

Light-bellied Brent Goose

Branta bernicla hrota

(East Canadian High Arctic population) in Canada, Ireland, Iceland, France,
Greenland, Scotland, Wales, England, the Channel Islands and Spain

1960/61 – 1999/2000

James A Robinson¹, Kendrew Colhoun², Gudmundur A Gudmundsson³, David Boertmann⁴,
Oscar J Merne⁵, Micháel O'Briain⁶, Alex A Portig⁷, Kerry Mackie⁸ & Hugh Boyd⁹

¹The Wildfowl & Wetlands Trust, Slimbridge, Glos GL2 7BT, UK

²BirdWatch Ireland, Ruttledge House, 8 Longford Place, Monkstown, Dublin, Ireland

³Icelandic Institute of Natural History, P.O. Box 5320, IS-125 Reykjavik, Iceland

⁴Dept. Arctic Environment, National Environmental Research Institute, Frederiksborgvej 399, P.O. Box
358, DK-4000 Roskilde, Denmark

⁵Dúchas, National Parks & Wildlife, 7 Ely Place, Dublin 2, Ireland

⁶DG ENV. B. 2, Nature and Biodiversity Unit, European Commission, Rue de la Loi 200, B-1049 Brussels,
Belgium

⁷Department of Biology & Biochemistry, Queen's University, Belfast BT7 1NN, UK

⁸The Wildfowl & Wetlands Trust, Castle Espie, Comber, Co. Down BT23 6EA, UK

⁹National Wildlife Centre, Canadian Wildlife Service, Environment Canada, Ottawa KIA 0H3, Canada



**JOINT
NATURE
CONSERVATION
COMMITTEE**

Waterbird Review Series

© The Wildfowl & Wetlands Trust/Joint Nature Conservation Committee

All rights reserved. Apart from any fair dealing for the purpose of private study, research, criticism or review (as permitted under the Copyright Designs and Patents Act 1988), no part of this publication may be reproduced, sorted in a retrieval system or transmitted in any form or by any means, electronic, electrical, chemical, optical, photocopying, recording or otherwise, without prior permission of the copyright holder.

ISBN 0 900806 49 4

This publication should be cited as:

Robinson, JA, K Colhoun, GA Gudmundsson, D Boertmann, OJ Merne, M O'Briain, AA Portig, K Mackie & H Boyd. 2004. *Light-bellied Brent Goose* *Branta bernicla hrota (East Canadian High Arctic population) in Canada, Ireland, Iceland, France, Greenland, Scotland, Wales, England, the Channel Islands and Spain 1960/61 – 1999/2000*. Waterbird Review Series, The Wildfowl & Wetlands Trust/Joint Nature Conservation Committee, Slimbridge.

Published by:

The Wildfowl & Wetlands Trust
Slimbridge
Gloucestershire
GL2 7BT

Joint Nature Conservation Committee
Monkstone House
City Road
Peterborough
PE1 1JY

T: 01453 891900
F: 01453 890827
E: research@wwt.org.uk

T: 01733 562626
F: 01733 555948
E: communications@jncc.gov.uk

Design and typeset by Paul Marshall
Cover design by Pyneapple

Printed by Crowes Complete Print, 50 Hurricane Way, Airport Industrial Estate, Norwich, Norfolk NR6 6JB

Front cover: Light-bellied Brent Goose (Bull Island, Dublin, Ireland) by Tom Ennis/Windrush Photos
Back cover: Strangford Lough (Northern Ireland) by David Tipling/Windrush Photos

CONTENTS

Summary	v
1 The East Canadian High Arctic Light-bellied Brent Goose	1
1.1 Introduction	1
1.2 Background	1
1.3 Monitoring and population assessment	2
1.3.1 Counts	2
1.3.2 Productivity	3
1.3.3 Ringing	3
1.3.4 Population assessment	3
1.4 Annual cycle	4
1.4.1 Breeding season	4
1.4.2 Autumn migration	7
1.4.3 Winter distribution	7
1.4.4 Spring migration	8
1.5 Conservation and management	9
1.5.1 Legislation and other conservation measures	9
1.5.2 Hunting	11
1.5.3 Agricultural conflict	11
2 Survey of areas used during the non-breeding season	13
2.1 Ireland	15
2.1.1 Londonderry	15
2.1.2 Antrim and Down	15
2.1.3 Louth	21
2.1.4 Dublin	21
2.1.5 Wicklow	26
2.1.6 Wexford	26
2.1.7 Waterford	29
2.1.8 Cork	29
2.1.9 Kerry	30
2.1.10 The Shannon Estuary (Cos. Kerry, Clare and Limerick)	31
2.1.11 Clare	31
2.1.12 Galway	33
2.1.13 Mayo	33
2.1.14 Sligo, Leitrim and Donegal	33
2.2 Iceland	36
2.2.1 Internationally important sites	36
2.3 Greenland	39
2.4 France	40
2.4.1 Internationally important sites	40
2.5 Scotland	40

2.6	Wales	41
2.7	England	41
2.8	The Channel Islands	41
2.9	Spain	41
3	Future research needs	42
4	Acknowledgements	44
5	References	45

SUMMARY

This review aims to assess changes in the abundance and distribution of the East Canadian High Arctic population of the Light-bellied Brent Goose *Branta bernicla brota* throughout its range since 1960/61, focusing primarily on its winter range in Ireland, to collate available historical information prior to that winter, to review published data on the ecology of this goose population, and to describe numbers, trends and site use at the key resorts.

The population of Light-bellied Brent Goose that winters in Ireland breeds in the east Canadian High Arctic. It undertakes one of the longest migrations of any Western Palearctic goose population, crossing the Greenland ice-cap, staging at sites in Greenland and Iceland before crossing the North Atlantic to winter in Ireland.

The Light-bellied Brent Goose is the most numerous goose species in Ireland. In the 1950s, the population was estimated to comprise around 6,000 individuals. The first complete census undertaken in Ireland in 1960/61 estimated the population at about 11,900 birds, suggesting that there had been a rapid increase in numbers during the 1950s. The population fluctuated between 7,300 and 16,000 individuals through the 1960s, remaining relatively stable (11,000-17,000) through the 1970s. There was a marked increase to over 24,500 in autumn 1985, but then, seemingly, a fall in the early 1990s to around 8,300. Numbers increased through the mid to late 1990s peaking at over 19,000 in winter 1999/2000. However, given large variation in the coverage and accuracy of individual censuses, it is unclear whether many of these trends are an accurate representation of population dynamics.

Strangford Lough in Northern Ireland hosts over 75% of the population during the late autumn and is now by far the most important site for the geese. Lough Foyle, on the north coast, has become increasingly important in recent years as a landfall site. As winter progresses, birds disperse around the coast of Ireland, favouring sites in the northwest, east, southeast, southwest and west of the country with notably high numbers at Dublin Bay and Wexford Harbour and Slobs. Over 3,000 Light-bellied Brent Geese also disperse thinly along the rocky coastlines of Ireland in late winter. Much smaller wintering flocks also occur in northern France, the Channel Islands and occasionally along the west coast of Britain.

It has been suggested that, before a wasting disease caused almost the entire depletion of *Zostera* in Ireland during the 1930s, Light-bellied Brent Geese may have relied almost entirely on this plant during the winter. Since then, the birds' diet in estuarine and saltmarsh areas has become more cosmopolitan, including algal foods such as *Enteromorpha* and *Ulva*, and saltmarsh plants such as *Festuca* and *Puccinella*.

Inland feeding was first recorded in Ireland and Iceland during the mid 1970s. Feeding on grasslands has increased steadily since then, especially at sites in the east and southeast of Ireland, with 25% of the population spending a large proportion of its time foraging on managed grasslands. In a few areas, most notably Wexford Slobs, Dungarvan Harbour and Strangford Lough, Light-bellied Brent Geese have been observed feeding on cereal crops, waste in autumn stubbles, spring seed, and waste potatoes. However, although large areas of these food types remain into the early spring, most birds return to the saltmarshes to exploit fresh growth of more natural foods prior to spring migration.

Counts undertaken for the Wetland Bird Survey and Irish Wetland Bird Survey indicate that 25 sites in Ireland are internationally important for the Light-bellied Brent Goose, regularly supporting at least 200 individuals. Numerically, by far the most important sites are Strangford Lough, Lough Foyle, Dublin Bay and Wexford Harbour and Slobs. Although data are more sparse, a number of important staging areas in Iceland and Greenland have also been identified. Information on numbers, trends and site use at these key resorts, in Ireland and in other range states, is given in this review.

Future research is required to inform the production of an International Flyway Management Plan (FMP) for this population of Light-bellied Brent Geese. Integral to the development of the FMP will be the construction of an individuals-based population model which should help to predict the likely effects and impacts of novel threats to this goose population, e.g. from the effects of global climate change. Accurate delimitation of the flyway, using satellite technology, and identification of key staging sites for protection are also key research requirements to underpin conservation action.

1 THE EAST CANADIAN HIGH ARCTIC LIGHT-BELLIED BRENT GOOSE

1.1 Introduction

The first published estimate of the size of the East Canadian High Arctic Light-bellied Brent Goose *Branta bernicla brota* population was made by Kennedy *et al.* (1954) in their book *Birds of Ireland*. Since that time, a large amount of information regarding the abundance, movements, behavioural ecology and demography of this population of Light-bellied Brent Geese has been collected by amateur and professional enthusiasts throughout the flyway. However, this population remains one of the least studied of all the goose populations that spend the winter in the Western Palearctic and there are many gaps in our knowledge. Much of the available information on this population has been published piecemeal or is hidden in the form of internal reports or unpublished databases. In an attempt to collate all this information, this report aims to assess changes in the abundance and distribution of the East Canadian High Arctic Light-bellied Brent Goose since the 1950s, and to review our knowledge of the ecology of this goose.

This report is split into two main sections and follows the format of recent monitoring reviews produced, or in preparation, for geese and swans (e.g. Fox *et al.* 1994a). The first section provides a review of our current knowledge of the ecology of this population of Light-bellied Brent Geese, providing a backdrop against which the monitoring information can be interpreted. In addition, gaps in our knowledge are highlighted, as are the conservation threats that face these geese. Much of the information used in this section draws from the account by Merne *et al.* (1999) in *Goose Populations of the Western Palearctic*. Additional information is presented here, bringing our knowledge of this population up to date.

The second section presents monitoring data on a regional scale from winter 1960/61 to 1999/2000. Spatial and temporal changes in abundance, productivity and distribution are examined. Annual maxima are illustrated for internationally important sites, i.e. those that regularly support more than 1% of the population.

