Between year variation and causes of mortality in the non-breeding population of the Mute Swan *Cygnus olor* in the Netherlands, with special reference to hunting

HANS ESSELINK and JAN H. BEEKMAN

The non-breeding population, mainly young and sub-adult birds, of the Mute Swan in the Netherlands concentrates each year during the summer in lakes IJsselmeer and Grevelingen, where they moult in large flocks. The numbers of these moulting birds vary considerably from year to year. For instance on Lake IJsselmeer between 1983 and 1987 a decline from 4,750 to 2,870 birds was recorded. With data on reproductive success, survival of young birds in their first year (banding data) and mortality differences between severe and mild winters (banding data) this paper attempts to analyse the main factors causing these differences in the non-breeding population. The human impact through shooting swans (20-25% of the Dutch population annually) and disturbing breeding attempts (30-40% annually) for protection of agricultural interests is also covered.

Contrary to general belief in the Netherlands, the Mute Swan, *Cygnus olor*, is an endemic species. Remains have been found during archaeological excavations of waste pits at barrows in the western parts of the Netherlands. These birds were hunted about 2000 years ago. However, since the Middle Ages, Mute Swans have been semi-domesticated, while free-living birds were still hunted. Swans have been kept as fancy birds and viewed as a status symbol by the nobility and middle classes. The swans were found in castle moats and in ponds of city parks. The Mute Swan also became economically important, mainly as a source of meat and down, so much so that birds were imported from south-east Russia in large numbers. This had a serious effect in that it was responsible for a major decline of the Mute Swan population in the Black and Caspian Sea region (G.A. Krivonosov, pers. comm.). Swan breeding farms were established in the north and west of the Netherlands where swans were bred under semi-natural conditions. The main reason for farming was the trade of the meat and down, especially the white down from the cygnets of the "Polish morph" (Munro *et al.* 1968). To prevent the adults and the cygnets from flying away the birds were pinioned.

At the beginning of this century, virtually no wild Mute Swans bred in the Netherlands. The species only occurred as a scarce wintering bird. However, in 1936 a law was passed to protect birds against hunting and nest disturbance. Trade of protected birds and their eggs was prohibited. The first incidental pairs of Mute Swans breeding in the wild were recorded in the early thirties, but a growing Dutch population of Mute Swans was not established before 1948 when one pair started breeding on Lake Zwarte Meer (Timmerman 1957). Moreover, the economic importance of swan farming had already decreased prior to WWII and therefore breeding centres were closed. Young birds that were no longer pinioned escaped into the wild. In the mid-seventies the population had increased to about 2,500 pairs (SOVON 1979) and nowadays the population estimate is between 3,000 and 4,000 breeding pairs (SOVON 1987). So, the Dutch population of wild Mute Swans partly originates from birds surviving swan breeding farms, but growth of the population was only possible under the protection of the legislation achieved in 1936. A few cases have also been cited of birds from the Baltic population, which were probably forced into the Netherlands in severe winters, forming a pairbond with birds from the Dutch population (Dirksen & Esselink 1989). Based on mid-winter counts the present population in the Netherlands has been estimated at approximately 13,000 birds (SOVON 1987).

Swans which breed successfully, moult on their territory while rearing cygnets. The non-breeding population, mainly young and subadult birds and failed breeders, moult in

