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Wintering swans *Cygnus spp.* and Coot *Fulica atra* in the Öresund, South Sweden, in relation to available food recources

Övervintrande svanar Cygnus spp *och sothöns* Fulica atra *i Öresund, södra Sverige, i relation till tillgängliga födoresurser*

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Abstract

In connection with the building of a Fixed Link (bridge – artificial island – tunnel) between Sweden and Denmark intensive studies of waterfowl and benthic fauna and flora in the Öresund were undertaken as a part of the Environmental Impact Assessment Study. This paper analysis the occurrences of staging and wintering herbivores (i.e. Mute Swan *Cygnus olor* and Coot *Fulica atra*) in relation to available food resources. It was concluded that the proportion of *Zostera* and *Ruppia* consumed by the birds during September–March was about 10% of the available standing crop in the autumn or less. During ice-periods large parts of the available feeding areas are covered by ice, and during an extended ice-period in 1995/1996 the calculated food consumption for the ice-free areas was of the same magnitude as the calculated standing crop of food plants.

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Introduction

The southern part of the Öresund between Sweden and Denmark has long been known as an internationally important staging and wintering area for a number of different waterfowl species (Nilsson 1975, 1996a). Part of the area (Falsterbo–Foteviken) is listed among the Swedish Ramsaar-sites, as is the case for the Danish island of Saltholm. Moreover, a number of other sites in the Öresund do also full-fill the criteria for internationally important wintering sites for waterfowl, even if they have not been designated as internationally important areas under the Ramsaar-convention.

Due to the importance of the area for a number of bird species, intensive studies of staging and wintering waterfowl on both the Swedish and Danish side of the Öresund were included in the Environmental Impact Assessment (EIA) study for the Fixed Link between Sweden and Denmark which was build during the latter part of the 1990s and which was ready in the summer of 2000 (Öresundskonsortiet 1995, 1998). This link, which is 16 km long, consists of a combined railroad and motorway connection from Lernacken on the Swedish side of the Öresund to Kastrup in Denmark, including a 1092 m long high bridge, 6700 m of connecting bridges, an artificial island and a 3500 m sink-tunnel.

One of the conditions for building the fixed link was that the construction should not obstruct the water currents in and out of the Baltic Sea, which are of vital importance for this sea area. Thus large-scale compensatory dredgings were undertaken in addition to the dredging for the construction of the bridge and tunnel. As there was a potential risk that excessive sediment spill from the dredging could have a negative effect on marine life in the area, including staging and wintering waterfowl, an extensive monitoring programme on the benthic flora and fauna as well as waterfowl was included in a Control Programme. Thus data on the availability of important food species for swans and Coot were collected and could be used for comparison with waterfowl census data from the same areas.

In this paper I will relate the occurrence of waterfowl feeding on aquatic vegetation (i.e. swans and Coot) in the study area during the non-breeding season to their food supply, whereas the occurrence of the different waterfowl species in the southern part of the Öresund will be described elsewhere (L. Nilsson & M. Green, in prep.). More detailed data from the waterfowl work are found in technical reports from the project, where the pos-

sible effects of the construction work on the bird fauna have been evaluated in detail (see Nilsson 1996b, 1998, 1999a, 1999b, 2001. Regular waterfowl counts have been undertaken in the area since 1964/65 (Nilsson 1996a, unpubl.).

Study area

The general area for the impact assessment study related to the Fixed Link was from Fasterbo in the south to Barsebäck (Figure 1, cf. Nilsson 1996b, 1998), but more intensive studies were undertaken closer to the construction site and to the south of it. The possible impact zone according to the EIA (Öresundskonsortiet 1995, 1998) extends to and includes the Malmö harbour area, but the area between Lernacken (where the bridge reaches the Swedish coast) and Malmö has very little of natural waterfowl habitat, especially for herbivorous birds.

Lernacken in the north of the study area is an area of artificial hills in the shore-line created from deposits of calciferous material. Further south Klagshamn is an artificial peninsula made of similar material from excavations. Originally, the area between Lernacken and Foteviken had grazed shore meadows but north of Klagshamn the meadows are no longer grazed as is also the case for some areas south of Klagshamn. Anyhow, Foteviken still has the largest area of grazed marine shore meadows in Sweden.

The water area between Lernacken and Foteviken is in general very shallow, large parts having a water depth of less than 3 m (Figure 1), extensive areas having a depth of less than 1 m. The inner parts are muddy with patches of *Ruppia*, whereas extensive *Zostera* meadows on sand are found further out (VKI/Toxicon 1996a, 1996b, 1996c, SEMAC 1997, 1998).

Due to the currents in the Öresund the waters off Lernacken are among the last areas to freeze during hard winters, the area of open water sometimes extending south to the Klagshamn peninsula, whereas the rest of the southern part of the Swedish Öresund coast is totally ice-covered. Moreover, just south of Lernacken the current keep even shallow water free of ice during cold periods.