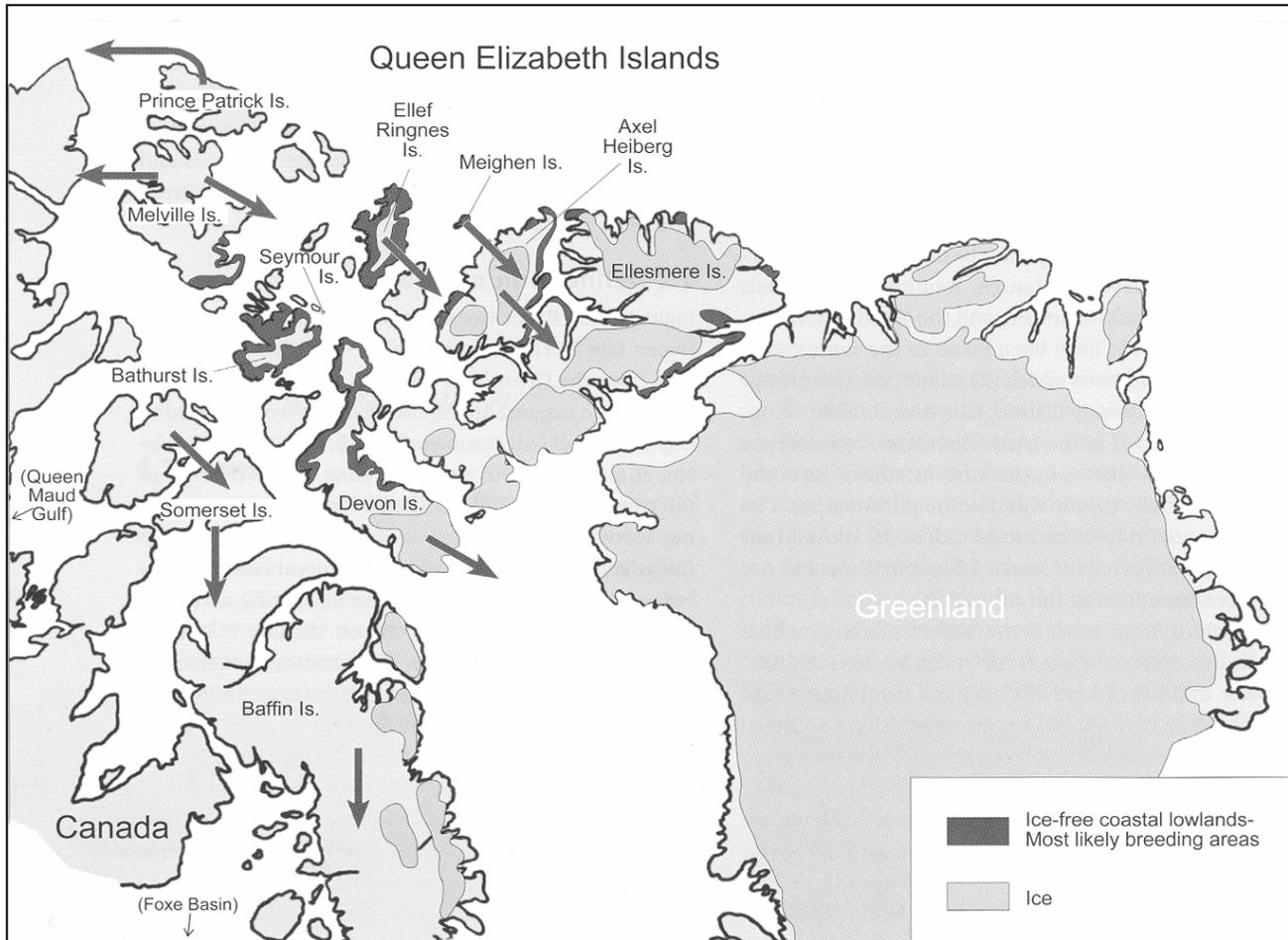
1.2 Background

There are four recognised biogeographical populations of *Branta bernicla brota*. One of these populations breeds in Svalbard and northeastern Greenland and winters around the North Sea (Scott & Rose 1996, Clausen *et al.* 1998). That population comprises approximately 5,000 individuals (Wetlands International 2002).

The remaining three populations breed in the Canadian Arctic, between 75° and 82° N (Fig. 1). One of these populations is known as the ‘Grey-bellied Parry Island’ or ‘Western High Arctic Brent Goose’ and breeds on Melville Island, Prince Patrick Island and several smaller islands nearby (Boyd & Maltby 1979). These birds winter on the Pacific coasts of the USA, primarily in Padilla Bay, Washington State, although a few travel further south to western Mexico. There are 7,500 individuals in this population (Wetlands International 2002).

Another population, known as the ‘Atlantic Brant’ breeds in eastern Canada, from Queen Maud Gulf east to Baffin Island and from Southampton Island to Somerset Island. These birds winter on the Atlantic coast of the USA, from Massachusetts south to the Carolinas, staging in James Bay. This population comprises 181,600 individuals (Wetlands International 2002).

The third population, and the subject of this review, is known as the ‘East Canadian High Arctic Light-bellied Brent Goose’, contains around 20,000 birds, and breeds in the eastern Queen Elizabeth Islands from eastern Melville Island to Devon Island and northern Ellesmere Island (Wetlands International 2002). Ringing recoveries indicate that an unknown proportion of the population moult to the west of the known breeding range, on Prince Patrick Island (Sean Boyd pers. comm.). In the early 1900s, Light-bellied Brent Geese also bred in northwest Greenland (Salomonsen 1950), a tradition which has since ceased, but it is unclear whether these birds came from the East Canadian High Arctic or the Svalbard/northeastern Greenland population. Almost all the geese from the East Canadian population winter in Ireland, with much smaller numbers reaching the Channel Islands, the west coast of Britain and the north coasts of France and

Figure 1. Distribution of the North American breeding populations of *Branta bernicla hrota* (from Merne *et al.* 1999)

Spain. Staging is known to occur in Greenland, Iceland and in the Hebrides, yet little is known about the staging areas along vast areas of the flyway, especially in Greenland and Canada.

Although Atlantic Brant are indistinguishable from the East Canadian High Arctic birds in the field, the two populations are geographically discrete and separated for conservation purposes. Shields (1990) showed by genetic analysis that the Western High Arctic (Grey-bellied) Brent Goose is genetically distinct from the East Canadian High Arctic Light-bellied Brent Goose and the Black Brant *Branta bernicla nigricans*, probably constituting the oldest of these three Brent Goose populations. Research into the genetic structure of the global Brent Goose species 'ring' is on-going and should provide further insights into the delimitation of these populations.

For the purposes of this report, the 'East Canadian High Arctic Light-bellied Brent Goose' shall be referred to as 'Light-bellied Brent Goose'.

1.3 Monitoring and population assessment

1.3.1 Counts

International monitoring

Annual all-Ireland censuses were initiated by Major Robert F. Rutledge in 1960/61 and were continued by the Irish Wildfowl Committee/Irish Wildbird Conservancy (Cabot 1965, 1966, 1967, 1968, 1973, 1974, 1975) and then the Forest & Wildlife Service (predecessors of the current National Parks and Wildlife Service). Michael O'Briain established the Irish Brent Goose Study in 1983 and organised the national censuses up to the early 1990s.

Since 1996, all-Ireland censuses of this population have been organised by the Irish Brent Goose Research Group (IBGRG) through The Wildfowl & Wetlands Trust (WWT) and the Irish Wetland Bird Survey (I-WeBS). In its current form, the census takes place in October and January and involves co-ordinated counts at all, or nearly all, important Light

-bellied Brent Goose sites throughout Ireland. Although not truly international, the all-Ireland census covers the majority of the population and there are plans to include counts from northern France and the Channel Islands in the future.

National monitoring

Before the 1960s, waterbird counting in Ireland was sporadic and the results were largely unpublished (Colhoun 2001). Annual site-based monitoring throughout Ireland has been on-going since the late 1960s and is now undertaken primarily through the UK Wetland Bird Survey (WeBS) and I-WeBS. Co-ordinated wildfowl counts were initiated by the International Waterfowl Research Bureau in 1967. The first comprehensive national waterbird counts took place in the winters between 1971 and 1974 and the results were published in *Ireland's Wetlands and their birds* (Hutchinson 1979). Over a decade later, a repeat survey, the Winter Wetlands Survey was undertaken, covering the period 1984/85-1986/87. The results were published in *Ireland's Wetland Wealth* (Sheppard 1993).

The inclusion of wetland sites in Northern Ireland within WeBS began in 1986 (Salmon *et al.* 1987). Given the lack of similar co-ordinated monitoring in the Republic of Ireland, I-WeBS was initiated in winter 1994/95. WeBS and I-WeBS counts are made by volunteer, and some professional, ornithologists at a variety of wetland habitats generally on the middle Sunday of each month, and primarily between September and March (Cranswick *et al.* 1997, Colhoun 2001). 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 (see Gilbert *et al.* 1998). Counters are encouraged to make their count during the morning, primarily to ensure co-ordination. Low tide counts are also organised under WeBS.

1.3.2 Productivity

Productivity is measured during the all-Ireland census in the autumn and more opportunistically during the winter. The proportion of first winter birds and brood sizes are measured at key resorts, especially at Strangford Lough, although sample sizes and timing of assessment can vary markedly between years.

1.3.3 Ringing

The Canadian Wildlife Service and University College, Dublin colour-marked many birds on

Bathurst Island between 1984-86 and these were studied intensively as they moved through Ireland (O'Briain & Healy 1991). Since then, no birds have been marked on the breeding grounds. However, two Light-bellied Brent Geese colour-marked on the moulting areas of the Western High Arctic 'Grey-bellied' Brent Goose at Walker Bay on Prince Patrick Island have since been recorded in Ireland.

A small number of birds were cannon-netted and marked at Strangford Lough in February 1989, and until recently were the only geese to have been marked on the wintering grounds. Regular catching and marking will now be undertaken throughout the flyway as part of an on-going programme of research co-ordinated by WWT; a total of almost 200 birds were colour-marked in Ireland in winters 2000/01 and 2002/03 and Iceland in spring 2001 and 2002. A co-ordinated re-sighting scheme is also being organised to help monitor movements and life histories of these birds and to improve our knowledge of population delimitation during the non-breeding season.

1.3.4 Population assessment

International censuses

No estimates of the numbers of Light-bellied Brent Geese in Ireland were made prior to the 1950s, although there is some evidence that the goose was 'abundant' up until the around 1850. Between 1850 and 1900, the population appeared to decline rapidly, possibly due to hunting pressure. In a telegram to Joe Cunningham, a ministerial advisor at the time, Peter Scott estimated that the population was at around 10,000 in 1934. The decline probably continued until the early 1950s (Kennedy *et al.* 1954). Disappearance of their favoured food, *Zostera*, at key sites in the 1930s, as a consequence of a 'wasting disease' (Rasmussen 1977), probably kept the population at this low level.

Kennedy *et al.* (1954) and Ruttledge & Hall Watt (1958), estimated the population to comprise *c.* 6,000 individuals during the middle of the 20th century. The first complete census undertaken in Ireland in winter 1960/61 estimated the population to comprise 11,900 birds suggesting that there was a rapid increase in numbers during the 1950s (Fig. 2). Counts made throughout the 1960s and 1970s indicated that the population fluctuated between around 7,300 and 13,000 individuals, although Lance Turtle suggested the population may have been as high as 30,000 during the early 1970s. He based this estimate on annual peak daytime counts of 10,000 birds at Strangford Lough, numbers of birds flying to the lough to roost after feeding in the pladdies

between the Sheilas and Gransha Point, and rough estimates of numbers elsewhere in Ireland at that time. Large differences between population estimates recorded up until the early 1970s may, in part, be explained by variable rates of productivity and first-year survival. However, it is perhaps more likely that incomplete coverage, lack of co-ordination between counts and the use of different count methods was responsible for variable estimates.

Changes in census technique during the 1970s, primarily by counting during the early winter when the majority of birds congregate at Strangford Lough in Northern Ireland, probably increased count accuracy somewhat. There is a positive relationship between peak counts at Strangford Lough and the national peak count since winter 1970/71 (Fig. 3; $R^2 = 0.25$, $F_{1,28} = 9.6$; $P < 0.01$). The population continued to fluctuate in size through the 1970s from around 8,400 to 16,100 (Fig. 2). Highly successful breeding seasons during the early 1980s (1983, 1984 and 1985 especially) and an increase in counter effort were probably jointly responsible for the counts of around 25,000 birds by winter 1985/86. However, this rate of increase was not sustained through the late 1980s and early 1990s as peak counts levelled at around 20,000 and then fell to just over 8,000 by 1994/95 (Fig. 2). Although productivity was low in the early 1990s, the decline in active counter co-ordination in Ireland may have been partly responsible for this apparent decline in population size. This would explain why a count of 16,000 birds in Iceland in May 1995 was much higher than the peak count of 8,519 in Ireland in the previous winter.

Since winter 1996/97, when the all-Ireland census started, productivity and counter effort has been high and the population estimate increased to a high of around 20,000 in 1999/2000 (Fig. 2). However, even with these methodological improvements, there is no relationship between annual productivity and the proportional increase in population size (Fig. 4; $R^2 = 0.5$, $F_{1,28} = 2.3$; $P > 0.05$). In light of this discrepancy, and given that variation in survival rates are unlikely to explain the large fluctuations in population size, improvements to census technique and productivity estimation should be investigated.

WeBS indices

Because WeBS sites are not necessarily covered annually, changes in Light-bellied Brent Goose numbers in Northern Ireland cannot be determined simply by comparing the total number of birds counted in each year. Consequently, indexing techniques have been developed which allow between-year comparisons of numbers, even if the true population size is unknown (see Musgrove *et al.* 2001 for further details). Given that most of the

population occur in Northern Ireland in late autumn, these indices are possibly more representative of annual changes in population size than annual census totals.

Productivity

Annual productivity has been estimated in Ireland in most years since 1960/61 (Fig. 2). Between 1960/61-1999/2000, the mean proportion of juvenile Light-bellied Brent Geese was 14% (range 0-47%). No long-term trend in productivity is evident. Mean brood size varies between 0 and 3.1 juveniles per pair.

