

Light-bellied Brent Goose

Branta bernicla hrota

(East Atlantic population) in Svalbard, Greenland, Franz Josef Land,
Norway, Denmark, the Netherlands and Britain

1960/61 – 2000/01

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SUMMARY

This review aims to assess the changes in status, abundance and distribution of the Svalbard/North Greenland population of Light-bellied Brent Geese *Branta bernicla brota* throughout its range, focusing primarily on its winter range in England and Denmark since winter 1960/61, to collate gathered information prior to that winter, to review published and unpublished data on the ecology of this goose population, and to describe numbers, trends and site use at the key resorts in the non-breeding range and during other periods of the annual cycle. In this review, this biogeographic population is referred to as the East Atlantic Light-bellied Brent Goose.

This population of Light-bellied Brent Geese breeds in the High Arctic, primarily in Svalbard, east Greenland and Franz Josef Land, and winters primarily in Denmark and at Lindisfarne, northeast England. The geese stage in Denmark in the spring before embarking on the longest unbroken migration of any Western Palearctic goose population to breeding grounds farther north than those of any other goose population. Post-breeding and non-breeding birds moult in the Arctic, before migrating direct to Denmark or England.

The population size was in the region of 50,000 individuals before a wasting disease in *Zostera marina*, a principal food, and/or human over-exploitation caused a massive decline in the first half of the 20th century. The population, then wintering mainly in Denmark, decreased to a low of 1,600–2,000 in the years 1967–71. The population has since grown slowly, to over 6,600 by 2001, around half of which regularly winters in Britain.

This population of Light-bellied Brent Goose has a restricted non-breeding distribution. Recent counts demonstrate that 11 non-breeding sites are internationally important: 10 in Denmark and one in Britain, four of which regularly hold over 50% of the population. There is much interchange of individuals between these sites. Traditionally, the main wintering sites were Mariager & Randers Fjords in Denmark, but Lindisfarne has become increasingly important with numbers increasing from around 200 individuals in the 1950s to 2,500–3,000 in the 1990s. During the late 1990s, Nibe & Gjøl Bredninger in Denmark was also a key wintering site. Occasionally, during severe weather in Denmark, up to 80% of the population uses Lindisfarne, and flocks scatter to alternative coastal sites around the North Sea, especially in the Netherlands.

Birds have been arriving at wintering sites increasingly early, with a corresponding decrease in

the use of the previous main autumn staging area in the Danish Wadden Sea. By mid to late winter, most birds have moved from the wintering sites to spring staging areas at Nissum Fjord, and increasingly at Agerø and several other sites, in Denmark. In spring, what appears to be the whole population is found in Denmark. Evidence suggests that many Light-bellied Brent Geese stage at non-breeding sites in Svalbard before moving to the breeding areas.

The majority of the population breeds in Svalbard. Breeding numbers have declined severely since the beginning of the 20th century, when many birds were believed to nest on the westernmost islands. Today the main colonies are on Tusenøyane, in the southeast, and Moffen, in the northwest, where internationally important numbers nest. Productivity is also highest in these areas. A recently discovered breeding area in northeast Greenland held 1,100 adult birds in 1998. The size of the population on Franz Josef Land is difficult to gauge because of the lack of surveys, but is likely to be small and relatively unproductive. Sparse data suggest that moulting areas are highly dispersed, with internationally important numbers found at eight sites in Svalbard and one in Greenland. The moulting grounds of over half the population, however, remain unknown.

Traditionally, Light-bellied Brent Geese used only what might be regarded as natural habitats, feeding on intertidal and subtidal seagrass (*Zostera* spp. and *Ruppia* spp.) and algal (*Enteromorpha* spp. and *Ulva lactuca*) beds and saltmarshes. Since 1991, however, birds have started feeding on agricultural land at many of their winter and spring sites, using autumn-sown cereals, pastures and spring-sown cereal seeds, which leads to conflicts with agricultural interests. Breeding birds are known to feed on tundra herbs, mosses and lichens.

Further basic research into the distribution and ecology of breeding, moulting and migrating birds should help to fill existing gaps in knowledge that are vital for the effective conservation of this population. Continued monitoring, ringing and ecological studies at the winter and spring staging sites will mean that changes in the population can be detected and allow the development of individuals-based models, a population viability analysis and, ultimately, a flyway management plan. This work should focus particularly on possible environmental perturbations, such as climate change, that may adversely affect the conservation status of the population, as well as on direct conflict with human activities.

1 THE EAST ATLANTIC LIGHT-BELLIED BRENT GOOSE

1.1 Introduction

This flyway population of Light-bellied Brent Geese *Branta bernicla hrota* breeds on Svalbard, Franz Josef Land and northeast Greenland (Clausen *et al.* 1999), winters in northwest Europe (Fig. 1) and is known as the ‘Svalbard/North Greenland’ or ‘East Atlantic’ Light-bellied Brent Goose. In this review it will be referred to either as the ‘East Atlantic Light-bellied Brent Goose’ or simply the ‘Light-bellied Brent Goose’.

The first reliable estimate for the size of this population was published in the early 1950s (Salomonsen 1958). Co-ordinated counts of the whole population began in 1980 – but scattered information from the Danish spring staging areas from the 1960s and 1970s gives fairly reliable information about the population size in that period also (Fog 1967, 1972, Norderhaug 1969, 1989). Detailed ecological studies began on the Danish wintering and Svalbard breeding grounds in the 1980s and at Lindisfarne and northeast Greenland in the 1990s. This has resulted in an extensive knowledge of this population’s status and ecology. Whilst much of this work has been published, some remains unpublished or in the form of internal reports and theses. It is the aim of this review to collate this scattered information to assess changes in the abundance and distribution of this population over the last 50 years and review our knowledge of its ecology.

This report is split into three main sections and follows the format of recent monitoring reviews produced, or in preparation, for geese and swans (e.g. Fox *et al.* 1994). Current knowledge of the ecology of East Atlantic Light-bellied Brent Geese is reviewed in the first section, providing a back-drop against which the monitoring information can be interpreted. Gaps in our knowledge are highlighted, as are the conservation threats that face this population. Much of the information used in this section is drawn from the account by Clausen *et al.* (1999) in *Goose Populations of the Western Palearctic* and

from the Svalbard Goose Conference papers collated in *Norsk Polarinstitutt Skrifter* No. 200 (1998). Additional information from other papers and unpublished material is presented here, giving an up-to-date account of our knowledge of this goose population.

The second section presents site-specific monitoring data for wintering and spring staging sites, in some cases from as early as winter 1960/61, to at least 1999/2000. Annual maxima are illustrated for internationally important sites, i.e. those that regularly support over 1% of the flyway population (presently 50 individuals; Wetlands International 2002), and spatial and temporal changes in abundance and distribution are examined. The use of occasional wintering sites is summarised. The third section summarises the known status and distribution of breeding and moulting birds in the Arctic and follows a format similar to the second.

1.2 Background

Brent Geese are circumpolar in their breeding range and winter on both east and west coasts of Eurasia and North America (Owen 1980). They breed on tundra and winter in coastal areas, feeding on intertidal vegetation (Ganter 2000) and, in some areas, on adjacent farmland (Owen 1980). The world population of the species was estimated at approximately 560,000 individuals in the early 1990s (Madsen *et al.* 1996), comprising several sub-species with recently contested taxonomic relationships (Millington 1997, Sangster *et al.* 1997). Indeed, Sangster *et al.* (1997) argue that the taxa are distinct enough to constitute three different species. However, the British Ornithological Union (BOU) disputes this and continues to classify the taxon group as three subspecies: the Light-bellied Brent (*B. b. hrota*), Dark-bellied Brent (*B. b. bernicla*) and Black Brant (*B. b. nigricans*) (Sangster 2000, Bloomfield & McCallum 2001).

Figure 1. Flyway range of the East Atlantic Light-bellied Brent Goose *Branta bernicla hrota*. All known regularly used sites are highlighted. Distinction is made between sites of international importance (filled dots, including possible internationally important sites in the Netherlands and the Arctic) and other sites (open dots)



Global numbers of Light-bellied Brent Geese (also referred to as Pale-bellied; Sangster *et al.* 1997) totalled approximately 125,000 individuals in the early 1990s (Madsen *et al.* 1996), and have since increased slightly; they comprise four distinct flyway populations. Of these, c. 10,000 constitute what is sometimes considered a subspecies in its own right, known as the 'Grey-bellied' Brent Goose.

They breed in western Arctic Canada and winter on the western seaboard of North America. Of the remaining Light-bellied Brent Geese, c. 100,000 breed in Arctic Canada and winter on the eastern coasts of North America and c. 20,000 also breed in Arctic Canada but winter mainly in Ireland. The smallest population, numbering 6,600 individuals, is the subject of this review.

1.3 Monitoring and population assessment

1.3.1 Counts

International monitoring

Co-ordinated mid monthly counts covering all British and Danish wintering sites have been made annually since 1980 by teams of voluntary and professional observers. The highest total number of birds counted at any one time during a winter season has been taken as the annual population estimate. In most years the peak count has been recorded in autumn or mid winter.

National monitoring

Sporadic counts were made at British sites from as early as 1878 (Chapman 1889), but many of these were not explicit with regard to the subspecies of Brent Goose involved. Annual site-based monitoring in Britain has been on-going since the late 1940s and is now undertaken primarily through the Wetland Bird Survey (WeBS). Since 1947, WeBS counts have been made by volunteer ornithologists at a variety of wetland habitats, generally on the middle Sunday of each month and primarily between September and March (Atkinson-Willes 1963, Owen *et al.* 1986, Cranswick *et al.* 1997). Count dates are co-ordinated nationwide and are chosen to occur on days when high tide occurs during the morning, thus concentrating waterbirds into a small number of roosting areas at coastal sites (Gilbert *et al.* 1998). Counters are encouraged to make their count during the morning to ensure co-ordination across sites. The results of the survey are published annually (e.g. Pollitt *et al.* 2003). From 1989 onwards, counts have also been made at Lindisfarne every two weeks.

During 1980–1995, core monthly counts were conducted at all Danish sites. However, one to three supplementary counts per month were also made throughout this period at Mariager Fjord, Agerø and Nibe Bredning, and to varying degrees at other sites. Since 1996 at least one – but usually two – counts have been made at all regularly used Danish staging sites during September–January and April–May, whereas information from counts in February–March are more scattered.

As part of the national goose counting scheme in the Netherlands, Light-bellied Brent Geese are counted monthly at all regular sites between October and March, and again in May.

1.3.2 Productivity

Up to a year after hatching, juvenile Brent Geese can be identified in the field by their diagnostic pale wing-covert edgings. Systematic surveys of breeding success, assessing the proportion of first-year birds on wintering grounds, began in Denmark in 1980/81 (Clausen *et al.* 1998) and have since been carried out annually. Since 1989, the population has also been sampled for juveniles at Lindisfarne, and during this time there has been no significant difference between the proportion of juveniles on either side of the North Sea (Clausen *et al.* 1999). The largest, single, co-ordinated sample obtained in autumn or early winter, when all juvenile birds retain obvious distinguishing plumage characteristics, is used to assess annual breeding success.

1.3.3 Ringing

Some birds were caught and ringed using metal rings in Svalbard in the 1950s (Boyd 1959). Fourteen geese were colour-ringed either in Denmark or Svalbard in the 1980s. Since 1991, over four hundred have been caught and colour-ringed using cannon-nets at Lindisfarne and in Denmark, to coincide with an intensive programme of re-sighting. Over 9,000 re-sightings had been made by 2000. These data have been used to estimate survival in the population (Clausen *et al.* 2001), and have helped reveal many of the movements and life histories that are detailed in this review.

Until 2000, birds were marked with a darvic ring engraved with a two-letter code on the leg (some with a coloured plastic ring above the darvic ring) and a combination of two coloured plastic rings over a metal ring on the opposite leg (Clausen & Percival 1992). This system has now changed in order to try to reduce the problem of ring loss (Clausen *et al.*

2001), and since 2001 the marking scheme has been a white darvic on the left and yellow darvic on the right leg, each with a single engraved digit.

1.3.4 Population assessment

International censuses

The first estimate (uncorroborated) of the population size was of 40,000–50,000 individuals in 1891, based on observations of autumn migration along the Norwegian coast (Salomonsen 1958). Up to 10,000 birds, nearly all Light-bellied, used to winter in the Moray Firth, Scotland, when the British total was probably at least 20,000 (Owen *et al.* 1986). In the 1930s, the population went through a catastrophic decline and by the time of the first reliable estimate in the 1950s there were only c. 4,000 individuals. Up to 4,000 were still present in the Moray Firth in the 1930s but the site was deserted soon afterwards. By 1966/67, the population was down to just 1,600 individuals (Fog 1972), but increased slowly to c. 3,500 by the first half of the 1980s (Fig. 2; Madsen 1984, Norderhaug 1989). The population increased further to a level fluctuating between 4,000–5,800 in the first half of the 1990s (Clausen *et al.* 1999), and had reached 6,600 by winter 2000/01 (Fig. 2; Clausen *et al.* 1998 updated). However, this still constitutes one of the smallest and most threatened goose populations in the world (Madsen 1991, Madsen *et al.* 1996).

The population estimates made before 1980 are based generally on co-ordinated counts across the known sites, so it is possible that some birds were overlooked at unknown sites. However, the increasing numbers on the spring staging grounds throughout the 1970s indicate that the population increase over this time is accurate. In the beginning

of the 1980s there was evidence that birds had been overlooked early in the autumn (Madsen 1984), but this was resolved with proper identification of the important staging areas in the Danish Wadden Sea in the mid 1980s (Clausen & Fischer 1994). Clausen *et al.* (1998) reported that birds were likely to have been overlooked particularly in late winter and spring, with up to 2,000 birds ‘missing’ in late spring in the early 1990s. Counts of migratory birds from Lista in Norway show that several Light-bellied Brent Geese departed very early, in 1991 at least (M. Green & P. Clausen unpubl. data), and this may have contributed to this discrepancy. Late autumn and early winter counts are thought to ‘capture’ virtually the whole population, given its small size and restricted range, therefore estimates of the total population since 1980 can be considered highly accurate.

WeBS counts

Light-bellied Brent Geese have been monitored regularly at Lindisfarne and other sites in Britain through national waterbird monitoring schemes since 1960 (see Section 2). These counts often underestimate peak numbers, either because peak numbers remain for less than an inter-WeBS count period, or because WeBS counts are made at high tide, when the birds form tight roosting flocks on the water and numbers are difficult to assess accurately (Lindisfarne National Nature Reserve (NNR) unpubl. data). This has become an important issue in recent years with the occurrence of higher numbers at Lindisfarne.

Because Lindisfarne is the only regular British wintering site, it is not possible to create a national population index; therefore, the only appropriate comparison of the Lindisfarne flock size against a wider trend is with the total biogeographical population.

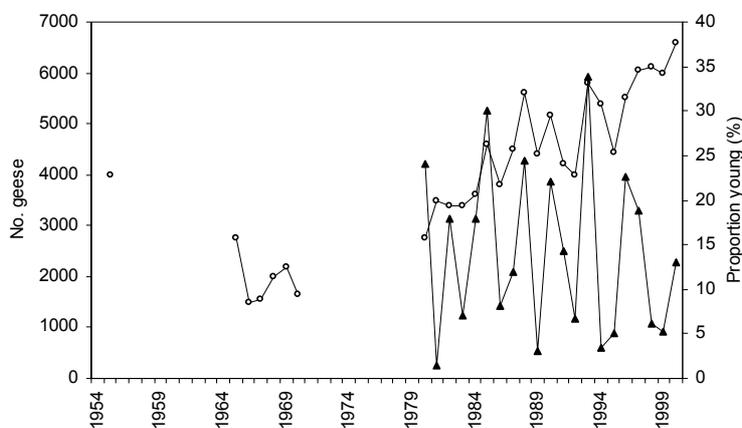


Figure 2. Population size and reproductive success of the East Atlantic Light-bellied Brent Goose population 1955/56–2000/01 (○ = number of geese; ▲ = % of juveniles) (Clausen *et al.* 1999 updated)

Productivity

Annual productivity has been estimated every winter since 1980/81, with a mean of 14.2% (range 1.5–33.9%) between 1980/81 and 2000/01. Breeding success has been highly variable over this period (Fig. 2), with no significant trend ($r^2 = 0.02$, $p = 0.55$; Denny 2001).

Survival

The earliest survival estimate for this population was calculated by Boyd (1959), using recoveries from a cohort ringed in 1954. The estimate was 0.83 ± 0.08 , but this was during a period when the population was hunted.

Applying capture-recapture statistical techniques to colour-ring re-sightings, Clausen *et al.* (2001) calculated survival rates for adults and yearlings on data collected between 1991 and 1999. Clausen *et al.* (2001) divided the year into three periods: autumn (September–December), winter (January–March) and spring (April–May). Survival from autumn to winter was high (0.999 monthly survival rate (MSR)), lower from winter to spring (0.985 MSR) and lowest from spring to autumn (0.982 MSR). Survival between winter and spring was much lower after a cold winter (0.968 MSR in 1995/96) than it was after other, ‘normal’ winters (0.991 MSR). The overall annual survival rate was 0.870. This compares directly to an apparent survival rate of 0.873 calculated by Clausen *et al.* (1998) for the period 1981–1995 (based on population counts). The survival of juveniles may be even lower than that of older birds, especially during cold winters. Clausen *et al.* (1998) thus report that only 35.8% of 1,380 goslings produced during summer 1985 survived their first and cold winter.

The high over-winter survival of individuals in mild winters, but higher mortality over cold winters and during the summer (Clausen *et al.* 2001), suggest that the long-term population size may be limited by specific mortality events at these times. High summer mortality may be due to high levels of predation, and energetic stress for breeding and moulting adults, but is likely to be due partly to the long, unbroken migration (5,000–6,600 km return journey) taken by this population (Clausen *et al.* 2003). The cold-winter mortality is probably due to the birds’ having to find alternative feeding areas or lose body condition when Danish feeding grounds freeze over (Percival & Anderson 1998, Cottaar *et al.* 1999a,b, Clausen *et al.* 2001). At such times, the intertidal habitats at Lindisfarne are unable to support an influx of Danish birds on the highly depleted *Zostera* beds during mid to late winter (Percival *et al.* 1996, Denny 2001).