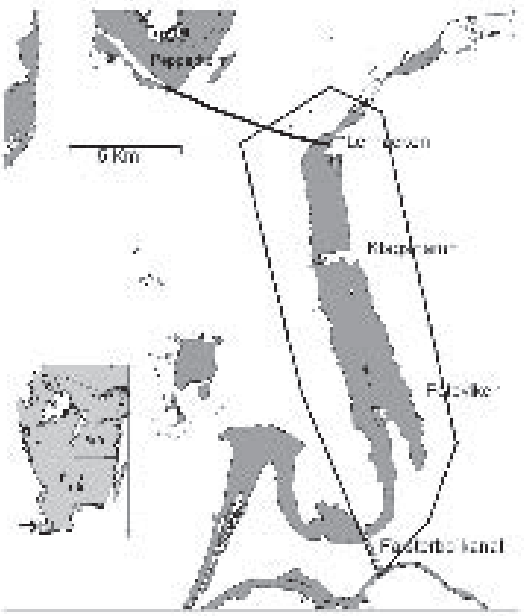


Figure 1. Map of the study area in the Öresund. For a general position in south Sweden, see inserted map. Areas with a water depth of less than 3 m marked with grey tone.
Karta över undersökningsområdet i södra Öresund. Områden med ett vattendjup om mindre än 3m markerade med grå ton.

Material & Methods

Waterfowl counts

The utilization of the area by feeding waterfowl was based on the calculation of bird-days for the different species in different areas. In 1995/1996 and 1996/1997 counts were undertaken each week in the entire area between Barsebäck and Falsterbo (Nilsson 1996b, 1998, Nilsson & Green in prep), of which the present study area (Figure 1) forms a part. Counts of all species were also performed each week during August–March 1997/1998 in the main study area (Nilsson 1999a).

The counts were undertaken from the shore either through telescopes from fixed observation points so situated that the entire sectors could be covered or by the observer walking along the shore line. Telescopes with 20–50 X magnification were regularly used. Counts were only undertaken during good weather conditions. For a thorough description and discussion of census methods see Nilsson (1975, 1976, 1991).

Estimation of food consumption of different species

Among the plant feeders, swans (mainly Mute Swans *Cygnus olor*) and Coot *Fulica atra* are important in the study area. They regularly feed on *Ruppia* and *Zostera* in the area. The consumption of sea grasses by the moulting Mute Swans of Salt-

holm have been evaluated by Clausen et al. (1995, 1996), where a thorough discussion of the calculation of energy consumption of swans is found. There was a marked variation in the different estimates of the food consumption of swans, between 352 g and 620 g dry-weight of *Zostera* per 24 h. Mathiasson (1973), who also studied moulting Mute Swans, estimated the daily food consumption to 3.66 kg wet weight, corresponding to 586 g dry weight. Measurements and estimates from other parts of the season are lacking. In the calculations here I have used an overall value of 3.5 kg fresh weight as the daily consumption, i.e. in the higher part of the interval as the estimates were for summer time but the present study relates to the entire year. Studies of the Canada Goose *Branta canadensis* (Williams & Kendeigh 1982) showed that the energy consumption of geese (and also other waterfowl) will be about 25–30% higher in winter than in summer. Thus a 25% higher estimate was used for the ice-periods in the winter, i. e. 4375 g fresh weight.

The Coot is normally considered a plant feeder (Borowiec 1975, Hurter 1972, 1979) but can also use animal food, e.g. Suter (1982) found it feeding on *Dreissena* in the Lake of Constance. It is not known to which extent it utilises animal food in the Öresund area. Based on laboratory studies and field observations Hurter (1972, 1979) estimated the food requirements of the Coot for different plant foods as follows: *Bromus racemosus* 640 KJ/ 24 h (1110 g fresh weight), *Phragmites communis* 706 KJ/24 h (730 g), *Potamogeton pectinatus* 710 KJ/ 24 h (2980 g) and *Ranunculus fluitans* 1000 KJ/ 24 h (3650 g*). Ruppia* is apparently an important food for the Coot in brackish water (Verhoeven 1980). According to three different methods he gives the consumption of *Ruppia* as 38.1, 52.3 and 82.8 g/24 h ash-free dry-weight but considers the middle value as the most correct one. This corresponds to a daily food consumption of 305 g fresh/ weight, which will be used in the calculations here. In line with the discussion above a 25% higher estimate was use for the ice-period, i.e. 375 g fresh weight/24 hours.