1.4 Annual cycle

1.4.1 Breeding season

Range

All the Light-bellied Brent Geese that spend the winter in Ireland are thought to breed in eastern Arctic Canada (Boyd 1980). A few non-breeders also spend the summer in northern west Greenland and in western Iceland. The range of this population overlaps with that of the Grey-bellied Brent Goose on Melville Island. Light-bellied Brent Geese ringed on Melville Island, Bathurst, Axel Heiberg, Ellesmere and Seymour Islands during the 1970s and 1980s were subsequently recorded in Ireland. Some birds also nest on Ellef Ringnes and Devon Island (Boyd & Maltby 1979). (The Light-bellied Brent Geese which breed further south, mainly on Baffin, Southampton and islands in the Foxe Basin, winter in the eastern United States, i.e. part of the 'Atlantic Brant' population).

Within the breeding areas, Light-bellied Brent Geese are highly dispersed, most breeding and moulting at extremely low densities (O'Briain *et al.* 1998). For this reason, only a small proportion of the breeding range has been accurately delimited.

Light-bellied Brent Geese nested in the northern areas of Greenland during the early 1900s, yet numbers there declined markedly over the last century (Salomonsen 1950). It is unclear from which population these birds originated. However, breeding grounds in northeastern Greenland (Kilen and Kronprins Christian Land; Hjort *et al.* 1987, Hjort 1995) have now been shown to be occupied by birds from the Svalbard population of Light-bellied Brent Geese which winter around the North Sea (Clausen & Bustness 1998). Previously occupied areas in northwestern Greenland are now deserted (Meltote 1976, Meltote *et al.* 1981).

Figure 2. Annual population estimates (bars) and productivity (line) for East Canadian High Arctic Light-bellied Brent Geese, 1960/61-1999/2000

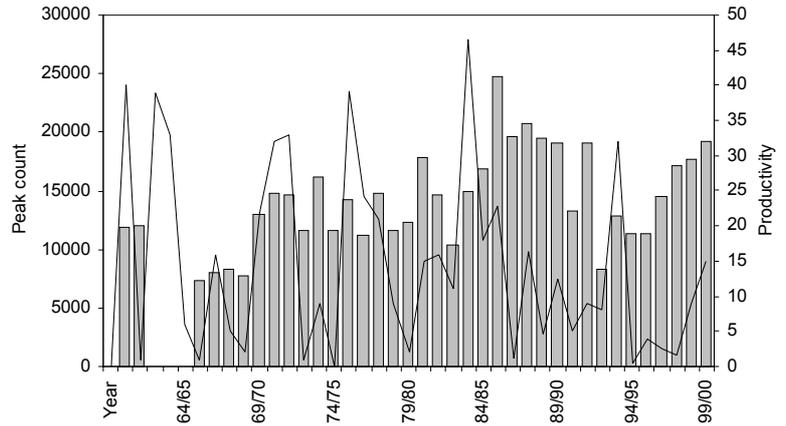


Figure 3. The relationship between peak counts of Light-bellied Brent Geese at Strangford Lough and the all-Ireland census total, 1970/71-1999/2000

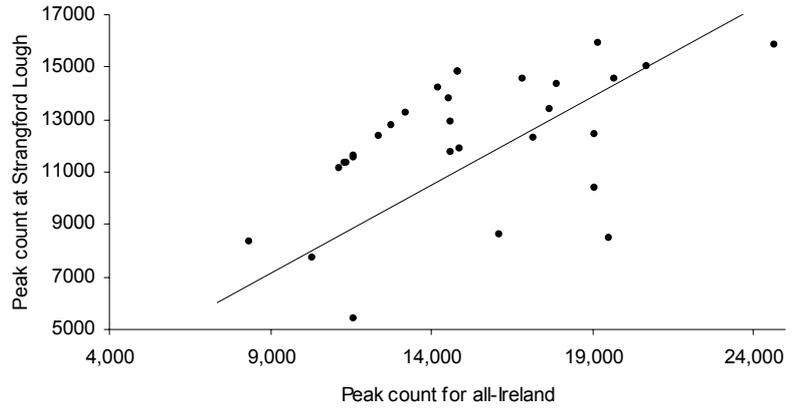
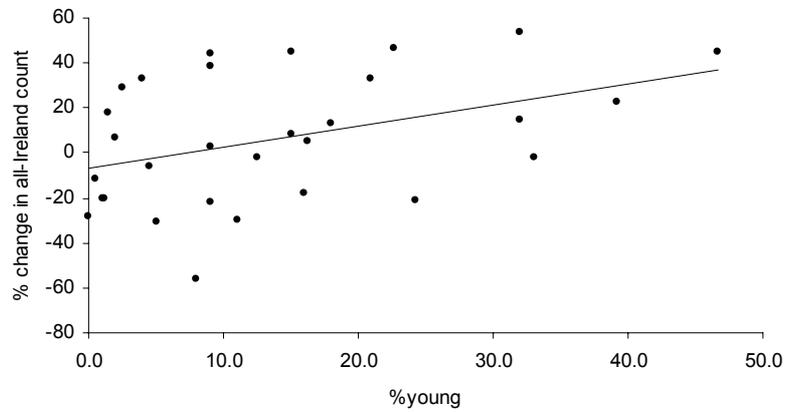


Figure 4. The relationship between annual changes in population estimate and productivity in the East Canadian High Arctic Light-bellied Brent Goose, 1960/61-1999/2000



Breeding ecology

The Canadian Museum of Nature, the Canadian Wildlife Service (CWS) and the Irish Brent Goose Study undertook studies of reproductive performance of Light-bellied Brent Geese on Bathurst and Seymour Islands between 1968 and 1989. In most years, Light-bellied Brent Geese arrived in Polar Bear Pass on Bathurst Island before dispersing to breeding sites on the same or adjacent islands. In three of the coldest summers (1974, 1986, and 1988), when mean temperatures for the period 1-20 June were below -3°C , Light-bellied Brent Geese did not attempt to nest. In other years they nested and produced young. In 1987, Arctic Foxes *Alopex lagopus* were extremely abundant on Bathurst Island and took large numbers of young, eventually causing complete breeding failure on that island during that year.

Annual precipitation is low throughout the Queen Elizabeth Islands and tends to be greatest during July-October. Delayed snowmelt in June often delays nesting attempts and makes it easier for predators to find nests. The major predators on the breeding grounds are Arctic Foxes, Polar Bears *Ursus maritimus*, gulls *Larus* spp., skuas *Stercorarius* spp., Snowy Owls *Nyctea scandiaca*, Gyrfalcons *Falco rusticolus*, Rough-legged Buzzards *Buteo lagopus* and Ravens *Corvus corax*.

Three discrete habitat types are used during the breeding season (O'Briain *et al.* 1998). Upon arrival at Polar Bear Pass on Bathurst Island, birds feed in wet sedge meadows and thermal oases which tend to melt earlier than other wetland habitats and are often the only feeding habitat available. Dispersal to nesting sites usually occurs during the second week of June. Most Light-bellied Brent Goose nests are isolated, and widely dispersed, usually associated with freshwater lakes or braided riverbeds, although small colonies occur on offshore islands. Nest-sites are on the ground and generally exposed, although often located next to boulders.

On Bathurst Island, brood rearing occurs on the shorelines of lakes, estuaries, and rivers. Rearing habitats are characterised by narrow mossy margins, occasional small patches of wet sedge in lowland meadows, upland areas with sparse cover dominated by forbs, and a few areas of estuarine saltmarsh. Broods feed on sparsely distributed graminoids and other fleshy plants and mosses. Those using estuarine habitats also have access to dense swards of arctic graminoids such as *Carex subspathacea* and *Puccinella phrygamodes* which are important components of the diets of goslings in more southerly locations. Unusual environmental conditions, such as snow-free winters, spring ice-

storms and cold summers, can alter the vegetation structure available to birds on the breeding grounds which restricts the distribution of high quality brood rearing areas in many years.

Boyd & Maltby (1979) assessed the amount of suitable breeding available to nesting Light-bellied Brent Geese and discovered that lakes, ponds and braided channels occupy only 1% of the area of Bathurst Island and wet meadows only 1.3%. These results suggest strongly that the availability of suitable habitat is extremely low and explains why the geese nest over such a wide area and at low densities. Because of the scarcity of snow on the island it is unlikely that any changes in climate would result in this habitat increasing substantially.

In the former breeding habitats used in northern Greenland, generally located on small offshore islands, Light-bellied Brent Geese fed primarily on *Ranunculus nivalis*, *R. sulphureus*, *Eriophorum scheuchzeri* and *Cerastium alpinum* (Salomonsen 1950). Today, non-breeding flocks containing up to 20 individuals remain in northern west Greenland using small islands or coastal lagoons.

Nearly all of the on-site information on the breeding success of this population comes from expeditions undertaken during 1968-1987 (O'Briain *et al.* 1998). The peak laying period occurs in mid June. Mean clutch size is 4.5 eggs per pair ($n = 24$). Mean incubation period is 23 days ($n = 7$). Hatching occurs during 11-14 July. On lakes, broods are raised singly or in loose groups of 2-3 families (accompanied by both parents), whereas on rivers and estuarine habitats groups of up to 15 families are observed. Goslings fledge generally in the second half of August and occasionally into early September. There is no information available on the nesting or fledging success. The only estimates of breeding success come from observations of flocks on the wintering grounds.

Although Lemmings *Dicrostonyx* spp. are numerous in the Queen Elizabeth Islands, there does not appear to be any cyclic relationship between them and the numbers of predators on the islands (Gray 1990), so that the intensity of predation on goose nests is unpredictable.

No large numbers of moulting birds have been found away from the breeding areas, although in harsh weather conditions movements of birds to alternative sites may occur. On Bathurst Island, non-breeding adults assemble during June in small flocks to moult around nearby lakes, river valleys and mouths of estuaries (O'Briain *et al.* 1998). The flightless period begins in early July and lasts around

20-22 days. These birds begin flying again in late July to early August (O'Briain *et al.* 1998). Ringing studies indicate that failed breeders moult in the vicinity of the breeding sites and that there may be some fidelity to nesting areas between years, although variations in the timing of snowmelt cause individuals to nest in different sites from year to year.

1.4.2 Autumn migration

Light-bellied Brent Geese leave their breeding areas by mid August and the first birds arrive in central and northern parts of Greenland in late August, non-breeding or failed breeders arriving first (Boertmann *et al.* 1997). Although the period of autumn staging is longer than spring staging in Greenland, most geese have left this area by mid September although some remain until October. Most observations and counts have been made between the Qaanaaq District in the north and Sisimiut District in the south. Some of these birds stage for several days. In west Greenland, the most important staging areas are located on the west coast of the Svartenhuk Peninsula, the north coast of the Nuussuaq Peninsula and the west coast of Disko Island. In east Greenland, staging Light-bellied Brent Geese have only been recorded near the town of Ammassalik and usually close to, or in, the town.

In central west Greenland, Light-bellied Brent Geese occur at almost any shallow coast, coastal lagoon or lake near the coast, and occasionally at inland lakes. However, the most preferred habitats are either small offshore islands or shallow coasts with lagoons or saltmarsh.

In autumn, most birds probably arrive in Greenland directly from Canada, but some may arrive via the Thule District and islands off northwest Greenland. The main flyway to the east coast of Greenland is probably across the inland ice from the Disko Bugt to the Tasiilaq area, but direct observations indicate that some may cross both north and south of this flyway. Observations and ring recoveries indicate that an unknown proportion of the population probably does not cross the ice-cap during the autumn, following instead the west coast of Greenland to the southern tip before leaving for Ireland. The first arrivals in Ireland and Iceland coincide in late August providing evidence that various routes are taken by these geese after departure from the breeding grounds. Given that small numbers of birds are recorded in Galicia in northern Spain in September and regularly at County Kerry in the Republic of Ireland in August, it is possible that some birds may be making a rapid Atlantic sea-crossing directly from Cape Farewell.

Numbers of birds passing through Greenland are relatively small suggesting that many birds are undetected, or migrate directly to Iceland without staging in northwest Greenland.

Large numbers of Light-bellied Brent Geese stage in western Iceland during the autumn with approximately 10,000 birds regularly using the area between Hjørsey and Straumfjörður (Gardarsson 1979). The first birds arrive in Iceland at the beginning of September and most of them have left by the end of October.

