REPORT

Effects of cleaning and rehabilitation of oiled seabirds

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Foreword

The Swedish Environmental Protection Agency has requested the Environmental Advisory Service for Oil and Chemical Spills at IVL Swedish Environmental Research Institute, Ltd. together with experts at the University of Lund and the Swedish Wildlife Rehabilitators Association to conduct an investigation on issues related to cleaning and rehabilitation of seabirds contaminated by oil spills in the Baltic Sea area. The Advisory Service was founded in 1980 as a centre of competence on the effects of oil spills and accidental outlets of chemicals in the marine and limnic environments. The service is financed by the Swedish Environmental Protection Agency and is intended to support the Rescue Service, and regional and local authorities with information to help reduce harmful impacts on the environment and health.

Contents

1 Introduction

1.1 Background

The Baltic Sea area is an important route for commercial transports at sea. Thousands of cargoes are carried weekly across the sea. Although legally forbidden, a number of oil spills are detected each year by the national authorities. Inevitably these spills hit birds dwelling in the area. Depending on the properties of the oil, the birds are contaminated differently. Oil contamination may be more or less directly lethal by impacting the birds physically, which reduces their ability to feed themselves or, if oil is ingested, inducing toxic effects. Several attempts, mainly by voluntary organizations, have been made to rescue and clean oil contaminated birds.

A map of the Baltic Sea area is shown in Figure 1.

Figure 1 Map of the Baltic Sea area (© Microsoft Corp 2008)

1.2 Aims

It is the aim of this project to provide support to the evaluation of effects of rehabilitation of birds, rescued and cleaned of contamination with oil at sea. Information should be collected to address the following questions:

- What species of birds are threatened by oil contamination in the Swedish marine environment of the Baltic Sea, and what is their status on the national Red-list
- The distribution and population numbers of these threatened bird species
- The present capacity in Sweden to treat and rehabilitate oiled birds
- Facilities for cleaning oiled birds, e.g. temperate water, localities, feeding and rehabilitation
- Previous experience of survival of cleaning treatment; immediate, after one winter and at the following breeding period
- Cleaning and rehabilitation success in different species and age categories

2 Bird species exposed to oil in the Swedish marine environment

Several bird species occur in the Baltic Sea area. Of special concern in relation to exposure to oil spills are those species who breed, migrate through or rest and winter in the area. If they feed by diving in the seawater they are also particularly vulnerable. Fourteen species of birds in the Swedish marine environment are judged to be of special concern according to these criteria and should be considered for cleaning operations. These include four species of grebes: Great Crested Grebe *Podiceps cristatus* (skäggdopping), Red-necked Grebe *P. grisegena* (gråhakedopping), Slavonian Grebe *P. auritus* (svarthakedopping) and Black-necked Grebe *P. nigricollis* (svarthalsad dopping); two divers: Black-throated Diver *Gavia arctica* (storlom) and Red-throated Diver *G. stellata* (smålom); three auks: Guillemot *Uria aalge* (sillgrissla), Black Guillemot *Cepphus grylle* (tobisgrissla) and Razorbill *Alca torda* (tordmule) and five duck species: Velvet Scoter *Melanitta fusca* (svärta), Red-breasted Merganser *Mergus serrator* (småskrake), Common Eider *Somateria mollissima* (ejder), Long-tailed Duck *Clangula hyemalis* (alfågel) and Steller's Eider *Polysticta stelleri* (alförrädare). There are also other birds, such as gulls and terns, waders, swans, geese and dabbling ducks, that might be affected by an oil spill at sea and for which cleaning operations may be considered. However, it is believed that the plumage condition of these birds is not as critical as for those that dive in deep seawater for foraging.

Five of these fourteen bird species are listed on the Swedish national Red-list (http://www.artdata.slu.se/rodlista). The Slavonian Grebe, Black-necked Grebe and Long-tailed Duck are classified as Vulnerable (VU), and the Red-throated Diver and Velvet Scoter are in the Near Threatened (NT) category. None of the fourteen species is endemic in the Baltic area; therefore the whole population of a species is not threatened to be extinguished. Several species have isolated local populations in the area without exchange with other populations of the species. If an oil spill hits a considerable part of such a population, it may cause an irreversible damage for that species, e.g. the whole winter population of Guillemot may be extinguished by an oil spill in the wintering areas in the southern part of the Baltic Sea. The majority of all Long-tailed Ducks of the Western Palearctic winters in the Baltic Sea with up to 25 % on Hoburgs bank and east of Gotland (Durinck et al. 1994; Larsson, Tydén 2005, 2008).

3 Distribution and population numbers in the Baltic area of fourteen bird species threatened by oil contamination

Systematic inventories of resting and wintering seabirds in the Baltic Sea have been conducted at a Swedish national level since 1967. Since that year nationwide inventories have also been performed in some of the neighbouring countries. These inventories have in most cases only surveyed inner coastal areas while the open sea areas of the Baltic Sea have only been surveyed in 1992/1993 (Durinck et al. 1994). The latest complete wintering seabird inventory of inner coastal sea areas in Sweden (including inland waters) was conducted in 2004 (Nilsson 2008b, http://www.zoo.ekol.lu.se/waterfowl/index.htm). A new inventory of wintering seabirds in the Baltic Sea was initiated in the winter 2007, but only parts of the area were covered that year due to weather conditions.

There are no concluding report yet published concerning the breeding populations of the fourteen species, however information could possibly be gained from different ongoing projects. Researchers at the University of Lund for example, collect information from local and regional sources to create a database from which it should be possible to estimate the order of magnitude of breeding populations of bird species in Sweden. Corresponding work from coastal areas has been reported to the Swedish EPA (M. Green, unpublished).

3.1 The Baltic Sea as wintering area for bird species threatened by oil spills

Table 1 shows the estimated population totals for the Swedish parts of the Baltic Sea, the entire Baltic Sea and NW Europe, respectively. The population numbers in the Baltic Sea are related to the numbers in NW Europe.

Table 1. Estimated wintering numbers of some seabirds in the Baltic Sea in the 1992/93 inventory (Durinck et al. 1994) as compared to the total populations in NW Europe.

Bird species	Sweden	Baltic Sea	Total NW Europe	Baltic Sea percentage (%)
Black-throated and Red-throated Divers	2 195	57 000	110 000	51.5
Great Crested Grebe	615	11 325	100 000	11.3
Red-necked Grebe	+	5 500	15 000	36.7
Slavonian Grebe	+	1 830	5 000	36.6
Black-necked Grebe	Not reported			
Long-tailed Duck	1 525 400	4 270 000	4 700 000	90.9
Steller's Eider	50	6 845	15 000	45.0
Common Eider	7 120	1 050 000	3 000 000	34.9
Velvet Scoter	5 530	932 000	1 300 000	93.3
Common Scoter	400	783 000	1 000 000	78.3
Red-breasted Merganser	5 200	44 300	100 000	44.3
Guillemot	15 000	85 900	8 300 000	0.8
Razorbill	20 000	156 000	1 200 000	13.0
Black guillemot	4 200	27 310	50 000	54.6

Table 2 shows counts of five bird species wintering at sea in different parts of the Baltic Sea surrounding southern Sweden, i.e. the areas covered in the 2007 inventory. Due to bad flying conditions in the winter 2007 only parts of the planned total inventory could be conducted.

Table 2. Estimated numbers of wintering sea ducks (including Common Scoter) in different off-shore areas along the Swedish coast surveyed in the winter 2007.

Area	Common Eider	Velvet Scoter	Common Scoter	Long-tailed Duck	Red-breasted Merganser	Total
North Öland banks	2 300	0	0	11 000	20	13 330
East Öland	1 500	1 850	3 220	19 000	280	25 850
Kalmarsund	1 450	870	20 640	23 000	920	46 880
Blekinge outer	450	0	0	300	30	780
Hanöbukten	1 100	3240	13 500	23 000	230	41 070
South coast of Scania	300	10	560	2 200	200	3 270
SW Scania	10 500	180	2 100	1 700	2 600	17 080
Total	**17 600**	**6 150**	**40 030**	**80 200**	**4 280**	**148 260**

As Table 1 and 2 cover different areas and the 2007 survey only covered parts of the area, the tables cannot be directly compared. The area covered in the survey 2007 is shown in Figure 2.

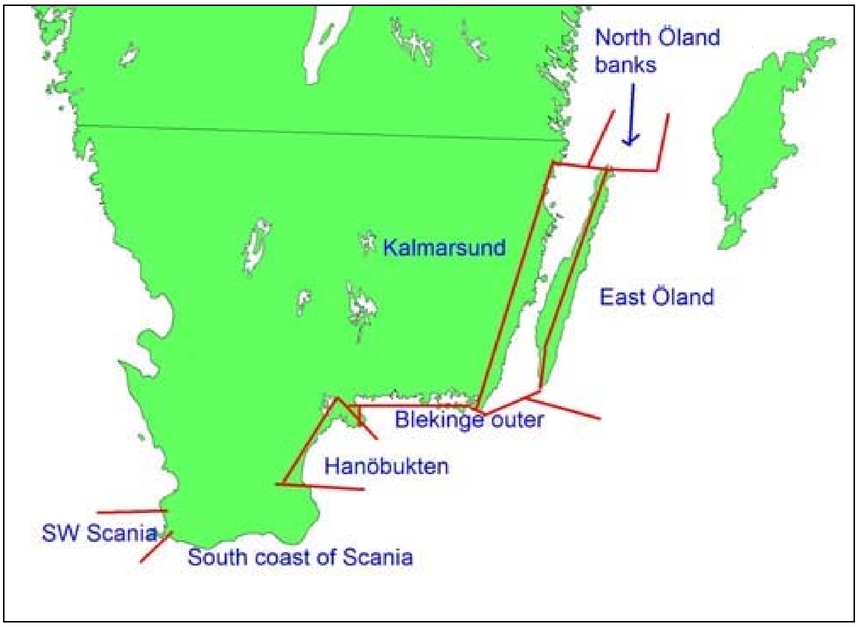

Figure 2 Map showing coastal areas in southern Sweden in the survey of sea ducks 2007

Nevertheless, the partial survey in 2007 shows much higher totals for both Common Eider and Common Scoter than the total survey in 1992-93. In Common Eider this partly reflects the restricted distribution of the species in the Swedish part of the Baltic Sea during the winter. Almost the entire winter range in the Baltic proper was covered in 2007. Moreover, the ship used in 1992 and 1993 could not cover all important areas for the species due to its deep-reaching. The general trend for this species in NW Europe is an increase to a peak in the 1990s followed by a marked decrease (Desholm et al. 2002). For the Common Scoter there has been a marked change in distribution in the period between the two surveys, large flocks having established a wintering tradition in Swedish waters recently (Nilsson, Green 2007).

3.1.1 Black-throated Diver *Gavia arctica* & Red-throated Diver *Gavia stellata*

Both species of divers breed in Swedish inland waters. The breeding populations in Sweden are estimated at 1 600 for Red-throated and 6 100 for Black-throated Diver. The two species are not easily separated in the field during winter inventories, especially when surveyed by boat or aeroplane. Most of the divers were found in other parts of the Baltic Sea (Figure 3), only ca. 2 000 of the estimated 5 700 wintering divers were found in Swedish waters, distributed in Kattegatt 760, S Kalmarsund 55, E of Gotland 970 and southern Midsjöbanken 170.

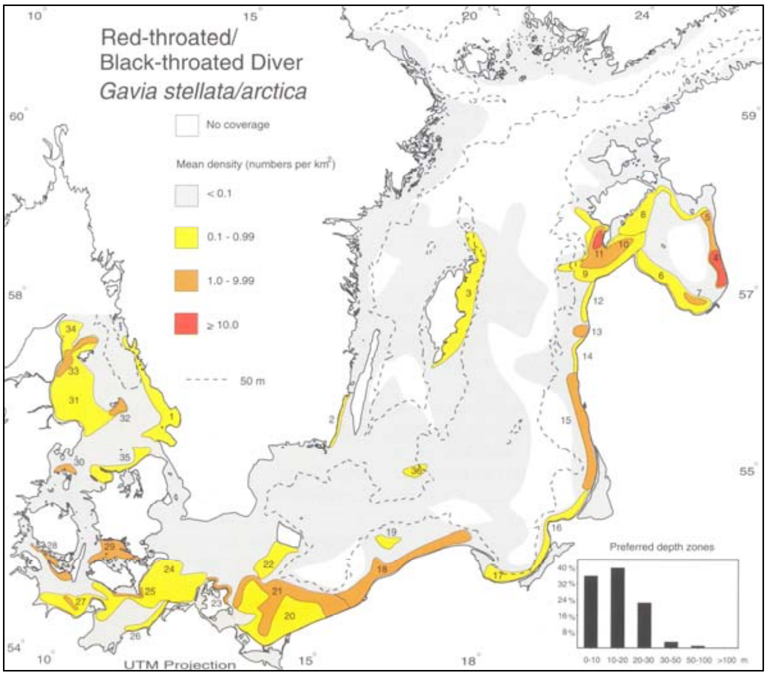

Figure 3. Winter distribution of Black-throated Diver and Red-throated Diver in the Baltic Sea in the complete inventory 1992/93 (Durinck et al. 1994).

In the second planned inventory of the Baltic Sea from 2007 only parts of the area could be surveyed. The other parts will be surveyed in 2009. Important movements of divers have been observed along the Swedish coast and gatherings of resting divers have been recorded at different shallow areas of the Baltic Sea, however details are still poorly known. Hopefully this knowledge will increase by the planned inventory of open sea areas.

