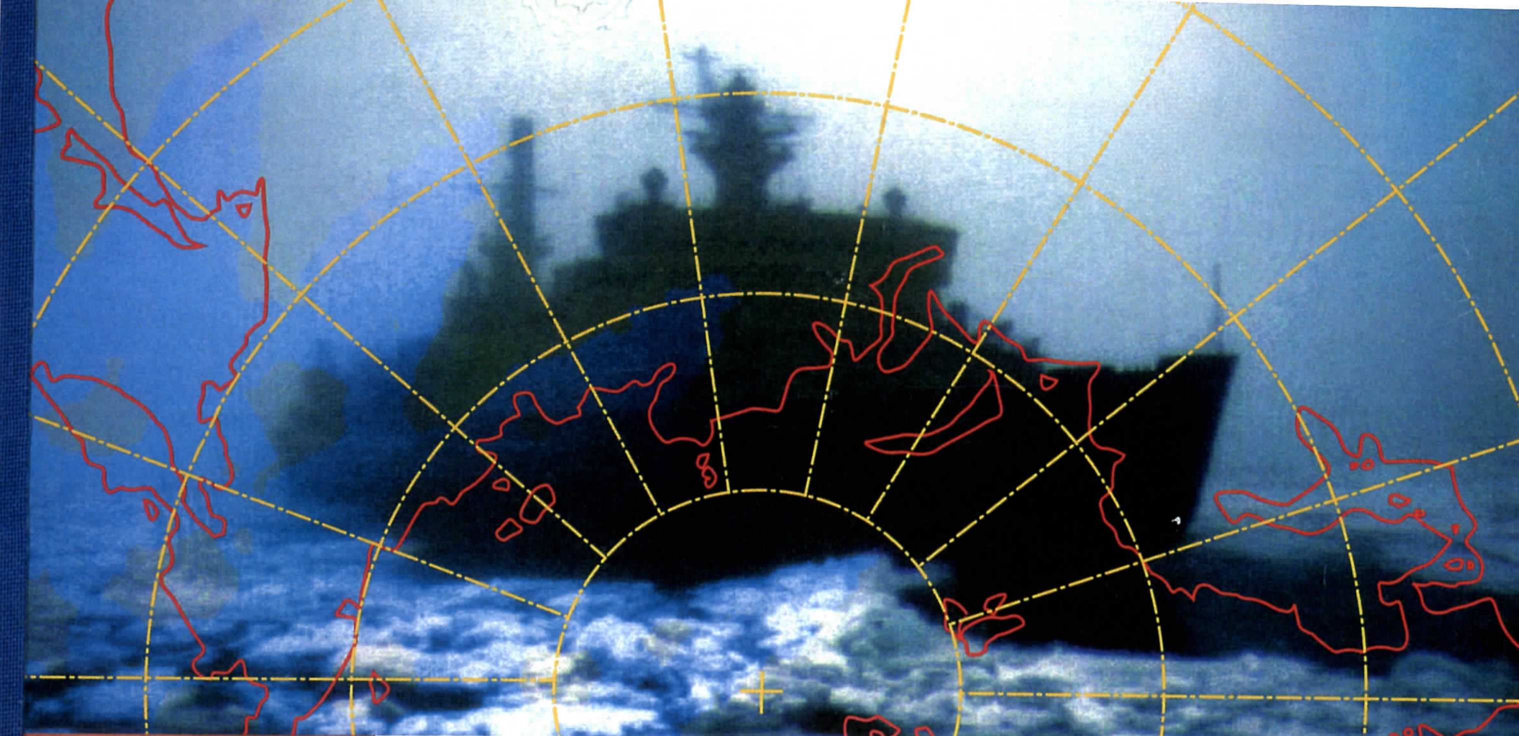

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Oil Vulnerability Assessment for Marine Birds occurring along the Northern Sea Route Area

By Maria Gavrilo, Vidar Bakken, Liudmila Firsova, Vladimir Kalyakin, Vladimir Morozov, Irina Pokrovskaya and Kjell Isaksen

INSROP International Northern Sea Route Programme

Central Marine Research & Design Institute, Russia

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Supervisor: Vidar Bakken

Title: **Oil Vulnerability Assessment for Marine Birds occurring along the Northern Sea Route Area**

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What is an INSROP Working Paper and how to handle it:

FOREWORD - INSROP WORKING PAPER

INSROP is a five-year multidisciplinary and multilateral research programme, the main phase of which commenced in June 1993. The three principal cooperating partners are **Central Marine Research & Design Institute (CNIIMF)**, St. Petersburg, Russia; **Ship and Ocean Foundation (SOF)**, Tokyo, Japan; and **Fridtjof Nansen Institute (FNI)**, Lysaker, Norway. The INSROP Secretariat is shared between CNIIMF and FNI and is located at FNI.

INSROP is split into four main projects: 1) Natural Conditions and Ice Navigation; 2) Environmental Factors; 3) Trade and Commercial Shipping Aspects of the NSR; and 4) Political, Legal and Strategic Factors. The aim of INSROP is to build up a knowledge base adequate to provide a foundation for long-term planning and decision-making by state agencies as well as private companies etc., for purposes of promoting rational decisionmaking concerning the use of the Northern Sea Route for transit and regional development.

INSROP is a direct result of the normalization of the international situation and the Murmansk initiatives of the former Soviet Union in 1987, when the readiness of the USSR to open the NSR for international shipping was officially declared. The Murmansk Initiatives enabled the continuation, expansion and intensification of traditional collaboration between the states in the Arctic, including safety and efficiency of shipping. Russia, being the successor state to the USSR, supports the Murmansk Initiatives. The initiatives stimulated contact and cooperation between CNIIMF and FNI in 1988 and resulted in a pilot study of the NSR in 1991. In 1992 SOF entered INSROP as a third partner on an equal basis with CNIIMF and FNI.

The complete series of publications may be obtained from the Fridtjof Nansen Institute.

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OIL VULNERABILITY ASSESSMENT FOR MARINE BIRDS OCCURRING ALONG THE NORTHERN SEA ROUTE AREA

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1. INTRODUCTION

According to Thomassen *et al.* (1994) the effects of the opening of international navigation along the Northern Sea Route (NSR) on the environment shall be evaluated in relation to pollution, waste, noise, physical disturbance and socio/economic factors. In this report we have analysed the effects in relation to pollution, especially oil pollution. The main work has been conducted during two expert workshops in St. Petersburg in January and March 1994. The latter involved Russian ornithologists experienced in field work in the Russian Arctic. New information relevant to this study and obtained later is also included. During preparation of the final version of the report valuable comments on eider biology were given by Diana Solovieva (Lena-Delta State Reserve).

2. METHODS

The methods for the assessment of vulnerability in relation to oil used in this report are described by Anker-Nilssen (1987) and also more briefly by Mehlum & Bakken (1994).

The first step in the process is to identify the area of risk for oil pollution. Ideally the delimitation of this area should be based on simulations of oil drift from potential spill locations, i.e. surface and subsurface water movement trajectories along the sailing routes. The next step is to make a list of the species potentially affected by an oil spill; this is normally all species connected to the sea or the coast within the area. In the case of the NSR, the area of concern is so huge that a division into separate regions with separate species lists is advantageous.

To assess each species' vulnerability to oil within an area a set of vulnerability criteria was designed by Anker-Nilssen (1987) (see list below). There are 9 vulnerability criteria describing the vulnerability at the individual level and 8 criteria at the population level. Based on knowledge on the species' biology in the area, each of these criteria are given values from one (the criterion is of little importance) to three (the criterion is very important). The criteria are as follows (after T. Anker-Nilssen & W. Vader unpubl.):

Individual vulnerability (IV)

Ta Time in the area (Short/Moderate/Long). The amount of time the average individual is present in the study area in the season concerned.

Ts Time at sea (Short/Moderate/Long). The amount of time the average individual spends at sea per day.

Au Area utilisation (Little/Moderate/Much). The area of sea the average individual covers in a given time, i.e. does it move around a lot or not.

Bs Behaviour at sea (Not very vulnerable/Moderately vulnerable/Very vulnerable). The time budgets of different behaviour at sea (e.g. swimming, diving, displaying, loafing, sleeping) for the average individual, and how this behavioural pattern affects its vulnerability to oil.

Sa Shore affinity (Weak/Moderate/Strong). To which extent the average individual is attracted to shore areas where oil has a tendency to accumulate.

Pr Possibility of oil being detected by a bird (Good/Moderate/Poor). The chance the average individual has of reacting to (and possibly avoiding) oil at sea. This criterion is considered independent of the birds themselves, and is only judged according to environmental factors, such as temperature, weather, and light conditions.

Fc Flight capability (Good/Moderate/Poor). How well the average individual is able to fly. This includes both specific differences and temporary flightlessness of young and moulting birds.

Pf Physical fitness (Good/Moderate/Poor). The physical condition of the average individual.

Rc Recovery capability (Good/Moderate/Poor). The average individual's chance of recovery after oiling. This criterion is dependent on body size and different aspects of feeding strategy, and whether the bird can find sufficient food on land (which will reduce cooling and increase its chance of survival).

Population Vulnerability (PV)

De Degree of exposure (Weak/Moderate/Strong). How the local population is distributed within the study area in relation to oil spill exposure, *i.e.* to which degree the birds are protected by natural oil barriers (islands, fjords, etc.).

Ps Population size (Large/Moderate/Small). The number of individuals in the local population. This criterion is judged independent of species.

Ft Flocking tendency (Weak/Moderate/Strong). The tendency of the birds to occur in large or small flocks or as scattered individuals.

Fi Frequency of immatures (Large/Moderate/Small). The proportion of young (non-breeding) birds in the local population.

Rp Reproductive potential (Large/Moderate/Small). The reproductive strategy of the species concerned, as reflected by generation time, age at first breeding, clutch size, annual survival, etc.

Pt Population trend (Positive/Stable/Negative). The present trend in local population numbers.

Vp Vulnerable part of population (Small/Moderate/Large). Relative size of the local population compared to the natural population it belongs to (or is recruited from).

Pi Potential immigration (Large/Moderate/Small). The chance of immigration from surrounding areas into the study area after a sudden decrease in the local population (*e.g.* caused by oiling). This criterion is dependent upon the number, population development, and philopatry of birds present in surrounding areas.

The criteria are grouped in five vulnerability factors and given individual weights (Table 1). The end products, calculated in two formulas, are a value of individual vulnerability (IV) and a value of population vulnerability (PV); both between one and three. Populations with PV-values of two or three in the spring and summer seasons, and three in autumn and winter are considered highly vulnerable to oil spills in the respective seasons.

Table 1. Grouping of vulnerability criteria on the individual and population levels. The relative weight given to each criterion is shown in parentheses (after Anker-Nilssen 1987, and Anker-Nilssen & Vader unpubl.).

Vulnerability factor	Vulnerability criteria	
	Individual level	Population level
A. *Presence* (Time in area)	Ta	–
B. *Time at risk* (Time at sea when in area)	Ts	–
C. *Exposure to oil* (Possibility of getting near to oil while at sea in the area)	Au(2)+Bs+Sa(2)	De
D. *Oiling* (Possibility of injury as a consequence of oiling)	Pr+Fc(4)	Ps+Ft(2)
E. *Oiling effects* (Reduced survival and reproduction as a result of oiling)	Pf+Rc	Fi(2)+Rp(4)+Pt(2)+Vp(4)+Pi

$$IV = Ta * Ts * \left(\frac{2Au + Bs + 2Sa}{5}\right) * \left(\frac{Pr + 4Fc}{5}\right) * \left(\frac{Pf + Rc}{2}\right)$$

$$PV = IV * De * \left(\frac{Ps + 2Ft}{3}\right) * \left(\frac{2Fi + 4Rp + 2Pt + 4Vp + Pi}{13}\right)$$

3. SPECIAL CONSIDERATIONS FOR THE NSR-AREA

Considering possible oil spills in connection with the Northern Sea Route activity there are several factors that should be emphasised. The area of concern is very large, and it is heavily influenced by sea ice. The sources of potential oil pollution are moving vessels and not stationary platforms. To deal with these special factors in the best possible way we have found it advantageous to make some modifications both in the definitions of some of the criteria and also in the indexing process as compared to the original method designed by Anker-Nilssen (1987).

3.1 AREA AT RISK

The Northern Sea Route covers a huge area and stretches along the coasts of four Siberian seas with highly different environmental conditions. Also the species composition, the ecology of the species, and the state of knowledge on the avifauna differ greatly between these areas. The risk of accidents also varies for different areas. So far, there is no information about the area of risk for oil spills from NSR-activity. Hence, it is not possible to define exactly the areas potentially exposed to oil spills along the NSR. In this report we have defined the whole coastline along the NSR as the area of risk. The northernmost limit of the area follows the geographical boundary of the Siberian seas, that is, all the main islands are included.

On the basis of the geographical distribution of the species, subspecies and populations, as well as of the landscape-biotopical features of the coast, the following natural regions were identified (Fig. 1):

I. Novaya Zemlya–West Siberia

II. Taimyr–Severnaya Zemlya

III. Yakutia

IV. Chukotka

The use of this large-scale zoning is justified by the poor information support. It is probable that not even a large oil spill will cover a considerable proportion of these large regions. Due to the almost complete absence of reliable recent data, especially on the population status of the marine birds in the area, we have not found it suitable to divide the total area into smaller regions.

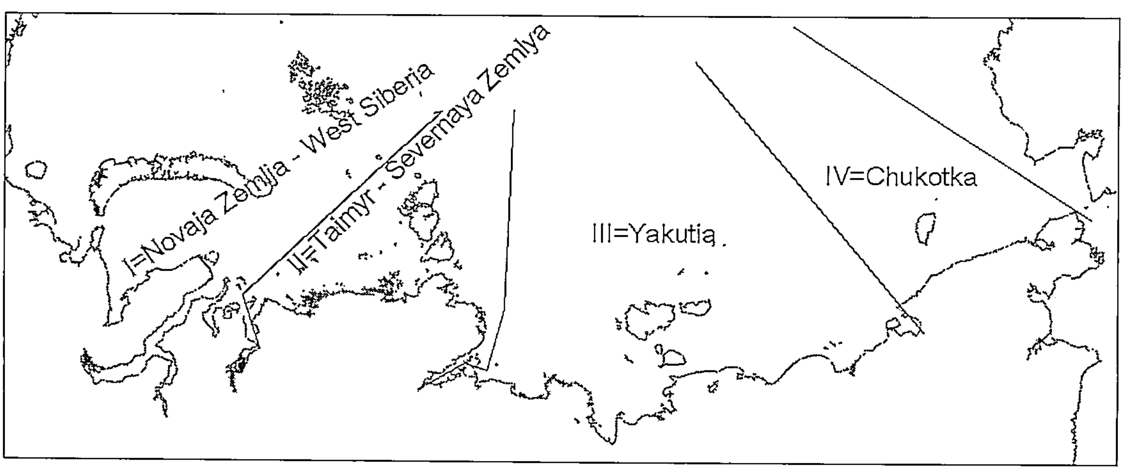

Fig. 1. The Northern Sea Route area divided into regions (1-IV)

3.2 GENERAL COMMENTS ON SOME CRITERIA

As the area under consideration extends far both in a north–south and a east–west direction, the ecology of a species may differ between different parts of the area. In particular, the populations occurring within the NSR-area differ in their marine ecology as compared to those inhabiting the Barents Sea region. This is because climatic conditions, and especially ice conditions, are much more severe in the Siberian seas. It should also be emphasised that most estimates concerning periods of the year other than the nesting period are only marginally based on information obtained within the NSR-area. This is because the marine birds in the NSR-area have been even less studied during the nonbreeding period than during the nesting period. Data from the time the birds spend at sea are practically absent.

Some modifications of the original vulnerability criteria are described below.

Sa (Shore affinity) – We consider that during the ice period the ice edge for this factor is similar to the coastline. We therefore think it is reasonable to convert this factor into shore and ice edge affinity, at least for the spring and winter periods.

Bs (Behaviour at sea) – The habit of Kittiwakes *Rissa tridactyla* and the gulls of the genus *Larus*, as well as Ivory Gulls *Pagophila eburnea* and Pomarine Skuas *Stercorarius pomarinus* to follow ships increases the probability of contact with an oil spill. We therefore consider their behaviour at sea 'very vulnerable' (3). However, it is not known to what extent such behaviour is characteristic for the breeding birds that are connected with the nesting sites (*Bs*=3 for Nesting populations was followed by a question mark).

Pr (Possibility of reaction) – Due to the extremely harsh and unstable weather conditions, we find that within the area under consideration it is impossible to definetely conclude that the conditions in some of the seasons (except winter) are more or less favourable for recovery after pollution. A longer period of low temperature and unfavourable ice conditions during the nesting period may have a stronger negative influence than the more average less favourable conditions in spring or autumn. The values given to this factor indicate average predictability of weather in various regions (according to consultation with the experts of Sub-program I) and should be regarded as very arbitrary.

Ps (Population size) – The following categories are used: No.<5.000: small (3); 5.001<No.<100.000: medium (2); and No.>100.001: large (1).

Vp (Vulnerable part of the population) – At the present level of knowledge we have to use very large regions (see above). Within regions of this size, one or even several natural populations may exist. When using the OVI methods, a possible damage for some local population is estimated. Unless spatially clumped, only a relatively small part of the population in the large regions used here will in most cases be affected during a single oil spill. We give the value 1 to this factor to avoid overestimation.

Further comments are given below for each season separately.

The NSR covers a vast area and knowledge on the biology of bird populations in the area is mostly relatively poor. Some of the values of the vulnerability criteria are therefore only best guesses made by experts working with the actual species in the area.

For some of the most uncertain criteria, alternative values have been used, resulting in two alternative vulnerability values. These are given in separate lines in the assessment tables.

3.3 DEFINITION OF SEASONS

We decided to include only the nesting period in the summer period. This does not include the whole breeding period, as the end of the breeding period of the ducks *Anseriformes* largely coincides with moulting in autumn, and of the Brünnich's Guillemot *Uria lomvia* also with the beginning of migration. Thus, this report defines the **'Nesting period'** of the various species as follows:

- divers, waders, gulls and skuas – from the beginning of nesting up to fledging;
- swans, geese and ducks – from the beginning of nesting up to the time when chicks leave the nest;
- cormorants and auks – from the beginning of nesting up to the time when birds leave the colonies.