1.4.3 Winter distribution

Range

Small numbers of Light-bellied Brent Geese appear at sites in County Kerry and at Strangford Lough as early as late August (Hutchinson 1979). However, the main arrival occurs from late September to late October. Five sites are used extensively by Light-bellied Brent Geese at this time (O'Briain & Healy 1991). Strangford Lough in Northern Ireland supports at least 75% of the population during the late autumn (October-November). Lough Foyle, on the north coast, has become increasingly important as a landfall site in recent decades. Smaller numbers of birds use Sligo and Killala Bays in the west and Castlemaine Harbour in the southwest during the autumn. All of these sites are rich in *Zostera* spp. and continue to be important, to a lesser extent, as the winter progresses.

Later in the winter, other sites in Ireland become more important for Light-bellied Brent Geese. Other key sites in Northern Ireland are situated along the east coast and are estuarine or rocky coasts providing suitable feeding opportunities. East coast sites are also important in the Republic of Ireland with large numbers of birds using sites in and around the Dublin area. In the southeast, there are several important sites in Wexford and Waterford and further west there are large numbers at sites in Kerry, Clare, around the Shannon Estuary, Galway, Sligo and Donegal. Full accounts of the most important sites are detailed in the second part of this review. Over 3,000 Light-bellied Brent Geese disperse very thinly along the rocky coastlines of Ireland in the late winter and early spring (Colhoun & Newton 2000).

Until the late 1930s, small numbers of Light-bellied Brent Geese, presumably from the East Canadian High Arctic population, wintered on Islay and other Hebridean islands in Scotland (Berry 1939). In recent years, only passage birds have been recorded at these sites with any regularity, although flocks of several hundred birds are not unusual in the autumn.

Large numbers of Light-bellied Brent Geese spend the winter in the Channel Islands, along the northwest coast of France and in Galicia in northwest Spain (Debout & Leclerc 1990, Luis José Salaverri Leiras pers. comm.). Re-sightings of ringed birds indicate that these birds are probably from the East Canadian High Arctic population. Havre de Regenville, in western Normandy, regularly supports over 600 birds and currently qualifies as an internationally important site for this population (R. Mahéo pers. comm.). In all these areas, Light-bellied Brent Geese are outnumbered by Dark-bellied Brent Geese *B. b. bernicla*. Increasing numbers of birds also use suitable areas of mudflat along the west coast of Britain, especially on the estuaries of the Camel and Exe.

Re-sightings of colour-marked birds indicate that very small numbers of birds may move to North Sea coasts where they mix with other Brent Goose populations (e.g. Lambeck 1977). However, the level of mixing remains unquantified and deserves further attention.

Habitat and feeding ecology

Light-bellied Brent Geese rely almost entirely on intertidal areas with extensive swards of *Zostera* during early winter. O'Briain & Healy (1991) recorded over 90% of the population using this habitat. Both *Z. noltii* and *Z. angustifolia* are important food plants. The depletion of *Zostera* stocks by geese and Wigeon *Anas penelope* is the major cause of redistribution of these birds through the winter, both within and between sites (Brown 1988, O'Briain 1991, O'Briain & Healy 1991).

It has been suggested that before a 'wasting disease' caused almost the entire depletion of *Zostera* in Ireland during the 1930s, Light-bellied Brent Geese may have relied almost entirely on this food resource throughout the winter. Since then, the diet of these Light-bellied Brent Geese in estuarine and saltmarsh areas has included algal foods such as *Enteromorpha* and *Ulva*, and saltmarsh plants such as *Festuca* and *Puccinella* (O'Briain & Healy 1991, Portig *et al.* 1994, Mathers & Montgomery 1997, Mathers *et al.* 1998a). Inclusion of saltmarsh plants in the diet has meant that birds have food available throughout the tidal cycle in many areas. It has been suggested that depletion of favoured foods changes the relative amounts of different food types in the diet of birds (O'Briain & Healy 1991). The large numbers of Light-bellied Brent Geese that disperse along the rocky coastlines of Ireland probably feed on various species of algae.

Inland feeding was first recorded in Ireland during the mid 1970s. In 1976, high water levels at

Tacumshim Lake in County Wexford inundated traditional feeding areas for some 600 birds. This temporary loss of habitat forced birds to feed on fields adjacent to the lake. Inland feeding in grassland habitats has steadily increased since that initial record, especially in the east and southeast. It is now estimated that a quarter of the population spends a large proportion of its time foraging on managed grasslands. In Dublin, these areas are often used for recreation, i.e. playing fields, golf courses. Some birds also now feed on semi-natural/low intensity grasslands on the Skerries Islands, Lambay Island, Ireland's Eye and the Keeraghs (Co. Wexford) in mid to late winter.

In a few areas, most notably Wexford Slobs, Dungarvan Harbour and Strangford Lough, Light-bellied Brent Geese have been seen feeding on autumn stubbles, spring re-seeds, sprouting spring cereals and waste potatoes (Ruttledge 1985, Smiddy 1987). Although large areas of these food types remain into the early spring, most birds return to the saltmarshes, to exploit fresh growth of more natural foods, prior to spring migration.

In most areas, Light-bellied Brent Geese are distributed over intertidal areas and grassland adjacent to the coast. However, during the mid 1990s many birds began flying several kilometres inland from Dublin Bay over Dublin City to feed in recreational grasslands.

1.4.4 Spring migration

The first Light-bellied Brent Geese arrive in Iceland in early April, with a peak arrival during the first week of May. Very few birds are recorded in Ireland after the end of April. It is unlikely any Light-bellied Brent Geese fly directly from Ireland to Cape Farewell. Departures from Iceland occur in late May and turnover rates seem to be low. Probably the entire population stages along the west coast of Iceland (Gardarsson 1974, Gardarsson & Gudmundsson 1997).

The major spring concentrations of Light-bellied Brent Geese in Iceland occur in the intertidal areas in the bays and fjords of Faxaflói Bight between Reykjavik and Snaefellsnes, and in the southern fjords of the Breiðafjörður (Gardarsson & Gudmundsson 1997). Light-bellied Brent Geese feed predominantly on *Zostera marina*, *Puccinella* spp. and green algae at these sites and on adjacent agriculturally improved grasslands.

The Icelandic staging grounds are extremely important for re-fuelling purposes as the birds have

limited opportunities to feed elsewhere before their flight over the Greenland ice-cap, imposing high energetic demands (Alerstam *et al.* 1990, Gudmundsson *et al.* 1995).

Spring migration through west Greenland has been observed since the early part of the last century (Bertelsen 1921, Porsild 1922, Salomonsen 1950, 1967, Bennike 1990). The spring migration through Greenland is thought to be very rapid. The birds arrive in east Greenland (in the Tasiilaq District) from the Icelandic staging sites in late May, and may stage there before the trans-glacial flight to central west Greenland around Disko Bay. They arrive at Disko Bay in the first weeks of June, and almost all observations concern birds in flight. Very few staging birds have been observed in spring, and then only in periods of bad weather. Spring observations have been restricted to the south and west coasts of Disko Island.

1.5 Conservation and management

1.5.1 Legislation and other conservation measures

1.5.1.1 International

Conservation status

In BirdLife International's Species of European Conservation Concern, the Brent Goose is classified as a SPEC3 species which means that it has an unfavourable conservation status in Europe, but is not concentrated in Europe (Tucker & Heath 1994). The population is also listed under Category A (2) of the Africa-Eurasian Waterbird Agreement, prepared under the Bonn Convention on Migratory Species, because there are only between 10,000 and 25,000 individuals in the population. For this population of Brent Geese, the Action Plan of the Agreement requires Parties to prepare national action plans 'with a view to improving...overall conservation status'.

Habitat protection

The EC Directive on the conservation of wild birds requires Member States to classify Special Protection Areas (SPAs) for this migratory species. In the UK, the SPA suite comprises six sites where Light-bellied Brent Goose has been listed as a qualifying species, supporting on average 14,000 individuals between them and representing 70% of the all-Ireland population (Stroud *et al.* 2001). In the Republic of Ireland, all internationally and nationally important sites for Light-bellied Brent Geese have been

designated as SPAs and the species receives additional protection at those sites which qualify on the basis that they regularly support more than 20,000 waterbirds.

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'.

The North Bull Island, an important area for Light-bellied Brent Geese in Dublin Bay, has been designated a Biosphere Reserve under the UNESCO Man and Biosphere (MAB) Programme.

Species protection

General provisions of the EC Birds Directive apply within the European Union. The species is listed in Annex II of the Directive which restricts areas in which hunting may occur under national legislation. As a migratory species, the general provisions of the Bern Convention also offer protection.

Other measures

The AEWAs urges co-operation between Parties on the conservation management for populations listed in Category A.

In 1989, the Canadian Wildlife Service (CWS) signed a Memorandum of Understanding with the Irish National Parks & Wildlife Service twinning Polar Bear Pass National Wildlife Area (NWA) with three nature reserves in County Dublin (North Bull Island, Rogerstown Estuary and Baldoyle Estuary) as 'Sister Reserves'. In the same year, CWS and the Northern Ireland Department of the Environment and the Northern Ireland National Trust signed a Statement of Intent linking Polar Bear Pass NWA with areas in Strangford Lough protected by the Strangford Lough Wildlife Scheme. These agreements were implemented for a five-year period in the first instance; unfortunately, neither has been formally reviewed since.

1.5.1.2 Individual countries

1.5.1.2.1 Canada

Habitat protection

Polar Bear Pass, in the centre of Bathurst Island (76° N, 100° W) is an important breeding and moulting area, where much of the ringing and breeding research has been carried out. In recognition of its importance, Polar Bear Pass was designated as a National Wildlife Area in 1982. This makes it

possible to regulate access and prevent mining and other habitat-damaging activities.

In 1996, the remainder of the island to the north of the Pass was identified as a National Park Reserve, which will include the existing Migratory Bird Sanctuary on Seymour Island, which was created in 1975 to protect one of the few lowland colonies of Ivory Gulls *Pagophila eburnea*. Light-bellied Brent Geese also breed on Seymour Island. The process of converting the Reserve into a National Park is lengthy, but will eventually be completed, as has happened in the Northern Ellesmere National Park, now operational. This Park affords protection, with controlled access, to an area around Lake Hazen, an important 'biological oasis' in the interior. Light-bellied Brent Geese do not nest near the lake, but the Park includes some areas where small numbers of Light-bellied Brent Geese breed. The majority of Light-bellied Brent Geese breeding and moulting on Ellesmere Island do so in the south.

The adjacent Axel Heiberg Island probably holds more Light-bellied Brent Geese than any other of the Queen Elizabeth Islands, the majority of Brent Geese on Melville Island forming part of the 'Grey-bellied' Western High Arctic population. The present breeding, brood-rearing and moulting areas of the Light-bellied Brent Geese are poorly known, most knowledge of their distribution dating from the 1960s and 1970s, when oil exploration in the archipelago led the federal government to undertake geological and ecological surveys to identify areas at special risk. There proved to be large reserves of gas under the Sverdrup Basin, and smaller amounts of oil. No exploitation of either seems likely in the near future, because of the expense and difficulty of operating offshore at high latitudes and of getting the products to market. The remoteness of this region provides the best protection for the very limited areas of lowland wet meadows that are used by geese and most other breeding birds in the area.

Species protection

This population is afforded protection under the Migratory Birds Convention Act 1917 which prohibits shooting between 10 March and 1 September. Although the Migratory Birds Convention signed in 1995 allows spring shooting by indigenous people, the effects on this population are thought to be small as there are only two Inuit settlements within the breeding range, neither close to high densities of birds. However, the impact of this hunting on population dynamics deserves further attention.

1.5.1.2.2 Greenland

Habitat protection

As mentioned previously, very little is known about the staging areas in Greenland (Boertmann *et al.* 1997). Nordfjord on Disko Island is offered some protection under a Ramsar site designation. The threat of incidental oil spillage in offshore habitats frequented by staging birds suggests identification and protection of important sites remains a priority.

Species protection

The species is fully protected in Greenland but is known to be shot illegally in some areas.

1.5.1.2.3 Iceland

Habitat protection

Grunnafjörður in Faxalói, an important staging site, has been protected under the Nature Conservation Act since 1994 and was designated as a Ramsar site in 1996. An act conferring protection on the Breiðafjörður was passed in 1995. There are also plans to protect the shoreline at Alftanes, just south of Reykjavik, which is an important staging area for Light-bellied Brent Geese.