Results

Occurrence and numbers

Three species of plant feeders are of interest here as they utilise submerged vegetation to a high degree, the Mute Swan *Cygnus olor*, the Whooper Swan *Cygnus cygnus* and the Coot *Fulica atra*. The Wigeon *Anas penelope* is another common herbivor in the area, but it mostly feeds by grazing on the shore meadows and farmland in the autumn and winter, even if small flocks can feed on floating *Zostera*. The Wigeon is not considered any further here. The Whooper Swan has in recent years to a large extent become a terrestrial feeder, but still a proportion of the swans in the area feed on submerged vegetation (the terrestrial Whoopers not being included in the counts). Large numbers of especially Canada Geese *Branta canadensis* use the Foteviken area as their night-time roost. They feed in the surrounding fields, but can occasionally feed on *Zostera.* The geese are not considered any further here.

The southern part of the Öresund is an important area for Mute Swans all the year round. Important numbers moult in the Öresund, especially on the island of Saltholm, but there are also large flocks in summer in the Foteviken area. During autumn there is a steady built-up in numbers of swans in the area, reaching peak numbers of between 2000 and 2500 in 1995/96 and between 1500 and 2000 in the other two years shown in the graph (Figure 2). The highest peaks in especially 1995/96 were found during the ice-period.

The Mute Swans occur all over the area, but numbers in the Foteviken area are appreciably higher than in the area between Lernacken and Klagshamn during normal periods. In periods with ice there is however a concentration of the Mute Swans in the areas close to Lernacken as these are the last to freeze in this part of Öresund.

The Whooper Swan is a regular winter visitor to the area (Figure 2). Peak counts have been around 150. Generally there are more Whooper Swans in the Foteviken area, but in recent years there has been a change in their habits and more and more swans are feeding in the fields.

The Coot is also a regular staging and wintering bird in the area with flocks feeding both in Foteviken and north of Klagshamn. Peak counts in some years were 2000 and more, occurring during the autumn, whereas winter counts were lower.

Food requirements

Using literature data for the food consumption (see methods) and the number of bird-days from the counts, it was calculated that the swans using the area between Lernacken and Foteviken consumed between 780 and 1166 tons of fresh weight of submerged vegetation, mainly *Zostera,* between September and March, incl. in the study years (Table 1). With a similar calculation the overall food consumption by the Coot was estimated to be between

