Erimo Area Kuril Harbor Seal Specified Rare Wildlife Management Plan

March 2016

Ministry of the Environment

Contents

1. Plan establishment background

The Kuril harbor seal is distributed across an area stretching from the eastern coastline of Hokkaido to Cape Erimo; these seals display a high level of philopatry, using the same rocky shore reefs as haul-out sites throughout the year. It is believed that there were at least 1 500 individuals living on the Hokkaido coastline in the 1940s (Inukai 1942, Itoo and Shukunobe 1986). However, after World War II, with overhunting for meat and hides as well as habitat deterioration due to revetments along the coastline, etc., the number of confirmed individuals had fallen to less than 400 by the 1970s (Mammal Research Group Marine Animal Consultation Meeting 1973, 1979, 1980a, 1980b, Hayama 1988). According to the population survey reported at the 1973 Marine Mammal Research Group meeting, it became clear that the members of this species inhabiting the Hokkaido coastline were on the verge of extinction (Kobayashi et al. 2014), and they were assessed as being Endangered and became protected in 1998. Since 1980, both seal hunting and the construction of revetments, which destroys the rocky shore reefs where the seals haul-out, have been stopped. As a result, the confirmed number of individuals has been on a growing trend, and the largest number of individuals of this species hauling out on the Hokkaido shoreline had recovered to 1 089 in 2008 (Kobayashi et al. 2014). In light of this situation, the assessment category of this species was changed from Endangered to Vulnerable in August 2012. At Cape Erimo, the largest haul-out site in Hokkaido, the largest recorded number of individuals hauling out was approximately 150 in the 1970s, but had risen to approximately 600 in 2013 (Kobayashi et al. 2014). Further, because there is some distance between Cape Erimo and other haul-out sites, the population breeding in the Cape Erimo area is thought to have a tendency toward genetic independence. Moreover, with the increase in the number of individuals of this species at Cape Erimo, the damage caused to the fishing industry by Kuril harbor seals, primarily to salmon in trap nets, has become a serious situation; in the Erimo area, ¥63 000 000 in damages was reported in FY 2014 for damage done to the catch in salmon trap nets alone (Hokkaido Government). In addition, other types of damage to the fishing industry are being reported, including damage to octopus fishing from seals eating octopus, and it is thought that these have newly originated as a result of the expansion of the Kuril harbor seal's range. Conversely, Kuril harbor seals are being used as a resource for tourism, and people are searching for ways of coexisting with this species.

In light of this situation, the Ministry of the Environment has been making efforts to assess the sustainability of the Kuril harbor seal in the Erimo area and to mitigate the damage to the fishing industry, and on 9. May 2014, a plan was established meeting the standards for Specified Wildlife Conservation and Management Plans as designated in

Paragraph 7 of the Wildlife Protection and Hunting Management Act, with its period until 31. March 2016.

Regarding mitigation of damage to the fishing industry, the Ministry of the Environment, working through partnerships with researchers and other local stakeholders, and with the understanding and cooperation of members of the fishing industry, made improvements to fishing nets, etc., with a certain level of effectiveness (see Supplement 8). However, the damage situation remains severe (see Supplement 7).

Further, with the enforcement of the revision of the Wildlife Protection and Hunting Management Act to the Wildlife Protection, Control, and Hunting Management Act on 29. May 2015, for rare wildlife whose population in specified areas is increasing and whose range is expanding, it has become possible to establish Specified Rare Wildlife Management Plans when deemed necessary for systematic population management. These plans work to safely preserve the species and local populations of said rare wildlife, from the point of view of conserving biodiversity, preserving habitats, as well as of planning sound development of agriculture, forestry, and fisheries. Moreover, wildlife which has been removed from the list of threatened species but for which no procedure for protection and management has been established, and for which it is necessary to move forward with protection and management while in the early stages considering procedures for systematic protection and management, is now considered rare wildlife under Ministry of the Environment fundamental guidelines, which were amended after the enforcement of the abovementioned revised Law in December of 2015.

In light of this situation, regarding the assessment of the sustainability of the Kuril harbor seal, in addition to the many years of observation records of the number of individuals hauling out from the Kuril Harbor Seal Research Group and others, the latest survey results, including aerial vehicle and transmitter tagging data, have provided corrected values for the data regarding discovery rates, haul-out probability, and others (see Supplements 3 and 4), and it has become possible to calculate the probability of extinction of this species using numerical analysis. Based on the results of the analysis done by the Kuril Harbor Seal Science Committee, among others (see Supplements 5 and 6), the Kuril harbor seal's extinction risk level has been reassessed by the Ministry of the Environment Red List Investigative Committee, and in September 2015 it was determined that according to the Red List assessment categories, Near Threatened was appropriate, and that this species did not qualify for designation as Endangered or Vulnerable. This was achieved as a result of many years of protection efforts and the understanding and cooperation of local shareholders.

In light of this situation, in accordance with the abovementioned revision to the Wildlife Protection, Control, and Hunting Management Act, until a procedure for the management of the Kuril harbor seal has been established, leaving the Kuril harbor seal

designated as Rare Wildlife under the above law, the Ministry of the Environment established the Erimo Area Kuril Harbor Seal Specified Rare Wildlife Management Plan (hereafter, the "Management Plan"), whose target is the population breeding in the Cape Erimo area.

2. Plan goal

The goal of the Management Plan is the establishment of procedures for population management, damage prevention, monitoring, etc., through the Ministry of the Environment partnering with a variety of project commissioning entities, in order to promote current and future coexistence between the Kuril harbor seal population in the Erimo area and the local community, including the coastal fishing industry, so as to prevent the Kuril harbor seal from once again becoming threatened.

3. Wildlife species to be managed

Kuril harbor seal (*Phoca vitulina*)

4. Plan term

This plan's term shall be from 1. April 2016 to 31. March 2020.

5. Zone in which management of specified rare wildlife is to be performed

The zone inhabited by the population breeding in the Cape Erimo area.

6. Specified rare wildlife management objectives

(1) The first objective is to perform management aimed at maintaining the Kuril harbor seal population at a sustainable level, and also mitigating the damage done to the fishing industry.

- Because damage prevention alone cannot provide protection from all damage, such as expansion in the scope of the damage done to the fishing industry following increases in the Kuril harbor seal population, some seals will be captured in order to mitigate the damage done to the fishing industry.
- However, the sustainability of this population must be guaranteed, and the Ministry of the Environment intends to keep the probability of extinction within the next 100 years to below 10%.
- The maximum allowed annual combined capture and bycatch level will be reexamined each year from the perspective of adaptive management, making possible responses to unforeseen circumstances such as epidemic outbreaks;

and taking into account the most recent assessment of the population situation, the number of deaths caused by humans up to the previous year, and the sex ratio and age composition of the seals that have died.

- The number of individuals to be captured will be adjusted freely to fit the trends in the number of bycatch deaths in the previous year.
- The actions listed above will be carried out, while at the same time information necessary for the reevaluation of the plan will be collected, all with the goal of appropriate population management.

(2) The second objective is to work toward mitigation of damage to the fishing industry through improvement in damage prevention procedures.

- The Ministry of the Environment verifies the results of the various prevention procedures implemented to date (Supplement 8), and establishes improved procedures (including improvements in fishing nets, improvements in acoustic repellent devices, and investigation into the conditions under which they may be installed) as well as new procedures (including the capture, training, and release of individuals that habitually break into fishing nets and other fishing implements).
- These procedures are being implemented in collaboration with researchers and other related parties, and with adequate consideration of opinions from local fishermen.

7 Items pertaining to strategies for specified rare wildlife management

- It has become clear from surveys to date that damage is caused to salmon trap nets not so much by juveniles, who are easily bycaught, but by specific subadults and adults (Supplements 2 and 3). For this reason, the Ministry of the Environment will selectively capture subadults and adults that persistently attack trap nets, and develop techniques to avoid juvenile bycatch. Through the establishment of these techniques, the Ministry will selectively capture subadults and adults that persistently attack trap nets, and work to reduce the number of juvenile deaths caused by bycatch.
- The primary procedures for capture are procedures which allow for the selection of individuals that persistently attack trap nets, including but not necessarily limited to captures made directly through trap nets themselves and traps designed to capture seals.
- Other procedures (including the use of firearms) will also be considered as necessity dictates.
- The capture of seals will take place with the cooperation of local residents.

- To the fullest extent possible, the Ministry of the Environment is considering ways of effectively putting captured individuals to practical use, including use for research in order to gather data which will facilitate appropriate population management, and strategically raising individuals and transferring them to zoos and aquariums for educational and other purposes. Moreover, in cases when captured individuals are to be euthanized, it is to be done in a manner which limits their suffering to the greatest extent possible.

8 Items pertaining to measures for the prevention of damage caused by specified rare wildlife

- The following damage prevention measures are being implemented. Regarding these procedures, their effectiveness is being verified concurrently with their implementation, and other procedures will be considered as necessity dictates. Further, it is necessary to gain the cooperation of members of the fishing industry for the consideration and implementation of these measures.