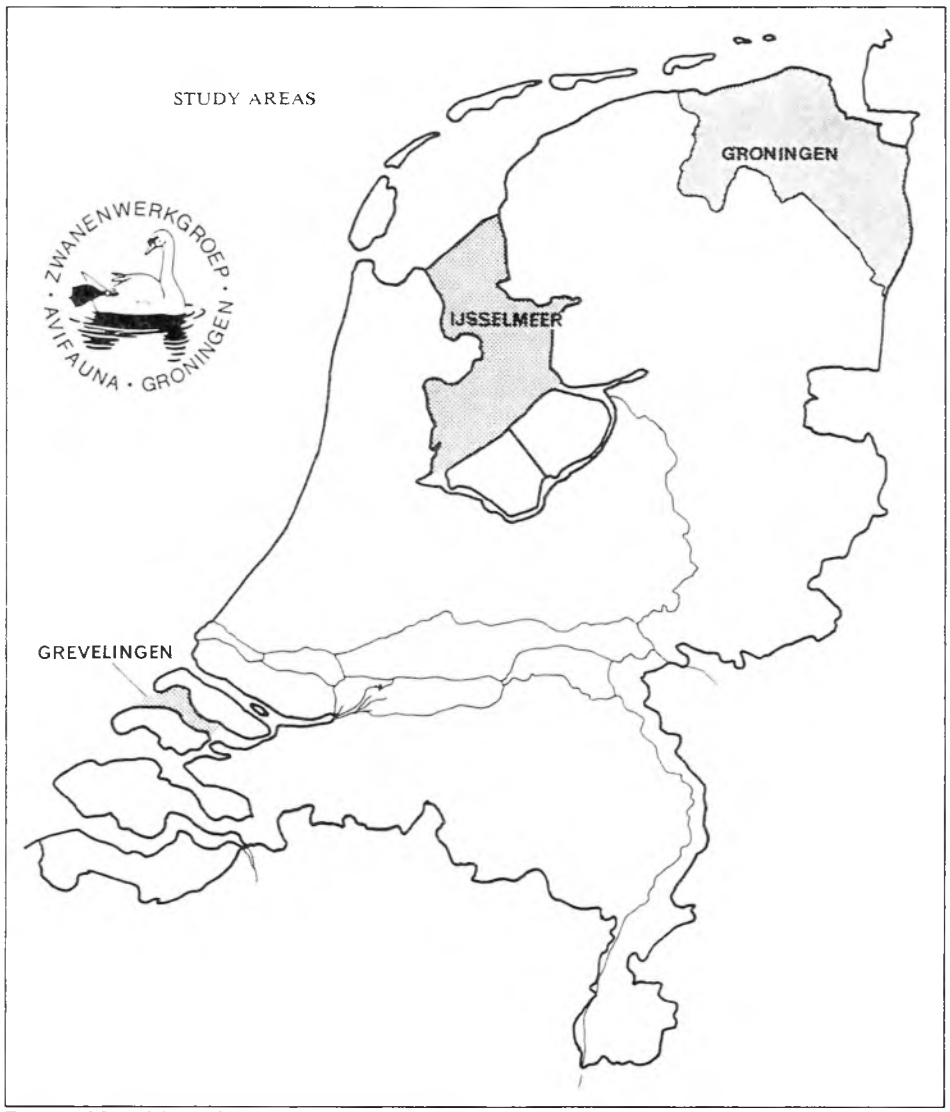

Figure 1. Map of the study areas in the Netherlands.

large flocks on lakes IJsselmeer and Grevelingen during July and August (Fig. 1). During the primary-moult the swans are unable to fly. The number of these moulting birds varies considerably from year to year. In this paper we will attempt to analyse the main factors causing these differences in non-breeding population size, with data on population development, annual reproductive success and mortality rates. Data on mortality causes were analysed and we will show the effect of human impact by legal shooting of large numbers of Mute Swans and (mainly) illegal disturbance of breeding attempts with the aim of protecting agricultural interests. The payments made to compensate for supposed crop damage amount to £7,300 to £26,000 annually (Lemmens 1983). Despite formal protection, hunting and disturbance of nesting attempts are tolerated by national and regional authorities, under the erroneous assumption that the Mute Swan is not an endemic species and is only an agricultural pest. The possible effect of this shooting on otherwise strictly protected Bewick's Swans, *Cygnus bewickii*, and Whooper Swans, *C.*

cygnus, overwintering in the Netherlands will also be discussed.

Study areas

The breeding population of Mute Swans in the province of Groningen in the north-eastern part of the Netherlands (Fig. 1) has been studied since 1984. The area consists mainly of flat open land, intensively used in agriculture for tillage and cattle-breeding. The area is intersected with many ditches, channels and streams. Mute Swans breed along these ditches, channels and small rivers, but also occasionally in city-parks, on the banks of (artificial) ponds and in reed-beds in lakes. Higher concentrations of breeding pairs are found in grassland areas (van Dijk *et al.* 1986, Beekman 1991).

The large moulting flocks of non-breeding swans are found mainly in the IJsselmeer and Grevelingen area (Fig. 1). Lake IJsselmeer situated in the centre of the Netherlands is a shallow fresh-water lake, covering an expanse of 2,000 km². Moulting flocks concentrate along the dikes, where they feed on green algae *Cladophora* spp., which grow below the water-surface on boulders (van Dijk & van Eerden 1991). Lake Grevelingen, in the south-eastern part of the Netherlands, which was separated from the North Sea in 1971 by a dike, is now a shallow salt-water lake. It has become most suitable for moulting Mute Swans, where they feed on Eelgrass *Zostera marina* (Nienhuis & van Ierland 1979, Nienhuis & Groenendijk 1986).

Methods

The analysis of the development of the breeding population in recent years is based on the number of breeding pairs counted in the province of Groningen and the standardised summer-counts in experimental plots nation-wide carried out by volunteers of SOVON (Co-operative Organisations for Ornithological Research Netherlands). From literature, data from the international mid-winter waterfowl censuses (IWRB) were used for the nation-wide winter-population estimates (van den Bergh 1967-1987). The accuracy of these counts is discussed with the results. Censuses of the moulting areas were carried out either by boat or aeroplane at monthly intervals and coverage can be considered complete. The maximum number of birds counted in July or August was used for the analysis.