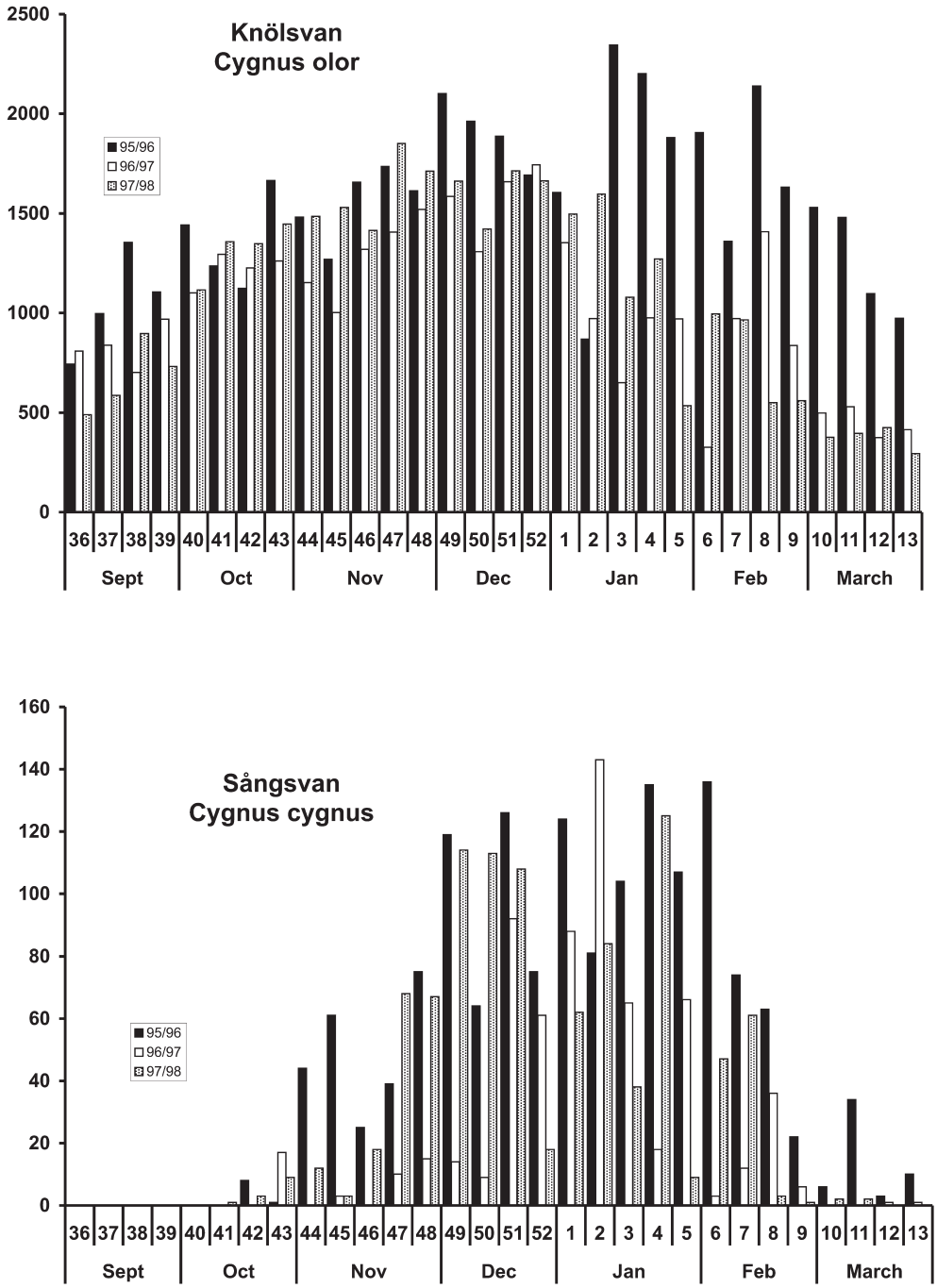
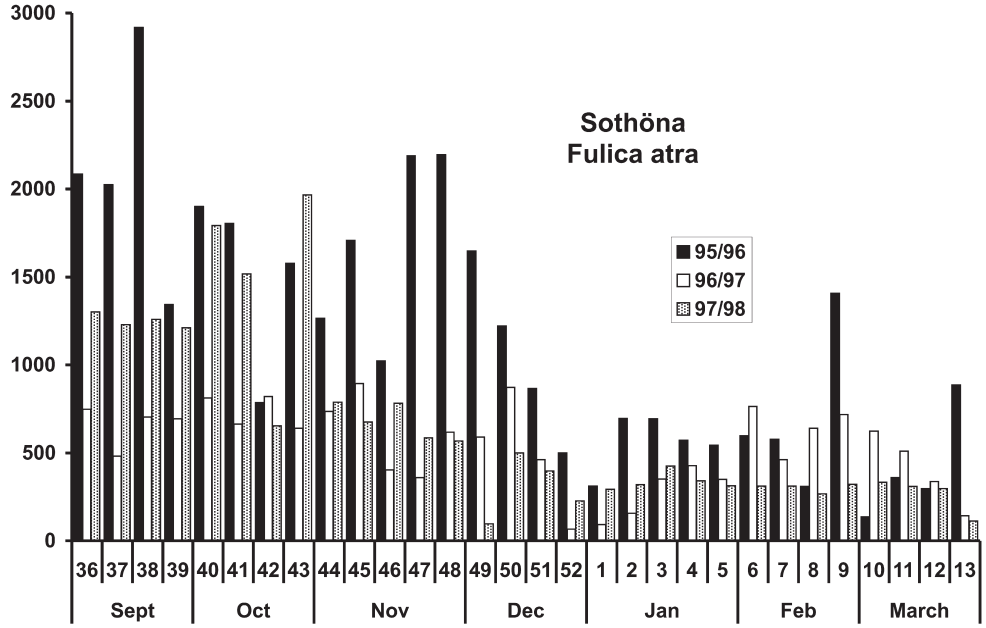


Figure 2. Total numbers counted per ten-day periods of Mute Swan *Cygnus olor*, Whooper Swan *Cygnus cygnus* and Coot *Fulica atra* in the study area during September–March 1995/96–1997/98. Among Whooper Swans, only those feeding on aquatic areas are included.
Antal knölsvanar, sångsvanar och sothöns i undersökningsområdet i södra Öresund September–March 1995/96–1997/98. Notera att endast sångsvanar som födosöker i havet är medräknade.



34 and 72 tons. Over the entire area, this compares to 40 to 60 g/m^2 fresh weight for the period September –March for the Coot and Swans in the area if they can use all parts within "swan-depth".

During the ice-period most areas with *Ruppia* were covered by ice and not available to the feeding waterfowl. The calculated rate of food exploitation for the ice-free areas during the ice-period in 1995/96 was high, 504 g/m^2 , whereas the value was lower for the shorter ice-period in 1996/97, 189 g/m^2 (Table 2). To this should be added some consumption by Coot.

Exploitation of food resources

In the autumn of 1995 the total standing crop of *Ruppia* was measured in some areas in Lommabukten and around Klagshamn. For a depth of 0.4 m the standing crop varied between 62 and 152 g/m^2 dry weight, whereas the standing crop at the stations with a depth of 0.8 m varied between 44 and 82 g/m^2 (VKI/Toxicon 1996a). Expressed as wet-weight the values are about 6 times larger. The standing crop of *Zostera* in the Öresund is also high, maximum biomasses, which are reached in August, amounting to 200–700 g DW/m^2 in different areas (VKI/Toxicon 1996b) or 1200–4300 g wet weight /m^2. Part of the biomass is in the underground parts.