(1) Improvement of fishing nets

The Ministry of the Environment will continue to move forward with the improvement of nets that prevent damage, through procedures to deter Kuril harbor seals from entering trap nets (such as installing rope grids), and procedures to separate salmon and Kuril harbor seals inside of trap nets (such as installing partition nets), all while considering the opinions of fishing industry members. Further, the Ministry will provide feedback to the local community about the results of attempts at improvement, and promote prevention initiatives.

(2) Improvement of acoustic repellent devices, etc.

In addition to developing devices with powerful repellent effects on Kuril harbor seals, the Ministry of the Environment is also considering installation methods which will better make use of these effects.

The Ministry is also gathering data about damage other than that done to salmon trap nets, and surveying the real extent of the damage to the fishing industry. Particularly, as the damage to octopus fishing is immense and growing, it is also necessary to consider damage prevention procedures in this area.

9 Other items necessary for specified rare wildlife management

(1) Items related to habitat protection and the local community

The Kuril harbor seal is the only seal living in the Hokkaido region that displays a high level of philopatry, using rocky shore reefs for pupping. In Hokkaido, a total of 11 haul-out sites have been identified, including those at Nemuro, Hamanaka, and Akkeshi, with Cape Erimo being the southernmost point (Yoshida et al. 2011) (Fig. 1). Particularly, the Kuril harbor seals breeding in the Erimo area are concentrated around the rocky shore reefs at Cape Erimo, and in recent years, the total area of the haul-out sites has been expanding (Fig. 2). Further, it has been pointed out that in the Erimo area, there are some new haul-out sites that are used only during breeding season.

Regarding the Kuril harbor seal's food sources, feeding habits surveys conducted at Hokkaido's Cape Nosappu have reported that bottomfish are their primary prey, and that they are highly dependent on the shallow ocean environments near the coastline (Nakaoka et al. 1986, Wada et al. 1992). In a 2014 survey conducted by the Environment Research and Technology Development Fund, bottomfish, which are potential prey of the Kuril harbor seal were collected in the Cape Erimo haul-out site area, and it was shown that the cottidae are their primary food source during winter and spring seasons. Further, in analysis of the stomach contents of individuals bycaught in trap nets, etc., octopodidae, Alaska pollock, saffron cod, gadidae, and others were identified, but salmon appeared infrequently. However, because the majority of bycaught individuals were juveniles, and because the survey was conducted during a limited period of time, there is insufficient data regarding what subadults and adults eat (Supplement 2).

Further, the position of Kuril harbor seals in coastal marine ecosystems, and the interaction between Kuril harbor seals and their habitat (the effects of their habitation trends on coastal marine life, and so on) are unknown.

Moreover, in order to achieve coexistence with the Kuril harbor seal, both the point of view of their relationship with the fishing industry and its activities, and the point of view of their relationship with the local community, including use for tourism and applications in local education, are highly important.

For these reasons, the Ministry of the Environment is gathering additional information regarding their habitat, sources of food, etc., and conducting surveys on the type of environment that will allow the Kuril harbor seals to survive in this area, from the point of view of the relationship between the Kuril harbor seals and the local community, as well as from the point of view of habitat and marine resources in the Erimo area.

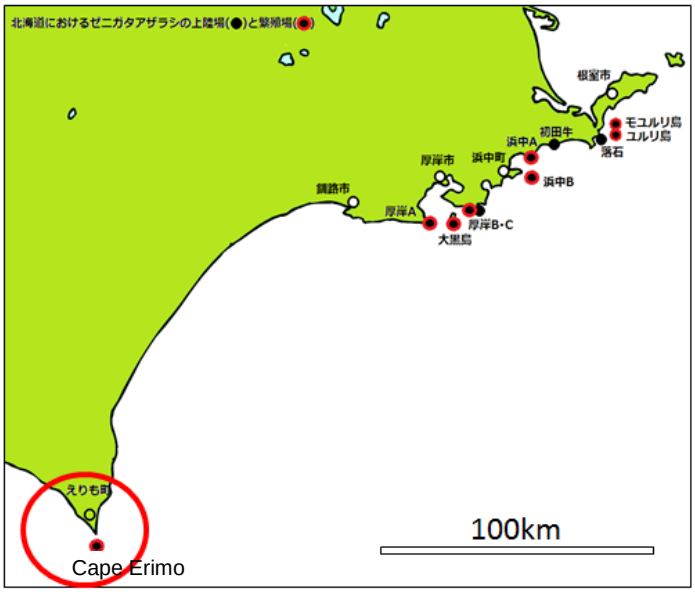


Figure 1. Distribution of Kuril harbor seal haul-out sites in Hokkaido

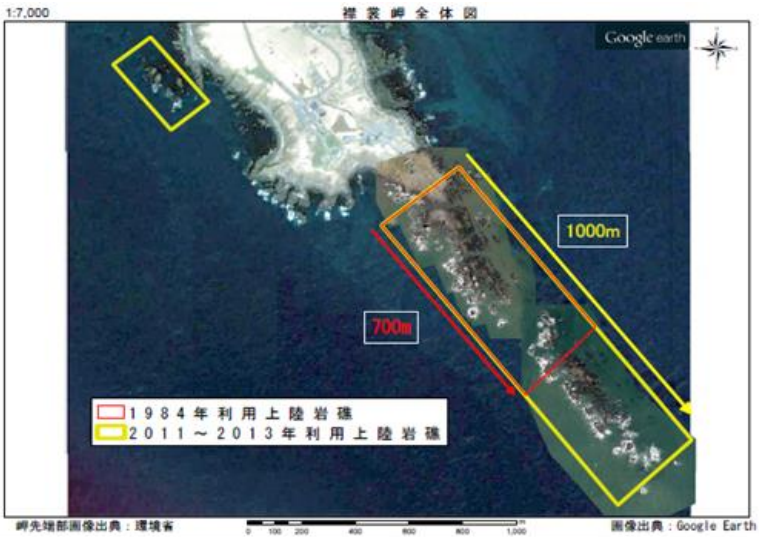


Figure 2. Expansion of the haul-out sites in the Erimo area

(2) Items related to monitoring

- In order to appropriately carry out the management of Kuril harbor seals according to this Management Plan, monitoring will be carried out on a continuing basis.
- Population conditions and the effects of management are being verified, and the following items will be periodically inspected in order to provide feedback about the Management Plan. Further, survey items will be added as necessary for the performance of adaptive management.

1. Population size and composition

Counting through visual checks and aerial census data, and ascertainment of population composition (age and sex composition)
2. Number of bycaught seals
Organized by sex and age; also used in the indices mentioned in 4 below
3. Number of caught seals
Organized by sex, age
4. Damage situation
Ascertainment of the scope and severity of damage (using multiple indices, including: type of fish, damage situation by fishing industry type (cost of damage, etc.), damage rate, amount of fish caught), feeding habits surveys (surveys of stomach contents, etc.)
5. Habitation trends
Breeding situation, range, etc.
6. Habitat
Sources of food, etc., assessment of coastal ecosystem
7. Sustainability assessment

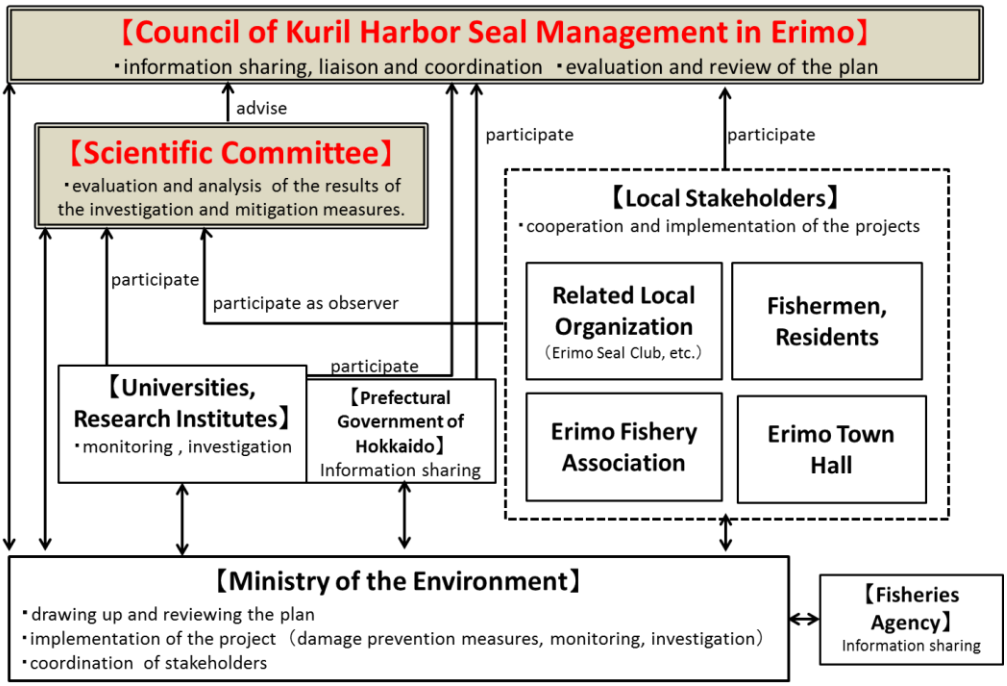
(3) Establishment of the Project Implementation Plan

In order to appropriately implement the Management Plan based on the adaptive management approach, a Project Implementation Plan (hereafter, "Implementation Plan") will be established every fiscal year; additionally, the effects of the project's implementation will be verified, and this will be reflected in the following year's Implementation Plan.