Although the young of divers, waders and skuas leave the nests soon after hatching, they remain in the area around the nest (divers and skuas) or they are not connected with the sea (waders). We therefore include the period up to fledging in the 'Nesting population' for these species.

The term **'Postnesting and moulting population'** includes:

- divers, waders, gulls and skuas – from fledging of the young up to the time when the birds leave the area for wintering;
- swans, geese and ducks – the period from the young leave the nest to the time when the birds depart from the area for wintering;
- cormorants and auks– from the time the birds leave the colonies up to the time of departure from the area for wintering.

For the wintering populations (parts of the populations of auks and Ivory Gull) we assume the time of the stable ice-cover formation to be the end of this period.

4. SPECIES AND POPULATIONS CONSIDERED

A preliminary list of seasonal populations to be included in the vulnerability assessment was prepared at the January meeting. It included the populations of divers, waterfowl, waders and seabirds that belong to the sea along the NSR-coast. Later, during the second meeting experts experienced in field work with birds along the NSR-area decided to make some changes in this list. Both the biology of populations occurring along the NSR-area and the state of knowledge on their biology were taken into account. Comments clarifying some of the decisions made are given below.

4.1 GENERAL LIST

The Bewick's Swan *Cygnus columbianus bewickii* is included as it comes out to the coast during moulting in some regions.

The Bean Goose *Anser fabalis* is included as it moults in deltas and comes out to the coast in some regions as well (Kalyakin pers. obs.; Pokrovskaya & Tertitskiy 1993).

The Common Scoter *Melanitta nigra* and Goosander *Mergus merganser* are included as they appear on the coast of Novaya Zemlya and in the south-eastern Kara Sea during moulting and migration (Kalyakin pers. obs.; Mineev 1994).

The Ruff *Philomachus pugnax* is included as it comes out at the Kara Sea coast during summer and autumn migration.

4.2 SPRING

The spring migration of skuas is known to pass over the sea in the Barents Sea. Extremely different ice conditions of the Siberian Seas as compared to the Barents Sea do not allow us to simply extrapolate the migration patterns of skuas observed in the Barents Sea to the NSR-area. The few observations in the NSR-area suggest both inland and marine spring migration routes (Morozov and Kalyakin, pers. obs., Zhitkov 1912). However, since there were no observations of skuas at sea during this period, no indexing was made.

4.3 SUMMER

The Arctic Skua *Stercorarius parasiticus* is known to remain at the sea during nesting because it feeds mainly by kleptoparasitisism on other seabirds. Different feeding habits are known from the NSR-area, including predation on eggs and young of other birds, kleptoparasitism on seabirds and self-dependent fishing and gathering of marine invertebrates (M. Gavrilo pers. obs., Syroechkovskiy & Lappo 1994 and others). It is not known, however, to what extent breeding birds have the sea as their habitat. Therefore, the indexing concerns only a small fraction of the breeding birds which use the sea in any way.

The Sanderling *Calidris alba*, the Little Stint *C. minuta*, the Dunlin *C. alpina*, the Spoon-billed Sandpiper *Eurynorhynchus pygmeus* are included as individuals from the coastal populations (inhabiting a narrow band of tundra along the sea) can feed also in the littoral zone (in those places where it is developed). However, this is true only for a small fraction of the total populations of these species.

4.4 AUTUMN

Loons *Gavia spp.* Observations in the course of the expeditions *Tundra ecology-94* and *KAREX-95* have shown that divers are often encountered at sea (M. Gavrilo pers. obs.). However, the absence of specific data on the biology of divers during the postnesting period within the NSR-area makes an assessment of their vulnerability difficult. The index of both individual and population vulnerability can vary from 1 to 3 for all divers depending on the dates of departure, the time spent at sea and area utilisation. This is why these species are excluded from the assessment for the autumn season.

The final list includes 311 seasonal populations, taking into account the division of the NSR-area into four natural regions.

5. INDEXING AND COMMENTS ON SOME SEASONS

5.1 WINTER (APPENDIX I)

Reliable data on wintering of marine birds within the NSR-area are available only for Novaya Zemlya including the areas Northeast of the Cape Zhelaniya (Butiev 1959) and Matochkin Shar Strait (Dubrovskiy 1933). On the basis of these data, indexing of winter populations of four species of marine birds for region 1 is made (Appendix I).

5.1.1 Comments on some criteria

Au (Area utilisation) – The use of the area by birds is largely determined by the distribution and dimensions of polynyas and leads. It is therefore difficult to determine this criterion, but it is evident that ice will restrict the area available for foraging (and for some species also resting) as compared to ice-free waters.

Sa (Shore affinity) – As explained above, this criterion should reflect the probability of contact with oil, which has a tendency to accumulate along the shore. In the case of an oil spill occurring in a polynya or a lead during the winter, the whole surface of unfrozen water will act as an accumulating reservoir. Therefore, we give this criterion the value 3 for all species considered, independent of their behaviour in relation to the shoreline.

Pf (Physical fitness) – There are no data on the conditions of the wintering birds, apart from the indication that there were found frozen guillemots at the shore. Presuming very severe conditions of wintering, we estimate this criterion not to be lower than 2.

Vp (Vulnerable part of population) – The winter period is the only period for which we can estimate the vulnerable part of the populations, as it is evident that only a small proportion of the birds remain in the area during the winter (*Vp*=1).

5.1.2 Analysis of the vulnerability of the populations

In spite of very few available data on the wintering of seabirds within the NSR-area, the species known to spend the winter there belong to the category of true seabirds that are highly vulnerable. Very severe winter conditions in the Siberian Arctic also aggravate to this situation. Thus, all populations of marine birds known to winter in region I, are highly vulnerable with regard to oil pollution. However, there are no current reliable data on the distribution, abundance, biology or even occurrence of marine birds within the NSR-area during winter.

5.2 SPRING; THE PREBREEDING PERIOD (APPENDIX II)

5.2.1 Comments on some criteria

Ta, *Ts*, *Au* (Time in the area, Time at sea, and Area utilisation) – There are very few data on spring migration and prebreeding biology of the marine birds occurring in the NSR-area. Information about dates of spring arrival and biology during the prebreeding period are valid only for birds that have arrived at the breeding grounds. No data on the marine period is available. Values on these criteria were given very approximately and could in some instances vary between 1 and 3. These are all criteria that contribute considerably to the final value.

De (Degree of exposure) – Estimated very approximately since a significant part of the area is ice covered during the prebreeding period. This will influence on the distribution of the spilled oil and the degree of exposure.

Ps (Population size) – There are very few data on the abundance of birds during the prebreeding period. The most uncertain values were given to the Red-throated Diver *Gavia stellata* and the Brünnich's Guillemot (region I); the Spectacled Eider *Somateria fischeri*, the Ross's Gull *Rhodostetia rosea* and the Arctic Tern *Sterna paradisaea* (region II); The Common *Eider Somateria molissima*, the Ivory Gull, the Ross's Gull, the Sabine's Gull *Xema sabini* and Arctic tern (region III); and the White-billed Diver, the Spectacled Eider, the Ivory Gull, the Sabine's Gull and the Herring Gull *Larus argentatus* (region IV).

Fi (Frequency of immatures) (spring and summer) – There are almost no data on the spatial and temporal distribution of immature birds in relation to adults for most species in the given area. Probably, a proportion of the immature birds move into the area later in summer than the adults (for example, immature larger gulls of different ages are observed in the Kara Sea in late summer; M. Gavrilo pers. obs.). Young birds of the Ivory Gull may stay in the ice-edge zone of the Arctic seas.

5.2.2 Analysis of the vulnerability of populations

Divers – In spring the vulnerability of all divers is low. Alternative values for the most uncertain vulnerability criteria all result in a vulnerability index of 1 for the Black-throated Diver *Gavia arctica* and the White-billed Diver, and 2 for the Red-throated Diver.

Marine ducks – If the criteria for which there is little scientific basis are set equal to two, all species of eiders will be classified as low vulnerability. However, there are no data on the prebreeding distribution. Possibly the birds use polynyas in this period, which has been suggested by some authors (Rutilevskiy 1957; Kishchinskiy 1982). Thus, the estimate of the criteria *Ta* (Time in the area) may vary from 1 to 3; it can also turn out to be different in various regions. If it turns out that the eiders are found at sea in the vicinity of the breeding site in spring, then the estimate of the criteria *Ts* (Time at sea) should be increased to 3. These criteria, which are very uncertain, have a large impact both on the individual and on the population vulnerability index. Depending on the assessment of *Ta* and *Ts* the final vulnerability value may vary from 1 to 3.

According to the present state of knowledge it is possible to say, however, that the Pacific Steller's Eiders *Polysticta stelleri* are less vulnerable in relation to oil spills as compared to other marine ducks. This is because their spring migration passes over the mainland. The King Eiders *Somateria spectabilis*, at least from the western regions, are less vulnerable compared to the Common Eider, because they are more attached to freshwater lakes and ponds. In general, the most vulnerable species are the Common and the Spectacled Eiders, the least vulnerable is the Steller's Eider, while the King Eider and the Long-tailed Duck are of moderate vulnerability.

Gulls – The larger gulls, the Sabine's Gull, the Ross's Gull and the Arctic Tern belong to the category of low vulnerability during spring in spite of the alternative values given to some uncertain criteria. The Ivory Gull has the largest number of uncertain criteria values, mainly in connection with the population criteria. The final vulnerability index (with different combinations of alternative criteria values) may vary from 1 to 2 for this species.

Auks – These are the most vulnerable species in all regions. The variations in the vulnerability indexes due to uncertain estimates of some criteria are within index values of 3 (except for the Black Guillemot *Cepphus grylle* in region III). In the case of a very good immigration potential, the population vulnerability would decrease for this species.

Thus, only auks appear to be undoubtedly highly vulnerable to oil spills during the spring (prebreeding) period. The Red-throated Diver, Kittiwake and Ivory Gull have moderate vulnerability. Sea ducks, except the Steller's Eider, are very likely to be highly vulnerable to oil pollution, but they cannot be definetely assessed with the present state of knowledge on their distribution in this period. The rest of the species are of low vulnerability to oil pollution.

5.3 SUMMER; THE NESTING PERIOD (APPENDIX III)

5.3.1 Comments to some criteria

Pf (Physical fitness) – There are very few specific data available. It has been shown that during the nesting period waders increase in weight, which indicates a good physical condition. On the other hand, it is known that marine ducks lose weight while incubating. There are no direct data on the remaining species. Our tentative assumption is that the physical condition of the rest of the species is moderate or poor due to variable weather and hence a possibly strained energy budget (estimate 2). It appears that the physical state of the birds may vary depending on the environmental conditions. Changing the values of these criteria will in many cases result in changed vulnerability indexes.

De (Degree of exposure) – Estimates of exposure degree are very approximate (estimated on the average of the region).

Ps and *Pt* (Population size and Population trend) – There are no recent quantitative data on the population size of most of the species in the NSR-area. There is reliable information on population trends from a very limited number of locations. Often we have to extrapolate the tendencies from these local areas to the entire identified region (for example, the data from Wrangel Island are taken to be representative for the entire Chukotka region). The values given to these criteria are therefore very unreliable. For example, the populations of the Horned Puffin *Fratercula corniculata* on Kolyuchin Island and Wrangel Island have opposite trends (Kondratiev *et al.* 1987; Stishov *et al.* 1991); this is why the final estimate has a mean value.

5.3.2 Analysis of the vulnerability of populations

Divers – The individual vulnerability of the Black-throated Diver is low. The population vulnerability may be low or moderate depending on the physical fitness. The Red-throated Diver is found to have moderate vulnerability both on individual and population levels. However, we should mention that the only data available on nesting biology and feeding (Soloviev 1992) were extrapolated from the Chukchi Peninsula to other regions. The White-billed Diver is a species with lower reproduction potential and is therefore more vulnerable to oil spills (PV-value of 2–3). The final result is also affected by the physical fitness of the birds. On the whole, with a moderate biotope exposure and good physical fitness of the birds, the White-billed Diver has a moderate vulnerability with regard to oil pollution.

Geese – In spite of the possible variations due to uncertain criteria values, the vulnerability indexes are all equal to 1.

Marine ducks – The most vulnerable species is the Common Eider, the individual vulnerability index of which is maximum (3), while the population vulnerability index varies in different regions and under different conditions. Only the Common Eider in region I (belonging to the nominative subspecies) seems to be definetely vulnerable at both levels. The populations of the Pacific Common Eider (regions III and IV) are less vulnerable due to biological differences, distribution patterns and more favourable conditions in these regions. However, the situation in region III is not clear; the final PV-value may vary from 1 to 3 depending on population characteristics, time spent at sea and degree of biotope protection. The other species of eiders are less vulnerable since their main habitat is not at sea during the nesting period, but more information about habitat use would be of great importance. The most uncertain index is for the King Eider in region III. The Long-tailed Duck *Clangula hyemalis* and the Spectacled Eider seem to be the least vulnerable.

Waders – As expected, since they are not so attached to the sea, waders are not so vulnerable to oil spills. All species have vulnerability indexes equal to 1.

Gulls and skuas – The larger gulls, the Arctic Skua *Stercorarius parasiticus* and the Arctic Tern have low vulnerability to oil spills in the nesting period. The Ivory Gull has a moderate vulnerability at the individual level during the nesting period. The vulnerability at the population level can turn out to be higher depending on the population trend and degree of exposure. Region II is known to contain the main concentrations of nesting colonies of the Ivory Gull. This is why we for this region as a whole consider the *Vp* (Vulnerable part of population) as moderate or high, which in turn may increase the index of the population vulnerability up to 3. Kittiwakes are found to be highly vulnerable. Uncertain estimates of their physical fitness results in slight variations in the vulnerability at the individual level and, in region IV, at the population level as well. The latter could be explained by better population status and more favourable conditions in the region.

Auks and cormorants – The most vulnerable species among the auks, independent of region and variations in the most uncertain criteria values, appear to be the Brünnich's Guillemot, the Little Auk *Alle alle* and the Horned Puffin. The vulnerability of the Black Guillemot may vary between 2 and 3 depending on physical fitness and population characteristics. This is also the case for the Pelagic Cormorant *Phalacrocorax pelagicus* in region IV.

Thus, during the nesting period the auks and the Kittiwake are undoubtedly vulnerable both at the individual and the population levels. Other vulnerable species are the White-billed Diver, the Pelagic Cormorant and the Common Eider; their vulnerability can, however, vary depending on the region and on some population characteristics. The Red-throated Diver and the Ivory Gull are of moderate vulnerability, whereas the King Eider and the Steller's Eider have uncertain, though probably also moderate population vulnerability.

5.4 AUTUMN; THE POSTNESTING AND MOULTING PERIOD (APPENDIX IV)

5.4.1 Comments on some criteria

Ta (Time in the area) – There are no relevant data from the NSR-area (especially for the time spent at sea) and the assessment is therefore very approximate. The time of the formation of a stable ice cover is assumed to be the end of the period.

Ts (Time at sea) – For skuas this criterion is given approximate values as direct observations are practically absent. On the other hand, one may presume that this indicator varies significantly depending on the presence of available food on the tundra both from year to year and between different regions.

Pf (Physical fitness) – For skuas this is determined very approximately, as for gulls.

Ps (Population size) – The size of the population was estimated by taking into account the total number of birds passing through the regions during the autumn. The most uncertain estimates are for the Bewick's Swan, the Northern Pintail *Anas acuta*, the Greater Scaup *Aythya marila*, the Steller's Eider, the Velver Scoter *Melanitta fusca*, the Bar-tailed Godwit and the Ivory Gull (region I); the Temminck's Stint *Calidris temminckii*, the Skua sp., the Ross's Gull, the Sabine's Gull and the Arctic Tern (region II); the Common Eider, the Steller's Eider, the Ruff, the Sharp-tailed Sandpiper *Calidris acuminata*, the Red-necked Stint *Calidris ruficollis*, the Skua *sp.*, the Ross's Gull, the Sabine's Gull, the Glaucous Gull *Larus hyperboreus*, the Arctic tern and the Brünnich's Guillemot (region III); and the Bean Goose, the Long-billed Dowitcher *Limnodromus scolopaceus* and the Sabine's Gull (region IV). When only poor estimates were available, the lowest possible values were usually used.

5.4.2 Analysis of the vulnerability of the populations

Wildfowl – Barnacle Geese *Branta leucopsis* and Emperor Geese *Philacte canagica*, eiders and other marine ducks appear to be highly vulnerable both at the individual and the population levels. The least vulnerable are the Bewick's Swan, the Bean Goose and the Northern Pintail. The Brent Goose *Branta bernicla* has an intermediate position. Possible variations within inaccurate estimates do not affect the final index values.

Waders – With regard to the waders the vulnerability model does not work since for all species except for phalaropes *Phalaropus sp.*, *Ts* (Time at sea) and, hence, also total vulnerability is equal to zero. Attempts to modify the model, assuming the time spent in the littoral zone to be the time at sea for the waders, placed these species in the category of low vulnerability. The littoral zone of the open coast of the Arctic Siberian seas is very harsh due to sea-ice scouring. The concentrations of waders are found in the river mouths etc., i.e. to the more protected coastal areas.

Skuas – These species spend more time at sea during the postnesting period, and the Pomarine Skua are ship-followers, especially in ice-covered waters (M. Gavrilo pers. obs. in the course of the expedition *Tundra ecology-94*), thus they appear to be of moderate vulnerability in relation to oil spills during this period.

Gulls – the Kittiwake and the Ivory Gull are the most vulnerable species of the gulls, having high vulnerability on the population level and moderate vulnerability on the individual level. The Sabine's Gull and the Ross's Gull both have moderate vulnerability in relation to oil. The main breeding grounds of the Ross's Gull are located in region III. With favourable population characteristics (high and increasing numbers and good immigration potential) the vulnerability index in this area may turn out to be small. For the Sabine's Gull in region III, the vulnerability index is decisively affected by the time spent within the area. Larger gulls and the Arctic Tern are less vulnerable in relation to oil.