The standing crop of *Ruppia* varies markedly over the season from nearly 200 g DW /m^2 in some stations in October it was about 70–100 g dry weight in December and only a few gram in March. If only the shoots are utilised the October values are reduced to 75–80 g and the March values to 4 g. *Zostera* also shows a marked seasonal variation in biomass from peak mean values of around 250 g DW/m^2 in summer to a low of slightly more than 100 g DW/m^2 for the above-ground parts in winter (VKI/Toxicon 1996b, 1996c). This corresponds to about 600 g wet weight/m^2 for the above-ground parts in December

In the autumn of 1996, the biomass of *Zostera* on the Swedish side south of the link alignment was between 65 and 165 g dry weight per m^2, which is between 390 and 990 g wet weight per m^2 (SEMAC 1997, 1998). These values are however general mean values and the biomass was lower in the more shallow waters around 50 g dry weight. Moreover the coverage of *Zostera* was around 70%, which means available food resources of between 280 and 700 g wet weight per m^2.

In general, the consumption rates of the plant feeders were small compared to the available standing crop of *Ruppia* in the shallowest areas as is the case for the parts of the *Zostera* meadows within reach for the swans. The values presented in Table 1 indicate a consumption rate of about 10% less

Table 1. Calculation of food requirements for swans and Coot in the Foteviken–Lernacken area September–March 1995/96–1997/98.
Beräkning av födobehovet för rastande och övervintrande svanar och sothöns mellan Foteviken och Lernacken under september–mars 1995/97–1997/98.

	1995/96	1996/97	1997/98
Number of bird days *Antal fågeldagar*			
Cygnus olor knölsvan	322560	218197	230685
Cygnus cygnus sångsvan	10752	4620	6776
Total swans *Summa svanar*	333312	222817	237461
Fulica atra *sothöna*	241017	112847	136409
Total swans and Coot *Summa svanar och sothöna*	921627	618422	527702
Total food requirement (Ton wet weight) *Summa födobehov (ton våtvikt)*			
Swans *svanar* (3500 g/24h)	1166	780	831
Fulica atra sothöna (300 g/24h)	72	34	41
Total *Summa*	1238	814	872
Food requirements *födobehov* (g/m^2) Calculated for swan depth (2050 ha) *Beräknat för svandjup*	60	40	42

than that of the available standing crop of food plants. Similarly in an ice-free winter the available food resources of *Ruppia* in these shallow waters and *Zostera* in slightly deeper water would have been more than sufficient for the wintering swans and Coots in the area, only a small percentage of the total standing crops being used.

During the ice-period in 1995/96 the total calculated food consumption per m^2 was not much lower than the normal standing crop values reported by VKI/Toxicon (1996b, 1996c). Even if the biomass values used for the *Zostera* are only general data that varies much between different sites, it is clear that the swans were close to the limit set by the available food resources by the ice. It is however probable that the effective feeding areas can have been slightly larger than given in the calculations here as the ice shifted position somewhat during the winter, i.e. even if the total ice-free area was similar. On the other hand some areas included in the vegetated areas can have been without vegetation, which will not be taken into account when using overall mean values.

Discussion

According to the calculations presented here, the staging and wintering Swans (mainly Mute Swans) and Coots have rich food supplies in the Swedish part of the Öresund with ample food resources of *Zostera* and *Ruppia* within "swan-depth". The overall food consumption of the swans and Coot during September–March was calculated to be 10% or less of the available standing crop of food plants. Even if the study refers to the autumn and winter situation, the production of the *Zostera* vegetation has not stopped by the beginning of September, so the available food resources are actually higher than indicated by the comparison here. During the ice-free periods of the cold winters and in ice-free winters such as 1997/98 and 1998/99 the food resources of *Zostera* and *Ruppia* were sufficient for much larger numbers of swans (and Coot) than actually present in the Öresund

Studies relating the food consumption of swans and Coot to their food resources are few, but Clausen & Krause-Jensen (1994) compared the food consumption of herbivorous waterfowl and *Zostera* production in a Danish fjord and calculated the mean grazing pressure on *Zostera* to be 12% of the production on an annual basis. Studies on moulting Mute Swan in the Öresund were undertaken as a part of the Control Program for the Fixed Link, also including comparisons between swan numbers and available food resources. It was generally concluded that the food resources were plentiful for the moulting swans (cf. e.g. Kahlert et al. 2000).