3.1.2 Great Crested Grebe *Podiceps cristatus*

The breeding Swedish population of Great Crested Grebe has been estimated at about 20 000 pairs. No accurate estimate of numbers of breeding pairs in coastal areas exists, but the species breeds in the inner bays of the archipelagos along the whole Swedish coastline. The number of wintering grebes in the Baltic area was calculated at 11 300 individuals in the main survey in 1992/93, of which 615 were estimated in two Swedish areas: Lundåkrabukten with 500 and Blekinge archipelago with about 115 individuals (Figure 4).

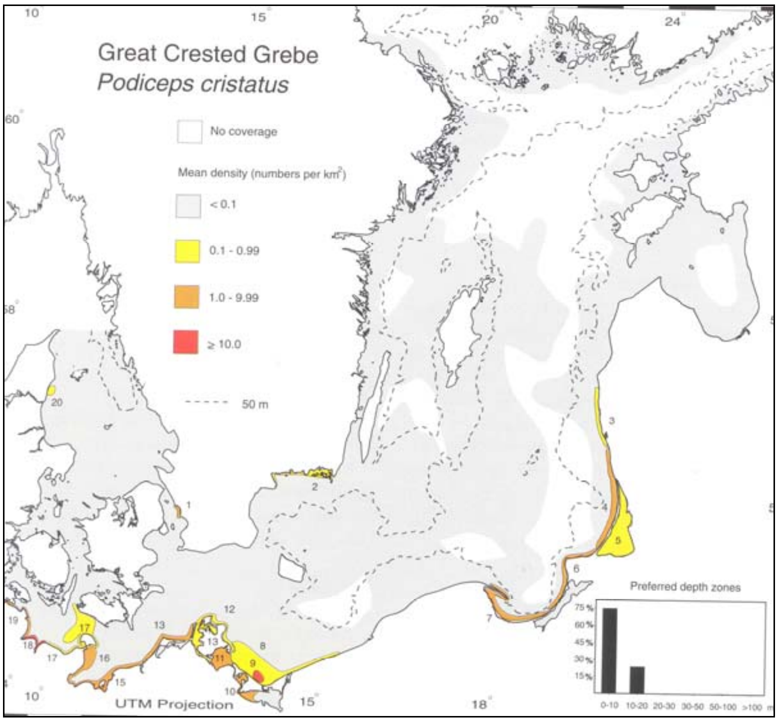

Figure 4. Winter distribution of Great Crested Grebe in the Baltic Sea in the complete inventory 1992/93 (Durinck et al. 1994).

Considerable changes in distribution and numbers have been observed in recent years (Nilsson 2008a). In the latest nationwide survey of coastal areas (covering most of wintering distribution of the species), the Swedish wintering population was calculated at 5 000 individuals. The increase occurred mainly during the last 15 years. The majority of wintering Great Crested Grebes were observed along the coasts from Öresund to Blekinge and some localities outside Öland and Gotland (Figure 5). It is still unknown whether there is a corresponding increase in other parts of the Baltic Sea area. The grebes migrate along the Swedish Coast, but locations of important resting areas are not known.

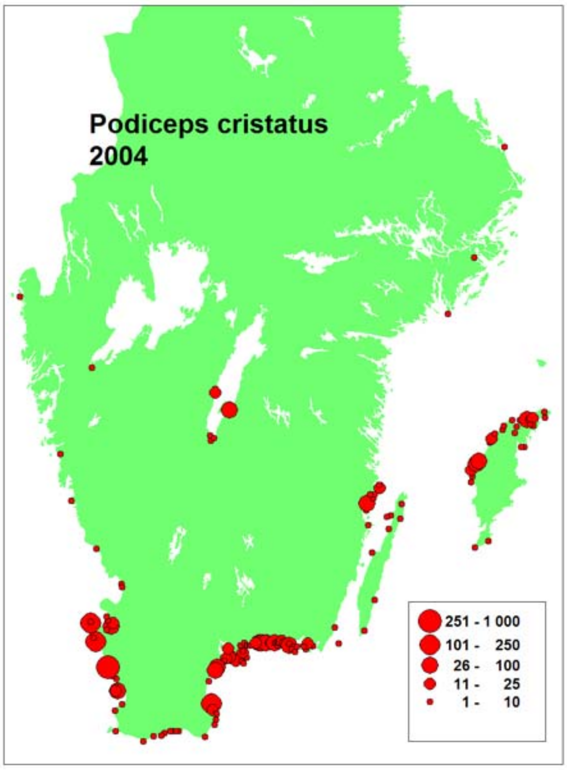

Figure 5. Winter distribution of Great Crested Grebe in Swedish coastal areas in 2004.

3.1.3 Red-necked Grebe *Podiceps grisegena*

The Red-necked Grebe breeds sparingly along the northern Swedish coast from Ångermanland to Norrbotten, in shallow coastal bays with rich vegetation and in eutrophic lakes. It also breeds in lakes in southern Sweden. The total population is calculated at 960 breeding pairs with a considerable population along the coasts of Västerbotten and Norrbotten.

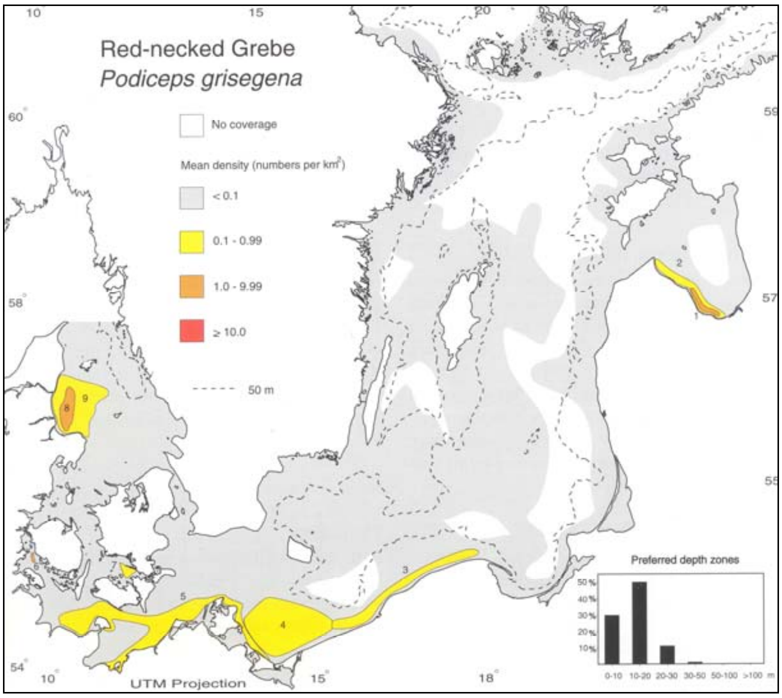

Figure 6. Winter distribution of Red-necked Grebe in the Baltic Sea in the complete inventory 1992/93 (Durinck et al. 1994).

In the Baltic Sea inventory in 1992/93 the winter population was calculated at approximately 5 500 individuals; no concentrations were found in Swedish waters. Two more important areas were identified outside of Swedish waters: western Kattegatt and the Pomeranian Bay (Figure 6). In the latest nationwide survey of Swedish waters about 50 individuals were counted, scattered along the Swedish coast.

Migration of Red-necked Grebes occurs along the Swedish coast, e.g. through Kalmarsund, but concentrations of great numbers of resting birds are unknown.

3.1.4 Slavonian Grebe *Podiceps auritus*

The Swedish breeding population of Slavonian Grebe is approximately 1 200 pairs distributed mainly in the eastern parts of the country. It is predominantly an inland water inhabitant. In the Baltic Sea inventory in 1992/93 the winter population was calculated at about 1 800 individuals; no observations in Swedish parts of the area (Figure 7). In the latest nationwide survey 2004 about 80 individuals were counted, scattered along the Swedish coasts of the Baltic Sea.

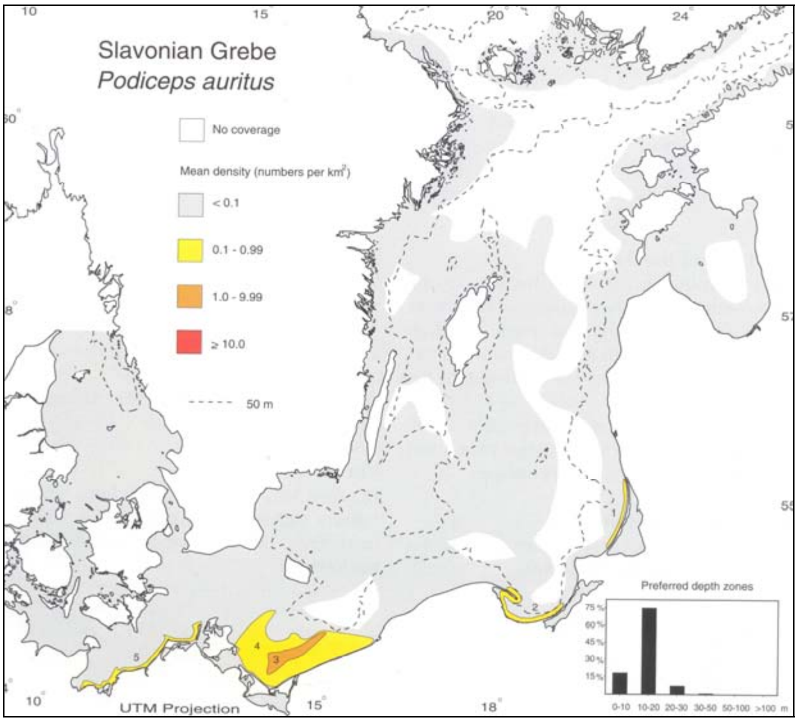

Figure 7. Winter distribution of Slavonian Grebe in the Baltic Sea in the complete inventory 1992/93 (Durinck et al. 1994).

3.1.5 Black-necked Grebe *Podiceps nigricollis*

Approximately 60 pairs of the Black-necked Grebe breed in Hornborgasjön, although breeding has also been observed at some inland localities in certain years. Data on wintering birds in the Baltic Sea area are not known. In the Swedish surveys the species has been observed at some occasions.

3.1.6 Long-tailed Duck *Clangula hyemalis*

The Long-tailed Duck is the dominate species wintering in the open sea area of the Baltic Sea (Figure 8). In the 1992/93 inventory the total population was estimated at about 4.2 million individuals, which is the absolute majority of the total breeding population in Europe and considerable parts of Western Asia. Approximately one third of this population was found in Swedish waters with Hoburgs bank being the most concentrated area with an estimated population of 925 000 individuals at that time (Figure 10).

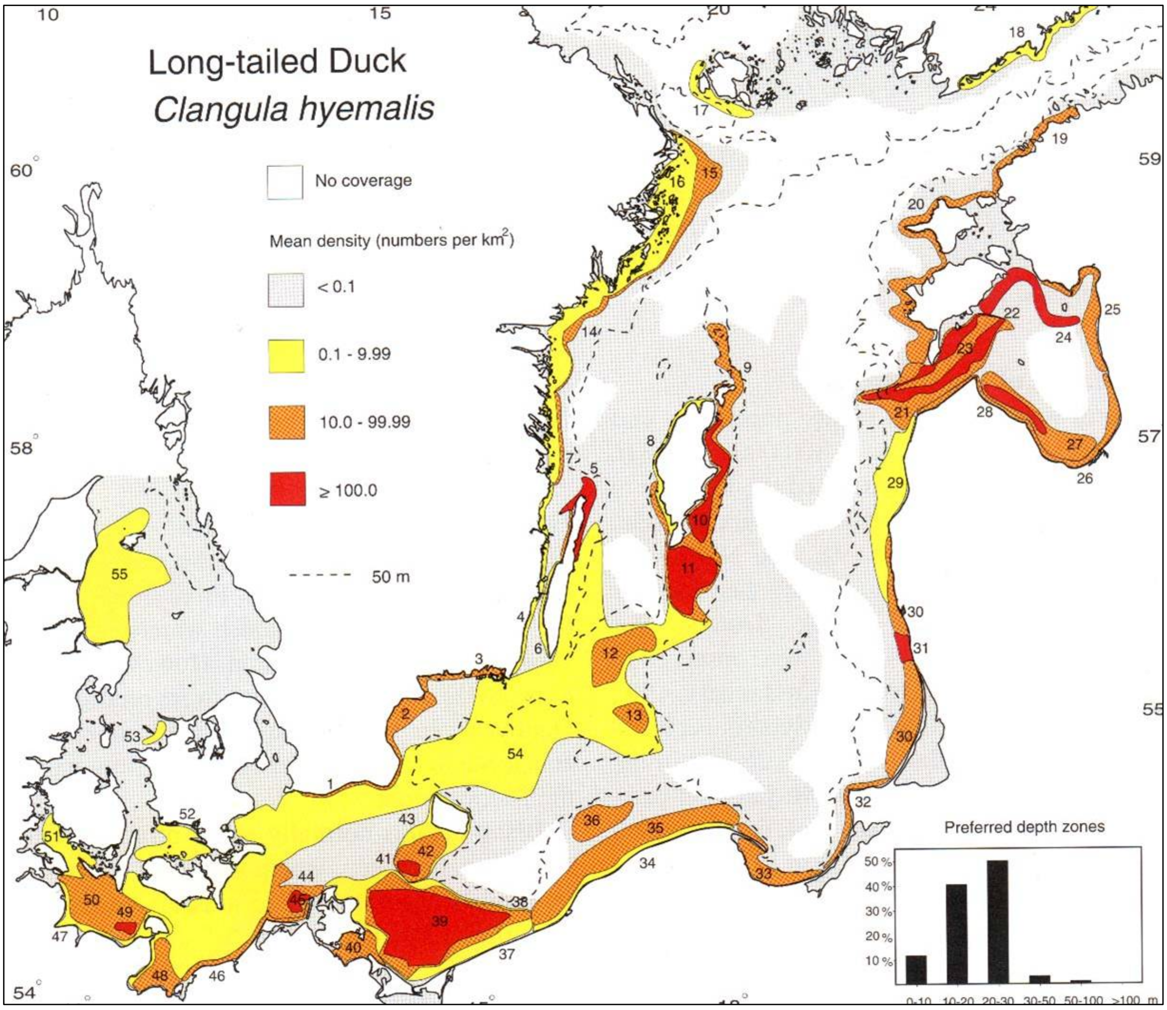

Figure 8. Winter distribution of Long-tailed Duck in the Baltic Sea in the complete inventory 1992/93 (Durinck et al. 1994).