Auks and Pelagic Cormorant – As in other seasons these species are highly vulnerable in relation to oil spills.

Thus, the most vulnerable species during the postnesting period appear to be the Pelagic Cormorant, all auks, marine ducks (moulting and rearing broods at sea), as well as Emperor Geese and Barnacle Geese which are closely attached to the sea during this period. The Ivory Gull and the Kittiwake appear to be less vulnerable (on the individual level). The rest of the gull species have a moderate or low vulnerability index. The waders are the least exposed to oil spills.

6. RESULTS, DISCUSSION AND GENERAL CONCLUSIONS

The application of the present method for the assessment of oil vulnerability of the species inhabiting the vast and poorly investigated territory of the NSR is difficult at the present state of knowledge. The greatest difficulties have occurred during the identification of the natural regions and in the assessment of the fraction of the natural population which may be exposed to a possible impact (*Vp*). Due to the absence of necessary recent data on population numbers and dynamics, and on phenology and distribution of species within the NSR-area, the vulnerability index values may in some cases vary from the minimum to the maximum value.

Of the 311 seasonal populations considered, 92 are found to be highly vulnerable to oil spills (population vulnerability index of two or three in the spring and summer seasons, and three in the autumn and winter seasons). Another 28 populations may potentially also come into this category after a specification of some features of their biology and distribution in the NSR-area. The rest of the populations (191) have less vulnerability to oil spills (Table 2).

Table 2. Vulnerability to oil of seabirds along the NSR. The numbers are number of populations for each vulnerability category and region. The populations are categorised in populations with high vulnerability (dark shading) and populations with low vulnerability (unshaded). Populations for which the vulnerability has not been finally determined and that might be highly vulnerable have light shading.

	Winter	Spring				Nesting				Autumn				
PV	I	I	II	III	IV	I	II	III	IV	I	II	III	IV	Sum
3	4	3	3	1	2	4	4	2	4	12	7	9	11	66
2	0	3	2	1	1	1	1	2	2	4	5	1	5	28
2–3	0	1	0	4	0	1	2	2	3	0	0	0	0	13
1–3	0	0	2	1	4	0	0	2	0	0	0	1	0	10
1–2	0	3	2	1	1	4	3	2	2	0	0	3	1	22
1	0	5	7	9	9	15	15	15	17	19	21	22	18	172
Sum	4	15	16	17	17	25	25	25	28	35	33	36	35	311

Highly vulnerable 92

Populations potentially of high vulnerability 28

Populations of low vulnerability: 191

By seasons the list of highly vulnerable populations are as follows (be aware of the differences between regions; see also Appendix V)

Winter: The Ivory Gull, the Brünnich's Guillemot, the Black Guillemot and the Little Auk.

Spring: The Common Eider, the King Eider, the Spectacled Eider, the Kittiwake, the Brünnich's Guillemot, the Black Guillemot, the Little Auk, and also possibly the Red-throated Diver, the Long-tailed Duck, the Ivory Gull and, to a lesser extent, the Steller's Eider.

Nesting period: The White-billed Diver, the Red-throated Diver, the Pelagic Cormorant, the Common Eider, the King Eider, the Steller's Eider, the Kittiwake, the Ivory Gull, the Brünnich's Guillemot, the Black Guillemot, the Little Auk, the Horned Puffin, and possibly also the Black-throated Diver and the Bewick's Swan.

Postnesting period: The Pelagic Cormorant, the Emperor Goose, the Barnacle Goose, the Greater Scaup, all species of eiders, the Long-tailed Duck, the Common Scoter, the Velvet Scooter, the Goosander, the Kittiwake, the Ivory Gull, the Brünnich's Guillemot, the Black Guillemot, the Little Auk, the Horned Puffin, and possibly also all species of divers (cf. section 4.4).

The postnesting period has the highest number of highly vulnerable populations (Table 3). However, the spring and nesting periods have high numbers of populations with uncertain vulnerability, and these seasons may attain similar numbers of highly vulnerable populations when one obtains more information on the biology of these populations with uncertain vulnerability. It should be noted that the postnesting season coincides with the period of the most intensive ship traffic along the NSR.

Table 3. The number of populations of high, low and uncertain (potentially high) vulnerability to oil after season (winter (Wi), spring (Sp), nesting (Ne) and autumn (Au)).

	Wi	Sp	Ne	Au
High	4	21	28	39
Uncertain	0	14	13	1
Low	0	30	62	99
Sum	4	65	103	139
% highly vulnerable	100	32	27	28

Region I (Novaya Zemlya–West Siberia) has a somewhat higher number of highly vulnerable populations compared to the other regions. Also, the proportion of highly vulnerable populations is highest in this region (Table 4). The reasons may be both of natural origin and induced by the state of knowledge. Favourable hydrological conditions of the south-western Kara Sea and its geographical position account for the diversity of marine birds found here. Waters of the eastern zone of the NSR-area (regions III and IV) are only assumed to be intensively used by the marine birds; no specific data are available. On the other hand, geographical features of the area seem to account for the spring migration over the mainland.

The low number of highly vulnerable populations in region II during the postnesting period is undoubtedly caused by the northern position of the area.

Table 4. The number of populations of high, low and uncertain (potentially high) vulnerability to oil in each region.

	I	II	III	IV
High	29	19	21	23
Uncertain	7	7	7	7
Low	43	48	50	50
Sum	79	74	78	80
% highly vulnerable	37	26	27	29

The species having the highest number of vulnerable populations within the NSR area are shown in table 5. Auks and marine ducks have the highest number of vulnerable populations (Table 5) and the reasons are mainly that these species are widespread in the NSR area and generally among the most vulnerable to oil spills.

Table 5. Species within the NSR-area found to be highly vulnerable to oil spills (long-term effects) in one or more regions and seasons (population vulnerability index 2 or 3 in spring and nesting seasons and 3 in other seasons). The number of highly vulnerable populations is listed for each species (the maximum number of populations is 16 for 4 seasons and regions).

Species	No. of populations
Gavia stellata	6
Gavia adamsii	4
Phalacrocorax pelagicus	2
Philacte canagica	1
Branta leucopsis	1
Aythya marila	1
Somateria mollissima	9
Somateria spectabilis	8
Somateria fischeri	4
Polysticta stelleri	5
Clangula hyemalis	7
Melanitta fusca	1
Melanitta nigra	1
Mergus merganser	1
Rissa tridactyla	11
Pagophila eburnea	6
Uria lomvia	13
Cepphus grylle	13
Alle alle	5
Fratercula corniculata	2

The greatest uncertainty in the final values of the vulnerability indices is caused by uncertainty in the estimates of spatial-temporal (*Ta*, Time in the area; *Ts*, Time at sea; *Au*, Area utilisation; and *Fi*, Frequency of immatures) and physiological factors (*Pf*, Physical fitness). It should be noted that almost all the uncertain vulnerability indices are for the spring and nesting seasons.

The difficulties related to the absence of reliable recent data on population numbers have already been mentioned (uncertainty in estimates of the factors *Pt*, Population trend; *Vp*, Vulnerable part of population; and, for a number of species, *De*, Degree of exposure).

Thus, this oil vulnerability assessment has not only made it possible to identify the most vulnerable populations with regard to oil pollution, but also to identify the most significant gaps in the knowledge on biology and distribution of the marine birds in this area. Hence, this should form a valuable basis for making priorities on future studies aimed at eliminating these gaps in our knowledge.

It is of evident importance to carry out counts to investigate the numbers and distribution of seabirds and waterfowl at sea in the area. This especially concerns divers, marine ducks (eiders and Long-tailed Ducks), Gulls and auks during the non-breeding period (in spring along the systems of leads and polynyas, and in autumn in various regions of the Siberian Seas). The most effective method for carrying out these studies appears to be aircraft surveys. By using this method one can cover the entire vast area of the NSR in a relatively short period, and obtain basic data on the distribution and number of the species. It seems that such studies will provide useful data not only for the INSROP Project II.4.2 'Environmental Atlas – Marine birds', but also for Project II.4.3 'Environmental Atlas – Marine mammals'. More data on non-breeding biology and bioenergetics of marine birds are also needed.

The evaluation of the oil vulnerability of marine birds is a part of the selection of Valued Ecosystem Components (VECs) to be considered within the framework of INSROP project II.4.2 *Marine birds* (see Bakken *et al.* 1996). In this evaluation other factors such as economic importance, vulnerability in relation to other hazards than oil, and the conservation value of the individual species should be taken into account. A simple matrix (Table 6) shows all species or species groups that have high values for one or more of these factors. Here, a species is defined to have conservation value of international importance if the population size within the NSR-area is more than half of the total world population (the Spectacled Eider, the Steller's Eider, the Ivory Gull and the Spoon-billed Sandpiper), or if it is represented by endemic breeding subspecies (the Dark-bellied Brent Goose *B. bernicla bernicla* and the Brünnich's Guillemot *U. lomvia eleonorae*); and of national conservation value if the species is included in the Russian Red Data Book (see Appendix VI).

Table 6. List of species/habitats that should be considered within the INSROP framework.

Species	OV	VV	EU	CV
Gavia stellata	3	1	1	-
Gavia adamsii	3	1	1	N
Phalacracorax pelagicus	3	1	1	-
Cygnus columbianus bewickii	1	1	1	N
Anser fabalis	1	2	3	-
Philacte canagica	3	3	1	N
Branta leucopsis	3	3	1	N
Branta bernicla	2	3	3	I
Somateria mollissima	3	2	2	-
Somateria spectabilis	3	1	3	-
Somateria fischeri	3	2	1	I
Polysticta stelleri	3	2	1	I
Rhodostethia rosea	1	1	1	I
Rissa tridactyla	3	1	1	-
Pagophila eburnea	3	2	1	I
Uria lomvia	3	1	1	I
Ducks on moulting areas	3	3	3	1
Waders on feeding and roosting areas	1	3	2	(I)

OV: Vulnerability in relation to oil (PV)
VV: Vulnerability in relation to other factors: disturbance, poaching etc.
EU: Economic use
CV: Conservational value (no, N=National, I=International)

7. BRIEF SPECIES DESCRIPTIONS

Brief descriptions of the species found to be highly vulnerable to oil spills (long-term effects) in one or more regions and seasons (population vulnerability index 2 or 3 in the spring and nesting seasons and 3 in the other seasons) are given below. These descriptions include brief information on distribution with an emphasis on the NSR-area, the most recent population estimates available, as well as relevant information on biology.

RED-THROATED DIVER *(Gavia stellata)*

General distribution/numbers: The breeding range is circumpolar with a more northern distribution as compared to the other divers. It is common in the tundra area, but rare in the taiga. No total population estimate is available.

The NSR-area: Inhabits the mainland tundra and all archipelagos along the whole NSR-area. Total number is unknown. It outnumbers other species of divers in some areas where more than one species occur. The breeding densities for the area concerned vary from 0.02 to 0.5

pairs/km^2 (Flint 1982a, Soloviev 1992). High densities during the postbreeding period are known both on the tundra and at sea from Bely Island and the southwesternmost part of the Kara Sea (Gavrilo & Nordin 1995; Gavrilo unpubl.)

Biology: A crucial factor for breeding is the availability of both very small nesting lakes and fish-rich seas, large lakes or rivers used for foraging. The main food is fish caught by diving. It feeds more in the sea than other divers during breeding (Soloviev 1992). Laying of eggs occurs from mid-June to early July varying between regions and seasons. The clutch consists usually of two eggs. It should be noted that nonbreeding adults spend the summer within the nesting biotopes while immature birds are recorded at sea only (Flint 1982a). Contrary to Black-throated Divers, Red-throated Divers are not known to form concentrations at sea during migration. Autumn migration extends throughout September–October.

WHITE-BILLED DIVER (*Gavia adamsii*)

General distribution/numbers: Inhabits the Arctic (mostly coastal areas) of Eurasia and North America except for the area from eastern Canada to Kolguyev and Novaya Zemlya. The number is very variable from area to area, but in most regions the species is rare. No total population estimate is available.

The NSR-area: Inhabits tundra regions, both near the sea and in the inland (sometimes visiting forest areas) along the whole NSR. The total number is unknown. Within the study area there are two areas with the most dense population known; the eastern side of the lower reaches of the Yenisey River and Chukotka (Krechmar 1966; Flint 1982b).

Biology: An obligatory condition for breeding is the availability of large water bodies rich in fish (the sea, lakes or rivers), however the distribution is characterised by extreme non-uniformity that cannot be attributed to the absence of favourable biotopes. During the nonbreeding season the species is found only at sea. It feeds on fish caught by diving. The biology of the species has been very poorly studied, but compared to other species of divers it may have a lower breeding potential. The laying of eggs occurs in late June to early July. The clutch consists of one or two eggs. Autumn migration occurs in September to early October.

PELAGIC CORMORANT (*Phalacrocorax pelagicus*)

General distribution/numbers: The breeding range is in the North Pacific, including the coasts of the Chukchi, Bering and Okhotsk Seas. The world population is apparently relatively stable, with some fluctuations. It is not globally threatened. The greatest abundance is found on the Kuril Islands, with 50–60,000 birds, also ca. 100,000 birds spread over the Bering Sea (del Hoyo *et al.* 1992).

The NSR-area: The Chukchi Peninsula up to Chaun Bay and Wrangel Island are inhabited by the largest subspecies of the Pelagic Cormorant. The total number in this area is estimated at more than 1,000 pairs (Golovkin 1984; Stishov *et al.* 1991). It has decreased in number on the Wrangel and Kolyuchin Islands (Kondratiev 1986; Stishov *et al.* 1991).

Biology: Breeds on cliffs in mixed colonies not exceeding 100–200 pairs within the NSR. Preys mainly on non-schooling fishes. Feeds by pursuit-diving in sheltered coastal waters. Cormorants come to the breeding area in mid-May after open water appears. Laying begins in early June and continues for a month. The clutch usually contains 3–4 eggs. Fledging in the second half of August to mid September. Departs the breeding grounds during late September to mid-October (Stishov *et al.* 1991). Nonbreeding birds spend the nesting season within the colonies concentrating in so-called 'clubs'.

EMPEROR GOOSE (*Philacte canagica*)

General distribution/numbers: Inhabits Chukotka and the western coast of Alaska. After declining during the years 1960–1980, the numbers were restored to 60,000 in 1992 (Petersen *et al.* 1994).

The NSR-area: The northern coast of the Chukchi Peninsula east of the Amguema River valley. The number of Emperor Geese within the NSR-area is estimated to be minimum 2,000 individuals (Eldridge *et al.* 1993), and maximum 5,500 individuals (Hodges and Eldridge unpubl. report).

Biology: It is the most marine of the goose species using the marine coast including the littoral zone for feeding, brooding and moulting. Nests on the tundra close to the shore in solitary pairs. The clutch contains 4 (2–7) eggs. Laying begins in early June. Males leave their mates during incubating, but join the broods for the rearing period. The nesting part of the population probably does not exceed 20% of the total number of birds that arrive at the breeding grounds (Kishchinskiy 1988). Autumn migration occurs in the second half of August. Winter mortality is relatively high compared to other species of geese (Petersen *et al.* 1994).

BARNACLE GOOSE (*Branta leucopsis*)

General distribution/numbers: Inhabits East Greenland, Svalbard and Northwest Russia. All three populations have increased during the last decades. The total world population in winter has been estimated at minimum ca. 110,000 individuals (Madsen 1994).

The NSR-area: Breeds in the westernmost part of the NSR-area, including the Novaya Zemlya archipelago, Vaigach Island and the northern part of Yugor Peninsula. The total number of the Russian population was estimated at ca. 120,000 individuals (Rose & Scott 1994). Only a small proportion of this population occurs along the coast of the NSR-area, including 3–8,000 birds on Vaigach Island (Kalyakin 1986) and 550 birds at the Yugor Peninsula (Morozov 1995).

Biology: Closely connected to the sea. Breeds along the coast, using river canyons, cliffs, small islands, and flat biotopes as well. Breeding and moulting birds keep to the coast, and sometimes swim at sea close to the coast. Winters on coastal pasture and grassy islands. Highly gregarious, often forms colonies. The clutch contains 4–5 eggs and is laid in June. The ratio between breeding and nonbreeding birds is highly variable from year to year. Moults from mid-July to mid-August. Departs from the breeding grounds in September.

GREATER SCAUP (*Aythya marila*)

General distribution/numbers: Inhabits the tundra zone both in North America and Eurasia. Common and widespread species. Winter population is estimated at ca. 200,000 in the western Palearctic and ca. 750,000 in North America in mid 1970s (del Hoyo *et al.* 1992), but the total population in the former USSR alone was estimated at 1.5 million individuals with a slightly decreasing tendency (Krivenko 1991).

The NSR-area: The breeding range reaches the Arctic coast in several places (Yugor Peninsula, Vaigach Island, south-western Yamal and Taimyr (*A. m. marila)*, Kolyma-Delta and Chaun Bay (*A. m. mariloides*)). An unknown, but likely insignificant proportion of the total population comes out to the Arctic seas and deltas during moulting and migrating. Accumulations at sea are known along the Kara coast of the Yugor Peninsula and in Baydaratskaya Bay.

Biology: During the nesting period the Greater Scaup keeps to small and shallow water bodies on the tundra; only moulting and migrating birds appear at sea. Molluscs are often a major item in their diet. It feeds mainly by diving. Laying occurs in late June to early July. The clutch usually contains 8–11 eggs. Males and nonbreeding birds leave the tundra by mid-July. The species' habit of concentrating in large numbers at sea in winter and probably while moulting, renders it more vulnerable to oil pollution than other ducks.

COMMON EIDER (*Somateria mollissima*)

General distribution/numbers: The breeding range is almost circumpolar with a break in Central Siberia. It migrates from high Arctic archipelagos to seas of the temperate zone. In Europe it is a widespread and very abundant species, with generally stable populations. The population of the nominative subspecies is estimated at 3 million with the largest numbers in the Baltic Sea (Rose & Scott 1994). The population in the North Pacific is estimated at more than 125,000 individuals with a declining tendency (Goudie *et al.* 1995).