The calculation of yearly reproductive success was based on the number of cygnets present at the time of banding, i.e. near fledging in late August. However, since not all broods could always be captured, total number of breeding pairs, proportion of successful breeders and average brood size were used to arrive at a total estimate for that year. Three datasets were available for the analysis of mortality causes: the recoveries from the Dutch banding scheme, diagnoses of mortality on free-living birds by the Central Veterinary Institute (CDI) and the number of legally shot swans per year as given by the Ministry of Agriculture, Nature-Management and Fisheries, which issues hunting permits.

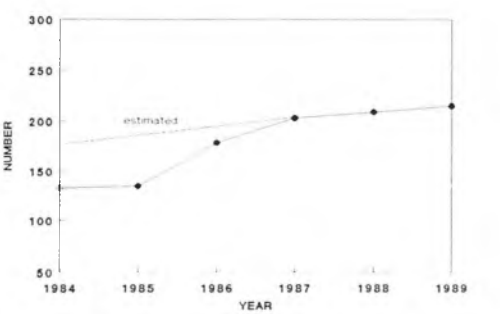

Figure 2. Number of Mute Swan breeding pairs per year in the province of Groningen, the Netherlands.

Results and discussion

Development of the breeding population.

In the seventies and early eighties the Dutch Mute Swan population was still increasing and reached a maximum of around 3,500 breeding pairs (SOVON 1979, 1987). During the present six year study of the breeding population in the province of Groningen approximately 210 breeding pairs have been counted during the last three years (Fig. 2). There appears to have been a major increase after the first two years, but our study area was not completely covered during these two years. An adjusted estimate, based on data from later years, is given: most pairs that were found in later years appeared to breed in earlier years as well, according to landowners. So during the six year study period the local population has only slightly increased. A slight decrease in breeding numbers can be concluded from the nation-wide census data (Fig. 3). However, this is probably due to an increase in the number of experimental plots in non Mute Swan

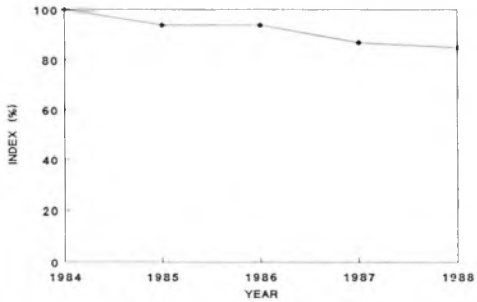

Figure 3. Annual nation-wide index of Mute Swan breeding pairs based on standardised summer surveys in experimental plots. 1984 is 100%. Source: SOVON newsletter 3, 1989.

habitats. Based on these two datasets we assume that the Dutch breeding-population of Mute Swans has remained almost stable during the last six years.

Reproductive success

A pair of Mute Swans, having nested once, will almost invariably nest again in the following year, irrespective of success. During the years 1984-1989 there was little variation in the percentage of successful breeding pairs (at least one cygnet fledged) which fluctuated around 60 per cent (Fig. 4). The majority (90%) of breeding attempts which failed to produce fledging cygnets were disturbed by humans. Usually eggs were taken and nests destroyed, but some-

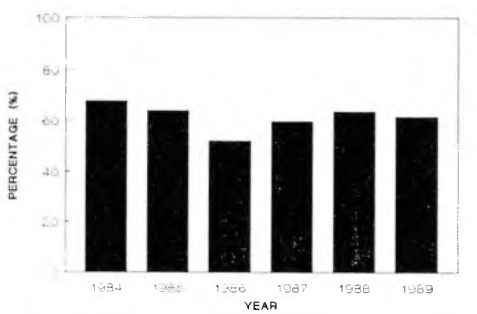

Figure 4. Proportion of successful Mute Swan breeding pairs (at least one cygnet fledged) per year in the province of Groningen, the Netherlands.

times even the birds themselves (adults and/or cygnets) were taken away or beaten to death. It was found that in most cases destruction occurred because of the farmers' belief that the swans damage their crops and meadows, but mindless vandalism was also found to occur.