Species protection

The Light-bellied Brent Goose is fully protected in Iceland. Prior to 1966, a hunting season between 20 August and 31 October was permitted.

1.5.1.2.4 Northern Ireland and Britain

Conservation status

The Brent Goose appears on the 'Amber' list of the 'Population Status of Birds in the UK, Channel Islands and the Isle of Man' because 20% or more of the Northwest European Brent Goose 'population' occurs in the UK during the non-breeding season, 50% or more of the UK non-breeding 'population' can be found at ten or fewer sites and because it has an unfavourable conservation status in Europe (SPEC 3) (Gregory *et al.* 2002).

This species also appears on the 'Amber' list of the 'Birds of Conservation Concern in Ireland' because more than 50% of the Irish non-breeding population can be found at ten or fewer sites and because it has an unfavourable conservation status in Europe (SPEC 3) (Newton *et al.* 1999).

Habitat protection

The key site designation for Light-bellied Brent Geese in Britain is Site of Special Scientific Interest (SSSI) and Area of Special Scientific Interest (ASSI) in Northern Ireland. Guidelines for the selection of

sites have been formally published 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 which 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 & Countryside Act 1981 and the Nature Conservation and Amenity Lands (Northern Ireland) Order 1985. Under these provisions operations likely to damage the nature conservation interest of SSSIs are subject to control.

Species protection

In Northern Ireland, Light-bellied Brent Geese have been protected since the 1930s. Full protection is currently afforded under the Wildlife (Northern Ireland) Order 1985. Hunting is also prohibited in Great Britain under the Wildlife & Countryside Act 1981.

Other measures

Outside of national legislative site-safeguard, the National Trust established the Strangford Lough Wildlife Scheme in 1966, which provides extra protection for Light-bellied Brent Geese at this particularly important site.

1.5.1.2.5 Republic of Ireland

Conservation status

This species appears on the 'Amber' list of the 'Birds of Conservation Concern in Ireland' because 50% or more of the Irish non-breeding population can be found at ten or fewer sites and because it has an unfavourable conservation status in Europe (Newton *et al.* 1999).

Habitat protection

Site protection is offered under the Wildlife Acts 1976 and 2000. Important sites are designated as Nature Reserves, Refuges for Fauna or Natural Heritage Areas.

Species protection

Hunting was legal in the country until the late 1950s. The goose is now fully protected under the Wildlife Acts 1976 and 2000.

1.5.1.2.6 France

Habitat protection

The only internationally important site in France, Baie des Veys et Marias du Contentin, is designated as a Nature Reserve and Regional National Park.

Species protection

Although there is pressure to resume shooting of Dark-bellied Brent Geese, the French hunting organisations acknowledge that areas used by Light-bellied Brent Geese should remain protected, with no shooting allowed (Veiga 1999).

1.5.2 Hunting

Although the Light-bellied Brent Goose is fully protected in Greenland, some illegal hunting occurs (Boertmann *et al.* 1997). For example, in September 2000, 12 birds were shot at Godhavn on Disko Island and in August 2001 a flock of 55 birds was shot at the settlement Qaarsut in Umannaq Municipality.

Illegal and accidental hunting probably occurs on a small scale elsewhere in the range. For example, in the Republic of Ireland, there are known cases of farmers shooting birds to protect crops. Indigenous hunters in the Canadian Arctic also take an unknown number of birds legally.

1.5.3 Agricultural conflict

As mentioned above, Light-bellied Brent Geese have taken to feeding on agricultural land over recent decades. During 1992/93-1995/96, Andrews *et al.* (1996) found that 89% of the fields used by Light-bellied Brent Geese around Strangford Lough were managed as improved grassland, although birds did use re-seeded grasslands and winter cereals. The use of cereals by Dark-bellied Brent Geese in eastern England has caused some concern, with crop yields falling almost 10% in fields which have been heavily grazed (Owen 1976, Summers 1990, Vickery & Sutherland 1992).

The extent of damage, if any, is minor at present. It seems unlikely that the utilization of farmed crops in Ireland will increase substantially in the future, though potential reductions in the extent of intertidal area through sea-level rise may result in birds switching from estuarine habitats to agricultural areas (e.g. Percival *et al.* 1996).

Some Icelandic farmers complain about Light-bellied Brent Geese grazing on their land and use scaring

devices, but very few farmers are involved and the damage is small, except in years when the growth of

grass is delayed by late snow melt and geese compete for food with sheep during the lambing period.

2 SURVEY OF AREAS USED DURING THE NON-BREEDING SEASON

The following accounts provide a detailed review of the abundance, distribution and phenology of East Canadian High Arctic Light-bellied Brent Geese during the non-breeding season, based on data collected through international and national monitoring schemes. Some counts were obtained from county bird reports or submitted by regional experts. For Irish sites, geographically discrete regions of importance for wintering Light-bellied Brent Geese are considered separately and each is split into four sections. Given the paucity of long-term data, more limited information is presented for other countries.

Background

This section provides brief information on the distribution of Light-bellied Brent Geese in the region and the types of habitats that are used.

Historical status

Based primarily on data collected since 1960/61, this section provides an overview of trends in numbers at a site-based and regional level. However, where data or published information are available, the status prior to 1960/61 is also reviewed. This section highlights those sites which were once important for Light-bellied Brent Geese but where numbers have fallen over the review period.

Internationally/nationally important sites

Detailed accounts of important sites are presented. Wetland sites are considered internationally important if they regularly support 1% of the individuals in the East Canadian High Arctic population following the criteria agreed by the Contracting Parties to the Ramsar Convention on Wetlands of International Importance. A wetland in Britain is considered nationally important if it regularly holds 1% or more of the estimated British population and in the island of Ireland if it holds 1% or more of the estimated all-Ireland population. Provisional assessments of importance are made on the basis of a minimum of three years data, following the Ramsar Convention. Assessments of site importance in Iceland and Greenland are provided by regional experts using available data.

Currently, the threshold for international and all-Ireland importance is 200 birds (Wetlands International 2002). Five-year mean maxima for each internationally and nationally important site in Ireland are shown in Table 1. The locations of each of these sites are illustrated in Fig. 5.

Table 1. Sites of international and national importance for Light-bellied Brent Geese in Ireland (arranged in descending order of importance)

Site name	5-year mean (1995/96-1999/2000)
1. Strangford Lough	13,349
2. Lough Foyle	3,765
3. Dublin Bay	2,407
4. Wexford Harbour & Slobs	1,469
5. Tralee Bay and Barrow Harbour	1,412
6. Broadmeadow (Malahide) Estuary	1,104
7. Rogerstown Estuary	1,069
8. North Wicklow Coastal Marshes	859
9. Baldoyle Bay	726
10. Dungarvan Harbour	723
11. Castlemaine Harbour & Rossbehy Creek	694
12. Inner Galway Bay	676
13. Seagrang Park	626
14. Bannow Bay	561
15. Shannon & Fergus Estuary	494
16. Sligo Bay Complex	405
17. Tramore Back Strand & Bay	398
18. Dundalk Bay	370
19. Trawbreaga Bay	362
20. Carlingford Lough	350
21. Killough Harbour	311
22. The Cull & Killag	290
23. Skerries Islands	242
24. Larne Lough	218
25. Outer Ards	202

Site accounts contain detailed information on current status and trends, site protection measures, habitats present, and site use. Co-ordinates and national grid references are given for internationally important sites. For definitions of site safeguards and selection criteria/guidelines mentioned in the text, see www.ehsni.gov.uk for Areas of Special Scientific Interest and National Nature Reserves in Northern Ireland, www.heritageireland.ie for site protection measures in the Republic of Ireland, Stroud *et al.* (2001) and Dúchas (2002) for Special Protection Areas (SPAs) in Northern Ireland and the Republic of Ireland, 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 an asterisk. 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

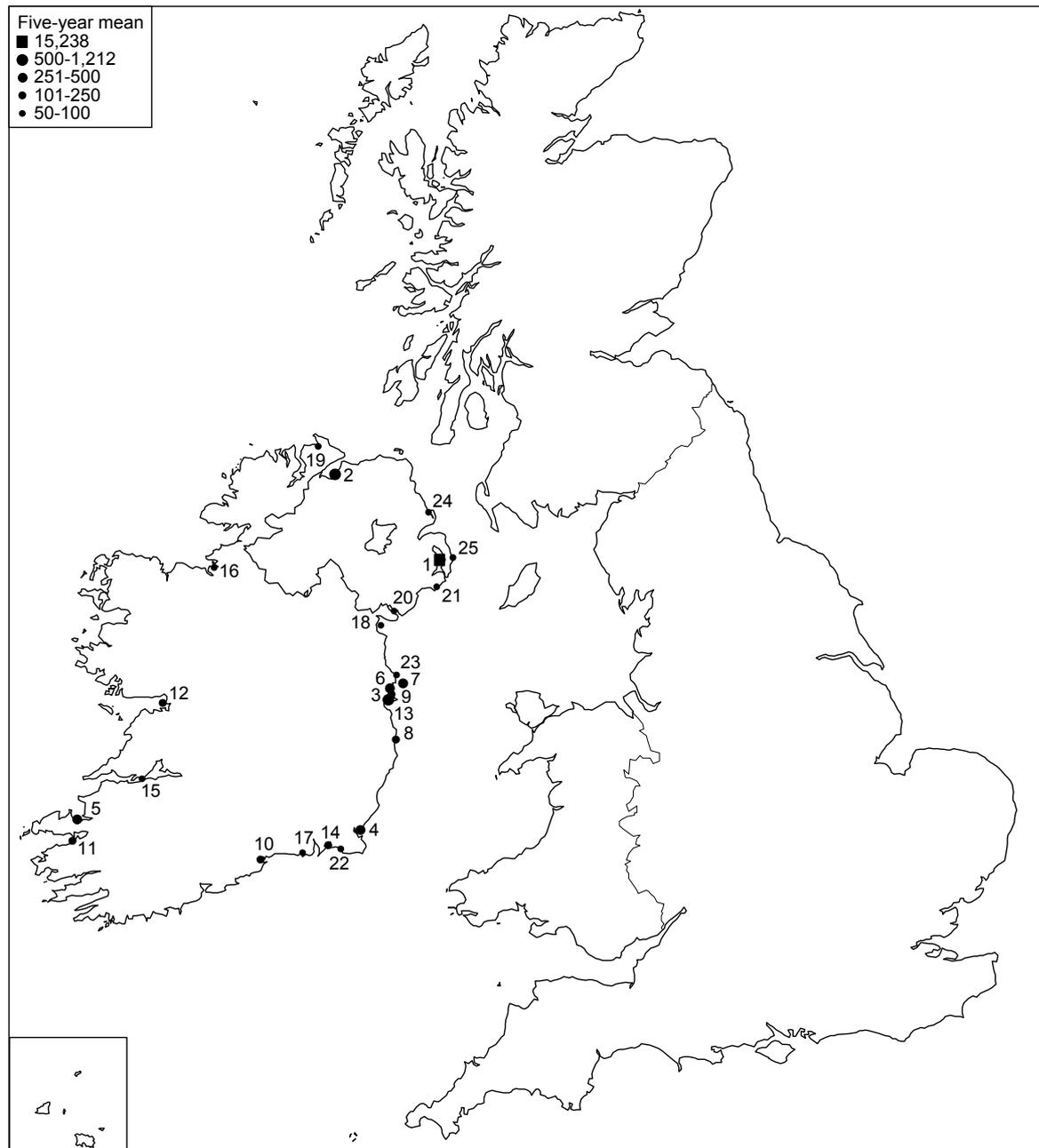
This section lists those sites which regularly support flocks of 20 or more Light-bellied Brent Geese during peak times in the winter and/or which have a long history of occupancy but which do not support nationally or internationally

important numbers according to WeBS or I-WeBS data. National grid references are provided for each of these sites.

Key references

This section provides a comprehensive list of relevant literature and published monitoring data on Light-bellied Brent Geese in each region. These are cited in full in Section 5 of this review.

Figure 5. Internationally important sites for Light-bellied Brent Geese in Ireland (see Table 1 for key to sites)



2.1 Ireland

2.1.1 Londonderry

2.1.1.1 Background

There are very few coastal wetlands in Londonderry, the most important site for Light-bellied Brent Geese being the cross-border site at Lough Foyle. Birds generally favour the Northern Ireland side of this large sea lough because of the extensive intertidal mudflats on the southern and eastern shores which support extensive beds of *Zostera*. Lough Foyle is a key landfall site for birds in the autumn (see below).