The NSR-area: The nominative subspecies penetrates the westernmost part of the NSR-area up to the Kara Sea Islands and the Severnaya Zemlya archipelago (Syroechkovskiy & Lappo 1995; A. Volkov pers. comm.), but in very insignificant numbers as compared to the total population. The Asian subspecies *S. mollissima v-nigrum* inhabits the coast eastward of the Chaun Bay to the Bering strait as well as the New Siberian Islands and the Wrangel Island. The population is estimated at 20,000 having declined three- to fourfold since the early 1970s (Goudie *et al.* 1995).

Biology: Inhabits shallow coastal water with adjacent small islands. Within the NSR-area the biotope preference of the subspecies differs significantly. *S. m. mollissima* is strongly attached to coastal areas and breeds mainly in colonies. *S. m. v-nigrum* breeds on the near-sea tundra, rears the broods in fresh-water bodies and does not form dense colonies. The Common Eiders preys mostly on molluscs, but also crustaceans and other marine invertebrates. Feeds by diving. Laying occurs in the second half of June. The clutch usually contains 4–6 (1–8) eggs. Males and nonbreeding birds fly to the sea right after the laying is completed. The may stay in the area until the sea freezes. Little is known about the at-sea period of the eiders. It is assumed to use polynyas during migration and the prebreeding period (Rutilevskiy 1957; Kishchinskiy 1982b).

KING EIDER (*Somateria spectabilis*)

General distribution/numbers: The breeding range is almost circumpolar within the Arctic tundra zone. It is a common and locally very abundant species. Total numbers are roughly estimated at 2–3 million birds (del Hoyo *et al.* 1992).

The NSR-area: Inhabits almost all the coastline along the NSR-area except for the easternmost part. The population inhabiting the NSR-area is roughly estimated at 840,000 individuals (see Solovieva, King Eider in Gavrilo *et al.* In press.). The population is thought to be stable in Russia, but declining in North America.

Biology: Stays at sea most of the year, only appearing on the tundra for breeding. Nests on tundra of different types with fresh-water bodies. Breeds usually in single pairs, but colonies of medium density are sometimes found in small river mouths. The species concentrates in estuaries and shallow marine waters before migration. Preys on different benthic marine invertebrates. Feeds mostly by diving. Prefers deeper waters compared to other eider species except for the Spectacled Eider. Laying of eggs occurs in June. The clutch contains 4–5 (2–7) eggs. Females with broods leave the breeding grounds in September, whereas other birds leave earlier. Little is known about the at-sea period of life. At-sea migration depends greatly on ice conditions.

SPECTACLED EIDER (*Somateria fischeri*)

General distribution/numbers: The breeding range covers the Arctic coasts of Yakutia and Alaska. It is a threatened species; the total population is estimated at less than 50,000 individuals with a declining tendency (Goudie *et al.* 1995).

The NSR-area: Inhabits the near-sea tundra from the Lena Delta to the Amguema River. In some regions (Nizhnekolymsk and the Chaun tundra) it outnumbers the other species of eiders (Krechmar *et al.* 1991). The total number within the NSR-area is estimated at 30–35,000 individuals (see Kondratiev, Spectacled Eider in Gavrilo *et al.* in press.)

Biology: Keeps at sea during a large part of the year. Breeds on tundra associated with deltas close to the sea. Nests in single pairs or in small colonies in optimal biotopes. Preys on different invertebrates, including planktonic crustaceans during brooding. Feeds mostly by diving, but also on the surface. Laying occurs in June. The clutch size is 3–6 eggs. The males move to the sea when the eggs have been laid. The remaining birds including the young ones move to the sea by late August. In winter, the birds concentrate in small geographical areas at ice edges and polynyas offshore. The at-sea period of life is very poorly studied.

STELLER'S EIDER (*Polysticta stelleri*)

General distribution/numbers: Two geographical populations exist: the western population breeds from the central Taimyr to the Kola Peninsula, whereas the eastern population breeds along the Arctic coasts of Alaska and Northeast Asia. The total world population is estimated at 100,000–150,000 (Goudie *et al.* 1995; Nygard *et al.* 1995), with a major decline during this century. At present, the western population demonstrates a tendency for increase while the eastern one decreases. The Steller's Eider is classified as *Globally Threatened* (Collar *et al.* 1994).

The NSR-area: A vast majority of the Steller's Eiders breeds along the Siberian coast, but noticeable fluctuations are characteristic of the species due to low nest-site fidelity.

Biology: Spends much of the year at sea. Keeps inshore; uses shallow waters less than 10 m in depth. Preys mainly on molluscs and crustaceans. Feeds mostly by diving, but also by dabbling on the surface. Breeds in single pairs on the tundra near the sea; in optimal biotopes the birds may form colonies of medium density. Laying starts in the second half of June. The clutch contains 5–8 eggs. Rears ducklings in freshwater bodies. Nonbreeding birds start summer migration already in June, while breeding females may stay until mid-September.

LONG-TAILED DUCK (*Clangula hyemalis*)

General distribution/numbers: The breeding range is circumpolar. It is a widespread species and the most abundant tundra duck. The world population is estimated at 10 million individuals (del Hoyo *et al.* 1992), but is probably even larger (see below). The population seems to be stable in most regions, but it is known to decline in North America.

The NSR-area: Numerous on the mainland tundra along the whole NSR except for the northernmost Taimyr. It is absent as a breeding species on Severnaya Zemlya and on the minor islands in the Kara and Laptev Seas; on the other Arctic archipelagos it breeds sporadically. The total population in the former USSR was estimated at 10 million individuals and was assumed to be stable (Krivenko 1991).

Biology: During the breeding season, the species inhabits a wide spectrum of tundra biotopes. As many other species of the *Anatidae* in this area, it moults north of the breeding range, often concentrated in coastal waters of the Arctic archipelagos. It is considered a pagophilous species and is supposed to occur in the area north of the edge of the drifting ice during summer migrations (Kishchinskiy 1982a, b), but the at-sea period of life is poorly documented. Preys on benthic marine invertebrates, mostly molluscs and crustaceans; in freshwater also on insects and their larvae. Very active diver. Laying starts in the second half of June in spite of the early arrival. The clutch contains 6–9 (5–11) eggs. The broods keep to freshwater bodies. Summer migration occurs in late June. In autumn the species occurs everywhere at sea in the area up to September–October, that is, up to the freezing of the sea.

COMMON SCOTER (*Melanitta nigra*)

General distribution/numbers: Breeds from eastern Canada and Iceland in the west to Alaska in the east. There are no well-based estimates of the size of the world population, but it is estimated that 800,000 individuals winter in the Western Palearctic (del Hoyo *et al.* 1992). The population is considered to be stable.

The NSR-area: The breeding grounds reach the Arctic coast only in some areas (Yugor Peninsula, Vaigach Island, south-western Yamal, and the lower reaches of the Yenisey and Khatanga Rivers). Accumulations at sea are known along the Kara coast of the Yugor Peninsula and in Baidaratskaya Bay. Birds from West Siberia are very likely to cross land directly to the sea, because they appear in great numbers between the Yamal and Yugor Peninsulas in the autumn (Mineyev 1994). It is difficult to estimate the number of Common Scoters occurring along the Arctic coast within the NSR-area.

Biology: Nests close to different freshwater bodies on the southern tundra and forest tundra. Nonbreeding birds and males move to the sea after completing breeding. It is known to form big flocks while moulting and staging at sea. Feeds mostly on molluscs, but also other invertebrates and fish. Feeds almost exclusively by diving. Egg laying starts at the end of June. The clutch contains 6–8 (5–11) eggs. Summer migration from the tundra is observed in late June – early July, but the main flyway passes over the sea. Only ducks using marine biotopes are relevant when considering the INSROP, but both distribution and biology of the species during the marine period of life have been poorly investigated.

VELVET SCOTER (*Melanitta fusca*)

General distribution/numbers: Widespread in Eurasia on the southern tundra and in boreal forests to the Khatanga River in the east. There is no well-based estimate of the size of the world population. It is estimated at definetely more than 250,000 individuals wintering in the Western Palearctic (Ader & Keskpaik 1994), and is thought to be stable.

The NSR-area: The breeding grounds reach the Arctic coast only in places (Yugor Peninsula, Southwest Yamal, lower reaches of Yenisey and Khatanga Rivers), but is not abundant there. Accumulations at sea are known in the south-westernmost Kara Sea. It is difficult to estimate the number of the Velvet Scoter inhabiting the Arctic coast along the NSR. Birds from West Siberia are very likely to cross land directly to the sea because they appear in great numbers between the Yamal and Yugor Peninsulas in autumn (Mineyev 1994). The Russian population is considered in general to be stable.

Biology: During the nesting period it keeps to different water bodies on the tundra and forest tundra. During the rest of the year it is closely attached to the sea. Preys on different aquatic invertebrates, sometimes fish. Feeds almost exclusively by diving. Breeds in single pairs. Laying starts in late June – early July. The clutch contains 7–9 (5–12) eggs. Only ducks using marine biotopes are relevant while considering the INSROP, but very little is known about their life at sea. A very noticeable summer migration is observed in July in some places along the coast of the Yugor Peninsula.

GOOSANDER (*Mergus merganser*)

General distribution/numbers: Widespread in boreal forests in Eurasia and North America. No total population estimate is available. It is estimated at slightly less than 800,000 individuals in the Northern Pacific Rim (Goudie *et al.* 1995). The current population trend seems to be slightly increasing or stable in different regions (del Hoyo *et al.* 1992).

The NSR-area: The nesting area does not reach the Arctic coast within the area; the most northern findings refer to the Yenisey valley and the Yamal, both at 69° N. It comes to sea for moulting and migration in the south-western Kara Sea. The total number in the former USSR was estimated at 140,000 individuals and the population was considered to be stable (Krivenko 1991), but later the same figure has been used when referring to the region eastward of the Lena river (Goudie *et al.* 1995). Accumulations along the NSR-area are known along the coast of the south-western Kara Sea. It is difficult to estimate the proportion of the Russian population of Goosanders that appears on the Arctic coast along the NSR. The density of Goosanders at sea along Yugor Peninsula was found to be 6 individuals/km^2 (Mineyev 1994). It is known that large flocks of birds from East Siberia go through the Yugor Shar Strait in summer (Karpovich & Kokhanov 1967).

Biology: Breeds close to freshwater bodies in forests. Only nonbreeding, moulting and migrating birds go north and appear at sea. Summer migration occurs in late June – early July. Preys mainly on fish, also aquatic invertebrates. Feeds mostly by diving from the surface. Breeds in single pairs. The clutch contains 8–12 (6–17) eggs. Only ducks using marine biotopes are relevant while considering the INSROP, but little is known about their life at sea. Departs the marine areas by early October.

KITTIWAKE (*Rissa tridactyla*)

General distribution/numbers: The breeding range is almost circumpolar over the Arctic and Boreal climatic zones. The winter grounds are distributed between 40° and 60° N both in the Atlantic and Pacific Oceans. The world population number is estimated at ca. 6–8 million pairs (Lloyd *et al.* 1991).

The NSR-area: Breeding colonies of Kittiwakes in the Siberian shelf seas are located on the islands of the Arctic archipelagos and on the shores of Taimyr. During the non-breeding period the birds are observed practically over the whole area of these seas. The size of the breeding population inhabiting the NSR-area is estimated at ca. 150,000 pairs (see Firsova *Kittiwake*, in Gavrilo *et al.* 1995). Data on population trends is available for a very limited number of locations only. The population size is known to fluctuate on Wrangel Island and increase in some Chukchi colonies (Stishov *et al.* 1991; Kondratiev 1986).

Biology: Breeds separately or in mixed colonies with other species not exceeding 10,000–18,000 pairs within the NSR-area. Breeding begins 1–2 months after the arrival. Timing of laying varies between the regions and seasons and falls in late May–June. The clutch contains 1–3 eggs. Kittiwakes leave the colonies in September and depart the breeding grounds during late September – October. Preys mainly on small fish (Polar Cod within the NSR-area) and invertebrates. Food is picked up from the surface while in flight or on the water, sometimes feeds by plunge diving. Foraging distances may extend 100 km away from the breeding colony, but are usually 20–30 km (Demme 1934; Stishov *et al.* 1991).

IVORY GULL (*Pagophila eburnea*)

General distribution/numbers: The breeding range is scattered on the Arctic islands (including Greenland) from northern Canada in the west to Severnaya Zemlya in the east. The world population is roughly estimated at 15,000 breeding pairs in favourable years (Volkov *Ivory gull* in Gavrilo *et al.* 1995).

The NSR-area: Breeding colonies are known in the Severnaya Zemlya archipelago and the Kara Sea Islands, solitary breeding is known from Novaya Zemlya (Antipin 1938; Dementiev *et al.* 1951; Yudin & Firsova 1988; Syroechkovskiy & Lappo 1994). A. Volkov roughly estimates the breeding population within the NSR-area at 7,000 pairs.

Biology: Breeds in colonies and sometimes as single pairs both on the plain tundra and on rocky cliffs. The colony of 1100 pairs found on the Sedov Islands is the largest known (de Korte & Volkov 1993). Ivory Gulls may appear at the breeding places as early as late March and depart in September–November (Uspenskiy 1969). The clutch contains 1–3 eggs. During breeding, the diet is based on fish (mainly Polar Cod) and planktonic invertebrates. Feeds from the surface while in flight or picks up food items from the ice. Swimming is not common for this gull. The biology of the Ivory Gull, including breeding distribution, nesting success and feeding, is considered highly dependent on sea-ice conditions. Outside the breeding season it is known to be a scavenger.

BRÜNNICH'S GUILLEMOT (*Uria lomvia*)

General distribution/numbers: The breeding range is circumpolar over the Arctic and Sub-Arctic seas. The latest estimate for the breeding part of the world population is at 14 million pairs with 10 million in the Atlantic and 4 million in the north Pacific.

The NSR-area: Breeding colonies of Brünnich's Guillemots within the NSR-area are located on the islands of the Arctic archipelagos (except for Severnaya Zemlya), some small islands near the eastern shore of Taimyr and on the Chukchi Peninsula. Birds inhabiting the Laptev Sea and De-Long Islands are treated as an endemic subspecies *U. l. eleonorae*. Based on a rough estimation by Golovkin (1984), with some additions, about 120,000 pairs of Brünnich's Guillemots breed within the NSR-area, including 75,000 *U. l. eleonorae*. The population trend is unknown.

Biology: Breeds in colonies not exceeding 10,000–30,000 pairs in numbers within the NSR-area. The breeding range is limited by ice conditions. It appears at the colonies in May – early June, but seems to keep to the polynyas before this time. Duration of the stay in the vicinity of the breeding cliffs is 100–140 days. Lays one egg only. The chicks leave the colony before they are able to fly. Cases of completely unsuccessful breeding due to heavy ice conditions around the colonies are reported from the area under consideration (Pridatko 1986). Feeds by pursuit diving. Preys on small fish (mainly Polar Cod within the NSR-area) and pelagic crustaceans. The few observations of feeding Brünnich's Guillemots within the NSR-area give a foraging range of 20–25 km (Golovkin & Flint 1975; Pridatko 1986), but from other regions they are known to fly 100–175 km to reach preferable feeding biotopes (Gaston & Nettleship 1981).

BLACK GUILLEMOT (*Cepphus grylle*)

General distribution/numbers: The breeding range is almost circumpolar over the Arctic and Sub-Arctic seas, and penetrates the northernmost archipelagos. Nesting in hidden places it is difficult to count. Available data on abundance suggest that the world population is less than half a million pairs. The population trend differs between different parts of the breeding range.

The NSR-area: Inhabits suitable coasts along the whole area except for the easternmost coast of the Chukchi Peninsula. We roughly estimate the population of the NSR-area at several tens of thousands pairs. The largest colonies are known from the New Siberian Islands, and Wrangel and Herald Islands (Uspenskiy 1963; Stishov *et al.* 1991). The population seems stable.

Biology: Breeds in colonies and single pairs along the rocky coasts. It is more associated with coastal and ice-filled waters as than the other auks. Comes to the breeding area in April–May, and the last birds leave the vicinity of the colonies after sea freezing. Long distance migration is not characteristic for this species. At least a part of the Black Guillemot population is very likely to spend the winter in the polynyas within the NSR-area. Lays 2 eggs. Feeds by pursuit diving. Preys on different near bottom organisms including fish, crustaceans and molluscs.

LITTLE AUK (*Alle alle*)

General distribution/numbers: The breeding range stretches from the eastern Canadian Arctic to Severnaya Zemlya, with possible breeding localities also in the Bering Sea. It is one of the most abundant auks; the world population is very roughly estimated at 8–18 million pairs (Nettleship and Evans 1985).

The NSR-area: Within the area under consideration it breeds in Severnaya Zemlya archipelago only. The number here is roughly estimated at 10–80,000 pairs (de Korte *et al.* 1995). No information about the population trend is available, but the population is probably stable.

Biology: Breeds in colonies. Breeding in rock crevices is only known from the Severnaya Zemlya. Arrives at the polynyas near the colonies already in April (Ushakov 1951), but no data on breeding biology and phenology are available from the NSR-area. Feeds by pursuit diving. Preys on abundant planktonic organisms, mainly crustaceans. Birds breeding in Severnaya Zemlya must overcome quite a long distance to reach feeding biotopes because there is usually heavy ice close to the colonies.

HORNED PUFFIN (*Fratercula corniculata*)

General distribution/numbers: Breeds in the North Pacific. Not abundant along the whole breeding range. The Alaskan population is estimated at 1.5 million individuals (Sowls *et al.* 1978, cit. after Kharitonov 1990).

The NSR-area: Breeds on the Chukchi Sea coast only, reaching the northern- and westernmost limits of its breeding range on Wrangel Island. The total number for this area is roughly estimated at more than 10,000 pairs (Golovkin 1984). The population is highly fluctuating and seems to have a decreasing tendency (Kondratiev 1986; Stishov *et al.* 1991).