The 2007 winter inventory (Table 2) only covered parts of this area. Important areas that were counted in the 2007 inventory and earlier inventories were the waters around Öland and Hanöbukten, which were also included in the inventories in the 1970s. In these areas the winter populations of Long-tailed Duck have decreased to less than half between the survey occasions (Figure 9). Comparable data are not available from other main Swedish coastal areas.

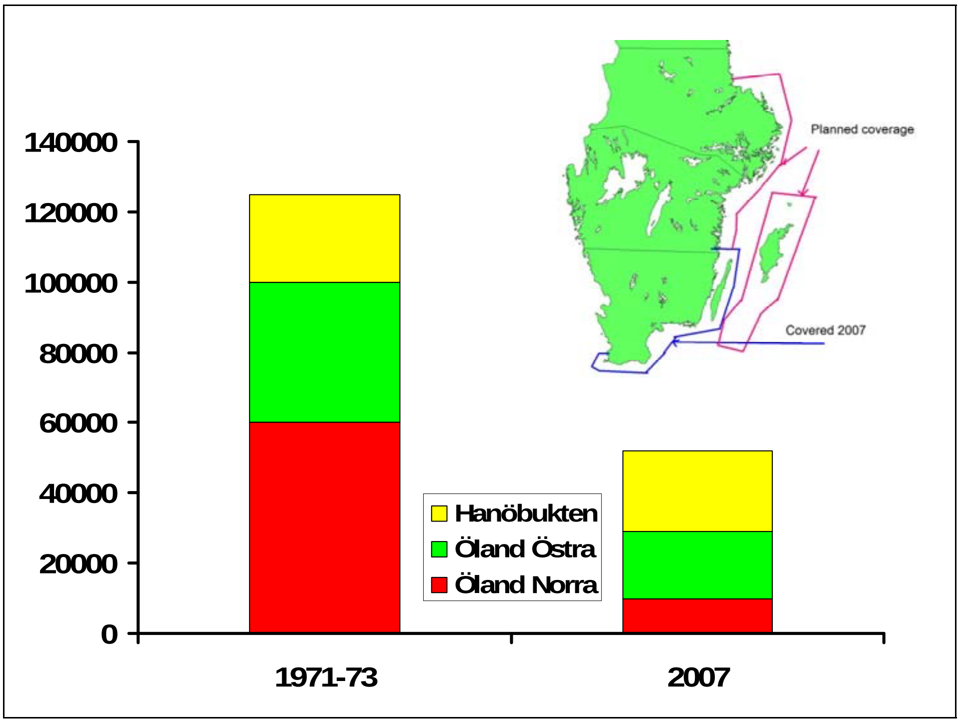

Figure 9. Population numbers of Long-tailed Duck in important wintering regions in covering surveys 1971-73 and 2007.

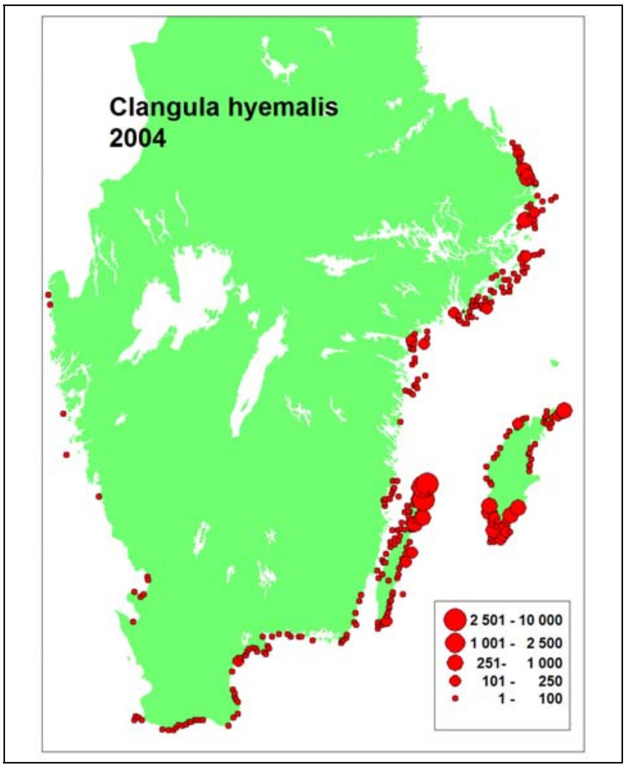

Figure 10. Winter distribution of Long-tailed Duck in the nationwide inventories of coastal areas in Sweden 2004. Note that the most important parts are the outer coastal areas.

Decreasing population trends have been observed in the numbers of wintering Long-tailed Ducks both along the Swedish south coast and along other coastal areas. Similarly decreasing trends have been noted both during autumn and spring, in numbers of migrating birds in the Finnish Bay, where most birds pass on their route to and from the Baltic Sea. All data indicate apparent decreases in numbers of Long-tailed Ducks in the Baltic Sea, but a more precise analysis is still missing.

3.1.7 Steller's Eider *Polysticta stelleri*

Two main distribution areas were observed along the coasts of Estonia – Lithuania (Figure 11), with the largest flock at Saarema with 5 760 individuals. In all of Sweden 50 individuals were observed. During the more recent winters, the numbers along the Swedish coasts have decreased considerably; only singles have been observed.

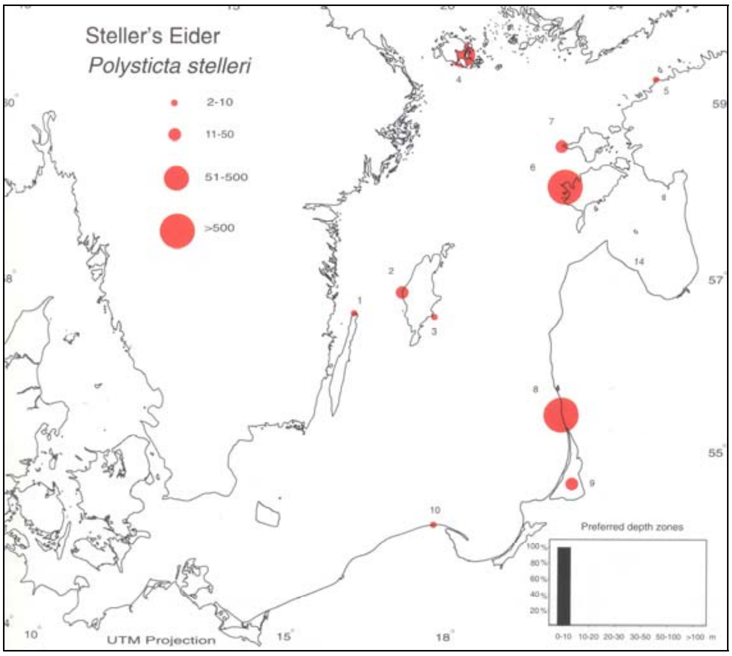

Figure 11. Winter distribution of Steller's Eider in the Baltic Sea in the complete inventory 1992/93 (Durinck et al. 1994).

3.1.8 Velvet Scoter *Melanitta fusca*

The Velvet Scoter breeds in the high mountains and in the lowland lakes close to this area, as well as in the archipelagos of the Baltic Sea.

The total breeding population in Sweden is estimated at 11 000 pairs of which 8 000 breed along the coasts (M. Green pers. commun.).

According to Å. Andersson (pers. commun.) the population in the Stockholm archipelago is considered to have decreased from about 7 700 pairs in the 1970s to less than 1 000 pairs in the latest years. On the other hand, some increase has been observed along the coasts of Norrland. The population along the coast of Västerbotten is probably the densest with some thousands of pairs.

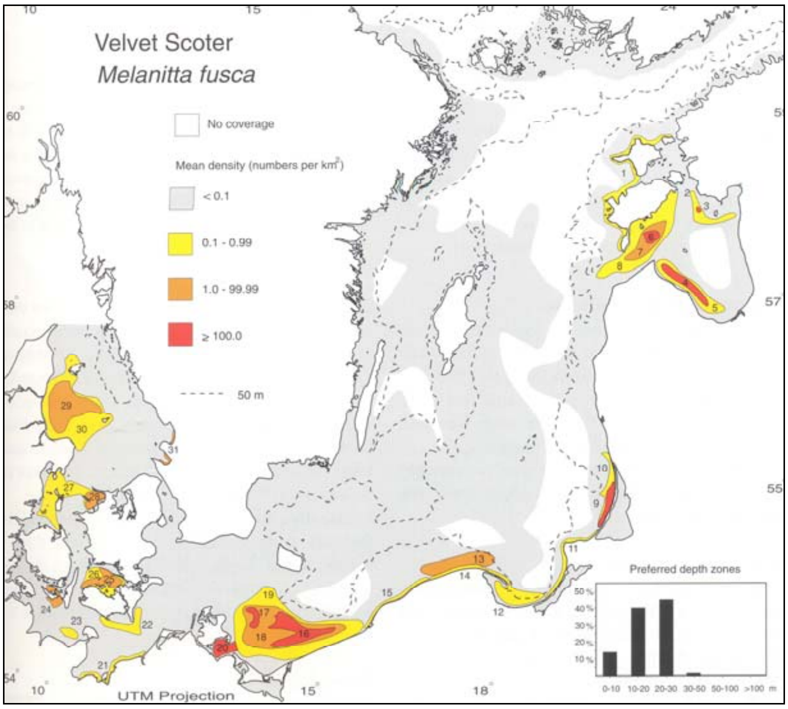

Figure 12. Winter distribution of Velvet Scoter in the Baltic Sea in the complete inventory 1992/93 (Durinck et al. 1994).

In the winter great numbers of Velvet Scoters are found in the greater Baltic Sea area (including Kattegatt) with an estimated number in 1992-93 of 932 000 individuals. The greatest numbers were observed in the Riga Bay and the Pomeranian Bay, while the population in Swedish waters was calculated at 730, with small numbers in Skälderviken and Laholmsbukten (Figure 12).

The winter distribution of Velvet Scoter is not easily surveyed in land-based inventories (as shown in Figure 13). In the inventory in the winter 2007 the population number was calculated at about 6 000 individuals in the areas east of Öland and in Hanöbukten, but from the land only small numbers were observed.

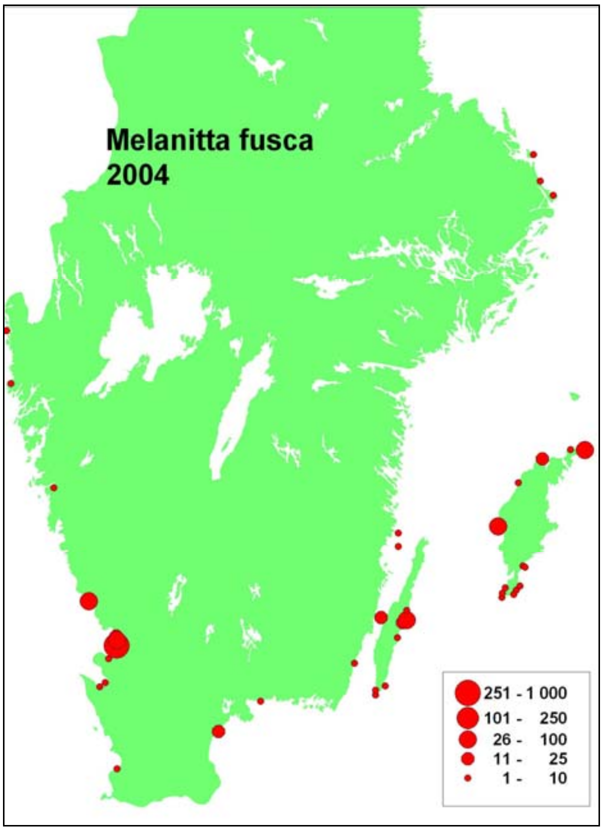

Figure 13. Distribution of Velvet Scoter in the complete midwinter inventory 2004.

3.1.9 Common Eider *Somateria mollissima*

The Common Eider is the most important breeding duck species in the Baltic Sea. The Swedish breeding population was estimated at about 170 000 pairs in the 1970s, increasing to about 270 000 pairs in the middle of the 1980s (Desholm et al. 2002). The increase probably continued to the mid 1990s, but more accurate data are lacking except for in limited areas. In later years the population of the Common Eider has in general decreased and the breeding population along the Swedish coasts is calculated at about 210 000 pairs (M. Green pers. commun.). The decrease in the NW European population of Common Eider was observed in the latter years of the 1990s, when the numbers in the midwinter counts in the important Danish wintering areas decreased drastically. A survey of the recent populations of Common Eider in different countries was presented on a work-shop in Estonia 2002 (Desholm et al. 2002).