The average number of cygnets fledged per

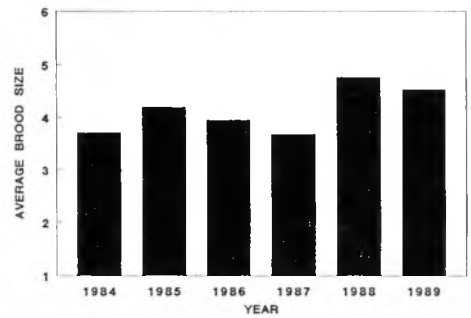

Figure 5. Average number of Mute Swan cygnets fledged per successful breeding pair per year in the province of Groningen, the Netherlands.

successful pair varies from year to year (Fig. 5). The winters 87/88 and 88/89 were extremely mild. During these years the females were able to reach a peak body-condition early in the breeding season and so they started laying eggs earlier in the season and also laid more eggs than after more severe winters (Birkhead *et al.* 1983, Walter *et al.* 1991, Beekman 1991). The late winter of 86/87 was very severe and the opposite result was found, with the lowest average fledging success of our study.

Using the number of breeding pairs, the proportion of successful breeders and the average number of cygnets fledged per brood, the

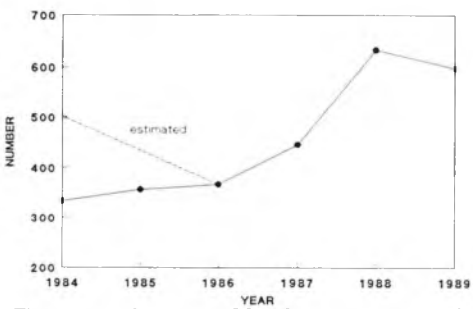

Figure 6. Total number of Mute Swan cygnets fledged per year in the province of Groningen, the Netherlands.

total number of cygnets fledged per year was calculated (Fig. 6). The effect of mild and severe winters is reflected by high numbers of fledged cygnets in 1988 (634) and 1989 (599) and low numbers in 1986 (367) and 1987 (445).

Winter censuses

During the winter, breeding pairs and their offspring tend to stay in their territories and are difficult to count due to the fact that they are

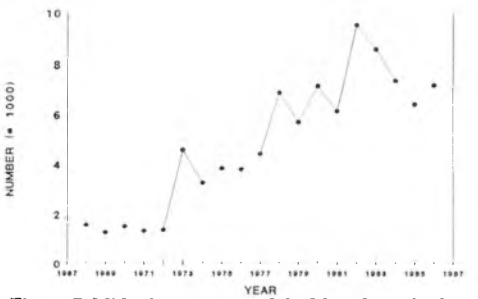

Figure 7. Mid-winter counts of the Mute Swan in the Netherlands based on the IWRB international mid-winter waterfowl census. Source: L. M. J. van den Bergh 1967-87.

often found in low-lying ditches. Other juveniles, already independent from their parents, as well as swans that have not been able to establish territories, disperse over the lower parts of the Netherlands in small flocks where they feed on grass. Only when the weather is severe and the meadows are covered with snow do the swans disappear from the grassland areas and show up in places where waterfowl traditionally concentrate during the winter (Ruitenbeek 1980). This behaviour has serious consequences for the number of Mute Swans counted during winter censuses. For example, January 1982 was very cold with a lot of snow, and a maximum number of 9,532 Mute Swans was counted during the mid-winter census, which is about 2,000 birds more than in mild winters. Figure 7 depicts the fluctuations in numbers of Mute Swans found in the Netherlands in mid-January. Between 1972 and 1982, an increase was recorded, whereas between 1982 and 1985 a small decrease was noted. The increase can partly be explained by an increasing population size, but also by an increase in the number of sites counted, leading to more flocks on meadows being included (Ruitenbeek 1980). The decrease cannot be explained and must be due to incomplete coverage. Note that the number of swans counted each winter amounts to only 60-70% of the estimated total population size of 13,000 birds (SOVON 1987). The dispersing and concentrating behaviour of swans in the winter, plus the fact that in severe winters up to about 1,000 birds from the Baltic population may winter in the Netherlands, means that care must be taken when interpreting winter counts in relation to the number of swans counted on the moulting grounds next summer.

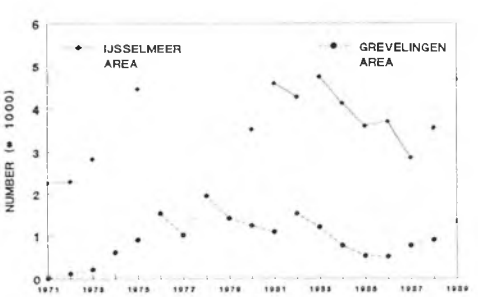

Figure 8. Annual maximum number of Mute Swans in moulting flocks at Lake IJsselmeer and Lake Grevelingen in July or August.