2.1.1.2 Historical status

Lough Foyle was identified as a key site for the species in the 19th century (Ussher & Warren 1900). Kennedy *et al.* (1954) indicated that Lough Foyle supported large numbers of Light-bellied Brent Geese during the late 1930s, although actual numbers remain unknown. From the mid 1940s to the mid 1950s, around 100 birds were recorded regularly at the site. Through the late 1950s and early 1960s the site supported around 850 birds during the late autumn (Ruttledge 1966). Up to 500 birds were recorded regularly in the early 1970s (Hutchinson 1979), increasing to around 1,500 birds by the mid 1980s (Sheppard 1993), mirroring the probable increase in total population size at that time.

2.1.1.3 Internationally important sites

i) Lough Foyle

Five-year mean 95/96-99/2000: 3,756

Site conservation status

SPA (NI/RoI) (selection stage 1.2 in Northern Ireland)

Ramsar (Lough Foyle: criterion 6)

ASSI

IBA (Lough Foyle and River Foyle: criteria A4i, B1i, B2, C2, C6)

Site description and habitat

Lough Foyle (C6025; 55° 06'N 7° 07'W) is a large shallow estuary comprising extensive mudflats on its southern side, shell ridges, mussel-beds, and limited areas of saltmarsh. Behind the intertidal zone there are extensive areas of alluvial land claimed from the sea in the nineteenth century.

Numbers and trends

During the 1950s, around 100 birds were recorded regularly at Lough Foyle (Ruttledge 1966). Numbers have increased markedly since the early 1980s, peaking in the autumns of 1990 and 1995, when over 5,000 birds were recorded, and lowest in 1992 and 1993 (Fig. 6). This trend followed the Northern Ireland WeBS indices closely until after the mid 1990s when, although the population continued to increase, numbers at Lough Foyle began to decrease. Peak counts have declined since the 1995 peak. The site is an important landfall site for birds in the autumn with smaller flocks remaining through the winter (Fig. 7).

2.1.1.4 Other sites

Away from Lough Foyle, Light-bellied Brent Geese are uncommon in Londonderry with fewer than ten birds recorded regularly on the narrow Bann Estuary (C7935).

2.1.2 Antrim and Down

2.1.2.1 Background

The coastlines of Antrim and Down are dominated by drumlins and the major estuarine systems of Strangford Lough and Belfast Lough. Strangford Lough is the most important landfall site for Light-bellied Brent Geese in Ireland, supporting over 75% of the population in late October/early November (see below). Numbers fall through November and December as birds disperse around the coastline of Ireland and perhaps move to the Channel Islands and the Normandy coast.

2.1.2.2 Historical status

Strangford Lough, Carlingford Lough, Larne Lough and Belfast Lough were identified as key sites in the 19th century (Ussher & Warren 1900). Around 5,000 Light-bellied Brent Geese were recorded at Strangford Lough in 1937, yet numbers fell well below 500 between then and 1950 (Kennedy *et al.* 1954). During the 1950s, small flocks were also recorded at Carlingford Lough. Numbers built up at Strangford Lough through the 1950s and early 1960s when around 3,650 birds were recorded regularly in the autumn (Ruttledge & Hall Watt 1958, Ruttledge 1966). Up to 100 birds were also recorded at Carlingford Lough and Larne Lough during this period. In the early 1970s, Strangford Lough became even more important, supporting 10,000 birds, some 60-70% of the population, in the autumn (Hutchinson 1979). Counts of around 100 birds were

recorded regularly at Larne Lough and Carlingford Lough at this time. Into the early 1980s, counts at Strangford Lough exceeded 14,600, with around 380 and 230 birds at Carlingford Lough and Killough Harbour, respectively (Sheppard 1993). The increase in the region over the early 1980s can be explained by the increase in total population size during the same period.

2.1.2.3 Internationally important sites

i) Strangford Lough

Five-year mean 95/96-99/2000: 13,349

Site conservation status

SPA (Strangford Lough: selection stage 1.2)

Ramsar (Strangford Lough: criterion 6)

ASSI

IBA (Strangford Lough and Islands: criteria A4i, B1i, C3)

Strangford Lough Wildlife Scheme (National Trust)

Site description and habitat

Strangford Lough (J5560; 54° 27'N 5° 35'W) is located on the east coast of County Down. It is a shallow sea lough with an indented shoreline and a wide variety of marine and intertidal habitats. The lough, although almost completely land-locked, contains extensive areas of mudflat, saltmarsh and rocky coastline with many islands resulting from flooded drumlins. The site is notable as the most important autumn arrival site for Light-bellied Brent Geese in Ireland. It has been estimated that up to 75% of the population occur at the site through late October and early November (O'Briain & Healy 1991).

The majority of birds forage on mudflats at the north end of the lough during the autumn, in areas where there is high food availability (Mathers *et al.* 1998b). At this time they feed primarily on *Zostera*, moving progressively onto areas with green algae and saltmarsh through the winter. During mid winter and spring, birds also forage on improved pastures close to the shore (Mathers *et al.* 1998c). Birds have also been observed feeding on cereals in recent years.

Numbers and trends

The numbers of Light-bellied Brent Geese occurring at Strangford Lough have remained relatively stable since the early 1970s, with between 8,000-15,000 recorded in most years (Fig. 8). Peak counts were much lower prior to this period with numbers as low as 500 during the early 1950s, probably because there was little food to support large flocks of birds after the *Zostera* 'wasting disease' in the 1930s (Kennedy *et al.* 1954). Numbers peak in late October/early

November and then fall as birds disperse to other sites in Ireland (Fig. 9). Around 3,000 birds remain through the winter.

Large differences between counts made on consecutive days during the autumn indicate that turnover of birds may be high at this site. Therefore, the total proportion of the population passing through Strangford Lough remains unclear and requires further attention.

ii) Carlingford Lough

Five-year mean 95/96-99/2000: 350

Site conservation status

SPA (NI/RoI) (selection stage 1.2 in Northern Ireland)

Ramsar (Carlingford Lough: criterion 6)

ASSI

IBA (Carlingford Lough including Green Island: criteria B1i, C3)

Site description and habitat

Carlingford Lough (J2013; 54° 03'N 6° 08'W) is a long and narrow, fjord-like sea lough surrounded on both sides by mountains, straddling the border between Northern Ireland and the Republic of Ireland. The lough was formed by the scouring of a glacier during the Pleistocene. The northern shore includes significant expanses of intertidal mudflats and saltmarsh, especially towards the mouth of the lough. The SPA on the Republic of Ireland side, between Carlingford and Greenore, comprises extensive intertidal mudflats.

Numbers and trends

Between the late 1950s and early 1970s, Carlingford Lough regularly supported around 100 Light-bellied Brent Geese, although counts were irregular (Fig. 10; Ruttledge & Hall Watt 1958, Hutchinson 1979). Numbers increased through the early 1980s following an increase in the total number of birds recorded in Ireland. However, since the mid 1980s, numbers have declined to around 200 with unusually large counts of 500-600 birds recorded in 1993/94 and 1998/99. Peak counts are generally recorded in early spring (Fig. 11).

Figure 6. Light-bellied Brent Geese at Lough Foyle, 1960/61-1999/2000: peak counts (bars) and Northern Ireland index (line) (asterisks denote years with no known data)

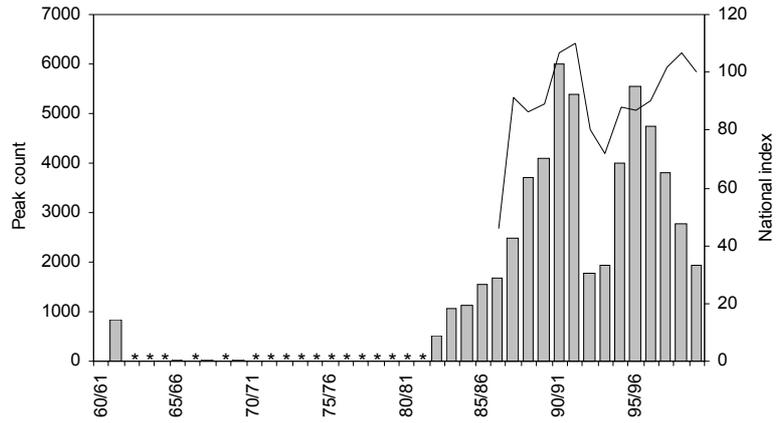


Figure 7. Light-bellied Brent Geese at Lough Foyle, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)

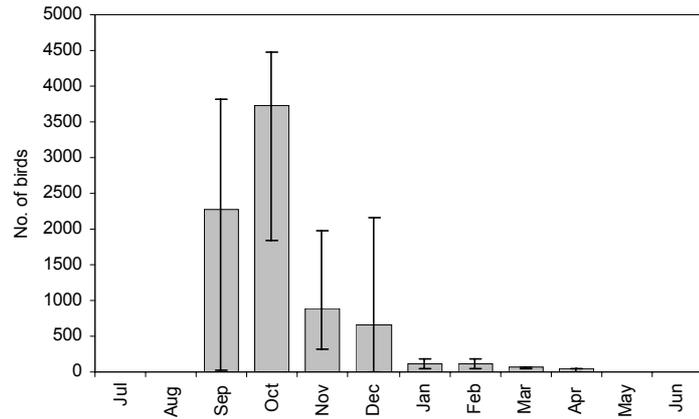


Figure 8. Light-bellied Brent Geese at Strangford Lough, 1960/61-1999/2000: peak counts (bars) and Northern Ireland index (line) (asterisks denote years with no known data)

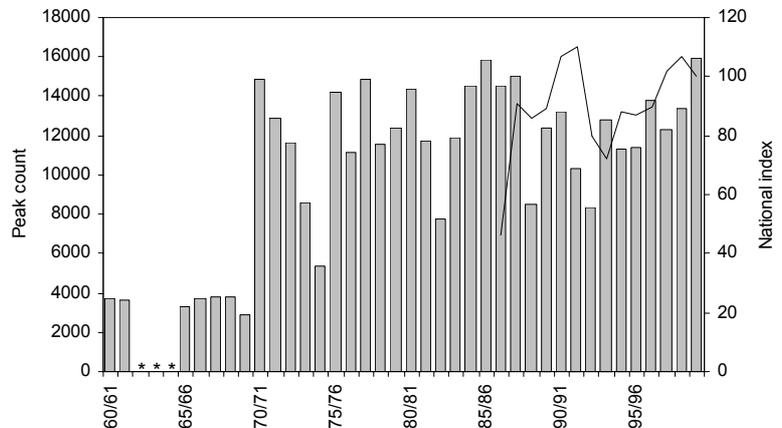
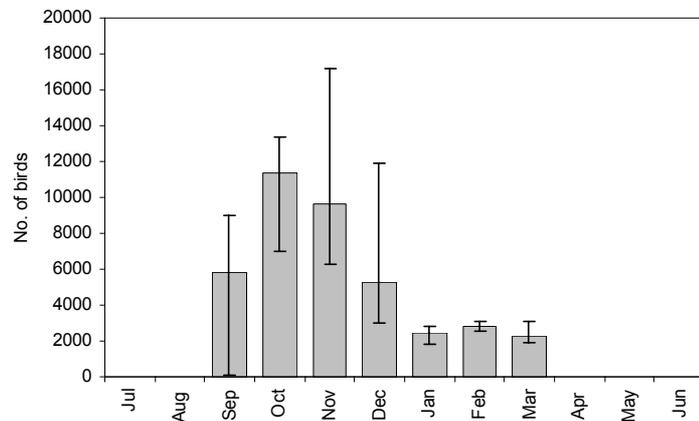


Figure 9. Light-bellied Brent Geese at Strangford Lough, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)



iii) Killough Harbour

Five-year mean 95/96-99/2000: 311

Site conservation status

SPA (Killough Harbour: selection stage 1.2)

Ramsar (Killough Harbour: criterion 6)

ASSI

IBA (Killough Harbour and Coney Island Bay: criteria B1i, C3)

Site description and habitat

Killough Harbour (J5437; 54° 15'N 5° 38'W) lies on the southeast coast of County Down in Northern Ireland. It is a small estuary with areas of intertidal mudflats and shingle banks.