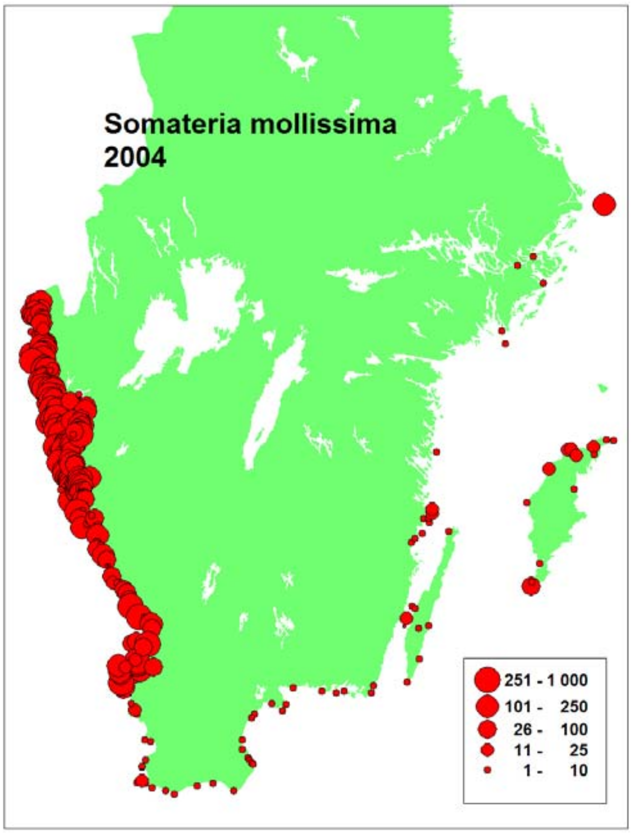

Figure 14. Distribution of Common Eider in the covering midwinter survey 2004.

Apart from many other open sea dwelling diving ducks, the Common Eider is predominantly distributed in inner coastal waters so ordinary midwinter counts present a rather fair estimate of the occurrence of the species. In the latest inventory in 2004 about 36 000 individuals were counted in Bohuslän, while another 10 000 individuals were counted along the coasts from Halland to Kalmar län, including Gotland. In these parts of the country more individuals should be expected to winter here, but a great number winter outside Sweden in the SW parts of the Baltic Sea and in Kattegatt (Figure 15 and Figure 15).

In the main inventories of the Baltic Sea in 1992/93 the Common Eider population in the area including Kattegatt was counted at about 1 048 000 individuals. This number has decreased considerably. In this population number, less than 7 000 individuals were counted in Swedish waters (note that the important Swedish winter population in Bohuslän was not included in the surveyed area).

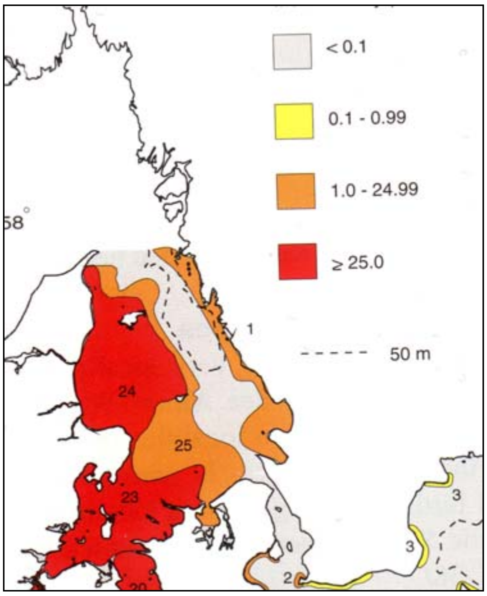

Figure 15. Winter distribution of Common Eider in Kattegatt and the Danish straits in the complete inventory 1992/93 (Durinck et al. 1994).

3.1.10 Red-breasted Merganser *Mergus serrator*

The Red-breasted Merganser is distributed in most parts of the country. The total breeding population is calculated at about 15 000 pairs, of which approximately 10 000 pairs are estimated to be breeding in the coastal areas (M. Green, pers. commun.).

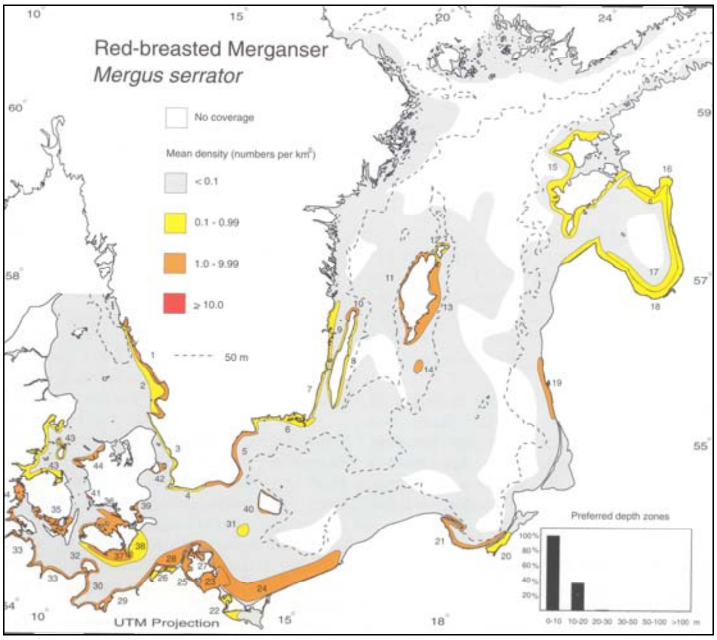

Figure 16. Winter distribution of Red-breasted Merganser in the Baltic Sea in the complete inventory 1992/93).

The population of wintering Red-breasted Merganser in the Baltic Sea area was counted in the main inventory of the area in 1992/93 at about 44 000 individuals in the whole Baltic Sea area. The main distribution of the species was in the SW part of the Baltic Sea and around Gotland, but the birds were normally not as concentrated to certain areas as with many other sea-dwelling diving ducks (Figure 17 and Figure 17). At that occasion the Swedish wintering population was calculated at about 5 000 individuals as compared to 6 000 individuals in the main survey in 2004, but the national midwinter counts in Sweden has shown a significantly increasing trend over the years (Nilsson 2008b). Recent surveys in SW Sweden (Nilsson unpublished) indicate that the population in this area can be substantially higher than this.

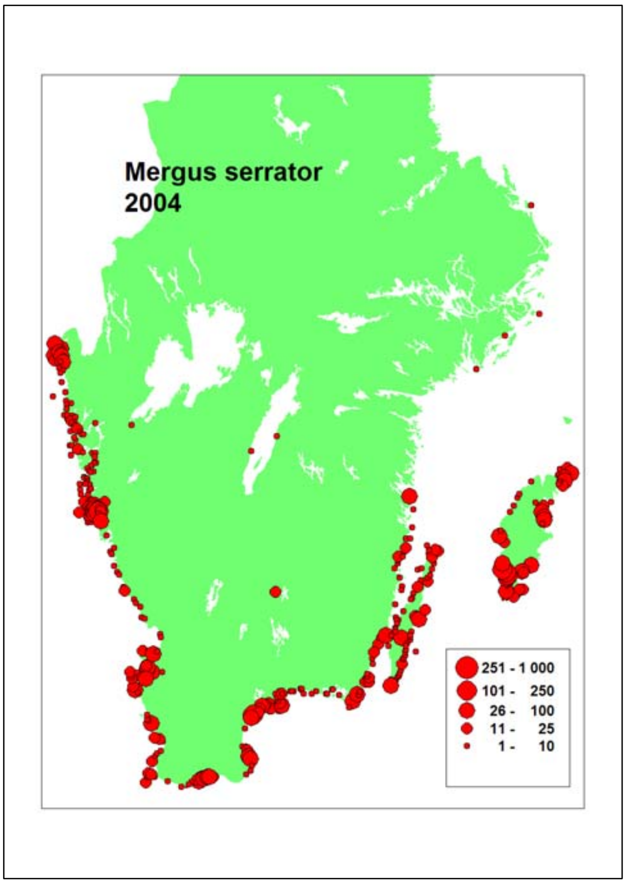

Figure 17. Distribution of Red-breasted Merganser in the complete survey of inner coastal areas in the winter 2004.

3.1.11 Guillemot *Uria aalge*

The current breeding population of Guillemot in Swedish waters is calculated at about 11 000 pairs. The main colonies are found on Stora Karlsö and Lilla Karlsö, where up to 9 000 pairs have been counted in some years. Other important colonies are found in Södermanland and the island Bonden in Ångermanland with more than 1 000 pairs each. Another greater colony is found on the Danish island Graesholmen outside Bornholm. Its breeding population was estimated at about 2 500 pairs around year 2000.

Data of the open sea distribution in the Baltic Sea is mainly limited to the main survey in 1992/93 (Figure 18). The species is distributed all over the Baltic Sea with a certain concentration (in the winter counts) in the areas surrounding the southernmost colonies. In the winter Guillemots are distributed over a considerable area in the central parts of the Baltic Sea. It is noteworthy that the Baltic Sea population of Guillemots, which includes yearlings, should number about 45 000 individuals in total, and is well separated from the greater population on the Swedish west coast. Kattegatt is invaded each late autumn and winter by a considerable number of Guillemots (cfr. Figure 18).

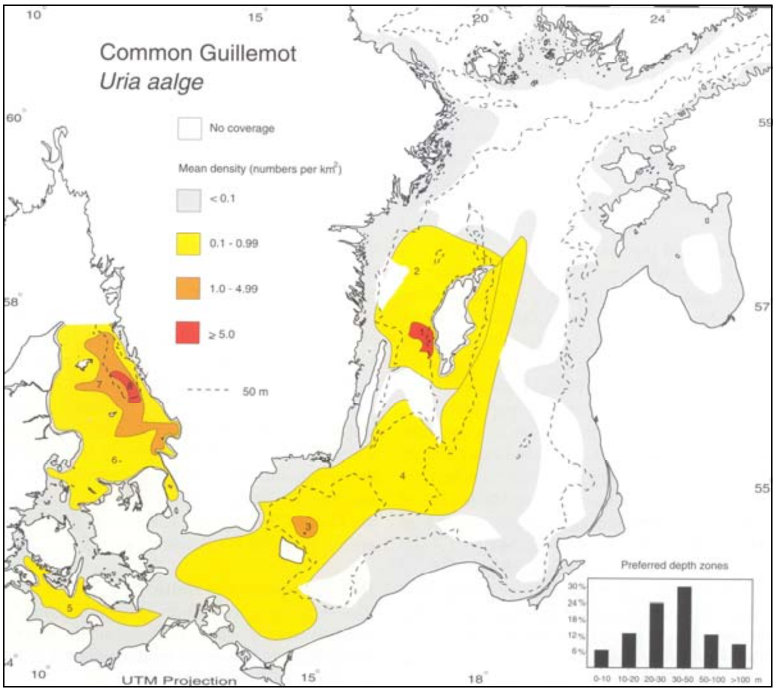

Figure 18. Winter distribution of Guillemot in the Baltic Sea in the complete inventory 1992/93 (Durinck et al. 1994).

3.1.12 Razorbill *Alca torda*

The breeding population of Razorbill along the Swedish coast is estimated at about 23 000 pairs. The main colonies are found on Karlsöarna with about 6 000 pairs. Aside from those, there are important colonies along the archipelagoes of the Swedish east coast, namely the archipelagoes of Södermanland and Stockholm and in Ångermanland and Västerbotten. Furthermore, some thousands of pairs of Razorbill are breeding in Finland, while the colony on Graesholm outside Bornholm counts about 600 – 750 pairs. The Razorbill population in the Baltic Sea should have increased since the beginning of the 20th century, when the total population was estimated at 15 000 pairs, corresponding to at least 45 000 individuals in the winter population. The present winter population should count more than 60 000 individuals.

The winter population of Razorbill was widely distributed in the central parts of the Baltic Sea, with concentrations in an area west of Gotland and another outside the Riga Bay (Figure 19). Probably only small numbers of the population migrate to Kattegatt.

During some years considerable parts of the NE Atlantic population of Razorbill are found on the shallow areas of Kattegatt, which constitutes a very important wintering area for the species with about 120 000 individuals counted in the main survey 1992/93. These Razorbills are mostly separated from the Razorbills in the Baltic proper.

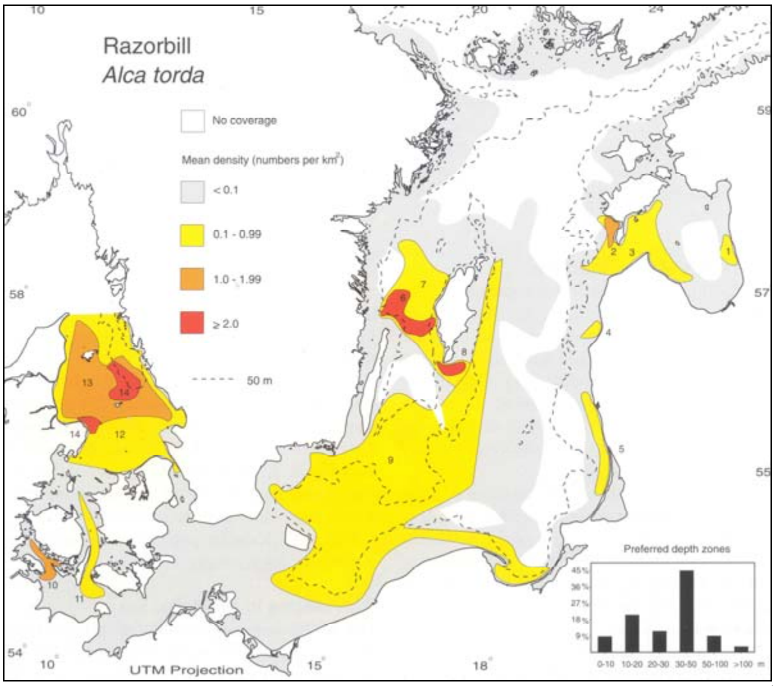

Figure 19. Winter distribution of Razorbill in the Baltic Sea in the complete inventory 1992/93 (Durinck et al. 1994).