Biology: It nests in mixed colonies using rock crevices and screes. It arrives at the breeding colonies late, right at the beginning of breeding (in mid-June on the Wrangel Island). The breeding biology of Horned Puffins on the Chukchi Peninsula is very poorly known due to the inaccessibility of the nests and the species' hidden behaviour. Lays one egg. Chicks leave colonies fully fledged in September. Preys mainly on fish and pelagic invertebrates. Feeds by pursuit diving often close to the shore.

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APPENDIX I-VI

APPENDIX I. Vulnerability assessment of oil/seabirds in the NSR-area for the winter season. Only region 1 has been considered as this is the only region supported by information. Vulnerable populations in bold.

WINTER, REGION 1	Ta	Ts	Au	Bs	Sa	Pr	Fc	Pf	Rc	De	Ps	Ft	Fi	Rp	Pt	Vp	Pi	IV-tot	PV-tot	IV-value	PV-value
1 **Pagophila eburnea**	3	3	2	1	3	3	1	2	1	3	3	1	2	2	2	1	1	41,58	335,84	**3**	**3**
2 **Uria lomvia**	3	3	1	3	3	3	2	3	3	3	3	2	2	3	3	1	3	130,68	2040,62	**3**	**3**
3 **Cepphus grylle**	3	3	1	3	3	3	1	2	3	3	3	1	2	3	2	1	2	69,30	693,00	**3**	**3**
4 **Alle alle**	3	3	1	3	3	3	1	2	3	3	3	1	2	1	2	1	2	69,30	479,77	**3**	**3**

APPENDIX II. Vulnerability assessment of oil/seabirds in the NSR-area for the spring season. The assessment is done for regions 1-4 separately. Shaded areas indicate alternative indexing. Vulnerable populations in bold.

SPRING, REGION 1	Ta	Ts	Au	Bs	Sa	Pr	Fc	Pf	Rc	De	Ps	Ft	Fi	Rp	Pt	Vp	Pi	IV-tot	PV-tot	IV-value	PV-value
1 Gavia stellata	1	3	1	3	1	2	2	1	3	2	3	1	3	2	2	1	2	16,80	103,38	**2**	**2**
2 Gavia arctica	1	3	1	3	0	2	2	1	3	2	3	1	3	2	2	1	2	12,00	73,85	**1**	**1**
3 Gavia adamsii	1	3	1	3	0	2	2	1	3	2	3	1	3	3	2	1	3	12,00	89,23	**1**	**1**
4 *Somateria mollissima*	2	2	2	3	3	2	1	1	2	2	2	3	3	1	2	1	3	18,72	161,28	**2**	**2**
4a Somateria mollissima	3	3	2	3	3	2	1	1	2	2	2	3	3	1	2	1	3	42,12	362,88	**3**	**3**
5 *Somateria spectabilis*	2	1	3	3	3	2	1	1	2	2	1	3	3	1	2	1	3	10,80	81,42	**1**	**1**
5a Somateria spectabilis	3	2	3	3	3	2	1	1	2	2	1	3	3	1	2	1	3	32,40	244,25	**2**	**2**
6 *Polysticta stelleri*	1	1	3	3	3	2	1	1	2	2	2	2	3	1	1	1	3	5,40	31,57	**1**	**1**
6a Polysticta stelleri	2	2	3	3	3	2	1	1	2	2	2	2	3	1	1	1	3	21,60	126,28	**2**	**2**
7 *Clangula hyemalis*	1	2	3	3	3	2	1	1	2	2	1	3	2	1	2	1	2	10,80	69,78	**1**	**1**
7a Clangula hyemalis	2	2	3	3	3	2	1	1	2	2	1	3	3	1	2	1	2	21,60	155,08	**2**	**2**
8 Larus argentatus	2	1	2	3	1	2	1	1	1	2	3	1	2	2	2	1	1	4,32	23,26	**1**	**1**
9 Larus hyperboreus	2	1	2	3	1	2	1	1	1	2	3	1	2	2	1	1	1	4,32	21,05	**1**	**1**
10 Rissa tridactyla	2	3	3	3	1	2	1	1	1	2	2	2	3	2	1	1	1	15,84	102,35	**2**	**2**
11 Pagophila eburnea	3	3	3	2	1	2	1	1	1	2	3	1	2	2	2	1	2	21,60	121,85	**2**	**2**
12 Sterna paradisaea	1	2	1	2	2	2	1	2	2	2	3	1	2	1	2	1	1	7,68	33,48	**1**	**1**
13 **Uria lomvia**	3	3	3	3	1	2	2	2	3	2	3	3	2	3	3	1	3	99,00	1325,08	**3**	**3**
14 **Cepphus grylle**	3	3	1	3	2	2	1	1	3	2	3	2	2	3	2	1	2	38,88	362,88	**3**	**3**
15 **Alle alle**	3	3	3	3	1	2	1	2	3	2	3	3	2	3	2	1	2	59,40	712,80	**3**	**3**

APPENDIX II continued.

SPRING, REGION 2	Ta	Ts	Au	Bs	Sa	Pr	Fc	Pf	Rc	De	Ps	Ft	Fi	Rp	Pt	Vp	Pi	IV-tot	PV-tot	IV-value	PV-value
16 Gavia stellata	1	3	1	3	1	2	2	1	3	2	3	1	3	2	2	1	2	16,80	103,38	**2**	**2**
17 Gavia arctica	1	3	1	3	0	2	2	1	3	2	3	1	3	2	2	1	2	12,00	73,85	**1**	**1**
18 Gavia adamsii	1	3	1	3	0	2	2	1	3	2	3	1	3	3	2	1	3	12,00	89,23	**1**	**1**
19 ***Somateria spectabilis***	1	2	2	3	3	2	1	1	2	2	2	3	3	1	2	1	3	9,36	80,64	**1**	**1**
19a Somateria spectabilis	3	3	2	3	3	2	1	1	2	2	2	3	3	1	2	1	3	42,12	362,88	**3**	**3**
20 ***Polysticta stelleri***	1	1	2	3	3	2	1	1	2	2	3	2	3	1	1	1	3	4,68	31,92	**1**	**1**
20a Polysticta stelleri	2	2	3	3	3	2	1	1	2	2	3	2	3	1	1	1	3	21,60	147,32	**2**	**2**
21 ***Clangula hyemalis***	1	2	3	3	3	2	1	1	2	2	2	3	2	1	2	1	2	10,80	79,75	**1**	**1**
21a Clangula hyemalis	3	3	3	3	3	2	1	1	2	2	2	3	3	1	2	1	2	48,60	398,77	**3**	**3**
22 Xema sabini	1	1	1	1	2	2	1	1	1	2	3	2	2	2	2	1	2	1,68	13,27	**1**	**1**
23 Larus argentatus	2	1	2	3	1	2	1	1	1	2	3	2	2	2	2	1	1	4,32	32,57	**1**	**1**
24 Larus hyperboreus	2	1	2	3	1	2	1	1	1	2	2	1	2	2	2	1	1	4,32	18,61	**1**	**1**
25 Rhodostethia rosea	1	1	1	1	2	2	1	1	1	2	2	2	2	2	2	1	2	1,68	11,37	**1**	**1**
26 Rissa tridactyla	2	3	3	3	1	2	1	1	1	2	2	3	3	2	2	1	2	15,84	155,96	**2**	**2**
27 *Pagophila eburnea*	3	3	3	2	1	2	1	1	1	2	2	1	2	2	2	1	2	21,60	97,48	**2**	**1**
27a Pagophila eburnea	3	3	3	2	1	2	1	1	1	2	2	1	2	2	2	2	2	21,60	115,20	**2**	**2**
28 Sterna paradisaea	1	2	1	2	2	2	1	2	2	2	2	1	2	1	2	1	1	7,68	26,78	**1**	**1**
29 **Uria lomvia**	3	3	3	3	1	2	2	2	3	2	2	3	2	3	2	1	3	99,00	1096,62	**3**	**3**
30 **Cepphus grylle**	3	3	1	3	2	2	1	1	3	2	2	2	2	3	2	1	2	38,88	311,04	**3**	**3**
31 **Alle alle**	3	3	3	3	1	2	1	2	3	2	1	3	2	3	2	1	2	59,40	554,40	**3**	**3**

APPENDIX II continued.

SPRING, REGION 3	Ta	Ts	Au	Bs	Sa	Pr	Fc	Pf	Rc	De	Ps	Ft	Fi	Rp	Pt	Vp	Pi	IV-tot	PV-tot	IV-value	PV-value
32 Gavia stellata	1	3	1	3	1	1	2	1	3	2	2	1	3	2	2	1	2	15,12	74,44	**1**	**1**
33 Gavia arctica	1	3	1	3	0	1	2	1	3	2	2	1	3	2	2	1	2	10,80	53,17	**1**	**1**
34 Gavia adamsii	1	3	1	3	0	1	2	1	3	2	3	1	3	3	2	1	3	10,80	80,31	**1**	**1**
35 ***Somateria mollissima***	1	3	2	3	3	1	1	1	2	2	2	3	3	1	2	1	3	11,70	100,80	**1**	**2**
35a Somateria mollissima	3	3	2	3	3	1	1	1	2	2	2	3	3	1	2	1	3	35,10	302,40	**3**	**3**
36 ***Somateria spectabilis***	2	2	3	3	3	1	1	1	2	2	2	3	3	1	2	1	3	18,00	155,08	**2**	**2**
36a Somateria spectabilis	3	3	3	3	3	1	1	1	2	2	1	3	3	1	2	1	3	40,50	305,31	**3**	**3**
37 ***Somateria fischeri***	1	3	3	3	3	1	1	1	2	2	2	3	3	1	3	1	3	13,50	127,38	**1**	**2**
37a Somateria fischeri	2	3	3	3	3	1	1	1	2	2	2	3	3	1	3	1	3	27,00	254,77	**2**	**3**
38 Polysticta stelleri	2	1	3	3	3	1	1	1	2	2	2	2	3	1	3	1	3	9,00	63,69	**1**	**1**
39 ***Clangula hyemalis***	1	2	3	3	3	1	1	1	2	2	1	3	3	1	2	1	2	9,00	64,62	**1**	**1**
39a Clangula hyemalis	3	3	3	3	3	1	1	1	2	2	1	3	2	1	2	1	2	40,50	261,69	**3**	**3**
40 Xema sabini	1	1	1	1	2	1	1	1	1	2	2	2	2	2	2	1	2	1,40	9,48	**1**	**1**
41 Larus argentatus	2	1	2	3	1	1	1	1	1	2	2	2	2	2	2	1	1	3,60	23,26	**1**	**1**
42 Larus hyperboreus	2	1	2	3	1	1	1	1	1	2	1	1	2	2	2	1	1	3,60	11,63	**1**	**1**
43 Rhodostethia rosea	1	1	1	1	2	1	1	1	1	2	2	2	2	2	2	1	2	1,40	9,48	**1**	**1**
44 Rissa tridactyla	2	3	3	3	1	1	1	1	1	2	2	3	3	2	2	1	2	13,20	129,97	**1**	**2**
45 *Pagophila eburnea*	3	3	3	2	1	1	1	1	1	2	2	1	2	2	2	1	2	18,00	81,23	**2**	**1**
45a Pagophila eburnea	3	3	3	2	1	1	1	1	1	2	3	1	2	2	2	1	2	18,00	101,54	**2**	**2**
46 Sterna paradisaea	1	2	1	2	2	1	1	2	2	2	2	1	2	1	2	1	1	6,40	22,32	**1**	**1**
47 **Uria lomvia**	3	3	3	3	1	1	2	2	3	2	2	3	2	3	2	1	3	89,10	986,95	**3**	**3**
48 ***Cepphus grylle***	3	3	1	3	2	1	1	1	3	2	2	2	2	3	2	1	2	32,40	259,20	**2**	**3**
48a Cepphus grylle	3	3	1	3	2	1	1	1	3	2	2	2	2	3	2	1	1	32,40	249,23	**2**	**2**

APPENDIX II continued.

SPRING, REGION 4	Ta	Ts	Au	Bs	Sa	Pr	Fc	Pf	Rc	De	Ps	Ft	Fi	Rp	Pt	Vp	Pi	IV-tot	PV-tot	IV-value	PV-value
49 Gavia stellata	1	3	1	3	1	1	2	1	3	2	2	1	3	2	2	1	2	15,12	74,44	**1**	**1**
50 Gavia arctica	1	3	1	3	0	1	2	1	3	2	2	1	3	2	2	1	2	10,80	53,17	**1**	**1**
51 Gavia adamsii	1	3	1	3	0	1	2	1	3	2	3	1	3	3	2	1	3	10,80	80,31	**1**	**1**
52 ***Somateria mollissima***	1	3	2	3	3	1	1	1	2	2	1	3	3	1	2	1	3	11,70	88,20	**1**	**1**
52a Somateria mollissima	3	3	2	3	3	1	1	1	2	2	1	3	3	1	2	1	3	35,10	264,60	3	3
53 ***Somateria spectabilis***	1	2	3	3	3	1	1	1	2	2	1	3	3	1	2	1	3	9,00	67,85	**1**	**1**
53a Somateria spectabilis	3	3	3	3	3	1	1	1	2	2	1	3	3	1	2	1	3	40,50	305,31	3	3
54 ***Somateria fischeri***	1	2	3	3	3	1	1	1	2	2	2	3	3	1	3	1	3	9,00	84,92	**1**	**1**
54a Somateria fischeri	3	3	3	3	3	1	1	1	2	2	2	3	3	1	3	1	3	40,50	382,15	3	3
55 Polysticta stelleri	2	1	3	3	3	1	1	1	2	2	3	2	3	1	3	1	3	9,00	74,31	**1**	**1**
56 ***Clangula hyemalis***	1	2	3	3	3	1	1	1	2	2	1	3	2	1	2	1	2	9,00	58,15	**1**	**1**
56a Clangula hyemalis	3	3	3	3	3	1	1	1	2	2	1	3	2	1	2	1	2	40,50	261,69	3	3
57 Xema sabini	1	1	1	1	2	1	1	1	1	2	2	2	2	2	2	1	2	1,40	9,48	**1**	**1**
58 Larus argentatus	2	1	2	3	1	1	1	1	1	2	2	2	2	2	2	1	1	3,60	23,26	**1**	**1**
59 Larus hyperboreus	2	1	2	3	1	1	1	1	1	2	2	1	2	2	2	1	1	3,60	15,51	**1**	**1**
60 Rhodostethia rosea	1	1	1	1	2	1	1	1	1	2	3	2	2	2	2	1	2	1,40	11,06	**1**	**1**
61 Rissa tridactyla	2	3	3	3	1	1	1	1	1	2	1	3	3	2	2	1	1	13,20	108,98	**1**	**2**
62 *Pagophila eburnea*	3	3	3	2	1	1	1	1	1	2	2	1	2	2	2	1	2	18,00	81,23	**2**	**1**
62a Pagophila eburnea	3	3	3	2	1	1	1	1	1	2	3	1	3	2	3	1	2	18,00	120,00	2	2
63 Sterna paradisaea	1	2	1	2	2	1	1	2	2	2	2	1	2	1	2	1	1	6,40	22,32	**1**	**1**
64 **Uria lomvia**	3	3	3	3	1	1	2	2	3	2	1	3	2	3	2	1	3	89,10	863,58	**3**	**3**
65 **Cepphus grylle**	3	3	1	3	2	1	1	1	3	2	2	2	2	3	2	1	2	32,40	259,20	**2**	**3**

APPENDIX III. Vulnerability assessment of oil/seabirds in the NSR-area for the nesting season. The assessment is done for regions 1-4 separately. Shaded areas indicate alternative indexing. Vulnerable populations in bold.

NESTING, REGION 1	Ta	Ts	Au	Bs	Sa	Pr	Fc	Pf	Rc	De	Ps	Ft	Fi	Rp	Pt	Vp	Pi	IV-tot	PV-tot	IV-value	PV-value
1 **Gavia stellata**	3	2	1	3	0	1	2	2	2	3	3	1	3	2	2	1	3	21,60	207,69	2	2
2 ***Gavia arctica***	3	1	1	3	0	1	2	2	2	3	3	1	3	2	2	1	3	10,80	103,85	1	2
2a Gavia arctica	3	1	1	3	0	1	2	1	2	3	3	1	3	2	2	1	3	8,10	77,88	1	1
3 **Gavia adamsii**	3	2	2	3	0	1	2	2	2	3	3	1	3	3	2	1	3	30,24	337,29	2	3
3a ***Gavia adamsii***	3	2	2	3	0	1	2	1	2	2	3	1	3	3	2	1	3	22,68	168,65	2	2
4 Cygnus columbianus bewickii	3	1	1	1	2	1	1	2	1	2	3	1	2	3	1	1	2	6,30	38,77	1	1
5 Anser fabalis	3	1	1	1	2	1	1	2	1	3	2	1	2	1	1	1	1	6,30	29,08	1	1
6 Branta leucopsis	3	2	1	2	2	1	1	2	1	2	2	1	2	1	1	1	2	14,40	47,26	1	1
7 Branta bernicla	3	1	1	1	2	1	1	2	1	2	3	1	2	2	2	1	2	6,30	35,54	1	1
8 **Somateria mollissima**	3	3	2	3	2	1	2	2	2	2	2	1	2	2	2	1	3	71,28	336,30	3	3
9 Somateria spectabilis	3	1	1	3	1	1	2	2	2	2	2	1	2	2	2	1	3	15,12	71,34	1	1
9 ***Somateria spectabilis***	3	2	1	3	1	1	2	2	2	2	2	1	2	2	2	1	3	30,24	142,67	2	2
10 Polysticta stelleri	3	1	1	3	2	1	1	2	2	2	3	1	2	2	2	1	2	10,80	60,92	1	1
10 ***Polysticta stelleri***	3	2	1	3	2	1	1	2	2	2	3	1	2	2	2	1	2	21,60	121,85	2	2
11 Clangula hyemalis	3	1	1	3	2	1	1	2	1	2	1	1	2	1	2	1	2	8,10	22,43	1	1
12 Charadrius hiaticula	3	1	1	0	3	1	1	1	1	2	2	1	3	1	2	1	1	4,80	18,71	1	1
13 Calidris minuta	3	1	1	0	3	1	1	1	1	2	1	1	3	1	2	1	1	4,80	14,03	1	1
14 Calidris temminckii	3	1	1	0	3	1	1	1	1	2	3	1	3	1	2	1	1	4,80	23,38	1	1
15 Calidris maritima	3	1	1	0	3	1	1	1	1	2	2	1	3	1	2	1	1	4,80	18,71	1	1
16 Calidris alpina	3	1	1	0	3	1	1	1	1	2	2	1	3	1	2	1	1	4,80	18,71	1	1
17 Arenaria interpres	3	1	1	0	3	1	1	1	1	2	2	1	3	1	2	1	1	4,80	18,71	1	1
18 Stercorarius parasiticus	3	1	1	1	1	1	1	2	1	2	3	1	3	2	2	1	2	4,50	27,69	1	1
19 Larus argentatus	3	1	2	3	2	1	1	2	1	2	3	1	2	2	2	1	1	9,90	53,31	1	1
20 Larus hyperboreus	3	1	2	3	2	1	1	2	1	2	2	1	2	2	1	1	1	9,90	38,58	1	1
21 **Rissa tridactyla**	3	3	3	3	1	1	1	2	1	3	2	2	3	2	1	1	1	29,70	287,86	2	3
21a **Rissa tridactyla**	3	3	3	3	1	1	1	3	1	3	2	2	3	2	1	1	1	39,60	383,82	3	3
22 Pagophila eburnea	3	2	2	1	2	1	1	2	1	2	3	1	2	2	2	1	2	16,20	91,38	2	1
22a ***Pagophila eburnea***	3	2	2	2	2	1	1	2	1	2	3	1	2	2	3	1	2	18,00	110,77	2	2
23 Sterna paradisaea	3	1	1	2	1	1	1	2	2	2	2	1	3	2	2	1	1	7,20	33,97	1	1
24 **Uria lomvia**	3	3	3	3	0	1	2	2	3	3	2	2	2	3	3	1	3	72,90	975,74	3	3
25 **Cepphus grylle**	3	3	2	3	1	1	1	2	3	2	3	1	2	3	2	1	2	40,50	270,00	3	3

APPENDIX III continued.

