conditions for Arctic ringed seal lairs?

- (4) Does the status review report adequately characterize the importance of snow cover and lairs for evaluation of risks to the persistence of the Arctic subspecies of ringed seals?

Your inclusion in this special peer review is very important to the listing process. We appreciate your assistance in this special peer review and request that you submit written comments...

Enclosures

- 1) Status review of the ringed seal
- 2) Outline of ringed seal status review sections for review

Enclosure 1

Kelly, B. P., J. L. Bengston, P. L. Boveng, M. F. Cameron, S. P. Dahle, J. K. Jansen, E. A. Logerwell, J. E. Overland, C. L. Sabine, G. T. Waring, and J. M. Wilder. 2010. Status review of the ringed seal (*Phoca hispida*). U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-212. 250 p. Available at <http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-212.pdf>.

Enclosure 2

Ringed seal status review report sections for review

Highlighted sections contain information pertaining to:

- (1) observations or projections of snow cover on sea ice, particularly in the Arctic; or
- (2) the physical/biological basis for determining ringed seals' snow-cover habitat needs, including the phenology, distribution, and depth of snow cover, and the importance of subnivean lairs to ringed seals.

Section	Pages
Executive Summary	xii-xiv
2.4.2 Seasonal Distribution, Habitat-use, and Movements – Subnivean period	13-14
2.5 Reproduction and Molting	15
4.2.1.1.1 Effects of climate change on the annual formation of ringed seals' habitat	46, 48-49
4.2.1.1.1.2.1 Data and analytical methods	52
4.2.1.1.1.3.3 Northern Hemisphere/Regional snow-cover predictions	82-86
4.2.1.1.2 Effects of climate change on the quality of ringed seals' habitat	88-89
4.2.1.2.1 Impacts related to changes in ice and snow cover	105-112
4.2.3.3 Predation	127-129