3.1.13 Black Guillemot *Cepphus grylle*

The total Swedish coastal population of Black Guillemot is estimated at 11 000 pairs (M. Green pers. commun.). Probably 950 pairs are breeding in the Swedish Westcoast, the rest distributed in the archipelagos of the east coast, where the Stockholm archipelago is dominating the southern part of the distribution area. A considerable number of breeding Black Guillemots are found in Västerbotten and Ångermanland.

Besides the Swedish population at least 5 000 pairs probably breed along the Finnish coasts. In the Danish part of Kattegatt about 800 pairs were breeding at the beginning of the 1990s.

Altogether the breeding population in the Baltic Sea including Kattegatt numbers at about 50 000 individuals.

In the winters the Black Guillemot is found in a number of areas, but especially in the southern part of the Baltic Sea (Figure 20), where the waters around Midsjöbankarna and east and south of Gotland are important areas as well as the German and Polish coasts.

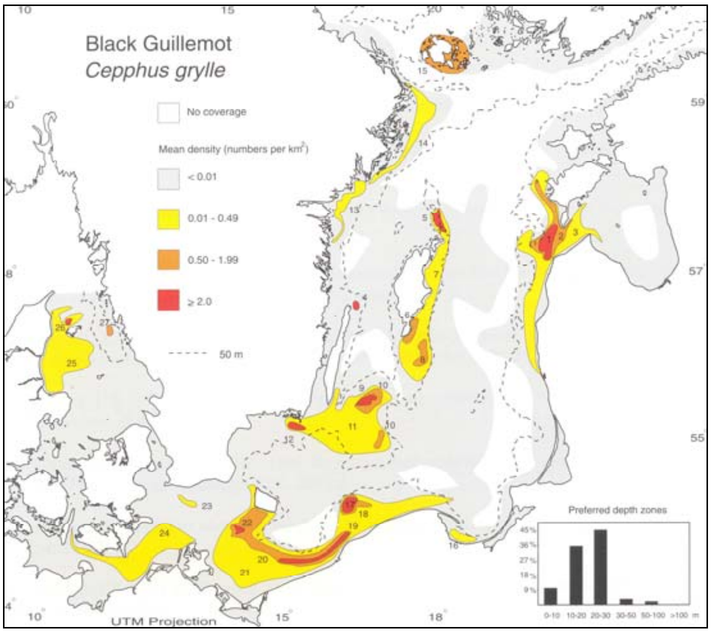

Figure 20. Distribution of Black Guillemot in the Baltic Sea in the complete winter inventory 1992/93 (Durinck et al. 1994).

4 The Swedish capacity for cleaning oiled birds

In Sweden, very little attention was paid to wildlife rehabilitation before 1979 when a centre was opened in Kristianstad, Skåne. Further centres have been established and in most cases societies have been founded to take responsibility for their operations. In 1997 the national Swedish Wildlife Rehabilitators Association (KFV:s Riksförbund, SWRA) was founded.

At present, only the coast of Skåne is well equipped with eight small centres belonging to SWRA along some 300 km of coastline. Most of the remaining 33 centres in Sweden are also situated close to the coast, but they are unevenly distributed along the 160000 km of Swedish coastline. The goal is to establish a cover along the whole Swedish coastline similar to the Skåne model, but since the expansion of the SWRA centres is funded through donations, the development is, by necessity, slow.

At present there are about 200 persons in Skåne, 30 – 40 in Gothenburg and about ten from Djurens Rätt in Stockholm with experience of cleaning oiled birds. This part of the organization is currently becoming better organized and experienced through cooperation with the Svenska Blå Stjärnan. There is also cooperation within the area between Sweden, Finland and Estonia. Swedish wildlife rehabilitators are, and have been, taught from the more experienced wildlife rehabilitation organisations as the IBRRC and Tri-State in the USA and the RSPCA in England. Such teaching is facilitated by the Sea Alarm Foundation.

Today, 41 mainly small wildlife rehabilitation centres are members of the SWRA, of these 10-15 have particular experience treating oiled birds. Three of the centres have experience treating hundreds of oiled birds but none are experienced to deal with a major incident where several thousand casualties may need to be dealt with, since no such accident has occurred in Swedish waters. The capacity is very much dependent on which part of the Swedish coast is affected. In the case of a large spill cooperation is necessary and temporary facilities have to be built close to the affected area. If the spill is situated far away from existing centres it could take up to 48 hours to get an effective organisation established.

The current organisation is unlikely to treat more than 10 000 birds and such an operation would require assistance from abroad. It is not possible to collect all birds during an oil spill, although a majority of the birds can be captured during a local offshore oil spill. During an oil spill at sea, it is estimated that probably only 10 % of the affected birds are recovered for rehabilitation. To increase the capacity and the capability of effectively dealing with a major oil incident, there has to be an interest and will of the responsible authorities to act. For example, to be able to capture more birds off shore, there has to be increased access to small boats. Individuals also have to be educated in the means of capturing and handling oiled wildlife. Training between responsible authorities, such as the Coast Guard and SWRA is necessary and should be seen as a priority.

The oil industry has developed "The Tiered Response" depending on the degree and severity of individual oil incidents (IPIECA 2004). Such a classification guides all involved in the response to act most efficiently and effectively. The levels are:

Tier 1: A situation that will only have local impact and require only local resources. The response strategy should be well-defined and documented.

Tier 2: A situation that has national significance. The response strategy will need to be aligned/developed according to national policy/regulations.

Tier 3: A situation that has international significance. The response strategy will need intergovernmental and additional experience will be required to deal with casualties.

(from IPIECA 2004).

At present the only site capable of dealing with a Tier 2 response is Skåne. In Skåne there are eight cooperating rehabilitation centres with an oil directorate, a regional organisation, personnel for capture and transportation, bird minders and a base organisation. The current capacity is 1000 birds. These numbers can be effectively dealt with at the existing facilities, but will probably require some additional support.

It is difficult to determine precisely when an accident requires a Tier 3 response. In Skåne, an estimate would be that the accident should be classified as Tier 3 if 3000 oiled birds are collected. For the rest of Sweden, except for perhaps in the Gothenburg region, the limit for a Tier 3 response might be 1000 collected oiled birds. During a Tier 3 response, the national capacity is not likely capable of dealing with that many oiled birds. International assistance from the Sea Alarm Foundation in Brussels has to be called upon for help by experienced individuals.

5 Criteria for cleaning oiled birds

Preparedness is the keyword for a successful oiled wildlife response. Because Sweden has a climate which only allows outdoor facilities during the summer, it is necessary to have a wildlife rehabilitation centre as close as possible to an oil spill, so that at least in the initial stages of a response they are able to take care of the first victims of the spill. An evaluation of each operation is necessary to improve the preparedness for the next event.

5.1 Rehabilitation procedure

The following brief description of the procedures used after an oil spill affecting wildlife has been taken from a compendium in wildlife rehabilitation used in the training of future wildlife rehabilitators and first aiders within the SWRA (Hammarberg & Hillarp 2008). The compendium is based on a previous edition also including information from other sources (Anon 1997, Andersson & Walter 2005, Nijkamp 2006, Jokinen 2006). The procedure of oil rehabilitation is described below (Table 3).

Table 3. Brief description of rehabilitation procedures after oiling of birds.

Phase	Description
Capture	• The birds are captured close to oil spill
Rest	• The birds have a few hours rest
Triage	• During the whole procedure the ability to go back to a life in the wild and reproduction is evaluated • Those not fit for further treatment or release will be euthanized
Transportation	• Transportation to temporary treatment
Banding	• The birds are temporarily banded and registered
Stabilization	• If needed, birds are treated with barium sulphate to bind and transport oil in the body • Fluid therapy • Medication • Prioritizing is performed during the course of stabilization. There is a set of criteria for euthanasia • Euthanasia executed according regulations of the Swedish Board of Agriculture
Rest	• After stabilization, the birds rest for 24 hours
Triage	• A second triage is performed with the help of blood tests performed by a veterinarian
Cleaning	• Cleaning and rinsing
Rest	• 12 hour rest
Flotation test	• The birds are tested in a pool
Rehabilitation	• Birds are kept under surveillance in pools or in cage in natural waters • The birds are rehabilitated during 1-3 weeks • Birds with deteriorating health are culled
Release	• The birds are released after weighing, inspection and ringing according to the ringing department of the Swedish Museum of Natural History • The birds are released to there capturing location unless this is still contaminated

Careful records are kept of birds that are treated for oil contamination: date and location of oil contamination, reason for oil spill, species, sex, age, date and location for release, if dead or euthanized. Treated birds are banded as a part of the treatment protocol.

5.2 Resources

5.2.1 Time

The time needed to rehabilitate heavily oiled birds, is up to three weeks. For birds with less oiling the time is normally about five weeks since they often suffer from secondary effects of the oiling as dehydration, malnutrition and infections. This is because they usually can not be caught until their condition has deteriorated. As the birds have to be in good condition before the washing it is absolutely necessary to rehydrate, feed and stop infections. The heavily oiled birds are often in good condition under the oil and therefore demand less time.

5.2.2 Facility and equipment requirements

Facility and equipment requirements are well described in the literature, and summaries can be found in sources such as IPIECA (2004). The most important requirements of an oiled bird rehabilitation facility are space, ventilation, water and electricity. Equipment should support the protocols that are used, but normally include suitable pens (900 x 900 mm, which can hold one swan or one Canada Goose or two small geese or four Eider Ducks or five smaller ducks), washing equipment and pools for waterproofing and reconditioning.

Equipment consisting of four flight containers with specialised gear and consumables can be rented from the Oil Spill Response Ltd in Southampton (UK). The Finnish government has similar equipment, the mobile bird cleaning unit (BCU). Eastern Uusimaa Region Regional Rescue Services (IUPL) is responsible for the technical preparedness of the unit. IUPL sends sufficient technical personnel with the unit. WWF Finland upholds a pool of experts and volunteers to work with the unit. WWF Finland can also provide training for Swedish volunteers on site.

Other requirements are sanitary facilities for the personnel, rest rooms, possibilities to get food and drink and to keep records of the work.

5.2.3 Health and safety

Personal protection equipment (PPE) and health and safety training is important for staff and volunteers in order to be safe during an oil spill response. Appendix A shows a list of equipment for use by different personnel categories in the rehabilitation of oiled birds. When handling birds with long and sharp beaks, e.g., cormorants, divers, grebes, storks, herons, bitterns, gannets, and even tha small Water Rail, protective goggles or visors should be used.

5.2.4 Staff requirements

The cleaning staff consists of groups of five to seven individuals, where one person is in charge of two washing lines, each consisting of three to four wash-tubes and served by two cleaners, one to hold the bird, the other to do the cleaning (in the case of swans there will be three persons involved). With skilled personnel, good water quality and oil reacting to the detergent; the bird can be cleaned from the oil within 15 - 30 minutes. It is then rinsed for another 30 - 60 minutes. It is estimated that 60 people can clean and rinse about 100 birds in one day. Breaks are very important between birds as well as long rests between shifts. It is important to have stand-by personnel due to the very hard work and high capacity need.

People from all over often turn up to volunteer during an oil spill as experienced by the Fu Shan Hai and the Prestige accidents. Therefore there is a need for a volunteer telephone line where names, skills and phone numbers are registered so volunteers can be contacted when needed.

5.2.5 Cleaning requirements

For cleaning, each bird requires 600 - 1200 l of water at 42 °C. The concentration of $CaCO_3$ in the water should be within 40 - 60 ppm (Clumpner 1991, Holcomb 1993). A lower concentration will not remove the detergent (usually Yes©) and a higher concentration will leave $CaCO_3$ crystals on the feathers thus hindering the coat from becoming waterproof. The best places for cleaning birds are generally the hose cleaning facilities of larger rescue stations. The procedure is very stressful for the bird; therefore fluid therapy is given between the cleaning and rinsing. After washing and rinsing the birds need to dry for 12 hours indoors in a temperature kept at 30 - 35° C. Pools or cages with natural water are needed before release.

6 Previous experience of survival following rehabilitation

Oil contamination of seabirds has many effects on the bird population. If no measures are taken, the birds will most probably not survive even a small contamination since after extensive self-cleaning the insulating effect of the plumagae is damaged. The birds loose energy without possibility to compensate. In severe cases even the inner organs suffer from the oil toxicity, at least upon contamination with light oils. If the birds are rehabilitated, there are several ways to express survivability. First, the bird must survive treatment, which is expressed as the release rate after rehabilitation. Secondly, the bird has to survive after treatment and release, i.e. post-release or post rehabilitation survival. Together with the number of birds treated these two rates have a direct impact on the size of the population. But there are also indirect effects of oil contamination such as reduced breeding success of de-oiled birds that affect the population dynamics on a longer perspective.

The results on how birds respond to treatment and how they survive after treatment is in many senses contradictive, since both high and low post-survival and release rates have been recorded in the last decades. Much has happened in the last 10 – 15 years and experience has been gained from earlier cleaning operations. This means that knowledge about cleaning, handling and triage has improved. Despite this, there is still much to learn.

This chapter presents a summary of some of the results from earlier cleaning operations, both in Sweden and internationally. Survival during treatment and post treatment as well as experience of secondary effects after oiling is covered.

6.1 International experience

On the subject of release rate, Lindgren & Fejes (2003) quoted the International Bird Rescue Research Centre (IBRRC). In their appendix, release rates of nearly 100 rehabilitations from the 1970's until 2002 suggested an average release rate of 50 %. The data suggests there is a decreased release rate for a higher number of treated birds.