NESTING, REGION 2	Ta	Ts	Au	Bs	Sa	Pr	Fc	Pf	Rc	De	Ps	Ft	Fi	Rp	Pt	Vp	Pi	IV-tot	PV-tot	IV-value	PV-value
26 **Gavia stellata**	3	2	1	3	0	2	2	2	2	3	3	1	3	2	2	1	3	24,00	230,77	**2**	**2**
27 ***Gavia arctica***	3	1	1	3	0	2	2	2	2	3	3	1	3	2	2	1	3	12,00	115,38	**1**	**2**
27a Gavia arctica	3	1	1	3	0	2	2	1	2	3	3	1	3	2	2	1	3	9,00	86,54	**1**	**1**
28 **Gavia adamsii**	3	2	2	3	0	2	2	2	2	3	3	1	3	3	2	1	3	33,60	374,77	**2**	**3**
28a ***Gavia adamsii***	3	2	2	3	0	2	2	1	2	2	3	1	3	3	2	1	3	25,20	187,38	**2**	**2**
29 Cygnus columbianus bewickii	3	1	1	1	2	2	1	2	1	2	3	1	2	3	3	1	3	7,56	56,22	**1**	**1**
29a ***Cygnus columbianus bewic***	3	1	1	1	2	2	1	3	1	3	3	1	3	3	3	1	3	10,08	120,18	**1**	**2**
30 Branta bernicla	3	1	1	1	2	2	1	2	1	2	1	1	2	2	1	1	3	7,56	24,42	**1**	**1**
31 Somateria spectabilis	3	1	1	3	1	2	2	2	2	2	2	1	2	2	2	1	3	16,80	79,26	**2**	**1**
31a ***Somateria spectabilis***	3	1	1	3	1	2	2	3	2	3	2	1	2	2	2	1	3	21,00	148,62	**2**	**2**
32 Polysticta stelleri	3	1	1	3	2	2	1	2	2	2	3	1	3	2	1	1	2	12,96	73,11	**1**	**1**
33 Clangula hyemalis	3	1	1	3	2	2	1	2	1	2	2	1	2	1	2	1	2	9,72	35,89	**1**	**1**
34 Charadrius hiaticula	3	1	1	0	3	2	1	1	1	2	2	1	3	1	2	1	1	5,76	22,45	**1**	**1**
35 Calidris alba	3	1	1	0	3	2	1	1	1	2	3	1	3	1	2	1	1	5,76	28,06	**1**	**1**
36 Calidris minuta	3	1	1	0	3	2	1	1	1	2	2	1	3	1	2	1	1	5,76	22,45	**1**	**1**
37 Calidris temminckii	3	1	1	0	3	2	1	1	1	2	3	1	3	1	2	1	1	5,76	28,06	**1**	**1**
38 Calidris maritima	3	1	1	0	3	2	1	1	1	2	3	1	3	1	2	1	1	5,76	28,06	**1**	**1**
39 Calidris alpina	3	1	1	0	3	2	1	1	1	2	3	1	3	1	2	1	1	5,76	28,06	**1**	**1**
40 Arenaria interpres	3	1	1	0	3	2	1	1	1	2	2	1	3	1	2	1	1	5,76	22,45	**1**	**1**
41 Stercorarius parasiticus	3	1	1	1	1	2	1	2	1	2	3	1	3	2	2	1	2	5,40	33,23	**1**	**1**
42 Xema sabini	3	1	2	1	1	2	1	2	1	2	3	1	2	2	2	1	2	7,56	42,65	**1**	**1**
43 Larus argentatus	3	1	2	3	2	2	1	2	1	2	3	1	3	2	2	1	1	11,88	70,06	**1**	**1**
44 Larus hyperboreus	3	1	2	3	2	2	1	2	1	2	2	1	3	2	2	1	1	11,88	56,05	**1**	**1**
45 **Rissa tridactyla**	3	3	3	3	1	2	1	2	1	2	2	3	3	2	2	1	2	35,64	350,92	**3**	**3**
46 ***Pagophila eburnea***	3	2	2	1	2	2	1	2	1	2	2	2	2	2	2	1	2	19,44	131,59	**2**	**2**
46a ***Pagophila eburnea***	3	2	2	2	2	2	1	2	1	2	2	2	2	2	2	3	2	21,60	199,38	**2**	**2**
46b **Pagophila eburnea**	3	2	2	1	2	2	1	2	1	3	2	2	2	2	3	2	2	19,44	251,22	**2**	**3**
47 Sterna paradisaea	3	1	1	2	1	2	1	2	2	2	2	1	3	2	2	1	1	8,64	40,76	**1**	**1**
48 **Uria lomvia**	3	3	3	3	0	2	2	2	3	3	2	2	2	3	2	1	3	81,00	1009,38	**3**	**3**
49 **Cepphus grylle**	3	3	2	3	1	2	1	2	3	2	2	1	3	3	2	1	2	48,60	279,14	**3**	**3**
50 **Alle alle**	3	3	2	3	0	2	1	2	3	3	1	2	2	3	2	1	2	37,80	378,00	**3**	**3**

APPENDIX III continued.

NESTING, REGION 3	Ta	Ts	Au	Bs	Sa	Pr	Fc	Pf	Rc	De	Ps	Ft	Fi	Rp	Pt	Vp	Pi	IV-tot	PV-tot	IV-value	PV-value
51 **Gavia stellata**	3	2	1	3	0	1	2	2	2	3	3	1	3	2	2	1	3	21,60	207,69	2	2
52 ***Gavia arctica***	3	1	1	3	0	1	2	2	2	3	3	1	3	2	2	1	3	10,80	103,85	1	2
52a Gavia arctica	3	1	1	3	0	1	2	2	2	2	3	1	3	2	3	1	3	10,80	74,77	1	1
53 **Gavia adamsii**	3	2	2	3	0	1	2	2	2	3	3	1	3	3	2	1	3	30,24	337,29	2	3
53a ***Gavia adamsii***	3	2	2	3	0	1	2	1	2	2	3	1	3	3	2	1	3	22,68	168,65	2	2
54 Cygnus columbianus bewickii	3	1	1	1	2	1	1	2	1	2	3	1	2	3	2	1	3	6,30	43,62	1	1
54a ***Cygnus columbianus bewic***	3	1	1	1	2	1	1	3	1	3	3	1	3	3	3	1	3	8,40	100,15	1	2
55 Anser fabalis	3	1	1	1	2	1	1	2	1	2	2	1	2	1	3	1	1	6,30	24,55	1	1
56 Branta bernicla	3	1	1	1	2	1	1	2	1	2	3	1	2	2	3	1	3	6,30	40,38	1	1
57 **Somateria mollissima**	3	2	2	3	2	1	2	3	2	2	2	1	2	2	2	1	3	59,40	280,25	3	3
57a ***Somateria mollissima***	3	2	2	3	2	1	2	2	2	2	2	1	2	2	2	1	3	47,52	224,20	3	2
57b Somateria mollissima	3	1	2	3	2	1	2	2	2	1	1	1	2	2	1	1	3	23,76	38,38	2	1
58 Somateria spectabilis	3	1	1	3	1	1	2	2	2	2	2	1	2	2	2	1	3	15,12	71,34	1	1
58a ***Somateria spectabilis***	3	1	1	3	1	1	2	2	2	3	2	1	3	2	3	1	3	15,12	125,61	1	2
58b **Somateria spectabilis**	3	2	1	3	1	1	2	2	2	3	2	1	3	2	3	1	3	30,24	251,22	2	3
59 Somateria fischeri	3	1	1	3	1	1	1	2	2	2	2	1	3	3	3	1	3	8,40	53,42	1	1
60 **Polysticta stelleri**	3	2	1	3	2	1	1	2	2	2	2	1	3	3	3	1	3	21,60	137,35	2	2
61 Clangula hyemalis	3	1	1	3	2	1	1	2	1	2	1	1	2	2	2	1	2	8,10	27,42	1	1
62 Charadrius hiaticula	3	1	1	0	3	1	1	1	1	2	1	1	3	1	2	1	1	4,80	14,03	1	1
63 Calidris alba	3	1	1	0	3	1	1	1	1	2	2	1	3	1	2	1	1	4,80	18,71	1	1
64 Calidris minuta	3	1	1	0	3	1	1	1	1	2	2	1	3	1	2	1	1	4,80	18,71	1	1
65 Calidris temminckii	3	1	1	0	3	1	1	1	1	2	2	1	3	1	2	1	1	4,80	18,71	1	1
66 Calidris alpina	3	1	1	0	3	1	1	1	1	2	1	1	3	1	2	1	1	4,80	14,03	1	1
67 Arenaria interpres	3	1	1	0	3	1	1	1	1	2	2	1	3	1	2	1	1	4,80	18,71	1	1
68 Stercorarius parasiticus	3	1	1	1	1	1	1	2	1	2	2	1	3	2	2	1	2	4,50	22,15	1	1
69 Xema sabini	3	1	2	1	1	1	1	2	1	2	2	1	2	2	2	1	2	6,30	28,43	1	1
70 Larus argentatus	3	1	2	3	2	1	1	2	1	2	2	1	2	2	2	1	1	9,90	42,65	1	1
71 Larus hyperboreus	3	1	2	3	2	1	1	2	1	2	1	1	2	2	2	1	1	9,90	31,98	1	1
72 **Rissa tridactyla**	3	3	3	3	1	1	1	2	1	2	2	3	3	2	2	1	2	29,70	292,43	2	3
73 Sterna paradisaea	3	1	1	2	1	1	1	2	2	2	2	1	3	2	2	1	1	7,20	33,97	1	1
74 **Uria lomvia**	3	3	3	3	0	1	2	2	3	3	2	2	2	3	2	1	2	72,90	874,80	3	3
75 ***Cepphus grylle***	3	3	2	3	1	1	1	2	3	2	2	1	3	3	2	1	2	40,50	232,62	3	2
75a **Cepphus grylle**	3	3	2	3	1	1	1	3	3	2	2	1	3	3	2	2	3	48,60	328,98	3	3

APPENDIX III continued.

NESTING, REGION 4	Ta	Ts	Au	Bs	Sa	Pr	Fc	Pf	Rc	De	Ps	Ft	Fi	Rp	Pt	Vp	Pi	IV-tot	PV-tot	IV-value	PV-value
76 **Gavia stellata**	3	2	1	3	0	1	2	2	2	2	2	1	3	2	2	1	3	21,60	110,77	2	2
77 Gavia arctica	3	1	1	3	0	1	2	2	2	2	2	1	3	2	2	1	3	10,80	55,38	1	1
78 ***Gavia adamsii***	3	2	2	3	0	1	2	2	2	2	3	1	3	3	2	1	3	30,24	224,86	2	2
78a **Gavia adamsii**	3	2	2	3	0	1	2	3	2	2	3	1	3	3	3	1	3	37,80	300,46	3	3
79 ***Phalacrocorax pelagicus***	3	3	2	3	0	1	1	2	3	3	3	1	2	2	1	1	2	31,50	242,31	2	2
79a **Phalacrocorax pelagicus**	3	3	2	3	0	1	1	2	3	3	3	1	2	2	1	1	3	31,50	254,42	2	3
79b **Phalacrocorax pelagicus**	3	3	2	3	0	1	1	3	3	3	3	1	2	2	1	1	3	37,80	305,31	3	3
80 Cygnus columbianus bewickii	3	1	1	1	1	1	1	2	1	1	3	1	2	3	3	1	3	4,50	16,73	1	1
81 Anser fabalis	3	1	1	1	1	1	1	2	1	1	3	1	2	1	3	1	3	4,50	12,12	1	1
82 Philacte canagica	3	2	1	2	2	1	1	2	1	1	2	1	2	2	3	1	3	14,40	36,92	1	1
83 Branta bernicla	3	1	1	1	1	1	1	2	1	1	3	1	2	2	3	1	3	4,50	14,42	1	1
84 **Somateria mollissima**	3	2	2	3	2	1	2	2	2	2	2	1	2	2	2	1	3	47,52	224,20	3	2
85 Somateria spectabilis	3	1	1	3	1	1	2	2	2	2	2	1	2	2	2	1	3	15,12	71,34	1	1
85a ***Somateria spectabilis***	3	2	1	3	1	1	2	2	2	2	2	1	2	2	2	1	3	30,24	142,67	2	2
86 Somateria fischeri	3	1	1	3	1	1	1	2	2	2	2	1	3	2	3	1	3	8,40	46,52	1	1
87 **Polysticta stelleri**	3	2	1	3	2	1	1	2	2	2	2	1	3	2	3	1	3	21,60	119,63	2	2
88 Clangula hyemalis	3	1	1	3	1	1	1	2	2	2	1	1	2	1	2	1	2	8,40	23,26	1	1
89 Charadrius hiaticula	3	1	1	0	3	1	1	1	1	1	2	1	3	1	2	1	1	4,80	9,35	1	1
90 Calidris minuta	3	1	1	0	3	1	1	1	1	1	3	1	3	1	2	1	1	4,80	11,69	1	1
91 Calidris temminckii	3	1	1	0	3	1	1	1	1	1	2	1	3	1	2	1	1	4,80	9,35	1	1
92 Calidris alpina	3	1	1	0	3	1	1	1	1	1	1	1	3	1	2	1	1	4,80	7,02	1	1
93 Eurynorhynchus pygmaeus	3	1	1	0	3	1	1	1	1	1	3	1	3	1	2	1	2	4,80	12,31	1	1
94 Arenaria interpres	3	1	1	0	3	1	1	1	1	1	2	1	3	1	2	1	1	4,80	9,35	1	1
95 Stercorarius parasiticus	3	1	1	1	1	1	1	2	1	2	3	1	3	2	2	1	2	4,50	27,69	1	1
96 Xema sabini	3	1	2	1	1	1	1	2	1	1	2	1	2	2	2	1	2	6,30	14,22	1	1
97 Larus argentatus	3	1	2	3	2	1	1	2	1	2	2	1	2	2	2	1	1	9,90	42,65	1	1
98 Larus hyperboreus	3	1	2	3	2	1	1	2	1	2	2	1	2	2	2	1	1	9,90	42,65	1	1
99 **Rissa tridactyla**	3	3	3	3	1	1	1	2	2	3	1	2	3	2	1	1	1	39,60	319,85	3	3
99a ***Rissa tridactyla***	3	3	3	2	1	1	1	1	2	3	1	2	3	2	1	1	1	27,00	218,08	2	2
100 Sterna paradisaea	3	1	1	2	1	1	1	2	2	2	2	1	3	2	2	1	1	7,20	33,97	1	1
101 **Uria lomvia**	3	3	3	3	0	1	2	2	3	3	1	2	2	3	2	1	3	72,90	757,04	3	3
102 **Cepphus grylle**	3	3	2	3	1	1	1	2	3	3	2	1	2	3	2	1	2	40,50	324,00	3	3
103 **Fratercula corniculata**	3	3	2	3	0	1	1	2	3	3	3	1	2	3	2	1	3	31,50	327,12	2	3
103a **Fratercula corniculata**	3	3	2	3	0	1	1	3	3	3	3	1	2	3	3	1	3	37,80	421,62	3	3

APPENDIX IV. Vulnerability assessment of oil/seabirds in the NSR-area for the post-nesting (autumn) season. The assessment is done for regions 1-4 separately. Shaded areas indicate alternative indexing. Vulnerable populations in bold.