Numbers and trends

Although numbers fluctuate between years, around 200-300 Light-bellied Brent Geese have been recorded annually at Killough Harbour since the mid 1980s (Fig. 12, Sheppard 1993). The first data became available in winter 1987/88. The site generally supports highest numbers during late winter.

iv) Larne Lough

Five-year mean 95/96-99/2000: 218

Site conservation status

SPA (Larne Lough: selection stage 1.2)

Ramsar (Larne Lough: criterion 6)

ASSI

IBA (Larne Lough and Swan/Blue Circle Islands: criteria B1i, C3)

Site description and habitat

Larne Lough (D4200; 54° 49'N 5° 46'W) is a long, shallow sea lough, in-filled with sediments of fine muddy sand. The south end of the lough has extensive areas of intertidal mudflats. The northern end is much deeper and subject to regular dredging as it is a major shipping port. Other habitats present include mussel-beds and saltmarshes, especially in the upper reaches of the sea lough.

Numbers and trends

Between the late 1950s and early 1970s, flocks comprising around 100 Light-bellied Brent Geese were recorded regularly at Larne Lough (Fig. 13; Rutledge 1966, Hutchinson 1979). Given the paucity of data, it is unclear how many birds used the site through the 1970s and early 1980s. However, since the early 1980s, between 150 and 300 birds have been recorded suggesting an increase over this period (Fig. 13; Sheppard 1993). Peak numbers are

recorded in September and again in mid winter (Fig. 14).

v) Outer Ards

Five-year mean 95/96-99/2000: 202

Site conservation status

SPA (Outer Ards: selection stage 1.2)

Ramsar (Outer Ards: criterion 6)

SSSI

IBA (Outer Ards Peninsula: criteria B1i, C3)

Site description and habitat

The Outer Ards (J6663; 54° 29'N 5° 25'W) peninsula is a flat, east facing sheltered shoreline of the Irish Sea. The rocky intertidal area comprises low platforms, up to 200 m across, separated by wide areas of mobile sediment. The site also has expanses of boulder, cobble, gravel, sand and intertidal mudflats together with dune and maritime grasslands, maritime heath and cliff ledge vegetation. Saltmarsh, tidal and non-tidal fens and freshwater areas are present. There are many offshore reefs and islets associated with this length of coastline.

Numbers and trends

Since the mid 1980s, around 150-200 Light-bellied Brent Geese have been recorded regularly at this site during peak periods (Fig. 15), generally in March (Fig. 16). These data highlight the importance of this site during the spring. Unfortunately, there are no data available prior to winter 1985/86 to assess longer-term trends.

2.1.2.4 Other sites

Around 50-250 birds are recorded annually at Inner Dundrum Bay (J4235), peaking between December and February. Belfast Lough (J4083) is far less important, supporting around 20 birds during the mid winter months. There is some evidence that it may have been far more important in the 19th century.

2.1.2.5 Key references

Fox *et al.* (1994b), Mathers & Montgomery (1997), Mathers *et al.* (1998a, 1998b, 1998c, 2000)

Figure 10. Light-bellied Brent Geese at Carlingford Lough, 1960/61-1999/2000: peak counts (bars) and Northern Ireland index (line) (asterisks denote years with no known data)

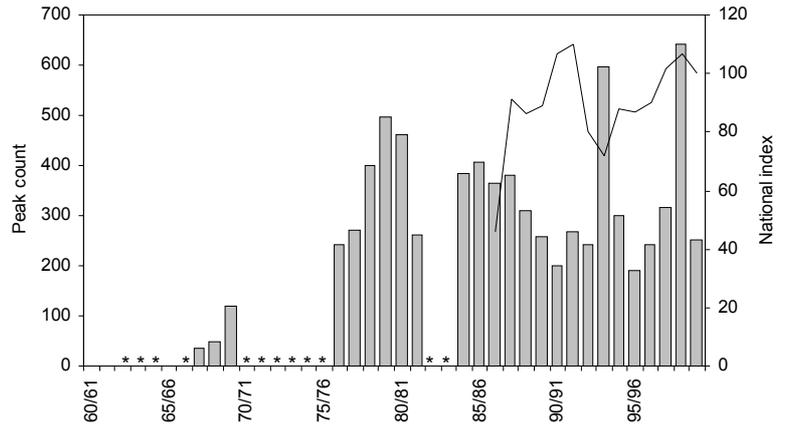


Figure 11. Light-bellied Brent Geese at Carlingford Lough, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)

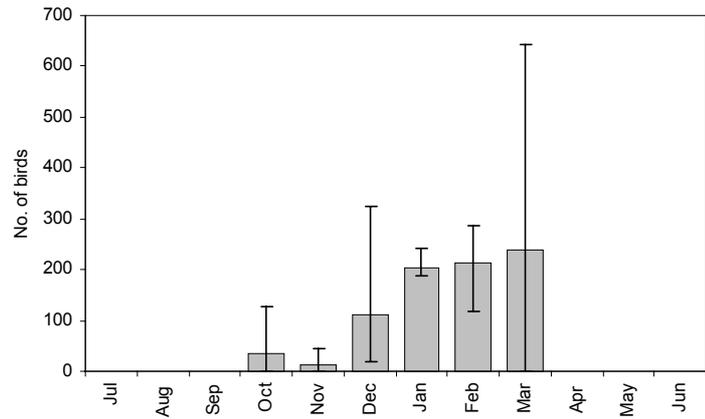
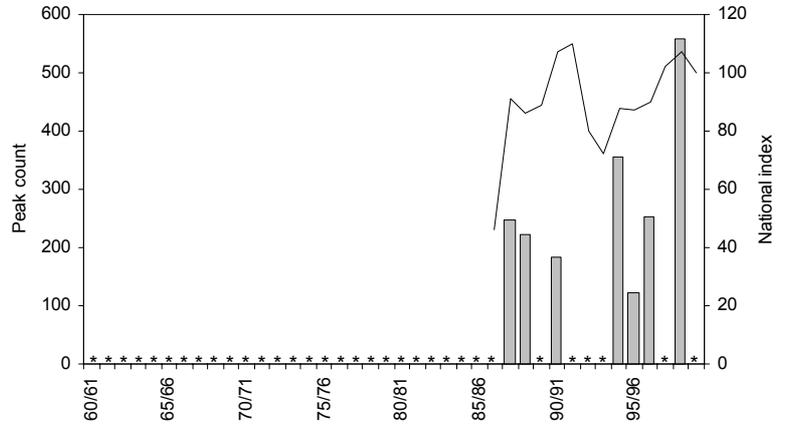


Figure 12. Light-bellied Brent Geese at Killough Harbour, 1960/61-1999/2000: peak counts (bars) and Northern Ireland index (line) (asterisks denote years with no known data)



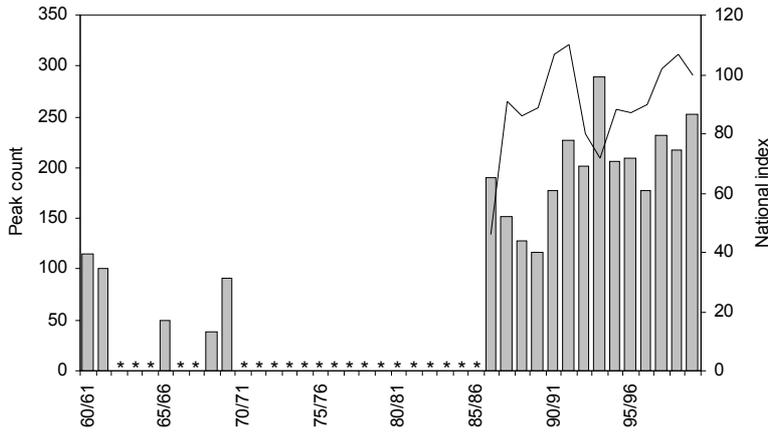


Figure 13. Light-bellied Brent Geese at Larne Lough, 1960/61-1999/2000: peak counts (bars) and Northern Ireland index (line) (asterisks denote years with no known data)

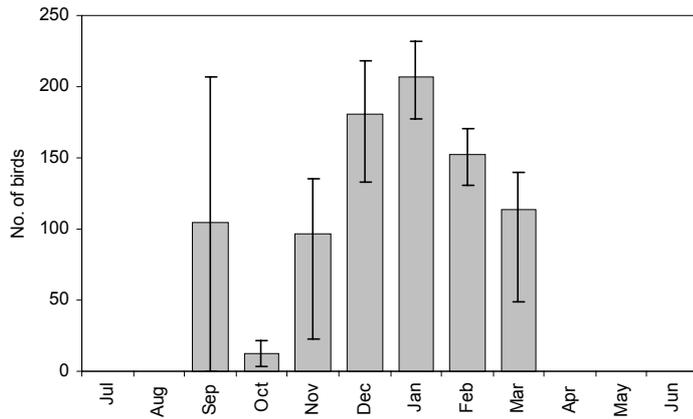


Figure 14. Light-bellied Brent Geese at Larne Lough, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)

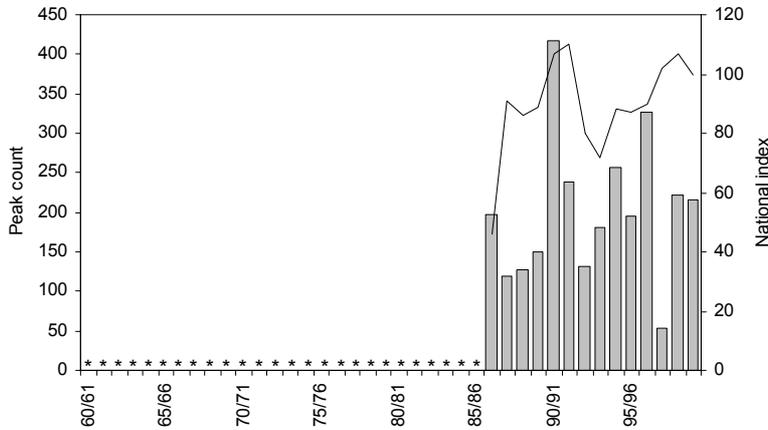


Figure 15. Light-bellied Brent Geese at Outer Ards, 1960/61-1999/2000: peak counts (bars) and Northern Ireland index (line) (asterisks denote years with no known data)

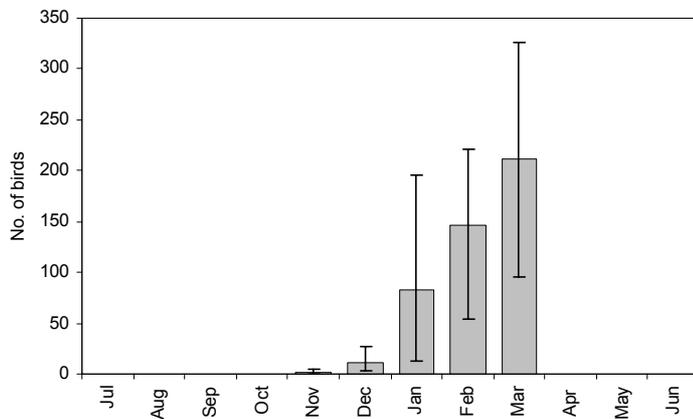


Figure 16. Light-bellied Brent Geese at Outer Ards, 1995/96-1999/2000: mean peak counts by month (error bars denote minimum and maximum peak counts during the period)

2.1.3 Louth

2.1.3.1 Background

Between Carlingford Lough and Dublin, the coast is low-lying and dominated by the large estuarine sea bay of Dundalk Bay. Along with the cross-border site at Carlingford Lough (see Antrim and Down), Dundalk Bay hosts internationally important numbers of Light-bellied Brent Geese.

2.1.3.2 Historical status

Dundalk Bay was highlighted as a key resort in the 19th century (Ussher & Warren 1900). Kennedy *et al.* (1954) indicated that, up until the 1950s, only small, transitory flocks of Light-bellied Brent Geese visited Dundalk Bay, generally during spring and autumn migration. Around 100 birds were recorded regularly at this site up until the mid 1970s (Hutchinson 1979), rising to around 250 by the mid 1980s (Sheppard 1993). Trends at sites elsewhere in the county remain unknown.