Internationally, several studies have been performed on survival rates of birds contaminated by oil spills. Some of the results from international operations are presented in Appendix B in more detail. Despite improvements in the field of rehabilitation during the last decades, it is difficult to draw a general conclusion of survival rates due to the many site-specific prerequisites (Russel et al. 2003). The IBRRC has listed 20 factors that contribute to survival rates of oil-affected birds (Appendix C), some examples include what sort of weather the birds are exposed to, if there are facilities for bird wash available and what numbers and what species are contaminated.

Sharp (1996) found efforts to rehabilitate oiled birds inefficient because of the low post-release survival rate. These results have been debated e.g. by Frink et al. (1996). Russel et al. (2003) found Sharp's conclusions "at minimum premature" and his analysis "to be far more conclusive than it is".

In a study on Little Penguins, Goldsworthy et al. (2000) found that the most important factor for survival was the extent of oiling which in turn affected the capture mass and general condition of the bird. Duration of rehabilitation and of transport after rehabilitation did not impose a threat on survivability.

Altwegg et al. (2008) reported high post-release survival of Cape Gannets, also concluding that several factors favour rehabilitation success in South Africa compared to the northern hemisphere. This may depend on behavioural differences between South African birds (Cape Gannet and Jackass Penguin) and species up north (e.g. Guillemots and Grebes) making them more resistant to stress. South African birds were also captured and released close to their breeding area, while migratory northern birds might become oiled far away and have to build up pre-migratory fat. This is one of the reasons why birds should be kept for a period after cleaning. Higher temperature in air and seawater may also favour rehabilitation in South Africa. Another factor favouring rehabilitation is the closeness of rehabilitation facilities to the bird colonies in South Africa. Hence, several factors of the IBRRC list are often met in South Africa, contributing to a high rate of survival.

It is difficult to determine post-release survival rates from band recoveries since there are such low encounter rates (Dunne, Miller 2007), which also has been experienced in Sweden.

Regarding secondary effects of oiling, a decreased fledging success compared to non-oiled birds has been reported for oiled Jackass Penguins (Barham et al. 2007) and reduced breeding has been reported for Brown Pelican (Anderson et al. 1996) although opposite results were obtained for Jackass Penguin in the report by Nel and Whittington (2003). However, the birds did not survive as well during periods of food shortage. Barham et al. (2007) also conclude that breeding is impaired after some spills, but not always. Reduced breeding for Jackass Penguin the first year after rehabilitation have also been reported by Wolfaardt (2007) after the Apollo Sea accident. The same results have been reported for Little Penguin (Giese et al. 2000) exposed at the Iron Baron oil spill. In this spill the overall breeding success recovered after the first year, although the fledging weight was lower for oiled birds compared to the control group.

There has been research performed on the Guillemot on the British Isles to determine the impact of climate and oil pollution on its population and demographics (Votier et al. 2005; 2008). These studies investigate the impact of four oil spills in Europe: Aegean Sea (1992), Sea Empress (1996), Erika (1999) and Prestige (2002). Population census data and capture-mark-recapture data was used to analyze the effects of birds in Wales and Ireland. In the study from 2005 the winter survival probability ranged between 87.9 and 97.5 %. The four lowest rates were experienced the winters after the four oil spills. What also affects survival is the North Atlantic oscillation, which is an index of oceanographic and climatic conditions. The later study from 2008 demonstrated that during these oil spill events, there was an increased recruitment from the group juveniles (0-3 years) to non-breeders (i.e. sexually immature birds, 4-6 years of age). The same effect was not demonstrated between non-breeders and breeders (>6 years), however there were not many recoveries of breeders. The authors suggest that recruitment of non-breeders can compensate for losses in the breeding population after oil spills. Camphuysen (2007) also quoted authors on the subject of age distribution among oiled birds, saying that non-breeders can form a buffer population towards the original breeding adults. These reports concerning compensation within the population does not address the survival after rehabilitation explicitly, but it enlightens the difficulty of assessing population impacts after oil spills of a seabird population with many non-breeding individuals.

Another important issue is how different age categories should be treated. Camphuysen (2007) concludes that when it comes to long-lived seabirds, it is advisable to treat adults rather than juveniles if a choice is to be made. This is because of the slow growth of these species that makes an adult more "valuable" to the population than a juvenile. It is statistically more probable that the adult will contribute more to the population than the juvenile.

Regarding differences between different species, high post-release survival has been reported for Cape Gannet (Altwegg et al. 2008), Jackass Penguin (Underhill et al. 2000), Canada Goose and Mallard (Dunne, Miller 2007) and Western Gull (Golightly et al. 2002). Newman et al. (2004) report high survival rates of Guillemot after the first month following rehabilitation. After this first period, de-oiled Guillemots survived as well and migrated as far as birds in the non-oiled control group. Lesser survival of oiled birds after rehabilitation than that of non-oiled birds has been reported for Brown Pelican (Anderson et al. 1996), American Coot (Anderson et al. 2000) and Little Penguin (Goldsworthy et al. 2000).

IBRRC concludes that it is not possible to extrapolate post-release survival between different species (Russel et al. 2003). This is due to the fact that birds have evolved during a long period of time and different species respond differently to changes in their environment and combinations of stressors such as oiling, capture and rehabilitation.

It is important to note that it is very difficult to determine the direct effects on seabird populations following an oil spill. This is because the long-term studies need to be in place beforehand at the breeding area of the population, even though the breeding area only indirectly is affected by the oil spill (Camphuysen, 2007). Reliable information about survival rates and affected age categories is therefore hard to obtain.

In summary, there have been both positive response from international experience with treatment operations, as well as criticisms concerning low survival and negative secondary population effects. The international experience is often concerned with Penguins. Since it is difficult to extrapolate between species (Russel et al. 2003) it is consequently difficult to draw a general conclusion on the survival of the Swedish species in this report. It is also worth noting that there have been a wide range of methods used, an aspect which obstructs comparison between the studies.

6.2 National experience

In the Baltic Sea area the overall survival rate should be measured after one winter and at the first reproduction occasion after the rehabilitation operations have taken place. The number of species threatened to oil spill varies over the year depending on season. In general, oil contamination in the winter is causing more severe problems than in the summer since birds are gathered in dense populations in localized areas in the winter. Food and resources are limited and temperature itself is a stress factor. Small amounts of oil contamination may be self-repaired if it occurs just before the moulting period in the summer.

The first large-scale operation to clean oiled birds in Sweden was in 1967 when 152 oiled Mute Swans (*Cygnus olor*) were caught at Stenungsund on the west coast of Sweden. 132 swans were successfully treated and released after three months (Mathiasson 1986).

Some experience has been gained from the Fågelcentralen rehabilitation centre at Kungälv (T. Järås, pers. commun.). 210 treated Guillemots were released after rehabilitation from 388 captured individuals. These birds belong mostly to the populations inhabiting the North Sea and Norwegian waters, but their survival rates upon rehabilitation may also represent the Baltic Guillemot population. Not all birds had been contaminated by oil prior to treatment: 147 were oiled, 54 wind-driven, two caught in fishing nets, another two hit by cars and for the residual six individuals no cause of injury had been registered. The lethality during the treatment was higher among weather-driven birds (56 %) as compared to oiled birds (40 %). 195 birds were banded before their release and 17 of these were later recovered (7 %). Three originally oil contaminated birds were found dead only some weeks after treatment in the vicinity of the release site. They were considered unsuccessful regarding survival after rehabilitation. The other recoveries were birds killed in circumstances that could not be related to survival of rehabilitation.

Out of 500 oiled birds captured for treatment by SWRA Skåne Sydväst from 1990-2008 and by Fågelskydd Spillepeng (both in Skåne) 1997-2008, approximately 250 were in a condition sufficient for release after treatment. The number of birds and species are shown in Table 4. Recapture data is still scarce and probably insufficient for statistical evaluation.

Table 4. Experience of rehabilitation at two rehabilitation centres in Skåne.

Species/species group	SWRA Skåne Sydväst 1990-2008			Fågelskydd, Spillepeng Malmö 1997-2008		
	Treated	Released	Release rate	Treated	Released	Release rate
Mute Swan	28	20	71 %	12	9	75 %
Dabbling ducks	2	2	100 %	7	2	29 %
Diving ducks (large)	344	158	46 %	10	3	30 %
Diving ducks (small)	16	5	31 %	1	0	0 %
Auks	7	4	57 %	3	3	100 %
Gulls	3	2	67 %	2	0	0 %
Divers	3	0	0 %			
Shelduck	2	2	100 %			
Crakes, Common Coot	34	30	88 %			
Mergansers	7	4	57 %			
Northern Fulmar				1	1	100 %
Grebes				2	1	50%
Tawny Owl				1	1	100 %
Feral Pigeon				1	1	100 %
Hooded Crow				1	1	100 %
Sum:	456	231	50 %	41	22	54 %

All species and age categories can in principle survive rehabilitation, since the main issue is not the stress during washing but the condition of the bird. If the condition of the bird is too bad the bird will not pass the initial triage. If there is hope of recovery, the birds are washed when their general condition has improved. The general condition is more or less easy to improve for different species. For the species that are not so easily helped, the risk for secondary injuries due to captivity is increased and the bird might have to be euthanized.

Instead of asking the question of which species or age categories can be washed, the question to ask is which species can be returned to their natural habitat with a good future result. When it comes to this perspective, species/groups of species that can be restored are Mute Swan, geese, gulls, Eurasian Coot, diving ducks and grebes. Auks and divers are more difficult to restore to their natural habitat.

The requirement of plumage conditions is higher for deep diving birds than for birds feeding semi-aquatically. Many diving birds are also fed fat herring to increase weight and there is always a risk of contamination of herring oil with environmental contaminants. The survival rate also depends on factors like general condition at capture, acceptance of new and unusual food (e.g. Common Eider feed on blue mussels in the wild, but in captivity they are offered herring), etc. Birds with severe oil contamination leave the aquatic environment if possible. These birds may easily be captured for cleaning operations. Birds with patches of oil leave the water to avoid drowning due to water-soaked plumage. They use their body heat to dry. As soon as they are dry, they go back into the water to feed and get soaked again. This will happen over and over again until their reduced fat deposits are emptied and muscular protein is used for the same purpose. The bird will soon be unable to fly and it generally ends with pneumonia and death. These birds are easily caught in the late stages of this process.

Otherwise the ability to capture oiled birds will be an important factor in the successful treatment. If the resources are limited, for example during a large spill with large amounts of birds, prioritisation will be made. The first priority is birds in good condition and adult birds in favour of pulli and juveniles, because young birds have a greater natural mortality. Threatened species, of course, are also a high priority.

7 Two scenarios: Oil spill affecting Long-tailed Duck and Guillemot

In order to see the full effect of an oil spill on a specific bird population, much information and data about the behaviour and dynamics of the species is needed. It is commonly rare to have this detailed overview and most often, the natural variations or effects of environmental changes might be large. During these circumstances, models can be employed and calibrated towards available data. In this chapter, a basic population model is developed to serve as an aid in understanding of the effects of an oil spill on two of the species in this report.

For the modelling, the Long-tailed Duck wintering at Hoburgs bank south of Gotland and the population of Guillemot breeding at Stora Karlsö west of Gotland were used. There are two main reasons for the choice of these species. Most importantly, both species prevail in large numbers in the Baltic Sea, and even though none of the species is endemic, the two locations outside Gotland host a large part of the Baltic Sea population. Secondly, it is of interest to cover one wintering and one nesting species, and two birds with different survival rates.

7.1 Model description

When considering population dynamics, the simplest model is described by the following relationship:

Change over time = birth – death – migration

This is also the approach in this report, although there is no term for migration since the birds are considered to show a high degree of site fidelity to there breeding or wintering locations. When describing the two different species, the following model is used:

$$x(t) = x(t-1) + a(t)x(t-1) - b(t)x(t-1) - c(t)x(t-1) + d(t)e(t)x(t-1),$$

x(t) total number of birds at time t
x(t-1) total number of birds at time t-1
a(t) hatched and survived birds at each time interval during hatching season
b(t) deceased birds at each time interval
c(t) deceased birds through oil spill at each time interval during occasion of oil spill
d(t) birds covered by rehabilitation during each time interval of rehabilitation
e(t) a combination of release rate and post-release survival until next breeding season

The population is divided into two age categories: young birds and breeding birds. The young birds can breed after a certain time period, see below. The total population is the sum of the young and the breeding populations. One month before breeding a proportion of the young birds are turned into breeding birds.

The model does not cover secondary effects of oil spills, such as decreased reproductive success the season after the spill. It only assumes a certain percentage of the birds, 93 %, are affected in total as a result of the oil spill. Survival (50 or 80 %) includes both release rates after rehabilitation, and post-release survival to the next breeding season. The model also assumes that the bird population is loyal to both its breeding and wintering area.

Other model limitations are that it is a linear simplification of reality and that there is no connection to the environment apart from assumptions of higher chick survival in some years for Long-tailed Duck. A more realistic approach would make it possible to include environment data such as food shortage, small rodents during nesting for the Long-tailed Duck (regulating predation pressure on the nests) or the availability of sprat for the Guillemot population. Other approaches could be to include more age categories or incorporate non-breeders into the adult population.

In the modelling there are an estimated number of washed birds for each of the populations. There is no connection between these numbers and the estimated resources for bird wash in Sweden. To wash this many birds chosen in the models calls for a very large rehabilitation operation. The numbers are used to exemplify the recovery after oiling of the respective species.

7.2 Long-tailed Duck at Hoburgs bank

The Long-tailed Duck which is wintering in the Baltic Sea breed on the Russian tundra, where it arrives in the middle of May. In late October - early November, the Long-tailed Duck migrates south to the Baltic Sea. They leave the Baltic in May to go back north, via the Finnish Bay, the main migration is seen from the coasts of south Finland and Estonia. For more information on the geographic distribution, see Chapter 3.1.6.