Table 2. Calculation of food requirements for swans and Coot in the Foteviken–Lernacken area during the ice periods in 1995/96 and 1996/97. Note that the estimated food consumption here is 25% higher than in Table 1 (cf. Williams & Kendeigh 1982 as discussed in the text for colder pcriods).
Beräkning av födobehovet för övervintrande svanar och sothöns mellan Foteviken och Lernacken under isperioder 1995/97 och 1996/97. Observera att den beräknade födokosumtionen här är 25% högre än i Tabell 1 (jfr Williams & Kendeigh 1982 för kallare perioder).

Ice-period *Isperiod*	1995/96 21 Dec– 31 Mar	1996/97 15 Dec– 10 Feb
Number of bird days *Antal fågeldagar*		
Cygnus olor knölsvan	163700	60600
Cygnus cygnus sångsvan	7700	3700
Total swans *Summa svanar*	171400	64300
Fulica atra sothöna	57000	18600
Total food requirements (ton wet weight) *Totalt födobehov (ton våtvikt)*		
Swans *svanar* (4375 g/24h)	750	282
Fulica atra sothöna (375 g/24h)	21	8
Total *Summa*	771	290
Available ice-free areas (mean in ha) *Tillgänglig isfri areal (medel i ha)*		
Swans *svanar*	150	180
Fulica atra sothöna	490	570
Food requirements (g/m2) *Födobehov*		
Swans *svanar*	500	188
Fulica atra sothöna	4	2
Total (g/ m2)	504	190

In the hard winters the situation was different as the swans are restricted to the few ice-free areas available and as they are moreover restricted to the shallowest parts that are the first to freeze. During the ice-period in the winter of 1995/96 the calculated food resources in the ice-free areas more or less balanced the amount of food needed by the swans. In this connection it must also be taken into consideration that the feeding waterfowl might reach a limit where the food is getting more scarce and that they accordingly cannot use all potentially available food resources.

It is well-known that Mute Swans and Coot suffer increased mortality due to food shortage in cold winters (Andersen-Harild 1981, Cave & Wisser 1985, Nilsson 1991, 2002). In the Coot the indices from the Swedish waterfowl counts showed a marked decrease after the hard winter of 1979, which caused a high mortality among the Coots (Nilsson 1991, unpubl.). The Swedish midwinter indices do not show especially marked declines after the hard winters for the Mute Swan, but the September indices in 1979, 1982, 1985 and 1987, i. e. years with hard ice-winters all show a decrease in the index values.

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References

Andersen-Harild, P. 1981. Population dynamics of *Cygnus olor* in Denmark. Pp. 176–191 in *Proceedings Second International Swan Symposium, Sapporo, Japan, 21–22 February 1980* (G. V. T. Matthews & M. Smart, Eds.). International Waterfowl Research Bureaus, Slimbridge.

Borowiec, E. 1975. Food of the coot (*Fulica atra*) in different Phenological periods. *Pol. Arch. Hydrobiol*. 22: 157–166.