10 Items pertaining to the Plan's implementation system

- The establishment of each of the management and monitoring procedures necessary for the implementation of the Management Plan will be carried out by the Ministry of the Environment in cooperation with various local organizations. Further, outside of the scope of the projects implemented by the Ministry of the Environment, the Ministry actively partners with initiatives from other organizations which facilitate coexistence between the Kuril harbor seals and the local community.
- Each Fiscal Year, the Ministry of the Environment will draw up a Project Implementation Plan based on the Management Plan, after listening to the opinions of a variety of stakeholders, including the Hokkaido Government, Erimo Town, fishing industry associations, members of the fishing industry, local residents, related organizations, and universities and research institutions (hereafter "stakeholders"), and implement the project based on the Implementation Plan in partnership with the stakeholders.

- The Ministry of the Environment is working to earn the cooperation of stakeholders and gather information about the operational situation of the projects being implemented by each organization. Concurrently, it is actively undertaking exchanges of information with institutions including the Fisheries Agency and the Hokkaido Government, as well as with private organizations related to the perspective of wildlife protection management.
- Feedback is given regarding the results of implementing projects based on the Implementation Plan.
- As a system for assessing and reexamining the Management Plan and the Implementation Plan, the Kuril Harbor Seal Science Committee (hereafter, the "Science Committee") and the Kuril Harbor Seal Protection Management Council (hereafter, the "Protection Management Council") have been created.
- The Science Committee is composed of experts in assessment and analysis, people related to local surveys, and researchers conducting surveys of Kuril harbor seals, among others. It performs monitoring and analysis and assessment of survey results, and proposes procedures for these. Further, it offers advice to the Protection Management Council from a scientific perspective.
- The Protection Management Council is composed of all stakeholders. For the coexistence of the Kuril harbor seal and the local community, not only projects based on the Management Plan and the Implementation Plan, but also the furtherance of initiatives by various organizations is highly important. Further, establishing and maintaining systems for long-term continuing initiatives is highly important from the point of view of continuing to perform population management, even after the conclusion of this plan. For this reason, the Protection Management Council performs not only assessment and reexamination of the Management Plan and Implementation Plan, but also the promotion of initiatives being implemented by each organization, as well as information exchange, and so on. Further, it serves as a platform for considering the relationship between the Kuril harbor seals and the local community, including their applications for education, tourism, and so on.
- The Ministry of the Environment is working to gain the understanding of the nation, increasing awareness both of the outcomes of the measures based on this plan, and of the value of wildlife management.



the Plan's implementation system

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Supplements

1. Ecology of the Kuril harbor seal

(1) Classification

Pinnipedia Phocidae

Binomial name: *Phoca vitulina*

Ministry of the Environment Red List (1998): Endangered

Ministry of the Environment Red List (2012): Vulnerable

Ministry of the Environment Red List (2015): Near Threatened

*On the IUCN Red List, the harbor seal is classified as having conservation status of Least Concern.

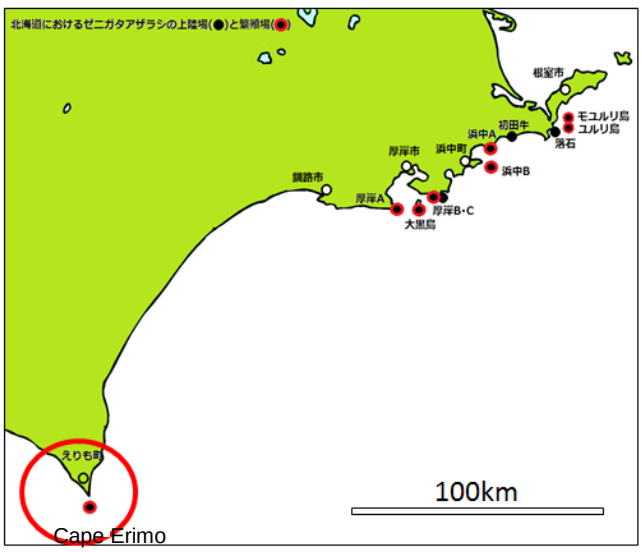
There are 5 species in the family *Phocidae* living in Japan: in addition to the Kuril harbor seal, there is the spotted seal, the ringed seal, the ribbon seal, and the bearded seal.

(2) Morphology

Adult males reach 174 to 186 cm in length, with females reaching 160 to 169 cm; male body weights range from 87 to 170 kg, and females from 60 to 142 kg.

(3) Distribution

- The Kuril harbor seal is widely distributed in coastal areas of the North Pacific and North Atlantic Oceans.
- The populations in the North Pacific Ocean, including Hokkaido, are distributed in coastal areas of the Commander Islands, the Kamchatka Peninsula, the Kuril Islands, Kunashiri, Shikotan, Etorofu, and the Habomai Islands, and from the eastern coast of Hokkaido to Cape Erimo.



(4) Ecology

- Kuril harbor seals live year-round in coastal areas, and pupping occurs on rocky shore reefs from May to early June.
- Distribution of Kuril harbor seal haul-out sites in Hokkaido:
- The primary breeding sites in Hokkaido are Daikoku Island and Cape Erimo.
- Their diet consists of coastal bottomfish, including the North Pacific giant octopus, the Japanese flying squid, saffron cod, cottidae, flatfish, and others.

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2 Ecology monitoring survey (FY 2014)

Working under contract from the Ministry of the Environment, the nonprofit organization Marine Wildlife Center of JAPAN collected the individuals caught and bycaught during the periods when trap nets were in place and during net improvement trial periods. In FY 2014, a survey of 79 individuals was conducted, measuring their body length, body weight, blubber thickness, as well as the following items.

(1) Age determination

Among a group of 79 individuals, 72.2% were under 1 year old, 16.5% were 1 year old, 5.1% were 2 years old; there was also one individual (a female) that was 4 years old, two individuals (a female and a male) that were 6 years old, one individual (a male) that was 12 years old, and the oldest (a female) was 32 years old (Fig. 1). The majority of the dead individuals that were collected were one year old or under (88.7% of all individuals).

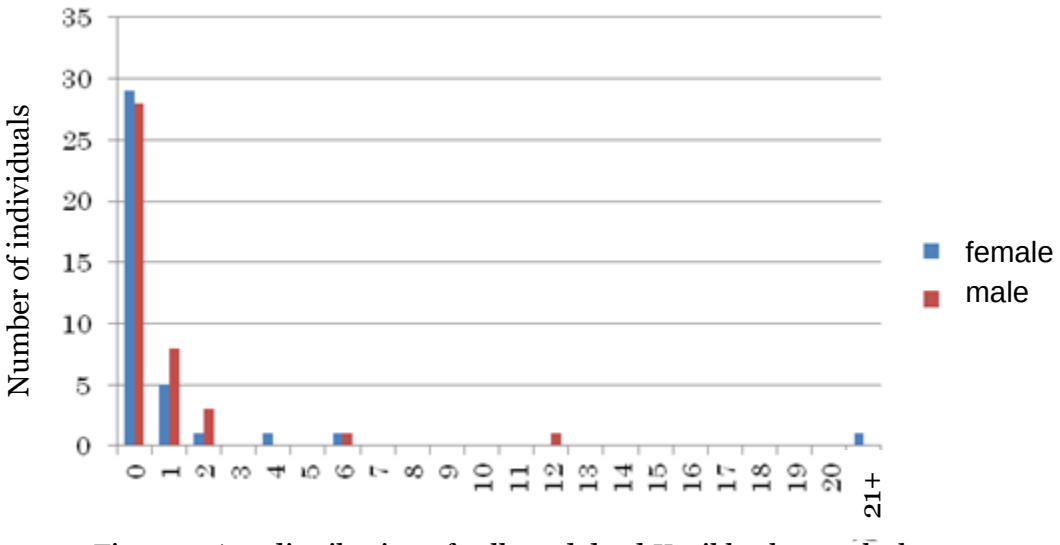

Figure 1. Age distribution of collected dead Kuril harbor seals, by sex

(2) Analysis of stomach contents

From a group of 79 individuals, those whose stomachs were empty were excluded, and stomach contents information was collected from 68 individuals. The frequency of occurrence (FO%) of each prey organism, and the proportion of all prey represented by a particular species of prey organism (I%) were calculated. Further, a Combined Rank Index was calculated, taking into account each prey organism's frequency of occurrence rank and proportion rank. This study succeeded in identifying 17 species in 12 families of fish and 4 species in 2 families of cephalopod. The following is a listing of the prey organisms found among the stomach contents of the individuals, in order of their frequency of occurrence