Counts on the moulting grounds

Lake IJsselmeer and Lake Grevelingen are the two areas in the Netherlands, where the young (second calendar year) and subadult birds, as well as the unsuccessful breeders moult in large flocks. In the early seventies the effect of an increasing swan population in the Netherlands was seen, while the number of moulting birds levelled off between 4,000 and 5,000 between 1975 and 1983 on Lake IJsselmeer, and between 1,000 and 1,500 on Lake Grevelingen (Fig. 8). A sharp decrease occurred between 1983 and 1987 which was followed by a sharp increase in the following two years. These fluctuations were most pronounced in Lake IJsselmeer where a decline was recorded from 4,750 to 2,870 between 1983-87, while numbers had risen again to 4,680 moulting birds in 1989.

Since the Dutch breeding population remains relatively stable, and the proportion of failed breeders (at least in Groningen) does not seem to have varied much during 1980-89, the fluctuations in numbers of moulting birds could only be explained by two main factors. The moulting flocks consist mainly of young and subadult birds, and hence their numbers must depend largely on the production of young in the previous two to three years and their subsequent survival until moulting. Since both cygnet production and survival depend on winter temperature effecting clutch sizes in the following spring and survival of cygnets of the previous year, we will discuss the fluctuations qualitatively in relation to the occurrence of severe winters. The marked

Table 1. Severe winters in the Netherlands.

1962/63
1969/70
1978/79
1981/82
1984/85
1985/86
1986/87

Table 2. Post-mortem analyses of Mute Swans in the Netherlands 1975-1989.
Source: Central Veterinary Institute (Th. Smit).

	Number	%		Number	%
Duckplague	2	1	Collisions	26	11
Tuberculosis	2	1	Bitten to death	5	2
Pasteurellosis	25	11	Oil	1	0.5
Botulism	13	6	Shot	8	4
Lung mycosis	8	4	Poison	8	4
Bacteria (Spp.)	10	4	Fishing tackle	7	3
Parasites	11	5	Other metals	2	1
Exhaustion	30	13	Others	69	30

decline in numbers on Lake IJsselmeer between 1983 and 1987 can only be partly explained by reduced cygnet production, and increased winter mortality of young birds since the first severe winter in that period was 1984-85 (Table 1). If reduced production of young or increased mortality were the only factors involved then lower numbers of moulting swans would not have been noted before 1985 or 1986. The onset of the decline was however already recorded in 1984. The mild winter of 1987/88 was followed by a slight increase in number of moulting birds in 1988. After the high production of young in 1988 and the mild winter of 1988/89 the increase in number of moulting birds in 1989 was the highest on record, resulting in almost 1,000 extra moulting Mute Swans on Lake IJsselmeer. So, breeding success and winter mortality only partially explains fluctuations in the non-breeding population.

Mortality

When analysing the results of the diagnoses of dead Mute Swans (Table 2), we have to make two major presumptions: 1. When the cause of death is obvious the birds will usually not be sent in for analysis. 2. When more than one bird dies of the same cause only one or a few birds will be sent in for analysis. However, an important advantage of these data is that we have precise knowledge of the causes of death. Unfortunately the amount of data is too small to use for analysis comparing years or months. In 32 % of all cases the cause of death was disease (Table 2). In 1977 and 1979 Pasteurellosis was found in epidemic proportions in Lake Grevelingen (Mullié *et al.* 1980) and this is perhaps responsible for the two small dips in Figure 8 in this area. Under severe winter conditions a lot of swans die due to exhaustion and the 13 % found is most probably an underestimate. In most cases it is obvious when swans have died due to collisions. Most of these birds are not sent to the CDI for analysis and so the 11 % found is far too low. In only 4 % of the cases had the swans been shot. Surprisingly only a few cases of poisoning (4 %) were recorded of which there was only one case of lead poisoning from fishing tackle and two from spent gunshot. In the Netherlands the widespread use of lead for fishing and shooting is still legal. When we compare our results with the data from the United Kingdom, where the lead poisoning from fishing tackle is a very serious problem, we find a remarkable difference. In post-mortem analyses in the United Kingdom the proportion of lead poisoning lies between 42.4 % and 77.7 % (French & Hunt in Birkhead & Perrins 1986, Sears 1988, Sears & Hunt 1991). There is no clear explanation for this difference between the United Kingdom and the Netherlands, since lead is also recognized as a major problem for waterfowl in the Netherlands (Smit *et al* 1988).

Table 3. Causes of mortality in the Mute Swan from banding recoveries in the Netherlands.