Cavé, A. J. & Visser, J. 1985. Winter severity and breeding

bird numbers in a Coot population. *Ardea* 73: 129 – 138.
Clausen, P., Kahlert, J., Fox, A. D. & Andersen-Harild, P. 1995. *Base-line Investigations of Moulting Mute Swans on Saltholm, June–October 1994*. NERI Report.
Clausen, P., Kahlert, J. Andersen-Harild, P. & Nilsson, L. 1996. *Base-line Investigations of moulting Mute Swans around Saltholm, 1993–1995: Results and Conclusions*. NERI Report.
Clausen, P. & Krause-Jensen, D. 1994. An annual budget of eelgrass *Zostera marina* consumption by herbivorous waterfowl in a shallow Danish estuary. Pp. 100–111 in *Vandfugles rolle som primaer-konsumenter i lavvandede fjordområder* (Clausen, P. 1994. PhD afhandlig.) Danmarks Miljöundersögelser/Aarhus Universitet. 126 s.
Hurter, H. 1972. Nahrung und Ernährungsweise des Blässhuhns *Fulica atra* am Sempachersee. *Ornithologische Beobacheter* 69: 125–149.
Hurter, H. 1979. Nahrungsökologie des Blässhuhns Fulica atra an den Überwinterungsgewässern im nördlichen Alpenvorland. *Ornithologische Beobachter* 76: 257–288.
Kahlert, J., Clausen, P. & Nilsson, L. 2000. *Monitoring of moulting mute swans around Saltholm, 1999*. NERI Report.
Mathiasson, S. 1973. A moulting population of nonbreeding Mute Swans with special reference to flightfeather moult, feeding ecology and habitat selection. *Wildfowl* 24: 43–53.
Nilsson, L. 1975. Midwinter distribution and numbers of Swedish Anatidae. *Ornis Scandinavica* 6: 83–107.
Nilsson, L. 1976. Monthly counts as a measure of population changes in some species of Anatidae in south Sweden. *Ornis Scandinavica* 7: 193–205.
Nilsson, L. 1991. Distribution, population size and long-term changes in population size of wintering waterfowl in Sweden. *Ornis Svecia* 1: 11–28. (In Swedish with English summary).
Nilsson, L. 1996a. *Resting and Wintering Waterfowl along the Swedish coast of the Öresund, 1962– 1995. Report to Öresundskonsortiet*. Ecological Institute, University of Lund.
Nilsson, L. 1996b. *Monitoring of resting and wintering waterfowl along the Swedish coast of southern Öresund July 1995–June 1996 in relation to the Fixed-Link across the Öresund. Report to Öresundskonsortiet*. Ecological Institute, University of Lund.
Nilsson, L. 1998. *Monitoring of resting and wintering waterfowl along the Swedish coast of southern Öresund July 1996–June 1997 in relation to the Fixed-Link across the Öresund. Report to Öresundskonsortiet*. Ecological Institute, University of Lund.
Nilsson, L. 1999a. *Monitoring of resting and wintering waterfowl along the Swedish coast of southern Öresund July 1997 – March 1998 in relation to the Fixed-Link across the Öresund. Report to Öresundskonsortiet*. Ecological Institute, University of Lund.
Nilsson, L. 1999a. *Monitoring of Tufted Ducks Aythya fuligula and Mute Swans Cygnus olor along the Swedish coast of southern Öresund July 1998 – March 1999 in relation to the Fixed-Link across the Öresund. Report to Öresundskonsortiet*. Ecological Institute, University of Lund.
Nilsson, L. 2001. *Monitoring of Tufted Ducks Aythya fuligula and Mute Swans Cygnus olor along the Swedish coast of southern Öresund July 1999 – March 2000 in relation to the Fixed-Link across the Öresund. Report to Öresundskonsortiet*. Ecological Institute, University of Lund.
Nilsson, L.2002. Numbers of Mute Swans and Whooper Swans in Sweden, 1967 – 2000. *Waterbirds* 25 (Special Publication 1): 53 – 60.
SEMAC JV 1997. *The Authorities' Control and Monitoring Programme for the Fixed Link Across Öresund. Benthic Vegetation*. Status Report 1996.
SEMAC JV. 1998. *Myndighedernes kontrol- og overvågningsprogram for Öresundsforbindelsens kyst-til-kyst anlaeg. Bentisk Vegetation*. Tillstandsrapport 1997.
Suter, W. 1982. Vergleichende Nahrungsökologie von überwinternden Tauchenten (Bucephala, Aythya) und Blässhuhn (Fulica atra) am Untersee-Ende/Hochrhein (Bodensee). *Ornithologische Beobacheter*. 79: 225–254.
Verhoeven, J.T.A. 1980. The ecology of Ruppia-dominated communities in western Europe. III. Aspects of production, consumption and decomposition. *Aquatic Botany* 8: 209–253.
VKI/Toxicon. 1996a. *Baseline Study of the Distribution and Dynamics of Ruppia around Saltholm and along the Swedish Coast*. Document No. 96/119/1E.
VKI/Toxicon. 1996b. *Documentation of the Eelgrass Model for Öresund*. Document No. 95/134/2E.
VKI/Toxicon. 1996c. *Dynamics of Eelgrass in Öresund and Assessment of Impact of Shading on Eeelgrass Growth at Different Depths and Times of Season*. Document No 96/108/1E.
Williams, J. E. & Kendeigh, S. C. 1982. Energetics of the Canada Goose. *Journal of Wildlife Management*. 46: 588–600.
Öresundskonsortiet 1995. *The Öresund Link. Supplementary Assessment of the Impacts on the Marine Environment of the Öresund Link*.
Öresundskonsortiet 1998. *Assessment of the Impacts on the Marine Environment of the Öresund Link.*

Sammanfattning

Södra Öresund är sedan gammalt känt som ett viktigt rast och vinterområde för ett flertal olika sjöfågelarter (Nilsson 1991). Många delområden uppfyller också kriterierna för internationellt skyddsvärda våtmarksområden. Beroende på områdets betydelse för fågelfaunan kom studier av de rastande och övervintrande sjöfåglarna att innefattas i kontrollprogrammet för den fasta förbindelsen över Öresund, vilken byggdes under den senare delen av 1990-talet och stod färdig sommaren 2000. Förbindelsen som är 16 km lång består av en kombinerad järnväg/motorväg från Lernacken på den svenska sidan till Kastrup på den danska sidan. Innefattande 1092 m högbro, 6700 m anslutningsbroar, 3500 m sänktunnel sam en konstgjord ö.