An adult duck has an average survival rate of five years, but there is unfortunately not much known about the breeding and fledging success. Each brood has been reported to consist of 6-7 ducklings on average (Pehrsson 1976), but the chick survival varies a lot from year to year (K. Larsson, pers. commun.). As with other arctic breeding birds, the Rodent cycle is of importance as the predation pressure on Long-tailed Duck nests will be appreciably higher in years with few rodents. During several years there may be no surviving juveniles, while in other years the population might consist of 30 % juveniles. The Long-tailed Duck start to breed at the age of two (Olsson 1976). This is demonstrated in Figure 21 where an overview of the dynamics for a hypothetical population of Long-tailed Duck at Hoburgs bank over a four-year period is presented. The population is set at 500 000 individuals, assuming a decline in the population since the 92/93 inventory (Chapter 3.1.6). In the first, third and forth years the breeding is not successful, only resulting in 0.1 surviving juveniles per breeding couple, including reduced survival during the first year. In year 2, the same value is 0.8. In the model, the competition and hence population regulation during years with less predation or many ducklings reported by Pehrsson (1976) is not included.

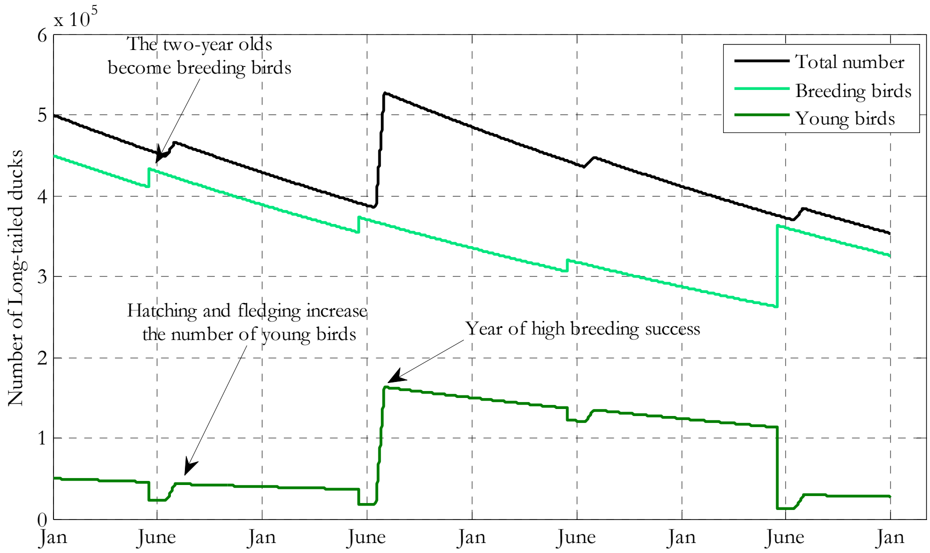

Figure 21. Population dynamics of Long-tailed Duck. In this scenario, the second year has a high number of surviving, hatched young birds, while the other years have a very low number of surviving hatched young birds.

In Figure 22, six scenarios during an oil spill event are shown. The oil spill is modelled to take place in January when the population is wintering at Hoburgs bank. In all scenarios, 93 % of the Long-tailed Duck population is affected by a severe oil spill in year 2. 10 % of the population or 40 000 individuals are cleaned and the survival, including release rate and post-release survival until next breeding season, is 50 or 80 %.

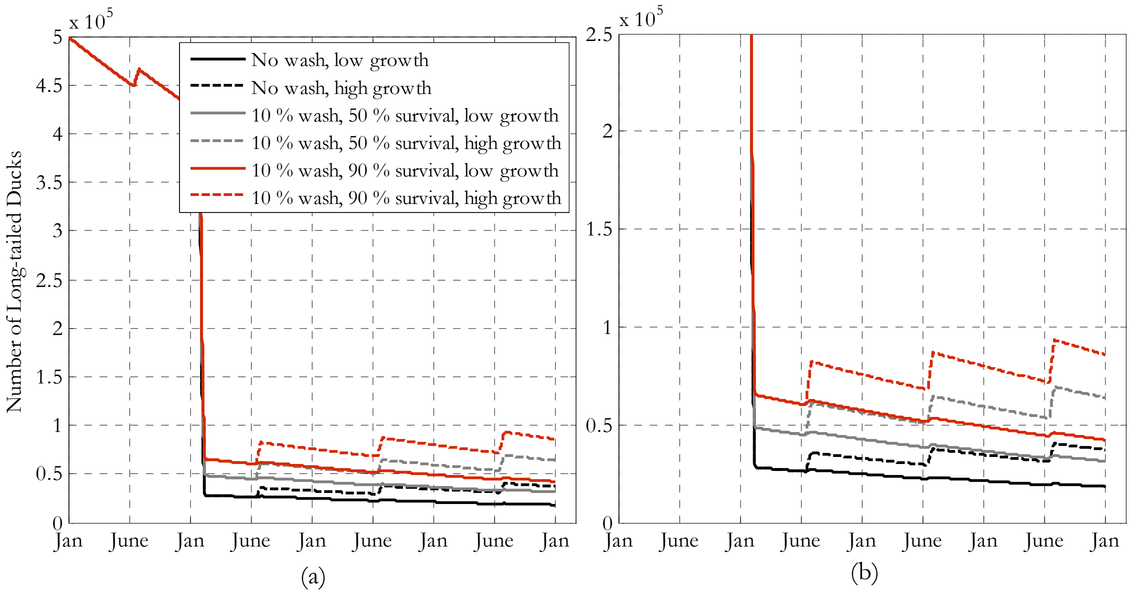

Figure 22. Scenarios with oiled Long-tailed Ducks at Hoburgs bank. Low and high numbers of breeding success (solid and dashed lines respectively), and varying numbers of washed and survived birds (black, grey and red). Number of birds washed: 40 000. (a) Full view. (b) 50 % zoom.

7.3 Guillemot at Stora Karlsö

The Guillemot nests at Stora Karlsö from the second half of April to the first half of July (Olsson et al. 2000). During this period, a very large percentage of the Baltic Sea population can be estimated to stay in the area (K. Larsson, pers. commun.). The fledging takes place from the last days of June and the following 20 days (Österblom, Olsson 2002). After this, the chicks jump from the ledges and leave the area with the father, swimming south to the wintering areas. The females continue to visit the breeding location from time to time shortly after fledging. The Guillemot winters in Central and Southern parts of the Baltic Sea, where the birds spend most of the period between September and February, as described in Chapter 3.1.11.

The Guillemot population of Isle of May, UK has been reported to have a minimum adult survival rate of between 92.6 and 97.3 %, and many ringed individuals have survived over 20 years (Olsson et al. 2000). The young birds become mature after 5 years. The number of fledged chicks per breeding pair in the Stora Karlsö population has been reported to decrease from the 1970s to the 1990s (Österblom, Olsson 2002). Between 1998 and 1999, this number was 0.671, which does not include mortality from leaving the cliffs.

In the following model, the adult survival rate is set at 95 %, and assumes an average survival of 20 years (Figure 23). The number of breeding pairs was estimated at 10 000 (Österblom et al. 2004) and the number of chicks per couple after breeding was assumed to be 0.25, including fledging success, mortality from leaving the nest and reduced survival during the chicks first time in life. This value has not been found in literature, but is found indirectly from the survival rate and the assumption that the population numbers are quite stable. Compared to the Long-tailed Duck population, the Guillemots have a more stable reproductive success rate, and in the model it was assumed to be constant from one year to another for simplifications. This also leaves fewer scenarios in the simulation of an oil spill (Figure 24). The oil spill in this scenario takes place just after fledging when both parents and fledged chicks are located in the same area at Stora Karlsö.

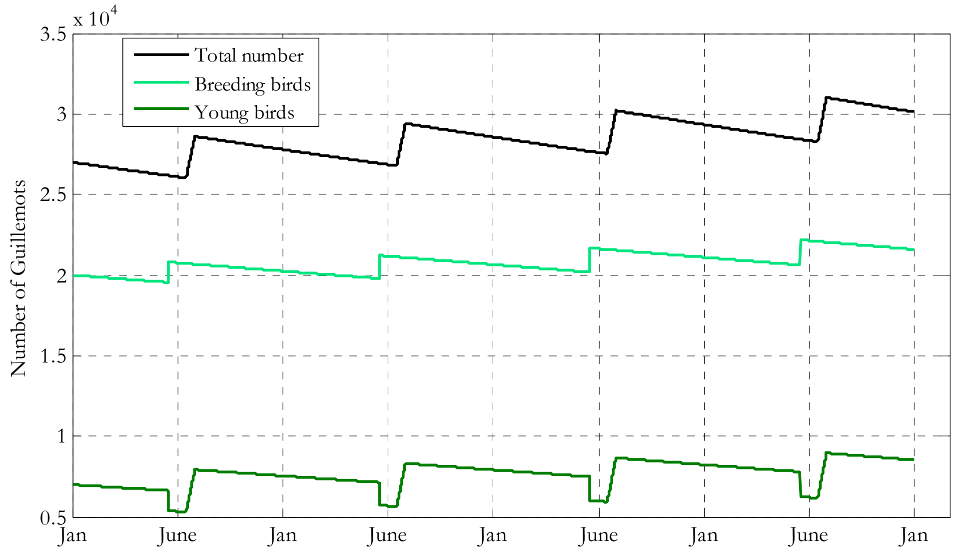

Figure 23. Number of Guillemots in a presumed population. Long-term positive trend on population numbers.

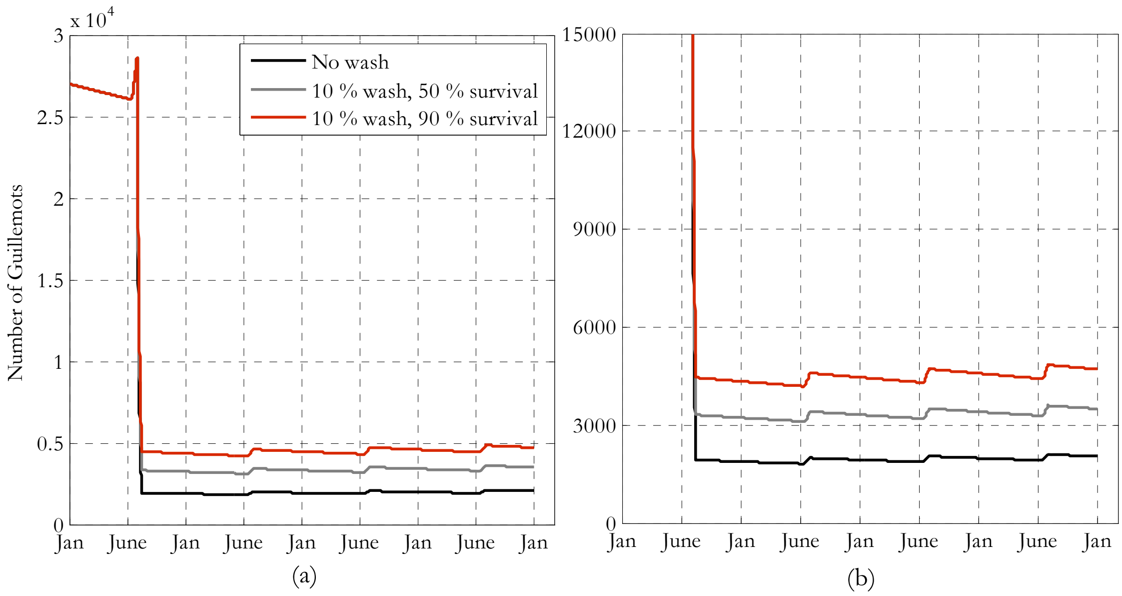

Figure 24. Scenarios with oiled Guillemot, and different outcomes of a presumed rehabilitation programme. Number of birds washed: 2700. (a) Full view. (b) 50 % zoom.

7.4 Comments on modelling results

When answering the question of how many birds should be washed in the case of an oil spill in order to have an effect on the population, there are several issues to be considered. It is not possible to draw any general conclusions of the eventual effect without recognizing which species prevail in the area. The wintering and nesting patterns, the growth rate each year and the variability in reproductive success from one year to another are factors that determine how severely the population will be affected. Also, the type of organization available for rehabilitation, as mentioned in Chapter 4, might affect the outcome and post-rehabilitation survival and therefore determine the limit of rehabilitation success.

The years following an oil spill will have different effects on a long-lived slow-growing population, such as the Guillemot, than on a species with higher reproduction rate during some years, such as the Long-tailed Duck. The population dynamics of Guillemot leaves the species more sensitive to oil-spills compared to the Long-tailed Duck due to its low reproduction rate.

The different effects of an oil spill on a Long-tailed Duck and on a Guillemot population are depicted in Figure 22 b and Figure 24 b. It is important to keep in mind that the reproductive success of the Long-tailed Duck varies a lot, and the different scenarios in Figure 22 can be considered worst case and best case scenarios. However, according to the model it is theoretically possible for the Long-tailed duck to have a population growth of 25 % (Figure 22 b) after three years while the growth of the Guillemot is slow and more or less constant. This demonstrates the different prerequisites for a slow-growing and more fast-growing species. The same situation would be valid if the Long-tailed Duck was compared to a species which had an even lower survival rate.

If the rehabilitating organization can only treat one species, the Guillemot should have a higher priority. But the probability that an oil spill will contaminate both species simultaneously is low, since they only stay in the same area for a very short period in April.