	Number	%
Overhead wires	243	25
Railway accidents	7	1
Road casualities	99	10
Buildings	8	1
Killed by animals	18	2
Shot	390	40
Poison	6	1
Oil	10	1
Other man-made causes	18	2
Exhaustion	98	10
Diseases	31	3
Others	44	5
Unknown	574	

If we compare the results of the post-mortem analysis of the CDI with the results based on the recoveries of the Dutch banding scheme, a few remarkable differences show up (Table 3). First

of all we have to make one important presumption. The dead birds recorded tend to be found by the general public who have a limited ability to judge the correct cause of death. This explains the high frequency of unknown causes of death and the low proportion of diseases reported (see also Table 2). But we also have to be careful with the interpretation of the more obvious causes. If only the known causes of death are taken into account, 39 % of deaths are due to collisions (mainly due to overhead wires) and road casualties. Up until now the results have been very similar compared with the data from the United Kingdom (Birkhead & Perrins 1986). 40% of the recovered birds had been shot which is an extremely high percentage, probably unique in Europe. We will discuss this in the next section. In both data sets about 90 % of the dead birds are juvenile and subadult birds.

Shooting

If farmers complain about damage to their fields by Mute Swans feeding and trampling on their grass or crops, they can get financial compensation or let the swans be shot by a hunter. The formal procedure is as follows: the farmer calls the regional consultant of the Ministry of Agriculture, Nature-Management and Fisheries to complain. The consultant will judge the damage on the spot and will normally give permission for some Mute Swans to be shot by a hunter, as a means to scare away the rest of the flock. The dead swans have to be delivered to a destruction company and if the swan carries a band it has to be recorded and the information sent to the consultant or the Dutch banding station. However, even nowadays, partly because of high working pressure among the clerks and reorganisation of the department involved, a telephone call is often sufficient to get permission to shoot Mute Swans. No on-the-spot judgement of the damage will be made, nor will the consultant check what swan species is/are involved. All the shot swans have to be recorded at the Ministry (Table 4). However, there are no data available from the Ministry for the years 1982, 1983, 1984, 1988 and 1989. If we compare the number of shot swans recorded by the Ministry with the results of the banding data for recoveries with known cause of death and we divide these into swans that were shot and were not shot, a very high proportion of deaths can be attributed to shooting (Fig. 9). A very high number of swans were most probably shot during 1982 - 1984, although the Ministry does not have the data readily available. Based on the causes of death from the banding data set and the bag counts before 1982, we estimate that around 2,000-3,000 swans per annum (about 25 % of the winter population) were shot between 1982 and 1985. This is in close accordance with the estimates given by Lemmens (1983) which were based on data from the Ministry itself. Lemmens (1983) found that 2,000-2,500 swans were shot in 1981 and 1982, and mentions an increased effort to diminish the population in 1983. A sustained average annual culling percentage of 20-25% of the population may explain the observed decline in moulting swans in later years, as recorded in 1983-87 (Fig. 8).

Table 4. Number of legally shot Mute Swans in the Netherlands. Source: Ministry of Agriculture, Nature Management and Fisheries.

	1981	1982	1983	1984	1985	1986	1987	1988	1989
Netherlands	1638				1237	903	256		
Groningen		40	125			9	9	20	42

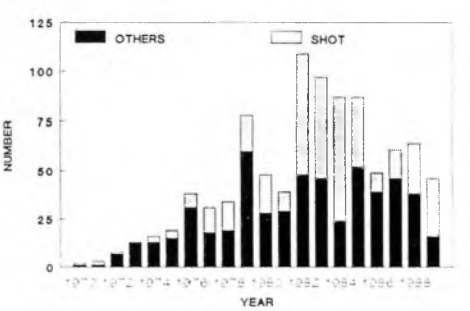

Figure 9. Number of Mute Swans shot and other known mortality causes per year in the Netherlands based on banding recoveries (n=972).

Table 5. Relation between age and death in the Mute Swan caused by shooting, from banding recoveries.

	Shot	Total	% shot
First year	78	344	23
Second year	38	99	38
Third year	20	64	31
Breeding birds	11	98	9

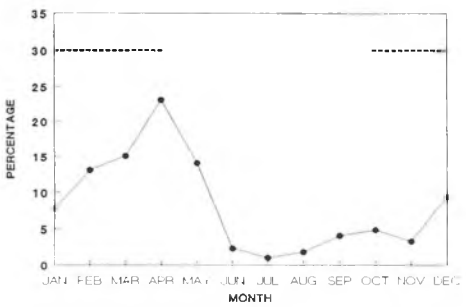

Figure 10. Proportion of Mute Swans shot per month in the Netherlands based on banding recoveries (n=390). The broken line shows the period that Bewick's Swans migrate through or winter in the Netherlands.

Shooting has again increased recently, at least in our study area (Table 4). Apparently, a year with good breeding success is immediately followed by increased complaints and subsequent hunting. Most of the shot swans are young and subadult birds, which are highly mobile and feed in small flocks on grass. However breeding birds also become the victim of shooting (Table 5), including an occasional pinioned bird, or some complete families.

Effects on migratory swans

About half of the entire flyway population of western Bewick's Swans spends the winter in the Netherlands and probably almost the whole population migrates through the Netherlands at some time during the wintering season (Dirksen & Beekman 1991). These birds often mix with flocks of Mute Swans. The Bewick's Swan is strictly protected in the Netherlands as it is in all other European countries, because of the small population size. Whooper Swans are also strictly protected and numbers wintering in the Netherlands have increased manyfold during the past two decades (van den Bergh 1967-87). Finally, during severe winters Baltic Mute Swans are forced to make frost rushes to the Netherlands and numbers probably exceed 1,000 birds in some years. About 30% of the Mute Swans that were banded abroad but recovered in the Netherlands were shot.

It is common knowledge among ornithologists that both inexperienced birdwatchers and most hunters have difficulties in discriminating between swan species, especially in flight. The period during which most Mute Swans are shot coincides almost completely with the period during which Bewick's Swans stay in the Netherlands (Fig. 10 and Dirksen *et al.*1991) and it seems likely that the migratory swan species become the victim of hunting activities. Bewick's Swans wintering in the United Kingdom have migrated through the Netherlands before reaching their final winter destination. 40.4% of the Bewick's Swans captured and X-rayed at Slimbridge, England, had lead shot in their body tissues (Rees *et al.* 1991). Of course we cannot conclude that all of these birds were shot at in the Netherlands, because illegal shooting probably also takes place in other countries. However the Netherlands will at least be partly responsible. Since Bewick's Swans are vulnerable because of their small population size and since the most serious damage done by Mute Swans occurs in late spring (April and May), we propose that shooting of Mute Swans in the Netherlands be prohibited during the winter season (October-March).

Conclusions

Factors that determine the size of the non-breeding population are:

— The number of breeding pairs. The population increase in the Netherlands has almost levelled off since 1980.
— Winter severity. Mild winters are followed by a high reproductive output and low winter mortality due to exhaustion. Severe winters give the opposite result.
— Epidemic diseases in moulting flocks can lower their numbers.

Major causes of mortality in Mute Swans in the Netherlands are collisions, shooting and diseases. Lead from fishing tackle and spent gun shot seems to play a minor role for the Mute Swan in the Netherlands. Hunting Mute Swans should be prohibited, not least for the protection of the migratory swans. Alternative methods need to be developed to scare away Mute Swans when they damage farmers' crops or grass and refuges ought to be established for them. At relatively little cost, set-aside agricultural land could easily be made attractive for waterfowl including Mute Swans.

We are indebted to Mennobart van Erden (RWS, Directorate Flevoland) for allowing us to use his data from monthly aerial surveys of Lake IJsselmeer. Peter Meininger and Gerald Slob kindly updated the census data from Lake Grevelingen. Theo Smit of the Central Veterinary Institute made the post-mortem analyses available. Rinse Wassenaar of the Dutch banding station (Vogeltrekstation Heteren) provided us with the Mute Swan recoveries. Andrie Binsbergen, Gerrit van Brakel and Lex

Tervelde of the Ministry of Agriculture, Nature Management and Fisheries kindly provided the data on numbers of Mute Swans shot. Leo van den Bergh, Bas de Bruin, Rob ter Horst, Henk and Kees Koffijberg, Ben Koks, Joep de Leeuw, Aan Pander, Berend Voslamber and Hans Zwaagstra helped collect other data. This study would not have been possible without the help of the enormous group of volunteers, especially the Groningen Mute Swan Research Group, who helped survey the breeding population, collected the data on reproductive success and assisted with the catching and banding of swans. We are indebted to Miriam Hall who improved our English. Different parts of this study were made possible through grants from the Province of Groningen, the municipality of Groningen, the Foundation Heimans en Thijsse-Fonds and Avifauna Groningen. The presentation of this paper was made possible through financial support from WWF, the Netherlands.

References

Beekman, J.H. 1991. Laying date and clutch size in relation to body weight in the Mute Swan, *Cygnus olor*. In: Sears, J. & Bacon, P.J. (eds.) *Proc. 3rd Int. Swan Symp.* Oxford, 1989. *Wildfowl*. (Supplement No. 1)

Bekhuis, J., van Dijk, A.J., Kwak, K. & Lensink, R. 1989. BMP: indexen en impressies (in Dutch). *SOVON-Nieuws* 2(2):6.

Birkhead, M.E. 1982. Causes of mortality in the Mute Swan. *J. Zool. Lond.* 198:1-11.

Birkhead, M.E., Bacon, P.J. & Walter, P.J. 1983. Factors affecting the breeding success of the Mute Swan *Cygnus olor*. *J. Anim. Ecol.* 52:727-741.

Birkhead, M.E. & Perrins C.M. 1986. *The Mute Swan.* London: Croom Helm.

Dirksen, S. & Esselink, H. 1991. Scandinavian-Baltic Mute Swans *Cygnus olor* in the Netherlands: movements under the influence of severe winter weather and their consequences. In: J. Sears & P.J. Bacon, (eds.) *Proc. 3rd Int. Swan Symp.* Oxford, 1989, *Wildfowl*. (Supplement No. 1)

Dirksen, S., Beekman, J.H. & Slagboom, T.H. 1991. Bewick's Swans, *Cygnus columbianus bewickii*, in the Netherlands: numbers, distribution and food choice during the wintering season. In: J. Sears & P.J. Bacon, (eds.) *Proc. 3rd Int. Swan Symp.* Oxford, 1989, *Wildfowl*. (Supplement No. 1)

van Dijk, K., Voslamber, B., Esselink, H. & Beekman, J.H. 1986. De Knobbelzwaan als broedvogel in Groningen in 1984 en 1985 (in Dutch). *Grauwe Gors* 14(1):12-25.

van Dijk, K. & van Eerden, M.R. 1991. Timing of primary moult of non-breeding Mute Swans *Cygnus olor*, at Lake IJsselmeer, the Netherlands. In: J. Sears & P.J. Bacon, (eds.) *Proc. 3rd Int. Swan Symp.* Oxford, 1989, *Wildfowl*. Special Supplement No. 1.

Lemmens, R.H.M.J. 1983. De Knobbelzwaan in Nederland: een lust of een last! *Een kwantitatief onderzoek aan Knobbelzwanenschade en bestrijdingstechnieken.* Staatsbosbeheer, Inspectie Natuurbehoud, Utrecht.

Mullié, W.C., Smit, Th. & Moraal, L G. 1980. Zwanensterfte ten gevolgen van vogelcholera in het Nederlands deltagebied in 1979 (with English summary). *Watervogels* 5(3):142-147.

Munro, R.E., Smith, L.T. & Kuppa, J.J 1968. The genetic basis of colour differences observed in the Mute Swan (*Cygnus olor*). *Auk* 85:504-505.

Nienhuis, P.H. & van Ierland, E.T.. 1978. Consumption of eelgrass (*Zostera marina*) by birds and invertebrates during the growing season in Lake Grevelingen (SW Netherlands). *Neth. J. Sea Res.* 12:180-194.

Nienhuis, P.H. & Groenendijk, A.M. 1986 Consumption of eel-grass (*Zostera marina*) by birds and invertebrates: an annual budget. *Mar. Ecol. Progr. Ser.* 29:29-35.

Rees, E.C., Bowler, J.M. & Butler, L. 1990. Bewick's and Whooper Swans: the 1989 - 1990 season. *Wildfowl* 41:176-181.

Renssen, Th.A. & Teixeira, R.M. 1980. Taxatie van het aantal Knobbelzwanen in Nederland (with English summary). *Watervogels* 5(1):18-24.

Ruitenbeek, W. 1980. Verschillen tussen aantallen in de zomer en in de winter getelde Knobbelzwanen (*Cygnus olor*) in Nederland (with English summary). *Watervogels* 5(1):25-26.

Sears, J. 1988. Regional and seasonal variations in lead poisoning in the Mute Swan (*Cygnus olor*) in relation to distribution of lead weights in the Thames area, England. *Biological Conservation* 46:115-134.

Sears, J. & Hunt A.E. 1991. Lead poisoning in Mute Swans, *Cygnus olor*, in England. In: J. Sears, & P.J. Bacon, (eds.) *Proc. 3rd Int. Swan Symp.* Oxford, 1989, *Wildfowl.* (Supplement No. 1)

Smit, Th., Bakhuizen, L. & Moraal, L.G. 1988. Metallisch lood als bron van loodvergiftiging in Nederland (with English summary). *Limosa* 61:175-178. SOVON. 1979. *Atlas van de Nederlandse broedvogels*. s-Graveland. Natuurmonumenten.

SOVON. 1987. *Atlas van de Nederlandse Vogels* (with English summary). Almelo: Jellema Druk.

Timmerman, A. 1957. "Wilde" Knobbelzwanen (*Cygnus olor*) op het

Waterwildreservaat Het Zwarte Meer (with English summary). *Limosa* 30:183-191.

Walter, P., Bacon, P.J. & Sears, J. 1991. An analysis of factors affecting the breeding success of Mute Swans, *Cygnus olor*, near Oxford, UK. In: J. Sears & P.J. Bacon, (eds.) *Proc. 3rd Int. Swan Symp.* Oxford, 1989, *Wildfowl.* (Supplement No. 1)

Hans Esselink and Jan H. Beekman, (Mute Swan Research Group, Avifauna Groningen), Zoological Laboratory, University of Groningen, P.O. Box 14, 9750 AA Haren, The Netherlands.