Of the six annual survival rates calculated for all Brent Goose populations, the two most recent estimates for East Atlantic Light-bellied Brent Geese are the highest – the next highest being 0.85 for the Dark-bellied Brent Goose (Summers & Underhill 1991). The lowest estimate is 0.70 for the Northwest Canadian population (Barry 1982). Note, however, that no survival rate has been estimated for the Eastern Canadian High Arctic Light-bellied Brent Goose population.

Population limitation

It is probable that a crash in the population early in the 20th century (Clausen *et al.* 1999) was due to intensive hunting, particularly on the wintering grounds in Denmark (Salomonsen 1958, Madsen 1987), and a decline in the winter food resource in the 1930s because of a *Zostera marina* ‘wasting’ disease (Rasmussen 1977). This suggests that at this time the population was winter limited. However, current hunting bans and refuge provision, and the recent changes and extension in the population’s wintering site use and high survival rates, suggest that winter food resources are no longer the major limiting factor during mild years, although this may not hold for severe winters. The low and fluctuating productivity is likely to be the main regulatory variable in the population (Clausen *et al.* 1999).

1.4 Annual cycle

1.4.1 Breeding season

Range

The main breeding area for East Atlantic Light-bellied Brent Geese is Svalbard, although there are significant numbers of breeding birds at Kilen, Greenland, and some are known to breed in Franz Josef Land (Clausen *et al.* 1999).

The first breeding was recorded in 1596 from Cummingøya and Steggholmen in northwestern Spitzbergen by Gerrit de Veer (Norderhaug 1984). De Veer collected 60 eggs, and his discovery of nesting Light-bellied Brent Geese dispelled the myth that they came from the fruits of trees in Scotland.

The Svalbard breeding areas are fairly well known and have changed quite markedly over the last few decades. Prior to the population decline in the last century, there were important breeding sites on islands off the west coast of Spitzbergen. Løvenskiold (1954, 1964) indicated that Light-bellied Brent Geese formerly bred in large numbers in the Sørkappøya, Dunøyane and Isøyane bird sanctuaries off the southwest coast of Spitzbergen, but these

were abandoned during the 1950s and the birds now occupy only small scattered colonies on the west coast (Prestrud & Børset 1984, Prokosch 1984). The most important breeding sites now appear to be on the east coast of Svalbard (Norderhaug 1969), particularly on the Tusenøyane archipelago, although the island of Moffen, off the north coast of Spitzbergen, holds significant numbers.

Owen & Norderhaug (1977) hypothesised that the change in breeding distribution may be due to competition for breeding sites from the increasing Barnacle Goose *Branta leucopsis* population. It has also been suggested that the distribution change is directly associated with the population decline in earlier decades (Ogilvie 1984). Madsen *et al.* (1989) suggest that in combination these two factors are dictating the present range: the now-increasing population is unable to re-colonise former breeding colonies on the west coast because of colonisation by, and subsequent competition from, the increasing Barnacle Goose population.

Light-bellied Brent Geese breed in small numbers on Franz Josef Land. Several surveys were undertaken in the 1980s and 1990s (cited in Clausen *et al.* 1999). Evidence of occupation by Light-bellied Brent Geese was found on many islands, but the surveyors failed to find significant numbers of birds, suggesting that they occurred at low density. A predicted estimate of 28–44 pairs on the whole archipelago has been calculated (D. Vangeluwe unpubl. data, cited in Clausen *et al.* 1999), although there are large, hitherto unexplored areas that may be capable of holding higher densities than those predicted.

The numbers of Light-bellied Brent Geese nesting in northern Greenland declined early last century (Salomonsen 1950). However, it is not known which population these birds were from: they could have been part of the East Canadian High Arctic population. In 1985, 850 Light-bellied Brent Geese were found in the Kilen area of northeast Greenland (Hjort *et al.* 1987). A satellite telemetry study has since demonstrated that these birds are part of the East Atlantic population (Clausen & Bustnes 1998). A Danish expedition in 1998 found approximately 1,100 individuals breeding or moulting in the area (Clausen & Laubek 1999); this equates to approximately 20% of the total population. Areas north and south of Kilen also held scattered breeding birds at low density (Hjort 1995).

Breeding ecology

The National Environmental Research Institute (NERI), Denmark, conducted research on the breeding grounds in the Tusenøyane archipelago in 1987, 1989 and 1991. To date, these studies form the

only detailed research into the breeding ecology of this population. The Light-bellied Brent Geese arrived on Tusenøyane during the first week of June, but waited 7–10 days before commencing egg-laying (between 8 and 16 June (median dates 10 June) in 1987 and 12 June in 1991; Madsen *et al.* 1998a). Males defended territories (mean size of 25 territories in 1987 was 2 ha) around nests located on snow-free patches. The average clutch size on Tusenøyane over three years was 4.0 ($n = 12$, range 2–6). Eggs hatched in early July (median date in 1987 was 7 July) and young left the nest almost immediately. From Kilen, studies later in the breeding season revealed a brood size of 3.44 in 1985 (Hjort *et al.* 1987).

Tusenøyane, in common with other known breeding sites, is a polar desert with vegetation dominated by lichens and mosses. When birds first arrive, the breeding grounds are usually covered in snow with a few snow-free patches where they feed on the flower buds of *Saxifraga* spp. and mosses (Madsen *et al.* 1998a). Marshy areas covered with mosses and *Cochlearia officinalis*, provide food after the snowmelt (Madsen *et al.* 1989). After hatching, families feed primarily on *Cochlearia* and *Saxifraga* but by this time the quality of food plants has started to decline and the biomass has been depleted by adult birds (Madsen *et al.* 1998a). At Kilen, breeding birds feed on *Papaver radicum* and *Alopecurus alpinus* (Hjort *et al.* 1987).

The field studies at Tusenøyane have shown that Light-bellied Brent Geese are subject to high nest predation pressure from Polar Bears *Ursus maritimus*, either through direct predation or by flushing females from the nest and allowing secondary predation by Arctic Skuas *Stercorarius parasiticus* (Madsen *et al.* 1998a). Polar Bears are most abundant when there is dense pack-ice in the surrounding Barents Sea, allowing dispersal from adjacent areas. They can easily locate nests in snow-free patches, and thus birds nesting in territories with high snow cover during early incubation suffer the heaviest predation pressure. This loss to predation is apparently restricted to the egg stage, with very few young depredated (Madsen *et al.* 1989, Bregnballe & Madsen 1990).

In some years, when Arctic Foxes *Alopex lagopus* are abundant, many birds are prevented from nesting in areas at risk from predation. Arctic Fox numbers on Svalbard appear to be linked to their population dynamics on the adjacent Siberian land-mass, where abundance is governed by lemming numbers (Summers & Underhill 1987), intimating that these foxes are travelling from Siberia in search of food. Because pack-ice facilitates long-distance dispersal of

predators, percentage ice cover can be used as a proximate predictor of predator abundance. Madsen *et al.* (1998a) demonstrated that 58% of the variation in annual breeding success of the whole population can be explained by sea-ice cover in the Tusenøyane area. This suggests that nest predation is a major factor limiting the ability of the Light-bellied Brent Goose population to recover to its former size and, in turn, that breeding birds on Tusenøyane appear to account for a large proportion of the population's productivity.

It is suggested by Madsen *et al.* (1998a) that, despite the delay in egg-laying (see above) leading to young feeding on inferior food resources, the timing of nesting is a compromise between optimal food quality and avoidance of nest predation by Polar Bears.

The breeding grounds at Kilen have a low density of terrestrial predators, being surrounded on three sides by glaciers and on the fourth by sea which, given Kilen's position relative to the Northeast Water Polynia, is never completely ice-bound; this restricts access to the area for bears and foxes. The high breeding success noted there in 1985 by Hjort *et al.* (1987) may be indicative of this fact and helps explain why some Light-bellied Brent Geese extend their already lengthy migration to breed there. However, in 1998, Light-bellied Brent Geese nevertheless experienced an almost complete breeding failure due to predation from Arctic Foxes. The 1,100 adults produced only between 25 and 41 goslings that summer (Clausen & Laubek 1999).

Moulting period

In common with other wildfowl species, Light-bellied Brent Geese shed all their flight feathers simultaneously when moulting and so experience a period of flightlessness, when they tend to gather into large flocks.

On Svalbard, moult begins in mid July, with failed/non-breeders starting several days earlier than successful breeders (Madsen *et al.* 1989). On Tusenøyane, small groups of birds moult (425 in 1989), but in years of poor breeding success most birds leave to moult elsewhere. At the other main breeding site of Moffen Island, small numbers also moult (up to 125). Significant numbers of moulting birds have been observed at other widely scattered localities. However, the majority of moulting sites on Svalbard remain undiscovered.

The timing of moult on Kilen is similar to that on Tusenøyane, and the site has been used by large numbers of moulting birds in the two years that studies have been carried out. Hjort *et al.* (1987)

found c. 312 moulting birds (calculation from Clausen *et al.* 1999), and Clausen & Laubek (1999) recorded c. 1,100 moulting birds – making Kilen the single most important known moulting site.

The only evidence for moulting sites on Franz Josef Land is of moulted feathers found on Mabel and Klagenfurt Islands during an expedition in the early 1990s (Clausen *et al.* 1999). The lack of coverage of this archipelago means that significant moulting areas may exist but are as yet undiscovered.

1.4.2 Autumn migration

Range

In studies using satellite telemetry, birds breeding in Greenland moved to Svalbard in late August (Clausen & Bustnes 1998, P. Clausen, M. Green & T. Alerstam unpubl. data) and would therefore have spent 2–3 weeks post-moult feeding in Greenland, prior to migration. They then spend some time in Svalbard, possibly joining Svalbard-breeding birds before the migration south. During this time, many birds work their way south to the southern tip of Spitzbergen (P. Clausen, M. Green & T. Alerstam unpubl. data). The majority of birds leave Svalbard by mid September, although exceptionally some may remain to mid October.

The median arrival date in Denmark ranges between 4 and 25 September (in 1980–1992; Clausen & Fischer 1994). Most birds appear to fly direct to autumn staging grounds in Denmark (Wadden Sea and Mariager Fjord) and, increasingly, to Lindisfarne, although some birds stage briefly on Bjørnøya. There is evidence that some birds that stage initially on the Wadden Sea rapidly move on to Lindisfarne. Small flocks of Light-bellied Brent Geese are frequently recorded along the east coast of Britain in early autumn. These are assumed to be birds making landfall before filtering along the coast to Lindisfarne.

1.4.3 Winter distribution

Range

The East Atlantic Light-bellied Brent Goose population currently winters regularly only in Denmark and at Lindisfarne. In Britain, Lindisfarne is the only site regularly used, although there is evidence that other areas, such as the Moray Firth, were used historically (Madsen 1987). The pattern of site use at Lindisfarne has changed in parallel with that in Denmark. Until the mid 1980s, birds used Lindisfarne mainly as a midwinter site, particularly during cold weather (Madsen 1984). After a run of

cold winters in the early 1980s, birds have apparently increased their use of the site by arriving earlier in the season, with some birds now arriving direct from the breeding grounds (Clausen *et al.* 1998). This has been explained by declines in available feeding resources in Denmark forcing more birds to find alternative feeding grounds (Clausen & Percival 1998). Since the mid 1980s, however, numbers have remained stable at Lindisfarne (Denny 2001), though with considerable year-to-year variation.

Birds depart from Lindisfarne for Denmark between December and March, with the main exodus usually occurring in January and February, depending on local food resource levels and weather conditions in Denmark. In some winters, small numbers remain into April, feeding on the new growth of saltmarsh vegetation (Anderson 1999).

At the end of the 20th century, Lindisfarne supports about half of the population of Light-bellied Brent Geese through the autumn and winter, holding as much as 80% of the population in years when weather conditions are particularly cold in Denmark (Clausen *et al.* 1998, Batten *et al.* 1990).

In Denmark, a series of wintering sites is used from autumn to spring (Madsen 1984), with recent changes in the phenology of movements between them (Clausen *et al.* 1998). Historical data suggest that the present range is similar to that known before the population decline (Fog 1967), with concentrations in north and west Jutland. There is one point of evidence to suggest that Light-bellied Brent Geese wintered in small numbers in eastern Denmark, but this is uncertain (evidence from Schiøler 1925).

Nissum Fjord, Mariager & Randers Fjords and the Danish Wadden Sea east of the islands of Fanø and Mandø are the three sites used regularly since the 1950s (Salomonsen 1958, Fog 1967). From around 1970, birds started using Nissum Bredning and Agerø (Madsen 1994). During the early 1990s, birds began to use three new sites – the Northern Kattegat Coast, Nibe & Gjøll Bredning and Venø (Jørgensen *et al.* 1994, Clausen *et al.* 1999), and another two sites were colonised at the turn of the century – the Northern Djursland Coast and Risgårde Bredning & Rotholme.

Habitat use and feeding ecology

In the most recent 6–8 years, the typical pattern of habitat utilisation by Light-bellied Brent Geese has been for autumn and early winter feeding on intertidal or aquatic vegetation in the Danish Wadden Sea, at Mariager & Randers Fjords, Nibe & Gjøll Bredninger, the Northern Kattegat Coast, and

at Lindisfarne, followed by winter feeding on aquatic vegetation in shallow fjords in Danish sites. In addition, small numbers remain grazing saltmarshes at Lindisfarne until late winter (Anderson 1999).

At Lindisfarne and in the Danish Wadden Sea, intertidal vegetation beds are used exclusively in the autumn – estuarine *Zostera noltii* and *Z. angustifolia*, in particular, but also *Enteromorpha* spp. (Madsen 1984, 1988, Percival & Evans 1997). As the season progresses, the intertidal vegetation biomass declines through natural seasonal senescence and storm damage (Percival *et al.* 1996). At Mariager & Randers Fjords and on the Northern Kattegat Coast, Light-bellied Brent Geese feed initially on intertidal *Ruppia maritima* or submerged *Ruppia cirrhosa* beds. Following depletion of the intertidal *Zostera* or *Ruppia* resources, there is then a switch to submerged *Z. marina* beds and saltmarshes and, to a lesser extent, pasture – the use of the latter two habitats associated with the early spring bite in late winter (Clausen & Percival 1998, Anderson 1999).

This pattern is broken in severe cold, when the shallow fjords in Denmark freeze, making *Z. marina* unavailable, and forcing birds to move to other feeding areas. In these conditions, there is an exodus of Light-bellied Brent Geese from Denmark; this often occurs in mid winter and coincides with the time when numbers usually begin to increase in Denmark. Many birds move to Lindisfarne, although ‘small numbers’ are known to move to other areas in Britain, the Netherlands, France and Germany (van den Berg 1984, Prokosch 1984, Cottaar *et al.* 1999a,b). Associated with these hard winters has been the use of novel feeding habitats, namely pasture and winter cereal fields at Lindisfarne (Percival & Anderson 1998). When conditions become milder, the population resumes its normal pattern of habitat use and distribution.

Recently, there has been an increase in feeding on agricultural land. Since the early 1990s, birds have fed on pasture/winter cereals at Lindisfarne, Randers Fjord and Agerø in winter/spring, and on newly sown barley fields in spring. The use of agricultural habitat is becoming more regular at Lindisfarne, with birds feeding on winter cereals by mid November in 2001/02 (P. Davey pers. comm.). Since 2000/01, the same has happened at Nibe & Gjøll Bredninger and in the surroundings of Mariager Fjord (P. Clausen unpubl. data).

1.4.4 Spring staging and migration

In spring, what appears to be the whole population congregates in northwest Jutland, Denmark,

particularly around Agerø in the Limfjord. As in early winter, in early and mid spring *Zostera* is the favoured food resource for Light-bellied Brent Geese. They feed in shallow fjords on the submerged *Z. marina* and also make extensive use of saltmarshes, where they feed on the graminoids (*Puccinellia maritima*, *Festuca rubra*) and fleshy halophytes (*Triglochin maritima*, *Plantago maritima*, *Aster tripolium* and *Spergularia media*). *Zostera* is preferred because in terms of energy intake it is a more profitable food than saltmarsh vegetation (Clausen & Percival 1998). Clausen (1998) demonstrated that when feeding on *Zostera* beds birds reacted less to disturbance and flew less, thereby expending less energy. However, saltmarshes are an important alternative feeding habitat when *Zostera* is unavailable, particularly in years when *Zostera* biomass is lower (probably due to lower overwinter shoot survival).

In the non-tidal Limfjord, water levels are critical to the availability of *Zostera* (Clausen 2000). Water levels are dictated by atmospheric pressure, wind speeds and persistent wind patterns – extensive periods of westerlies will lead to water levels being too high for birds to reach the submerged *Zostera*. During such periods, saltmarshes are heavily used. Large year-to-year variations in water levels have a major influence on habitat use (Clausen 1998).

However, in late spring the situation becomes more complicated: the graminoids have increased in biomass, as have the saltmarsh halophytes that have the high protein content required by females for egg laying, and the nutritional quality of *Zostera* in terms of protein content has declined (Clausen 1994). Although the pattern is not clear, this leads to a switch from foraging on *Zostera* beds to saltmarshes in late spring, independent of water levels (Clausen 2000).

Most Light-bellied Brent Geese leave their spring staging sites in Denmark in the last week of May. Soon after leaving Denmark, these birds are often seen migrating off the coast of Norway, particularly at Lista bird observatory (94% of all birds observed at Lista 1990–2001 were recorded from 25 to 31 May, $n = 25,759$, M. Green & P. Clausen unpubl. data), and arrive on the breeding grounds approximately two weeks later (Clausen *et al.* 1999). Given a flight speed of 70 km/hour (estimate in Lindell 1977) birds should fly this distance in 35 hours. This time gap led to speculation that birds were stopping to re-fuel for several days somewhere *en route*. It was suggested that this could be somewhere along the Norwegian coast north of Bergen, where Svalbard breeding Pink-footed Geese *Anser brachyrhynchus* and Barnacle Geese are known to

stage. Also, during mild springs, some birds have apparently left Denmark early, but have not subsequently arrived early on the breeding grounds (Clausen *et al.* 1998), adding weight to the hypothesis of a spring migration staging area. However, two satellite telemetry studies did not back up such an assertion, suggesting that birds migrate directly to the Arctic, stopping only briefly on the Norwegian coast, probably to rest and drink (Clausen & Bustnes 1998, Clausen *et al.* 2003).

Small flocks of up to 23 birds were reported on Bjørnøya, mid-way between Norway and Svalbard, in the 1960s (Mehlum 1998). As monitoring on the island is virtually non-existent, it may be an important spring staging area, although no satellite-tracked birds staged there on spring migration. However, one satellite-tracked bird did stop for a short time on Hopen Island, southeast of Edgeøya.

The satellite telemetry studies and ground-based surveys carried out in recent years suggest that most birds make landfall in south Svalbard and then move north and east to their breeding grounds after 1–2 weeks, or west to Kilen, Greenland (Clausen *et al.* 2003). Satellite-tagged birds also migrated directly to Kilen from Denmark (Clausen & Bustnes 1998).

1.5 Conservation and management

1.5.1 Legislation and other conservation measures

1.5.1.1 International

Conservation status

The East Atlantic Light-bellied Brent Goose population is listed under category A (1c) of the African-Eurasian Migratory Waterbird Agreement, prepared under the Convention on the Conservation of Migratory Species of Wild Animals (CMS, the ‘Bonn Convention’), because it numbers fewer than 10,000 individuals. This means that, in addition to complying with the general provisions of the agreement, Parties should co-operate to produce a flyway management plan for the population.

In BirdLife International’s List of Species of Conservation Concern, the Brent Goose is classified as a SPEC3 species, in recognition of its unfavourable conservation status (vulnerable) in Europe whilst not being concentrated in Europe (Tucker & Heath 1994).

Habitat protection

The EC Directive on the Conservation of Wild Birds requires Member States to classify Special Protection Areas (SPAs) for this migratory species. All but one of the regular wintering sites for the population are designated as SPAs. Further international protection of important wetland habitats for Light-bellied Brent Geese is provided through the 'Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat' and the 'Bern Convention on the Conservation of Wildlife and Natural Habitats 1979'.

In Britain, one SPA is notified for East Atlantic Light-bellied Brent Geese. This is Lindisfarne, and this site alone regularly holds close to 100% of the UK and over 50% of the international population. Lindisfarne is also a Ramsar site.

In Denmark, 10 sites that are used regularly by Light-bellied Brent Geese are located within SPAs, and five of these are protected as Ramsar sites. The only site not protected as an SPA is the most recently established one, Risgårde Bredning & Rotholme. The Light-Bellied Brent Goose is listed as a qualifying species for the five sites that were used regularly during the 1960s and 1970s, as well as in the list for SPA no. 112, a new SPA introduced in 2003 that includes the Northern Djursland Coast. At present, the subspecies is not mentioned as a qualifying species for SPAs situated in Nibe & Gjøl Bredninger, along the Northern Kattegat Coast and Venø, nor at Agger Tange (northern part of the Nissum Bredning site) and Mågerødde (northern part of the Agerø site). It is, however, foreseen that the subspecies will be introduced as a qualifying species in 2004, as part of a forthcoming revision of the site-listings.

The SPA network also gives a very high degree of protection from habitat degradation and destruction. Member States are required to take steps to avoid both deterioration of the habitats supporting the species for which the site is designated and disturbance of these species. Under European law, any project affecting an SPA, and that is not essential for its conservation, must be assessed for its implications in terms of the site's conservation objectives. If a project is deemed likely to have an adverse effect on the site and/or birds, it can go ahead only if there are overriding reasons of public interest. In such cases, compensatory measures are usually instigated, which tend to focus on the creation of alternative, nearby habitats for the species in question.

Species protection

All Brent Goose populations are listed under Annex II/2 of the EC Birds Directive 79/409, Appendix III of the Convention on the Conservation of European Wildlife and Natural Habitats ('Bern Convention') and Appendix II of the Bonn Convention (Stroud *et al.* 1990). Additionally, the Light-bellied Brent Goose is protected in Britain, currently under the Wildlife and Countryside Act 1981, and has been so since 1954. Elsewhere, protection for Light-bellied Brent Geese has been introduced at different times: the Netherlands in 1950, Svalbard in 1955, Norway in 1971, and Denmark in 1972. Brent Geese can still be shot legally in Britain, however, under a government licence, in cases where agricultural damage is proven and severe, although no such licence has ever been granted for Light-bellied Brent Geese.

Other measures

Despite the high degree of site and habitat protection outlined above, several habitat management problems exist at the wintering sites. Saltmarshes, especially around Lindisfarne, Mariager and Nissum Fjords, require grazing management to increase their use by geese. Also, agricultural run-off has increased eutrophication and turbidity, particularly in Nissum Fjord and Nibe & Gjøl Bredninger, which has reduced the distribution of *Zostera*. Site management plans based mostly on existing research should be a future priority.

1.5.1.2 Individual countries**1.5.1.2.1 Britain***Conservation status*

In Britain, the Brent Goose is Amber-listed on the list of Birds of Conservation Concern (Gregory *et al.* 2002). This is because it is a species with unfavourable conservation status in Europe, $\geq 50\%$ of the UK non-breeding population is found in 10 or fewer sites, and $\geq 20\%$ of the Northwest European non-breeding population occurs in the UK.

Habitat protection

The key site designation for Light-bellied Brent Geese in Britain is Site of Special Scientific Interest (SSSI). Guidelines for the selection of sites were published formally by the Nature Conservancy Council in 1989 under the title *Guidelines for the selection of biological SSSIs*. National Nature Reserves (NNR) are areas of national and sometimes international importance that are owned or leased by the appropriate statutory conservation body, or bodies leased by them, or are managed in accordance with Nature Reserve Agreements with landowners

and occupiers. NNRs are also classified as SSSIs and attract similar protection. Legislative protection for these sites derives from the Wildlife and Countryside Act 1981. Under these provisions, operations likely to damage the nature conservation interest of SSSIs are subject to control. Lindisfarne is designated as an SSSI and an NNR.

In 1997, English Nature introduced a trial shooting-free refuge across half of the area used by Light-bellied Brent Geese at Lindisfarne (Percival & Denny 2000). This was considered to have a positive effect and the refuge was established permanently in 2000 (Denny 2001).

Species protection

The Light-bellied Brent Goose is currently afforded full protection under the Wildlife and Countryside Act 1981.

1.5.1.2.2 Denmark

Conservation status

The Light-bellied Brent Goose is Yellow-listed as a migratory species for which Denmark has special responsibility, due to the regular presence of $\geq 20\%$ of the flyway population in the country (Stoltze 1998).

Habitat protection

During 1994–2001, Denmark doubled the shooting-free area in coastal areas by introducing 37 new reserves and enlarging 12 existing reserves in 31 SPAs situated outside the Wadden Sea (Clausen *et al.* 2004). The creation of these shooting-free refuges was planned primarily to reduce disturbance levels – and in an appraisal of the planned reserve network, highest priority was given to all SPAs used by Light-bellied Brent Geese (Madsen *et al.* 1998b). As a result, nine refuges with total shooting bans have been established: one around Agerø, two in Nissum Bredning, one in each of Mariager Fjord and Randers Fjord, three along the Northern Kattegat Coast and an extension of the existing reserve at Nissum Fjord to include *Zostera marina* beds. Several of these refuges have adjacent areas where hunting activities are limited.

These refuges, together with an existing refuge at Gjøl Bredning, Denmark, and improved legislation in the Wadden Sea region, where hunting in areas used by the Light-bellied Brent Geese was phased out during the 1990s (Bregnballe *et al.* 2003), ensure effective protection of Light-bellied Brent Geese from hunting disturbance and many other potential disturbance sources during autumn and winter, when hunting takes place. In addition to benefiting from these hunting regulations, Light-bellied Brent Geese

also benefit from ‘breeding bird’ reserves that restrict public access to small islands and some saltmarsh areas, usually from 1 or 15 April to mid summer. This gives birds 1½–2 months’ undisturbed feeding on several saltmarshes in spring staging areas. Such ‘breeding bird’ reserves are found around Nissum Fjord, Agerø, Nissum Bredning, Venø, Nibe & Gjøl Bredninger and Risgårde Bredning & Rotholme.

In Denmark, all saltmarshes greater than 1 ha in area have been protected since 1984 against drainage and cultivation under the Nature Conservation Act.

Species protection

The Light-bellied Brent Goose is protected at all times in Denmark.

1.5.1.2.3 The Netherlands

At Terschelling, the saltmarshes are included in SPA/Ramsar site boundaries, but since Light-bellied Brent Geese visit the area in winter and stay in the polder at this time they are outside the protected areas. Only a few individuals present in spring might use the saltmarsh. All other important sites are unprotected, being pastures (or occasionally sown for winter cereals) completely inside the seawalls (polders). Future influxes and further increases in numbers in the Netherlands could be sustained on existing habitat as the birds use mainly agricultural crops. However, this may bring them into greater agricultural conflict with humans, with associated conservation repercussions.

1.5.1.2.4 The breeding grounds (Svalbard, North Greenland and Franz Josef Land)

Species protection

The Light-bellied Brent Goose is fully protected throughout its breeding range.

Habitat protection

All breeding and moulting sites are in remote and relatively undisturbed areas of the High Arctic. In Svalbard, 57% of all land has been protected as national parks or nature reserves since 1973, including the main breeding and moulting areas (Haga & Bjørge 1986). With the establishment of three new national parks in 2003 and three new nature reserves in 2002-03 the proportion protected has increased to c. 65% (Governor of Svalbard website at http://www.sysselmannen.svalbard.no/mvern_svalbard.htm). The Greenland breeding/moulting grounds are included in the North and East Greenland National Park, and Kilen has been designated as a Ramsar site and Biosphere Reserve. There is no habitat protection on Franz

Josef Land, although proposed protection zoning (Uspenski & Tomkovich 1987) would, if implemented, bring the protective status up to Svalbard standards. Some breeding sites and many moulting sites within these areas remain unknown, and therefore their specific habitat protection status is unquantifiable.

1.5.2 Hunting

Direct mortality

Illegal shooting of Light-bellied Brent Geese using both punt and shoulder-guns occurred at Lindisfarne and possibly elsewhere during the 1990s (Clausen *et al.* 1999), although such incidents are assumed to be infrequent, particularly in the light of the high over-winter survival of the population (Clausen *et al.* 2001). Historically, there was uncontrolled egg and down collection by Norwegian fishermen and sailors visiting Svalbard, and opportunistic hunting of birds on breeding/moulting grounds by miners working on Svalbard. Light-bellied Brent Geese are now fully protected in Svalbard (Salomonsen 1958, Madsen 1987). Generally, breeding and moulting areas are remote from human settlement, and hunting is probably non-existent in these areas.

Disturbance

At Lindisfarne, hunting of waterfowl species, which co-exist with Light-bellied Brent Geese in winter (mainly Wigeon *Anas penelope*), can cause disturbance, resulting in reduced feeding rates, lower overall utilization of the food resource and changes in distribution (Denny 2001). However, the overall numbers of Light-bellied Brent Geese have not increased in response to a reduction in hunting levels. This is probably due to the small size of the population and the limited potential for the local or the flyway populations to increase in response to lower disturbance. Interestingly, Light-bellied Brent Geese did not change their distribution in response to refuge creation in Denmark (Madsen 1998). However, hunting disturbance is likely to have implications for the population in other areas of the range, as has been shown for other goose species (e.g. Béchet *et al.* 2003).

1.5.3 Agricultural conflict

In many other goose populations, a move onto agricultural land has been coincident with substantial increases in numbers over recent decades (Madsen 1991). Until 1995, the East Atlantic Light-bellied Brent Geese population had not exploited agricultural land to any great extent. However,

agricultural conflict has become an issue in recent years in the wintering range as birds have moved away from their traditional feeding habitats onto farmland. At Lindisfarne, use of autumn-sown cereals in significant quantity was first noted in 1995/96. There had been occasional use of farmland by up to 500 birds before this, but for a few days only (Smith 1977). The pattern of habitat use by Light-bellied Brent Geese at Lindisfarne is shown in Fig. 3.

In 1995/96, a peak of 1,750 birds was recorded feeding on cereal fields, coinciding with a period when c. 80% of the population was present at Lindisfarne (Percival & Anderson 1998). Percival & Anderson (1998) attributed this change in behaviour to the depletion of the intertidal food resource to low levels at this time, and to the high quality of the cereals, being rich in soluble protein content (a readily assimilated source of nitrogen) (Anderson *et al.* 1997). They suggested that there is a perceived or actual cost associated with birds using this food resource, in terms of increased disturbance/predation risk, and that this may have prevented this habitat from being used previously. Since the mid 1990s, significant numbers of Light-bellied Brent Geese have been using both winter cereals and pasture, and this behaviour seems to be increasing: since 2000 they have been moving onto fields as early as November (P. Davey pers. comm.). This increasing trend has inevitably led to conflict with local farmers. In response to this conflict, English Nature is working towards introducing a farmland scheme to be launched in autumn 2003 (P. Davey pers. comm.).

In Denmark, Light-bellied Brent Geese have traditionally grazed saltmarshes but with the recent increase in numbers around Agerø, where there are large areas of saltmarsh used for stock grazing, conflict with farmers has increased. In addition, the recent use of winter and spring cereals around Nissum Fjord, Agerø, Mariager and Randers Fjords has begun to cause problems.

There are considerable conservation implications for the recent switch to feeding on agricultural land. The birds benefit from improved food availability, and possibly quality, but it also brings them into conflict with agricultural interests. Shooting to disturb birds off fields is not an option given the small population size, and the best long-term solution may be to provide alternative disturbance-free refuges with high quality food resources. Such areas could be created at Lindisfarne through managed-realignment schemes, combining habitat creation with flood alleviation requirements.

2 SURVEY OF AREAS USED DURING THE NON-BREEDING SEASON

This section reviews the abundance, distribution and phenology of East Atlantic Light-bellied Brent Geese at key sites during the non-breeding season, based on data collected through international, national and regional monitoring schemes. With only 11 internationally important sites in Denmark and Britain, many sites that are not of national or international importance have also been reviewed across the range. However, only sites that are known to have held at least 10 individuals in any one season since 1960/61 (arbitrarily selected threshold) are reviewed.

Background

This section provides brief information on the regional distribution and phenology of East Atlantic Light-bellied Brent Geese and the types of habitats that are used.

Historical status

This section outlines the use of sites in the region, mainly using systematic survey data since 1960/61. However, earlier records are used where available.

Internationally/nationally important sites

Detailed accounts of internationally and nationally important sites are presented. Wetland sites are considered internationally important if they regularly support 1% of the individuals in a waterbird population, following the criteria agreed by the Contracting Parties to the Ramsar Convention. A wetland is considered nationally important if it regularly holds 1% or more of the estimated national population. Provisional assessments of importance are made on the basis of a minimum of three years' data, following the Ramsar Convention.

The threshold for international importance during the five-year period used for site assessment in this review was 50 individuals (Wetlands International 2002). Five-year means for internationally important sites in Denmark and Britain are shown in Table 1.

Site accounts contain detailed information on current status and trends, site protection measures, habitats present, and site use. For definitions of site safeguards and selection criteria/guidelines mentioned in the text, see www.english-nature.org.uk for SSSIs and NNRs in England, Stroud *et al.* (2001) for SPAs in Britain, Miljø- & Energiministeriet (1996) for SPAs in Denmark, Ramsar (1999) for Ramsar sites, and Heath & Evans (2000) for Important Bird Areas (IBAs).

For each site, figures are presented showing the peak counts recorded in each season since winter 1960/61. Unless otherwise stated, years in which no counts were made at a site are highlighted by a filled circle. Figures illustrating the phenology of use are presented for those sites with adequate data. Columns represent mean counts made in each month between 1995/96 and 1999/2000. Bars represent maximum and minimum counts over this period.

Other sites

This section lists those sites that regularly support small flocks of Light-bellied Brent Geese during peak times in the winter and/or that have a long history of occupancy but which do not currently support nationally or internationally important numbers.

Table 1. Sites of international importance for East Atlantic Light-bellied Brent Geese during the non-breeding season

Site name	5-year mean (1996/97-2000/01)
Lindisfarne	2,884
Mariager & Randers Fjords	2,285
Agerø area	4,363
Wadden Sea	976*
Nissum Fjord	656
Nissum Bredning	617
Northern Kattegat Coast	929
Nibe & Gjøl Bredninger	2,168
Venø	423*
North Djursland Coast	199*
Risgårde Bredning/Rotholme	64*

* may represent underestimates, owing to poor coverage during seasons of peak abundance in some years

2.1 Britain

2.1.1 England

2.1.1.1 Background

East Atlantic Light-bellied Brent Geese use estuarine sites along the east and southeast coasts of England but the most important and only regular site is Lindisfarne (Fig. 3). Birds arrive at Lindisfarne in September and leave in March, numbers usually peaking in November. They feed on the *Zostera* beds until mid winter when they switch to saltmarshes and, increasingly, agricultural land. During cold weather the population can swell at Lindisfarne, and significant numbers of birds often use other sites.

2.1.1.2 Historical information

The only regular site for East Atlantic Light-bellied Brent Geese in England is Lindisfarne in Northumberland. All published material suggests that historically this has always been the case, with no significant flocks being recorded at any other site. Individuals, probably originating from this biogeographic population, regularly occur at sites on the east and south coasts of England amongst Dark-bellied Brent Geese, and larger flocks have occasionally been noted at east coast sites during hard weather, when individuals wintering in Denmark move further west and south. A large flock of 645 birds, recorded during a WeBS count in Essex, is thought to be erroneous and probably relates to the Dark-bellied subspecies.

2.1.1.3 Internationally important sites

i) Lindisfarne

Five-year mean 96/97–00/01: 2,884

Site conservation status

SPA (Lindisfarne: selection stage 1.2)

Ramsar (Lindisfarne: criterion 6)

NNR (Lindisfarne)

SSSI (Lindisfarne)

IBA (Lindisfarne: criteria B1i, C3)

Site description and habitat

Lindisfarne NNR covers 3,966 ha of coastal habitat in north Northumberland, running from Berwick-upon-Tweed south to Budle Bay (55°40'N 01°50'W; NU1041). It was declared an NNR in 1964. Rocky shores support a rich algal flora, and areas of

saltmarsh and sand dune are also present. Large areas of the reserve comprise intertidal sand and mudflats, which have been deposited behind the whinstone and sandbar island known as Holy Island. The island has been connected to the mainland at low tide since 1955, via a man-made causeway. Lindisfarne holds the only regular flock of East Atlantic Light-bellied Brent Geese in Britain and has held over 80% of the total international population. The birds are usually concentrated in the main embayment of Holy Island Sands and Fenham Flats. Budle Bay is a smaller embayment to the south of the main intertidal area. The intertidal vegetation beds in Budle Bay are sparse, and Light-bellied Brent Geese have been observed feeding there only occasionally.

Numbers and trends

Both peak numbers (Fig. 4) and the number of bird-days (Fig. 5) of Light-bellied Brent Geese increased during the 1970s and 1980s. During the 1990s, numbers levelled off somewhat in line with the overall population trend, with the exception of 1996/97 when around 75% of the total population was present as a result of the feeding grounds in Denmark freezing over for a time.

The phenology of Light-bellied Brent Geese at Lindisfarne has changed notably since the 1960s (Figs. 6 & 7). During the early period, from 1960 to 1983, numbers were generally low with birds arriving at the site in mid autumn and peaking in number in mid winter, then declining through late winter (Fig. 6). However, in recent years birds have been arriving increasingly early (Fig. 7), with an earlier peak in November, and the majority of birds leaving by February/March. Associated with this pattern has been decreasing use of the Danish autumn sites, such as the Wadden Sea, where declining *Zostera* resources may be helping to drive this pattern.

Site use

Large areas of mud flat (c. 800 ha) support communities of intertidal vegetation, with the eelgrasses *Zostera noltii* and *Zostera angustifolia* and filamentous algae *Enteromorpha* spp. being dominant. At Lindisfarne, Light-bellied Brent Geese feed primarily in this habitat (Smith 1977) and the pattern of their use of these areas has been investigated in some detail (Percival *et al.* 1996, Percival & Evans 1997, Percival *et al.* 1998). These intertidal vegetation beds lie predominantly on 'muddy' substrates (particle size <63 microns) between c. 1.5 m and 3.5 m above the mean low water mark. Maximum tidal range lies between 250 cm below and 310 cm above the British Ordnance

Figure 3. Internationally and nationally important sites for East Atlantic Light-bellied Brent Geese in Britain (only Lindisfarne (1) surpasses the relevant qualifying level)



Datum, although the mean tidal range is c. 460 cm. Factors such as wind strength and direction can influence the water level, with strong northerly winds increasing the submersion of the *Zostera* bed.

On average, the largest *Zostera* beds are submerged for three hours at high tide, but on spring tides this may rise to five hours, whilst on neap tides they may be completely submerged for only one hour. While the water is shallow enough to allow birds to graze either by submerging their heads or 'up-ending', birds can continue to feed, albeit at a slower rate. However, for the majority of the time that the mudflats are inundated the birds are unable to feed and usually congregate to roost and preen on sheltered areas of the water.

Initial food plant biomass generally varies between years but is usually c. 15 g dry weight m⁻² for above ground biomass for each *Zostera* species, and between 10–30 g dry weight m⁻² for *Enteromorpha* (Denny 2001).

In some years, from January onwards, birds make use of areas of saltmarsh adjacent to the mudflats, with the Snook and Longbridge saltmarshes most frequently used (Anderson 1999). Since 1995, birds have also used agricultural land (winter cereals and pasture) adjacent to the site, initially only in late winter, but the trend is for increasing use of such habitats earlier in the winter. This is illustrated in Fig. 8 (taken from Anderson 1999). The phenology of habitat use for the 1993/94 and 1994/95, when moderate numbers of birds were present, shows the exclusive use of mudflats from September to mid November and minimal use of saltmarsh and terrestrial habitats from mid November onwards. The sudden switch to using agricultural land in late winter occurred during the following two years.

2.1.1.4 Other sites

Since 1960, six other English sites have held at least ten birds from this population in at least four years.

i) Seahouses to Budle Point

This stretch of coast (55°30'N 1°30'W; NU2231) lies immediately south of Lindisfarne. It consists of sandy bays bound by rocky headlands and backed by sand dunes and pasture.

Light-bellied Brent Geese have been recorded here in small flocks of around 25 birds in the autumn and winter, feeding mainly on *Enteromorpha* and *Ulva* (Lindisfarne NNR unpubl. data). The arrival of small flocks and family parties in autumn suggests that these birds are making landfall on migration

before filtering up the coast to Lindisfarne. Birds have also been recorded here during hard winters (e.g. a peak count of 107 in January 1997) when birds were concentrated at Lindisfarne initially but then had to move to other areas nearby in search of food.

ii) Alnmouth–Boulmer

The stretch of coast between Alnmouth and Boulmer (55°26'N 1°35'W; NU2410) lies approximately 10–20 km south of Lindisfarne and 5 km south of Seahouses-Budle Point. It consists of sandy bays separated by rocky headlands and backed by sand dunes and both soft and hard cliffs. Small areas of saltmarsh are present on the Aln and Coquet Estuaries

Light-bellied Brent Geese have been recorded here in small flocks of on average 17, and up to 61, birds in the autumn and winter, feeding mainly on *Enteromorpha* and *Ulva* (Lindisfarne NNR unpubl. data). The arrival of small flocks and family parties in autumn suggests that these birds are making landfall on migration before filtering up the coast to Lindisfarne. Birds have also been recorded here during hard winters, when birds concentrated at Lindisfarne have had to move to other areas nearby in search of food.

iii) Humber Estuary

This site is a complex comprising the Humber Estuary and the coastline to the north and south of the Humber mouth (53°37'N 0°00'W; TA2020). It includes an elongated shingle-spit capped by sand dunes (Spurn Point), extensive intertidal habitats (especially mudflats), saline lagoons and beds of *Phragmites*.

Individuals and small flocks of up to 47 birds have been recorded, mainly feeding on the saltmarshes on Spurn Point and in the Saltfleetby area, often associated with Dark-bellied Brent Geese, which regularly winter here in large numbers. Many records are from hard weather periods.

iv) Langstone Harbour

Langstone Harbour (50°48'N 1°56'W; SU6902) is a sheltered estuary east of Portsmouth with tidal channels that drain the river basins and penetrate far inland. Habitats include extensive mudflats and associated saltmarshes, sand-dunes, islands, and areas of *Juncus* marsh and reedbed. Brent Geese feed on intertidal vegetation, saltmarshes, amenity grassland and farmland immediately adjacent to the coast.

Figure 4. Light-bellied Brent Geese at Lindsfarne, 1960/61-1999/2000: peak counts (bars) and population index (line)

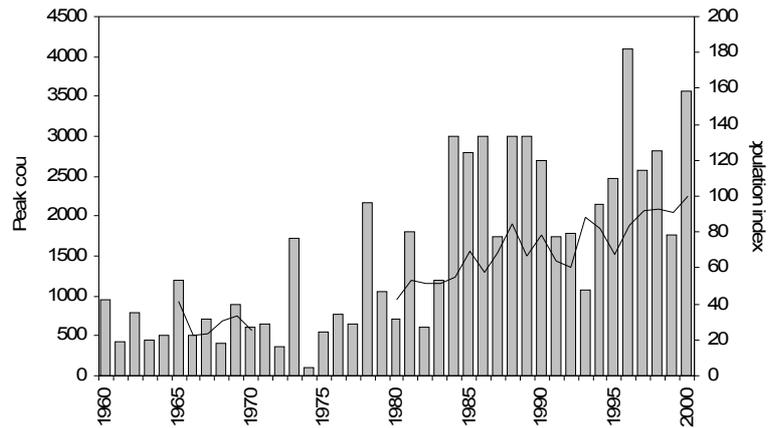


Figure 5. Light-bellied Brent Geese at Lindsfarne, 1960/61-1999/2000: bird-days (bars) and population index (line)

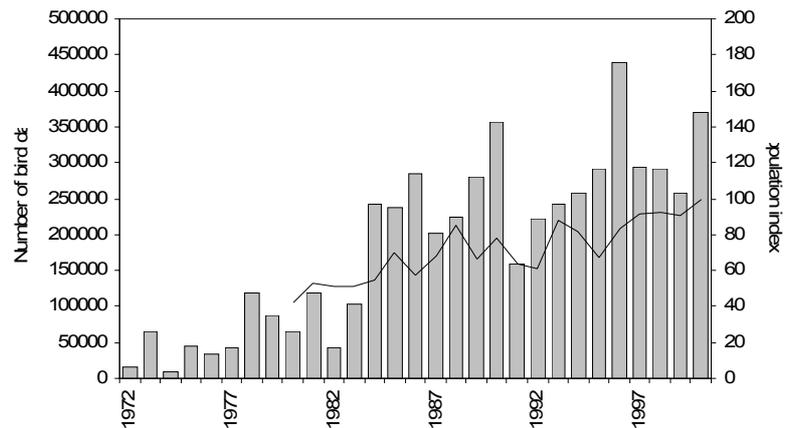


Figure 6. Light-bellied Brent Geese at Lindsfarne, 1960/61-1983/84: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)

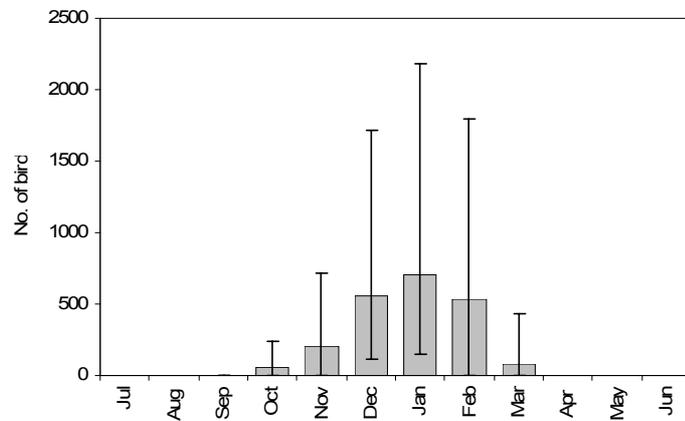
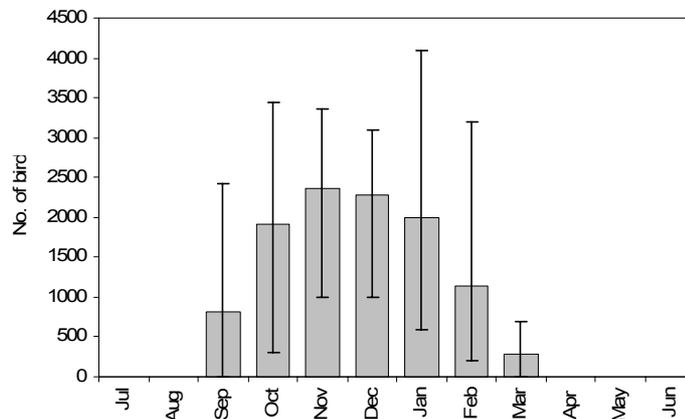
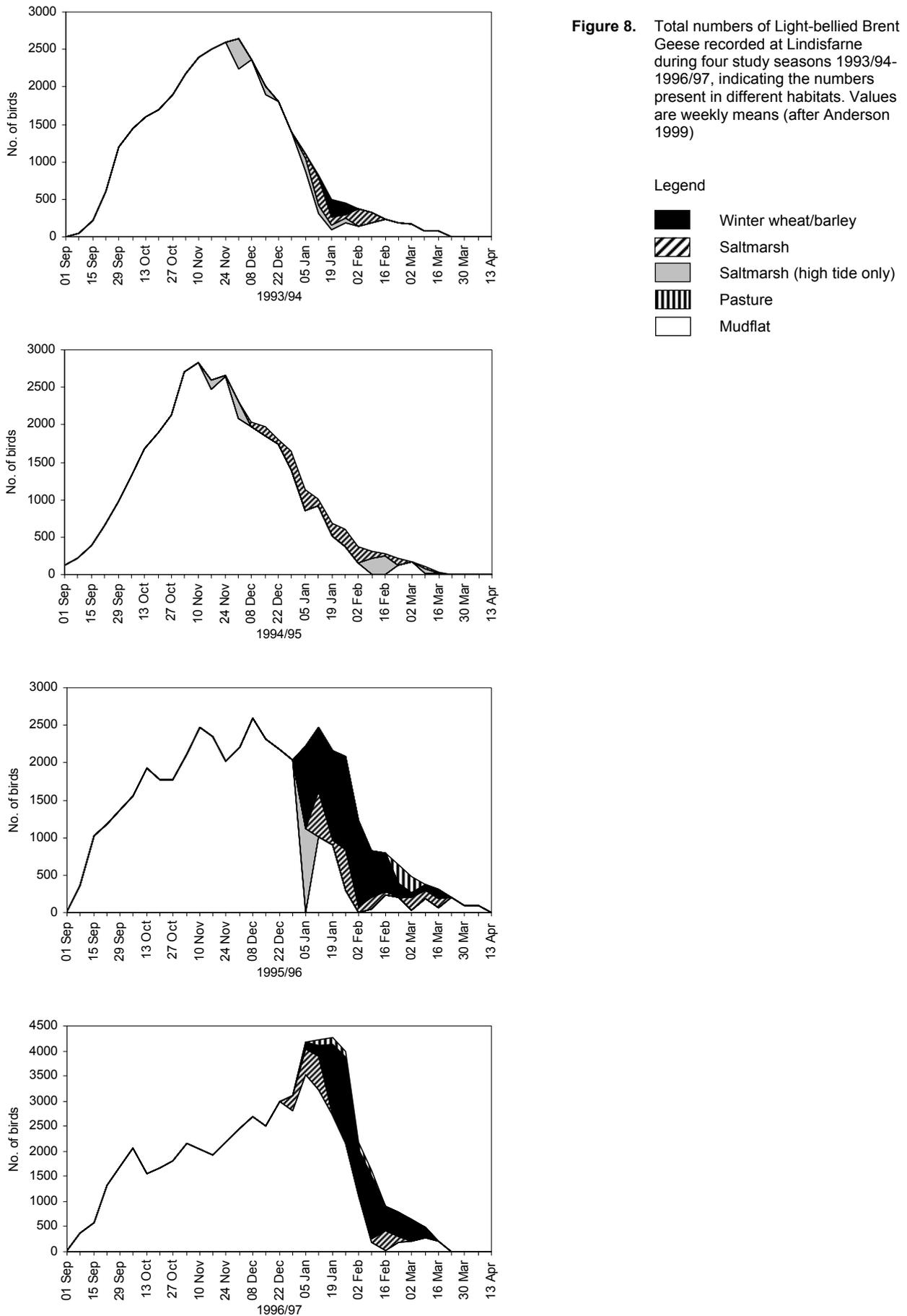


Figure 7. Light-bellied Brent Geese at Lindsfarne, 1984/85-2000/01: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)





Although fewer than 10 birds are recorded in most years, a flock of 33 was recorded in winter 1999/2000. Birds may be present in small numbers in mid winter during harsh weather on the continent, when birds move from Denmark. At this time of year, these birds join flocks of Dark-bellied Brent Geese feeding on saltmarshes, and increasingly in latter years on agricultural crops and amenity grassland (James 1996).

v) North Norfolk Coast

The North Norfolk Coast (52°58'N 0°35'W; TF8546) comprises a series of sites exhibiting a complex of different coastal habitats including extensive dunes systems, saltmarshes, mudflats and creeks.

Large flocks of Dark-bellied Brent Geese feed on the saltmarsh and, later in the season, coastal agricultural land. They roost on the sheltered coastal waters around Scolt Head Island. Small numbers (usually around 10) of Light-bellied Brent Geese have been recorded in most recent years, associating with the Dark-bellied birds. A flock of 33 birds was recorded by WeBS in winter 1986/87.

vi) The Wash

The Wash (52°55'N 0°20'W; TF5540) comprises one of the most important areas of estuarine mudflats, sandbanks and saltmarsh in Britain, including extensive *Zostera* beds. Included at the eastern end of the site are the low chalk cliffs at Hunstanton. Dune and saltmarsh communities show a typical flora and fauna, although much of the upper saltmarsh zone has been reclaimed. The Wash supports an important shellfishery.

Although Light-bellied Brent Geese are recorded regularly here, they apparently occur in low numbers (no more than 15 birds have been recorded in any one winter). However, given the large size of this site, and the large number of Dark-bellied birds that spend the winter here, it is likely that many Light-bellied birds are overlooked.

2.1.2 Scotland

2.1.2.1 Background

Small flocks of Light-bellied Brent Geese are recorded regularly, particularly in the autumn, at many east coast estuaries and lochs, and in the Northern Isles. The phenology of these records suggests that many birds may be making landfall before filtering down the country to Lindisfarne.

However, larger numbers have been recorded during cold weather movements. No sites in Scotland currently support internationally or nationally important numbers.

2.1.2.2 Historical status

Up to 10,000 Brent Geese, nearly all Light-bellied, used to winter in the Moray Firth when the British total probably exceeded 20,000 (Owen *et al.* 1986). Up to 4,000 were still there in the 1930s, but the site was deserted by these birds soon afterwards.

2.1.2.3 Other sites

i) Eden Estuary

The fairly small Eden Estuary (56°22'N 2°48'W; NO4719) is situated just north of St. Andrews and supports a wide diversity of habitats. The site includes extensive sandflats at the mouth of the estuary, and mudflats that support *Zostera*. Saltmarsh, wetland and sand dune habitats also occur.

Around 10 Light-bellied Brent Geese occur here annually, although nationally important numbers have been recorded, e.g. 44 in winter 1986/87.

ii) Loch of Strathbeg

The Loch of Strathbeg (57°37'N 1°52'W; NK0758) is the largest dune-lake in Britain (an area of 200 ha), and is situated inland from Rattray Head, the northeastern point of the Buchan coast. Habitats present include marginal vegetation to the lake and nearby agricultural fields.

This site is used irregularly by flocks of fewer than ten Light-bellied Brent Geese, with largest numbers recorded during the cold weather movements in the mid 1990s, e.g. 40 in winter 1995/96.

iii) Tynninghame Estuary

Tynninghame Estuary (56°00'N 2°21'W; NT6379) is a fairly small estuary east of Edinburgh at the mouth of the Firth of Forth, consisting of intertidal flats and saltmarsh.

Light-bellied Brent Geese are recorded at this site in most years, with internationally important numbers recorded in some years, e.g. 84 in 1996/97. It appears to be a site where regular landfall is made in the autumn by geese bound for Lindisfarne.

iv) Moray Firth

The Moray Firth (57°30'N 4°00'W; NH8060) is an area of coastline and estuary incorporating mud and sand flats with extensive *Zostera* beds and saltmarshes.

Use of this estuary appears to be similar to that of Tynninghame Estuary, with around 18 birds present in most years and a maximum count of 52 in 1996/97.

v) Ythan Estuary

The long, narrow estuary of the River Ythan (57°20'N 1°57'W; NK0026) runs in a north-south direction, entering the sea 18-km north of Aberdeen. There are associated areas of saltmarsh, and large tracts of sand dunes exist either side of the river mouth, which comprises extensive mud and gravel flats.

This site is used irregularly (around 35 birds in most years), with largest numbers recorded during the cold weather movements in the mid 1990s, e.g. 132 in 1986/87.

2.2 Denmark

2.2.1 Background

East Atlantic Light-bellied Brent Geese use estuarine sites along the west and northeast coasts of Jutland (the Danish mainland), including most of the Limfjord, which separates Jutland from Nørrejyske Ø (Fig. 9). Birds arrive in early to mid September and, if the winter is mild, stage through to the last week of May, when they depart for their breeding areas. In severe winters, areas of shallow water and saltmarshes freeze. At this time, Light-bellied Brent Geese leave the country for milder staging areas situated mostly in Britain and the Netherlands.

The Danish sites are used for only part of the winter, with one of the most recently established staging areas at Nibe & Gjøl Bredninger being the exception to this rule. This site has, in recent years, been a staging area for more than 500 Light-bellied Brent Geese between September and the end of May. At present, 50–75% of the global population uses Danish staging areas in autumn and winter (the remainder are at Lindisfarne), whereas the entire population is found in Denmark during April and May. The geese feed on *Ruppia* and *Zostera* beds

until late winter, when they switch to saltmarshes and, increasingly, agricultural land.

All but one of the sites used have been designated SPAs, and five are also protected as Ramsar sites. The Danish Ramsar site network was declared in 1977, and a provisional network of SPAs was announced in 1983. Exact borders for all Ramsar sites and SPAs (generally similar to those provisionally declared in 1977 and 1983, respectively) were published formally in 1996, together with a report that includes detailed maps and descriptions of all designated sites, including those mentioned below (Miljø- & Energiministeriet 1996). In the site accounts below, phenology descriptions are based on data collected during 1990/91–1995/96, when 2–3 or more monthly counts were carried out in most sites throughout the winter. In recent years, count effort has been lower, especially in January–March. Where data are available, changes in the temporal patterns of site use since 1995/96 are discussed.

2.2.2 Historical status

The present distribution of Light-bellied Brent Geese in Denmark is similar to that known from the late 19th and early 20th centuries. Birds were, however, more numerous in the central parts of the Limfjord and probably also around the island Læsø, northeast of Jutland at this time (Fog 1967). Although information is anecdotal, there is no doubt that Light-bellied Brent Geese were more abundant visitors than they are today in many of the sites used in more recent decades.

2.2.3 Internationally important sites

i) Mariager & Randers Fjords

Five-year mean 97/98–01/02: 2,285

Site conservation status

SPA (National No. 15 Randers og Mariager Fjord og Ålborg Bugt; qualifying species)
Ramsar (National No. 11, identical to SPA No. 15; qualifying species)
IBA (Parts of Randers and Mariager Fjords: criteria A4i, B1i, C3)
Two shooting-free refuges (Mariager Fjord and Sødring) cover most of the *Ruppia* and *Zostera* beds mentioned below.

Figure 9. Sites used regularly by East Atlantic Light-bellied Brent Geese in Denmark. Sites given in black are considered of international importance, sites in dark grey are new sites of potential importance. Light grey areas are designated as both Ramsar and Special Protection Areas (SPAs) and hatched areas are designated as SPAs only. Site names: 1) Mariager & Randers Fjords, 2) The Agerø area, 3) The Danish Wadden Sea, 4) Nissum Fjord, 5) Nissum Bredning, 6) Northern Kattegat Coast, 7) Nibe and Gjøl Bredninger, 8) Venø, 9) North Djursland Coast, 10) Risgårde Bredning & Rotholme, 11) Løgstør Bredning-Aggersborg, 12) Dråby Vig



Site description and habitat

The SPA/Ramsar site (56°40'N 10°17'E) covers 39,040 ha of coastal habitat in northeast Jutland and includes all mudflats, submerged vegetation and saltmarshes used by Light-bellied Brent Geese when staging at the site. Important feeding habitats are 480 ha of intertidal or submerged *Ruppia* sp. beds, 430 ha of *Zostera marina* beds and 420 ha of saltmarsh (Clausen & Percival 1998). Clausen & Percival (1998) provide detailed information on site and habitat use by Light-bellied Brent Geese staging in the area. It should, however, be mentioned that in recent years birds have been recorded in high numbers feeding on winter cereals around both Mariager and Randers Fjords (P. Clausen unpubl. data).

Numbers and trends

Both peak numbers (Fig. 10) and number of bird-days (not shown, but see Clausen *et al.* 1999) of Light-bellied Brent Geese increased between the 1960s and 1980s, following the increase in global population size. However, during the 1990s, numbers levelled off as birds began to use alternative sites during autumn and mid winter, the main staging period at the site. Fig. 10 shows that a lower proportion of the total population used Mariager & Randers Fjords during the 1990s than in the 1980s.

As shown by Clausen *et al.* (1998), the phenology of Light-bellied Brent Geese at Mariager & Randers Fjords has changed notably. From the 1950s to the mid 1980s, the birds used the site in highest numbers during the period from November to March, and they were absent during September and most of October. Today, large flocks arrive in early September, and peak numbers are recorded in September–November (Fig. 11). Numbers decline in December/January as birds move on to other sites.

Site use

The most important feeding habitats are the *Ruppia* spp. and *Zostera marina* beds, most of which are found in Mariager Fjord (Clausen & Percival 1998). When birds arrive in September they normally start feeding on the *Ruppia* beds, which are preferred over all other habitats (P. Clausen unpubl. data). As food gradually becomes depleted on the *Ruppia* beds, the birds switch to feeding on *Zostera* and, to some extent, *Ulva lactuca* beds. Saltmarshes serve primarily as important alternative feeding areas when the food resources in seagrass beds are depleted, or inaccessible during stormy periods when water levels are high. Associated with this spread over alternative habitats is a gradual movement of increasingly higher numbers of Light-

bellied Brent Geese to Randers Fjord. In the last 6–7 years, flocks have increasingly used winter cereal fields as feeding areas during mid winter. The habit started around Randers Fjord in the mid 1990s, usually with a flock of 100–300 birds on one or more fields. However, during recent winters, several hundred birds have frequently used winter cereals around Mariager Fjord (P. Clausen unpubl. data).

ii) The Agerø area

Five-year mean 97/98–01/02: 4,363

Site conservation status

SPA (National No. 25 Mågerodde and Karby Odde; National No. 27 Glomstrup Vig, Agerø, Munkholm og Katholm Odde, Lindholm og Rotholm; qualifying species)

IBA (Glomstrup Vig, Agerø, Munkholm and Katholm Odde, Lindholm, and Rotholm: non-listed species)

One shooting-free refuge (Agerø), and two breeding bird refuges with restricted public access during spring (Agerø and Katholm & Munkholm) are situated in the area

Site description and habitat

Two SPAs (56°43'N 8°33'E) cover 7,500 ha of coastal habitat in northwest Jutland and include all the saltmarsh and >95% of *Zostera marina* beds used by Light-bellied Brent Geese when staging in the area. Important feeding habitats include 1,130 ha of submerged *Zostera marina* beds and 750 ha of saltmarsh (Clausen & Percival 1998). Jørgensen *et al.* (1994) and Clausen (1998) provide detailed information on site and habitat use by Light-bellied Brent Geese staging in the area between 1989 and 1993. Since then, birds have used autumn- and spring-sown cereal fields, as well as pastures, more frequently (P. Clausen unpubl. data).

Numbers and trends

The first flock of Light-bellied Brent Geese was observed on the site in 1970. Since then, peak numbers (Fig. 12) and the number of bird-days (not shown, but see Clausen *et al.* 1999) of Light-bellied Brent Geese have increased considerably and the site has been the most important spring staging area for the population since 1987. During the 1990s, numbers levelled as birds began to use alternative sites during spring, but the Agerø area has nevertheless been used by well over 60–70% of the population in May during the last 10 years.

Clausen *et al.* (1998) showed that the phenology of Light-bellied Brent Geese around Agerø has changed considerably over recent decades. During the 1970s and most of the 1980s, birds used the site

only in spring, from March through May, but internationally important flocks are now found in the area in November, and more than 1,000 birds are present by January or February if the weather is mild (Fig. 13).

Site use

The most important feeding habitats are the rich *Zostera marina* beds that are found throughout the Limfjord in the Agerø area (Clausen & Percival 1998). From autumn to February, Light-bellied Brent Geese rarely use any other habitat while staging in the area. From February and throughout spring, saltmarshes become increasingly important as feeding areas, partly because the preferred *Zostera* beds are often inaccessible during windy periods when water levels are high (Clausen 2000). As mentioned above, increasing numbers of Light-bellied Brent Geese have used autumn- and spring-sown cereal fields and pastures as feeding areas in recent years. This happens most often during late winter, when *Zostera* supplies are low and before the growth of alternative food plants on saltmarshes, and during colder springs (P. Clausen unpubl. data).

From 1970 to the end of the 1990s, birds staging in the area used a communal night-time roost northwest of Agerø. Flocks could be observed arriving from feeding areas up to 12-km away from the roost, and included birds from the northernmost staging area around Mågerodde. However, comparisons between daytime and roost totals in recent years suggest that some flocks were missing from the Agerø night-roost. Indeed, in 2001 it was confirmed the area around Mågerodde had become a staging area in its own right, with birds using that area roosting in the Limfjord just outside Mågerodde.

iii) The Danish Wadden Sea

Five-year mean 97/98–01/02: 976

Site conservation status

SPA (National No. 53 Fanø; National No. 57 Vadehavet; qualifying species)
Ramsar (National No. 27, including SPA Nos. 53, 57, and several more SPAs in the region; qualifying species)
IBA (Vadehavet (Wadden Sea): criteria A4i, B1i, C3)

The shooting-free refuge (Vadehavet) has, since 1998, effectively halted all hunting activities at all the sites used by the Light-bellied Brent Geese staging in the area

Site description and habitat

The two SPA/Ramsar sites (55°20'N 8°31'E) cover more than 114,790 ha of coastal habitat in the Wadden Sea and include all mudflat and saltmarsh used by Light-bellied Brent Geese staging in the northern part of the Danish Wadden Sea. Important feeding habitats are intertidal *Zostera noltii/angustifolia* beds and *Enteromorpha* beds found east of the islands of Fanø and Mandø. The present areas of these beds have not been quantified but, according to Clausen & Fischer (1994) and Clausen & Percival (1998), they definitely declined in size during the late 1980s and early 1990s. These two sources provide detailed information on site and habitat use by Light-bellied Brent Geese staging in the area.

Numbers and trends

The numbers of, site use and habitat use by Light-bellied Brent Geese in the Danish Wadden Sea were unknown until the mid 1980s. It was known that the birds migrated annually down the west coast of Denmark and that ringed individuals were shot in the area in autumn during the 1950s and 1960s. This, together with the fact that no birds were seen anywhere else in September and most of October, led Salomonsen (1958), Fog (1967) and Madsen (1984) to the conclusion that the area was of major importance to the population. In 1986 and 1987, the first accurate counts were made in the area, and this practice, initiated by Kim Fischer, has continued since then. Both peak numbers (Fig. 14) and the number of bird-days (not shown, but see Clausen *et al.* 1999) of Light-bellied Brent Geese have gradually declined since the early 1990s as birds have begun to migrate directly to alternative sites, especially Lindisfarne, Mariager & Randers Fjords and Nibe & Gjøl Bredninger.

As shown by Clausen *et al.* (1998), the phenology of Light-bellied Brent Geese in the Danish Wadden Sea must have changed. From the 1950s to the mid 1980s, most of the global population must have used the site in September through to November (being absent elsewhere). Nowadays the site is used by more than 500 birds in September only, and by October most of these have left (Fig. 15). During the rest of the winter, small flocks may be seen in the area, especially when birds leave the rest of Denmark as fjords freeze up during cold weather.

Figure 10. Light-bellied Brent Geese at Mariager & Randers Fjords, 1960/61-2000/01: peak counts (bars) and population index (line) (circles denote years with no known data)

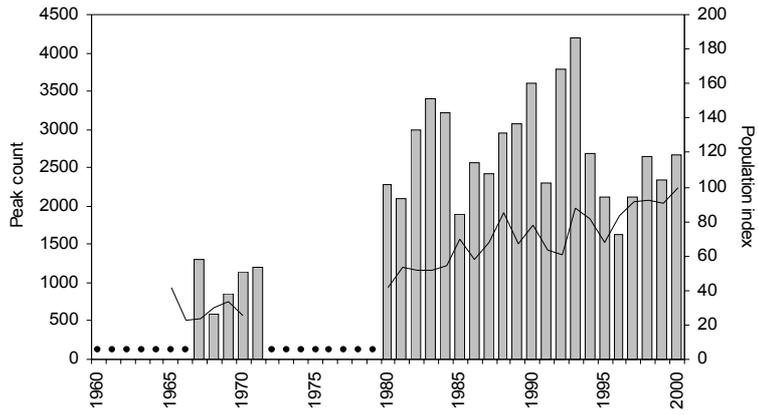


Figure 11. Light-bellied Brent Geese at Mariager & Randers Fjords, 1990/91-1995/96: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)

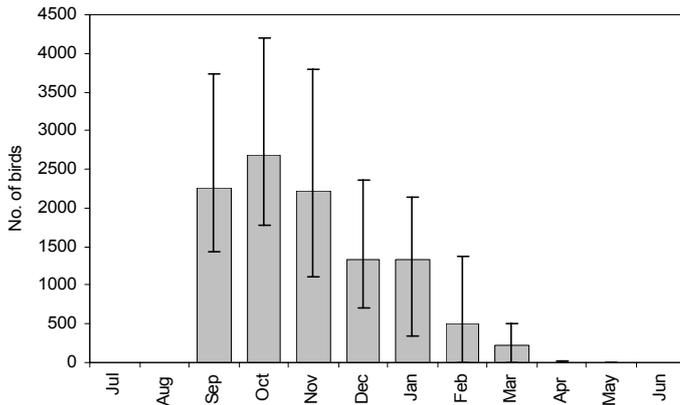


Figure 12. Light-bellied Brent Geese at the Agerø area, 1960/61-2000/01: peak counts (bars) and population index (line) (circles denote years with no known data)

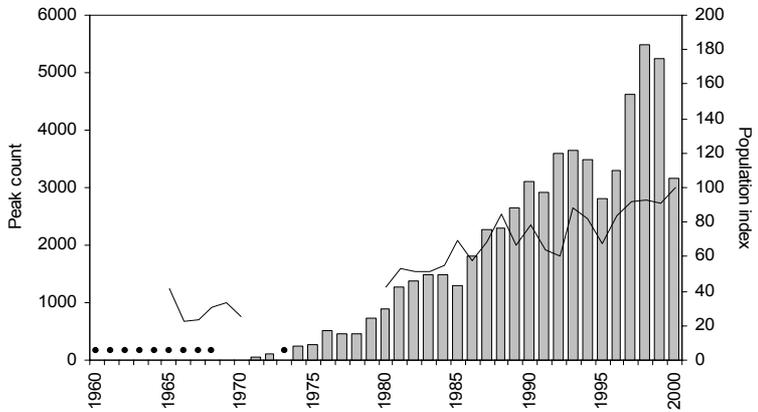
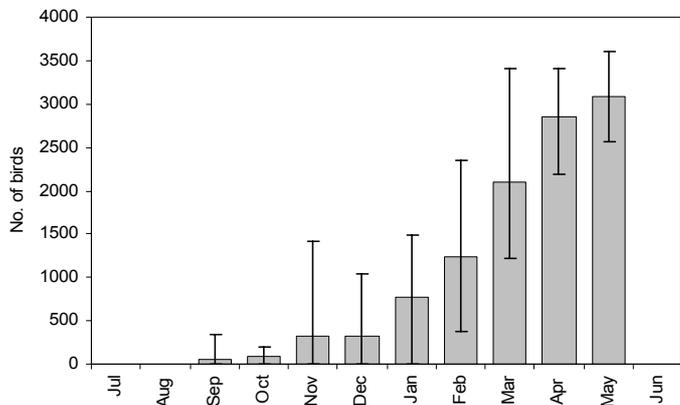


Figure 13. Light-bellied Brent Geese at the Agerø area, 1990/91-1995/96: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



Site use

The most important feeding habitats are the *Zostera* and *Enteromorpha* beds. Saltmarshes were only used as alternative feeding areas during exceptionally high, storm-induced tides in 1986–1989, during the four autumns when detailed ecological studies were conducted (Clausen & Fischer 1994). There is, however, some evidence that flocks fed on saltmarshes more frequently in the 1990s. In one cold year, a flock was observed feeding on winter cereal fields in polders inside the seawall.

iv) Nissum Fjord

Five-year mean 97/98–01/02: 656

Site conservation status

SPA (National No. 38 Nissum Fjord; qualifying species)
Ramsar (National No. 4, identical to SPA No. 38; qualifying species)
IBA (Nissum Fjord: non-listed species)
One shooting-free refuge (Nissum Fjord) covers most of the *Zostera* bed and several of the saltmarshes mentioned below.

Site description and habitat

The SPA/Ramsar site (56°24'N 8°09'E) covers 7,990 ha of coastal habitat in western Jutland, and includes all saltmarsh and submerged vegetation used by the Light-bellied Brent Geese staging in the area. The most important feeding habitat is 220 ha of saltmarsh (Clausen & Percival 1998). The site used to support 1,200 ha of submerged *Zostera marina* beds in the 1960s, but they gradually disappeared during the 1970s and 1980s due to the effects of eutrophication (Clausen & Percival 1998). In the 1990s, there were periods of recovery alternating with new collapses in the vegetation resource. Although a few hectares of *Zostera marina* have recovered, present densities are so low (Ringkøbing Amt 2003) that they currently attract very few Light-bellied Brent Geese (P. Clausen unpubl. data).

Numbers and trends

In the 1950s and 1960s, Nissum Fjord was believed to hold the whole global population in spring (Fog 1967, 1972). Both peak numbers (Fig. 16) and the number of bird-days (not shown, but see Clausen *et al.* 1999) of Light-bellied Brent Geese increased from the 1960s to the early 1980s, following the increase in the global population size. However, since the mid 1980s, numbers have declined as increasing numbers of birds moved to the Agerø area. Spring 1986 was the last time that Nissum Fjord was the most important spring staging area for the population. The decline in numbers is most

likely due to habitat deterioration, especially the decline in *Zostera* mentioned above, but also to poor grazing management of saltmarshes (Clausen & Percival 1998).

In contrast to many of the other sites, the phenology of Light-bellied Brent Geese at Nissum Fjord has remained rather stable. Small flocks occurred irregularly in Nissum Fjord in autumn during the 1960s (Fog 1972), but, since the 1950s, the site has generally been described as a spring staging area. Large flocks arrive in February/March and numbers peak during April/May (Fog 1967, Madsen 1984, Jørgensen *et al.* 1994) (Fig. 17).

Site use

The most important feeding habitat today is neither the historically most important *Zostera marina* beds (cf. Clausen & Percival 1998) nor the saltmarshes. Over the last 8–10 years, the majority of Light-bellied Brent Geese have been feeding on a site where grain is provided for staging birds during April and early May (Clausen & Percival 1998, P. Clausen unpubl. data). The bait site is one of many situated along the west coast of Jutland. It is operated by the Forest and Nature Agency in connection with a management scheme attempting to keep Pink-footed Geese away from newly sown spring cereal fields by providing alternative feeding areas. Bait is therefore sprayed over pastures or saltmarshes and large numbers of geese, including Light-bellied Brent Geese, are attracted to this novel man-made habitat. Over the last 8–10 years, therefore, the highest numbers of Light-bellied Brent Geese been observed during April, rapidly declining in number after 10 May, when baiting ceases. The decline in numbers in May corresponds with an increase usually seen around Agerø in the second half of May.

v) Nissum Bredning

Five-year mean 97/98–01/02: 617

Site conservation status

SPA (National No. 23 Agger Tange og Krik Vig; National No. 39 Harboør Tange; qualifying species)
Ramsar (National No. 5, includes SPA Nos. 23 and 39 as well as other areas; qualifying species)
IBA (Nissum Bredning: non-listed species)
Two shooting-free refuges (Agger Tange and Harboør Tange) cover most of the *Ruppia* and *Zostera* beds mentioned below. Both areas are also breeding bird refuges with restricted public access to most of the saltmarshes during spring.

Figure 14. Light-bellied Brent Geese in the Danish Wadden Sea, 1960/61-2000/01: peak counts (bars) and population index (line) (circles denote years with no known data)

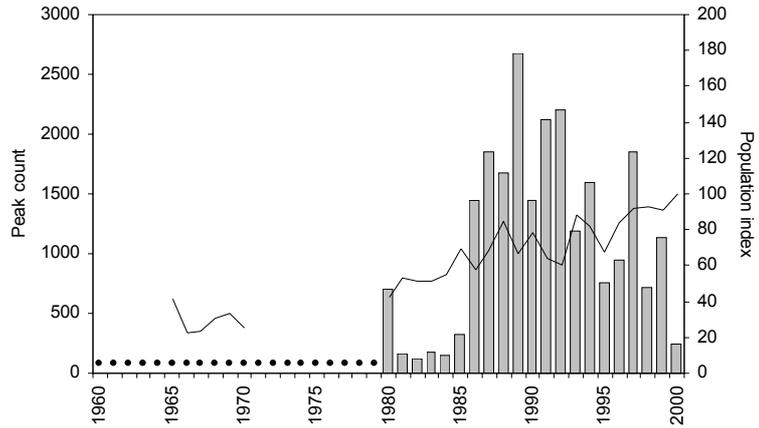


Figure 15. Light-bellied Brent Geese in the Danish Wadden Sea, 1990/91-1995/96: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)

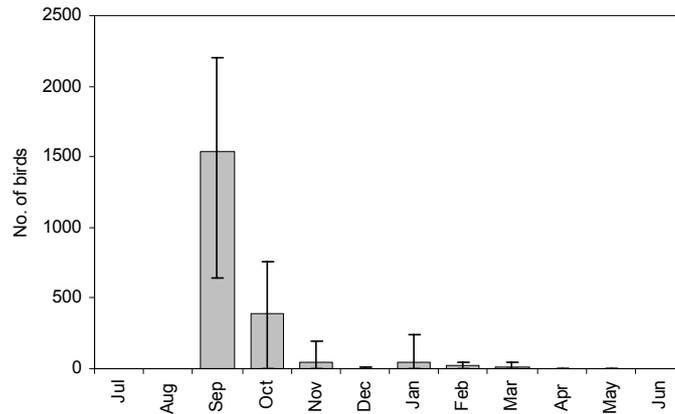


Figure 16. Light-bellied Brent Geese at Nissum Fjord, 1960/61-2000/01: peak counts (bars) and population index (line) (circles denote years with no known data)

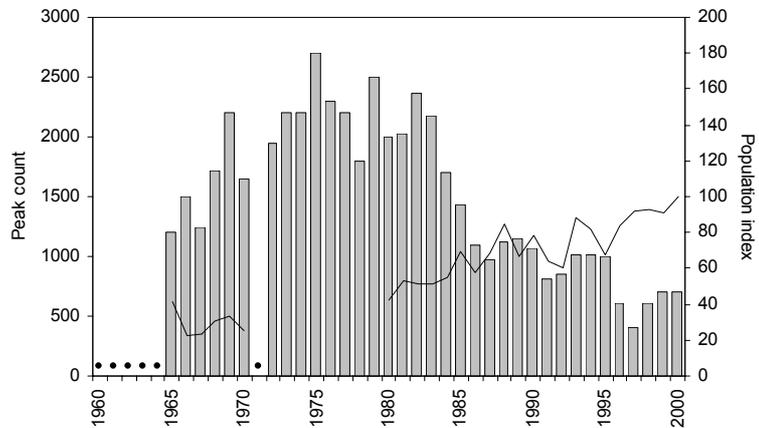
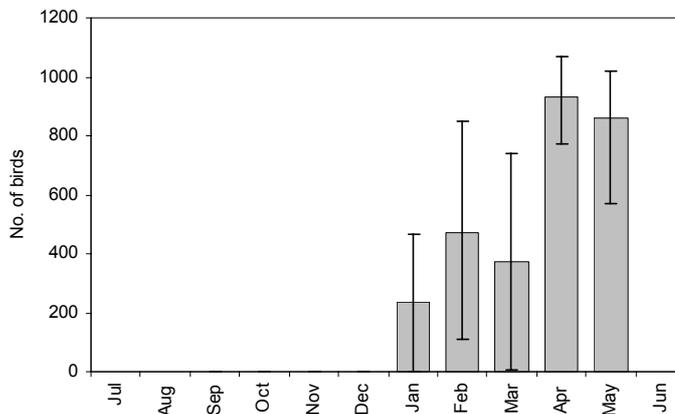


Figure 17. Light-bellied Brent Geese at Nissum Fjord, 1990/91-1995/96: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



Site description and habitat

The SPA/Ramsar sites (56°38'N 8°13'E) cover 12,770 ha of mostly coastal habitat in northwest Jutland and include all saltmarshes, coastal lagoons and most of the submerged vegetation used by Light-bellied Brent Geese staging in the area. Important feeding habitats are 450 ha of submerged *Zostera marina* beds and 90 ha of saltmarsh (Clausen & Percival 1998). Detailed information on site and habitat use by the Light-bellied Brent Geese staging in the area was provided by Clausen & Percival (1998). Since then, beds comprising 170 ha of *Ruppia cirrhosa* found in Harboør Fjord (the southernmost of three coastal lagoons in the area) have become increasingly important as a feeding area (Holm & Clausen unpubl. data).

Numbers and trends

The site was originally recognised as being important for Light-bellied Brent Geese in the late 1960s (Fog 1972). Both peak numbers (Fig. 18) and the number of bird-days (not shown, but see Clausen *et al.* 1999) of Light-bellied Brent Geese have increased from the 1960s to the 1980s, following the increase in global population size. The numbers of birds present in this area fluctuate more than at most other sites along the flyway. This is partly because the site is the last to freeze and the first to become ice-free during severe winters. In these years, a high proportion of the population is usually attracted to the site. In milder winters, generally fewer, but certainly internationally important numbers, of birds use the site.

As shown by Jørgensen *et al.* (1994), the phenology of Light-bellied Brent Geese at Nissum Bredning has changed considerably. In the early 1980s, the site was used regularly only in February and March. Today, large flocks arrive in October/November and peak numbers are recorded during January–March (Fig. 19). The tendency for some birds to stage through to early May is increasing (details below).

Site use

Previously, the most important feeding habitats were the *Zostera marina* beds in the Limfjord and saltmarshes (Clausen & Percival 1998). In recent years, an increasingly important feeding area during autumn and winter has been the *Ruppia cirrhosa* bed found in Harboør Fjord. Like the situation at Nissum Fjord, Harboør Tange hosts a bait site where grain is provided to staging geese during April and early May. The bait site was established in the early 1990s, and the first flocks of Light-bellied Brent Geese were observed feeding on the grain in 1992. Numbers on the bait site had rarely been more than 400 Light-bellied Brent Geese, but in

spring 2002 the site was moved from Knopper Enge to Plet Enge. The latter is the saltmarsh that Light-bellied Brent Geese use most regularly in the area. With the bait site now located on this preferred marsh there has been a massive increase in Light-bellied Brent Goose numbers using the area. In recent winters, more than 1,000 Light-bellied Brent Geese have used this new man-made habitat and have remained in such high numbers through to the end of April. As observed in Nissum Fjord, numbers decline rapidly in early May, when baiting ceases, and birds move onwards to the Agerø area.

vi) Northern Kattegat Coast

Five-year mean 97/98–01/02: 929

Site conservation status

SPA (National No. 2 Ålborg Bugt, nordlige del)
IBA (Northern Kattegat: non-listed species)
Three shooting-free refuges (Voerså-Stensnæs, Gerå, Hals-Egense) cover most of the *Ruppia* and *Zostera* beds and some of the saltmarshes mentioned below.

Site description and habitat

The SPA/Ramsar site (56°84'N 8°23'E) covers 31,460 ha of coastal habitats in northeast Jutland and includes all mudflats, most of the submerged vegetation, and all saltmarshes used by the Light-bellied Brent Geese when staging along the Northern Kattegat Coast. Important feeding habitats are approximately 140 ha of intertidal or submerged *Ruppia* spp. beds and some smaller *Zostera marina* and *Zostera noltii* beds (seagrass beds are only partly mapped, Bregnballe *et al.* 2001), and 420 ha of saltmarsh (Clausen & Percival 1998). Bregnballe *et al.* (2001) provide detailed information on site and habitat use by Light-bellied Brent Geese staging in the area, based on detailed surveys carried out in 1997–2000.

Numbers and trends

The first flocks of Light-bellied Brent Geese used this site in the autumn of 1989, and internationally important numbers have been recorded annually since then (Fig. 20). Both peak numbers and the number of bird-days (not shown, but see Clausen *et al.* 1999 and Bregnballe *et al.* 2001) of Light-bellied Brent Geese increased rapidly in these early years, but have levelled off in recent years, following the trend in global population size. Numbers tend to peak in late autumn (Fig. 21).

Figure 18. Light-bellied Brent Geese at Nissum Bredning, 1960/61-2000/01: peak counts (bars) and population index (line) (circles denote years with no known data)

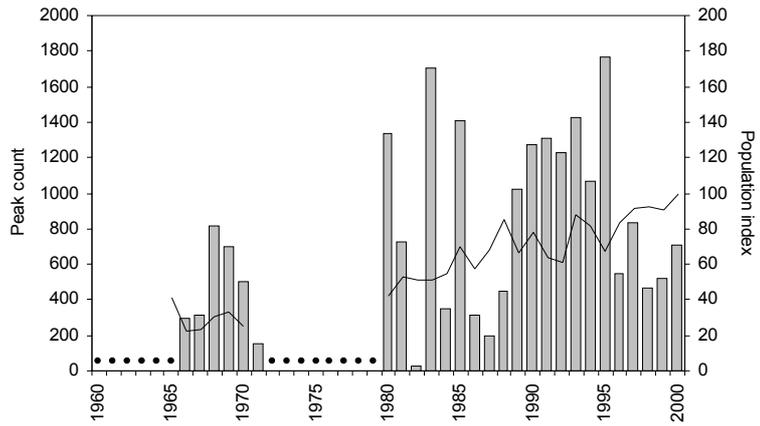


Figure 19. Light-bellied Brent Geese at Nissum Bredning, 1990/91-1995/96: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)

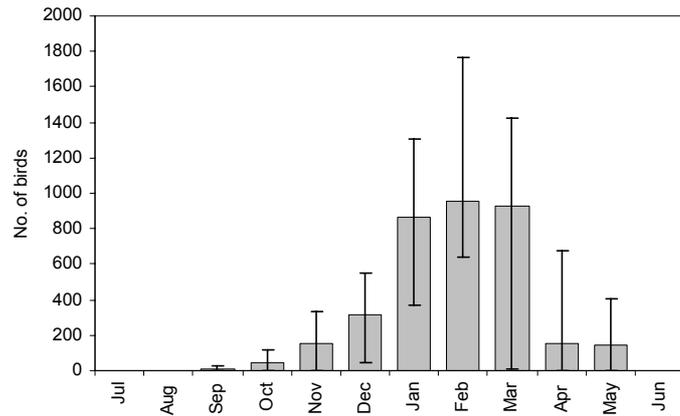


Figure 20. Light-bellied Brent Geese at the Northern Kattegat Coast, 1960/61-2000/01: peak counts (bars) and population index (line) (circles denote years with no known data)

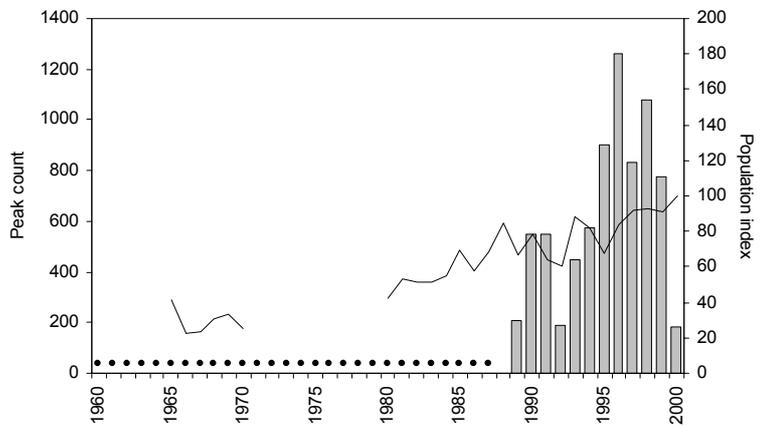
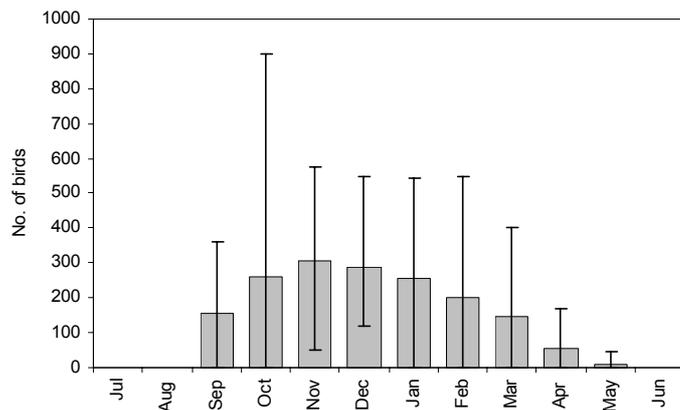


Figure 21. Light-bellied Brent Geese at the Northern Kattegat Coast, 1990/91-1995/96: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



Site use

The most important feeding habitats are the *Ruppia* spp. beds. *Zostera marina* and *Zostera noltii* beds are also used (Bregnballe *et al.* 2001). Saltmarshes serve primarily as important alternative feeding areas when food resources in all the seagrass beds have been depleted or are inaccessible during stormy periods when water levels are high.

vii) Nibe and Gjølbredninger

Five-year mean 97/98–01/02: 2,168

Site conservation status

SPA (National No. 1 Ulvedybet og Nibe Bredning)
Ramsar (National No. 7, identical to SPA No. 15)
IBA (Ulvedybet and Nibe Bredning: non-listed species)

One shooting-free refuge (Nibe & Gjølbredning) covers almost half of the *Ruppia* and *Zostera* beds mentioned below. All islands in Nibe & Gjølbredninger are breeding bird refuges with restricted public access to saltmarshes during spring.

Site description and habitat

The SPA/Ramsar site (57°00'N 9°35'E) covers 18,530 ha of mostly coastal habitat in northern Jutland and includes all submerged vegetation and saltmarshes used by the Light-bellied Brent Geese when staging in Nibe & Gjølbredninger. In the early and mid 1990s, the most important feeding habitats were 4,500 ha of *Zostera marina* beds in Nibe & Gjølbredninger (Clausen & Percival 1998). The *Zostera marina* beds in Nibe & Gjølbredninger, however, deteriorated considerably at the turn of the century, both in terms of areas covered as well as densities of *Zostera marina* present. The deterioration is most likely due to eutrophication. This means that in recent years, 530 ha of saltmarsh has become increasingly important as feeding habitat, as well as some remaining *Zostera* found east of Gjølbredning proper, near the islands Fruens Holm and Egholm.

Numbers and trends

Light-bellied Brent Geese began to use this site in the winter of 1990/91 and it has supported internationally important numbers every year since then. Peak numbers were recorded in the mid to late 1990s (Fig. 22) and the number of bird-days peaked at the same time (not shown, but see Clausen *et al.* 1999). With the recent collapse in *Zostera*, numbers of Light-bellied Brent Geese have been reduced to half of what they were in the immediately preceding years. Numbers in Nibe & Gjølbredning proper have been even lower, but well over 1,000 birds have started to use a hitherto unused *Zostera* bed found between Fruens Holm and Egholm, keeping

numbers in the SPA/Ramsar site well above 1,000 birds

The development of Nibe & Gjølbredninger as a staging area for Light-bellied Brent Geese in the 1990s was quite exceptional, given that geese, including Light-bellied Brent Geese, are normally considered to be highly traditional and site-faithful animals. In less than 10 years, annual peaks rose from zero to more than 2,000 birds, and the site became the only one in Denmark that held more than 500 birds from their arrival in September until departure in late May. That is not fully evident from the data presented in Fig. 23, but note that the 'maximum' lines related to counts made in the mid 1990s

Site use

The most important feeding habitats used to be the *Zostera marina* beds in Nibe & Gjølbredninger, used throughout the staging period. However, following the reduction in the availability of *Zostera*, birds have begun to feed much more frequently on saltmarshes throughout winter and in spring, and flocks have also been observed feeding on winter cereal fields in recent winters.

viii) Venø

Five-year mean 97/98–01/02: 423

Site conservation status

SPA (National No. 40 Venø og Venø Sund)
IBA (Venø and Venø Sund: non-listed species)
The area used by the Light-bellied Brent Geese is found inside a breeding bird refuge (Nørskov Vig) with restricted public access during spring.

Site description and habitat

The SPA (56°35'N 8°39'E) covers 2,920 ha of coastal habitat in northeast Jutland and includes all saltmarshes used by Light-bellied Brent Geese staging at the site. *Zostera marina* beds are found immediately north of the saltmarshes, but the extent of these is not precisely known.

Numbers and trends

The site has been visited regularly during spring since it was declared a breeding bird reserve in 1987. The first flock of Light-bellied Brent Geese was observed in spring 1992, and internationally important numbers have been recorded annually since spring 1993 (Fig. 24). From March to May, more than 250 birds use the site. It is not known for sure when the first Light-bellied Brent Geese arrive, but small numbers (fewer than 50) have been recorded in January in recent years.

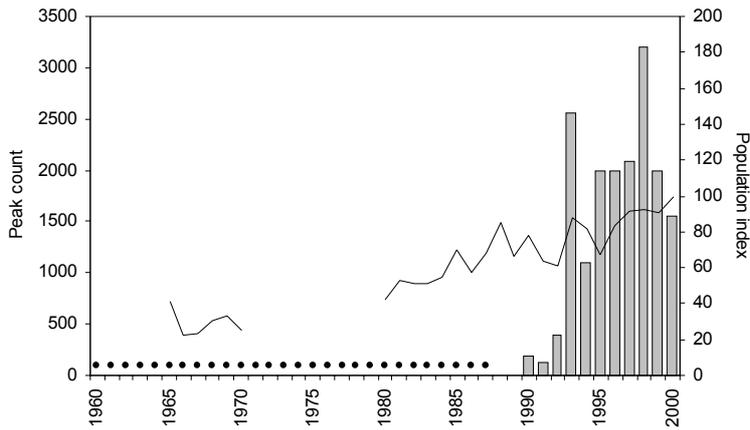


Figure 22. Light-bellied Brent Geese at Nibe & Gjøl Bredninger, 1960/61-2000/01: peak counts (bars) and population index (line) (circles denote years with no known data)

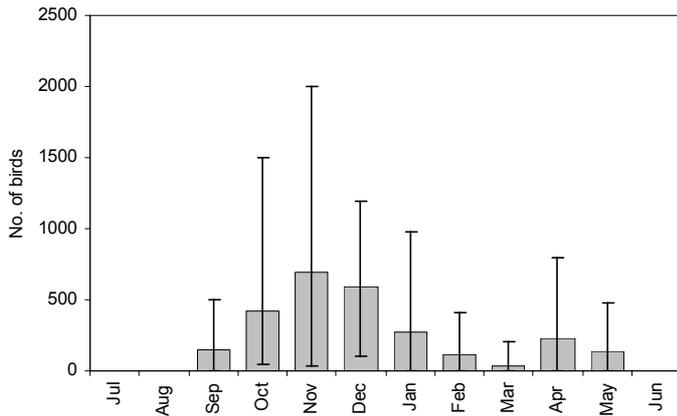


Figure 23. Light-bellied Brent Geese at Nibe & Gjøl Bredninger, 1990/91-1995/96: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)

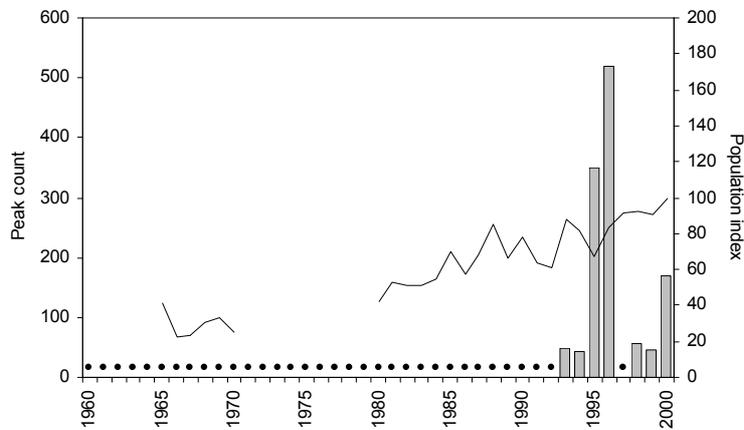


Figure 24. Light-bellied Brent Geese at Venø, 1960/61-2000/01: peak counts (bars) and population index (line) (circles denote years with no known data)

Site use

Light-bellied Brent Geese have hitherto always been observed feeding on the saltmarshes around Nørskov Vig at the north end of the island of Venø. Despite the presence of *Zostera* immediately north of Nørskov Vig, Light-bellied Brent Geese have not been observed using this food resource.

ix) North Djursland Coast

Five-year mean 97/98–01/02: 199

Site conservation status

SPA (National No. 112 Ålborg Bugt, østlige del, new site declared in 2003; qualifying species)

Site description and habitat

The SPA (56°32'N 10°44'E) covers 177,360 ha of coastal habitat northeast of Jutland and includes more than half of the intertidal mudflats and submerged vegetation used by Light-bellied Brent Geese staging in the area. The exact composition and areas of seagrass on the site are unknown.

Numbers and trends

The first flocks of fewer than 50 birds were observed on the site in winters 1993/94 and 1994/95. Large flocks were observed for the first time in the cold winter of 1995/96, when 350 Light-bellied Brent Geese used the site in mid winter, at the time when most birds fled from Denmark and flew to Lindisfarne (Percival & Anderson 1998), the Netherlands (Cottaar *et al.* 1999a,b) or Scotland (S. Percival & P. Clausen unpubl. data). The same thing happened in the following year, with a peak number of 520 birds present. Internationally important numbers have been recorded almost annually since then (Fig. 25).

Site use

Site and habitat use are not well known; NERI has not yet studied the ecology and use of the site. Flocks have been recorded during aerial surveys or by local observers. The data available suggest that the site is used primarily in late autumn and winter and, as judged from aerial surveys, the site probably has a food supply composed of intertidal *Ruppia maritima* and/or submerged *Zostera marina* beds and *Ulva lactuca*. Suitable saltmarshes are few, if present at all. The site could be considered an extension of the Mariager & Randers Fjords site, but the two sites are separated by a stretch of coastline where habitats are considered poor for feeding Light-bellied Brent Geese.

x) Risgårde Bredning & Rotholme

Five-year mean 97/98–01/02: 64

Site conservation status

IBA (Glomstrup Vig, Agerø, Munkholm and Katholm Odde, Lindholm, and Rotholm: non-listed species)

The area used by Light-bellied Brent Geese is found inside a breeding bird refuge (Rotholmene) with restricted public access during spring.

Site description and habitat

Light-bellied Brent Geese have so far been observed only on the small islets of Store and Lille Rotholm, situated at the south end of Risgårde Bredning (56°43'N 9°11'E). The islands host tern and gull colonies as well as a large Cormorant *Phalacrocorax carbo sinensis* colony, and have been counted annually in spring since the breeding bird reserve was established in 1977. Most of the 10 ha of islands are covered by saltmarshes, and small *Zostera marina* beds are found in the immediate vicinity of the islands.

Numbers and trends

The first 19 Light-bellied Brent Geese were recorded in May 1994. Since then, up to 300 birds have been recorded. However, visits to the islands have frequently been made in the very last few days in May, and in 2000, when only three birds were recorded, the visit was made on 29 May, after the mass departure of Light-bellied Brent Geese. Available data nevertheless suggest that the site is likely to become an internationally important staging area for Light-bellied Brent Geese (Fig. 26).

Site use

Nothing is known about site and habitat use by the Light-bellied Brent Geese on Rotholme. The islands have been visited only once a year by competent observers from the National Forest and Nature Agency or NERI, in order to count Cormorants. It is thus not known when birds arrive, nor whether numbers peak in May or perhaps earlier.

2.2.4 Other sites

Two further Danish sites, Løgstør Bredning-Aggersborg (56°59'N 8°85'E) and Dråby Vig (56°38'N 52°52'E), occasionally held internationally important numbers of Light-bellied Brent Geese during the 1990s and early this century. Data held by NERI suggest that they birds occur irregularly at these sites (P. Clausen unpubl. data). Both sites are used primarily during winter and early spring when birds fly over them on passage from the main

'autumn/winter' sites, Mariager-Randers Fjords, the Northern Kattegat Coast and Nibe-Gjøl Bredninger, to the main spring staging areas around Agerø, Nibe Bredning, Nissum Fjord and Agerø.

2.3 The Netherlands

2.3.1 Background

Before the decline in the global population, East Atlantic Light-bellied Brent Geese were common winter visitors to the *Zostera marina* beds of the former Zuider Zee (now the IJsselmeer). Birds deserted the Netherlands after the loss of *Zostera* beds in the 1930s and the enclosure of the IJsselmeer. Since the 1970s, a few individuals have been observed annually amongst flocks of Dark-bellied Brent Geese. However, during the cold winter of 1978/79 there was a larger influx of Light-bellied Brent Geese, which was repeated in several cold winters in the 1980s (Cottaar *et al.* 1999a), when up to 200 birds were recorded.

The largest influxes occurred during the cold winters of 1995/96 and 1996/97, with peak numbers of approximately 800 and 400 birds in each of these winters, respectively (Cottaar *et al.* 1999a,b). Smaller influxes occurred in 2001/02 and 2002/03.

Birds have concentrated at sites adjacent to the west coast, particularly in the southern Wadden Sea and to a lesser extent the Delta area in the southwest (Cottaar *et al.* 1999). The phenology of these influxes has been characterised by arrival in January, coinciding with freezing conditions in Denmark. Peak numbers have occurred in January/February and, particularly in 1995/96, some individuals have remained for several months.

Birds feed mainly on pasture and cereal fields, although some have been observed on saltmarshes in April and May. In 1995/96, several small flocks were observed far inland, close to rivers and waterbodies. Observations of marked birds indicate that during the 1995/96 influx birds originated mainly from Lindisfarne, whereas in 1996/97 many of the birds appear to have originated from Denmark (Cottaar *et al.* 1999a).

There have been four recent winters (between 1995/02 and 2002/03) when large numbers of Light-bellied Brent Geese have been recorded at Dutch sites, as mentioned above. During these winters eight sites have held an average of over 10 birds (Table 2).

Camperduin (52°44'N 4°39'E), Wieringen (52°51'N 5°01'E), Texel (53°11'N 4°51'E) and Terschelling (53°26'N 5°30'E) can be considered as regular staging sites that have supported Light-bellied Brent Geese during all four influxes. Camperduin and Wieringen might be considered internationally important, due to the fact that birds occur annually and average numbers generally exceed 50 birds. They have, nevertheless, not been listed as such in this review, because numbers in non-influx years are well below the 50-bird threshold. The high average numbers recorded at other sites are due primarily to the high numbers observed during the influx years in the 1990s.

Up to 18% of the global population was recorded in the Netherlands in the 1990s. Previous influxes had accounted for up to 5% of the population. This demonstrates that, during harsh winter weather conditions in northwest Europe, the Netherlands has held internationally important numbers of East Atlantic Light-bellied Brent Geese in recent years, and serves as an important winter refuge. 2.3.2. Norway

Observations of Light-bellied Brent Geese migrating along the coast at have been made at Lista Bird Observatory for over a century. Birds leaving 'en masse' from Denmark in late spring fly past Lista on their migration north. In most recent years, most of the population has been recorded moving along the coast. In the autumn, coastal passage is less evident, perhaps reflecting the slightly different migration routes taken by some birds returning directly to Lindisfarne (see <http://www.dmu.dk/CoastalZoneEcology/satellite>).

Discrepancies in the timings of departure from spring staging grounds and arrival on the breeding grounds have led to a hypothesis that Light-bellied Brent Geese stage on spring migration at an unknown site on the Norwegian coast, as is the case for the other two species of goose breeding on Svalbard. However, despite two satellite-tracking studies, there is still no direct evidence for birds staging on the Norwegian coast for anything other than a rest/drink (Clausen & Bustnes 1998). However, in two mild springs, numbers of birds in Denmark declined significantly at least one month before the main departure. With better early spring feeding conditions, some birds may have reached peak condition, migrated earlier and staged elsewhere en route to Svalbard. Work to identify staging areas in Norway should be conducted when such apparent early migration takes place again.

Figure 25. Light-bellied Brent Geese at the North Djursland Coast, 1960/61-2000/01: peak counts (bars) and population index (line) (circles denote years with no known data)

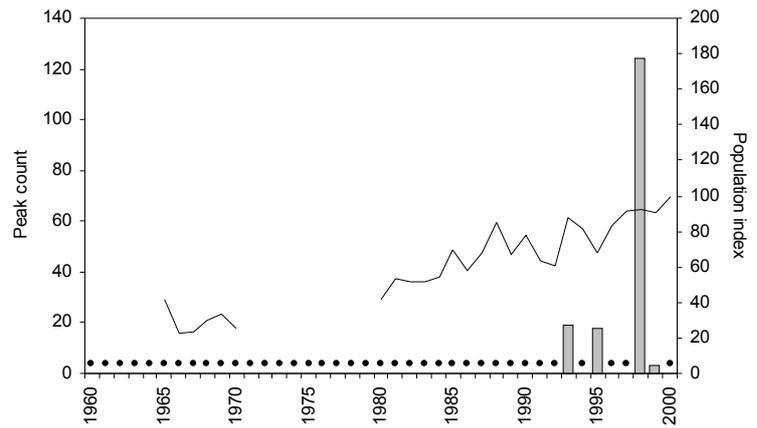


Figure 26. Light-bellied Brent Geese at Risgårde Bredning & Rotholme, 1960/61-2000/01: peak index (bars) and population size (line) (circles denote years with no known data)

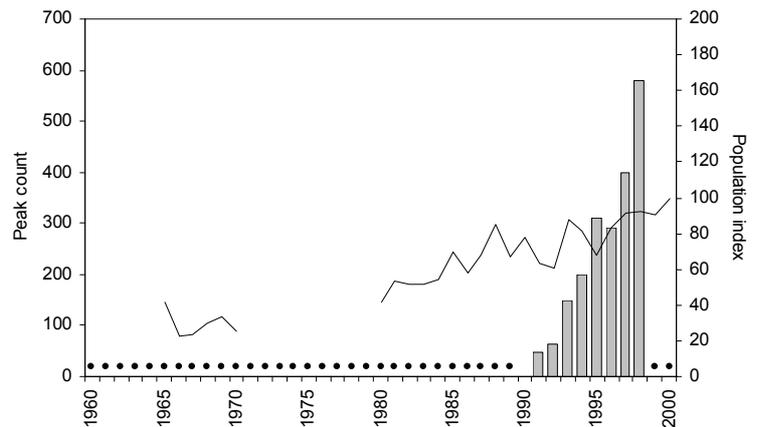


Table 2. Sites in the Netherlands supporting an average peak count of over ten Light-bellied Brent Geese in the four influx years 1995/96, 1996/97, 2001/02 and 2002/03

Site name	Province	Mean	Status
Camperduin	Noord-Holland	150	observed annually
Wieringen	Noord-Holland	62	observed annually
Den Helder	Noord-Holland	77	not observed annually
Terschelling	Friesland	20	regular site
Texel	Noord-Holland	28	regular site
IJmuiden	Noord-Holland	35	irregular site
Brouwersdam	Zeeland	15	only recorded in 95/96 and 96/97
Scharendijke	Zeeland	12	irregular site

3 SURVEY OF AREAS USED DURING THE BREEDING SEASON

This section reviews the abundance, distribution and phenology of East Atlantic Light-bellied Brent Geese at key sites during the breeding season and follows the format adopted in the previous section.

Until the 1980s it was thought that all East Atlantic Light-bellied Brent Geese bred on the Svalbard and Franz Josef archipelagos in the Arctic Ocean. However, in 1985, an expedition to Kilen, northeast Greenland, found 850 Light-bellied Brent Geese (Hjort *et al.* 1987). It was not known whether these birds were from the East Canadian High Arctic or Svalbard biogeographical populations until 1997, when two birds satellite-tagged in spring in Denmark migrated to Kilen for the breeding season (Clausen & Bustnes 1998).

Goose populations breeding in the Arctic spend a small part of the year there, but obviously safeguarding breeding sites is just as important as safeguarding sites during the non-breeding season. Three types of sites have to be considered for protection, in addition to breeding sites:

- 1) Pre-breeding staging sites, where the geese spend a week or two in early June, re-building some of the body reserves they have lost on their non-stop flight from Denmark to the Arctic.
- 2) Moulting sites, where failed breeders and non-breeding individuals form flocks and shed their flight feathers during July.
- 3) Post-moult staging sites, where birds rebuild body reserves lost during the breeding and moulting periods, enabling them to make the non-stop journey back to the wintering areas in Denmark and Britain.

Detailed knowledge about all four types of sites is sparse, due to the very expensive logistics involved in covering the sites in the areas used by East Atlantic Light-bellied Brent Geese during summer. Only a few expeditions have searched for the Light-bellied Brent Geese in Franz Josef Land, and Kilen has been visited by competent ornithologists only twice (in 1985 and 1998). Coverage of Svalbard is better, but only a few sites have been visited regularly at appropriate times of the summer to search for pre-breeding, breeding, moulting or post-moulting birds. Most records from Svalbard are thus from *ad hoc* projects covering parts of the archipelago, initiated by either the Norwegian Polar Institute or the Governor of Svalbard, or jointly by these two institutions.

Pre-breeding

Mehlum (1998) gives an overview of the then existing knowledge of sites used by East Atlantic Light-bellied Brent Geese during the pre-breeding period. Most flocks have been recorded on Bjørnøya, Hopen, Tusenøyane, and West Spitzbergen, but the only large flock mentioned was recorded at Vårsolbukta. This site has been visited almost annually since 1997, and may be considered internationally important (Fig. 27, Table 3). Large flocks have also been recorded in two years at Fuglehukken and once at Hyttevika (Fig 27, Table 3). Almost all birds tracked with satellite transmitters in 2001 staged at several valleys around Dicksonfjorden (Fig. 27). This area could be a very important pre-breeding site, but this has yet to be confirmed from ground or helicopter surveys. Two birds followed by satellite telemetry in 1997 flew to a pre-breeding site in Peary Land (Clausen & Bustnes 1998), probably the Mudderbugten area mentioned below.