It is important to notice that it is not only the survival rate that will determine the outcome for these species. Low reproduction rate together with unfavourable environmental conditions, such as low numbers of lemmings in the breeding areas, might be devastating for the Long-tailed Duck after a large oil spill. It might also be assumed that reduced reproductive success might follow an oil spill since the birds that survived might be in poor health.

In Figure 22, 40 000 birds are presumed to be washed which demands a large effort and is comparable with some of the largest rehabilitating operations since the 1970s (Lindgren, Fejes 2003). High reproductive success following no rehabilitation might lead to the same results as low reproductive success following an extensive cleaning operation with modest results, according to the model (Figure 22). If low survivability is achieved for the treatment operation, not much effect at all can be expected on the population.

However, this is only an example of two out of several species in this study, and the above models could only serve, with its limitations, as an aid to understand the possible dynamics of these species and of the possible scenarios for its specific survival rate.

8 Discussion and concluding remarks

In this study, 14 species that may be exposed to oil contamination in the Swedish marine environment of the Baltic Sea are listed. These are found to be particularly vulnerable to oil contamination due to breeding or wintering patterns and feeding regime. Information about the species and their geographical distribution is also given. The selection of the species seems relevant. Perhaps the Black Scoter could be included (78 % of the NW European wintering population has been recorded in the Baltic Sea area and in Kattegatt, but recently there also is an increasing proportion in the Swedish part of the Baltic proper). On the other hand Black-necked Grebe could probably be excluded, although it is highly rated on the national red-list. Very few individuals of the Swedish (or Nordic) breeding populations may winter in the Baltic Sea area and risk exposure to oil spills at sea. Several other bird species might be contaminated by oil at sea or on the shores and therefore considered for cleaning operations. The present selection of species which dive in deep seawater for feeding represents a group where the plumage condition is especially important.

The present population numbers of the selected bird species and their geographical distribution is shown with detailed maps. Since almost 15 years have passed since the latest covering inventory, conditions may have changed. However, during 2007 and 2008 new censuses have been initiated that may show more up-to-date patterns in the appearance of these birds in the area.

The capacity of treating oiled birds in the Swedish marine environment is very much dependent on where along the coast the spill occurs. The highest capacity is found in Skåne where the instantaneous capacity is about 1000 birds. If the spill is too large international help is needed. This limit is judged to be met when more than 3000 birds are affected in Skåne and more than 1000 birds in the rest of Sweden. The need for facilities and equipment requirements to conduct cleaning and rehabilitation of oiled birds is briefly outlined.

Regarding survival after treatment there is a large diversity of the international experience presented in this report. Proper information about survival rate and population effects demands for long-term ringing studies to be in place at the affected breeding area before the spill occurs. This is very seldom the case. The methods for evaluating survival or population effects in general vary a lot between different sources and it is therefore difficult to make comparisons. However it can not be doubted that previous experience with treating oiled Jackass Penguins has been an ecological success. It is hard to extrapolate survival rates between species and few of the international studies cover any of the 14 species in this study.

There is a risk that an oil spill will lead to secondary effects that might impose a threat to the population. Literature suggests that reduced breeding as well as reduced fledging has occurred for Brown Pelican and Jackass Penguin, respectively, while breeding was not impaired in another study. For long-lived seabirds it is more important to treat adults than juveniles since the juveniles have a higher natural mortality and it is less likely they will contribute to the population than the adults.

Out of 500 oiled birds captured for treatment by SWRA Skåne Sydväst from 1990-2008 and by Fågelskydd Spillepeng 1997-2008, approximately 250 were in a condition sufficient for release after the treatment. The average release rate of 50 % is very much in line with previous international experience. Internationally the release rate is lower when a larger number of birds are treated. In the Swedish west coast the average release rate for Guillemots that have been oiled, wind-driven or caught in fishing nets is 54 %. The lethality is higher for wind-driven birds than for oiled birds. The release rate for oiled birds is 60 %.

The important question to ask is which species can be returned to their natural habitat with good future results. When it comes to this perspective Mute Swan, geese, gulls, Eurasian Coot, diving ducks and grebes are easier to restore than auks and divers. Also, birds in their wintering areas are more sensitive to oil spills.

This leads to the following division among the fourteen species in this study:

Easier to restore to natural habitat	**More difficult to restore to natural habitat**
Great Crested Grebe (Skäggdopping)	Black-throated diver (Storlom)
Red-necked Grebe (Gråhakedopping)	Red-throated Diver (Smålom)
Slavonian Grebe (Svarthakedopping)	Guillemot (Sillgrissla)
Black-necked Grebe (Svarthalsad dopping)	Black Guillemot (Tobisgrissla)
Velvet Scoter (Svärta)	Razorbill (Tordmule)
Red-breasted Merganser (Småskrake)	
Common Eider (Ejder)	
Long-tailed Duck (Alfågel)	
Steller's Eider (Alförrädare)	

A basic population model was employed to visualize the effect of an oil spill on the Long-tailed Duck population at Hoburgs bank and on the Guillemot population at Stora Karlsö. The model demonstrated the difference between fast- and slow-growing populations, but it only represents a snapshot of what might happen for these two populations at a specific time of the year.

In summary, it is a difficult task to point out certain species that are possible to rehabilitate and need to be rehabilitated due to the discrepancies in data. All birds are in principle possible to treat depending on the degree of oiling. A better approach to evaluate a species vulnerability to oil spills might be to use risk assessments that are area, density and time dependant. In this context, oil vulnerability indices (OVI:s) have been employed since the late 1970s to rank how sensitive species are to oil pollution (Camphuysen 2007). There are several factors that can be incorporated in an OVI, some examples being reproductive potential, nesting density and population size. The OVI will then among other things depend on the behaviour of the species in relation to oil spills. What factors that have been included in the OVI:s has varied between the authors.

If an OVI is combined with information about population distribution, an overview of the different risk levels at different locations and different parts of the year is obtained. The principle is described in Figure 25.

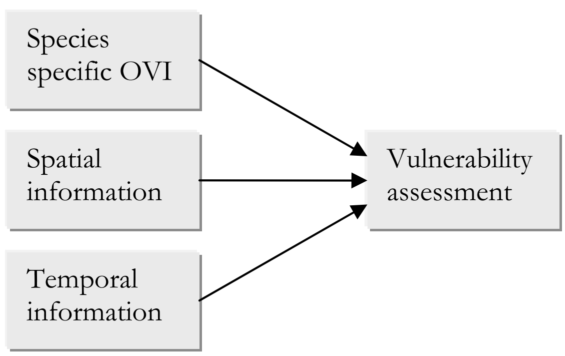

Figure 25. Information needed to obtain an area, density and time dependant vulnerability assessment.

This vulnerability assessment can be of great help in planning of activities that might lead to oil spills and in this way handle the original issue of pollution, but it can also be employed during acute oil spills to decide what areas and species should be given priority. For the moment no OVI:s are calculated for the Baltic Sea.

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Appendix A

Staff equipment for cleaning and rehabilitating oiled birds

Catchers and people handling the birds before cleaning:
Personal clothing for the season
Jacket and trousers in weather and oil resistant plastic-coated fabric
Rubber boots
Nitril gloves
Protective googles

Personnel cleaning birds:
Overalls (Tyvek)
Nitril gloves
Disposable apron
Protective googles
Rubber boots

Personnel working with cleaned birds:
Overalls
Protective disposable gloves
Rubber boots
Disposable apron (when handling animals)

Appendix B

Summary of international experience of survival after rehabilitation

Author	Region	Species	Spill	Year	Numbers[1]	Survivability	Comment
Altwegg et al. 2008	South Africa	Cape Gannet	Castillo de Bellver	1983	1491	• RR[2]=65 % (932 of 969 was ringed). • Annual survival non-oiled birds: 0.878-0.896. • Annual survival oiled birds: 0.855-0.880. • No increased mortality after release.	• 5000 estimated total number of oiled birds. • The study used standard capture-mark-recapture methods.
Anderson et al. 1996*	California	Brown Pelican	2 oil spills in the Southern California Bight	1990, 1991	Oiled, rehab: 112 Non-oiled, no rehab: 19	• Oiled pelicans disappeared faster than un-oiled pelicans according to telemetry. Lower survival according to resightings.	• Radio- and colour-marking. • No breeding activity of oiled birds the year after rehabilitation. • Oiled birds were further away from breeding colonies two years after rehabilitation than control birds.
Anderson et al. 2000	California	American Coot	Broken pipeline	1995	Oiled, rehab: 37 Non-oiled, no rehab: 38	• RR= 60 %. • Mortality among oiled coots consistently higher. • Overall survival during experiment: Oiled: 49 % Non-oiled: 76 %. • Projected annual mortality: Oiled: 65 % Non-oiled: 89 %.	• The oiled birds were first rehabilitated then kept in fenced marshes together with the reference group.
Barham et al. 2007	South Africa	Jackass Penguin	Treasure	2000	19000 420 nests 3 groups of pairs: (1) affected, (2) not affected, not banded, (3) not affected, banded.	• RR= 90 %. 17287 birds banded • Study focused on breeding success, see comments.	• Nest monitoring 2001-2005. • Study focused on period between hatching and fledging. • Hatching success did not vary between the three groups. • Fledging success: Treasure group: 43 %. Not affected: 61 %.

Author	Region	Species	Spill	Year	Numbers[1]	Survivability	Comment
Dunne, Miller 2007	North America	Canada Goose, Mallard	No specific	1974-2006	Mallard: 94 Canada Geese: 265	Mallard: • Annual survival oiled birds: 0.694, 0.685. • Annual survival non-oiled birds: 0.679, 0.685. Canada Goose: • Annual survival oiled birds: 0.717, 0.700. • Annual survival non-oiled birds: 0.738, 0.747. Oiled released birds have similar survival than non-oiled birds.	• The study analyzed banding data from USGS Bird Banding Laboratory. • The lower survival rate for Canada Geese is the result of one singular event (oil spill).
Goldsworthy et al. 2000*	Tasmania	Little Penguin	Iron Baron	1995	1800 rehabilitated	• Estimated post-release survival: 59 % (Ninth Island) and 44 % (Low Head). • Oiled birds had significantly lower survival rates.	• Survival rate estimated through recapture data • The most important factor determining survival was extent of oiling.
Golightly et al. 2002*	California	Western Gull	Torch/Platform Irene Pipeline	1997	Oiled, rehab: 7 Non-oiled, rehab:10 Non-oiled, no rehab:10	• All oiled and rehabilitated gulls survived until breakdown of transmitters. • No difference between geographical distribution of the three groups.	• Radio-telemetry used in the study.
Hull et al. 1998	Tasmania	Little Penguin	Iron Baron	1995	1894 rehabilitated, 25 allocated (12 oiled, 13 controls)	• Return rate to original area 62 % for rehab. birds and 50 % for controls (no stat. diff.). • No difference in return rate between sexes.	• 25 birds allocated, since breeding area still contaminated. Birds were equipped with radio transmitters.
Nel, Whittington (eds) 2003	South Africa	Jackass Penguin	Several. Apollo Sea (1994) and Treasure (2000) are two examples	1968-2000	Apollo: 10 000 Treasure: 20 000 >47 000 in total since 1968	• At present RR= 80 % at SANCCOB[3]. • Post-release annual survival rate the same as for un-oiled birds. • 87 % return to breeding colonies. • 60 % of resights at colonies breed.	• Breeding success no different compared to un-oiled. • Oiled birds fare less well during food shortage.
Newman et al. 2004	California	Guillemot	Stuyvesant	1999	31 oiled 25 non-oiled	• Until day 34: higher mortality (1:4) for oiled birds. • After day 34: No difference between the control groups.	• Time of study: 142 days • Monitoring performed through radio telemetry surveys.
Sharp 1996	North America	Western Grebe, Velvet Scoter, Guillemot	No specific	1969-1994	Oiled: 10+10+78 Non-oiled: 37+22+64	• Oiled birds survived between 0.2-0.4 months (median). • Non-oiled birds survived 20.8+15.5+7.2 months (median).	• The study analyzed banding data.

Author	Region	Species	Spill	Year	Numbers[1]	Survivability	Comment
Underhill et al. 1999	South Africa	Jackass Penguin	Apollo Sea	1994	4076 cleaned, released with bands (total number oiled: 10000)	• RR= 51 %. • Few Jackass Penguins died of oiling, most of them come ashore. • No post-release mass-mortality (compare Sharp, 1996). • The banded birds had a normal mortality rate for the species.	• Results from the resighting programme after the Apollo Sea accident.
Underhill et al. 2000	South Africa	Jackass Penguin	Apollo Sea	1994	4076 cleaned, released with bands (total number oiled: 10000)	• 53 % of birds alive 4 years after accident. • High survivability and successful rehabilitation.	• Results from the resighting programme after the Apollo Sea accident.

* Only abstract available

[1] Unless otherwise stated the number refers to the number of birds oiled, treated and studied within the study

[2] RR= release rate

[3] SANCCOB= South African National Foundation for the Conservation of Coastal Birds

Appendix C

Important factors for determination of survival rate for oiled birds according to Russel et al. (2003):

- Where did the oil spill occur?
- What type of oil was spilled?
- Was there a search and collection programme?
- If search and collection was done, who did it and was it affective?
- What sort of weather were the birds exposed to?
- What was the condition of the bird prior to oiling?
- Was stabilization done after capture?
- Were the birds stable prior to transport?
- Was the transport timely?
- Was there a facility available?
- If a facility was not available how long before one was found/constructed?
- Does the facility have adequate water?
- Does it have enough water to wash birds?
- Is there adequate ventilation?
- What species were admitted?
- In what numbers?
- What product was used to remove the oil?
- Was any blood work done prior to the washing process?
- Was any blood work done prior or release?
- Were trained personnel overseeing all aspects of the event?