AUTUMN, REGION 1	Ta	Ts	Au	Bs	Sa	Pr	Fc	Pf	Rc	De	Ps	Ft	Fi	Rp	Pt	Vp	Pi	IV-tot	PV-tot	IV-value	PV-value
1 Cygnus columbianus bewickii	3	1	1	2	1	1	3	1	2	2	3	2	2	3	3	1	2	14,04	141,12	1	2
2 Anser fabalis	2	1	1	2	1	1	3	2	2	2	1	3	1	1	1	1	1	12,48	58,24	1	1
3 **Branta leucopsis**	3	2	2	3	2	1	3	1	2	2	2	3	1	1	1	1	2	51,48	295,68	3	3
4 Branta bernicla	3	1	1	2	2	1	3	1	2	2	3	3	2	2	2	1	2	18,72	190,08	2	2
5 Anas acuta	1	1	1	2	1	1	3	1	2	1	2	2	1	1	2	1	2	4,68	11,52	1	1
6 **Aythya marila**	2	3	1	3	1	1	3	2	3	3	2	2	1	1	2	1	2	54,60	403,20	3	3
7 **Somateria mollissima**	3	3	2	3	2	1	3	2	3	3	2	3	1	1	2	1	3	128,70	1346,40	3	3
8 **Somateria spectabilis**	3	3	2	3	1	1	3	2	3	3	1	3	1	1	2	1	3	105,30	963,90	3	3
9 **Polysticta stelleri**	3	3	2	3	2	1	3	2	3	3	2	2	1	1	2	1	3	128,70	1009,80	3	3
10 **Clangula hyemalis**	3	3	2	3	2	1	3	2	3	3	1	2	1	1	2	1	2	128,70	792,00	3	3
11 **Melanitta nigra**	3	3	2	3	1	1	3	2	3	3	2	3	1	1	2	1	2	105,30	1036,80	3	3
12 **Melanitta fusca**	3	3	2	3	1	1	3	2	3	3	2	2	1	1	2	1	2	105,30	777,60	3	3
13 **Mergus merganser**	3	3	2	3	1	1	3	2	3	2	2	3	1	1	2	1	2	105,30	691,20	3	3
14 Charadrius hiaticula	1	3	1	1	3	1	1	1	1	2	2	1	1	1	2	1	1	5,40	16,62	1	1
15 Pluvialis apricaria	1	3	1	1	3	1	1	1	1	2	2	2	2	1	2	1	1	5,40	28,25	1	1
16 Pluvialis squatarola	1	3	1	1	3	1	1	1	1	2	3	1	2	1	2	1	1	5,40	23,54	1	1
17 Calidris alba	1	3	1	1	3	1	1	1	1	2	2	1	1	1	2	1	1	5,40	16,62	1	1
18 Calidris minuta	1	3	1	1	3	1	1	1	1	2	1	3	1	1	2	1	1	5,40	29,08	1	1
19 Calidris temminckii	1	3	1	1	3	1	1	1	1	2	1	1	1	1	2	1	1	5,40	12,46	1	1
20 Calidris ferruginea	1	3	1	1	3	1	1	1	1	2	1	3	1	1	2	1	1	5,40	29,08	1	1
21 Calidris maritima	2	3	1	1	3	1	1	1	1	2	3	1	1	1	2	1	1	10,80	41,54	1	1
22 Calidris alpina	1	3	1	1	3	1	1	1	1	2	1	3	1	1	2	1	1	5,40	29,08	1	1
23 Philomachus pugnax	1	3	1	1	3	1	1	1	1	2	1	2	1	1	2	1	1	5,40	20,77	1	1
24 Limosa lapponica	1	3	1	1	3	1	1	1	1	2	2	2	1	1	2	1	1	5,40	24,92	1	1
25 Arenaria interpres	1	3	1	1	3	1	1	1	1	2	2	2	1	1	2	1	1	5,40	24,92	1	1
26 Phalaropus lobatus	1	3	2	2	3	1	1	1	1	3	2	2	1	1	2	1	1	7,20	49,85	1	1
27 Stercorarius pomarinus	2	2	3	3	2	1	1	2	1	3	2	2	2	2	2	1	2	15,60	158,40	1	2
28 Stercorarius parasiticus	2	2	3	2	1	1	1	2	1	3	2	2	2	2	2	1	2	12,00	121,85	1	2
29 Stercorarius longicaudus	2	2	3	2	1	1	1	2	1	3	2	2	2	2	2	1	2	12,00	121,85	1	2
30 Larus argentatus	2	2	3	3	1	1	1	2	1	2	1	2	1	2	2	1	1	13,20	64,31	1	1
31 Larus hyperboreus	2	2	3	3	1	1	1	2	1	2	2	2	1	2	1	1	1	13,20	69,05	1	1
32 **Rissa tridactyla**	2	3	3	3	1	1	1	2	2	3	2	3	1	2	1	1	1	26,40	276,18	2	3
33 **Pagophila eburnea**	3	3	3	2	2	1	1	2	1	3	2	2	2	2	2	1	2	32,40	328,98	2	3
34 Sterna paradisaea	1	1	3	2	1	1	1	2	2	2	2	2	2	2	2	1	1	4,00	25,85	1	1
35 **Uria lomvia**	3	3	3	3	1	1	3	2	3	3	1	3	2	3	3	1	3	128,70	2009,70	3	3
36 **Cepphus grylle**	3	3	3	3	1	1	3	2	3	3	2	1	2	3	2	1	2	128,70	1029,60	3	3

APPENDIX IV continued.

AUTUMN, REGION 2	Ta	Ts	Au	Bs	Sa	Pr	Fc	Pf	Rc	De	Ps	Ft	Fi	Rp	Pt	Vp	Pi	IV-tot	PV-tot	IV-value	PV-value
37 Branta bernicla	3	1	1	2	2	2	3	1	2	2	1	3	2	1	1	1	3	20,16	123,03	2	2
38 **Somateria spectabilis**	3	3	2	3	1	2	3	2	3	2	1	2	1	1	2	1	3	113,40	494,31	3	3
39 **Clangula hyemalis**	3	3	2	3	2	2	3	2	3	2	1	2	1	1	2	1	2	138,60	568,62	3	3
40 Charadrius hiaticula	1	3	1	1	3	2	1	1	1	2	3	1	1	1	2	1	1	6,48	24,92	1	1
41 Pluvialis apricaria	1	3	1	1	3	2	1	1	1	2	3	1	2	1	2	1	1	6,48	28,25	1	1
42 Pluvialis fulva	1	3	1	1	3	2	1	1	1	2	3	1	2	1	2	1	1	6,48	28,25	1	1
43 Pluvialis squatarola	1	3	1	1	3	2	1	1	1	2	3	1	2	1	2	1	1	6,48	28,25	1	1
44 Calidris alba	1	3	1	1	3	2	1	1	1	2	3	1	1	1	2	1	1	6,48	24,92	1	1
45 Calidris ruficollis	1	3	1	1	3	2	1	1	1	2	3	2	1	1	2	1	1	6,48	34,89	1	1
46 Calidris minuta	1	3	1	1	3	2	1	1	1	2	1	2	1	1	2	1	1	6,48	24,92	1	1
47 Calidris temminckii	1	3	1	1	3	2	1	1	1	2	3	1	1	1	2	1	1	6,48	24,92	1	1
48 Calidris melanotos	1	3	1	1	3	2	1	1	1	2	3	2	1	1	2	1	1	6,48	34,89	1	1
49 Calidris ferruginea	1	3	1	1	3	2	1	1	1	2	1	2	1	1	2	1	1	6,48	24,92	1	1
50 Calidris maritima	1	3	1	1	3	2	1	1	1	2	3	1	1	1	2	1	1	6,48	24,92	1	1
51 Calidris alpina	1	3	1	1	3	2	1	1	1	2	2	2	1	1	2	1	1	6,48	29,91	1	1
52 Philomachus pugnax	1	3	1	1	3	2	1	1	1	2	2	3	1	1	2	1	1	6,48	39,88	1	1
53 Limosa lapponica	1	3	1	1	3	2	1	1	1	2	2	3	1	1	2	1	1	6,48	39,88	1	1
54 Arenaria interpres	1	3	1	1	3	2	1	1	1	2	3	2	1	1	2	1	1	6,48	34,89	1	1
55 Phalaropus fulicarius	1	3	1	2	2	2	1	1	1	2	2	2	1	1	2	1	1	5,76	26,58	1	1
56 Stercorarius pomarinus	2	2	3	3	2	2	1	2	1	3	2	2	2	2	2	1	2	18,72	190,08	2	2
57 Stercorarius parasiticus	2	2	3	2	1	2	1	2	1	3	2	2	2	2	2	1	2	14,40	146,22	1	2
58 Stercorarius longicaudus	2	2	3	2	1	2	1	2	1	3	2	2	2	2	2	1	2	14,40	146,22	1	2
59 Xema sabini	2	3	3	1	1	2	1	2	1	2	2	2	2	2	2	1	2	19,44	131,59	2	2
60 Larus argentatus	2	2	3	3	1	2	1	2	1	2	2	2	1	2	2	1	1	15,84	92,60	2	1
61 Larus hyperboreus	2	2	3	3	1	2	1	2	1	2	2	2	1	2	2	1	1	15,84	92,60	2	1
62 Rhodostethia rosea	2	3	3	1	1	2	1	2	1	2	2	2	2	2	2	1	2	19,44	131,59	2	2
63 **Rissa tridactyla**	2	2	3	3	1	2	1	2	2	3	2	3	1	2	2	1	2	21,12	259,94	2	3
64 ***Pagophila eburnea***	3	3	3	1	2	2	1	2	1	2	2	2	2	2	2	1	2	35,64	241,26	3	2
65a Pagophila eburnea	3	3	3	1	2	2	1	2	1	2	2	2	2	2	2	2	2	35,64	285,12	3	3
66 Sterna paradisaea	1	1	3	2	1	2	1	2	2	2	2	2	2	2	2	1	1	4,80	31,02	1	1
67 **Uria lomvia**	3	3	3	3	0	2	3	2	3	3	2	3	2	3	2	1	3	113,40	1884,18	3	3
68 **Cepphus grylle**	3	3	3	3	0	2	3	2	3	2	2	1	2	2	2	1	2	113,40	511,75	3	3
69 **Alle alle**	3	3	3	3	0	2	3	2	3	3	1	3	2	3	2	1	2	113,40	1587,60	3	3

APPENDIX IV continued.

AUTUMN, REGION 3	Ta	Ts	Au	Bs	Sa	Pr	Fc	Pf	Rc	De	Ps	Ft	Fi	Rp	Pt	Vp	Pi	IV-tot	PV-tot	IV-value	PV-value
69 Cygnus columbianus bewickii	3	1	1	2	1	1	3	1	2	2	3	1	2	3	2	1	3	14,04	97,20	**1**	**1**
69a Cygnus columbianus bewickii	3	1	1	2	1	1	3	1	2	2	3	1	2	3	3	1	3	14,04	104,40	**1**	**2**
70 Anser fabalis	2	1	1	2	1	1	3	2	2	2	1	2	2	1	3	1	1	12,48	60,80	**1**	**1**
71 Branta bernicla	3	1	1	2	2	1	3	1	2	2	2	3	2	2	3	1	3	18,72	192,00	**2**	**2**
72 **Somateria mollissima**	3	3	2	3	2	1	3	2	3	3	2	3	1	1	2	1	3	128,70	1346,40	**3**	**3**
73 **Somateria spectabilis**	3	3	2	3	1	1	3	2	3	3	1	3	1	1	2	1	3	105,30	963,90	**3**	**3**
74 **Somateria fischeri**	3	3	2	3	1	1	3	2	3	3	2	2	1	1	3	1	3	105,30	923,40	**3**	**3**
75 **Polysticta stelleri**	3	3	2	3	2	1	3	2	3	3	2	2	1	1	3	1	3	128,70	1128,60	**3**	**3**
76 **Clangula hyemalis**	3	3	2	3	2	1	3	2	3	3	1	2	1	1	2	1	2	128,70	792,00	**3**	**3**
77 Charadrius hiaticula	1	3	1	1	3	1	1	1	1	2	1	1	1	1	2	1	1	5,40	12,46	**1**	**1**
78 Pluvialis squatarola	1	3	1	1	1	1	1	1	1	1	2	1	2	1	2	1	1	3,00	5,23	**1**	**1**
79 Pluvialis fulva	1	3	1	1	1	1	1	1	1	1	2	1	2	1	2	1	1	3,00	5,23	**1**	**1**
80 Calidris alba	1	3	1	1	3	1	1	1	1	2	2	1	1	1	2	1	1	5,40	16,62	**1**	**1**
81 Calidris ruficollis	1	3	1	1	3	1	1	1	1	2	3	2	1	1	2	1	1	5,40	29,08	**1**	**1**
82 Calidris minuta	1	3	1	1	3	1	1	1	1	2	2	2	1	1	2	1	1	5,40	24,92	**1**	**1**
83 Calidris temminckii	1	3	1	1	3	1	1	1	1	2	1	2	1	1	2	1	1	5,40	20,77	**1**	**1**
84 Calidris melanotos	1	3	1	1	3	1	1	1	1	2	1	2	1	1	2	1	1	5,40	20,77	**1**	**1**
85 Calidris acuminata	1	3	1	1	3	1	1	1	1	2	2	2	1	1	2	1	1	5,40	24,92	**1**	**1**
86 Calidris ferruginea	1	3	1	1	3	1	1	1	1	2	2	2	1	1	2	1	1	5,40	24,92	**1**	**1**
87 Calidris alpina	1	3	1	1	3	1	1	1	1	2	1	2	1	1	2	1	1	5,40	20,77	**1**	**1**
88 Philomachus pugnax	1	3	1	1	3	1	1	1	1	2	2	2	1	1	2	1	1	5,40	24,92	**1**	**1**
89 Llimnodromus scolopaceus	1	3	1	1	3	1	1	1	1	2	2	1	1	1	2	1	1	5,40	16,62	**1**	**1**
90 Limosa lapponica	1	3	1	1	3	1	1	1	1	2	2	2	1	1	2	1	1	5,40	24,92	**1**	**1**
91 Arenaria interpres	1	3	1	1	3	1	1	1	1	2	2	2	1	1	2	1	1	5,40	24,92	**1**	**1**
92 Phalaropus lobatus	1	3	2	2	2	1	1	1	1	2	1	3	1	1	2	1	1	6,00	32,31	**1**	**1**
93 Phalaropus fulicarius	1	3	2	2	2	1	1	1	1	2	1	3	1	1	2	1	1	6,00	32,31	**1**	**1**
94 Stercorarius pomarinus	2	2	3	3	2	1	1	2	1	3	2	2	2	2	2	1	2	15,60	158,40	**1**	**2**
95 Stercorarius parasiticus	2	2	3	2	1	1	1	2	1	3	2	2	2	2	2	1	2	12,00	121,85	**1**	**2**
96 Stercorarius longicaudus	2	2	3	2	1	1	1	2	1	3	2	2	2	2	2	1	2	12,00	121,85	**1**	**2**
97 *Xema sabini*	2	3	3	1	1	1	1	2	1	2	3	2	2	2	2	1	2	16,20	127,94	**2**	**2**
97a Xema sabini	1	3	3	1	1	1	1	2	1	2	3	2	2	2	2	1	2	8,10	63,97	**1**	**1**
98 Larus argentatus	2	2	3	3	1	1	1	2	1	2	2	2	1	2	2	1	1	13,20	77,17	**1**	**1**
99 Larus hyperboreus	2	2	3	3	1	1	1	2	1	2	2	2	1	2	2	1	1	13,20	77,17	**1**	**1**
100 *Rhodostethia rosea*	2	3	3	1	1	1	1	2	1	2	3	2	2	2	2	1	2	16,20	127,94	**2**	**2**
100a Rhodostethia rosea	2	3	3	1	1	1	1	2	1	2	1	2	2	2	1	1	1	16,20	78,92	**2**	**1**
101 **Rissa tridactyla**	2	3	3	3	1	1	1	2	2	3	2	3	1	2	2	1	2	26,40	324,92	**2**	**3**

APPENDIX IV continued (autumn, region 3).

102 **Pagophila eburnea**	3	3	3	2	2	1	1	2	1	2	3	2	2	2	2	1	2	32,40	255,88	2	3
103 Sterna paradisea	1	1	3	2	1	1	1	2	2	1	2	2	2	2	2	1	1	4,00	12,92	1	1
104 **Uria lomvia**	3	3	3	3	0	2	3	2	3	3	2	3	2	3	2	1	3	113,40	1884,18	3	3
105 **Cepphus grylle**	3	3	3	3	0	1	3	2	3	3	2	1	2	3	2	1	2	105,30	842,40	3	3

APPENDIX IV continued.

AUTUMN, REGION 4	Ta	Ts	Au	Bs	Sa	Pr	Fc	Pf	Rc	De	Ps	Ft	Fi	Rp	Pt	Vp	Pi	IV-tot	PV-tot	IV-value	PV-value
106 **Phalacrocorax pelagicus**	2	2	3	3	1	2	2	2	3	3	3	2	1	2	1	1	2	44,00	426,46	3	3
107 Anser fabalis	2	1	1	2	1	2	3	2	2	1	3	2	2	1	3	1	3	13,44	50,66	1	1
108 **Philacte canagica**	2	2	1	2	3	2	3	2	2	2	2	3	2	2	3	1	3	44,80	459,49	3	3
109 Branta bernicla	3	1	1	2	2	2	3	1	2	1	2	3	2	2	3	1	3	20,16	103,38	2	2
110 **Somateria mollissima**	3	3	2	3	2	2	3	2	3	2	1	3	1	1	2	1	3	138,60	845,82	3	3
111 **Somateria spectabilis**	3	3	2	3	1	2	3	2	3	2	1	3	1	1	2	1	3	113,40	692,03	3	3
112 **Somateria fischeri**	3	3	2	3	1	2	3	2	3	3	2	2	1	1	3	1	3	113,40	994,43	3	3
113 **Polysticta stelleri**	3	3	2	3	2	2	3	2	3	2	2	2	1	1	3	1	3	138,60	810,28	3	3
114 **Clangula hyemalis**	3	3	2	3	2	2	3	2	3	2	1	2	1	1	2	1	2	138,60	568,62	3	3
115 Charadrius hiaticula	1	3	1	1	3	2	1	1	1	1	2	1	1	1	2	1	1	6,48	9,97	1	1
116 Pluvialis fulva	1	3	1	1	1	2	1	1	1	1	2	1	2	1	2	1	1	3,60	6,28	1	1
117 Pluvialis squatarola	1	3	1	1	3	2	1	1	1	1	3	1	2	1	2	1	1	6,48	14,12	1	1
118 Calidris mauri	1	3	1	1	3	2	1	1	1	1	3	2	1	1	2	1	1	6,48	17,45	1	1
119 Calidris ruficollis	1	3	1	1	3	2	1	1	1	1	2	2	1	1	2	1	1	6,48	14,95	1	1
120 Calidris temminckii	1	3	1	1	3	2	1	1	1	1	2	2	1	1	2	1	1	6,48	14,95	1	1
121 Calidris melanotos	1	3	1	1	3	2	1	1	1	1	1	2	1	1	2	1	1	6,48	12,46	1	1
122 Calidris alpina	1	3	1	1	3	2	1	1	1	1	1	3	1	1	2	1	1	6,48	17,45	1	1
123 Eurynorhynchus pygmeus	1	3	1	1	3	2	1	1	1	1	3	2	1	1	2	1	2	6,48	18,61	1	1
124 Limnodromus scolopaceus	1	3	1	1	2	2	1	1	1	1	3	1	1	1	2	1	1	5,04	9,69	1	1
125 Limosa lapponica	1	3	1	1	1	2	1	1	1	1	3	2	1	1	2	1	1	3,60	9,69	1	1
126 Arenaria interpres	1	3	1	1	3	2	1	1	1	1	1	2	1	1	2	1	1	6,48	12,46	1	1
127 Phalaropus lobatus	1	3	2	2	2	2	1	1	1	2	1	3	1	1	2	1	1	7,20	38,77	1	1
128 Phalaropus fulicarius	1	3	2	2	2	2	1	1	1	2	1	3	1	1	2	1	1	7,20	38,77	1	1
129 Stercorarius pomarinus	2	2	3	3	2	2	1	2	1	3	1	2	2	2	2	1	2	18,72	158,40	2	2
130 Stercorarius parasiticus	2	2	3	2	1	2	1	2	1	3	1	2	2	2	2	1	2	14,40	121,85	1	2
131 Stercorarius longicaudus	2	2	3	2	1	2	1	2	1	3	1	2	2	2	2	1	2	14,40	121,85	1	2
132 *Xema sabini*	2	3	3	1	1	2	1	2	1	2	2	2	2	2	2	1	2	19,44	131,59	2	2
132a Xema sabini	1	3	3	1	1	2	1	2	1	2	2	2	2	2	2	1	2	9,72	65,80	1	1
133 Larus argentatus	2	2	3	3	1	2	1	2	1	2	2	2	1	2	2	1	1	15,84	92,60	2	1
134 Larus hyperboreus	2	2	3	3	1	2	1	2	1	2	2	2	1	2	2	1	1	15,84	92,60	2	1
135 Rhodostethia rosea	2	3	3	1	1	2	1	2	1	2	1	2	2	2	3	1	3	19,44	124,62	2	2
136 **Rissa tridactyla**	2	3	3	3	1	2	1	2	2	3	1	3	1	2	1	1	1	31,68	289,99	2	3
137 **Pagophila eburnea**	3	3	3	2	2	2	1	2	1	2	2	2	2	2	2	1	2	38,88	263,19	3	3
138 Sterna paradisaea	1	1	3	2	1	2	1	2	2	2	1	2	2	2	2	1	1	4,80	25,85	1	1
139 **Uria lomvia**	3	3	3	3	0	2	3	2	3	3	1	3	2	3	2	1	3	113,40	1648,66	3	3
140 **Cepphus grylle**	3	3	3	3	0	2	3	2	3	3	2	1	2	3	2	1	2	113,40	907,20	3	3
141 **Fratercula corniculata**	3	3	3	3	0	2	3	2	3	3	3	1	2	3	2	1	3	113,40	1177,62	3	3

APPENDIX V. List of the highly vulnerable species with their population vulnerability index listed according to season and geographic region (I-IV).

WINTER POPULATIONS	Region				
	I	II	III	IV	Mean
1 Pagophila eburnea	3	-	-	-	3
2 Uria lomvia	3	-	-	-	3
3 Cepphus grylle	3	-	-	-	3
4 Alle alle	3	-	-	-	3

SPRING POPULATIONS	Region				
	I	II	III	IV	Mean
1 Gavia stellata	2	2	(1)	(1)	1,5
2 Somateria mollissima	2/3	-	2/3	1/3	2,3
3 Somateria spectabilis	(1/2)	1/3	2/3	1/3	2
4 Somateria fischeri	-	-	2/3	1/3	2,3
5 Polysticta stelleri	(1/2)	(1/2)	(1)	(1)	1,3
6 Clangula hyemalis	(1/2)	1/3	1/3	1/3	1,9
7 Rissa tridactyla	2	2	2	2	2
8 Pagophila eburnea	2	(1/2)	(1/2)	(1/2)	1,6
9 Uria lomvia	3	3	3	3	3
10 Cepphus grylle	3	3	2/3	3	2,9
11 Alle alle	3	3	-	-	3

NESTING POPULATIONS	Region				
	I	II	III	IV	Mean
1 Gavia stellata	2	2	2	2	2
2 Gavia adamsii	2/3	2/3	2/3	2/3	2,5
3 Phalacrocorax pelagicus	-	-	-	2/3	2,5
4 Somateria mollissima	3	-	1/3	2	2,3
5 Somateria spectabilis	(1/2)	(1/2)	1/3	(1/2)	1,6
6 Polysticta stelleri	(1/2)	(1)	2	2	1,6
7 Rissa tridactyla	3	3	3	2/3	2,8
8 Pagophila eburnea	(1/2)	2/3	-	-	2
9 Uria lomvia	3	3	3	3	3
10 Cepphus grylle	3	3	2/3	3	2,8
11 Alle alle	-	3	-	-	3
12 Fratercula corniculata	-	-	-	3	3

POSTNESTING POPULATIONS	Region				
	I	II	III	IV	Mean
1 Phalacrocorax pelagicus	-	-	-	3	3
2 Philacte canagica	-	-	-	3	3
3 Branta leucopsis	3	-	-	-	3
4 Aythya marila	3	-	-	-	3
5 Somateria mollissima	3	-	3	3	3
6 Somateria spectabilis	3	3	3	3	3
7 Somateria fischeri	-	-	3	3	3
8 Polysticta stelleri	3	-	3	3	3
9 Clangula hyemalis	3	3	3	3	3
10 Melanitta nigra	3	-	-	-	3
11 Melanitta fusca	3	-	-	-	3
12 Mergus merganser	3	-	-	-	3
13 Rissa tridactyla	3	3	3	3	3
14 Pagophila eburnea	3	2/3	3	3	2,8
15 Uria lomvia	3	3	3	3	3
16 Cepphus grylle	3	3	3	3	3
17 Alle alle	-	3	-	-	3
18 Fratercula corniculata	-	-	-	3	3

Appendix VI. Systematic list of species (and to some extent subspecies) treated. 'Red' indicates whether the species is included in the Red Data Books of the former USSR or the Russian Federation. Species or subspecies with winter populations (WP), spring populations (SP), nesting populations (NP) or postnesting populations (PP) in the NSR-area have no shading in the respective columns.

Scientific name	English name	Norwegian name	Red	WP	SP	NP	PP
Gavia stellata	Red-throated Diver	Smålom					
Gavia arctica	Black-throated Diver	Storlom					
Gavia adamsii	White-billed Diver	Gulnebblom	Yes				
Phalacrocorax pelagicus	Pelagic Cormorant	Beringskarv					
Cygnus columbianus bewickii	Bewick's Swan	Dvergsvane	Yes				
Anser fabalis	Bean Goose	Sædgås					
Philacte canagica	Emperor Goose	Keisergås	Yes				
Branta leucopsis	Barnacle Goose	Hvitkinngås	Yes*				
Branta bernicla	Brent Goose	Ringgås					
Anas acuta	Northern Pintail	Stjertand					
Aythya marila	Greater Scaup	Bergand					
Somateria mollissima	Common Eider	Ærfugl					
Somateria spectabilis	King Eider	Praktærfugl					
Somateria fischeri	Spectacled Eider	Brilleærfugl					
Polysticta stelleri	Steller's Eider	Stellerand					
Clangula hyemalis	Long-tailed Duck	Havelle					
Melanitta nigra	Common Scoter	Svartand					
Melanitta fusca	Velvet Scoter	Sjøorre					
Mergus merganser	Goosander	Laksand					
Charadrius hiaticula	Ringed Plover	Sandlo					
Pluvialis apricaria	Eurasian Golden Plover	Heilo					
Pluvialis fulva	Pacific Golden Plover	Sibirlo					
Pluvialis squatarola	Grey plover	Tundralo					
Calidris canutus	Red Knot	Polarsnipe					
Calidris alba	Sanderling	Sandløper					
Calidris mauri	Western Sandpiper	Beringsnipe					
Calidris ruficollis	Red-necked Stint	Rødstrupesnipe					
Calidris minuta	Little Stint	Dvergsnipe					
Calidris temminckii	Temminck's Stint	Temminksnipe					
Calidris melanotos	Pectoral Sandpiper	Alaskasnipe					
Calidris acuminata	Sharp-tailed Sandpiper	Spisshalesnipe					
Calidris ferruginea	Curlew Sandpiper	Tundrasnipe					
Calidris maritima	Purple Sandpiper	Fjæreplytt					
Calidris alpina	Dunlin	Myrsnipe					
Eurynorhynchus pygmeus	Spoon-billed Sandpiper	Skjesnipe	Yes				
Limicola falcinellus	Broad-billed Sandpiper	Fjellmyrløper					
Xema sabini	Sabine's Gull	Sabinemåke					
Larus argentatus	Herring Gull	Gråmåke					
Larus hyperboreus	Glaucous Gull	Polarmåke					
Rhodostethia rosea	Ross's Gull	Rosenmåke	Yes*				
Rissa tridactyla	Black-legged Kittiwake	Krykkje					
Pagophila eburnea	Ivory Gull	Ismåke	Yes				
Sterna paradisaea	Arctic Tern	Rødnebbterne					
Uria lomvia	Brünnich's Guillemot	Polarlomvi					
Cepphus grylle	Black Guillemot	Teist					
Alle alle	Little Auk	Alkekonge					
Fratercula corniculata	Horned Puffin	Hornlunde					

United States Department of the Interior

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IN REPLY REFER TO:
MBM

NOV 15 1997

Vidar Bakken
Norwegian Polar Institute
P.O. Box 5072, Majorstua
0301 Oslo
Norway

Dear Dr. Bakken:

Thank you for the opportunity to comment on the paper, " Oil Vulnerability Assessment for Marine Birds Occurring Along the Northern Sea Route Area". This project has obviously been a very challenging task for an area like the Northern Sea Route (N.S.R.). I believe it has been a necessary task as oil exploration and development in the Arctic continues. I thank the authors for undertaking this arduous task.

It was highlighted several times in the paper that the lack of reliable population and other biological data has made it difficult to accurately determine the vulnerability indices for several species or species groups during most seasons. As such, I agree with the authors that perhaps one of the most significant contributions of this paper is the identification of data gaps that hopefully will form the basis for determining new study priorities.

Several specific comments are indicated below.

1. Several "vulnerability" criteria were identified and, although the number of criteria makes for a complicated process, all are valuable to varying degrees in determining a species vulnerability index. Although the thought process that created the criteria was an important step in that information areas needing more study were identified, given the lack of reliable data at this time for so many of the vulnerability criteria, I suggest that the "formulas" could be simplified by deleting those criteria for which little data exists.

2. Page 2; 3rd paragraph, 2nd sentence. I suggest you add "surface and subsurface water movement trajectories along" the sailing routes.

3. Page 2, Area Utilization. I believe this is adequately covered by criteria Ta and Ts.

4. Page 2, Behavior at Sea. I suggest that in addition to the existing definition you include the concept of behavior toward oil on the water surface. I believe that recent spills have demonstrated a significant contrast in vulnerability and mortality between for example

auks and gulls or between diving seabirds and those species that are more mobile like the gulls. Suggest combining this criteria with the concept of Pr.

4. Page 3, Shore Affinity. This criteria is somewhat misleading in that not all spills hit the beach or that most of the oil in a spill hits the beach. For example, much of the oil during the EVOS drifted at-sea. Secondly, shore affinity may not be the most applicable criteria in an area that is often ice-covered or that has leads and polynyas. Either will capture oil or prevent oil from reaching the beach. I believe on page 5 you have perhaps made this adjustment.

5. Page 3, Possibility of Reaction. If I understand this criteria, I would suggest you change the title to "Possibility of oil being detected by a bird" and clarify the definition.

6. Page 3, Recovery Capability. I believe the record is clear that once a bird becomes oiled, even lightly oiled, in coldwater environments that it becomes a mortality statistic. If this criteria refers to "cleaning and rehabilitation" then the record shows that few birds are ever retrieved and, given the remoteness of the NSR, for those few that would be found alive the success rate would likely be very low.

7. Page 6, Behavior at Sea. In spite of their ship following tendencies, past oil spills do not show a high mortality of gulls.

8. Page 12, paragraph 5. Again, I believe that past spills have shown that the highly mobile gulls and skuas are not impacted significantly during a spill. This was the case with the Exxon Valdez spill which occurred in an area with many gulls and kittiwakes. I agree that seaducks, auks, cormorants, and divers are highly vulnerable to spills.

Thank you for the opportunity to comment on your paper. I wish you success.

Sincerely,

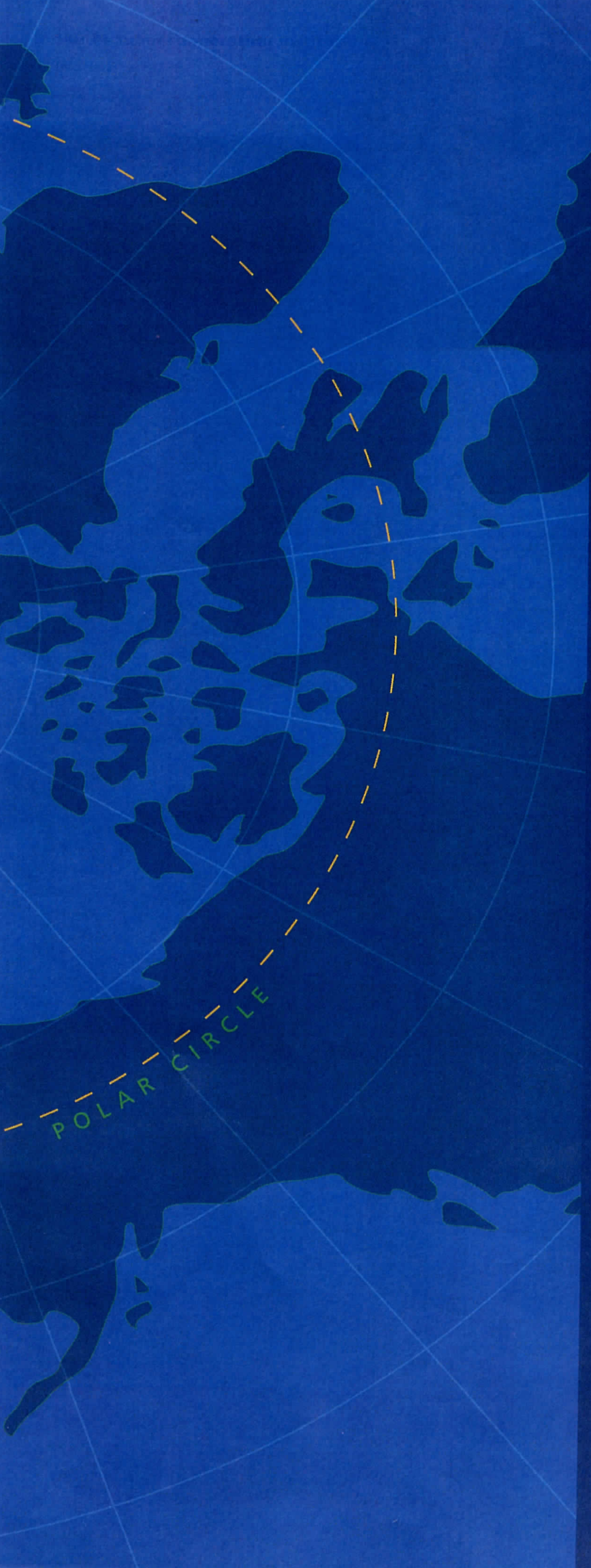
Kent Wohl

Kenton D. Wohl
Nongame Migratory Bird Coordinator

Reply from the authors

We will thank Kent Wohl for his thorough and detailed review of our paper. We have updated the paper according to the comments, but on some topics we found it difficult to update the present version. This is mainly in relation to comments on the vulnerability criteria and thereby changing the vulnerability model. We don't think the main results in this report will be affected by some minor changes in the model. However, his comments are important to take into consideration when the model hopefully will be evaluated in the near future.

The authors



The three main cooperating institutions of INSROP

Ship & Ocean Foundation (SOF), Tokyo, Japan.
SOF was established in 1975 as a non-profit organization to advance modernization and rationalization of Japan's shipbuilding and related industries, and to give assistance to non-profit organizations associated with these industries. SOF is provided with operation funds by the Sasakawa Foundation, the world's largest foundation operated with revenue from motorboat racing. An integral part of SOF, the Tsukuba Institute, carries out experimental research into ocean environment protection and ocean development.

Central Marine Research & Design Institute (CNIIMF), St. Petersburg, Russia.
CNIIMF was founded in 1929. The institute's research focus is applied and technological with four main goals: the improvment of merchant fleet efficiency; shipping safety; technical development of the merchant fleet; and design support for future fleet development. CNIIMF was a Russian state institution up to 1993, when it was converted into a stockholding company.

The Fridtjof Nansen Institute (FNI), Lysaker, Norway.
FNI was founded in 1958 and is based at Polhøgda, the home of Fridtjof Nansen, famous Norwegian polar explorer, scientist, humanist and statesman. The institute spesializes in applied social science research, with special focus on international resource and environmental management. In addition to INSROP, the research is organized in six integrated programmes. Typical of FNI research is a multidisciplinary approach, entailing extensive cooperation with other research institutions both at home and abroad. The INSROP Secretariat is located at FNI.