2.1.3.3 Internationally important sites

i) Carlingford Lough
(see Down and Antrim)

ii) Dundalk Bay

Five-year mean 95/96-99/2000: 370

Site conservation status

SPA (Dundalk Bay)

Ramsar (Dundalk Bay)

IBA (Dundalk Bay: criteria B1i, C3)

Site description and habitat

Dundalk Bay (J1000; 53° 55'N 6° 20'W) is a very large, open sea bay. The site comprises large areas of coarse mudflats and sandflats, which at low tide extend up to 3 km wide and 20 km from Ballymascanlon to Annagassan. There are also areas of saltmarsh, shingle beaches and tidal rivers. The site includes the small estuaries of the rivers Dee, Glyde, Fane and Castletown.

Numbers and trends

Dundalk Bay has regularly supported around 100-500 birds since the late 1960s, although there are large gaps in the late 1980s and early 1990s data set (Fig. 17; Sheppard 1993). Fewer than 50 birds were recorded in 1973/74 and 1981/82. Peak counts are generally recorded during the mid winter months or in early spring.

2.1.3.4 Other sites

Away from the key resorts at Carlingford Lough and Dundalk Bay, the restricted mudflats at the Boyne Estuary (O1577) support around 100-150 birds and the stretch of coastline between Dunany Point and Clogher Head (O1488) has hosted over 200 birds in recent winters. Flocks are occasionally recorded on the beaches between Clogher Head and the Boyne Estuary. There are also records of small flocks (usually fewer than 20) between Greenmore Point and Cooley Point.

2.1.4 Dublin

2.1.4.1 Background

The coast between Carlingford Lough and Dublin is low-lying and indented with many estuaries with large *Zostera* beds that attract Light-bellied Brent Geese. There are currently six sites in Dublin that support internationally important concentrations although by far the most important, numerically, is Dublin Bay (see below). Peak counts in the county are generally recorded during mid winter, after the large concentration of birds at Strangford Lough to the north have dispersed.

2.1.4.2 Historical status

Dublin Bay and Malahide Estuary were identified as key sites in the 19th century (Ussher & Warren 1900). Kennedy *et al.* (1954) identified three main groups of Light-bellied Brent Geese in Dublin: a flock of 200 or more on the shores near Sutton and the North Bull and at Merrion Strand in Dublin Bay (600-700 in 1954; Ruttledge & Hall Watt 1958), and similar sized flocks at Rogerstown and Broadmeadow (Malahide) Estuaries. In the late 1950s and early 1960s, Ruttledge (1966) indicated that during January the Broadmeadow (Malahide) and Rogerstown Estuaries supported around 400 birds between them with a further 300 birds present at North Bull and Baldoyle Bay. Into the early 1970s, numbers present at the Broadmeadow (Malahide) and Rogerstown Estuaries peaked at around 200 and 400 birds respectively, yet North Bull and Baldoyle Bay increased in importance, supporting up to 1,000 birds during mid winter (Hutchinson 1979). Over 2,000 birds were recorded in Dublin Bay between the mid 1980s and early 1990s, with a further 200-500 birds each recorded at Rogerstown and Broadmeadow (Malahide) Estuaries (Sheppard 1993).

2.1.4.3 Internationally important sites

i) Dublin Bay

Five-year mean 95/96-99/2000: 2,407

Site conservation status

SPA (North Bull Island; Sandymount Strand and the Tolka Estuary)
Ramsar (North Bull Island)
Nature Reserve (North Bull Island)
Statutory Wildfowl Sanctuary
Biosphere Reserve (North Bull Island)
Biogenetic Reserve (North Bull Island)
IBA (Dublin Bay: criteria B1i, C3)

Site description and habitat

Dublin Bay (O2237; 53° 21'N 6° 12'W) is a large bay and estuary adjacent to Dublin city, fed by the rivers Liffey, Dodder and Tolka. The site comprises extensive areas of sandflats, mudflats, saltmarsh, sand dunes and beaches. North Bull Island has a recreational beach. The Light-bellied Brent Geese generally feed on the extensive *Zostera* beds which grow between Kilbarrack and Sutton to the north of the island. In addition, the *Zostera* bed at Merrion Strand, in south Dublin Bay, is a particularly important feeding area for birds in the early winter (O'Briain 1991). Birds also feed on mats of green algae and on saltmarshes, golf courses and on park grassland and other recreational areas adjacent to the bay.

Numbers and trends

The numbers of Light-bellied Brent Geese recorded in Dublin Bay have increased gradually since the early 1960s. Around 200 birds were recorded regularly at the site between the mid 1940s and early 1960s (Kennedy *et al.* 1954, Ruttledge 1966), increasing to around 1,000 by the early 1970s and over 2,000 in the late 1980s/early 1990s (Fig. 18; Hutchinson 1979, Sheppard 1993). Peak numbers of birds have also increased since the mid 1990s; the site now regularly supporting 2,000-3,500 birds, peaking during December in most years.

ii) Rogerstown Estuary

Five-year mean 95/96-99/2000: 1,609

Site conservation status

SPA (Rogerstown Estuary)
Ramsar (Rogerstown Estuary)
Nature Reserve
Statutory Wildfowl Sanctuary
IBA (Rogerstown Estuary: criteria B1i, C3)

Site description and habitat

Rogerstown Estuary (O3352; 53° 30'N 6° 06'W) is a broad, muddy estuary separated from the sea by a sand/shingle bar and divided by the Dublin-Belfast railway line. The estuary contains large expanses of intertidal mudflats (c. 360 ha) and some saltmarsh.

Numbers and trends

Around 400-500 Light-bellied Brent Geese were recorded regularly at Rogerstown Estuary between the 1950s and mid 1980s (Fig. 19; Ruttledge 1966, Hutchinson 1979, Sheppard 1993), increasing in number through the late 1980s and early 1990s following the increase in total population size and counter effort. Peak counts have declined slightly since the all-time peak of over 1,800 in 1995/96, yet around 600-1,000 birds still use the site regularly. Maximum counts are generally recorded during mid winter.

iii) Broadmeadow (Malahide) Estuary

Five-year mean 95/96-99/2000: 1,104

Site conservation status

SPA (Broadmeadow/Swords Estuary)
Ramsar (Malahide Estuary)
IBA (Malahide/Broadmeadow Estuary: criteria B1i, C3)

Site description and habitat

The Broadmeadow Estuary (O2247; 53° 27'N 6° 09'W) is located north of Malahide and is divided by a railway viaduct. In many ways it is very similar to Rogerstown Estuary. The estuary is protected from the sea by large sand dunes. There are extensive sandflats and mudflats within the outer estuary. Inland of the viaduct, only the extreme inner part of the estuary drains at low tide because the tide only drops a few centimetres during the ebb tide. There is an area of saltmarsh here (i.e. at the top of the estuary).

Numbers and trends

Between the 1950s and mid 1980s, around 100-500 Light-bellied Brent Geese were recorded at this estuary (Fig. 20; Kennedy *et al.* 1954, Hutchinson 1979, Sheppard 1993). Since the mid 1990s, around 500-1,000 Light-bellied Brent Geese have been recorded at the site following increases through the late 1980s/early 1990s. An extraordinary count of almost 2,000 birds was made in winter 1995/96. Peak counts are generally recorded in mid winter.

Figure 17. Light-bellied Brent Geese at Dundalk Bay, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)

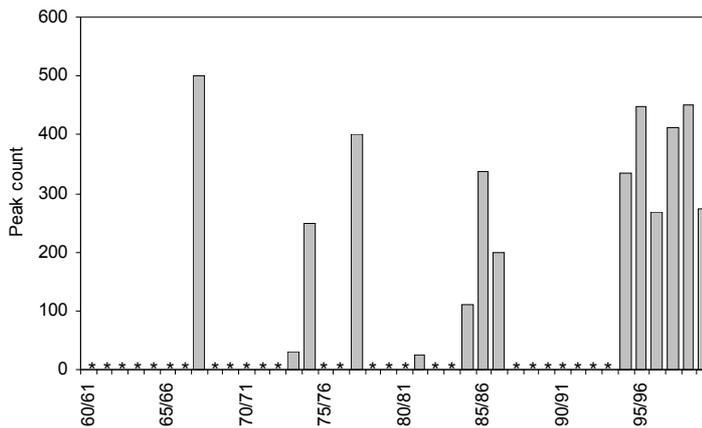


Figure 18. Light-bellied Brent Geese at Dublin Bay, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)

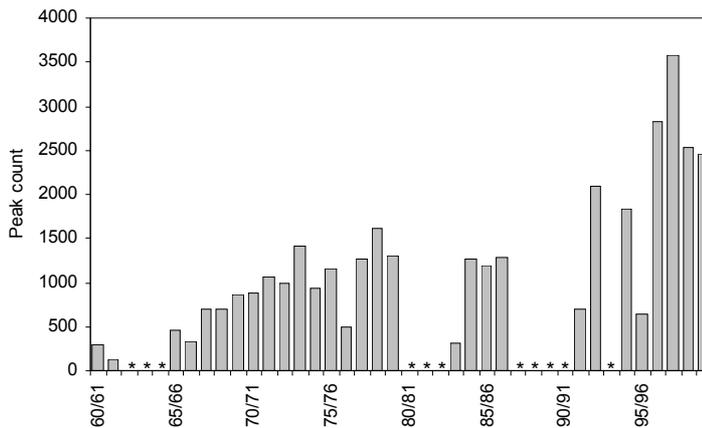


Figure 19. Light-bellied Brent Geese at Rogerstown Estuary, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)

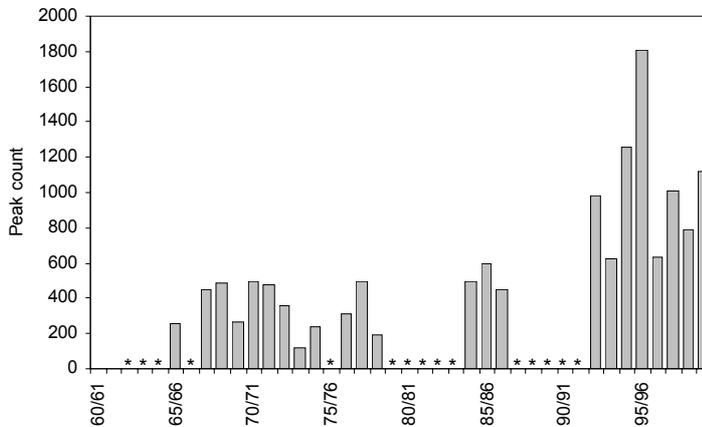
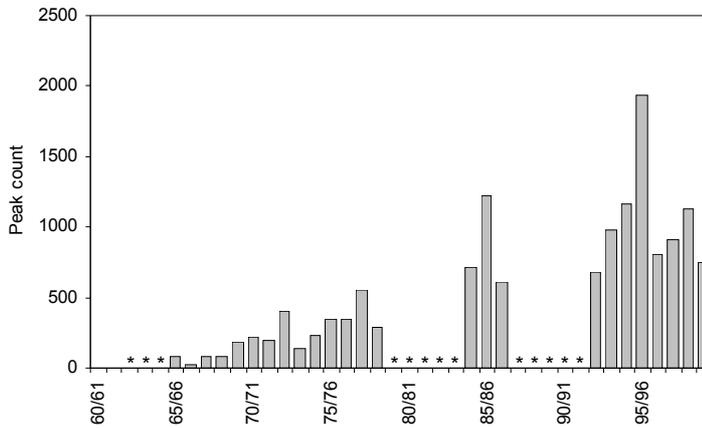


Figure 20. Light-bellied Brent Geese at Broadmeadow (Malahide) Estuary, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)



iv) Baldoyle Bay

Five-year mean 95/96-99/2000: 726

Site conservation status

Nature Reserve

SPA (Baldoyle Bay)

Ramsar (Baldoyle Bay)

IBA (Baldoyle Bay: criteria B1i, C3)

Site description and habitat

Baldoyle Bay (O2442; 53° 24'N 6° 08'W) is a long, narrow embayment, located between Broadmeadow (Malahide) Estuary and the North Bull. The tidal bay is protected from the open sea by a large sand-dune systems which provide suitable land for golf links. It comprises the estuary of the Sluice and Mayne rivers, over 95% of the estuary is exposed at low tide.

Numbers and trends

Several hundred Light-bellied Brent Geese have used Baldoyle Bay as a wintering site since the 1950s at least (Ruttledge 1966). Site maxima increased from around 65 birds in the early 1970s to around 450 by the mid 1980s (Fig. 21; Hutchinson 1979, