DANISH REVIEW OF GAME BIOLOGY Vol. 12 No. 4

Status and Management of Goose Populations in Europe, with Special Reference to Populations Resting and Breeding in Denmark

by
JESPER MADSEN

Med et dansk resumé:
Status og forvaltning
af gåsebestande i Europa,
og især bestande,
der raster og yngler i Danmark

Резюме на русском языке:
Состояние популяций гусей в Европе и
заведование ими, особенно популяций,
обитающих и гнездующих в Дании

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Abstract

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This paper reviews the status, ecology and management of goose populations in Europe. The development of populations within the 20th century is summarized, and factors determining their size discussed. Crop damage by geese, and its possible solution, is discussed. Proposals to future management and research are given.

Five populations passing through Denmark are used as examples, viz. *Anser fabalis fabalis,* the Svalbard *Anser brachyrhynchus,* the northwest European *Anser anser, Branta bernicla bernicla,* and the Svalbard *Branta bernicla hrota.* The five populations have in common, together with most of the other 16 populations occurring in Europe, that within this century they have increased in numbers and have changed feeding habits. In populations where the dynamics are known, the increase has been attributed to a better survival, and relaxation of shooting pressure seems to be the major causal factor. Many species have, during part of the winter season, changed from feeding in natural habitats or extensively farmed land to feeding on arable land or improved pastures. This has been attributed partly to the destruction of the former habitats (development, reclamation), and partly to better feeding conditions on the farmland. In *Branta b. bernicla* the population increase has led to an earlier exhaustion of the natural food resources on the mudflats, and consequently to the shift to pastures and winter cereal fields. The combination of changed habits and the increase in numbers has given rise to damage on crops. The best solution to the problems is to create refuges with alternative feeding areas, and a better protection and management of mudflats and marshes, which are traditional haunts. An international strategy for the management of the European goose populations is needed. It should be based on knowledge of dynamics and ecological requirements of the populations. Research on the breeding ecology is needed in most populations, however, especially in those breeding in Siberia. Studies of population dynamics are missing for some populations.

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Introduction

At some stage in their annual cycle, the European subcontinent harbours a total of 21 wild goose populations. Throughout this paper a population is defined as a group which is more or less discrete with little interchange of individuals with any other group of the same species. The populations total between 1,329,000 and 1,569,000 geese (Table 1), of which the bulk breeds in arctic regions outside Europe. With a few exceptions the populations have increased markedly during the second half of the 20th century, and the total number of geese wintering in Europe today is probably higher than ever before.

In the course of the last two centuries environmental conditions in Europe have altered considerably, especially due to the intensification of farming and the development of urban societies and industry. In Denmark for example, the uncultivated area, viz. heathlands, moorlands, meadows and saltmarshes, was reduced by 80-85% from 1850 to 1950, and the trend has been continuing since (FERDINAND 1980). Many of the traditional goose feeding sites have been changed into agricultural lands, and the geese have to a large extent changed their feeding habits. Thus, nowadays, at least 16 of the 21 goose populations rely partly or mostly on feeding habitats in cultivated lands during their stay in Europe.

The shift to the farmland has, combined with the increase in goose numbers given rise to conflicts with the farming community. Especially since the 1970s the farmers have shown a growing intolerance towards the geese.

This development has raised the question among wildlife administrators and nature conservationists of how to alleviate the conflicts and how to manage the goose populations and their habitats on an international as well as a national basis. So far the international efforts have been concerned only with the management of the Brent Goose (see SMART 1979, SCOTT & SMART 1982), and the only initiative has been an agreement of not to reopen the shooting season in countries where a ban was imposed.

In this paper the status and management of goose populations in Europe, and especially those passing through and breeding in Denmark is reviewed. The selected populations are:

Taiga Bean Goose *(Anser fabalis fabalis)*

Svalbard population of Pink-footed Goose *(Anser brachyrhynchus)*

Northwest European population of Greylag Goose *(Anser anser anser)*

Dark-bellied Brent Goose *(Branta bernicla bernicla)*

Svalbard population of Light-bellied Brent Goose *(Branta bernicla hrota)*

The purpose of the paper is:

1) to review the status of the five goose populations, including the distribution and number of geese, their ecology, past history, management and population development in all the range states,
2) to provide management and research recommendations for the populations,
3) to summarise and discuss in general trends in goose populations in Europe, factors determining population levels, and goose damage and possible solutions.

Without the international goose counts organized through the International Waterfowl Research Bureau (IWRB), it would not be possible to review the relatively detailed population and distributional

Table 1. Goose populations wintering and breeding in Europe. Most population estimates are based on data from 1980-1984.

Population	Breeding range	Winter range	Population size	Source
Bean Goose				
Anser fabalis fabalis	N Scandinavia, W Siberia	W Europe	60,000	VAN DEN BERGH (1985)
Anser fabalis rossicus	N Siberia	Central and W Europe	200,000-250,000	FOG (1982a)
Pink-footed Goose				
Anser brachyrhynchus	Iceland, E Greenland	British Isles	120,000	OGILVIE (1977-1985)
Anser brachyrhynchus	Svalbard	Denmark, Netherlands	25,000	MADSEN (1984a)
White-fronted Goose				
Anser albifrons albifrons	Siberia	Central and W Europe	300,000-400,000	NETHERLANDS GOOSE WORKING GROUP (unpubl.)
Anser albifrons flavirostris	W Greenland	British Isles	18,000	GREENLAND WHITE-FRONTED GOOSE STUDY (unpubl.)
Lesser White-fronted Goose				
Anser erythropus	N Scandinavia, Siberia	SE Europe, Asia Minor	25,000-50,000 (?)	TIMMERMAN et al.(1976)
Greylag Goose				
Anser anser	Iceland	Scotland	80,000	OGILVIE (1977-1985)
Anser anser	Outer Hebrides, Scotland	N Scotland	2,000	OGILVIE (1984)
Anser anser	W and NW Europe	Spain, Netherlands	130,000	PRESENT PAPER
Anser anser	Central and NE Europe	N Africa	20,000	HUDEC (1984)
Anser anser	E Europe	Balkan Peninsula	20,000-30,000 (?)	HUDEC (1984)
Canada Goose				
Branta canadensis	British Isles	British Isles	20,000	OGILVIE (1977)
Branta canadensis	Sweden	Baltic Basin	20,000	(NILSSON 1984a, MADSEN 1986)
Barnacle Goose				
Branta leucopsis	N Siberia, Gotland	Netherlands	60,000	EBBINGE (1982, unpubl.)
Branta leucopsis	E Greenland	Scotland, Ireland	25,000	OGILVIE (1983)
Branta leucopsis	Svalbard	Caelaverock, Scotland	10,000	OWEN (1984, unpubl.)
Brent Goose				
Branta bernicla bernicla	N Siberia	W Europe	150,000-200,000	IWRB BRENT GOOSE RESEARCH GROUP (unpubl.)
Branta bernicla hrota	NE Canada, N Greenland	Ireland	18,000	OGILVIE (1977-1985)
Branta bernicla hrota	Svalbard, Franz Josef Land	Denmark, England	4,000	MADSEN (1984c)
Red-breasted Goose				
Branta ruficollis	N Siberia	SE Europe, Caspian Sea	22,000-27,000	VINOKUROV (1982)

data. Partly due to the IWRB, partly to nationally organized counts, population sizes, proportion of juveniles and family group sizes are monitored each winter in most goose populations in Europe. From this basic work many more detailed investigations have originated, especially ringing and colour ringing programmes, from which much new information about population dynamics, life histories, migration patterns and behavioural ecology has emerged.

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Taiga Bean Goose *Anser fabalis fabalis* (with remarks on *Anser fabalis rossicus)*

Two subspecies of Bean Goose regularly winter in western Europe: the slenderbilled *Anser fabalis fabalis,* also called Taiga Bean Goose, and the shorter- and deeperbilled *Anser fabalis rossicus,* also called Tundra Bean Goose. Intermediate forms occur, and some authors (e.g. OGILVIE 1978) tend to consider the two forms to be intergrading, while others (ROSELAAR 1977, HUYSKENS 1977, 1979, VAN IMPE 1980a, 1980b, VAN DEN BERGH 1985) consider them as subspecies, as they have been shown to diverge in both morphology and ecology.

From the point af view of population management the two forms ought to be identified as separate entities, and in the present review this has been done. As the Bean Geese passing through Denmark solely belong to the *fabalis* population, special attention will be paid to this, while the *rossicus* population will only be mentioned briefly.

The *rossicus* population breeds in north Siberia, partly overlapping with *fabalis* (Fig. 1, after DELACOUR 1951 and later corrections), and is by far the most numerous of the two populations wintering in Europe. Recent counts in the wintering quarters have indicated that the population probably exceeds 200,000-250,000 geese (FOG 1982a). In autumn the population migrates south of the Baltic and has its main autumn haunts in the German Democratic Republic (GDR) and Poland (LITZBARSKI 1979). Depending on the severity of the winter, geese move on to the Netherlands and the western part of the Federal Republic of Germany (FRG) or into central Europe and as far as France and Spain (Fig. 2). Neck-banding carried out in the GDR (LITZBARSKI 1979) has revealed that there is some connection between the western and central European wintering grounds. Bean Geese wintering in the Netherlands may thus reappear in central Europe later in winter (VAN DEN BERGH 1985, LITZBARSKI unpubl.).

The *fabalis* population breeds in north Scandinavia, north Russia and west Siberia and has a more northwesterly wintering distribution, including Sweden, Denmark, the GDR and the Netherlands (Fig. 3). The population probably numbers more than 60,000 geese. Much new information concerning the migration pattern and ecology

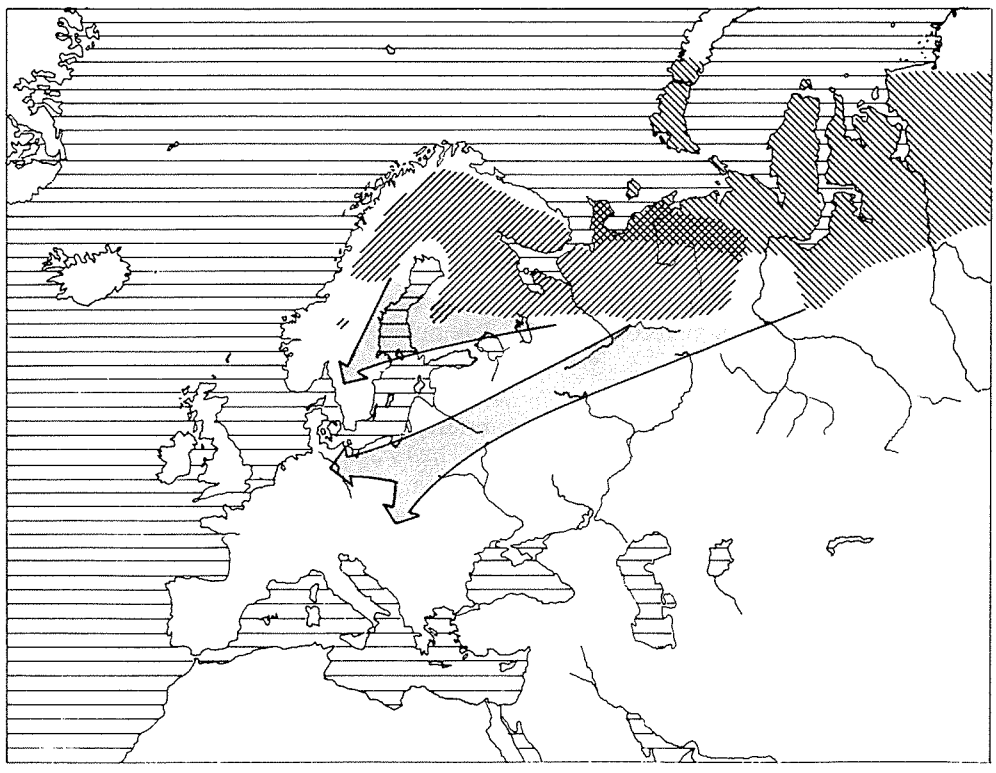


Fig. 1. Breeding distribution and migration routes of Bean Goose populations: To the west *Anser fabalis fabalis,* to the east *A. f. rossicus.* The extension of the range of *fabalis* into Siberia is not well known (After DELACOUR 1951, with later corrections).

of the population has arised from a Scandinavian study sponsored by the Nordic Council for Wildlife Research (NILSSON & FOG 1984).

Breeding grounds and breeding ecology

The number of breeding pairs in the Scandinavian countries and the Soviet Union is unknown. Only in Finland is it estimated that more than 1,000 pairs nest (PIRKOLA & KALINAINEN 1984), but the centre of gravity probably lies in the Soviet part of the breeding range, and on the southeast Kola peninsula breeding density is high (FILCHAGOV et al. 1985). In Finland the population has been increasing in the last decades, whereas in Sweden and Norway it has been decreasing over this century (MELLQUIST & VON BOTHMER 1982, 1984, HAFTORN 1971).

In Scandinavia and possibly also in the Soviet Union the preferred nesting habitat is the minerotrophic type of forest mire with *Carex, Eriophorum* and *Trichophorum* spp. (PIRKOLA & KALINAINEN 1984). Pairs usually nest solitarily or in small, loose colonies in scrub within the mires and feed either in fields cut for hay or in the mires (PIRKOLA & KALINAINEN 1984, MELLQUIST & VON BOTHMER 1984). The main food plants are sedges and grasses, *Equisetum* spp. and in summer various berries (PIRKOLA & KALINAINEN 1984, FILCHAGOV et al. 1985).

The phenology of the breeding season is poorly known. In Finland and on the Soviet part of the Kola peninsula the Bean Geese arrive on their breeding grounds from the second half of April to mid May (LAMPIO 1984, FILCHAGOV et al. 1985).

Moulting grounds are found in Finnmark in north Norway (TVEIT 1984), probably harbouring 1,100-2,300 geese (TVEIT unpubl.), and at the Kola peninsula in the Soviet Union (BIANKI cited in PIRKOLA & KALINAINEN 1984). Moulting concentrations are also known from south Novaya Zemlya and areas to the east (USPENSKI 1965), but are probably mainly used by the *rossicus* population.

Management measures and problems. In Scandinavia the breeding habitats have seriously deteriorated in various ways, of which forestry drainage and peat digging seem to be the most negative interferences (PIRKOLA & KALINAINEN 1984). The traditional hay-cutting in the mires has ceased in many areas, causing a change in the plant communities and a decrease in the Bean Goose population (MELLQUIST & VON BOTHMER 1982, 1984).

In Sweden the Swedish Sportsmen's Association together with the World Wildlife Fund have attempted to reintroduce Bean Geese to former breeding grounds where the vegetation is now managed to the benefit of the geese (MELLQUIST & VON BOTHMER 1982).

Wintering grounds

The wintering range of the *fabalis* population includes the countries Sweden, Denmark, the GDR and the Netherlands. Some *fabalis* flocks possibly also occur in Po-

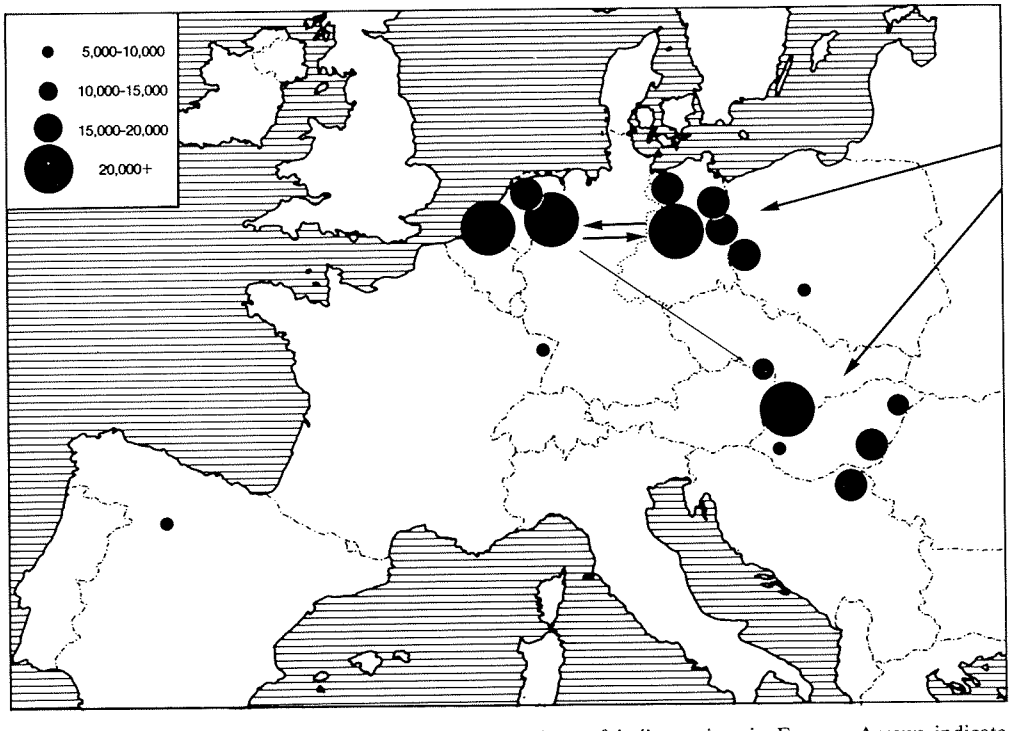


Fig. 2. Midwinter distribution of Tundra Bean Geese *Anser fabalis rossicus* in Europe. Arrows indicate directions of movements (After VAN DEN BERGH 1985).

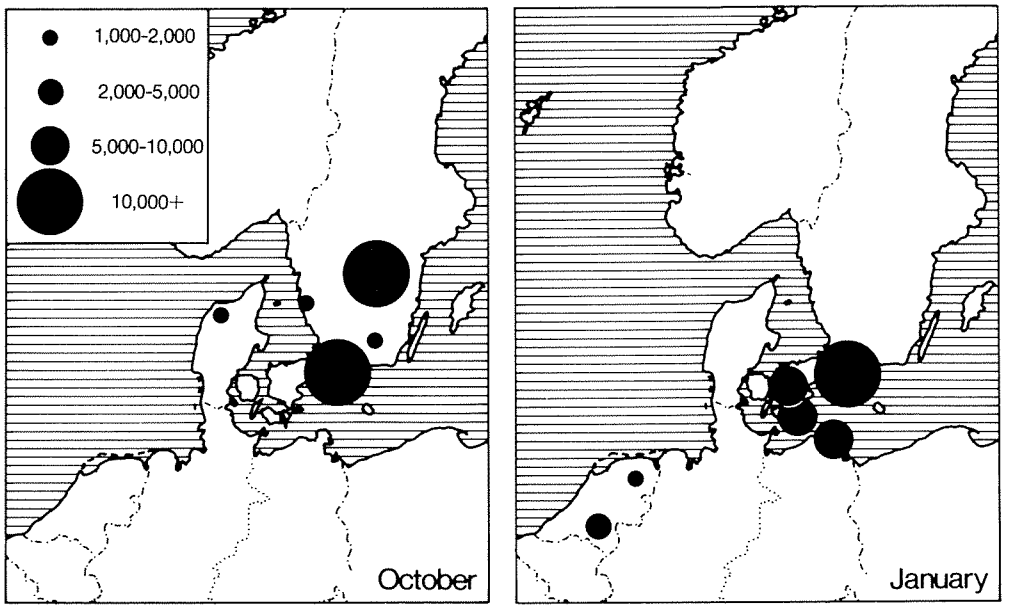


Fig. 3. Distribution of Taiga Bean Geese *Anser fabalis fabalis* in October and January. Sources, see text.

land, and few hundred reach southeast England. Spring staging areas are found in Denmark, Sweden and Finland. The pattern of occurrence in Sweden, Denmark and the Netherlands is shown in Fig. 4.

Sweden

Numbers and distribution. In autumn the Bean Geese arrive on the Swedish staging areas in late September, and usually peak numbers of 40,000 to 60,000 are reached in October (NILSSON & PERSSON 1984, NILSSON 1981, 1984a). The geese remain until the winter weather forces them to leave; in mild winters up to 25,000 stay. Spring migration starts in March and lasts until end of April. Numbers are usually lower than in autumn, and the passage seems to be rapid.

During autumn migration two staging areas dominate: Tåkern adjacent to lake Vättern, and southwest Skåne (NILSSON & PERSSON 1984). The Tåkern area is used only in autumn and deserted in November, while Skåne is also a wintering area. In spring the same areas are used as in autumn, but in addition, Bean Geese stage along the coast of north Sweden, where they are not seen in autumn.

Ecology. In autumn most geese feed on agricultural lands, especially waste grain in stubble fields, sugar beet, waste potatoes and winter cereals, whereas grasslands are only used to a minor extent. In winter the geese turn to winter cereal fields and grassland, while in spring they concentrate on grassland (NILSSON & PERSSON 1984). In winter the geese spend on average 78% of the active day feeding, and the feeding activity increases inversely with temperatures (EBENMAN et al. 1976).

Past history. In November 1956 and 1958 the first counts were organized in Skåne (MATHIASSON 1963), and 16,800 and 12,800 Bean Geese were found, respectively. In comparison, the November counts

between 1977 and 1980 varied between 17,900 and 28,700 individuals (NILSSON & PERSSON 1984). NILSSON & PERSSON, (1984) estimate that over the last two decades (1960 to 1980) the total autumn population has increased from about 20,000 to 40,000-60,000 geese. However, within the Swedish haunts the geese have redistributed. Thus, the importance of Tåkern has increased markedly during the last decades, whereas numbers in Skåne have remained more or less constant.

Legal status. In Norrbotten the open season extends from 1 to 15 September, in Skåne from 1 to 21 November. About 3,000 Bean Geese are bagged annually (THELANDER 1982).

Management measures and problems. Crop damage caused by grazing Bean Geese and Canada Geese has only been documented for winter rape (JÖNSSON 1982a), whereas damage to winter cereals is nonexistent or negligible (MARKGREN 1963, EBENMAN et al. 1976, JÖNSSON 1982a).

Plans to create goose refuges in order to alleviate conflicts with agriculture have been suggested (HAMILTON 1982, JÖNSSON 1982b).

Finland

Numbers and distribution. Having left Skåne in Sweden in spring, flocks of Bean Geese move on to Finland on their way to the breeding grounds. Major staging areas are found in the districts of Lumijoki, Liminka and Tyrnävä at the northeast corner of the Gulf of Bothnia (LAMPIO 1984). The first geese arrive along the west coast in the first half of April, and numbers peak in the last week of April/early May with more than 10,000 staging Bean Geese. The geese move on shortly after.

No information exists on autumn gathering places or their relative importance.

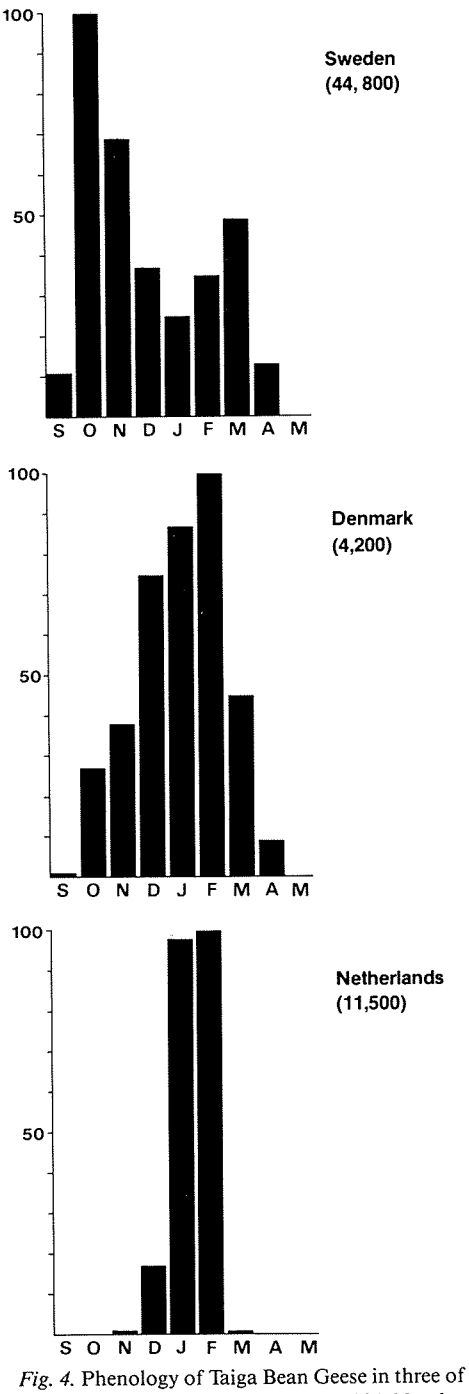


Fig. 4. Phenology of Taiga Bean Geese in three of the winter range states. Data from 1980-1984. Numbers in brackets give average maximum (=100%). Sources, see text.

Ecology. In spring the Bean Geese feed mainly in pastures and stubble fields which are ploughed late in spring after the departure of the geese (LAMPIO 1984).

Legal status. The open season extends from 20 August to 30 November, except for southern and western districts where it starts on 1 September. 4,000 to 5,000 Bean Geese are bagged annually (ERMALA & VIKBERG 1982).

Denmark

Numbers and distribution. In Denmark two groups of *fabalis* seem to stage and winter. In northwest Jutland Bean Geese arrive in the beginning of October, dispersed over 4-5 haunts. Numbers peak in November with 2,000-3,000 individuals; in mild winters some of the geese remain, while in cold winters they leave the region totally and reappear from March to April. In southeast Denmark another group arrives in December, and numbers peak in January and February. In 1980-83 up to 6,000 geese were counted in this region (MADSEN 1986), but in the winter 1985/86 up to 17,000 have been counted (H. E. JØRGENSEN pers. comm.). The highest numbers are recorded in cold winters, when the Bean Geese leave Skåne in Sweden and migrate further south. If the cold weather continues for longer periods, the geese also leave the Danish haunts.

Ecology. In northwest Jutland most of the geese feed on grasslands, but also on winter cereal fields and stubble fields. In southeast Denmark they feed primarily on winter cereals and to a minor degree on grasslands and sugar beet (MADSEN 1986). Some of the major Danish haunts are former or partly intact peatlands. Sometimes the geese are found roosting here; elsewhere the geese roost along the coasts or on lakes.

Past history. In northwest Jutland the numbers in autumn have declined much in this century, probably due to agricultural changes, but also to drainage of peatlands which were traditional Bean Goose haunts.

Legal status. The open season extends from 1 September to 31 December. According to FOG (1977) about 300 to 600 geese were bagged annually in the 1960s.

Management measures and problems. In two of the remaining peatlands where Bean Geese are staging, drainage and reclamation continue and threaten the original habitat.

German Democratic Republic

Numbers and distribution. The information is very scant, but according to LITZBARSKI (1979) Bean Geese from Sweden *(fabalis)* stay along the Baltic coast in winter. The rossicus population is mainly distributed in the central regions of the country. No exact figures on *fabalis* numbers have been published.

Legal status. The open season extends from mid August to 31 January (LAMPIO 1983).

The Netherlands

Numbers and distribution. The *fabalis* population has nine regular wintering sites distributed in the provinces Drenthe, Friesland, Overijssel, Noord-Brabant and Limburg. The haunts are separated from the haunts of the *rossicus* population. In mild winters up to 2,000 *fabalis* reach the Netherlands, in colder winters up to 17,000-18,000 (VAN DEN BERGH 1985, NETHERLANDS GOOSE WORKING GROUP 1983, 1984a, 1984b, in press). In colder winters more sites are used, and some mixing with the *rossicus* geese occurs. Usually the

first *fabalis* geese arrive in late October/early November, and numbers peak in January and February. By the end of February most geese have left the country.

Ecology. The *fabalis* geese occur in the few remaining peatlands where they mainly feed in meadows. Only in severe winters do they visit arable land feeding on winter cereals, waste potatoes and sugar beet (VAN IMPE 1980b, VAN DEN BERGH 1985). In contrast to the *fabalis,* the *rossicus* geese typically feed on arable lands on waste potatoes and sugar beet, and gradually change to grasslands as the winter proceeds. In some places the *fabalis* roost in the peatlands or on adjacent lakes, whereas the *rossicus* roost on shallow waters along the coast or on lakes and rivers.

Past history. According to references in VAN DEN BERGH (1985) the *fabalis* was formerly the more common of the two subspecies in the Netherlands, but the wintering population has declined over the present century.

Legal status. The open season extends from 1 September to 31 January, but shooting is only allowed from 30 minutes before sunrise to 10.00 a.m.

Management measures and problems. Since 1970 some of the feeding grounds have deteriorated due to drainage and development, and the goose numbers in those areas have declined (VAN DEN BERGH 1985). Most of the present roosts are refuges, while only a few of the feeding grounds are protected.

Population development

The most reliable estimate of the size of the *fabalis* population is presented by the Swedish autumn counts reviewed above. In October, when peak numbers are reached in Sweden, only less than 2,000 Bean Geese occur in Denmark. According to the counts the population has increased from about 20,000 in 1960 to 40,000-60,000 in 1977-1982 (NILSSON & PERSSON 1984, NILSSON 1981, 1984a). The increase has been reflected in the breeding population in Finland (PIRKOLA & KALINAINEN 1984), but not in the Swedish and Norwegian populations which have declined (MELLQUIST & VON BOTHMER 1982, HAFTORN 1971).

Discussion

A possible reason for the population increase is the spring shooting ban in the Soviet Union in the 1960s (PIRKOLA & KALINAINEN 1984), but other unknown factors may well have been operating.

Summarising the migration pattern of the *fabalis* population, Sweden is the principal autumn and spring staging area. In mild winters a high proportion of the population remains in Skåne, but usually most geese move on, first to Denmark, then to the Netherlands and probably the GDR. In mild winters the Netherlands are only reached by less than 2,000 birds, which may be the flocks staging in northwest Denmark until late autumn.

The population has to some extent retained its former adaptation to the mire habitat in the wintering areas. Although the geese are gradually changing habits, some flocks still feed on grasslands associated with peatlands, especially in the Netherlands, but also in Denmark and Sweden.

Management needs. In the breeding range the conservation of forest mire habitats is of vital importance for the future well-being of the *fabalis* population, and more efforts should be put into this matter. On the wintering grounds the *fabalis* is still associated with the peatland habitat, and the conservation of these sites is important to

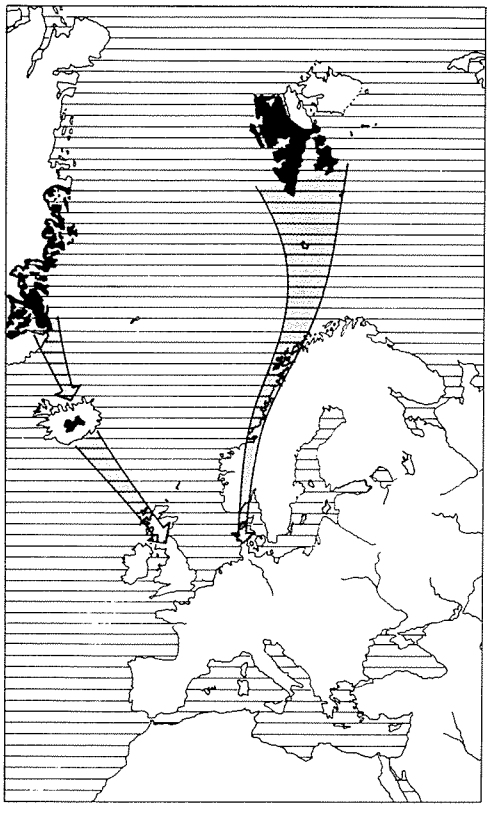


Fig. 5. Breeding distribution and migration routes of Pink-footed Geese. Sources, see text.

maintain the peculiar adaptation of this goose population.

Research needs. Very little is known about the situation of the Bean Geese and their racial distribution and ecology in the Soviet Union, and studies are badly needed.

Although a picture of the migration route of the *fabalis* population is emerging (NILSSON 1984b), more information is needed about the occurrence of the subspecies in the GDR.

Virtually nothing is known about the population dynamics of the *fabalis* subspecies. One way to get more information would be to carry out age counts and counts of family group sizes in Sweden in autumn, when most of the population is concentrated there.

Pink-footed Goose *Anser brachyrhynchus* (Svalbard population)

There are two separate populations of Pink-footed Geese in the world, one breeding in Svalbard and wintering in Denmark, the Netherlands and Belgium, another breeding in Iceland and east Greenland and wintering in the British Isles (Fig. 5). The former numbers at present about 25,000 individuals (MADSEN 1984a), the latter about 120,000 (OGILVIE 1982a, 1977-1985, unpubl.). Despite the nearness of the wintering ranges, ringing recoveries have shown that there is only a slight interchange and no net immigration or emigration of individuals between the two populations (EBBINGE et al. 1984, WILDFOWL TRUST unpubl. data).

In the following only the Svalbard population of Pink-footed Goose will be treated.

Breeding grounds and breeding ecology

According to LØVENSKIOLD (1963) and NORDERHAUG (1970) most Pink-footed Geese breed in western Svalbard, although many areas, especially in the eastern islands, are still unexplored. Compared to the other two breeding species, Barnacle Goose *Branta leucopsis* and Light-bellied Brent Goose *Branta bernicla hrota,* which are mainly concentrated to islets when breeding, the Pink-footed Geese have the widest distribution. Nesting habitats range from islets to inland tundras; lowland cliff sides beneath grassy slopes, especially close to sea bird colonies, seem to be a favourite

nest site (NYHOLM 1965, NORDERHAUG et al. 1964, F. MEHLUM pers. comm.). The wider distribution of the Pink-footed Geese is probably related to their ability to protect the nest from predation by Arctic Foxes *Alopex lagopus,* an ability the two smaller species do not share (e.g. LØVENSKIOLD 1963, EKKER 1981, MELTOFTE et al. 1981). The remains of adult Pink-footed Geese are, however, sometimes found at Arctic Fox dens (M. OWEN, pers. comm.).

The Pink-footed Geese usually arrive to Svalbard during the last 10 days of May when there is still extensive snow cover, and egg laying commences from the first days of June (LØVENSKIOLD 1963). In years of late snow melt, many birds are either breeding later or are prevented from breeding at all. In those years few juveniles are brought to the wintering grounds (Table 2). Hatching usually takes place during the first half of July. Autumn migration extends throughout September into October (LØVENSKIOLD 1963). As shown for the Barnacle Geese (PROP et al. 1984), the time of mass emigration probably depends on the time of heavy snow fall.

Besides some information about breeding biology (BLURTON JONES & GILLMOR 1959, LØVENSKIOLD 1963, NYHOLM 1965, EKKER 1981) and densities (NORDERHAUG 1970, PROKOSCH 1984a), there is very little published information about the summer ecology of the Svalbard population of Pink-footed Goose. This is in contrast to the intensive studies of the breeding ecology of the Svalbard population of Barnacle Goose carried out by a team of Dutch and British scientists (PROP et. al. 1981, 1984).

Table 2. Proportion (in %) of juveniles in the Svalbard breeding goose populations, as recorded on the wintering grounds (data from M. OWEN, M.A. OGILVIE, L. SCHILPEROORD, J. MADSEN unpubl.).

Year	Pink-footed Goose	Barnacle Goose	Light-bellied Brent Goose
1980	24.2	22.7	16.5-24.2[1]
1981	5-10[2]	3.2	1.5
1982	21.8	12.0	18.3
1983	10-12[3]	8.0	5.5-8.0[1]
1984	24.7	26.2	18.3
Mean	17.8	14.4	13.0

Notes: *1:* Variation between Danish and English estimates, *2:* Variation between Danish and Dutch estimates, *3:* Only small sample.

Legal status. The open season starts 21 August, previously 1 September with a possibility of shortening in years of late spring (F. MEHLUM pers. comm.). Since 1975 the Pink-footed Goose has been protected in spring. No bag statistics exist, but probably only a few hundred are bagged annually (F. MEHLUM pers. comm.).

Management measures and problems. Fifteen small bird sanctuaries are situated on the west coast of Svalbard, however, only a few pairs of Pink-footed Geese breed there (PRESTRUD & BØRSET 1984). On Svalbard human activities, i.e. industrial and touristic, are increasing. In the forthcoming years 15-20 oil exploration companies and groups are expected to be operating (F. MEHLUM pers. comm.), which will undoubtedly cause much disturbance to breeding and moulting geese and increase their susceptibility to Arctic Fox predation, especially due to heavy helicopter traffic (see MADSEN 1984b).

Migration routes and staging areas

Until recently the migration routes of the Pink-footed Geese from their Danish spring haunts to Svalbard, and the reverse autumn routes were unknown. However, goose flocks passing through central Norway (Fig. 5) from 5 to 25 May have been identified as Pink-footed Geese (FRENGEN 1977, BOLLINGMO 1981). Most geese seem to reach the northern Atlantic coastline at

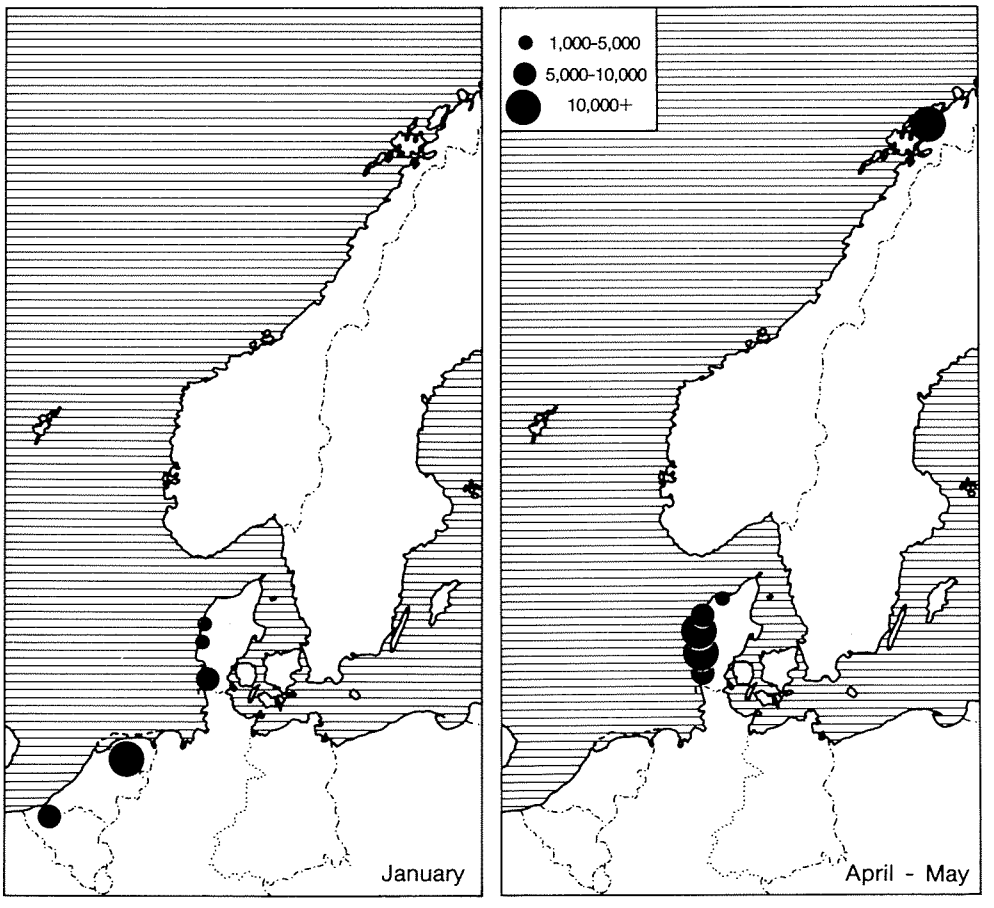


Fig. 6. Midwinter and spring distribution of the Svalbard Pink-footed Geese. Sources, see text.

Trondheim, from where they follow the coast.

A regular spring staging area has been found on the islands Andøya and Grunnfør in Nordland. Here up to 10,000 Pink-footed Geese have been recorded in mid May, and probably the entire population stops for 3-5 days (RIKARDSEN 1982, N. GULLESTAD pers. comm.). The geese leave the islands between 16 and 20 May.

The exact route from Nordland to Svalbard is still unknown, and it is also unknown whether the geese make a short stop on Bear Island or by-pass it. However, Bear Island is largely snow-covered in May, so the Pink-footed Geese probably, as do the Barnacle Geese, fly straight to Svalbard (M. OWEN pers. comm.). In autumn it is now known that flocks of Pink-footed Geese stop on Bear Island for a short time from mid September to early October (OWEN et al. 1985). The autumn migration route through Norway has not yet been described, but probably the geese follow the same path as in spring, though only stopping in Nordland for a short period (N. GULLESTAD pers. comm.).

Habitat selection. On Andøya in Nordland the geese graze in saltmarshes and fens, and

only to a little extent on agricultural land (RIKARDSEN 1982, N. GULLESTAD pers. comm.). In autumn they graze the short coastal tundra on Bear Island and grub for roots in heathy habitats behind the cliffs (M. OWEN pers. comm.).

Legal status. Open season extends from 21 August to 23 December (Norway in general) (LAMPIO 1983).

Management measures and problems. There are no protected feeding and resting areas.

Wintering grounds

The wintering grounds normally range from northwest Jutland in Denmark, over FRG, the Netherlands to northwest Belgium (Fig. 6). In cold winters the range can be extended to sites in northern France (HOLGERSEN 1958, ROUX 1962). The Pink-foot is a rare visitor in south Sweden (NILSSON & PERSSON 1982).

Below a national review of the present and past situation of the Pink-footed Goose is given. The relative distribution in the various countries through the winter season is presented in Fig. 7.

Denmark

Numbers and distribution. 12-14 sites situated in a narrow corridor along the west coast of Jutland are used by the Pink-footed Geese.

In autumn the first flocks arrive from 15-25 September (MADSEN 1980), and the staging population builds up to a peak around mid October, when the entire Svalbard population can be concentrated in the Danish haunts. Owing to shooting disturbance the geese are concentrated in only two farmland areas, holding 93% of all goose-days spent in the country in autumn, viz. Filsø and Vest Stadil Fjord (MADSEN 1986). However, in the autumns since 1981 their occurrence has changed quite dramatically. In the main haunt, Filsø, farming practice has changed; before 1980 winter crops were little used, but in the 1980s the areas of winter cereals and rape have increased (MADSEN 1986), and the stubble area, which is preferred by the geese (MADSEN 1985a) has declined. Due to the farmer's fear of damage to the winter cereals, the geese are driven off the farmland by intensified shooting pressure, resulting in an abrupt decrease in the autumn staging population. The geese now move on directly to the Netherlands, flying across the North Sea, and thus by-passing FRG. As a result the Pink-footed Geese now leave Denmark earlier than mid October, and in November only a few thousand geese remain.

As long as daily mean temperatures in winter remain below 0°C only few Pink-footed Geese winter in Denmark. However, from mid December flocks arrive from the south following 1-2 days of thaw. The geese make use of two haunts especially, in Ballum Enge with up to 16,000 individuals recorded in January and the Tipper peninsula with up to 6,000 (MADSEN 1985c, 1986). The geese probably come directly from the Netherlands.

From the end of March to the beginning of May the whole population is concentrated in Denmark. The geese make use of up to 14 sites on a chain along the west coast. Most sites are only used for a relatively short period, and there is much movement between them within short intervals (MADSEN 1984a).

Ecology. In autumn almost all geese feed on spilt grain in stubble fields (MADSEN 1984a); leaves of winter cereals are only grazed to a small extent. In winter and early spring, feeding is concentrated on grasslands, which are rough pastures and saltmarshes. Primary production on the grasslands starts at the end of March/beginning

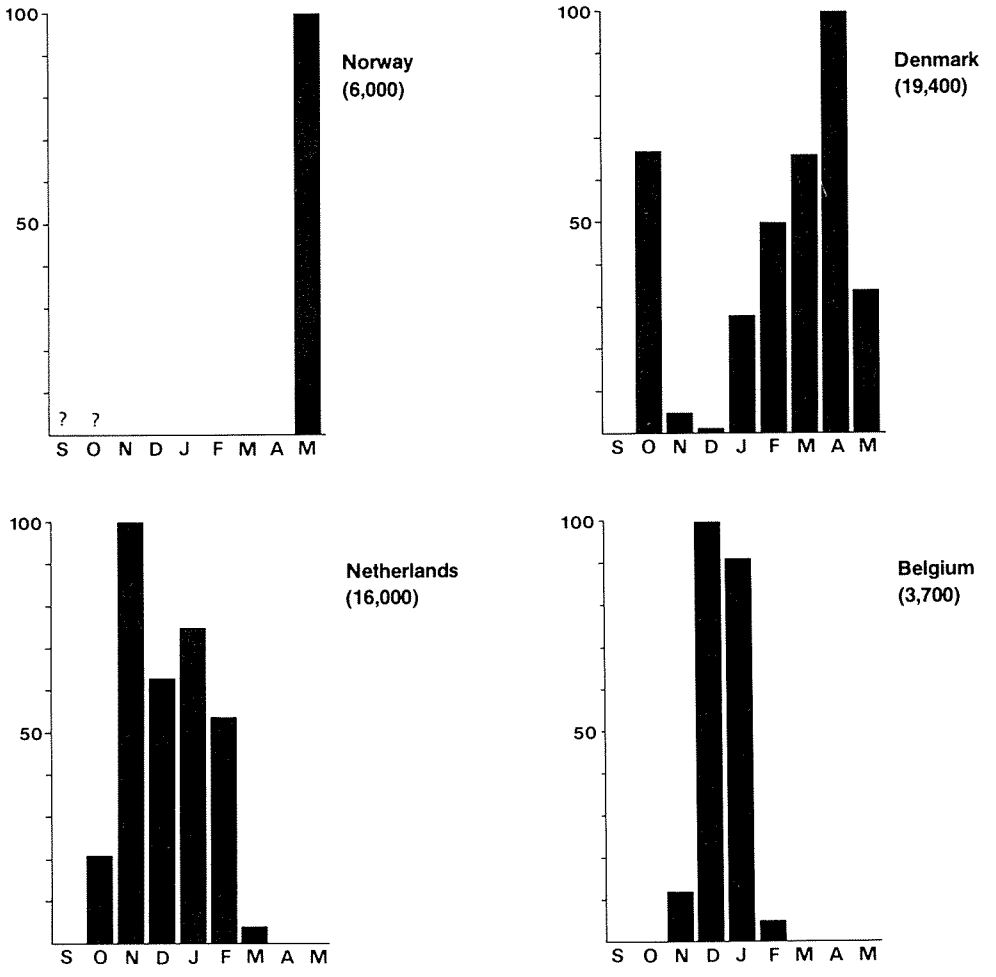


Fig. 7. Phenology of Svalbard Pink-footed Geese in the winter range states and on the migration route, expressed in percentage of peak month. Data from 1980-1985. Numbers in brackets give the average maximum (=100%). Sources, see text.

of April, and the wintering goose flocks gradually deplete the food resources, which are not replenished (LORENZEN & MADSEN 1985). In Værnengene (the Tipper peninsula) the goose flocks have a systematic foraging routine, revisiting the same fields at intervals, until a threshold green biomass of approx. 40 g dry weight per m^2 is reached, whereupon the flocks shift to other, previously ungrazed areas. LORENZEN & MADSEN (1985) concluded that the carrying capacity of Værnengene in winter was reached at about 150,000 goose-days, or about 1,000 goose-days/ha.

As sowing of spring cereals in west Jutland commences from end of March, the goose flocks gradually shift to the newly sown fields where they pick up grain from the surface. An analysis of daily energy balance of Pink-footed Geese feeding on grassland and newly sown fields, respectively, revealed that from an energetic point

of view it is of great advantage to feed in the latter habitat (MADSEN 1985b). From mid April to mid May the majority of geese feed on newly sown fields or are baited at Vest Stadil Fjord.

Past history. Before 1955 spring shooting of Pink-footed Goose was legal. The population only had few haunts in Denmark, the most important being Tipperne, where probably the entire Svalbard population could be concentrated in autumn and spring (LIND 1956, MADSEN 1980). Other known haunts were Filsø and some saltmarsh areas in the Danish Wadden Sea. In spring the geese fed entirely on grasslands, and in autumn also on stubble fields in Filsø. Following the spring shooting ban the geese gradually dispersed to other sites in west Jutland. In the late 1950s Vest Stadil Fjord, a former shallow lagoon with adjacent reed swamps, was reclaimed for agricultural land. Soon the Pink-footed Geese started to utilize the farmland, and this was the first place where they were observed to feed on the newly sown fields in spring (FOG 1982b). In the course of the 1970s a massive shift to the newly sown fields happened in many areas of west Jutland, and nowadays flocks of Pink-footed Geese are seen widely dispersed on fields even far inland, where they were unknown only five years ago (MADSEN 1984a).

Before 1979 the saltmarshes at Højer adjacent to the West German border were important staging areas for up to 3-5,000 Pink-footed Geese. However, since the marshes have been diked in 1979 most geese have abandoned the area, probably due to increased human activity and deterioration of the feeding grounds (GRAM 1982).

Legal status. The open season extends from 1 September to 31 December. Based on a questionnaire to Danish hunters, FOG (1977) estimated that 400-700 Pink-footed Geese were bagged annually in the 1960s; today the annual bag is believed to be about 1,500, based on contact with hunters in west Jutland (MADSEN unpubl.).

Management measures and problems. Due to claims of goose damage to newly sown oat fields and pastures at Vest Stadil Fjord in the early 1970s, an experiment was carried out, with the aim to keep the geese off the potentially damaged areas by means of baiting with grain (FOG 1982b). Since 1973 the Danish Game Foundation has paid for purchase and scattering of barley grain every spring; the geese have concentrated on the fields with bait, and claims of damage have almost stopped.

Claims of damage to newly sown cereal fields have also recently come from other sites, e.g. Filsø. Here the effect of goose feeding on yield structure of spring barley has been analysed in two consecutive years. A reduction of 7-20% in yield expressed in grain weight was estimated for central areas. However, much of the damage could probably be avoided by more careful drilling of the seed barley (LORENZEN & MADSEN 1986).

In only two Pink-footed Goose haunts, Tipperne and Vejlerne, are the feeding grounds and roosts protected areas, and shooting is not allowed. In four other places the feeding grounds are protected, but without shooting restrictions (MADSEN 1986).

In the 1960s the grasslands in Tipperne were overgrown, due to lack of cattle-grazing and cutting. Since 1972 a management programme was started by the Nature Conservancy Council to restore the original short-grazed habitat. During the period 1972-1978 the goose-grazed area was increased three-fold following reintroduced cattle-grazing and cutting (MADSEN 1980). However, due to the spring shift to the newly sown fields the population of Pink-footed Goose in Tipperne has declined despite the management programme.

Federal Republic of Germany

Past history. Formerly the Pink-footed Geese used sites along the German North Sea coastline (e.g., HOLGERSEN 1960, HUMMEL 1980). Four sites were important, all of which were saltmarshes and rough pastures: Emsland with maximum numbers of 2-3,000 geese, Föhr with 8-10,000, Jadebusen with up to 10,000, and Rodenäs-Vorland with up to 12,000 geese (see review by PROKOSCH 1984b). However, today none of these areas hold Pink-footed Geese in significant numbers, and in autumn and spring the geese by-pass the German haunts. On Föhr ploughing up of the goose-grazed pastures, settlement of human population, and probably increased shooting pressure in the 1950s was responsible for the population decrease; in Emsland drainage and reclamation in the 1950s; in Jadebusen increased human activity in the 1970s, and on Rodenäs-Vorland building of a seawall and subsequent increase in human activities since 1979 (see also p. 44) (PROKOSCH 1984b).