Villkoren för Öresundsförbindelsen stipulerade bl.a. att den inte får påverka strömmarna ut och in i Östersjön. För att uppfylla detta krav genomfördes en del kompenserande muddringar i anslutning till bron. Felaktigt genomförda muddringar skulle

kunna medföra ökat sedimentspill i Öresund och därmed en negativ påverkan på områdets undervattensfauna och flora. Omfattande studier av bottenfaunan oh floran (främst *Zostera* och *Ruppia*) kom därför att inkluderas i kontrollprogrammet och gav därmed förutsättningar för jämförelser mellan svanarnas och sothönsens födokrav och tillgången på föda i området.

I den här uppsatsen jämförs svanarnas och sothönsens förekomst i området i relation till de tillgängliga födoresurserna, medan inventeringarna kommer att presenteras mer i detalj i ett annat sammanhang (L. Nilsson & M. Green in prep.), för detaljer från fågelinventeringarna inom kontrollprogrammet hänvisas till de tekniska rapporterna (Nilsson 1996a, 1996b, 1998, 1999a, 1999b, 2001).

Undersökningsområde

Kontrollprogrammet omfattade på den svenska sidan kusten mellan Falsterbo och Barsebäck, men de här behandlade studierna genomfördes i området mellan brofästet vid Lernacken och Falsterbo kanal (Figur 1). Området kännetecknas av stora arealer grunt eller mycket grunt vatten. På de inre lerbottnarna finns en rik vegetation av *Ruppia*, medan omfattande *Zostera*-ängar återfinns på sandbottnarna längre ut V(KI/Toxicon 1999a, 1999b, 1999c, SEMAC 1997, 1998).

Material och Metoder

Fåglarnas utnyttjande av området har beräknats som ”fågel-dagar”. Under 1995/96 och 1996/97 inventerades området mellan Barsebäck och Falsterbo, medan inventeringarna 1997/98 begränsades till området mellan Lernacken och Falsterbo kanal. Hela området inventerades en gång per vecka.

Fåglarnas födobehov baseras på uppgifter hämtade från litteraturen (Clausen et al. 1995, 1996, Mathiasson 1973). I mina beräkningar har jag använt 3,5 kg färskvikt av *Zostera* per dygn som ett mått på svanarnas födobehov. För kalla perioder fann William & Kendeigh (1982) att energiåtgången för gäss och andra andfåglar var ca 25–30% högre. Jag har i beräkningarna använt ett motsvarande högre värde för isperioderna. Sothönans energibehov har bl.a. studerats av Hurter (1972, 1979) samt Verhoeven (1980). Baserat på dessa studier har jag i mina beräkningar utgått från 305 g färskvikt per dygn för sothönan.

Resultat

De viktigaste växtätande arterna i området var knölsvan, sångsvan och sothöna. Bläsanden förekommer också allmänt i området, men eftersom den huvudsakligen betar på strandängarna har jag inte tagit med den här även om den ibland kan furagera på *Zostera* som rivits loss av svanarna.

Antalet svanar och sothöns i området framgår av Figur 2. 1995/96 sågs som mest mellan 2000 och 2500 knölsvanar i området, medan det högsta antalet de båda andra undersökningsåren låg mellan 1500 och 2000. Antalet sångsvanar var väsentligt lägre, men jag har här endast räknat med de sångsvanar som söker föda i vattnet. För sothönsens del noterades som mest ca 2000 individ i undersökningsområdet.

Totalt beräknades svanarna i undersökningsområdet konsumera mellan 780 och 1166 ton färskvikt av undervattensvegetation, huvudsakligen *Zostera* mellan september och mars. Till detta skall läggas mellan 34 och 72 ton för sothönsen. Detta motsvarar totalt mellan 40 och 60 g/m^2 (Tabell 1). Under isperioderna begränsades särskilt svanarnas födosöksareal högst väsentligt (Tabell 2) och under särskilt isperioden 1995/96 var födouttaget ca 500 g/m^2.

Jämfört med mängden tillgänglig föda beräknades att svanarna och sothönsen under isfria förhållanden utnyttjade ca 10% eller mindre av den tillgängliga biomassan. Uttaget av föda var egentligen lägre eftersom viss produktion fortfarande sker under hösten. Under isperioderna närmade sig det beräknade födouttaget mängden tillgänglig föda.

Diskussion

Studierna visar klart att födotillgången för svanar och sothöns i undersökningsområdet i södra Öresund är tillräckliga för betydligt större mängder fåglar än vad som nu utnyttjar området. Totalt beräknades de utnyttja 10% eller mindre av den tillgängliga biomassan. Clausen & Krause-Jensen (1994) fann från en dansk fjord att de växtätande fåglarna (främst knölsvan) konsumerade ca 12% av produktionen.

Under isperioden 1995/96 var dock födotillgången knapp. Både sothöna (Cavé & Visser 1985) och knölsvan (Andersen-Harild 1981) visar under sådana förhållanden förhöjd dödlighet, vilket också återspeglas i de svenska andfågelindexen (Nilsson 1991, 2002).