(FO%): *octopodidae* species (33.8%), Alaska pollock (27.9%), unidentified fish species (25.0%), saffron cod (22.1%), *ommastrephidae* species (19.1%), sailfin sandfish (17.6%), *gadidae* (11.8%), salmon (10.3%), *hemilepidotus* (8.8%), *Ammodytes personatus* (7.4%), Japanese sardine (7.4%), *cottidae* (5.9%), Pacific cod (5.9%), Japanese surf smelt (2.9%), *liparidae* (2.9%), *sebastes* (2.9%), *Freemanichthys thompsoni* (1.5%), Pacific herring(1.5%), sea raven (1.5%), and flatfish (1.5%). Further, the highest proportion of prey organisms represented by each organism (I%) were: saffron cod (47.8%), *gadidae* (11.8%), Alaska pollock (10.4%), *octopodidae* species (8.4%), and *ommastrephidae* species (6.6%). Moreover, the highest ranks in the Combined Rank Index (CRI) were: *octopodidae* species, saffron cod, Alaska pollock, and *gadidae* (Fig. 2). According to the results given above, little salmon was found among the stomach contents of seals bycaught in trap nets, and salmon was surpassed by members of the cod family (*gadidae*) and cephalopods.

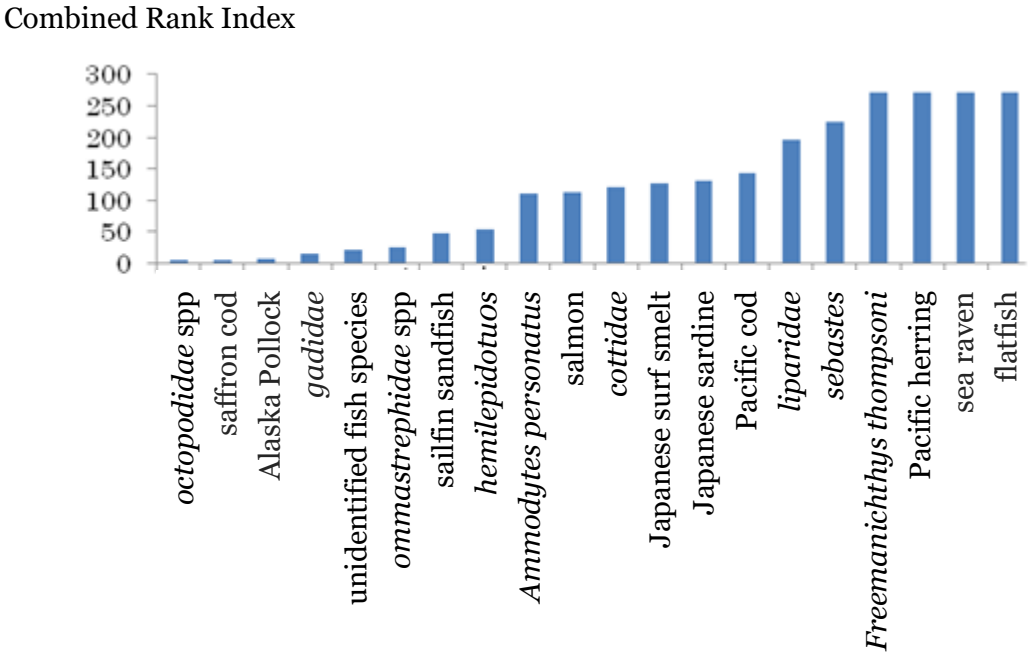

Figure 2. Combined Rank Index (CRI)

Focusing on the individuals in which salmon was found, there were seven such individuals. Further, the average body weight of individuals in which salmon was found was 71.0±28.7 kg. However, the average body weight of individuals in which salmon was not found was 36.6±11.2 kg, making the body weight of individuals in which salmon was found significantly heavier (Welch Two Sample t-test, $p<0.05$). For this reason, it was considered that the individuals feeding on salmon for food were individuals other than those in their first year of life. Further, many of the bycaught individuals were in their first year of life, and the data suggests that there is a possibility that the salmon predation rate found upon

analysis of stomach contents among individuals bycaught in trap nets has been underestimated.

(3) Survey of parity and breeding age

In males, testicle weight and size were measured, and the presence or absence of lumina in the seminiferous tubules was checked histologically. In females, ovary weight and size were measured, and the presence or absence of corpora lutea and corpora albicantia were checked both visually and histologically. Reproductive organs could be sampled in 37 males (25 were in their first year of life, 7 were one year old, 3 were two years old, 1 was six years old, and 1 was 12 years old), and 15 females (7 were in their first year of life, 4 were one year old, 1 was two years old, 1 was four years old, 1 was six years old, and 1 was 32 years old) for a total of 52 individuals surveyed. From these surveys, it has been estimated that among the Kuril harbor seals in the Erimo area, males reach physiological sexual maturity by at least age 6, and females reach physiological sexual maturity by at least age 4. However, in this survey, because there were few individuals over 2 years old among both males and females, a definitive conclusion about the age of sexual maturity among the Erimo area seals could not be reached. Further, with the recent increases in population, it has been suggested that compared to the individuals measured in the 1980s, body lengths for individuals in the Erimo area show signs of being smaller (Kobayashi unpublished), and that as a result, the breeding age is getting older. In light of this, it is believed that it will be possible to clarify the current age of sexual maturity among the Erimo area Kuril harbor seals by continuing to conduct surveys to gather data on large numbers of subadults and adults.

3. Survey and analysis of activity via transmitter tagging (FY 2011, 2012, 2014)

(1) Survey of haul-out probability, range, etc., using satellite transmitter tags (FY 2012, 2014).

Captured or bycaught Kuril harbor seals were fitted with satellite transmitter tags, and haul-out probability, range, and total range area were calculated using information about their positions gained from these satellite transmitter tags; information about their diving activities (dive depth, dive duration, number of dives) was calculated using dive data, and the differences between subadults and juveniles in these areas were also checked. In FY 2012, 1 juvenile male, 3 juvenile females, 3 subadult males, and 4 subadult females (a total of 11 individuals) were fitted with satellite transmitter tags. In FY 2014, 3 juvenile males, 5 juvenile females, 2 subadult males, and 3 subadult females (a total of 13 individuals) were fitted with satellite transmitter tags. During the period when autumn salmon trap net fishing is happening, the Kuril harbor seal's range generally does not extend beyond the rocky shore reefs of Cape Erimo where the animals haul out, and it has been surmised that their primary feeding location during this period is the coastal shallows in the immediate vicinity of their rocky shore reef haul-out sites. The range and haul-out probability found among juveniles had little variation regardless of season, whereas a 50% increase in range was found in both male and female subadults over the period from August to October, while their haul-out probability decreased during this period. Moreover, the average dive depth among juveniles was deeper than that among subadults during all seasons and at all times of day. Further, over the period from August to November, juvenile dive times were found to decrease while subadult dive times were found to increase. For both juveniles and subadults, there was an inverse relationship between dive time and the number of dives. For subadults, nutrients are stored up for winter more during early autumn than during summer, and it is thought that this is the result of their spending more time feeding than resting during that period. Moreover, the data suggested that subadults use the shallows which they learn are ideal as feeding areas. Conversely, attempts to locate juveniles' feeding areas led to the conclusion that they expand their range, swim down to deep waters, and feed there. Further, regardless of developmental stage, the deepest average dive depths and longest average dive times were found from 21:00 to 9:00, with the shallowest average dive depths and shortest average dive times found from 15:00 to 21:00. From these results, it is thought that feeding takes place between 21:00 and 9:00. Average dive depths among subadults were shallow - between 10 and 30 m, which conforms to conventional knowledge about harbor seals, while at the same time, the fact that the depths and distances from haul-out sites matches the locations of the Erimo area trap nets suggests the possibility that the subadults are using the trap nets as

feeding locations.

(2) Determination of the frequency of use of trap nets and predation using ultrasonic transmitter tags (FY 2014)

Ultrasonic transmitter tags were fitted to 8 males and 12 females (a total of 20 individuals), and through the installation of receivers at 20 trap nets under the control of the Erimo Fisheries Cooperative, the Ministry of the Environment surveyed the behavior by Kuril harbor seals of approaching and/or spending time in nets. The seals were divided into two broad groups based on their time spent in the trap nets, using cluster analysis: an under 40 kg group and an over 40 kg group. Further, using GAMM analysis, it was found that in terms of time of day of signal reception, there was a large difference between the under 40 kg group and the over 40 kg group ($p<0.05$), and that the number of times individuals approached the nets greatly increased during the night for the over 40 kg group. It has been reported that Kuril harbor seals swim about in order to feed during the night; Wright et al. (2007) reported that seals were in the water most from dusk through the middle of the night, and Frost et al. (2001) and Fujii et al. (2006) reported that they were in the water most at night. Because results showed that individuals over 40 kg were visiting the autumn salmon trap nets during the night, it was considered that they were visiting the trap nets in order to feed.