Today less than 1,000 Pink-footed Geese stay in FRG at any time during winter.

Legal status. Total protection since 1977.

The Netherlands

Numbers and distribution. Only one large area south of the town of Sneek in southwest Friesland is used by the Pink-footed Geese.

The first large flocks arrive in the second half of October; peak numbers are usually reached in November (TIMMERMAN 1977, ROOTH et al. 1981) with up to 18,000 recorded in the 1980s (SCHILPEROORD 1984). The geese have, however, since 1982 arrived about two weeks earlier (SCHILPEROORD 1984 and pers. comm.), because of the increased shooting pressure at the Danish autumn haunts. Numbers remain relatively constant until December, whereupon flocks move southwards to Belgium, and in mild winters northwards to Denmark. Normally all geese have left Friesland after the first week of February, though flocks may return later in February in response to adverse snow and frost conditions in Denmark (SCHILPEROORD 1984, MADSEN 1984a).

Ecology. Virtually all Pink-footed Geese are concentrated on grasslands, which are wet, fertilized pastures, intensively used in summer for cattle grazing and hay cutting (SCHILPEROORD 1984).

Past history. Pink-footed Geese have been known to winter in the province of Zeeland as far back as 1900. However, in around 1920 the geese abandoned the area (LEBRET 1959), and until the winter 1955/56 virtually no Pink-footed Geese occurred in the Netherlands. Then, rather abruptly, the wintering population in Friesland built up from a few hundred to about 12,000 geese (TIMMERMAN 1977); this happened in parallel with the decrease in the wintering populations in Emsland and Jadebusen in FRG. The peak number of 12,000 geese remained quite constant until the 1980s when numbers have reached a maximum of 18,000 (SCHILPEROORD 1984).

Legal status. Since 1976 the Pink-footed Goose is a protected species in the Netherlands. However, an unknown number, probably hundreds, are still shot due to misidentification by hunters (SCHILPEROORD pers. comm.).

Management measures and problems. Only a small part of the feeding grounds is protected, and there are no shooting restrictions, so disturbance from shooting restricts the available feeding grounds. In the near future the central part of the area will

be reclaimed and developed as agricultural land, probably having a deleterious effect on the goose habitat (SCHILPEROORD 1984).

The earlier arrival since 1982 has caused conflicts with farming interests, because the geese graze on grasslands meant for a late hay cut (SCHILPEROORD pers. comm.).

Belgium

Numbers and distribution. One area around the small town of Damme in northwest Belgium is a regular wintering ground (KUYKEN 1969, 1985).

The Pink-footed Geese usually arrive in mid November, and numbers peak around the turn of the year. In the 1980s the annual maximum has been around 3-4,000, though in 1981/82, which was a hard winter, 11,000 individuals were recorded. The geese leave the area by the beginning of February.

Ecology. The geese graze on wet pastures grazed by cattle from April to November (KUYKEN 1969).

Past history. The first Pink-footed Geese were recorded at Damme in the winter of 1958/59 (VANDEKERKHOVE et al. 1960), coinciding with the creation of a goose reserve with no shooting. In the 1960s up to 1,000 geese wintered (KUYKEN 1969), and since then the population has increased to 3-4,000 individuals (KUYKEN 1983, 1985).

Legal status. Since 1960 there has been local protection of the geese at Damme, and since 1968/69 local, legal prohibition of goose shooting. Since 1981/82 goose shooting in Belgium has been completely banned.

Management measures and problems. Local shooting prohibition at Damme and surrounding polders has increased the available goose feeding grounds (KUYKEN 1985). Goose numbers have increased, but the geese have dispersed over wider areas, resulting in a reduction of goose grazing pressures in the traditional haunt. Claims of damage in the 1960s were shown to be groundless (KUYKEN 1969).

Population development

Only since 1980 have coordinated population counts and age counts been performed (MADSEN 1982, 1984a, JEPSEN unpubl.). In an attempt to reconstruct the population development in the 20th century, MADSEN (1982) used the annual maximum figures recorded in Denmark in spring and autumn. With some reservations these figures are believed to reflect population trends, since the geese only make use of few haunts, especially pronounced before 1955 when spring shooting was legal. In Fig. 8 a reconstruction of the population trend is depicted.

The population seems to have increased in two steps in this century:

1) from approximately 10-12,000 geese in the 1930s-1950s to 15-18,000 geese in the 1960s-mid 1970s and
2) from 15-18,000 to 21-27,000 geese in the 1980s.

In the 1980s the population has been relatively stable at about 25,000 individuals on average.

Discussion

It has been suggested (MADSEN 1982) that the first increase in the Pink-footed Goose population was caused by the spring shooting ban in Denmark, both directly because of lowered mortality, and indirectly because more feeding area became available. Our knowledge about other influencing factors is, however, too scarce to make firm conclusions.

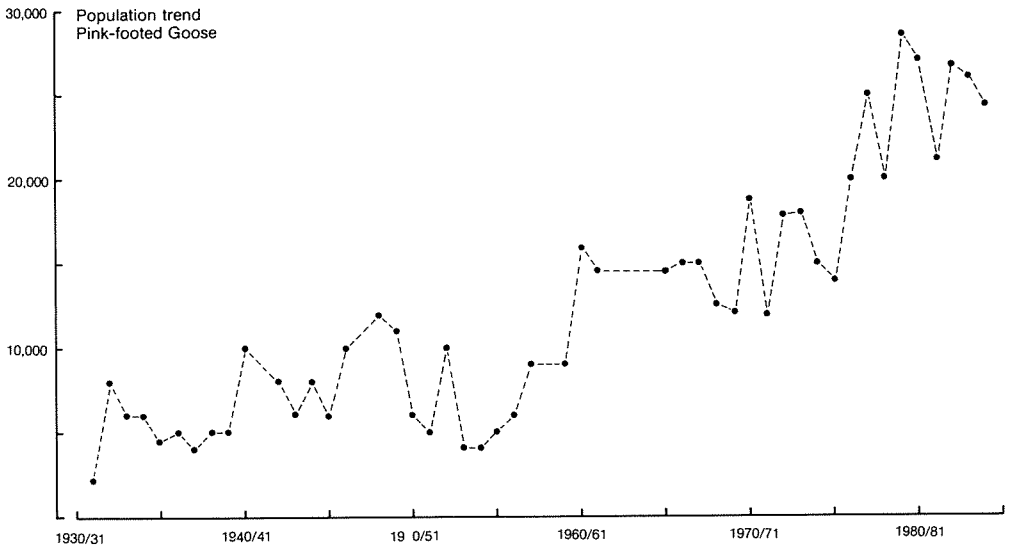


Fig. 8. Population development of the Svalbard population of Pink-footed Goose, 1930-1984 (After MADSEN 1982, 1984 and unpubl.).

The second increase may have occurred for several reasons: 1) baiting of geese at Vest Stadil Fjord in Denmark since 1973 may have improved the condition of the potential breeders, ultimately resulting in a higher recruitment to the population, 2) a spring shooting ban in Svalbard in 1975, a ban in the Netherlands in 1976 and in FRG in 1977 may have resulted in a lowered mortality. EBBINGE et al. (1984) have, on basis of ringing recoveries and goose captures in the Netherlands, calculated that the proportion of juveniles did not change significantly between the periods 1955-74, 29%, and 1975-83, 25%, whereas mortality in the two periods fell from 29% to 15%. These data suggest that the better protection of the population has been the factor causing the increase in the 1970s, whereas spring baiting seems to have played a minor role, if any.

The history of the Svalbard Pink-footed Goose in the 20th century is characteristic of many goose populations with regard to: 1) changes of wintering grounds, 2) changed feeding habits, and 3) increases in population size.

Changes of wintering grounds have taken place both within and between countries in the wintering quarters. In each case of change the reason has been attributed to human interference, either in the form of agricultural or urban/industrial development, or because shooting practices have changed. Shooting has been and still is a highly significant factor determining the winter distribution of Pink-footed Geese.

In the last decades changes in spring distribution also reflect a shift in feeding habits. This has been caused by changed farming practices in west Jutland, opening up a new habitat with an energetically favourable food resource in the form of grain. The shift to the newly sown fields has happened quite abruptly, and it cannot be ignored that – albeit alleviating a local damage problem – the baiting at Vest Stadil Fjord has accelerated the process, accustoming the population to feed on grain in spring, also producing artificially large

concentrations so that all birds are quickly exposed to the habit (MADSEN 1984a). The shift would probably have happened without baiting but at a slower rate.

Problems of goose damage can be identified in autumn in Denmark and the Netherlands and in spring in Denmark. In autumn the amount of damage in Denmark is undoubtedly exaggerated (LORENZEN & MADSEN 1986). However, the tolerance of the farmer at Filsø in Denmark to the geese has lessened due to the introduction of more vulnerable crops, a problem which also applies to other damage problems. Problems in autumn have been exacerbated by increased shooting disturbance in Denmark. This has caused the large concentrations of geese in the Filsø area. Damage problems in the Netherlands also relate to the shooting pressure in Denmark.

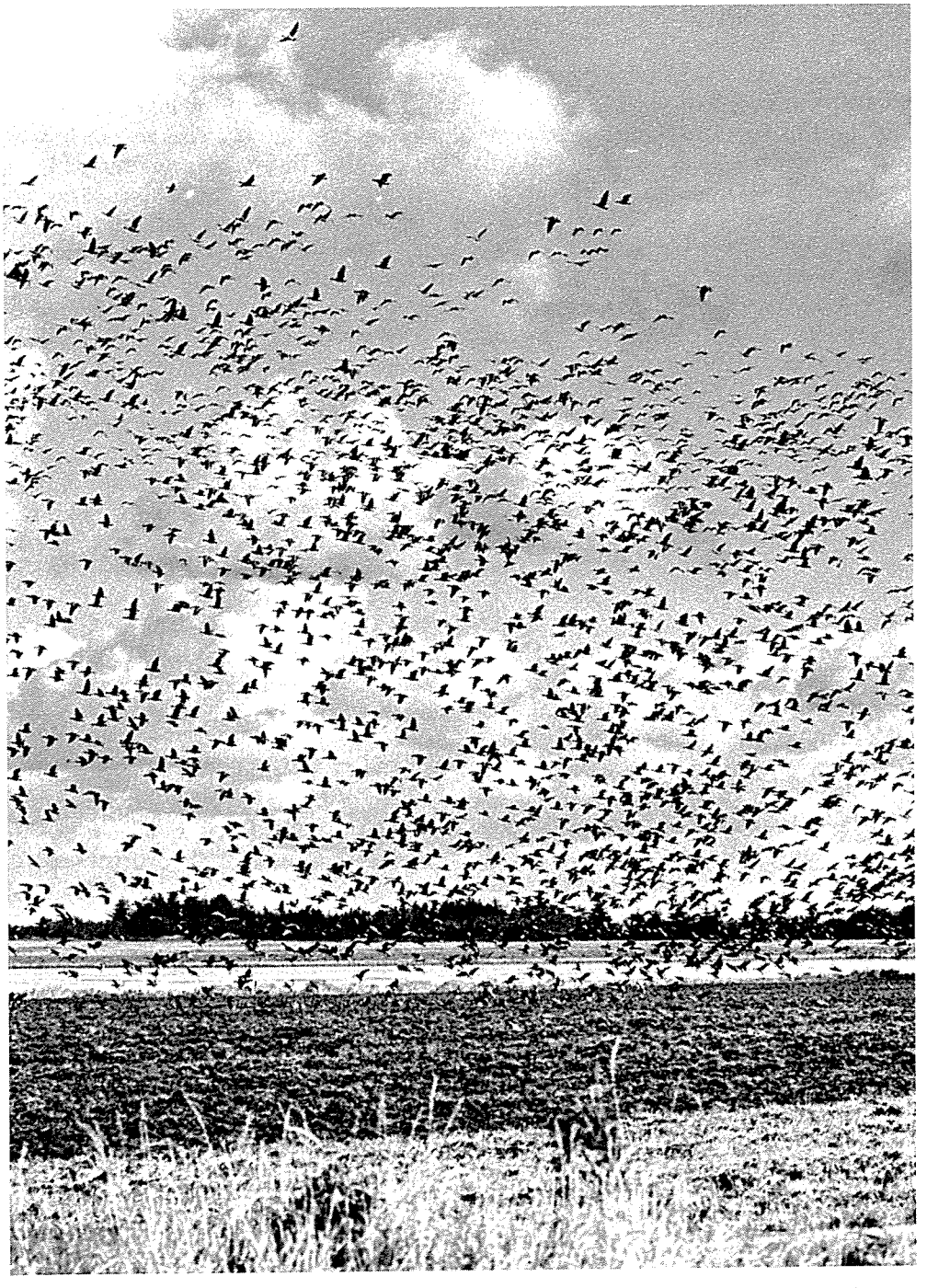
Management needs. Both from the point of view of recreational, shooting and agricultural interests, it is desirable that a solution to the autumn situation of the Pink-footed Goose in Denmark is found. A possibility is to regulate shooting pressures in certain traditional autumn haunts, where the geese do not cause damage, e.g., Vest Stadil Fjord. A dispersal of the population over large areas will give a lower grazing pressure overall, a model used with success in Belgium (KUYKEN 1985). A goose reserve with improved grasslands is planned in the Filsø area (JEPSEN 1984). This new feeding ground will, however, not be able to hold more than a small proportion of the population, due to the relatively small size of this reserve (MADSEN 1985d).

Solutions to the spring damage problems in Denmark are not so straightforward as those in autumn. It is believed that inevitably whatever management measure is taken, the geese will to some extent continue to feed on newly sown fields. However, the present situation is not sustainable, primarily due to a growing intolerance to the geese among farmers. Some of the agricultural lands visited by geese are already marginal with respect to quality and economics, and the farmers tend to believe that the goose feeding is the factor hampering a positive economic balance. Even if experiments show that the damage is exaggerated (e.g., LORENZEN & MADSEN 1986), the farmers will probably not tolerate the presence of the geese. In a recent meeting (November 1985) arranged by the Danish Wildlife Administration with farmers and hunting clubs in west Jutland, damage problems were discussed. It was agreed that a long term solution to the problems should be sought, and that the only possibility was to establish reserves for geese. The reserves should be on managed grasslands, so that the geese would have an alternative to the newly sown fields. This should be combined with some effective scaring devices in the most vulnerable fields. The baiting at Vest Stadil Fjord has solved some local short-term problems, but as long as this continues the geese will be acquainted with grain feeding. Baiting should only be used as a last resort, if the other devices should fail. Therefore, other solutions to the problems at Vest Stadil Fjord should be tried as soon as possible.

The wintering grounds in the Netherlands are to some extent threatened by development, and there seems to be an urgent need for the protection of the central feeding grounds. Recently, more Pink-footed Geese have moved on to Belgium in winter, probably as a result of the shooting ban there. If this situation should be permanent, steps to protect the Belgian sites ought to be taken very soon.

The spring staging areas in Norway have no protection, but it is unknown if threats to the areas exist.

Research needs. At present, the knowledge of the whereabouts of the Pink-footed



Part of a flock of Pink-footed Geese on the Filsø farmland, western Denmark, autumn 1978. Due to the farmer's fear of damage to winter cereals, the majority of the geese are now driven off the area in autumn. (Photo: E. Thomsen.)

Geese through the year is patchy (see also OGILVIE 1984). Especially in late autumn and in winter a high proportion of the population is missing in the international counts (SCHILPEROORD 1984). Migration routes through Norway are being tracked, but still the importance of the staging areas is little known. To enable proper management of the population throughout the annual cycle, more international cooperation of counts and research is needed. An individual marking programme would provide the best answers to many questions concerning migration routes, the importance of the different haunts and countries, and detailed population dynamics.

There is a great need for more information on the summer ecology of the Pink-footed Geese. NORDERHAUG (1970) predicted that a limit to the population would be reached at 12-13,000 individuals due to saturation of the breeding grounds. With hindsight this has proved not to hold true, but it should be expected that the situation on Svalbard means that further population growth may be limited at a level near the present 25,000-30,000 individuals. A study of breeding biology and habitat ecology along the lines of the Barnacle Goose studies in Svalbard (PROP et al. 1981, 1984) would provide much insight to the importance of the breeding grounds in determining population levels. Again, an individual marking programme would be a very useful tool.

Much ecological work has been done recently in Denmark, whereas only little has been done in Norway, the Netherlands and Belgium. The concentration of the geese in a few places offers a good opportunity to test the 'condition hypothesis' put forward by ANKNEY & MACINNES (1978) and later by EBBINGE et al. (1982), that the body condition of geese in spring is an important factor determining breeding success. This project would need the cooperation of Danish, Dutch and Norwegian researchers.

To evaluate the effect of various shooting practices on the staging geese, a project in Denmark in autumn should be set up. This study should be aimed at giving some practical devices for limiting shooting to tolerable levels, where the geese are still enabled to use the haunts.

Greylag Goose *Anser anser anser* (northwest European population)

The breeding range of the Greylag Goose extends from Iceland in the west to the eastern coast of the Soviet Union in the east. In the western Palearctic it has a disjunct breeding distribution in northwest and central Europe and in Iceland (Fig. 9). Five populations can be identified (HUDEC 1984, OGILVIE 1982b):

1) the Icelandic breeding population wintering in Scotland with about 80,000 geese (OGILVIE 1977-1985);
2) a resident population in northwest Scotland of 2,000-2,500;
3) the northwest European breeding population wintering in southern Spain and the Netherlands, about 130,000 geese (J. ROOTH pers. comm.), here referred to as northwest European population;
4) the central and northeast European breeding population wintering in north Africa, about 20,000, here referred to as the central European population, and
5) the west Soviet Union breeding population wintering in the south of the Balkan peninsula and the western part of Asia Minor, possibly about 20,000-30,000 geese.

During the present century Greylag Geese have been introduced in several parts of Europe, and today most of these are not possible to distinguish from the wild stock. Whereas the British populations seem to be discrete, the dividing lines between the con-

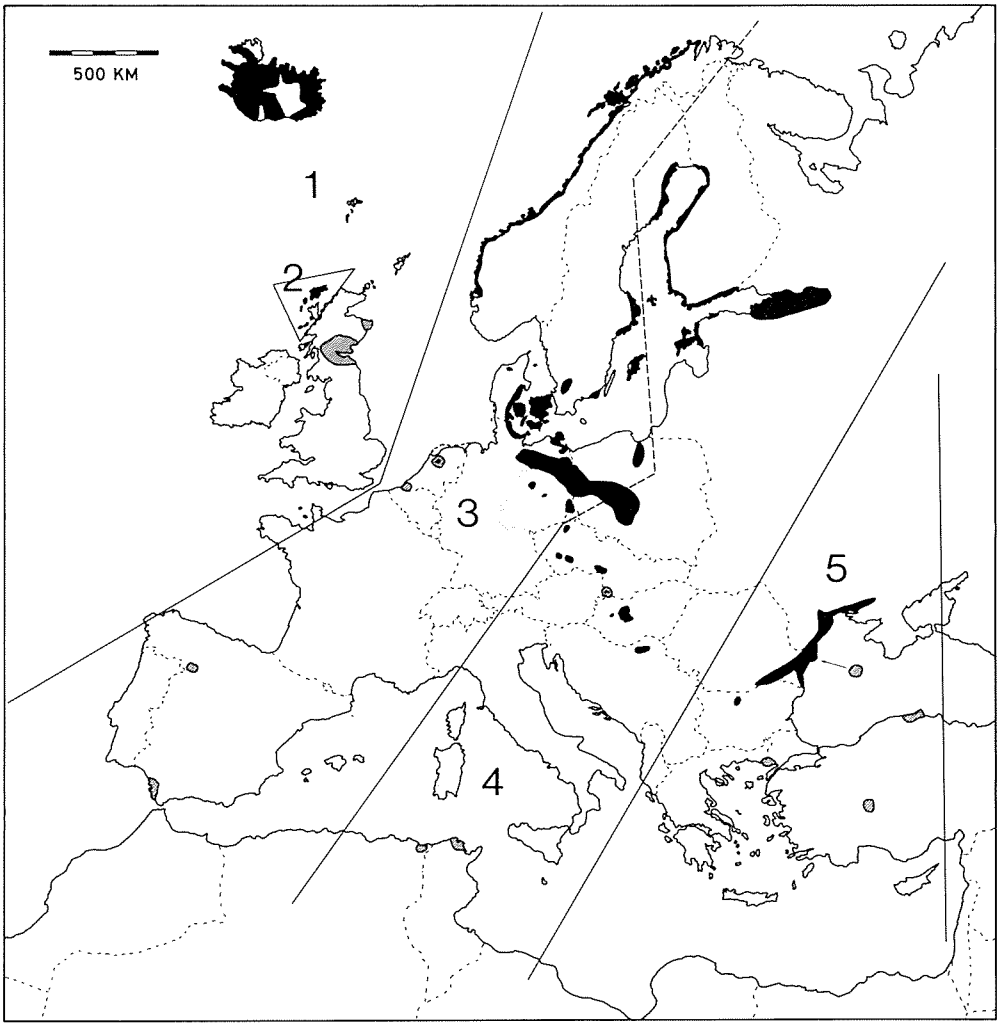


Fig. 9. Populations of Greylag Geese in Europe. 1: the Icelandic/Scottish population, 2: the north Scotland population, 3: the northwest European population, 4: the central European population, and 5: the east European population. Breeding areas are black, wintering areas hatched. Punctuated lines indicate that the border lines between flyways are not well known. (After HUDEC 1984, with a few amendments).

tinental populations are not quite clear, and ringing recoveries show that some mixing occurs. Thus, non-breeding individuals from the central European population move to moulting grounds in the range of the northwest European population (PALUDAN 1965, VON ESSEN & BEINERT 1982, GROMADZKI & MAJEWSKI 1984).

Ringing schemes which are presently under operation in Scandinavia under the auspices of the Nordic Council for Wildlife Research and in central Europe by East German, Polish, Czechoslovakian and Austrian biologists will hopefully throw more light on the movement patterns of populations in the near future. Much of the pre-

sent knowledge of population dynamics and migration of the European Greylag Geese has been compiled by HUDEC & RUTSCHKE (1982, 1984).

In the present review only the status and management of the northwest European population will be treated, including the states of Norway, Sweden, Denmark, GDR, FRG, Poland, the Netherlands and Spain. The population breeds in all these states, except Spain, and winters in Spain, the Netherlands and in small numbers in Norway, FRG and Denmark. Besides these countries an introduced population of approx. 300 birds breeds and winters in Belgium (LIPPENS 1971). Generally a few hundred to 2,000 stay in France during autumn and winter (ROUX 1962, C. RIOLS, unpubl.), and a few hundred winter in Portugal (OGILVIE 1978).

Breeding grounds and breeding ecology

The center of gravity of the breeding area of the Greylag Goose lies in the southern Baltic, viz. Denmark, Schleswig-Holstein in the FRG, north GDR and southwest Sweden (Fig. 3). The estimated size of the breeding population in the various range states is given in Table 3. The total for the population is thus estimated at 12,050 to 12,800 pairs. It must be noted, however, that the estimates are rough, as the assessment of the breeding geese is difficult due to their dispersed nesting, and furthermore because the estimates stem from different years. From Norway there exists no information about the total population size, but OGILVIE (1978) thought that it must be in the order of at least 2,000 pairs, which does not seem unrealistic and is probably an underestimate. The Norwegian Greylag Geese breed on small islands along the North Atlantic coastline, and are thus almost impossible to count. In several of the countries Greylag Geese have been introduced, and this category of breeders is very difficult to distinguish from the wild breeding population and is inevitably included in the figures. In Table 3 the total estimated breeding stock of Poland is included, although new data have shown that the Greylag Geese breeding in southern Poland seem to belong to the central European population (GROMADZKI & MAJEWSKI 1984). At present it is not known how many of the Polish birds move south to Central Europe. From ringing recoveries it is now evidenced that Estonian Greylag Geese belong to the central European population (KUMARI 1984).

Table 3. Estimate of the breeding pair numbers in the northwest European population of Greylag Goose.

Country	Breeding pairs	Source
Norway	(2,000)	OGILVIE 1978
Sweden	1,700-2,200	NILSSON 1982
Denmark	2,850-3,000	FOG et al. 1984
Poland	1,150	GROMADZKI & WIELOCH 1983
GDR	3,000	RUTSCHKE et al. 1982
FRG	1,000-1,100	HUMMEL 1982
Netherlands	320	DUBBELDAM & POORTER 1982
Belgium	30	LIPPENS 1971
TOTAL	12,050-12,800	

The breeding biology of the Greylag Geese has been described in detail by HUDEC & ROOTH (1970). Apart from the major phenological events, breeding will not be given much space here.

The adult Greylag Geese arrive on the breeding grounds in Denmark from the end of February to mid March (JENSEN 1977, MØLLER 1978), while the younger birds lag up to one month behind. In the FRG the first geese arrive from the end of January to the end of March (HAACK 1968), in the GDR from the beginning of February to the beginning of March (LITZBARSKI

1982), whereas in Norway the arrival is about one month later than in the GDR (HAFTORN 1971). Major stopping places between the wintering and breeding grounds are known from the Netherlands (ROOTH et al. 1981) and from the Wadden Sea coastline of the FRG (HUMMEL 1982).

The most frequently used nesting habitat is eutrophic fresh water with dense emergent vegetation, mostly reedbeds, with ready access to feeding grounds constituting meadows and pastures. In Norway and Sweden islets are common breeding habitats.

In Denmark and the GDR egg-laying usually commences from mid March (N. O. PREUSS pers. comm., HAUFF 1982, JØRGENSEN 1986). Peak hatching is in the last week of April, peak fledging in the end of June to mid July. The timing of egg-laying is, however, highly dependent on ice conditions on the nesting grounds (KUX & HUDEC 1970, PREUSS pers. comm.). In Norway eggs hatch during the last week of May, and young fledge during the first week of August (FOLKESTAD 1983).

Moult migration and moulting grounds

In the first half of the breeding season non-breeding Greylag Geese gather in small assemblages on the breeding grounds. In the GDR the non-breeders move away from most breeding grounds from mid March to end April and aggregate in a few traditional sites where they stay until end of May (RUTSCHKE 1982, LITZBARSKI 1982). In the GDR thus between 8,000 and 10,000 non-breeders are counted in mid May. From Holstein in the FRG similar May assemblages have been described (HAACK 1968).

In the course of May most non-breeders migrate to moulting centres situated in Norway, Sweden, Denmark, the Netherlands and Poland. The moult migration pattern is rather complex, and the northwest European moulting centres do not only receive geese from the northwest European population, but also from the central European population (PALUDAN 1965, HAACK & RINGLEBEN 1972, VON ESSEN & BEINERT 1982, GROMADZKI & MAJEWSKI 1984). The pattern is furthermore complicated by the fact that within the past decades some moulting areas have lost their value while others have been newly colonised or have increased in importance (see below).

Arrival on the moulting grounds in Denmark, the Netherlands and Sweden takes place in the second half of May (PALUDAN 1965, LEBRET & TIMMERMAN 1968, VON ESSEN & BEINERT 1982), and most geese seem to start to shed remiges by the end of May or the beginning of June, regaining the powers of flight 25-30 days later. In Ranafjord in Norway the geese do not regain

Table 4. Major moulting grounds for Greylag Geese in northern Europe.

Site and Country	Number of Geese	Year	Source
Oostvaarderplassen, Netherlands	20,000	1980-83	ROOTH pers. comm.
Vejlerne and Saltbækvig, Denmark	5,000	1980-83	MADSEN 1986
Gotland, Sweden[1]	3,300-5,400	1974-79	VON ESSEN & BEINERT 1982
Ranafjord etc., Norway	19,000	1985	FOLLESTAD et al. 1986
Słońsk, Poland	2,000	1980 (?)	GROMADZKI & MAJEWSKI 1984

Note: 1: Numbers have decreased to less than 2,000 since 1979.

flight before the second half of July (LUND 1965).

As a rule the moulting grounds are only used by the non-breeding Greylag Geese for a short period. Shortly after having regained the powers of flight most geese leave the areas, probably mostly in the direction of their homeland – from Scandinavia towards the southeast, and from the Netherlands towards the northeast and east. Neckbanding in the GDR has shown that 90% of the non-breeders leaving in May return to the country in July and August (LITZBARSKI 1982).

Below an outline of the present situation and the past history of the major moulting centres is given. In Table 4 the number of geese visiting the moulting grounds in the respective countries is shown.

Norway. Three islands on the coast of northwest Norway are known to be moulting grounds: Vega with 2,000 individuals, Vikna 500 and Smøla 100 (LUND 1965, 1971). From 1961-63 to 1971 the number of moulting geese around Vega doubled. In 1985 much of the Norwegian coastline has been searched, and 19,000 moulting Greylag Geese have been found (FOLLESTAD et al. 1986).

Denmark. Two moulting grounds exist at present: Vejlerne holds up to 1,000 individuals and Saltbækvig 2,000-3,000 (MADSEN 1986 and unpubl.). In the 1950s probably more than 3,000 non-breeding Greylag Geese moulted in Vejlerne, but since 1959 numbers declined sharply (PALUDAN 1965). Since the end of the 1960s, birds have been using Vejlerne again, although in smaller numbers.

Sweden: At present Greylag Geese moult around Gotland in the Baltic. In the 1970s up to 5,400 were recorded, but since 1979 numbers have declined (VON ESSEN & BEINERT 1982). Gotland was colonised in the 1950s, possibly in connection with the decrease in the Vejlerne population. Besides Gotland only two minor moulting grounds exist. During the 19th century the island of Hallands Väderö off northwest Skåne was a moulting ground for some hundreds of Greylag Geese (ANDERSSON 1969), but the geese had abandoned the area by the turn of the century, probably due to a heavy shooting pressure.

The Netherlands. Nowadays moulting Greylag Geese are found only in Oostvaarderplassen in Southern Flevoland (ROOTH pers. comm.). Southern Flevoland was reclaimed in 1968, but 5,000 ha of reed swamp and shallow lakes were maintained as a nature reserve. Since the 1970s Greylag Geese have been moulting here in increasing numbers, in 1974 more than 2,000 individuals (DUBBELDAM 1978), in 1980 6,000 (DUBBELDAM & POORTER 1982), and in 1984 20,000 (ROOTH pers. comm.). On their arrival the Greylag Geese feed on grass and during moult on *Phragmites* leaves and stems (DUBBELDAM & POORTER 1982).

Simultaneously with the increase in numbers in Oostvaarderplassen, two other moulting grounds fell into disuse, Steile Bank in Gaasterland and the Haringvliet in the Delta region, where up to 2,000-5,000 and 1,300 geese, respectively, moulted in the 1960s (LEBRET & TIMMERMAN 1968, OUWENEEL 1969, DUBBELDAM & POORTER 1982). Steile Bank was colonised for the first time in 1960, coinciding with the decrease in the Danish Vejlerne population.

Poland. A moulting ground at the Warta and Odra river confluence in the Slońsk region in west Poland receives between 1,400 and 2,500 Greylag Geese (GROMADZKI & MAJEWSKI 1984). These birds seem to originate mainly from the central European breeding grounds.

Autumn staging areas and wintering grounds

Following the fledging of the young and the regained powers of flight of adults in July the Greylag Geese gradually move to autumn gathering haunts (see RUTSCHKE 1982) where they remain until the emigration to the wintering grounds. Most non-breeders seem to return to their homeland from the moulting centres and join the family parties on the autumn haunts. The distribution in September is shown in Fig. 10, the known mid September concentrations in Table 5. In Fig. 11 the seasonal phenology in six range states is presented.

Norway

Numbers and distribution. No autumn staging areas are known from the literature, but some probably exist along the Atlantic coast. However, shooting disturbance is thought to cause many Greylag Geese to leave the breeding and gathering grounds prematurely in August (FOLKESTAD 1983). Southerly migrating flocks are seen at Jæren in southwest Norway from September to November (BYRKJEDAL & ELDØY 1981).

Table 5. The estimated size of the mid September population of the northwest European Greylag Geese. Most data stem from the late 1970s or early 1980s.

Country	Mid September number	Source
Norway	>1,000	no reference
Sweden	11,000-13,000	ANDERSSON 1982
Denmark	19,000-29,000	MADSEN 1986
Poland	>1,000	MAJEWSKI 1983
GDR	35,000-40,000	RUTSCHKE et al. 1982
FRG	6,000-8,000	HUMMEL 1982
Netherlands	20,000	ROOTH pers. comm.
TOTAL	93,000-112,000	

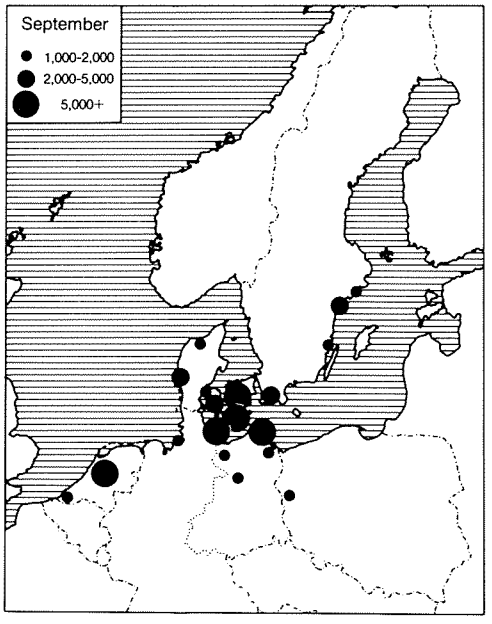


Fig. 10. September distribution of Greylag Geese in northwest Europe (northwest European population). Sources, see text.

The Norwegian data seem to be conflicting, but goose flocks may leave the country unnoticed before September.

At Jæren, and also in other sites in southern Norway, flocks of few hundred Greylag Geese stay through the winter, favoured by the relatively mild Atlantic weather conditions (BYRKJEDAL & ELDØY 1981).

Ecology. In autumn the geese feed on pastures (HAFTORN 1971) and probably also on saltmarshes.

Legal status. The open season ranges from 21 August to 23 December (LAMPIO 1983).

Management measures and problems. On the island of Smøla the season has been opened from 10 August, mainly to avoid crop damage (FOLKESTAD 1983). At this time not all goslings have fledged and not all adults have completed moult of remiges.

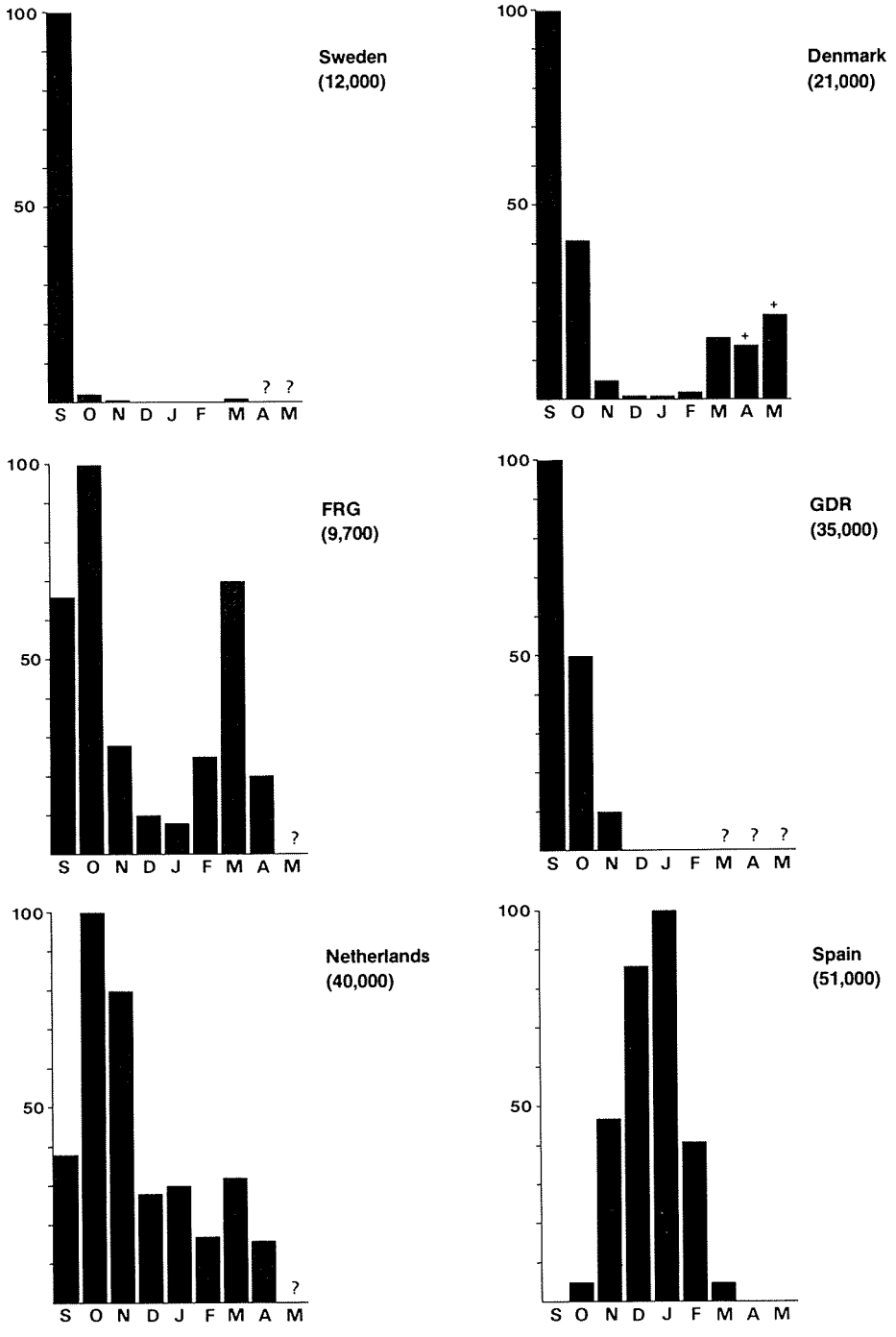


Fig. 11. Phenology of Greylag Geese in six range states of the northwest European population, expressed in percentage of peak month. Numbers in spring have been underestimated in the breeding range states. Most data from 1980-1984. Numbers in brackets give average maximum (=100%). Sources, see text.

Sweden

Numbers and distribution. In early autumn 12,000 to 20,000 Greylag Geese gather in Götaland and Svealand in south Sweden (ANDERSSON 1982, GREYLAG GOOSE PROJECT OF THE NORDIC COUNCIL FOR WILDLIFE RESEARCH unpubl.). The geeese arrive from the breeding grounds in July, and numbers reach their peak in September. Emigration takes place quickly after mid September, and in mid October only a few hundred are left in the country (NILSSON 1984a).

Ecology. The Greylag Geese feed on saltmarshes, stubbles, rape and clover fields (EHRLÉN & WAHLÉN 1979). The diurnal rhythm is diphasic, feeding occurring mainly in the morning and evening.

Past history. From the late 1960s to 1981 the number of Greylag Geese in most of the gathering places has increased by more than a three-fold (ANDERSSON 1982, EHRLÉN 1983).

Legal status. The Greylag Goose is protected in all counties except Kalmar, where there is an open season from 20 July to 31 August to avoid goose damage to crops (THELANDER 1982). About 1,000 Greylag Geese are bagged there annually.

Management measures and problems. In some areas grazing by Greylag Geese on clover fields causes damage (PETTERSON 1985).

Denmark

Numbers and distribution. From the end of July to the beginning of August the Greylag Geese move from the widely dispersed breeding grounds to the autumn gathering grounds (MADSEN 1986). The autumn peak numbers are reached in mid September with 20,000 to 30,000 geese (MADSEN 1986, GREYLAG GOOSE PROJECT OF THE NORDIC COUNCIL FOR WILDLIFE RESEARCH unpubl.). From the beginning of October numbers decline, and by mid November usually less than 1,000 Greylag Geese remain. Usually almost no geese winter, but in mild seasons a few hundred may stay at Tipperne in west Jutland (MADSEN 1985c).

Ecology. In autumn most Greylag Geese feed on stubble fields, followed by pastures and meadows. Winter cereals and sugar beet are used to a small extent. In July and August flocks may feed on ripening cereals (MADSEN 1986). The usual diurnal pattern is that the Greylag Geese feed around dawn and dusk and roost on lakes or lagoons during day and at night.

Past history. Within the last decade the autumn staging population has doubled. In the 1960s and 1970s 11,000 to 18,000 geese were counted in September, in the 1980s up to 32,000 (FOG 1977, MADSEN 1986, GREYLAG GOOSE PROJECT OF THE NORDIC COUNCIL FOR WILDLIFE RESEARCH unpubl.). In the same period the breeding population has increased considerably (FOG et al. 1984). Based on ringing recoveries PREUSS (1982) estimated an annual increase of approximately 9% in the Danish breeding population in the 1970s.

Legal status. The season is open from 1 August to 31 December. In the 1960s it was estimated that at least 1,500 to 1,700 Greylag Geese were bagged annually (FOG 1977). Today probably more than 5,000 geese are shot each year.

Management measures and problems. In most autumn haunts shooting is regulated by means of game reserves or privately (MADSEN 1986). However, in some haunts the staging Greylag Goose populations

have recently decreased due to intensified shooting disturbance.

Greylag Geese feeding on ripening cereals in summer cause local damage to crops. From 1972 to 1981 a total of 25 farmers have received licenses to shoot Greylag Geese to avoid the damage. However, according to J. FOG (1982), probably less than 100 geese have been shot during the whole period.

German Democratic Republic

Numbers and distribution. After return of the non-breeding geese from the moulting grounds and the fledging of young a summer migration takes place to the 20-25 traditional gathering places. By mid August 25,000 geese are in the country (LITZBARSKI 1982). In the second half of August flocks of Scandinavian and east European Greylag Geese move to the GDR, and in mid September a peak number of 35,000 to 40,000 is reached. Most of the geese from the central GDR move to autumn gathering grounds along the coast. From mid September to mid November the geese leave the country, and only few geese are wintering there.

Ecology. In summer and early autumn most geese feed in stubble fields and on pastures. Only to a small extent do the Greylag Geese feed on winter cereal fields (RUTSCHKE et al. 1982).

Past history. Within the last decades the breeding population has increased considerably (HAUFF 1982, NAACKE 1982). The autumn population has increased accordingly, although this has not been quantified.

Legal status. The open season extends from 16 July to 31 January. In the 1970s on average 360 Greylag Geese were bagged annually (RUTSCHKE et al. 1982).

Management measures and problems. Most of the gathering places are protected areas with shooting regulations or prohibition. According to RUTSCHKE et al. (1982) damage problems are not severe.

Poland

Numbers and distribution. Only a small amount of information exists. According to GROMADZKI & MAJEWSKI (1984) Greylag Geese stay in the country until October or November, and virtually no geese winter. Based on data presented by MAJEWSKI (1983) there seems to be an autumn population of about 1,000 geese in the Slońsk area alone, and the total for the country is probably much higher.

Past history. The breeding population has increased considerably during the last decades (GROMADZKI & WIELOCH 1983, MAJEWSKI 1983).

Legal status. The open season extends from 20 August to 10 February in the western part of Poland, and from 20 August to 30 April in the eastern and northern parts (GROMADZKI & WIELOCH 1983).

Federal Republic of Germany

Numbers and distribution. The most important autumn gathering grounds are situated in east Schleswig-Holstein and north Lower Saxony (HAACK 1968, HUMMEL 1982, 1977-1984, KNIEF pers. comm.). The flocks gradually concentrate in few places, reaching a peak of up to 12,000 individuals in October. Most of the geese in Schleswig-Holstein leave during October, whereas in Lower Saxony the geese stay until the onset of frost in November. Up to 1,000 Greylag Geese winter at the Elbe Estuary and along the East Friesian coast.

In cold winters the geese move on to the Netherlands (HUMMEL 1982).

Ecology. In summer and autumn Greylag Geese mainly feed on pastures, in stubble fields and to some degree in ripening cereal fields (HAACK 1968, KNIEF 1985, BRUNS & VAUK 1985-1986).

Past history. From 1974 to 1980 the autumn population has been steadily increasing (HUMMEL 1977-1984), and in Warder Lake in Holstein the population tripled from less than 500 to 1,500 geese from 1960 to 1967 (HAACK 1968).

Legal status. The open season is divided into two periods: 1-31 August and 1 November-15 January from half an hour before sunrise to 10.00 a.m. In Schleswig-Holstein the season is further restricted, and in Lower Saxony the Greylag Goose is protected throughout the year (HUMMEL 1982).

Management measures and problems. In Schleswig-Holstein the Greylag Geese cause damage to ripening cereals and cattle-grazed pastures. In the bird-sanctuary Wallnau on the island of Fehmarn Greylags have been baited with grain to alleviate local crop damage. Some compensation is paid to farmers (KNIEF 1985), in Schleswig-Holstein amounting to 7,500-25,000 DM annually (1980-1983), in the Dümmer in Lower Saxony 67,000 DM (total amount from 1976-1981).

The Netherlands

Numbers and distribution. The autumn population gradually builds up from August onwards, to reach peak in October and November of between 21,000 and 51,000 geese (ROOTH et al. 1981, NETHERLANDS GOOSE WORKING GROUP 1983, 1984a, 1984b, in press). Ringing recoveries have shown that most of the autumn staging geese come from the Scandinavian breeding grounds (ROOTH 1971). From mid November numbers decline, but 10,000 to 13,000 remain the whole winter.

In autumn most Greylag Geese stay in Oostvaarderplassen in Southern Flevoland, whereas the main winter concentrations are found further south in the Haringvliet area in the Delta region.

Ecology. In the Oostvaarderplassen both breeding, moulting and autumn staging geese feed on *Typha latifolia* and *Phragmites autralis* green parts and rhizomes (DUBBELDAM 1978, DUBBELDAM & POORTER 1982). By virtue of their feeding activity the Greylag Geese have been found to play a major role in the maintenance of the ecosystem of the open *Phragmites* marsh. In autumn when high numbers are present, flocks also make feeding flights to adjacent farmland fields of winter rape, and in winter to pastures and winter cereal fields.

Before the construction of the barrage in the Haringvliet in 1970 the wintering Greylag Geese there fed on *Scirpus* and pasture grasses (ZWARTZ 1972, OUWENEEL 1981), but since the tidal movements were nullified and the water became fresh the *Scirpus* areas disappeared. The geese now feed on fields with sugar beet and pastures in autumn and on pastures in winter (OUWENEEL 1981).

Past history. During the last two decades the Greylag Geese have been increasing greatly in numbers. In the 1960s 8,000 to 12,000 geese stayed in autumn and about 2,000 in mid January (ROOTH 1971), in the 1970s 21,000 to 38,000 geese stayed in autumn and about 10,000 in winter (ROOTH et al. 1981), and now up to 51,000 in autumn and 13,000 in winter.

Concurrently with the successive drainage of the Ijsselmeer polders from the

1940s to the 1970s, the Greylag Geese have moved considerably between sites, making use of the temporarily created marshlands which were – apart from the Oostvaarderplassen – later turned into farmland (ROOTH et al. 1981).

Legal status. The open season ranges from 10 October to 31 January from half an hour before sunrise to 10 a.m.

Management measures and problems. No severe crop damage by Greylag Geese has been reported. The Oostvaarderplassen has been preserved as a waterfowl reserve, and the water levels are managed to optimize the conditions for the breeding and resting birds.

Spain

Numbers and distribution. The Marismas (marshes) of the Guadalquivir River in south Spain are the main wintering area of the Atlantic flyway of Greylag Geese (SANCHEZ et al. 1977, AMAT 1986b). The wintering population has increased greatly, and in the 1980s 60,000 to 75,000 geese or about 70% of the flyway population winter in the Marismas. In the winters of 1980/81, 1981/82 and 1982/83 severe droughts occurred, and in 1980/81 about 10,000 Greylags died, mainly from starvation.

The first Greylag Geese arrive in the Marismas in September and numbers peak in December and January. By mid March almost all the geese have migrated north.

Greylag Geese started to winter in the salinas of Villáfafila in the Zamora province in northwest Spain in the late 1970s, and so far numbers have increased to more than 5,000 geese (counts by the Spanish Ornithological Society, submitted by J. AMAT).

In the winter of 1983/84 the population in Spain was estimated at 120,000 Greylag Geese (J. CASTROVIEJO pers. comm. to J. ROOTH).

Ecology. In winters with normal hydrological conditions in the Marismas the Greylag Geese concentrate just after arrival on flooded areas of *Scirpus littoralis.* Later, when other marsh zones become flooded, the geese move to areas of *Scirpus maritimus,* whose rhizomes constitute the main diet of the geese. They pull out the plants from the watersoftened ground with their bills (SANCHEZ et al. 1977, AMAT 1986a, b).

The feeding sites are usually within 100-500 m of the roost. The geese feed in the morning and late afternoon, roosting during most of the daytime (AMAT 1986b).

Under drought conditions the geese are unable to pull the *Scirpus* plants from the dry, hardened ground, and they have to spend more time feeding and with a reduced energetic return (AMAT 1986a). In the winters of 1980/81 to 1982/83 the geese made increasing use of other habitat types, such as winter cereal fields, stubble rice and pastures situated 1-5 km from the roosts (AMAT 1986b).

In the winters of 1983/84 and 1984/85, when the hydrological conditions were normal, the geese have probably as a result of the population increase in the Marismas also been using pastures, which is unusual in rainy seasons. This may indicate that the carrying capacity of the *Scirpus* habitats has been reached (AMAT 1986b).

Past history. Counts are available from the Marismas since the middle of this century. BERNIS (1964) stated, probably referring to the 1940s-1960s, that 5,000 to 10,000 Greylag Geese spent the winter there. In the winter of 1967/68 19,000 Greylag Geese were counted (BERNIS & VALVERDE 1972) (from the same season ROOTH (1971) gives the number of 25,000 geese); in the first half of the 1970s about 20,000 (SANCHEZ et al. 1977), and in the second half up to 75,000 geese (AMAT 1986b).

Legal status. The open season extends from mid September to the beginning of February. In years of severe drought (e.g., 1980/1981) the season may be closed. SANCHEZ et al. (1977) estimated that in years of flooding 1,500 to 2,000 geese were bagged in the Marismas, in drought years 6,000 to 7,000. Since 1981/82 shooting in the Donana National Park has been banned, probably resulting in a reduced kill. AMAT (1986b) writes that within the last two decades shooting pressure in the Marismas has declined considerably.

Management measures and problems. Part of the Marismas is a national park with restrictions on traffic and shooting. To the north of the national park the Marismas have been drained for agricultural purposes and the water contaminated with pesticides. As a consequence of these transformations the Marismas have suffered serious pertubations in the water inflow regime (AMAT 1986b). This has accentuated the problems in years with severe droughts. The national park area is entirely depending on its water supply from several rivers, but today only one flows into the area. A 'Water Supply Regeneration Plan' has now been initiated, aimed at increasing the water inflow and securing flooded marshlands under drought conditions.

Population development

Based on the results of mid-winter counts from Spain, the Netherlands and the FRG since 1967/68, a population trend as depicted in Fig. 12 is derived. It is, however, uncertain whether the graph gives a proper picture of the trend. In years with drought (1980-83) the Greylag Geese disperse over wider areas in the Marismas and it is therefore likely that some flocks have not been counted. The figures from the winters 1980/81, 1981/82 and 1982/83 are thus believed to be underestimates.

The trend is indicating an exponential growth over the last two decades, and within the last decade the population has increased by a four-fold, equivalent to an annual rate of increase of 13%. As it has been shown above, the development has been reflected simultaneously in all range states.

Discussion

The impressive growth in the Greylag Goose population has taken place despite the deterioration of the conditions in the Guadalquivir Marismas, where the droughts within a single season caused the death of 10,000 Greylag Geese. It cannot at present be said what has been the decisive factors causing the increase. Three factors have to be considered:

1) A net immigration of geese from the other populations. As shown above there is no clear-cut borderline between the northwest European and central European populations, and some mixing seems to occur. However, if there had been an immigration from the latter to the former, it would have been apparent from the intensive ringing schemes operating in both ranges. This has not been observed, and therefore this factor seems not to have been significant.

2) A lowered mortality. The harvest of the Greylag Geese along the migration route has been considerable. The annual bag in the 1970s probably exceeded 10,000 geese, and a relaxation of the shooting pressure may have caused the increase. In south Spain the shooting pressure has decreased over the last decades (AMAT 1986b), in Poland spring shooting has been banned since 1976 (MAJEWSKI 1983) and, possibly most significantly, an increasing proportion of the autumn population has been attracted to the Oostvaarderplassen refuge in the

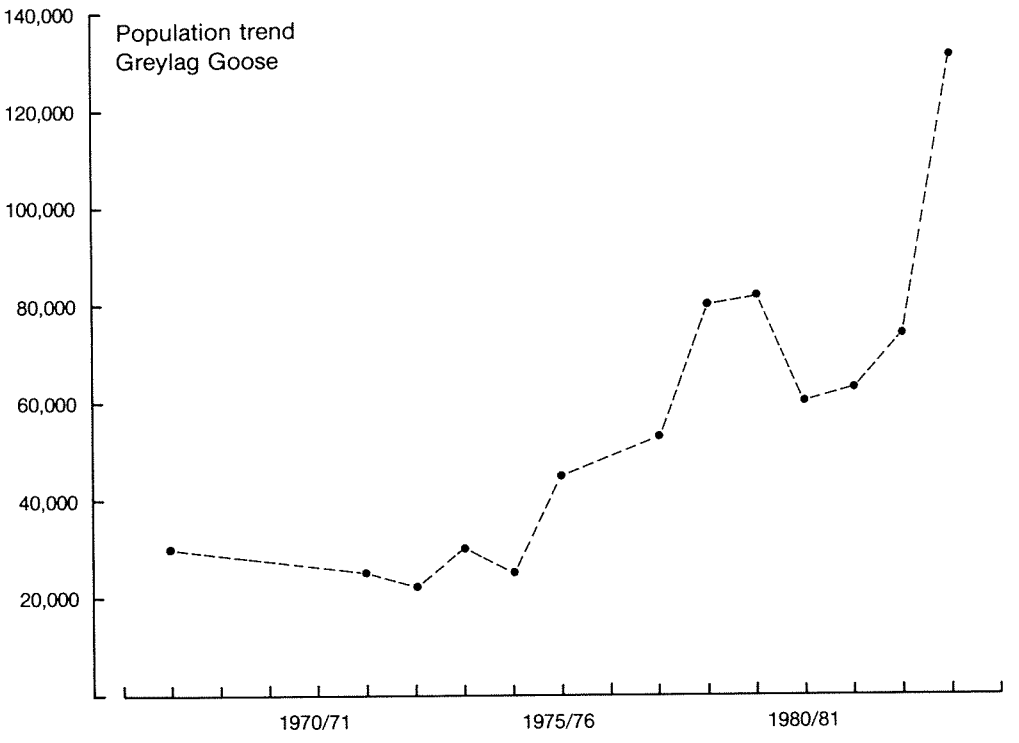


Fig. 12. Development of the northwest European population of Greylag Goose, 1967-1983. Sources, see text.

Netherlands, where the geese are virtually out of reach of hunters.

3) *An increased recruitment.* From various parts of the breeding range (e.g., MAJEWSKI 1983, BRUNS & VAUK 1985-1986) it has been recorded that within the last decades the breeding Greylag Geese have changed habits, adapting themselves to areas with human activity. This change may have increased the breeding capacity and the recruitment rate of population.

The evidence for especially the two latter hypotheses is, however, not firm. At present too little is known about population dynamics and interplaying density-dependent factors. In this context analyses of ringing data are much needed. As it is discussed later (see p. 59) the most likely explanation for the increase is, however, lowered mortality. No other goose population in Europe has demonstrated improvements in breeding success.

The story of the Greylag Geese in this century resembles that of the other goose populations in west Europe, in that they have been markedly increasing and have changed feeding habitats and partially migration patterns. The Greylag Geese still rely heavily on their traditional and natural food source, the *Scirpus* and other *Cyperaceae* as well as grasses. Feeding on these food plants is especially prevalent in Spain and the Netherlands, but also in other parts of the range during the breeding and moulting periods. The Greylag Goose of the Atlantic flyway has, however, throughout its range increasingly been feeding on pastures and arable land, and possibly due to this flexibility in habitat selection the

population has enabled itself to compensate for the negative effects of habitat deterioration, and has – although there is not necessarily a causal relationship – even increased in numbers.

Management needs. Nowadays in northwest Europe the Greylag Geese feed in a range of habitats. Crop damage is not a large-scale problem and is solved locally. Although autumn shooting is allowed in all range states, the geese seem to find enough refuges to sustain the shooting pressure and disturbance. Only in France does shooting seem to be so intensive that the geese have not a single, regular refuge. There, some refuge systems ought to be established, especially as they may act as alternative wintering sites to the Guadalquivir Marismas in drought years.

The situation in the Marismas, which was alarming in 1980 to 1983, can be solved to the benefit of the geese and other water birds breeding and wintering there, if present plans of improving the water supply are carried through with determination.

Research needs. To establish better population monitoring, more detailed and extensive observations of the numbers and distribution of Greylag Geese are needed especially in Poland and Norway. Ringing schemes should be expanded, so that the border lines between the northwest European and central European populations and the interrelation between them can be deciphered.

Ringing data have been compiled in several range states, primarily aimed at analysing the migration pattern of the Greylag Geese, but there are only a few analyses of population dynamics, a prerequisite for the future international management of the population. The analysis should contain both an overall and a national break-down of the ringing data, so that the condition of the entire population and its subpopulations can be studied. This project calls for international co-operation. Another possibility would be to organize age-ratio counts on autumn staging areas in northwest Europe. Although ageing in Greylag Goose is not easy, the excellent results from Britain show that it is indeed possible.

In this connection it must be stressed that future ringing schemes should be based on catching of breeding birds and goslings of known origin, and not as it has been practised in several studies on mass ringing of moulting birds, whose origin is not known. Furthermore, it cannot be ignored that the disturbance caused by the ringing actions on the moulting grounds has been the reason for the abandonment of some Danish and Swedish sites as suggested by LEBRET & TIMMERMAN (1968).

At present no studies have focused on body reserve dynamics and correlates with breeding success in the Greylag Goose, as it has been done for some af the arctic nesting populations. Here lies a challenge for international cooperation among goose biologists to make an integrated, comparative study which will contribute with valuable results to the future management of the population.

Dark-bellied Brent Goose *Branta bernicla bernicla*

The nominate race of the Brent Goose breeds in north Siberia and winters along the west European coastlines from Denmark to France (Fig. 13). In addition a few hundred geese occur in spring on the coast of the GDR (NEHLS 1979). The population has undergone tremendous changes in the present century. In the 1930s there was a dramatic decline in the Brent Goose population simultaneously with the die-off of its principal food *Zostera marina* all over Europe. After a period of protection by most

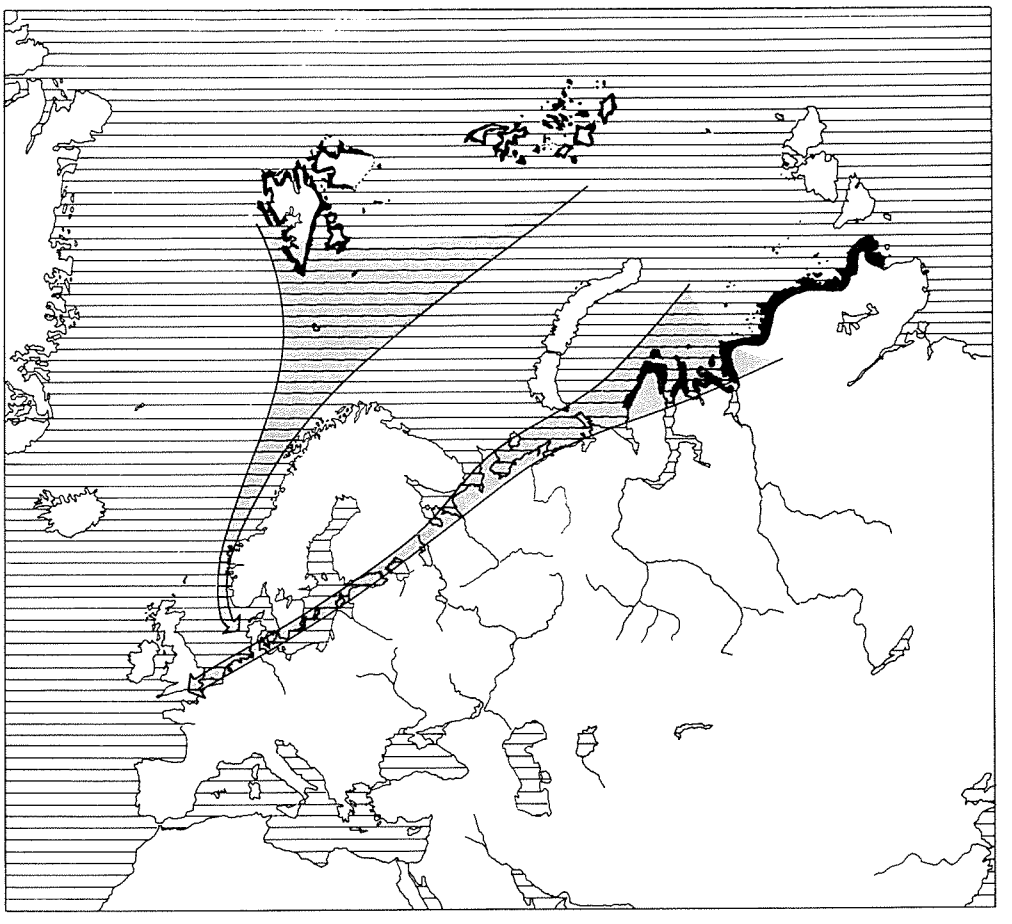


Fig. 13. Breeding distribution and migration routes of Light-bellied Brent Geese (west) and Dark-bellied Brent Geese (east). The extension of the breeding ranges are not well documented. Sources, see text.

countries throughout its range, the Brent Goose population has recovered from 16,000 in the 1950s to a present level fluctuating between 150,000 and 200,000, depending on breeding success (IWRB BRENT GOOSE RESEARCH GROUP, unpubl.).

The status and management of the Brent Goose has been much discussed in the last few decades. In parallel with the population increase, conflicts with agriculture have arisen in some countries, and there are some pressures from hunting organizations to re-open the season. With this background an international 'Technical Meeting on Western Palearctic Migratory Bird Management' was held in Paris in 1977 at the invitation of the International Council for Game and Wildlife Conservation (CIC) and the IWRB to present and discuss the status of the Brent Goose (see SMART 1979), and a second Technical Meeting in Paris in 1979 at the invitation of the International Foundation for the Conservation of Game (IGF) and the IWRB (see SCOTT & SMART 1982).

The present review is primarily based on the contributions from the proceedings of the two meetings as well as on more recent publications and unpublished information collected by the IWRB Brent Goose Research Group. Much of the recent knowledge stems from an intensive colour-marking project of the research group, initiated by a study of the implications of a third London airport and carried out by ST JOSEPH in England beginning in 1972/73.

Breeding grounds and breeding ecology

The breeding range of the Brent Goose is situated along the north Siberian coastline (Fig. 13) including the west Kolguev Island, northern half of the Yamal peninsula, islands in the Kara Sea, north Taimyr peninsula and east to Severnaya Zemlya (USPENSKI 1960, KISTCHINSKI & VRONSKI 1979). However, ornithological surveys have not been made there in recent years, and in the main breeding area, the Taimyr, not since 1949. USPENSKI (1960) states that moulting Brent Geese are found on Novaya Zemlya, along the north Taimyr and probably also in the rest of the breeding range.

Virtually nothing is known about the breeding biology of the subspecies. The geese usually arrive at the breeding areas between 10-20 June, and depart from the middle of August to the beginning of September (USPENSKI 1960).

Migration routes and staging areas

On migration from the breeding grounds in north Siberia to the wintering grounds in west Europe the Brent Geese cross the Kanin peninsula in the Barents Sea and pass through the White Sea across Onega Bay between the second half of September and the first half of October (Fig. 13) (USPENSKI 1960, BIANKI 1979). The geese fly via Lake Ladoga and maybe Lake Onega in the USSR to the Gulf of Finland, entering through the Bay of Vyborg, where they are observed from the first half of September to early October with a peak in the second half of September (LAMPIO 1979). The passage is also observed along the coast of Estonia with peak numbers in October (KUMARI 1979). Usually only a few Brent Geese are observed in the GDR (NEHLS 1979), and most flocks seem to pass the Swedish coastline. They pass through Kalmarsund, southeast Sweden, mainly in October (EDELSTAM 1972) and flocks also pass overland through Skåne (ALERSTAM 1976, LINDELL 1977). The geese usually reach Danish waters by the end of September with peak arrival in October (FOG 1972, MELTOFTE 1973). The flocks pass overland from the Baltic Sea to the Wadden Sea across southern Jutland and northern Schleswig (SCHMIDT 1976).

In spring the same route seems to be followed. A major migration through Kalmarsund is seen in the last ten days of May, in the Gulf of Finland and Estonia from late April to early June with peak numbers in late May (LAMPIO 1979, KUMARI 1979). The geese seem to pass the Kanin peninsula in the first half of June (BIANKI 1979).

Ecology. On the White Sea coasts in the autumn, the Brent Geese stop for a short period and feed on *Zostera* in shallow waters (BIANKI 1979). In Finland, Estonia and Sweden the geese usually do not stop (LAMPIO 1979, KUMARI 1979, FREDGA 1979), whereas thousands stay and feed on *Zostera* and green algae in shallow waters of the Danish Baltic Sea (MADSEN 1986).

Legal status. The Brent Goose is protected along the whole migration route.

Past history. In Finland, Sweden and the GDR an increase in numbers of geese has been recorded in parallel with the general population development since the 1960s. In

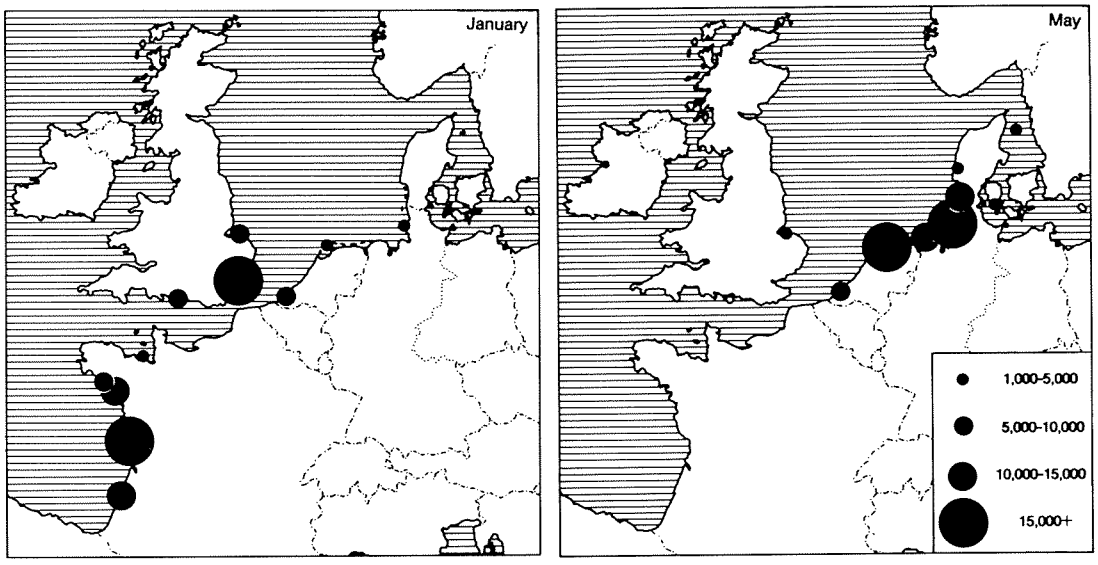


Fig. 14. Midwinter and spring distribution of Dark-bellied Brent Geese. Sources, see text.

the GDR the Brent Goose was considerably more abundant in the 1920s than at present (NEHLS 1979), reflecting the population decline in the 1930s.

Management measures and problems. There are no reports of feeding on farmland along the autumn and spring migration route.

Wintering grounds

The Dark-bellied Brent Goose winters from Denmark in the northeast, through FRG, the Netherlands, south and southeast England to the west coast of France (Fig. 14). In midwinter the population is mainly distributed in France, England and the southern part of the Netherlands; in mild winters, however, also in other parts of the winter range. In spring the population moves to the Netherlands, FRG and Denmark (Fig. 14) (ST JOSEPH 1979a, 1982). The phenology in the five winter range states is shown in Fig. 15.

Denmark

Numbers and distribution. The most important site of the Brent Goose is in the Wadden Sea, holding about 75% of the goose-days spent in Denmark (MADSEN 1986). Other important sites are in Ringkøbing Fjord, in the archipelago south of Funen and on the islands in the Kattegat. The Brent Goose arrives in Denmark by the end of September, and numbers peak in October with 11,000 to 40,000 individuals in 1980-1983 (MADSEN 1986). The geese usually leave by the end of November, and in winter only a few hundred remain, except for mild seasons where up to 5,000 may stay. From March to May a spring population of 14,000 to 23,000 geese is built up, representing 10-12% of the entire population (MADSEN 1986). The geese depart for the breeding grounds between 20-30 May (MADSEN 1985c, MØLLER 1978).

Ecology. In autumn the Brent Goose is almost exclusively confined to shallow waters

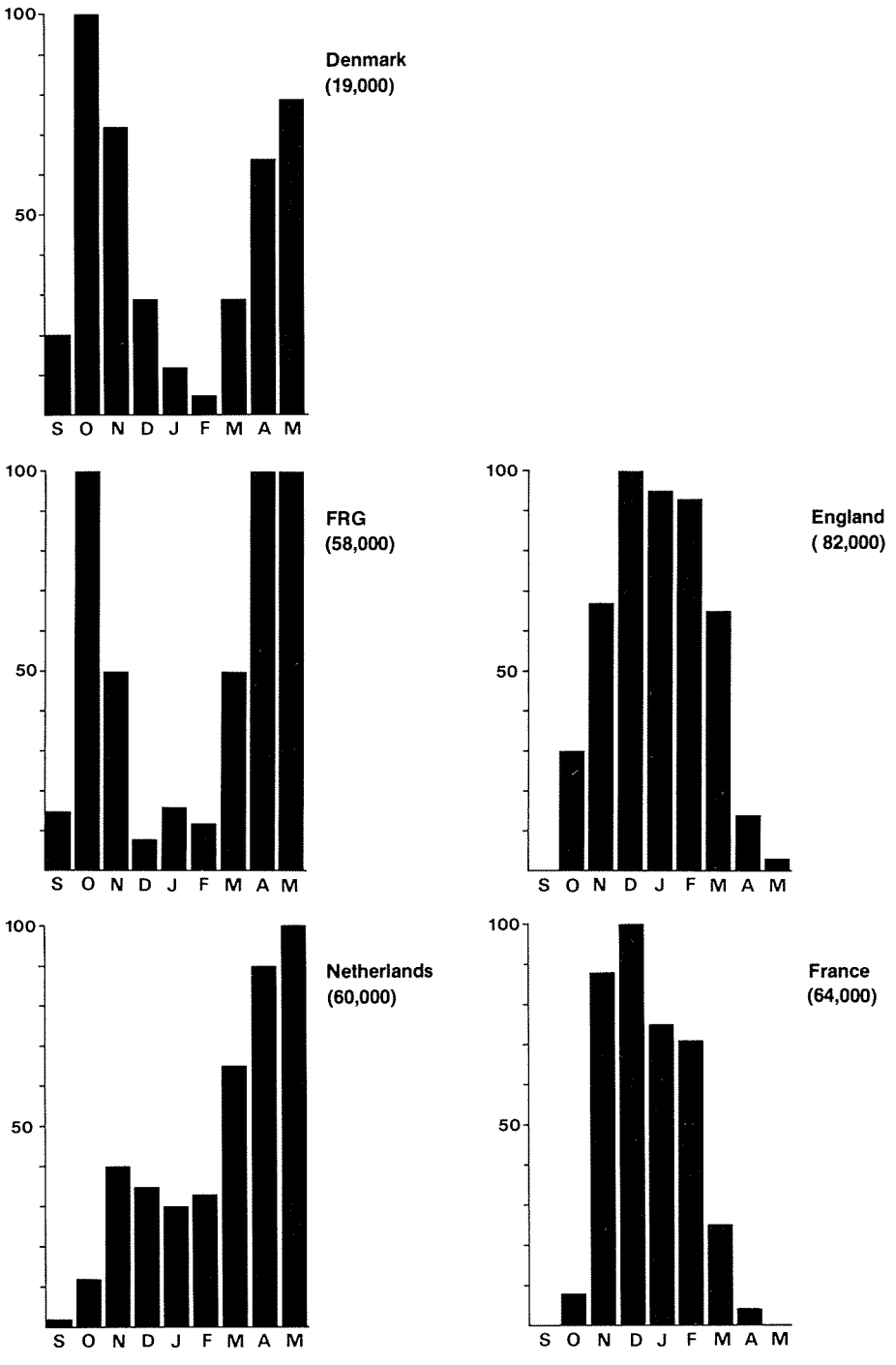


Fig. 15. Phenology of Dark-bellied Brent Geese in five winter range states, expressed in percentage of peak month. Most data are from 1980-1984 (data from FRG from 1975-1979). Numbers in brackets give average maximum (=100%). Sources, see text.

and mudflats feeding on *Zostera* and green algae, and only in few sites in the Wadden Sea flocks graze on saltmarshes created by land reclamation (MADSEN 1986). In spring the geese shift to saltmarshes. In Tipperne in Ringkøbing Fjord the geese graze on fresh water marshes and pastures (MADSEN 1985c, LORENZEN & MADSEN 1985).

Past history. The population decline in the first half of the century was also significant in Danish waters (MØLLER 1978), although the information is sparse, and the reduction cannot be quantified. Very soon after the die-off of the *Zostera marina* in 1932-33 flocks of Brent Geese were seen feeding on saltmarshes in spring (CHRISTIANSEN 1936). However, in contrast to the general downward trend, the spring population around Tipperne increased from approximately 1,000 in 1929-1931 to 2,000-4,000 in the mid 1930s (LIND 1956, MADSEN 1985c). Here the geese found an alternative diet consisting primarily of *Ruppia spp.*

From the 1960s to the 1980s the increase in the spring and autumn population in Denmark has been substantial, viz. approximately 4,000 to 11,000-40,000 (FOG 1972, MADSEN 1986).

Legal status. Total protection since 1972. In three years in the 1960s the annual bag was estimated at 1,200 to 3,000, 4-8% of the total population before shooting (FOG 1972).

Management measures and problems. Apart from an isolated case where usually not more than few hundred Brent Geese feed on winter wheat in October (MADSEN 1986), there are no reports of regular farmland feeding in Denmark (FOG 1977).

Since 1978 the dense submerged macrophyte stands in Ringkøbing Fjord suffered a die-off due to hyper-eutrofication of the water, and the 2,000-4,000 Brent Geese, which used to feed on these plants in spring were forced to shift to fresh water marshes (MADSEN 1985c).

Federal Republic of Germany

Numbers and distribution. The Brent Goose occurs along the German Wadden Sea coastline with the highest concentrations in the Northfriesian part (PROKOSCH 1984d, unpubl.). In the autumns of 1979-84, 50,000-60,000 and around 5,000 geese have been recorded in the Northfriesian and Lower Saxonian Wadden Sea, respectively; in spring 50,000-80,000 representing 35-49% of the total population and 10,000-15,000 representing 8-10% of the total population, respectively. In midwinter the population varies between 0 and 8,000 Brent Geese, dependent on the severity of the winter.

The geese arrive from mid September to the beginning of October, and numbers peak in October; by the end of November most geese have moved on to England and France (PROKOSCH 1984d). Based on sightings of colour-marked individuals it has been shown that the geese stage for a relatively short period, ranging from few days to four weeks. The geese may return in January, but most usually arrive in March, and spring staging numbers peak in April and May. In spring the geese stage for about two months, and they are strikingly faithful to their haunts from year to year (PROKOSCH 1984d). The geese depart in late May.

One of the major spring haunts, Rodenäs Foreshore, adjacent to the Danish border was diked in 1979-82 (for diking plans, see PROKOSCH 1979). Here up to 18,000 Brent Geese stayed prior to the diking. The population has gradually declined since; in 1983 down to 4,000 individuals (PROKOSCH 1984e). Sightings of colour-marked individuals have shown that most of the displaced geese have moved to the islands

of Sylt, where they have colonised a hitherto unimportant site, as well as Föhr and Langeness.

Ecology. In autumn most Brent Geese feed on intertidal mudflats, mainly on the extensive *Zostera* beds in the Northfriesian Wadden Sea (PROKOSCH 1984d). Only to a small extent do they make use of saltmarshes. From March onwards the geese are concentrated on saltmarshes grazed by cattle and sheep on the halligs and along the coastline. Only a small percentage of birds feed on the mudflats. In recent years flocks have been observed feeding on winter cereal fields inside the sea walls (PROKOSCH pers. comm.).

Based on observations of consecutive years with stable goose numbers in the traditional saltmarsh feeding grounds it is believed that the carrying capacity of these areas to Brent Geese has been reached (PROKOSCH pers. comm.). A registered increase in goose numbers in recent years has coincided with goose flocks using new, probably sub-optimal saltmarshes.

Past history. Before this century the Brent Geese were reported to be numerous in the Northfriesian Wadden Sea (see review by PROKOSCH 1984d). Following the die-off of the *Zostera marina* beds in 1932 it is known that the geese switched to saltmarshes. However, there are no reports quantifying the population decrease. In the springs of 1965 and 1966 when the first counts were arranged, 12,000-18,000 geese were counted representing 50-65% of the total population. Since then numbers in spring have increased, though at a lower rate than the total population (PROKOSCH 1984d). In the Wadden Sea of Lower Saxony the population has also increased considerably (PROKOSCH unpubl.).

Legal status. The Brent Goose was protected in Lower Saxony in 1977; in Schleswig-Holstein the season is open from 1 November to 15 January. It is estimated that up to 2,000 Brent Geese are bagged annually (PROKOSCH pers. comm.).

Management measures and problems. Since the 1970s the goose grazing on saltmarshes in spring has caused severe conflicts with cattle-holding farmers on the halligs in the Northfriesian Wadden Sea. Compensation for goose damage has been paid since 1973 (SCHWARZ & RÜGER 1979). Since 1980 270,000 to 300,000 DM have been paid annually by the Ministry of Agriculture and the County of Schleswig-Holstein (KNIEF 1985, PROKOSCH pers. comm.). The goose damage is especially severe on the small halligs with a large proportion of saltmarsh area, less severe on the larger halligs where the areas grazed are smaller. Assessment of damage is done *ad hoc* by a 'Brent Goose Committee', roughly estimating goose grazing pressure from dropping densities and vegetation height.

In a new 'Hallig-programme' presented by the Ministry of Agriculture the halligs will be subsidised for the conservation of the saltmarsh habitat and farming practice, and the geese will be included among the natural but manageable hazards of farming, and compensation for damage will therefore not be paid (PROKOSCH pers. comm.).

In 1982 the diking of 550 ha of saltmarsh on the Rodenäs Foreshore was concluded, and in 1986 the diking of another important spring feeding area for Brent Geese, Nordstrand Bay, will be finished with 845 ha of saltmarsh being diked (PROKOSCH 1979). In Rodenäs the diked saltmarsh has become a nature reserve with sheep grazed grasslands, and in spring flocks of geese now feed behind the sea wall, although it is only a quarter of the numbers which made use of the former foreshore.

With a recent proclamation of the Ger-

man Wadden Sea as a national park, including the part in Lower Saxony, but excluding the halligs, further diking should be brought to an end, and the feeding habitats of the Brent Geese secured.

The Netherlands

Numbers and distribution. Within the Netherlands two distinct Brent Goose areas can be described: The Wadden Sea in the north, and the Delta area in the southwest. Whereas the Wadden Sea is primarily a spring staging area, the Delta region is mainly a wintering site (ROOTH et al. 1981, NETHERLANDS GOOSE WORKING GROUP 1983, 1984a, 1984b, in press).

In the Wadden Sea the Brent Geese arrive in October, and numbers peak in October and November with between 10,000 and 29,000 geese (EBBINGE & BOUDEWIJN 1984). Usually less than 10,000 winter, though up to 22,000 have been observed in mild winters, representing on average 9% of the world population. By March the geese return from the wintering areas in England and France, and they stay until 20-25 May. In April and May 48,000 to 85,000 geese, or 33-42% of the world population stay here, with peak numbers recorded along the Friesian coast and on the islands of Terschelling and Texel (EBBINGE & BOUDEWIJN 1984).

In the Delta area the Brent Geese winter from October to April with peak numbers of 10,000 to 12,000, representing on average 7% of the total population reached in midwinter (NETHERLANDS GOOSE WORKING GROUP 1983). In the Delta area the numbers are hardly affected by cold spells.

Colour-marking has revealed that geese occurring in the Dutch Wadden Sea in spring winter in both England and France without tendency of preference of one of the two countries (EBBINGE & BOUDEWIJN 1984), as was previously suggested by ST JOSEPH (1979a).

Ecology. In the Wadden Sea a seasonal shift in habitat preference is observed (EBBINGE & BOUDEWIJN 1984; see also BILT & HELMING 1978). In autumn most Brent Geese feed on intertidal mudflats where the green algae *Enteromorpha* and *Ulva* constitute the major part of the diet (DIJKSTRA & DIJKSTRA-DE VLIEGER 1977). The *Zostera* beds, which had an extensive distribution before 1932, have hardly recovered since the die-off in 1932 (VAN DEN HOEK et al. 1979), and are therefore of little importance for the Brent Geese today (but see JACOBS et al. 1981). In late autumn the wintering stock of Brent Geese moves to improved grasslands bordering the Wadden Sea. From March onwards, the geese start feeding on natural saltmarshes and grazed saltmarshes created by land reclamation works. In spring some feeding also takes place on developing *Enteromorpha* and on diatoms (CADÉE 1972).

It has been shown that until mid April the digestibility of the pasture grasses is higher than that of the saltmarsh grasses, whereafter the digestibility of the later growing saltmarsh vegetation overtakes that of the pasture grasses (BOUDEWIJN 1984), explaining the shift in habitat preference of the Brent Geese in spring. On the saltmarshes *Plantago maritima* is a highly preferred food plant together with *Festuca* and *Puccinellia* (EBBINGE 1979). The repeated grazing of *Plantago* by the geese has been shown to keep the plants in an active stage of growth with high nutritive quality (PRINS et al. 1980).

In the Delta area the Brent Geese feed on *Zostera* and green algae in autumn (WOLFF et al. 1967), but change to improved inland grasslands later in autumn (NETHERLANDS GOOSE WORKING GROUP 1984a).

Past history. According to the review by MÖRZER BRUYNS & TIMMERMAN (1968) the number of Brent Geese in the Nether-

lands decreased catastrophically by an order of 90% or more shortly after 1932. The authors were convinced that it was directly caused by the disappearence of the *Zostera marina,* the staple food of the Brent Goose. In the years following the *Zostera* disease the geese were found feeding on inland grassland and winter wheat fields.

The first organized counts in the Netherlands in May 1960 recorded 2,600 to 3,000 Brent Geese, and in midwinter 1966/67 4,300 (MÖRZER BRUYNS & TIMMERMAN 1968). Since then the spring population has increased by more than a tenfold, the winter population by a threefold.

Legal status. Total protection since 1950.

Management measures and problems. The increased numbers of geese feeding inland on improved grasslands have caused conflicts with farmers who either produce hay or keep sheep or cattle. Damage problems are especially pronounced in spring (PFEIFFER 1979). So far there is little published information on damage assessment; however, direct compensation is paid to farmers from a fund created by a levy on hunting licenses. In 1979 more than half a million Dfl. were paid for all damage by geese in the Netherlands (DEN UIL et al. 1982), increasing to over one million Dfl. in the 1980s (VAN WELIE 1985). Texel, an island with very little saltmarsh left, has had most serious problems, because even in May there is no alternative feeding for the geese. Here a 110 ha farm, Zeeburg, has been turned into a Brent Goose reserve by the Dutch government in 1976 to alleviate the local damage problems (PFEIFFER 1979, PEERAER 1982). By scaring the geese from other farmland areas to the goose reserve, most of the damage problems have now been solved. Up to 10,000 Brent Geese feed within the reserve in spring (EBBINGE pers. comm.).

On Terschelling, where up to 15,000 Brent Geese stay in spring, most geese feed in a saltmarsh reserve, but there is also a considerable number visiting the polder grasslands. To solve the damage problems on the polders a scaring experiment was set up. By different scaring techniques, such as very pistols, rockets fired over flocks, shotguns fired over the flocks, geese killed by shotgun, the number of geese in the polder was reduced, but on the saltmarsh reserve numbers also went down. Counts on the neighbouring island and along the mainland coast, as well as an increase in the assessed goose damage in these areas showed that the displaced geese had settled there. It was thus concluded that, although solving the local conflicts on Terschelling, the problem itself was only relocated (THISSEN & BRUGGEMAN 1982).

On basis of analyses of grazing intensity on the saltmarshes in the Dutch Wadden Sea EBBINGE & BOUDEWIJN (1984) have estimated that with their present management, the saltmarshes cannot support significantly more Brent Geese. Thus, if numbers of Brent Geese continue to increase, an overspill to grassland is unavoidable and will increase. In addition to the saltmarsh area 1,200 ha of improved grasslands are needed to meet the food requirements of the present spring staging population. If the saltmarshes are better managed than today by use of intensified sheep grazing on the marshes created by land reclamation, the area of improved grassland necessary will be reduced. If scaring of geese from the polders is successful, alternative feeding grounds must be at hand, either on the saltmarshes or on the improved grasslands.

England

Numbers and distribution. The south and southeast coast of England, together with the west coast of France, constitute the central wintering ground of the Brent Goose (ST JOSEPH 1979a, 1982). In midwinter the

British population has varied between 66,500 and 92,600 birds in the 1980s (OGILVIE 1977-1985), representing 45-51% of the world population.

The first Brent Geese arrive at the end of September. Sites in Essex and Kent, especially Maplin Sands/Foulness Island receive birds early in the season, and the wintering population usually peaks in November and December. In contrast the peak on the south coast occurs later, in January and February (PRATER 1981). Numbers begin to diminish by the end of February and especially during March when the geese move on to the Wadden Sea. Since the late 1970s the Wash has become a regular spring staging area with up to 5,000 Brent Geese (PRATER 1981).

Ringing and sighting of colour-marked geese shows that the Brent Geese have a strong faithfulness to their wintering grounds in subsequent seasons. They do not only return to the same estuary, but also to the same section of coast within it (ST JOSEPH 1979a).

Ecology. The traditional winter feeding habitat of the Brent Goose is the intertidal flat with *Zostera* beds and green algae, which constitute the main food items (RANWELL & DOWNING 1959). Today the feeding habits have partly changed, and the geese make use of a wider range of habitats covering mudflats, saltmarshes and farmland areas, which are used in succession (CHARMAN 1979, TUBBS & TUBBS 1982). In autumn almost all Brent Geese feed on *Zostera.* At first the undisturbed mudflats are exploited, and later when these are depleted, the geese move into more disturbed areas and become partly habituated to human activity (OWENS 1977). When the *Zostera* beds have been depleted, and it is no longer profitable to feed there, the geese turn to *Enteromorpha.* From November onwards an increasing number changes to saltmarshes, feeding on *Puccinellia* and *Spergularia* (CHARMAN & MACEY 1978), and later on to farmland with winter cereals, improved grasslands and even onto playing fields. Before 1974 inland feeding was only found in isolated sites in Essex, but from 1973/74 the number of birds feeding inland as well as the number of inland sites have increased tremendously (ST JOSEPH 1979b, ROUND 1982). WHITE-ROBINSON (1982) compared the time budgets of Brent Geese feeding on inland pasture with time budgets on saltmarsh, and he found that pastures supported higher densities of geese, and having the choice of the two habitats, a flock spent almost 90% of its feeding time on pastures. However, certain individuals exclusively grazed on saltmarsh.

The number of geese feeding inland is correlated with the number of birds present along the coast, and the development has undoubtedly been caused by the population increase and the following faster depletion of the traditional food sources. In the 1980s more than 40,000 Brent Geese feed inland in late winter, and they now range up to 9 km from the water (OGILVIE pers. comm.) and have developed overland migration routes, too (HARRISON 1979). The inland feeding habit has spread along the south and southeast coast of England.

Past history. The known history of the Brent Geese in England has been reviewed by ATKINSON-WILLES & MATTHEWS (1960) and by OGILVIE & ST JOSEPH (1976). Information about numbers of the Dark-bellied Brent Goose in the period before 1930 is extremely scarce, and it is not possible from the English counts – as SALOMONSEN (1958) claimed – to give an exact estimate of the former population size, nor of the magnitude of the population decline in the 1930s. However, undoubtedly the former population decreased massively and possibly by the order of 75% (ATKINSON-WILLES & MATTHEWS 1960). In the mid

1950s the midwinter population amounted to 7,400 birds. In the 1960s the English population had increased to a mean of 16,000 birds, on average representing 63% of the total population (calculated from data in OGILVIE & ST JOSEPH 1976). In the 1970s the wintering population was steadily increasing, averaging 37,000 geese or 47% of the total population (calculated from data in OGILVIE 1979, 1977-1985), indicating that since the 1960s a higher proportion of geese wintered outside the English haunts.

Legal status. Fully protected since 1954. 300-400 geese are shot annually under license (see below). ST JOSEPH (cited in PROKOSCH 1984d) estimates that 1,000-2,000 Brent Geese are shot annually, either illegally or under license.

Management measures and problems. The inland feeding has given rise to conflicts with farmers complaining of goose damage on winter cereals. One big problem giving rise to increased damage is that farmers are growing cereals in more and more marginal areas because of price guarantees by the EEC. Wheat is now being grown right up to the sea wall, where there used to be a buffer of wet grazing land of little interest to the farmer in winter and which the geese could use (M. OWEN pers. comm.) Assessment of the damage has only been carried out in few cases, but the published examples of extreme cases have shown that the goose grazing can have a considerable negative effect on yields of winter wheat (ST JOSEPH 1979b, DEANS 1979). Various means of scaring have been tried but most have proved to be rather inefficient, unless pursued with a great deal of effort (ST JOSEPH 1979b). Since 1982/83 Brent Geese have been allowed to be shot under license (NUGENT 1985). In 1984/85 which is typical for recent years, 50-60 licenses were granted to farmers complaining of damage. A limit of 723 kills was set, but only 368 Brent Geese were actually killed (OGILVIE pers. comm.). Since the start of licensed shooting conflicts have levelled off. There exists no legal mechanism for direct compensation for damage. So far no special goose reserves have been created to lessen the conflicts. However, a saltmarsh area in Essex has just been protected by a non-government organisation mainly with the aim of establishing an undisturbed managed feeding ground where the Brent Geese will not cause damage (OGILVIE pers. comm.).

France

Numbers and distribution. Together with England, France is the principal wintering area for the Brent Goose. In mid January 1979-1984 the French wintering grounds harboured a total of 41,000-65,000 geese (MAHEO 1984 and unpubl.), representing on average 33% of the total population. The geese are found in estuaries from the western part of the English Channel south to the Bassin d'Arcachon near Bordeaux.

The Brent Geese start to arrive in October, and during November numbers rapidly increase, usually reaching a peak in December. From late January numbers begin to decline, and by the end of March most geese have left the country.

Along the French coast there is a temporal difference in site usage. The Golfe du Morbihan and nearby sites receive early arrivals by the end of October; numbers peak in November and December with 15,000-23,000 individuals (MAHEO 1984), and the geese already start leaving the area in December. From the Golfe du Morbihan the geese move on to the main wintering sites, of which Charente Maritime and Bassin d'Arcachon in the southwest range are the most important. Here the peak is usually a month later than at the Golfe du Morbihan.

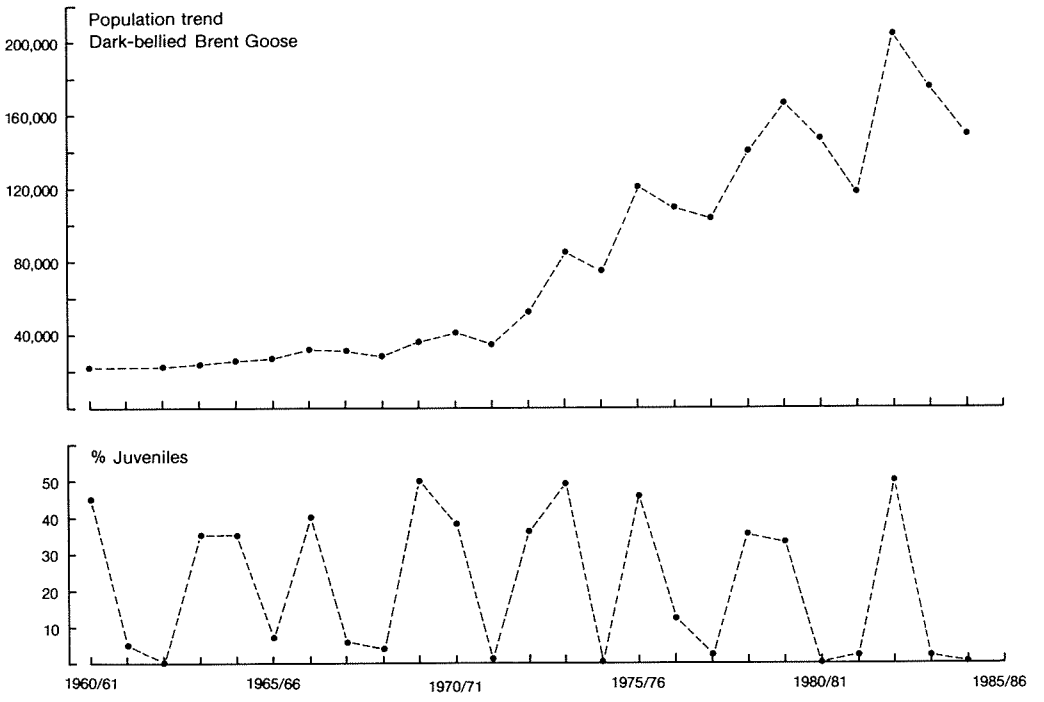


Fig. 16. Population development and percentage of juveniles in wintering flocks in Dark-bellied Brent Goose, 1960-1984 (IWRB BRENT GOOSE RESEARCH GROUP, unpubl.).

Ecology. The Brent Geese are almost completely restricted to the seashore, feeding on intertidal *Zostera marina* and *noltii* beds, and also on *Enteromorpha* and *Ulva.* Only to a small extent do the geese feed on saltmarshes (MAHEO 1979). Inland feeding only occurs in a single site, Baie de Bourgneuf, where usually a few hundred geese feed on improved grassland and winter cereal fields (BAVOUX et al. 1985).

Past history. Brent Geese have been counted in France since 1960-1961, when 6,000 to 7,000 were recorded. Later in the 1960s up to 11,500 individuals were counted, or on the average 32% of the total population (calculated from MAHEO 1984), and in the 1970s up to 65,000, or on average 36% of the total population. Numbers prior to 1960 are not known, but MAHEO (1976) mentions that the Brent Geese were probably much more numerous in the Golfe du Morbihan around 1930 than they are today.

In the 1960s and 1970s Golfe du Morbihan was the most important wintering area in France (MAHEO 1976), but since the late 1970s the site has primarily functioned as a pre-wintering site.

Legal status. Fully protected since 1966. In the Golfe du Morbihan MAHEO (1976) estimated that 300-500 geese were illegally killed each winter.

Management measures and problems. Only in the Baie de Bourgneuf are there conflicts with agriculture. Complaints by farmers of damage to winter cereals have caused the geese to be scared off the fields by various devices by the Ministry of Environment (BAVOUX et al. 1985).

Population development

It was shown by SALOMONSEN (1958) that the Brent Goose was much more numerous in the latter half of the 19th century, and that numbers decreased thereafter, reaching a low point in the 1950s. However, most of the evidence stems from the Svalbard Light-bellied Brent Goose population, and the numerical documentation from the literature concerning the Dark-bellied Brent Goose is, as it has been shown above, more fragmentary and anecdotal. Nevertheless, it is evident that the population underwent a drastic decline in the 1930s.

The population development since 1955 is well documented by internationally coordinated counts by the IWRB (Fig. 16). It was not until the 1960s that signs of recovery in the population size were recorded. From the beginning of the 1970s the population increased exponentially, reaching a record peak of 203,000 geese in 1982/83.

The high-arctic breeding Brent Geese are liable to high annual population fluctuations due to the variable conditions on the breeding grounds, and the number of juveniles brought to the wintering grounds varies between 0 and 53% of the total autumn population. Out of 28 years (1955-1982) only 13 were successful (i.e. more than 33% juveniles), and 12 with breeding failures (i.e. less than 7% juveniles) (PROKOSCH 1984d).

Discussion

The decrease in the Dark-bellied Brent Goose population in the 1930s happened simultaneously with the 'wasting disease' of *Zostera marina* along the Atlantic coastline in 1932, most probably caused by a series of mild winters combined with the virulence of the amoeboid parasite *Labyrinthula macrocystis* (see RASMUSSEN 1977 for a review). Whether it was the disappearance of the principal food source or other factors such as shooting pressure, or factors in combination, which were responsible for the decline in the Brent Goose population has been much questioned (VIERECK 1951, SALOMONSEN 1958, OGILVIE 1979). Direct starvation in the years following the die-off of the *Zostera* was not reported (SALOMONSEN 1958), but in the Dutch Wadden Sea geese were reported to be in very poor condition, some weighing only 0.5 kg instead of the usual 1.5 kg (MÖRZER BRUYNS & TIMMERMAN 1968). In fact at least to some extent the geese were able to switch to other food sources as the *Zostera marina* disappeared, mainly *Zostera noltii* which was not affected by the disease, green algae and saltmarsh vegetation (VIERECK 1951, SALOMONSEN 1958). However, the disappearance of *Zostera marina* may have caused the geese to become more vulnerable to shooting, both because of their poor condition, and because they were forced to seek food in areas where hunters had easier access to the birds. This was in fact what happened to the North American Light-bellied Brent Goose in 1971/72 when its principal food *Ulva* was scarce and it had to turn to saltmarshes rather than open bays. In that winter 70,700 geese were estimated to have been bagged, the highest ever recorded (ROGERS 1979). With the combination of a poor breeding season in the summer 1972, the population was reduced from 151,000 in January 1971 to 40,700 geese in January 1973. A similar coincidence of negative factors may have caused the depression of the Dark-bellied Brent Goose population, rather than the *Zostera* disease in itself.

The increase from the 1960s to the 1980s has been shown to be caused by a lowered annual mortality rate which decreased from an average of 22.1% (1963-1971) to 13.3% (1972-1982), whereas the proportion of juveniles did not change on the average 22.2% and 22.3%, respectively. Biologists

analysing the population dynamics have almost exclusively concluded that the relaxation in hunting pressure on the wintering grounds was responsible for the increase (OGILVIE 1979, PROKOSCH 1984d, EBBINGE 1985), and especially the shooting ban in Denmark since 1972.

It is known that *Zostera marina* recovered over most of its former range in western Europe from the 1940s, excluding the Dutch Wadden Sea, but the Brent Goose population did not increase accordingly (VIERECK 1951). Hence, it seems not to have been altered food conditions that has caused the increase.

The future population development of the Dark-bellied Brent Goose will, as long as shooting is banned over most of its range, be dependent on the carrying capacity of the breeding and wintering grounds. EBBINGE (1985) has shown that at higher population levels in the 1970s, the proportion of successful breeding pairs has been reduced, indicating that some density-dependent effects are operating on reproduction. At which stage in the life cycle this pressure lies is so far unknown. As there seems to be no ongoing Soviet studies on the breeding grounds, an early answer can hardly be expected.

Research in the Dutch and German Wadden Sea has shown that the acquisition of sufficient body reserves on the spring staging areas is a prerequisite for successful breeding (EBBINGE et al. 1982, PROKOSCH 1984d), and thus the conservation and management of the spring staging areas in the Wadden Sea are of vital importance for the well-being of the Brent Goose population. As indicated in the Dutch and Northfriesian Wadden Sea the carrying capacity of the saltmarshes in their present state has possibly been reached (EBBINGE & BOUDEWIJN 1984, PROKOSCH 1984d and pers. comm.). At the level of foraging goose flocks there has been shown to be much competition for preferred food patches, and a highly differing feeding efficiency among individuals, the most efficient birds also being the most successful breeders (DRENT & VAN EERDEN 1980, TEUNISSEN et al. 1985). Together, these works indicate that the spring staging areas do not offer an infinite scope for population growth, but rather that a density-dependent factor here could be acting on the reproductive capacity of the population. If the spring is the 'bottle neck' limiting population growth, further increase will depend on the possibility of the geese to make use of inland pastures to build up body reserves, a question which is presently being investigated in the Dutch Wadden Sea.

Conditions on the English and French wintering grounds do not appear to be limiting at present. The carrying capacity of the intertidal habitats in England has been exceeded, but by adapting themselves to inland feeding the geese have opened the doors to a new habitat which can – if the farming communities allow and/or sufficient reserves are created – support vast numbers of geese.

Management needs. At the two technical meetings in Paris the need for managing the Brent Goose population was highlighted (DE KLEMM 1979, SWIFT & HARRISON 1979, SMART 1979, ST JOSEPH 1982). At the time of the meetings (1977, 1979) the population was in an exponential growth phase, and conflicts with agriculture in Britain, the Netherlands and the FRG had sharpened. Since then the increase has levelled off, and although the solutions are not complete in the long term, ways of solving the damage problems have been found or are prepared in most cases. The strategy for alleviation of conflicts has not been internationally coordinated.

Licensed shooting as practised in England will not solve the conflicts with agriculture in the long term, because the problems are only relocated. As suggested by

ST JOSEPH (1982, unpubl.) and WHITE-ROBINSON (1982), a possible solution will be to develop scattered alternative feeding sites bordering the sea wall in the 'home range' of the goose flocks, accompanied by licensed shooting over vulnerable crops. This would probably be the cheapest solution and would prevent the massive concentration of geese in few large refuges.

EBBINGE & BOUDEWIJN (1984) advocate that to prevent damage along the Dutch Wadden Sea, the saltmarsh areas should be more effectively managed by summer grazing to raise the carrying capacity. Geese scared from susceptible grasslands would then have alternative refuge areas with sufficient resources.

If a shooting season should be reopened, several aspects should be addressed in an international forum before its eventual implementation.

First, the Brent Geese are liable to irregular breeding success, which results in an unequal age-cohort representation in the population. Population size is not an indicator of its resilience (KIRBY et al. 1985). A shooting system should therefore be finely-tuned with a harvest quota, derived from an annual assessment of population size and breeding success, and ideally, from a knowledge of population demography (as proposed by KIRBY et al. 1985).

Second, recognizing that the Brent Goose is a migratory species distributed over several countries, range states should jointly agree on a shooting system and on the setting of annual quotas in the respective countries. This implies that those states agree on a desirable population level and for guidelines on whether to have shooting and, if so, how much (see DE KLEMM 1979).

Third, a desirable population level should be defined, either by the North American concept of 'threshold level' which is a rather arbitrary level set as a guideline for shooting, or by the concept of a population level related to habitat carrying capacity. However, the application of the latter concept is a difficult affair, because it implies a coupling not only of shooting levels with the size of the natural resources, but also with agricultural damage problems, reserve policies and habitat management. This is not an easy pathway to handle which is illustrated by the example of the diking of Rodenäs Foreshore in the German Wadden Sea. The carrying capacity of the saltmarsh areas there has been reduced considerably, and the risk of damage to other more susceptible areas has increased accordingly. Not many would accept it as good management to depress the Brent Goose population to a level fitting the new capacity by shooting. It is more sensible to delay a decision on a reopened shooting season until the eventual levelling off of the population, which is predicted in the near future.

Research needs. As recommended at the technical meetings in Paris (SMART 1979, SCOTT & SMART 1982), studies of the breeding and moulting population of Brent Goose have the highest priority in the international efforts of research. At present virtually nothing is known about the population from June to mid September.

In the wintering quarters a great deal of work has been and is currently being done on assessment of food resources and exploitation rates by the Brent Geese. However, more information on food exploitation rates and carrying capacity of the *Zostera* beds and green algae shallows would be useful especially from France in order to get a more precise picture of how close to the ceiling of the capacity of the natural resources the population is and to analyse factors determining population movements within the wintering range (see DRENT et al. 1979).

Light-bellied Brent Goose *Branta bernicla hrota* (Svalbard population)

Two populations of Light-bellied Brent Goose winter in western Europe. One breeds in Svalbard and Franz Josef Land (Fig. 13) and winters in Denmark and England, the other breeds in northwest Canada and north Greenland and winters in Ireland. The Svalbard population which is treated in this review is one of the smallest goose stocks of the world, at present amounting to approximately 4,000 individuals (MADSEN 1984c), while the north Canadian population numbers around 18,000 (OGILVIE 1977-1985). A third population breeds in northern Canada and winters along the north American Atlantic coast, and counts at present around 130,000 individuals (KIRBY et al. 1985).

Breeding grounds and breeding ecology

The Light-bellied Brent Goose is a scattered breeder in Svalbard, and a rare breeder on Franz Josef Land. Before 1969 less than 100 breeding pairs could be accounted for in Svalbard (NORDERHAUG 1970), but many parts had only been visited by ornithologists once or not at all. In 1969 600-750 Brent Geese (including goslings, but the number of breeding pairs not estimated) were found on Tusenøyane in southeast Svalbard (NORDERHAUG 1974), and recently it has been confirmed that this archipelago is the main breeding area of the population. Thus the total population there in July/August 1985 was estimated at 1,200-2,000 geese, representing around 50% of the entire Light-bellied Brent Goose stock, of which 30-50% were breeding (F. MEHLUM pers. comm.). In Franz Josef Land very few pairs are known to breed (GORBUNOV 1932, TOMKOVICH 1984).

Very little is known about the breeding biology of the Brent Goose in Svalbard. According to LØVENSKIOLD (1963) they arrive during the last few days of May and the first days of June, indicating that they go almost non-stop from Denmark to Svalbard. From the middle of August the Brent Geese start to assemble, and southward movements begin by the end of August and last until the third week of September. Eggs have been found from 9 June and newly hatched goslings from 6 July. Most pairs nest on islands where Arctic Foxes usually do not have access, and more rarely Brent Geese breed on small islands in rivers (LØVENSKIOLD 1963). The Glaucous Gull *Larus hyperboreus* seems to be a heavy predator on Brent Goose eggs and goslings (NYHOLM 1965). The diet of the Brent Geese is reported to consist of grasses, mosses, algae, *Oxyria, Ranunculus* and other dicotyledons (LE ROI 1911, NYHOLM 1965).

Past history. LØVENSKIOLD (1963) states that the Brent Goose formerly, probably referring to the beginning of this century, was the most numerous of the goose species breeding in Svalbard. Brent Geese were breeding in large numbers on the islands along the coasts of Spitsbergen, but in the 1950s the population there was almost exterminated due to nest robbing by fishermen and whalers collecting eggs and down from Eider *Somateria mollissima* and Brent Goose nests. NORDERHAUG (1970) also concluded that the population had been heavily reduced in the first half of the century, but that it had then stabilized since the 1950s.

Legal status. Fully protected in Svalbard in 1955. Since 1963 when the Eider was protected, eggs of Brent Geese have not been gathered either (NORDERHAUG 1970).

Management measures and problems. In the bird sanctuaries in Svalbard less than 30 pairs of Brent Geese breed (PRESTRUD & BØRSET 1984). Tusenøyane are part of the Southeast Svalbard Nature Reserve with protection from all technical interference, but with no restrictions on landing on the islands (NORWEGIAN MINISTRY OF ENVIRONMENT).

Migration routes and staging areas

In spring the Light-bellied Brent Geese migrate from northwest Denmark to southwest Norway, west of Kristiansand to Jæren, where the passage culminates 20-26 May (HAFTORN 1971, BYRKJEDAL & ELDØY 1981). The northerly migration along the Norwegian west coast is seldom seen as the geese usually fly far from land, possibly directly to the breeding grounds (SALOMONSEN 1958). To what degree they stop on Bear Island is unknown, but as for the Pink-footed Geese, they probably by-pass.

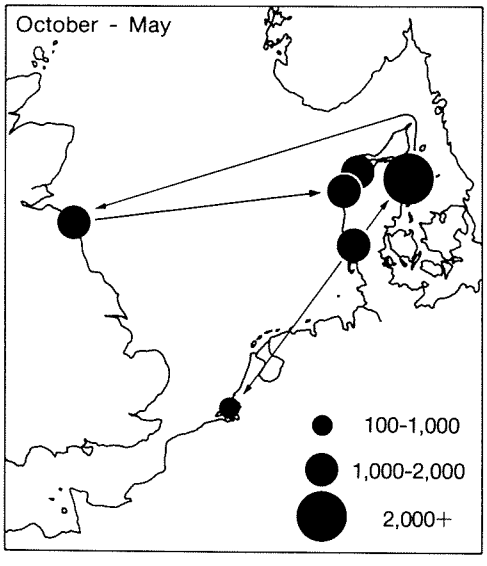


Fig. 17. Distribution of the Svalbard Light-bellied Brent Geese in the wintering quarters. Arrows indicate directions of movements. (After MADSEN 1984c).

In autumn at least part of the population stops on Bear Island on the southerly migration from Svalbard. In 1984 OWEN et al. (1985) recorded passage of flocks between 7-18 September with a maximum of 350 geese. The migration along the north Norwegian coast probably occurs far at sea. Flocks are regularly seen from Utsira to Jæren. In the latter place some flocks may rest before the passage to Denmark (SALOMONSEN 1958, BYRKJEDAL & ELDØY 1981). Most flocks pass Jæren in the first half of September.

Ecology. No published information exists. In 1984 J. M. BLACK (pers. comm.) saw flocks of Brent Geese grazing on the headland of Bear Island together with Barnacle Geese.

Legal status. Total protection in Norway.

Wintering grounds

The main wintering quarters are situated in Denmark and northeast England (Fig. 17). Very few individuals are seen in the West German Wadden Sea among the Dark-bellied Brent Geese (PROKOSCH 1984c). In the Netherlands up to 200 birds are seen in cold winters (LAMBECK 1981, VAN DEN BERGH 1984), probably displaced from the Danish Wadden Sea because of bad weather conditions, and few individuals are seen among the Dark-bellied Brent Geese in the Dutch Wadden Sea area (LAMBECK 1977).

The phenology in Denmark and England is shown in Fig. 18.

Denmark

Numbers and distribution. The population has five regular haunts which are used in succession: the Danish part of the Wadden Sea, Mariager and Randers Fjords, Nissum

Bredning, Agerø and Nissum Fjord (MADSEN 1984c).

The Light-bellied Brent Goose is the earliest among the arctic nesting geese to arrive in Denmark. On their way from Norway to the Wadden Sea peak numbers pass Blåvandshuk in southwest Jutland before mid September (MELTOFTE 1973), around two weeks ahead of the Dark-bellied Brent Geese. In September the Light-bellied Brent Geese are only seen in the Wadden Sea, though usually in small numbers. Larger flocks of up to 1,100 individuals have been recorded, and give rise to the suspicion that the majority of the population stays there in September and October. They may well be overlooked, due to the vastness of the area and to mixing with the more numerous Dark-bellied Brent Geese (MADSEN 1984c).

From the end of November most of the population is concentrated in Mariager Fjord. If the winter is mild, and the shallow waters not frozen, the geese remain there until March. However, in cold winters where Mariager Fjord becomes icebound an increasing proportion of the population is displaced to Lindisfarne in northeast England. Hence, the number of Brent Geese in Lindisfarne is negatively correlated with mean temperatures in Denmark in January and February (MADSEN 1984c). From March to the end of May the population gathers in two sites, Nissum Fjord and around the small island Agerø in northwest Jutland. Nissum Bredning is irregularly used. The geese leave the spring haunts between 20 to 31 May.

Ecology. In autumn and winter the Brent Geese feed on mudflats and shallow water. From March to May the geese gradually shift to saltmarshes and to lesser extent pastures (MADSEN 1984c).

Past history. In the beginning of this century Light-bellied Brent Geese were numerous in the shallow-watered fjords, Limfjorden, Nissum Fjord and Mariager Fjord, but declined drastically in numbers in the first half of the century (SALOMONSEN 1958, FOG 1972). In the 1960s the

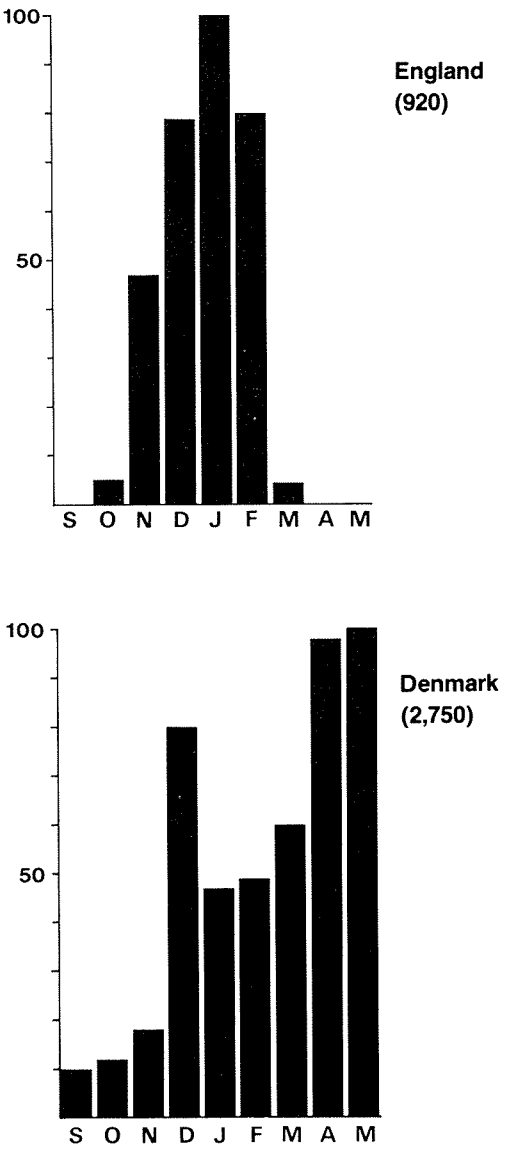


Fig. 18. Phenology of Light-bellied Brent Geese in the winter range, expressed in percentage of peak month. Data are from 1980-1984. Numbers in brackets give average maximum (=100%). Sources, see text.

spring population was confined to Nissum Fjord and Nissum Bredning, but since the mid 1970s an increasing part of the geese has stayed around the island Agerø in Limfjorden. Nissum Bredning was formerly an important spring haunt, but has now lost its value, probably due to pollution of the shallow waters.

Legal status. Total protection since 1972. Before the ban it was estimated that approximately 220 birds were bagged annually (FOG 1967), representing about 10% of the population.

Management measures and problems. The feeding grounds on saltmarshes are protected areas. However, apart from minor parts, none of the haunts are reserves with shooting regulations (MADSEN 1986). A general threat posed on the haunts is the increasing hypereutrofication and pollution of the shallow waters of the fjord systems. In Nissum Fjord the submerged macrophyte vegetation has almost died-out recently (JEPSEN 1984), as it has over large parts of Nissum Bredning.

England

Numbers and distribution. Only one site, Lindisfarne in Northumberland is used regularly by the Light-bellied Brent Geese.

The Brent Geese usually arrive in November, and numbers peak in January, although depending on the severity of the winter in Denmark (MADSEN 1984c). When the winters are mild in Denmark numbers remain below 1,000, but in cold winters the majority of the population is gathered at Lindisfarne, in January 1985 reaching a record maximum figure of 3,000 (OGILVIE 1977-1985). The geese leave Lindisfarne before mid March.

Ecology. The Brent Geese feed on beds of *Zostera* spp. on shallow waters and mudflats (SMITH cited in EVANS & DUGAN 1984).

Past history. Prior to the population decrease in the first half of this century large numbers wintered in Moray Basin and other sites in east Scotland. The origin of these flocks is unknown, and they may have been Canadian birds (OWEN pers. comm.). Flocks were also seen south to Essex (SALOMONSEN 1958, ATKINSON-WILLES & MATTHEWS 1960).

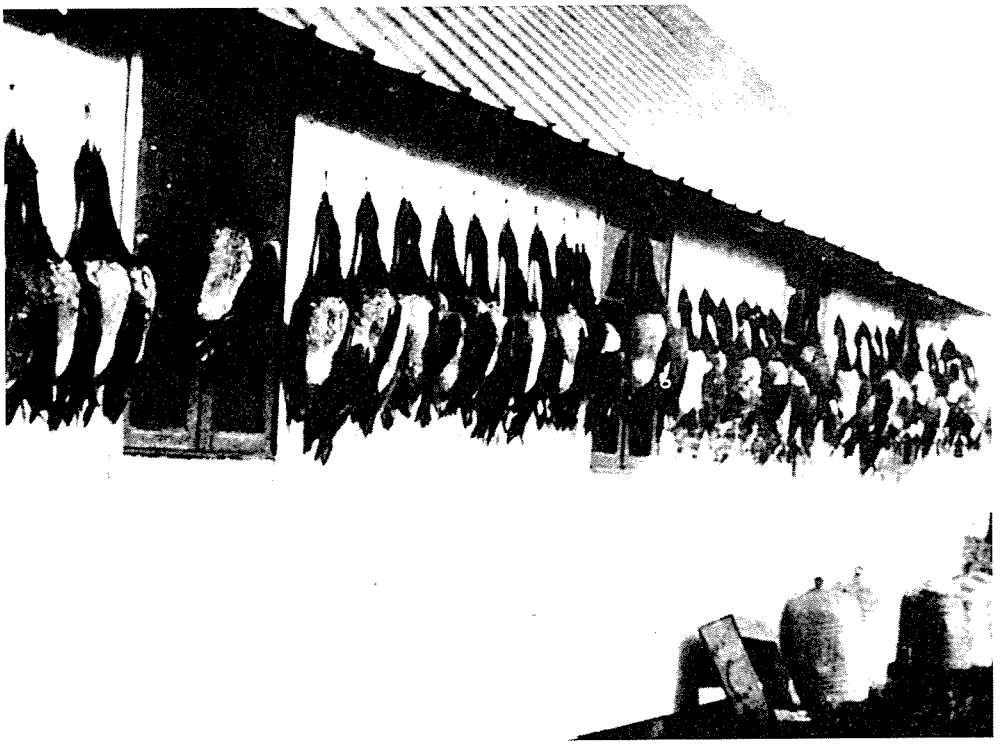
Legal status. Total protection since 1954.

Management measures and problems. The Lindisfarne area is a national nature reserve with some shooting restrictions, however, not over the central feeding grounds (NATURE CONSERVANCY COUNCIL unpubl.).

Population development

The fragmentary information that exists on the population trends of the Svalbard Light-bellied Brent Geese gives the impression of a population decline in parallel with that of the Dark-bellied population. Based on observations of the number of geese passing south Norway in autumn SALOMONSEN (1958) estimated that in the latter part of the 18th century the Svalbard population numbered at least 25,000 (SALOMONSEN made a wrong calculation in his paper, erroneously writing 250,000), and in the latter part of the 19th century at least 40,000-50,000 geese. Accordingly, LØVENSKIOLD (1963) notes that the Brent Goose was breeding in 'immense' numbers on the islands around Svalbard.

However, it was not until the middle of the present century when counts started in Britain and Denmark that it was identified how serious the population decline had been. SALOMONSEN (1958) estimated that the population did not exceed 4,000 indivi-



A wall full of bagged Light-bellied Brent Geese, western Limfjord, Denmark, in the 1940s. Despite the population decline in the 1930s, a fair number of Brent Geese was apparently shot in the following decade. This supports the theory that factors other than the die-back of the seagrass *Zostera marina,* e.g. overshooting, contributed to the decline. (Photographer unknown.)

duals in the 1950s, and from the breeding grounds it was correspondingly reported that most of the former breeding grounds were empty of Brent Geese (LØVENSKIOLD 1963, NORDERHAUG 1970). When counts in Denmark and England were coordinated in the late 1960s it was estimated that the population had dropped further to 1,600-2,000 individuals (FOG 1972). In the 1980s the population has recovered a little, now reaching around 4,000 geese (MADSEN 1984c). Breeding success expressed by the proportion of juveniles in the winter flocks shows that the population has a low average reproductive success (Table 2), which is lower than that of the other Svalbard goose populations.

Discussion

The reasons for the decline of the Svalbard population of Light-bellied Brent Goose in the first half of this century are probably the same as for the Dark-bellied Brent Goose population. The 'wasting disease' of the *Zostera* food supplies in the wintering quarters probably also affected the Light-bellied Brent Goose population as it was probably almost exclusively feeding on *Zostera marina* in autumn and winter. It is known that shooting pressure on the population in both autumn and spring was considerable (FOG 1972), and this may likewise have had a negative effect on the population level. Egg collection and associated

disturbance on the breeding islands of the Brent Geese may, in addition to the factors on the wintering grounds, have had a critical impact on the breeding success of the population.

It has been suggested that the Brent Goose and the Barnacle Goose compete for nest sites and food during the breeding season (OWEN & NORDERHAUG 1977), and that the increase of the Barnacle Goose population may have caused that the Brent Goose was forced out of some of the breeding areas. However, the decrease of the Brent Goose happened before the increase of the Barnacle Goose, but possibly the now densely breeding Barnacle Geese along the coasts of Spitsbergen may prevent the Brent Geese from re-establishing there.

Whilst the population of Dark-bellied Brent Goose has tripled in numbers since the shooting ban in Denmark in 1972, the Light-bellied Brent Goose population has shown only modest signs of recovery. An annual kill of approximately 220 birds in Denmark prior to 1972 (FOG 1967) may well have been the factor controlling population size, and a decreased shooting mortality can have been the reason for the positive development recorded since 1970.

Because the population of Svalbard Light-bellied Brent Goose is so small and often concentrated in one or two haunts, it is highly vulnerable to environmental perturbations or deterioration, as for example the die-off of the macrophyte vegetation in Nissum Fjord in Denmark. A single event of this character may affect the welfare of a major part of the population.

The reproductive rate in the population since 1980 has on average been low and not exceeded 25% of juveniles in the wintering flocks (Table 2). This feature is common to the other Svalbard goose populations, but in contrast to the Dark-bellied Brent Goose which has an average reproductive rate twice as high as the Light-bellied Brent Goose (see p. 50). In the Svalbard Barnacle Goose it has been concluded that at present the breeding success is limited by factors operating on the breeding grounds (OWEN 1984). In the Light-bellied Brent Goose there is so far no evidence as to the factors limiting the population growth.

Management needs. As long as the population has not recovered more than at present, highest possible priority should be given to protect the stock and its haunts. A reserve in the major Danish haunt, Mariager Fjord and Randers Fjord, to reduce disturbance is much needed. However, site protection will only be effective if the habitats are also preserved. This implies action against pollution of the coastal shallow waters.

If the shooting season of the Dark-bellied Brent Goose should be re-opened in Denmark, it should of course not include areas where Light-bellied Brent Geese occur. However, it must be emphasized that there does not exist a complete map of the whereabouts of the population in the winter range. For example it is not known how important the Wadden Sea is to the population. Before an eventual decision about re-opening the season, this basic information should be at hand.

At present only a small proportion of the population breeds in sanctuaries in Svalbard. The identification of Tusenøyane as the central breeding area of the population should be followed up by an analysis of needs for sanctuaries in the area.

Research needs. To make a proper management of the population and its sites, an inventory and monitoring scheme on several aspects of the ecology of the population should be initiated. First, virtually nothing is known about breeding ecology, and still there are many gaps in our knowledge of the breeding distribution. Second, there are times of the year (September, November,

March) where we do not know the whereabouts of a major part of the population. Third, little is known about factors determining population levels. As part of the latter the influence of spring feeding conditions on the build-up of body reserves ought to be studied. To enable these studies, a part of the population should be individually marked with plastic leg rings.

General discussion and conclusions

Population trends and regulation

One critical question in population management is what regulates the size of goose populations. In order to unravel this question the published population reviews are examined.

All five goose populations reviewed here, and most other populations wintering in Europe, have increased during the last decades. In six of the best monitored populations the possible reasons for the increasing trends have been analysed on basis of population parameters and life histories: Icelandic Pink-footed Goose (OGILVIE & BOYD 1976, EBBINGE 1985), Svalbard Pink-footed Goose (EBBINGE et al. 1984), European Whitefronted Goose (EBBINGE 1985), Svalbard Barnacle Goose (OWEN & NORDERHAUG 1977, OWEN 1984), Siberian Barnacle Goose (EBBINGE 1982), and Dark-bellied Brent Goose (PROKOSCH 1984c, EBBINGE 1985). Without any exceptions these six populations have increased.

A common feature in all six populations is that the increases have not been brought about by better reproduction. Annual recruitment has either been constant or has even decreased. The increases have on the other hand been attributed to a marked decrease in mortality. As the highest mortality in general is found in the wintering quarters and not on the breeding grounds, it seems that the releasing factors should be sought on the wintering grounds. In the six populations the increases have coincided with a better protection, and in all studies it is currently believed that restriction of shooting in Europe has been the prime releasing factor. Shooting has seemingly largely been an additive mortality factor, and not compensatory.

Changes in agricultural practice on the wintering grounds may have benefitted the geese in providing a more secure winter forage, leading to a better survival. In most cases, however, the population increases have been started abruptly over few years, suggesting that they were caused by action of a quick change in a single significant factor, e.g., shooting pressure, rather than a more gradual change, as for example the better feeding conditions changing over a longer span of years (EBBINGE 1985).

On the whole, conditions have probably been constant on the arctic breeding grounds. Only on Svalbard have bird sanctuaries provided a better protection to the Barnacle Geese.

In conclusion, the analyses of population dynamics of the six populations provide circumstantial evidence for the hypothesis that goose populations wintering in Europe have been – and some populations probably still are – regulated by shooting.

How far the goose populations will develop will depend on the ceiling of the habitat capacity of their environment. Density-dependent regulating mechanisms have been documented in some populations, and so far it has especially affected reproduction and not so much adult mortality (Icelandic Pink-footed Goose: OGILVIE & BOYD 1976, EBBINGE 1985; Icelandic Greylag Goose: BOYD & OGILVIE 1972; Greenland Barnacle Goose: OGILVIE 1978, CABOT & WEST 1983; Svalbard Barnacle Goose: OWEN 1984: Dark-bellied Brent Goose: EBBINGE 1985). This has for example been

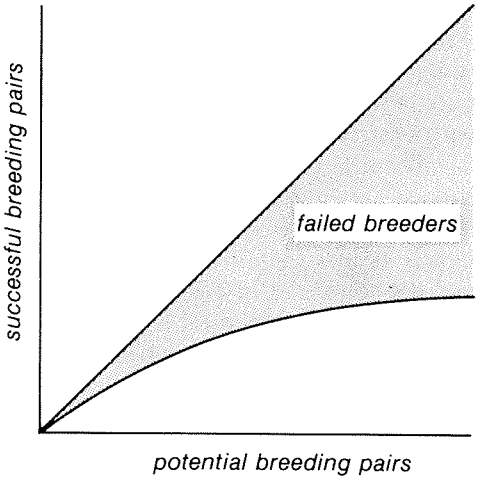


Fig. 19. Generalized trend found in several goose populations: the proportion of successful breeders is reduced at higher population levels (After EBBINGE 1985).

shown by the finding that the number of successful breeding pairs levels off with increased population size (Fig. 19).

The density-dependent effect can be brought about at various stages during prebreeding and breeding:

1) By increased competition on spring staging areas. During this period, where the geese put on weight and which is vital to the breeding potential, food competition may affect the breeding outcome. This may be the case in the Dark-bellied Brent Goose, which is concentrated on saltmarshes in the Wadden Sea, where there is a limited capacity (see p. 46), and possibly also in other populations.
2) Through competition for nest sites, including density effects on nesting success. This can be pronounced in populations where breeding is restricted to islets or cliffs, e.g., the Svalbard Barnacle Goose (OWEN 1984).
3) By increased competition for food during the nesting and fledging period. For the Svalbard Barnacle Goose it has been indicated that food resources during nesting and post-nesting limit breeding success (PROP et al. 1984), and likewise for the Pink-footed Goose breeding in central Iceland (GARDARSSON 1976). However, generally very little is known about the habitat capacity of the Arctic breeding grounds.

As it appears from the above discussion, the various predictions point in the direction that in the future the density-dependent factors will operate on the breeding grounds or the spring staging areas, but not on the wintering grounds. This is probably contrary to the original situation, where the goose populations supposedly were regulated by limited food resources on the wintering grounds (OWEN 1980a). Because of the shift to the agricultural lands, which has taken place in many goose populations over the last decades, potential food resources seem not to be limiting.

The hypothesis that populations will be regulated by factors on the breeding grounds, does primarily apply to those breeding in the north Atlantic and possibly those breeding along the north Siberian coastline. This, probably, does not apply to the Whitefronted Geese breeding over the vast expanses of the Siberian tundra or to the Greylag Geese breeding in west and central Europe, which still have the possibility of expanding their breeding range.

Goose damage and possible solutions

In January 1984 goose damage in west Europe was the theme of an IWRB meeting with participating biologists and wildlife administrators from eight countries. The aim of the meeting was to map the extent of damage and to discuss possible solutions.

The following discussion is partly based on the conclusions from the meeting (see RÜGER 1985).

In relation to national farm output the amount of goose damage in west Europe is negligible, but the income of individual farmers may be hampered seriously. The critical cases are when geese compete directly for food with sheep or cattle, e.g., Brent Geese in the Wadden Sea. Furthermore, damage can occur locally where geese graze winter cereals or take seeds in newly sown fields or ripening cereals. The extent of damage has increased over the last decade because the farmers increasingly make use of crops which are vulnerable to goose grazing, e.g., winter cereals and fertilized pastures. Assessment of the damage has, however, only been carried out in relatively few cases, and it is believed that the farmers often are prone to exaggerate the losses.

It is anticipated that goose damage to crops to some extent will occur as long as geese feed on farmlands. The question is then, how to alleviate the damage. Should it be done by scaring, by direct compensation to the farmers, or indirectly by purchase of land to create managed goose refuges?

Scaring devices, e.g., very pistols or dummies, only have a short-term effect, and can only be used with limited success in cases where the problem is isolated, but cannot be advocated generally. Either the geese will habituate to the deviceds, or the problems are only relocated to other potentially damaged areas. Licensed shooting over vulnerable crops may have some effect, as the English example with the Brent Geese feeding inland has shown (see p. 48). The relative success is more due to the psychological effect, which the farmer obtains by the legal possibility of doing something, rather than to the scaring effect.

Payment of direct compensation is practised in the Netherlands, FRG and on a small scale in Sweden. The Dutch example (see p. 46) shows, however, how easily the problems can be inflated, and it ought to discourage the application of that method.

The indirect way of compensation by purchase of alternative feeding grounds to draw geese from nearby farmland where they are accused of damage has been used with some success on Texel in the Dutch Wadden Sea, and it is planned to be used in the German Wadden Sea as well. Recently this method has been practiced on Islay in Scotland, where a goose refuge has been established in an area where Barnacle Geese cause damage to grass crops (NUGENT 1985).

At the IWRB goose damage meeting it was the general opinion that this form was the only possible long-term solution to the conflicts with the farming community. The refuges are, however, costly to establish and to manage, probably overriding the level of crop damage. Another problem is that big refuges will possibly attract so many geese that damage problems in the surrounding farmland are exacerbated (OWEN 1977, 1980b). A network of smaller refuges will probably alleviate that effect in some goose species, e.g. Brent Goose, as suggested by ST JOSEPH (unpubl.), but not in others. However, in planning future policies it is essential that our thinking is radical and flexible, to suit the particular situation and the needs of the particular species.

As a further complication the damage by Pink-footed Geese in Denmark and the Netherlands in autumn shows that the problem need not only be caused by the attraction of the geese to farmland areas, but may also be caused by shooting disturbance or other human activities, concentrating disproportionally large numbers of geese in a few areas (see p. 22). This indicates that solutions should often integrate other aspects than just the isolated damage problem.

For the Dark-bellied Brent Goose especially, it has been proposed, that one way

to reduce the damage would be to control the population size (SWIFT & HARRISON 1979, ST JOSEPH unpubl.). This argument is adduced because a correlation has been found between the population increase in the 1970s and the number of geese feeding inland in England. Today the problems have been reduced by the more pragmatic solution of licensed shooting (see p. 48), which is perhaps not a sustainable long-term solution, but it does on the other hand not imply any philosophy of how to manage bird populations in Europe. Population limitation seems to be a dangerous track to follow, if the basis is to regard the birds as hazards to the human society. According to that argument the habitat capacity should set the population levels. However, as various examples in this review have shown, the habitat capacity concept is difficult to handle, because the capacity is hard to measure and a variable parameter. The capacity will be highly dependent on human impact on the habitats, and as the natural and semi-natural habitats are decreasing in area all the time, solutions to damage problems should be based on the conservation and management of natural habitats rather than on population control.

Future management strategies

Although most populations are in a healthy state, they are under constant pressure from human impact, especially in the winter quarters, but also increasingly on the breeding grounds. Therefore, there is a great need for strategies for the long-term management of the geese all along their migration routes. It is important that we recognize the populations as international natural resources, and that strategies are based upon integrated knowledge of population dynamics and the ecological requirements of the geese. A shooting system should be based on and concerned with population parameters only. An important aim of a strategy is the restoration of endangered goose stocks, in Europe especially the Light-bellied Brent Goose from Svalbard and the Lesser Whitefronted Goose. A restoration plan should aim at habitat preservation and regulation of shooting and disturbance in key areas.

Dansk resumé

Status og forvaltning af gåsebestande i Europa, og især bestande, der raster og yngler i Danmark

I denne oversigt gøres der status over gåsebestandene, deres økologi og forvaltning i Europa. Bestandenes udvikling i det 20. århundrede resumeres, og det diskuteres, hvilke faktorer der bestemmer deres størrelse. Markskadeproblemer og deres mulige løsning diskuteres, og der gives forslag til fremtidig forvaltning og forskning. Specielt fem bestande, der trækker gennem Danmark eller yngler herhjemme, beskrives.

Skovsædgås (*Anser fabalis fabalis*)

Skovsædgåsen, der er en race af Sædgåsen, yngler i Nordskandinavien og Vestsibirien i delvis geografisk overlapning med Tundra Sædgås (*A. f. rossicus*) (Fig. 1). Den overvintrer i Sydsverige, Danmark, Østtyskland og Holland (Fig. 3 & 4), i de tre sidstnævnte lande især i kolde vintre, mens *rossicus*-bestanden overvintrer i Centraleuropa og Holland (Fig. 2). *Fabalis*-bestanden

tæller ca. 60.000 gæs, mens *rossicus*-bestanden tæller ca. 250.000. Der er normalt ikke blanding af de to bestande i overvintringsområdet. På overvintringspladserne har *fabalis*-bestanden en speciel tilknytning til moseområder og fourager på tilstødende græsarealer. Store dele af bestanden fouragerer i dag også på vintersæd, sukkerroer og andre landbrugsafgrøder. Der er ikke særlige markskadeproblemer. Bestanden er tredoblet fra 1960 til 1980. Af særlige trusler mod bestanden fremhæves ødelæggelsen af ynglebiotopen, skovmoserne, på grund af afvandinger og tørvegravning samt opgivelsen af høslæt omkring moserne. Der savnes viden om bestandens populationsdynamik, om antallet i Østtyskland og om yngleforholdene i Sovjetunionen.

Kortnæbbet Gås (*Anser brachyrhynchus)* (Svalbardbestanden)

Bestanden af Kortnæbbet Gås yngler på Svalbard og overvintrer i Danmark, Holland, Belgien og tidligere også i Vesttyskland (Fig. 5, 6 & 7). Under trækket i maj måned stopper bestanden kortvarigt i Nordnorge. Hovedparten af bestanden opholder sig i Vestjylland i oktober, og fra marts til maj forekommer hele bestanden her. I vintermånederne opholder hovedparten af de Kortnæbbede Gæs sig i Holland og Belgien, i milde vintre dog også i Sydvestdanmark.

Om efteråret fouragerer gæssene mest på stubmarker og lidt på vintersæd, om vinteren og tidligt forår på græsarealer, og i april-maj hovedsageligt på nysåede kornmarker i Vestjylland. Om efteråret forekommer der markskader på Filsø i Vestjylland, hvor gæssene i de senere år har fourageret på vintersæd. Gæssene fordrives og flyver til Holland, hvor de på grund af den tidlige ankomst gør skade på et sent høslæt. Markskadeproblemet forværres af, at gæssene samles på Filsø, fordi de fordrives fra Vest Stadil Fjord på grund af jagt. På Vest Stadil Fjord forvolder gæssene ellers ingen markskader om efteråret. Fourageringen på de nysåede marker om foråret har spredt sig langs den jyske vestkyst. Om foråret fodres gæssene på Vest Stadil Fjords marker med udlagt korn for at afbøde skaderne.

Fra 1955 til 1980 er bestanden fordoblet (Fig. 8), forårsaget af formindsket dødelighed, sandsynligvis som følge af formindsket jagttryk.

Langtidsløsninger på problemerne i Vestjylland er nødvendige. Der bør oprettes reservater for gæssene langs vestkysten med gode foragingsmuligheder. Fodringen af gæs bør opgives for om muligt at vænne gæssene af med at fouragere på nysåede marker. Om efteråret bør gæssene spredes på flere lokaliteter, f.eks. ved jagtreguleringer.

Der vides for lidt om populationsdynamiske forhold og yngleøkologien hos bestanden.

Grågås (*Anser anser anser*) (den nordvesteuropæiske bestand)

Bestanden af Grågås yngler i Nordvest-Europa og overvintrer i Sydspanien og Holland, med nogen overlapning til den central-europæiske bestand, der overvintrer i Nordafrika (Fig. 9).

Ynglebestanden tæller mindst 12.000 par (Tabel 3) og hele bestanden ca. 130.000 gæs. Ikkeynglende gæs i bestanden fælder svingfjer på specielle fældningspladser, især Oostvaarderplassen-reservatet i Holland, mindre antal langs Norges vestkyst, ved Gotland, i Danmark og Polen (Tabel 4).

I august-september samles gæssene på rastepladser især i det sydlige Østersøområde (Fig. 10 & 11, Tabel 5). Fra oktober sker trækket mod overvintringspladserne. Om efteråret fouragerer gæssene især på stubmarker og græsarealer, i mindre grad på kogleaks *Scirpus* spp. i flodlejer og sumpe. Om vinteren i Sydspanien tager gæssene især rodstængler og kogleaks i oversvømmede flodlejer i Coto Donana reservatet ved Guadalquivir floden. I vintrene 1980/81 til 1982/83 var der tørke i området, som forårsagede massedødsfald blandt gæssene på grund af fødemangel. Forholdene er i dag forbedrede, idet der nu ledes mere vand gennem reservatet.

På trods af tørken er bestanden firedoblet de sidste 10-12 år (Fig. 12). Årsagen hertil er sandsynligvis formindsket jagt på bestanden og muligvis forbedrede ynglevilkår. Markskader forårsaget af Grågæs er lokale og ikke alvorlige.

Der savnes populationsdynamiske undersøgelser af bestanden og bedre kendskab til udvekslingen mellem Grågås-bestandene i Europa.

Mørkbuget Knortegås (*Branta bernicla bernicla*)

Den Mørkbugede Knortegås yngler i Nordsibirien og overvintrer langs kysterne af Vesteuropa (Fig. 13, 14 & 15). Bestanden tæller ca. 150.000 gæs. Om efteråret opholder de fleste Knortegæs sig i Vadehavsområdet (Holland-Danmark). Om vinteren er bestanden koncentreret i England og Frankrig, og fra marts til maj i Vadehavsområdet. Om efteråret og vinteren fouragerer gæssene hovedsageligt på vadeflader, hvor de æder ålegræs *Zostera* spp. og grønalger. Om foråret skifter de over til af afgræsse strandenge. Gæssene er i stigende grad også begyndt at fouragere på græsmarker bag digerne i både England og Holland, hvilket hænger sammen med, at de nedgræsser ressourcerne på vaderne.

Siden begyndelsen af 1970erne er bestanden femdoblet (Fig.16), hvilket primært anses at skyldes jagtfredningen i Vesteuropa og specielt Danmark. I England, Holland og Vesttyskland forvolder gæssene markskader ved at konkurrere om græsset med får og kreaturer, men problemerne er delvis løst ved henholdsvis licensjagt, oprettelse af reservater og økonomisk kompensation til de ramte landmænd. Langtidsløsninger på problemerne savnes dog stadig. Digebyggerier i det tyske Vadehav har forværret problemerne, fordi græsningsarealerne er blevet formindsket. Genåbning af jagttid bør ske efter et internationalt kvotesystem baseret på viden om knortegæssenes populationsdynamik. Det foreslås, at man venter en årrække for at se, hvordan bestanden videre udvikler sig.

Der savnes viden om bestandens yngleøkologi.

Lysbuget Knortegås *(Branta bernicla hrota)*, (Svalbardbestanden)

Bestanden af Lysbuget Knortegås yngler på småøer omkring Svalbard og Franz Josef Land og overvintrer i Danmark og Østengland (Fig. 13, 17 & 18). Bestanden tæller kun 4.000 gæs. Bestanden har 4-5 rastepladser i Danmark, hvoraf Mariager Fjord/Randers Fjord er overvintringspladsen, Nissum Fjord og Sydvestmors forårsrastepladserne. Det er uvist, hvor bestanden opholder sig om efteråret, men sandsynligvis i det danske Vadehav. I strenge vintre flytter det meste af bestanden til Lindisfarne i England. Om efteråret og vinteren fouragerer gæssene på vadeflader og fladvand, hvor de æder ålegræs og grønalger, og om foråret afgræsser de især strandenge. Siden 1970 er bestanden omtrentligt fordoblet. Forurening i Nissum Fjord har ødelagt det meste af fjordvegetationen, der var vigtig fødekilde for knortegæssene, og forureningen af de indre danske farvande er også en trussel mod fjordvegetationen i Mariager Fjord.

Det foreslås, at der oprettes vildtreservat i Mariager Fjord, samt at der foretages bedre beskyttelse af det vigtigste yngleområde på Svalbard.

Der savnes viden om populationsdynamik, yngleøkologi og bestandens trækmønster.

I alt forekommer der 21 gåsebestande i Europa, der tilsammen tæller ca. 1,5 mill. gæs (Tabel 1). Næsten samtlige bestande er gået frem de sidste årtier. Populationsdynamiske analyser af seks bestande har samstemmende vist, at bestandene først og fremmest er gået frem på grund af formindsket dødelighed. Hovedansvarlig herfor anses at være, at jagttrykket generelt er blevet reduceret. Jagten har således en additiv effekt til de naturlige dødsårsager. I dag ses der i nogle bestande tæthedsafhængig regulering af reproduktionen, hvilket tyder på, at forhold på ynglepladserne i fremtiden vil begrænse bestandene (Fig. 19).

Gåseskader på landbrugsafgrøder er steget, dels fordi bestandene i høj grad har slået over på landbrugsjorden, dels fordi bestandene har været i fremgang, og dels fordi landbruget i stigende grad benytter afgrøder, der er følsomme over for gåsegræsning, f.eks. vintersæd, fremfor vårsæd.

Markskadeproblemerne vil bedst løses ved at oprette gåsereservater med græsarealer og en bedre beskyttelse og pleje af vader og fladvand, strandenge og enge, der er traditionelle gåserastepladser.

Der er behov for en international strategi for forvaltning af de europæiske gåsebestande. Strategien bør baseres på kendskab til bestandenes dynamik og økologiske behov. Jagten bør indrettes efter disse principper. Endvidere bør der sættes kræfter ind på at retablere de små bestande.

Резюме на русском языке:

Состояние популяций гусей в Европе и заведование ими, особенно популяций, обитающих и гнездующих в Дании

В этой обзорной статье дается отчет о популяциях гусей, их экологии, и заведовании ими в Европе. Резюмируется развитие популяций в 20 столетии, и обсуждаются условия, определяющие их численность. Обсуждаются проблемы вреда, причиняемого гусями на полях, и их возможные разрешения, и даются предложения о заведовании ими и исследовании их в будущем. В особенности описываются пять популяций, перелетающих через Данию и гнездующих там.

Гуменник (Anser fabalis fabalis)

Гуменник гнездует в северной Скандинавии и Западной Сибири, географически часто совпадая с тундровым гуменником (A. fabalis rossicus) (Фиг. I). Он зимует в Южной Швеции, Дании, Восточной Германии и Голландии (Фиг. 3 и 4). В трех последних странах этот вид особенно встречается в суровые зимы. Популяция fabalis составляет прибл. 60.000 гусей, а популяция rossicus прибл. 250.000. В районах зимовки эти две популяции нормально не смешиваются. На местах зимовки популяция fabalis предпочитает болотистые местности, и фуражирует на соседних с болотами травостойных лугах. Значительная часть популяции нынче также фуражирует на полях озимого хлеба, сахарной свеклы и других земледельческих культур. Вред, причиняемый полям, не представляет серьёзных проблем. С 1960 по 1980 г. популяция возросла втрое. Из особенных опасностей, грозящих популяции, придается значение порче биотопа гнездования, т. е. лесных болот вследствие осушения, раскапывания торфа и покидания сенокосных угодий вокруг болот. Не имеется достаточных сведений о популяционной динамике, о численности популяции в Восточной Германии и об условиях гнездования в Советском Союзе.

Короткоклювый гуменник (Anser brachyrynchus) (Шпицбергенская популяция)

Популяция короткоклювого гуменника гнездует на Шпицбергене и зимует в Дании, Голландии и Бельгии, а прежде также зимовала в Западной Германии (Фиг. 5, 6 и 7). На перелете в мае месяце популяция кратковременно останавливается в Северной Норвегии. Главная часть популяции в октябре находится в Западной Ютландии, а с марта по май там встречается вся популяция. В зимние месяцы наибольшая часть короткоклювых гуменников находится в Голландии и Бельгии, а в мягкие зимы также в Югозападной Дании. Осенью гуси главным образом фуражируют на жнивах, и немного на озимых культурах, зимой и ранней весной на травостойных лугах, а в апреле - мае на недавно засеянных нивах в Западной Ютландии. Осенью случаются повреждения полей на Фильсё в Западной Ютландии, где гуси за последние годы фуражировали на озимых культурах. Гусей угоняют, они улетают в Голландию, и вследствие раннего прибытия туда вредят поздним сенокосным лугам. Проблема вреда на полях обостряется тем, что охота угоняет гусей из Стадиль-Фиорда, где они иначе не причиняют вреда. Фуражирование весной на недавно засеянных нивах распространилось вдоль западного берега Ютландии. На полях у Западного Стадиль-Фиорда гусей для предотвращения вреда кормят выложенным зерном.

С 1955 по 1980 г. популяция возросла вдвое (Фиг. 8), вероятно благодаря пониженной заинтересованности охотников.

Требуются долгосрочные решения проблем в Западной Ютландии. Рекомендуется устроить для гусей заповедники вдоль западного берега с хорошими альтернативными возможностями фуражирования. Кормление гусей следует прекратить, чтобы отучить их от фуражирования на недавно засеянных полях. Осенью гусей следует рассредоточить на несколько местностей, напр. регулированием охоты.

О популяционной динамике и экологии размножения не имеется достаточных сведений.

Серый гусь (Anser anser anser) (Популяция Северозападной Европы)

Популяция серого гуся гнездует в Северозападной Европе, а зимует в Испании и Голландии, с некоторым совпаданием с популяцией Центральной Европы, зимующей в Север-

ной Африке (Фиг. 9). Гнездующая популяция составляет по меньшей мере I2.000 пар (Табл. 3), а вся популяция прибл. I30.000 гусей. Линька маховых перьев негнездующих гусей популяции происходит на специальных местах линьки, в особенности в заповеднике Оостваарденплассен в Голландии, а меньшее число их линяет вдоль западных берегов Норвегии, у острова Готланда, в Дании и в Польше (Табл. 4).

В августе - сентябре гуси собираются на местах привала, особенно в южной части Балтийского Моря (Фиг. II и I2). С октября происходит перелет на места зимовки. Осенью гуси в особенности фуражируют на жнивах и травостойных лугах, в меньшей степени камышем Scirpus spp. в руслах рек и болотах. Зимой, в Южной Испании, гуси в особенности питаются корневыми стеблями и камышем в наводненных руслах рек в заповеднике Коте Донана у реки Гвадалквивира. В зимах I980/8I и I982/83 в этом районе была засуха, и она вызвала массовую гибель гусей вследствие недостатка пищи. Нынче условия улучшились, так как теперь через заповедник проводится больше воды. Несмотря на засуху, популяция за последние I0 - I2 лет возросла в 4 раза (Фиг. I2). Это вероятно объясняется понижением заинтересованности охотников, а может быть также улучшением условий размножения. Вред на полях, причиняемый серыми гусями, только местный и несерьёзный. Не имеется исследований популяционной динамики и достаточных знаний об обмене между популяциями Европы.

Темнобрюхая черная казарка (Branta bernicla bernicla)

Темнобрюхая черная казарка гнездится в Северной Сибири и зимует вдоль берегов Западной Европы (Фиг. I3, I4 и I5). Численность популяции составляет прибл. I50.000 гусей. Осенью большинство казарок обитает в районе морских отмелей (от Голландии до Дании), зимой популяция концентрируется в Англии и Франции, а с марта по май в районе морских отмелей. Осенью и зимой гуси главным образом фуражируют на пространствах отмелей, где они питаются водяной травой Zostera spp. и водорослями. Весной они переходят к фуражированию на прибрежных лугах. Как в Англии, так и в Голландии, гуси в возрастающей степени также начали фуражировать на травостойных лугах за плотинами, что объясняется истощением рессурсов травы на отмелях. С начала I970-х годов популяция увеличилась в 5 раз, что главным образом считается результатом запрета охоты в Западной Европе, в особенности в Дании. В Англии, Голландии и Западной Германии гуси причиняют вред на пастбищах, конкурируя из-за травы с овцами и коровами, но эти проблемы отчасти разрешены, соответственно введением лицензий на охоту, учреждением заповедников и возмещением убытков пострадавшим земледельцам. Однако, всё еще нет долгосрочных решений этих проблем. У морских отмелей Германии проблемы обострились строительством плотин, так как этим сокращена площадь пастбищ. Если снова будет разрешена охота в определенные периоды, это следует организовать по международной системе квот, основанной на знании популяционной динамики. Предлагается обождать несколько лет, пока не выяснится дальнейшее развитие популяции.

Светлобрюхая черная казарка (Branta bernicla hrota) (Шпицбергенская популяция)

Популяция светлобрюхой черной казарки гнездится на островках вокруг Шпицбергена и Земли Франца Иосифа, а зимует в Дании и Восточной Англии (Фиг. I3, I7 и I8). Численность популяции составляет только 4.000 гусей. В Дании эта популяция имеет 4 - 5 мест привала, из которых Мариагер-Фиорд и Рандерс-Фиорд служат для зимовки, а Ниссум-Фиорд и югозападная часть острова Морс для обитания весной. Где популяция обитает осенью, точно не известно - вероятно на датских морских отмелях. В суровые зимы большинство популяции перелетает на остров Линдисфарн в Англии. Осенью и зимой гуси фуражируют на морских отмелях и других мелких водах, питаясь морской травой и водорослями, а весной главным образом съедают траву с прибрежных лугов. С I970 г. популяция возросла приблизительно вдвое. В Ниссум-Фиорде гаибольшая часть растительности уничтожена загрязнением. Она была важнейшей пищей казарок, и загрязнение внутренних датских вод также угрожает водяной растительности в Мари-

агер-Фиорде.

Предлагается устроить заповедники в Мариагер-Фиорде и у югозападной части острова Морс, и улучшить защиту важнейшего района гнездования на Шпицбергене.

О популяционной динамике, экологии гнездования и ходе перелетов нет достаточных сведений.

В общем, в Европе встречаются 21 популяция гусей, общей численности около 1,5 милл. особей. Почти все популяции за последнее десятилетие увеличились.

Анализы популяционной динамики шести популяций показали, что их рост главным образом произошел благодаря пониженной смертности, и что это прежде всего является результатом пониженной заинтересованности охотников. Следовательно, охота оказывала эффект, добавочный к естественным причинам смерти. Нынче у некоторых из популяций наблюдается регулирование воспроизведения, зависимое от плотности, и это указывает на то, что условия на местах гнездования в будущем ограничат численности популяций.

Вред, причиняемый гусями на полях, повысился, отчасти потому, что популяции в высокой степени перешли на посевные участки земли, отчасти вследствие роста популяций, а также потому, что земледельцы всё чаще сеют культуры, особенно чувствительные к фуражированию гусей, напр. переходять с ярового хлеба на озимый.

Проблемы вреда на полях лучше всего можно разрешить учреждением для гусей заповедников с травостойными пространствами, а также усиленной охраной и борьбой с загрязнением морских отмелей и других мелководных пространств, являющихся традиционными местами привала.

Требуется международная стратегия по заведыванию европейскими популяциями гусей. Эта стратегия должна быть основана на знании динамики и экологических потребностей этих популяций. Охоту следует организовать по этим принципам. Следует также принять меры для восстановления малочисленных популяций.

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