Breeding

The breeding grounds in Franz Josef Land are practically unknown (and probably few, Clausen *et al.* 1999). Even those in Svalbard are poorly known, with only the breeding grounds around Tusenøyane being studied in any depth (Norderhaug 1974, Madsen *et al.* 1989, 1992). Over half the population remains unaccounted for during the breeding season, although Tusenøyane is known to account for the majority of successful breeding attempts in some years (Clausen *et al.* 1999). Besides Tusenøyane, the only Svalbard breeding site known with more than 20 pairs is Moffen (Mehlum 1998). On Kilen, 99 pairs bred successfully in 1985 (Clausen *et al.* 1999 inferred from data in Hjort *et al.* 1987), but only 25–41 goslings were recorded in 1998 (Clausen & Laubek 1999), i.e. 10–15 pairs bred successfully. Outside Kilen, only a few breeding pairs have been found (Hjort 1995). *Moulting* Franz Josef Land probably serves as an important moulting area, but evidence is anecdotal and based on observations of large densities of droppings (Clausen *et al.* 1999). In Svalbard, the most important known moulting area is on North Spitzbergen, in the surroundings of Liefdefjorden, Woodfjorden and Wijdefjorden, as well as on Moffen. These areas held internationally important numbers during surveys (Mehlum 1998), and were used by some satellite-tracked individuals in the summer of 2001 (P. Clausen, M. Green & T. Alerstam unpubl. data). Tusenøyane is probably the second most important, known moulting site on

Figure 27. Location of important sites during the breeding season (as mentioned in Table 3 and associated text). Light grey denotes glacier-free areas. 1) Tusenøyane, 2) North Spitzbergen, 3) Moffen, 4) Vårsolbukta, 5) Fuglehuken, 6) Rippfjorden, 7) Augustabukta, 8) Dicksonfjorden, 9) Dunøyane-Hyttevika, 10) Sørkapp, 11) Bjørnøya, 12) Kilen, 13) Mudderbugten, Peary Land

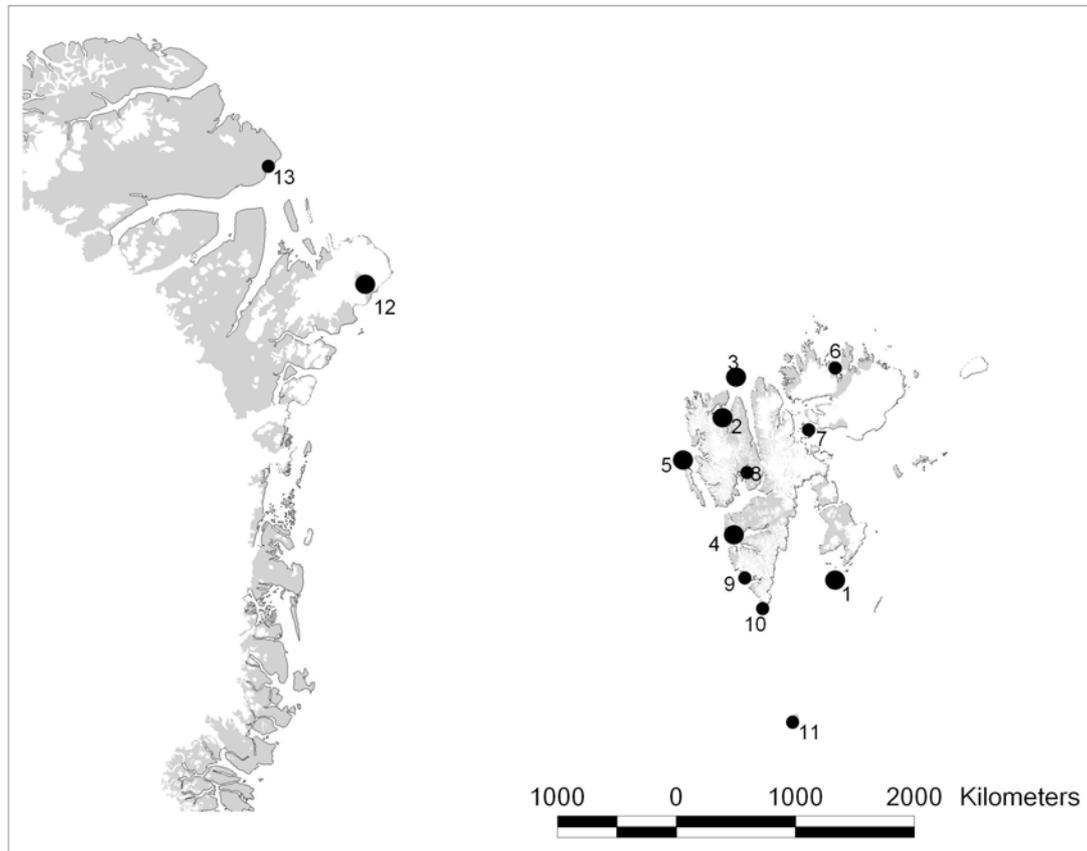


Table 3. Sites of international and potential international importance for East Atlantic Light-bellied Brent Geese in the Arctic. Sites in *italics* are considered internationally important, either because they have regularly supported more than 50 birds, or have held very large numbers in the few years when they have been surveyed. The other sites may be internationally important also, but more surveys are needed to confirm their status.

Site	Use and maximum breeding numbers known				Maximum count
	Pre-breeding	Breeding	Moulting	Post-moult	
<i>Tusenøyane, Svalbard</i>	+	435-600 pairs, 1985	+	+	500-1200
<i>North Spitzbergen, Svalbard</i>			+	+	c. 600
<i>Moffen, Svalbard</i>		43 pairs, 1993	+	+	318 in 1996
<i>Vårsolbukta, Svalbard</i>	+				821 in 2001*
<i>Fuglehuken, Svalbard</i>					215 in 1998
					119 in 1999
Rippfjorden, Svalbard				+	>100
Augustabukta, Svalbard				+	>100
Dicksonfjorden, Svalbard	+?		+?	+?	**
Dunøyane-Hyttevika, Svalbard	+			+	365 in 2003
Sørkapp, Svalbard				+	120 in 1964
Bjørnøya, Svalbard	+			+	350 in 1984
<i>Kilen, Greenland</i>		99 pairs, 1985	+	+	1,100 in 1998
Peary Land, Greenland	+?			+	75 in 1998

Sources: Mehlum (1998), and unpublished internal reports to the Governor of Svalbard (data 1998-2003). Notes: * Annual maxima: Vårsolbukta: 200 in 1997, 412 in 1998, 441 in 1999, 821 in 2001, 162 in 2003; ** site used by five of seven birds followed with satellite transmitters in 2001 (Clausen, Green & Alerstam, unpubl. data)

Svalbard, but only for a few hundred birds (Mehlum 1998). In 1985 c. 300 non-breeding birds moulted at Kilen (Clausen *et al.* 1999). The moulting grounds of more than 3,000 of the East Atlantic Light-bellied Brent Geese in poor breeding years thus remained uncertain up to 1998 (Clausen *et al.* 1999), but in 1998 almost 1,100 birds were found moulting at Kilen (Clausen & Laubek 1999), the largest known moulting flock recorded.

Post-mouling

Judged from the information given by Mehlum (1998), post-mouling flocks are mostly found in sites that are also used during pre-breeding or moult. The most important sites found before 1997 were Moffen, North Spitzbergen, and Tusenøyane. Rijpfjorden and Augustabukta in Nordaustlandet, Dunøyane and Sørkapp in West Spitzbergen, and southernmost Bjørnøya may also be important sites (Mehlum 1998, Table 3). The Greenland-breeding birds stage in Kilen during August, but leave the area in the last few days of August, as shown from the results of ground surveys (Hjort *et al.* 1987), and satellite telemetry (Clausen & Bustnes 1998, P. Clausen, M. Green & T. Alerstam, unpubl. data). The only large flock observed outside Kilen was seen at Mudderbugten in Peary Land, 75 birds in August 1998 (Clausen & Laubek 1999).

3.1 Svalbard

i) Tusenøyane

Site conservation status

Southeast Svalbard Nature Reserve
IBA (South-east Svalbard Nature Reserve: criteria A3, A4i, B1i, B2)

Site description and habitat

Tusenøyane (77°00'N 22°00'E) is a group of many rocky, low-lying islets (the largest being c. 200 ha) in an area of shallow sea, some distance from the southwest coast of the island of Edgeøya. There is no human settlement in the area.

The most serious threat to the bird life on the islands is an oil spill (there are plans to open the northern Barents Sea to test-drilling for oil and gas). Although access to the islands is prohibited during the breeding season, increased traffic from tourist boats at Tusenøyane may be a threat, as breeding Light-bellied Brent Geese are very shy and may suffer increased predation of eggs and young if disturbed. The goose populations are monitored irregularly by the Norwegian Polar Institute and/or the Governor of Svalbard.

Numbers and status

Limited monitoring suggests that in good breeding years up to 600 pairs may breed on this archipelago, but that in many years fewer than 100 pairs breed. This is the core breeding area, and breeding success of these birds apparently dictates breeding success across the whole population (Madsen *et al.* 1998, Clausen *et al.* 1999).

ii) North Spitzbergen

Site conservation status

Northwest Spitzbergen National Park (Partial)
IBA (North-west Spitzbergen National Park: criteria A4i, B1i, B2)
Would be further protected by a proposed Inner Wijdefjorden nature reserve (Sysselmannen 2002).

Site description and habitat

This is a vast area across which several moulting flocks have been identified in the past, in Liefdefjorden, Woodfjorden and Wijdefjorden (76° 30'N 13° 30'E). There is no settlement in the area, and the area is so large and remote that there are unlikely to be any potential human impacts.

iii) Moffen

Site conservation status

Northwest Spitzbergen National Park
IBA (Northwest Spitzbergen National Park: criteria A4i, B1i, B2)

Site description and habitat

A small tundra island (80°03'N 14°30'E) north of West Spitzbergen. No threats are known. Access to Moffen Nature Reserve is prohibited between 15 May and 15 September (including the adjacent marine areas and airspace below 500 m).

Numbers and status

The scant survey data suggest that approximately 50 pairs of Light-bellied Brent Geese probably breed on this island. A moulting flock of 125 birds has been recorded.

iv) Vårsolbukta

Site conservation status

Nordenskiöld Land National Park (since 2003)
IBA (Nordenskiöldkysten: non-listed species)

Site description and habitat

A bay situated on the north coast of Bellsund (77°45'N 14°20'E), just south of Ingeborgfjellet, with tundra habitats. No major threats are known. There is no settlement in the immediate vicinity of

the area, but residents and tourists frequently visit Vårsolbukta on trips from Longyearbyen.

Numbers and status

A very important pre-breeding staging site, with more than 200 birds in most years when surveys were undertaken. More than 800 birds have been recorded (Table 3).

v) Fuglehuken

Site conservation status

Forlandet National Park
IBA (Forlandet National Park: non-listed species)

Site description and habitat

A small tundra island (78°54'N 10°30'E) north of West Spitzbergen. There is no settlement in the area and no major threats are known.

Numbers and status

In two survey years, more than 100 birds used the site as a pre-breeding staging area. Flocks have been observed migrating in a northwesterly direction from the site, which would suggest that they were on onward migration to Greenland.

vi) Rijpfjorden

Site conservation status

Northeast Svalbard Nature Reserve
IBA (Northeast Svalbard Nature Reserve: non-listed species)

Site description and habitat

This is a vast area (80°10'N 22°00'E) across which moulting and post-moulting flocks (> 100 birds) have been recorded in the past. There is no settlement in the area, and it is so large and remote that there are unlikely to be any potential human impacts.

vii) Augustabukta

Site conservation status

Northeast Svalbard Nature Reserve
IBA (Northeast Svalbard Nature Reserve: non-listed species)

Site description and habitat

This is a vast area (79°20'N 20°00'E) across which moulting and post-moulting flocks (> 100 birds) have been recorded in the past. There is no settlement in the area, and it is so large and remote that there are unlikely to be any potential human impacts.

viii) Dicksonfjorden

Site conservation status

North Isfjorden National Park (since 2003).

Site description and habitat

A fjord northeast of Longyearbyen (78°43'N 15°12'E), with several river valleys that are likely to include suitable goose habitat. No major threats are known; there is no settlement in the area, but residents and tourists frequently visit the site on trips from Longyearbyen.

Numbers and status

Ground or helicopter-based surveys have so far not found any larger concentrations of Light-bellied Brent Geese in this area (Mehlum 1998). However, it is remarkable that five of seven satellite-tracked birds used this area as a pre-breeding staging area, three moulted there (as none of them bred, Clausen *et al.* 2003), and four used the area post-moult (P. Clausen, M. Green and T. Alerstam unpubl. data). These observations suggest that this site could be of major significance for Light-bellied Brent Geese in most of the summer period.

ix) Dunøyane-Hyttevika

Site conservation status

South Spitzbergen National Park
Breeding bird reserve (Dunøyane)
IBA (South Spitzbergen National Park: non-listed species)

Site description and habitat

A bay situated on the north coast of Bellsund (77°02'N 15°10'E), just south of Ingeborgfjellet, with tundra habitats. No major threats are known.

Numbers and status

Mentioned as a potentially important post-moulting site (Mehlum 1998), but with fewer than 100 birds recorded. In spring 2003, 365 birds were counted during the pre-breeding period (Table 3).

x) Sørkapp

Site conservation status

South Spitzbergen National Park
Breeding bird reserve (Sørkappøya)
IBA (South Spitzbergen National Park: non-listed species)

Site description and habitat

Southernmost parts of West Spitzbergen and the island Sørkappøya (76°30'N 16°30'E), with tundra habitats. There is no settlement in the area and no major threats are known.

Numbers and status

Mentioned as a potentially important post-moulting site (Mehlum 1998), although this is based on a count of 120 birds in 1964 (Table 3). Two of seven satellite-tracked birds used this area as a post-moulting staging area (P. Clausen, M. Green and T. Alerstam unpubl. data).

xi) Bjørnøya (Bear Island)*Site conservation status*

Bjørnøya Nature Reserve (since 2002)
IBA (Bjørnøya: non-listed species)
(some parts of the island with restricted public access during the summer: 15 June – 31 August)

Site description and habitat

An oceanic island (74°20'N 18°46'E) between Spitzbergen and Norway. There are steep sea cliffs at the southern end, while the northern part is flat with numerous lakes and ponds. There is rich vegetation close to the seabird colonies, but tundra is far more sparse in the central and northern parts. The only permanent human settlement on the island is a meteorological station, which does not pose any threat to the bird life.

There is no settlement in the area, apart from a meteorological and radio station. Bjørnøya might have been developed as a supply base for ships and oil rigs, in the event of future activity by the oil industry in the Barents Sea. However, in 1999, the Norwegian government suggested that the whole island might be designated as a Nature Reserve and it was designated as such in 2002. Presently, the greatest threat is from oil spills. The use of this island by staging Light-bellied Brent Geese is poorly known, and surveys are required.

Numbers and status

Very little is known about the use of this island. Up to 350 Light-bellied Brent Geese have been recorded here on autumn and spring passage, but the island's strategic position on the flyway suggests that it may be an important resting/staging site.

3.2 Greenland**i) Kilen***Site conservation status*

North and Northeast Greenland National Park
Ramsar (Kilen)
Biosphere Reserve (North and Northeast Greenland National Park)
IBA (Kilen: criteria B1i, B2)

Site description and habitat

A flat, gravel plain (81°12'N 13°30'W) comprising polar desert and meltwater rivers, surrounded on three sides by glaciers and on the fourth by the polar sea. The site is logistically difficult to approach in summer, and no major threats are known.

Numbers and status

Discovered only in 1985, and confirmed to support breeding birds from the East Atlantic population in 1997, this breeding and moulting area appears to be used regularly by approximately 20% of the global population (Clausen *et al.* 1999, Clausen & Laubek 1999, Table 3). Nothing is known of the historical use of this site.

ii) Peary Land*Site conservation status*

Northeast Greenland National Park

Site description and habitat

Peary Land (82°28'N 20°50'W) is a large area with relatively few glaciers, and its topography, with many hills and mountains scattered around river valleys, gives a slightly warmer climate than most of north and northeast Greenland. Vegetation growth is rich in many valleys and supplies food for numerous mammals, e.g. lemmings. The site is logistically difficult to approach during summer, and no serious threats are known.

Numbers and status

Breeding Light-bellied Brent Geese were found in many parts of Peary Land during the first half of the 20th century, but they disappeared from the area somewhere around the 1950s (Meltofte 1976). The whole peninsula (and other parts of Northern Greenland) was surveyed by geologists throughout the 1980s, without any Light-bellied Brent Geese being found. The observation of a post-moulting flock of 75 birds at Mudderbugten in 1998 thus represents the first evidence of a possible re-establishment in the area. The darvic rings on two birds from the flock were read, but neither of these had been recorded at Kilen during the moulting period of the same summer.

3.3 Franz Josef Land

Light-bellied Brent Geese are known to breed and moult on this archipelago in small numbers, but the densities are probably so low, and the whole area so large and remote, that little is known about distribution and numbers. For the same reason, serious human threats are unlikely to be of importance.

4 FUTURE RESEARCH NEEDS

Given the paucity of survey and research work on breeding and moulting birds, projects should focus on basic research into the distribution and ecology of breeding, moulting and migrating birds. This should help to fill existing gaps in our knowledge, which are vital for the effective conservation of this goose population.

In the non-breeding/moulting areas, monitoring and research should build on the existing detailed knowledge, in particularly strengthening the co-ordinated efforts between countries on the conservation management of this population. This work should focus particularly on possible environmental perturbations that may adversely affect the conservation status of the population,

such as climate change, as well as direct conflict with human activities.

Continued monitoring, ringing and ecological studies at the winter and spring staging sites, will mean that changes in the population can be detected, and allow the development of individuals-based models and a population viability analysis. Efforts are underway to develop individuals-based models using existing data collected in Denmark and at Lindisfarne.

As the African-Eurasian Waterbird Agreement requires, national action plans should be prepared and co-ordinated across Member States to create a fully integrated flyway management plan.

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The authors have made every effort to include all known data in this review. Given, however, that a number of unpublished reports and databases may have been overlooked, we urge readers to submit new and additional data to the authors, especially where there are apparent gaps in our data sets.

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