(3) Determination of haul-out probability (FY 2011)

The number of Kuril harbor seals fitted with EM transmitter tags from 19. June to 21. June, 2011 was six; the number of seals fitted with tags during the period from 2. July to 3. July was one, for a total of seven individuals (Group 1). The number of Kuril harbor seals fitted with EM transmitter tags from 29. August to 2. September, 2011 was 13; however, because no signal was ever received from four of these individuals, and three individuals were bycaught again and died before the survey was carried out (Group 2), the individuals from whom a signal was received in Group 2 were combined with those in Group 1 for a total of 13 individuals (9 juveniles and 4 subadults).

Signals were received using a portable-type amateur radio (FT-817ND) manufactured by Vertex Standard and capable of operating using eight “AA” batteries, measuring 38 mm in height, 135 mm in width, and 165 mm in thickness, and weighing 900 g. A four-element Yagi antenna was connected, measuring 1 100 mm in height and 1 000 mm in width. Between 28. June and 18. November, 2011 (primarily during molting season), a count of the number of individuals, gathering of environmental data, and reception of signals were performed every hour from 6:00 to 18:00, daily (Ogihara 2012).

It is said that seals spend long periods hauling out, and that their haul-out probability is high during molting season. Regarding the proportion of tagged individuals hauling out, in some instances, if the total number of individuals hauling out is too low, there may be no tagged individuals hauling out. For this reason, in order to find a total number of individuals hauling out at which sufficient data can be gathered, the proportion of tagged individuals whose transmission could be received was checked on days with over 300 total individuals hauling out, and it was found to be 0.64 ± 0.17 (SD). The haul-out probability can be estimated at 0.61 - 0.65 according to the research report given by Harvey and Goley (2011) on harbor seals in California. Further, an individual identification survey found that the haul-out probability of adults is higher than that of immature individuals (Kobayashi unpublished). Because there were no adults included in this survey, the possibility that the haul-out probability estimate might be low was taken into consideration, and a value of 0.64 for the Cape Erimo haul-out probability was deemed reasonable.

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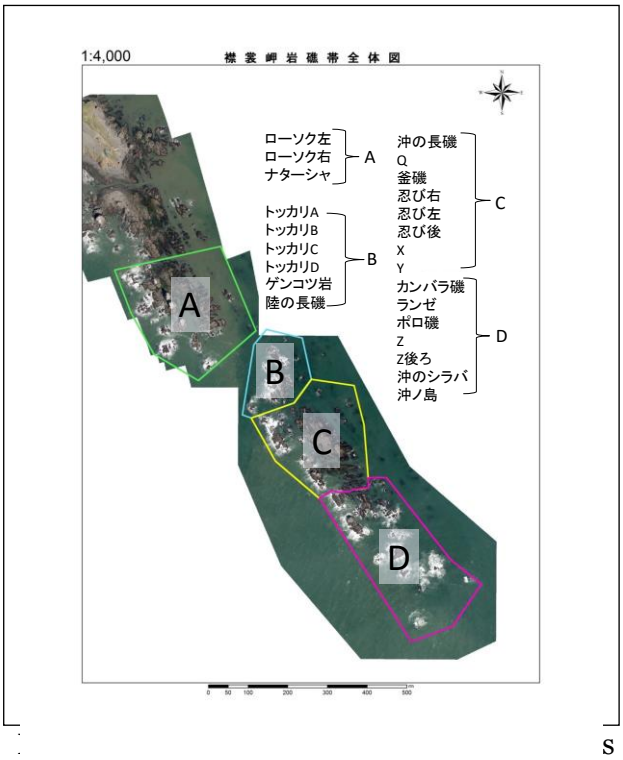
4. Erimo area Kuril harbor seal population confirmation survey (aerial census) (FY 2013, 2014)

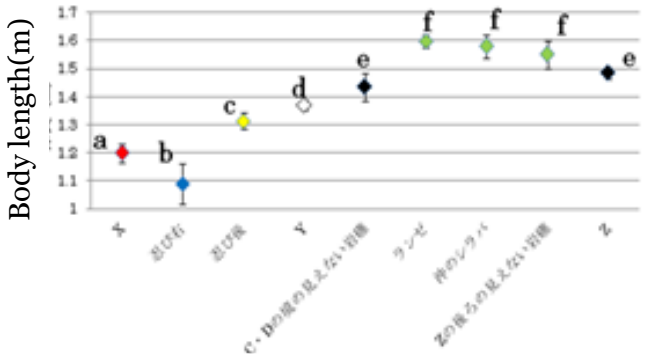
Aerial counts in FY 2013 (one count by manned helicopter in October, one count by unmanned aerial vehicle (UAV) in November) and FY 2014 (one count by manned helicopter in August, three counts by UAV between August and November) made it possible to accurately ascertain the population size, as well as to calculate the margin of error of aerial census information by performing visual observation from land. Regarding population data from aerial surveys, the number of individuals appearing in images taken during both manned and unmanned aerial surveys was counted three times, and the largest value was used. Setting the population count found from aircraft in each aerial survey as 100%, these numbers and the population counts found by two investigators were compared to find the difference between them and calculate the omission rate, dividing the haul-out sites into four zones (A, B, C, D; Fig. 1). Excluding cases when the number of individuals hauling out was extremely low (cases when fewer than four individuals were hauling out) and calculating, the results suggested that the omission rate varies depending on the investigator, and that the variation has a tendency to be greater as the distance from the observation point or number of individuals increases. Dividing haul-out sites into four zones (A, B, C, D) and calculating the minimum average and maximum average omission rate for each zone gave the following results: A (28.37), B (11.97 - 15.76), C (15.31 - 28.98), D (16.39 - 18.51). Because the omission rate varies with changes in the number of individuals hauling out, corrections were made taking into account the proportion of individuals hauling out in each of the four zones (A, B, C, D) at the time the omission rate was calculated. When the average value was calculated from the corrected values, the omission rate came out to 22.05% ± 3.34, and the discovery rate was came out to 77.9% (0.78).



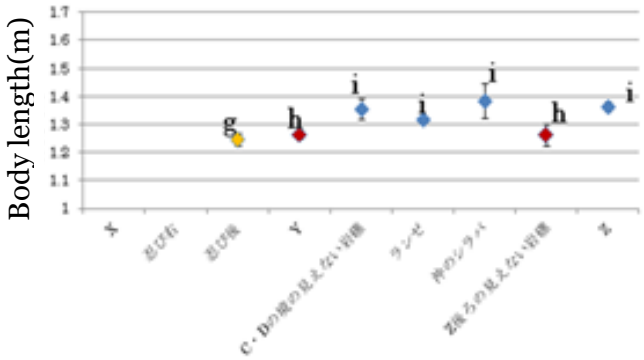
S

Moreover, in order to derive the body length composition of the population using various haul-out sites via unmanned aerial vehicle (UAV), each individual was counted three times using QGIS (cross-platform open-source software), and the average value was calculated. Further, the data used was collected on two occasions: 9. October 2014 and 9. November 2014. Using the data from 9. October, the rocky shore reef haul-out sites could be divided into six zones based on the body length compositions of the seals that used them: X (Zone C) (a), Shinobi right (Zone C) (b), Shinobi rear (Zone C) (c) , Y (Zone C) (d), "rocky shore reefs with limited visibility behind C and D" (Zone C) (e), Z (Zone D) (e), Ranze (Zone D) (f), Offshore Shiraba (Zone D) (f), and "rocky shore reefs with limited visibility behind Z" (Zone D) (f). In particular, the number of large individuals was high in the following zones: Ranze (Zone D), Offshore Shiraba (Zone D), and "rocky shore reefs with limited visibility behind Z" (Zone D). Conversely, the number of small individuals was high in Shinobi rear (Zone C) and X (Zone C). Further, using the data from 9. November, the rocky shore reef haul-out sites could be divided into 3 zones based on the body length compositions of the individuals that used them (Fig. 2): Shinobi rear (Zone C) (g), Y (Zone C) (h), "rocky shore reefs with limited visibility behind Z" (Zone D) (h), "rocky shore reefs with limited visibility behind C and D" (Zone C) (i), Ranze (Zone D) (i), Offshore Shiraba (Zone D) (i). In particular, the number of large individuals was high in the following zones: "rocky shore reefs with limited visibility behind C and D" (Zone C), Ranze (Zone D) , Offshore Shiraba (Zone D), and Z (Zone D). Conversely, the number of small individuals was high in Shinobi rear (Zone C). Moreover, there was a difference in the sizes of the seals using Shinobi rear

(Zone C), and Offshore Shiraba (Zone D) on 9. October and 9. November, with the seals hauling out on 9. October having greater body length. This data suggests that different individuals use different sites in different seasons.



Average body length at each haul-out site on 9th Oct.



Average body length at each haul-out site on 9th Nov.

Figure 2 Comparison of average body length at each haul-out site

5. Results of Kuril harbor seal Erimo population numerical analysis

Kuril Harbor Seal Science Committee

1 Abstract

The Kuril Harbor Seal Science Committee conducted a numerical assessment of the Kuril harbor seals living in the Erimo area. Namely, the Science Committee conducted a statistical resource assessment while monitoring population dynamics. Based on the results, resource trend simulations were run using several hypothetical scenarios. The results of those simulations showed that the resource levels in each of the hypothetical resource dynamics models were greatly improved when compared with the levels at the time when the Kuril harbor seal was added to the Red List; and at the same time, the probability of extinction in the next 100 years was shown not to exceed 10%, even when considering reasonable levels of statistical variation and uncertainties such as epidemic outbreaks.

2 Goals

The goals of this numerical assessment were to perform statistical inferences of population dynamics based on the observation data, and, through a risk assessment simulation, to analyze the probability of the Kuril harbor seal Erimo population going extinct within the next 100 years.

3 Methods

(1) Data used

1 Observed number of individuals hauling out during pupping season and molting season.

The Science Committee used the population numbers observed by the Marine Mammal Research Group and the Kuril Harbor Seal Research Group (hereafter “Seal Research Group”) between 1974 and 2013, as well as the population numbers observed by the Ishikawa & Tokyo University of Agriculture group between 1998 and 2013. Because these values were reached through observation of the number of individual Kuril harbor seals at the haul-out sites from on land, there are omissions resulting from individuals that could not be discovered because they were submerged in the water, as well as individuals that were hauling out but were missed during the on-land observation. For this reason the value estimated from transmitter tag surveys etc. for the haul-out probability was corrected using the value estimated for

the discovery rate from the results of the aerial censuses. Further, because there was a tendency toward underestimation compared to the value observed by the Seal Research Group and the Ishikawa & Tokyo University of Agriculture group, the relative detection probability was estimated inside the model as a relative bias.

2 Time sequence of bycaught individuals

Because only data from the past few years is available, it was assumed that a fixed ratio of the population was bycaught. However, the number of bycaught individuals was estimated inside the model based on the number of individuals captured in recent years.

(2) Resource dynamics models

Because these investigations were carried out using multiple methods, the following two models were used in our analysis.

1 Production model

This model expresses the changes over time in the aggregate population. It assumes that the age composition is constant and unchanging, but it allows estimation using a relatively small amount of data.

2 Age-composition model incorporating density-dependent reproduction structure

This model expresses the changes over time in the number of individuals organized by age within the population. It requires a relatively large amount of data, but it is possible to create expressive age-composition models which hypothesize diverse biological parameters. In the case of the Kuril harbor seal, because there are independent observed values for the number of individuals in their first year of life and those in their second year of life and older during breeding season, it is possible to estimate the reproduction relationship from the data. However, assumptions were made about the discovery rate of individuals in their first year of life, the natural mortality rate at each year of life, and so on.

(3) Establishing a risk assessment scenario

In addition to the normal parameters of the above models, the following were established in further consideration of safety.

1 Process error

In the production model, the Science Committee estimated parameters using an observation error model, and estimated that the coefficient of variation (CV, the logarithmic standard deviation) was 0.076 for the Ishikawa & Tokyo

University of Agriculture group's observation error, which is thought to be relatively small.

This error includes the process error value and all other types of error, and it is difficult to imagine that the observation error and process error together could exceed this value.

However, since neither of these errors is actually zero, the process error coefficient of variation was assumed to be 0.05, which is a sufficiently conservative baseline.

In the age-composition model, the standard deviation was 0.231 between the number of individuals in their first year of life as estimated using the method of maximum likelihood and the number of individuals in their first year of life as observed by the Ishikawa & Tokyo University of Agriculture group.

The size of this variation includes both the observation error and the process error present in the number of individuals in their first year of life, and as such it was determined that even a conservative estimate of the reproduction error coefficient of variation would not exceed 0.2.

2 Incidence and mortality rate of phocine distemper

There have not been any mass die-offs caused by this disease in Japan, but because there have been some such cases in Europe, data in the literature regarding the European cases was used for reference. The mortality rate varies depending on the geographical or marine region; for example, during the outbreak that took place in 1998, there was a margin of 1 - 50% depending on the geographical region, and in 2002 there was a margin of 1 - 66%. It is known that the individuals who survive have antibodies. Seal life expectancy is approximately 20 years for males, and approximately 30 years for females. From this data, it is considered that a sufficiently conservative assessment is possible by assuming a 50% mortality rate based on one outbreak every 20 years.

4 Results

(1) Results of analysis using the production model

When calculations were made assuming 5 random outbreaks of phocine distemper with a 50% mortality rate over a 100 year period, as well as process error (CV = 0.05), the probability of extinction within 100 years was less than 5% (Fig. 1).

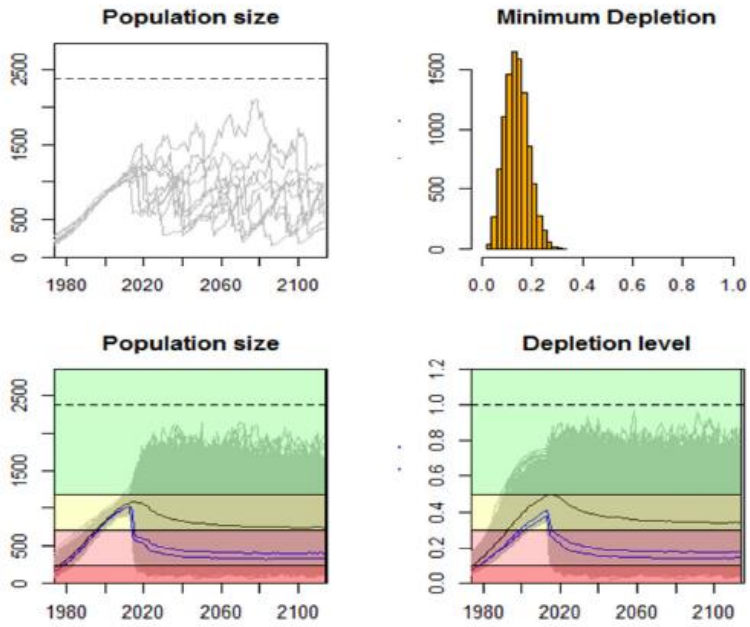


Figure 1. Future predictions of population dynamics accounting for estimation error using Bayesian methods. The figure in the upper-left shows the first 10 predictions out of a total of 10 000 repetitions. The blue lines show the 5% and 10% marks, and the black line shows the median (same below).

(2) Results of analysis using the age-composition model incorporating density-dependent reproduction structure

When calculations were made assuming 5 random outbreaks of phocine distemper with a 50% mortality rate over a 100 year period, as well as reproduction process error (CV=0.2), the probability of extinction within 100 years was less than 1% (Fig. 2).

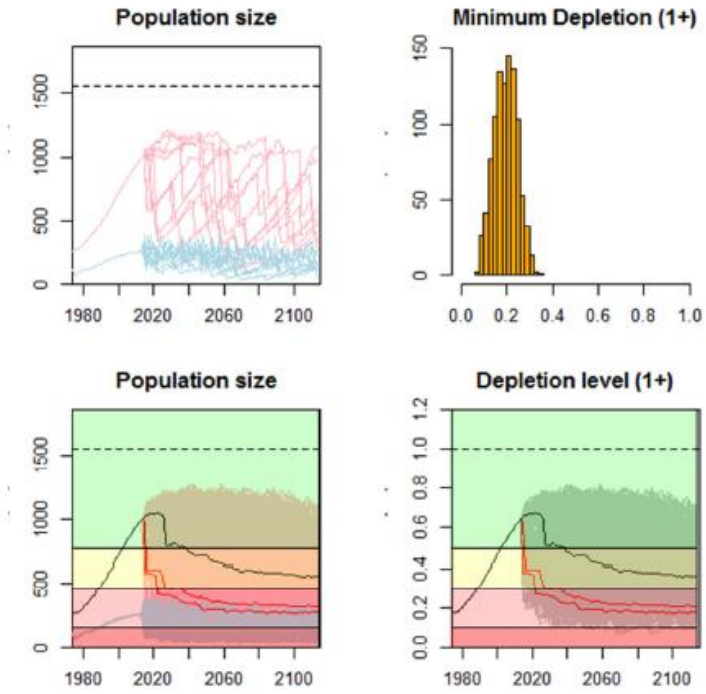

Population size
Minimum Depletion (1+)
Population size
Depletion level (1+)
0
500
1000
1500
1980
2020
2060
2100
0
50
100
150
0.0
0.2
0.4
0.6
0.8
1.0
0.0
0.2
0.4
0.6
0.8
1.0
1.2

Figure 2

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6 Estimation of the number of adult Kuril harbor seals in Hokkaido

Kuril Harbor Seal Science Committee

1 Abstract

It was estimated from the number of individuals discovered hauling out, the discovery rate, the haul-out probability, the ratio of adult individuals calculated from the body length composition of hauled out individuals, etc., that the total number of adult individuals in all of Hokkaido was roughly 1 000 during the five-year period from 2010 to 2014.

2 Methods and Results

The numbers of individual Kuril harbor seals discovered hauling out during molting season at Cape Erimo and Akkeshi Daikoku Island in the past five years are given in the chart below. From this data, and accounting for the discovery rate, the number of adult individuals hauling out in the above areas was estimated, and then the total number of adult individuals hauling out in all of Hokkaido was estimated. Because it is thought that the haul-out probability is not necessarily the same between adult individuals and other individuals, they were designated as P_A and P_J, respectively. In order to estimate the number of adult individuals with this procedure, the following information is needed: the ratio of adult individuals hauling out versus all individuals hauling out (designated as m; varies depending on the season); the discovery rate of individuals hauling out (designated as s; it can be estimated that there has not been variation in this value in recent years); and the haul-out probability (P_A and P_J). Among these, the item for which there is the least information is the ratio of P_A to P_J (designated as α). It is thought that adult individuals have a higher haul-out probability ($\alpha \geqq 1$), however, because the value of α is less than 1.5, as is shown below, the total number of adult individuals in all of Hokkaido was estimated for three possible values of α: 1, 1.25, and 1.5.

Table 1. Discovery rate of Kuril harbor seal individuals hauling out during molting season at Cape Erimo and Akkeshi Daikoku Island (from Ogihara 2012, Takinami 2013, Yoneyama 2014, Nagashima 2015, Kimura 2015)

	Cape Erimo (maximum number of individuals hauling out during molting season)	Akkeshi Daikoku Island (maximum number of individuals hauling out during molting season)	Total (X)
2014	451	225	676
2013	492	238	730
2012	539	254	793
2011	391	250	641
2010	592	263	855

The discovery rate for individuals hauling out during molting season (s) was analysed from aerial census data and estimated to be 0.78 (Supplement 4). The proportion of individuals hauling out at Cape Erimo and Akkeshi Daikoku Island versus the total number of individuals hauling out in all of Hokkaido was 69.35±5.78 % (average±SD) in the real observation data for the 28-year period from 1983 to 2010 (Kobayashi et al. 2014). This proportion was designated as f, and the discovery rate for individuals hauling out at Cape Erimo and Akkeshi Daikoku Island was designated as X.

Among the total number of adult individuals in all of Hokkaido N_A, the proportion f were distributed across Cape Erimo and Akkeshi Daikoku Island, and this multiplied by their haul-out probability gives the estimated number of adult individuals hauling out at Cape Erimo and Akkeshi Daikoku Island (fP_AN_A), and the observed number of individuals among these was sfP_AN_A. Because the proportion of adult individuals among all individuals hauling out is m, the total number of individuals hauling out discovered at Cape Erimo and Akkeshi Daikoku Island can be described as sfP_AN_A/m. This is the X in charts 1 and 2. If it is assumed that the discovery rate (s) and the proportion of individuals in this area compared to all of Hokkaido (f) are as given above, and if m and P_A can be estimated, it is possible to calculate back to X from N_A, as follows:

$N_A=mX/sfP_A$

Identification of individuals at haul-out sites as adults or non-adults is based entirely on body length. From the measurement of the body length composition of the population (Marine Wildlife Center of JAPAN 2015) using unmanned aerial vehicle (hereafter, UAV) photography data collected during molting season, individuals with body lengths of 1.5 m and over were considered to be adults (Morohoshi 2014, Suzuki 1986). In the 9. October 2014 photography data, of 351 individuals whose body lengths could be measured, 264 individuals (67.5%) had body lengths of 1.5 m and over. Further, in the 9. November 2014 photography data, of 338 individuals whose body lengths could be measured, 107 individuals (31.7%) had body lengths of 1.5 m and over. In this way, the ratio of adult individuals hauling out (m) varies greatly depending on the season. It is believed that the haul-out probability is steady for juveniles, regardless of the season, while the haul-out probability of adults decreases moving into autumn (Maezawa 2015). Therefore, it was considered that the ratio of adult individuals hauling out in the FY 2014 molting season was as high as or higher than the ratio for October given above, giving a conservative assumption of $m \geqq 0.675$ (an underestimation of N_A).

Thus, from the discovery rate of hauling out individuals (X), the number of adult individuals in the Cape Erimo and Akkeshi Daikoku area ($mX/s=fP_AN_A$) and the total number of adult individuals that hauled out in all of Hokkaido (P_AN_A) were estimated as given in Table 2.

For the interval estimation of P_AN_A given here, f was considered to have a margin of the average given above ± 2 standard deviations.

Table 2. The number of individuals discovered hauling out at Cape Erimo and Akkeshi Daikoku (X), the estimated number of adult individuals hauling out at Cape Erimo and Akkeshi Daikoku ($mX/s=fP_AN_A$), and the estimated total number of adult individuals hauling out in all of Hokkaido (P_AN_A).

	Number of individuals discovered hauling out at Cape Erimo and Akkeshi Daikoku (X)	Estimated number of adult individuals hauling out in this area ($mX/s=fP_AN_A$)	Estimated total number of adult individuals hauling out in all of Hokkaido (P_AN_A)
2014	676	585.0	843.5 (723.0 - 1512.3)
2013	730	631.7	910.9 (783.8 - 1193.1)
2012	793	686.3	989.5 (848.2 - 1187.5)
2011	641	554.7	799.9 (685.6 - 959.9)
2010	855	739.9	1066.9 (914.5 - 1281.3)

Aside from those at haul-out sites, there are adults swimming in the water. The haul-out probability of individuals other than adults during molting season P_J, was estimated to be 0.64 using EM tracking tag data in Erimo (Ogihara 2012, revised). The haul-out rate for adults alone has not been estimated.

The haul-out probability of adult individuals (A) was assumed to be the haul-out probability of non-adult individuals (J) multiplied by a factor of α ($P_A=\alpha P_J$, $\alpha \geqq 1$). Because the haul-out probability P_A must logically be less than 1, it can be reasoned from $P_J=0.64$ that $\alpha < 1.5$. Therefore, the total number of adults, including individuals in the water, was estimated for α values of 1.25 and 1.5 (Table 3). Furthermore, the haul-out probability calculated outside of Japan including adult individuals was extremely close to 0.64 (0.61 - 0.65, Harvey and Goley 2011), and $\alpha \approx 1$ was considered to be the real value. Thus, as is shown in Table 3, even if α is 1.25, the estimated number was over 1 000, and the number of

adult individuals during the five-year period from 2010 to 2014 was estimated to be over 1 000 for all of Hokkaido.

Table 3. Estimated total number of adult individuals in all of Hokkaido for various values of α.

α =	1	1.25	1.5
P_A	64%	80%	96%
2014	1318.0 (1129.7-1581.7)	1054.4 (933.8-1265.4)	878.7 (753.2-1054.5)
2013	1423.3 (1223.-1708.)	1138.7 (976.-1366.4)	948.9 (813.3-1138.7)
2012	1546.2 (1325.3-1855.5)	1236.9 (1362.2-1484.4)	1030.8 (883.5-1237.)
2011	1249.8 (1071.2-1499.8)	999.8 (857.-1199.8)	833.2 (714.2-999.9)
2010	1667.0 (1428.9-2508.5)	1333.6 (1143.1-1641.4)	1111.4 (952.6-1333.7)

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7 Fishing industry damage situation (FY 2011 - 2014)

According to the "Survey on the Actual Situation of Damage Caused to the Fishing Industry by Marine Wildlife (Fishing Industry Damage Situation Survey)" conducted by the Hokkaido Government Department of Fisheries and Forestry, and Erimo Fisheries Cooperative Association resources, the cost of the damage done to the fishing industry by Kuril harbor seals tends to increase every year, and the damage in the Erimo area accounts for nearly half of that cost.

Costs of fishing industry damage from Kuril harbor seals (in thousands of yen)

	2011	2012	2013	2014
All of Hokkaido *1	29,986	53,430	79,980	117,096
All Erimo Fisheries Cooperative trap nets *2	28,601	38,841	39,682	63,480

*1 Hokkaido Government Department of Fisheries and Forestry resources
*2 Erimo Fisheries Cooperative Association resources

The majority of the damage caused to the fishing industry by Kuril harbor seals is not in the form of damage done to nets, but rather comes in the form of seals biting pieces off of the heads, abdomens, etc. of salmon. Salmon that have been bitten lose their commercial value, which therefore is an economic loss. Moreover, it is said that invisible damage is caused in the form of salmon being prevented from entering trap nets. Further, the damage done to octopus fishing is becoming more severe.

The autumn salmon trap nets in the Cape Erimo area are floating-type nets in which the bag section of the net does not sink, and there is no ceiling net on the area between the end of the lead and just before the beginning of the bag net. For this reason, when Kuril harbor seals enter the nets, it is easy for them to breathe by pushing up on the ceiling net inside the bag net, or going back outside of the trap net, and it is therefore believed that they learn everything from how to invade the nets to how to escape from them, and that they are therefore able to freely enter and exit trap nets.

It has been reported that generally, the feeding habits of this species, and specifically this subspecies, are as follows: they prefer to prey on bottomfish and cephalopods in shallow waters (Brown and Mate 1983, Nakaoka et al. 1986, Olsen et al. 1995, Andersen et al. 2004,

Luxa and Acevedo-Guiterrez 2013, Bromaghin et al. 2013, Geiger et al. 2013); they prefer fish species with seasonally concentrated distribution density during spawning and breeding, and fish species that swim in large schools (Harkonen 1987, Olsen et al. 1995, Hauksson and Bogason 1997, Hall et al. 1998, Brown et al.1998, Hammill and Stenson 2000, Hammill et al. 2010); and they periodically make use of specific feeding spaces (Thompson and Miller 1990, Tollit et al. 1998, Wright et al. 2007). For this reason, it is suggested that they make habitual use of specific points in the ocean, such as trap nets, fishing nets, and other locations with high concentrations of fish. The possibility is being considered that fishing equipment such as trap nets, where prey gather seasonally, are favorite feeding locations for Kuril harbor seals.

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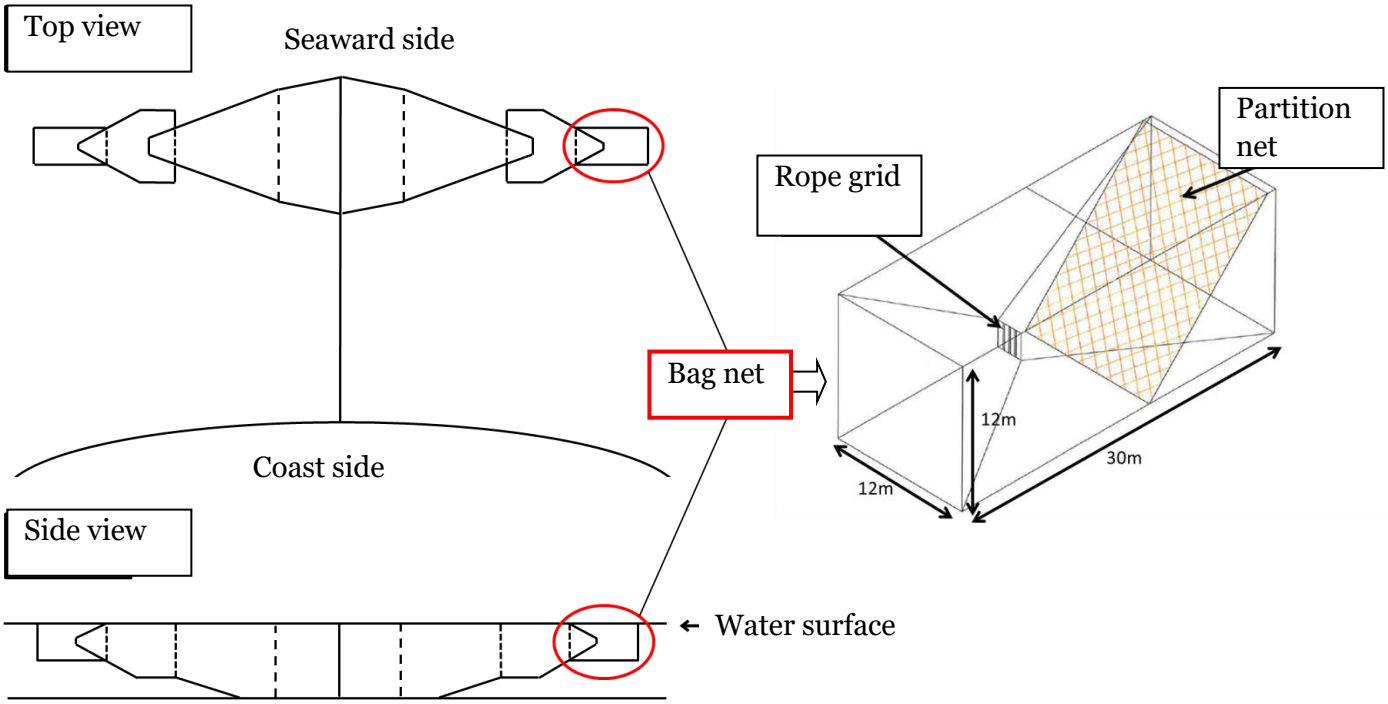
8 Considering damage prevention measures (FY 2014, 2015)

(1) Testing of improved damage preventing nets

The goal of this test was to prevent both damage caused by Kuril harbor seals and bycatch, and was carried out before the autumn fishing season and during the spring and autumn fishing seasons in 2014 and 2015 with the cooperation of members of the fishing industry, and in partnership with the Environment Research and Technology Development Fund (Development of protection management procedures aimed at the coexistence of the coastal fishing industry and the Kuril harbor seals of the Oyashio coastal area (2014 - 2015) Representative researcher: Yasunori Sakurai, Hokkaido University). Tests were performed on two improved net configurations, and their effectiveness at reducing damage was assessed. The improved nets include partition nets inside the bag net areas to separate Kuril harbor seals and salmon, and rope grids to act as obstacles for Kuril harbor seals entering and exiting the nets (grid opening sizes of 40 × 70 cm and 40 × 40 cm were used in FY 2014, and 20 × 40 cm and 20 × 20 cm in FY 2015).

Full structural diagram of a trap net　　Structural diagram of an improved net (bag net)



a rope grid

a partition net (orange)

Underwater cameras and sonar cameras were installed inside of bag nets and in their vicinity in order to photograph Kuril harbor seals and salmon entering the nets, as well as to survey the situation of the fish caught in the nets and verify the effectiveness of the improved nets. From these results, it was shown that the partition nets have a certain level of effectiveness at keeping the salmon and the Kuril harbor seals separated, and that while the rope grids were able to reduce damage, depending on the grid opening size, they also had a large effect on the behavior of salmon entering the nets, etc. Because the rope grids were very effective at reducing damage, members of the fishing industry continued to use them after the experiments were finished.

In the future, further considerations are necessary regarding improvements to the structures of rope grids in order to lessen the effect on salmon entering the nets, adapting the structure etc. of partition nets and positioning them in front of the entrance to the bag nets in order to prevent Kuril harbor seals from entering, and so on.

(2) Verification and improvement of acoustic repellent equipment

Initiatives have been implemented in the Erimo area to test damage prevention through the installation of equipment that emits sound waves to repel Kuril harbor seals, but their damage reduction effects were temporary. For this reason, in FY 2014 and FY 2015, working in cooperation with Tokyo University of Agriculture, the Hokkaido Industrial Technology Center, and others, experiments were conducted in floating cages installed in fishing ports, working toward the development of new equipment, and in order to survey the behavior of Kuril harbor seals in response to this equipment and the effectiveness of the existing repellent equipment.

In the experiments for the development of new equipment, working in cooperation with members of the fishing industry, captured Kuril harbor seals were kept temporarily in floating cages installed in the Cape Erimo fishing port, and a study of their behavior was conducted in order to improve the repellent equipment; it was shown that the sound waves

that were emitted had clear effects on the behavior of Kuril harbor seals, such as provoking them into diving behaviors.

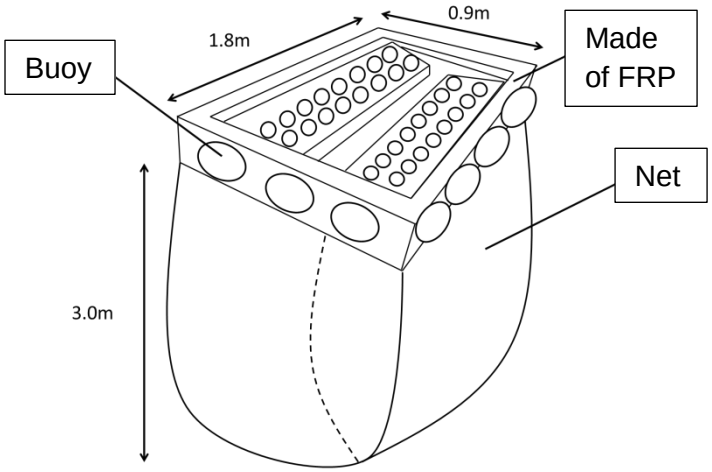
In the future, further considerations of more effective sound wave intensity, timing of sound wave emissions, equipment installation methods, etc. are necessary.

A floating cage installed in a fishing port

A Kuril harbor seal in a floating cage

(3) Placement of a trap used for capturing seals

In order to develop procedures for capturing Kuril harbor seals swimming in the area around trap nets, new traps were designed using for reference the structures of seal capture traps that have had success in eastern Hokkaido. These new traps were tested during the spring fishing season of FY 2015.



Structure of the trap used for capturing seals

A captured Kuril harbor seal

By installing a trap near the trap nets and placing bait inside, one juvenile individual was successfully captured.

In the future, further considerations of new structures that can withstand placement in the open ocean, more effective installation methods for capture, etc. are necessary.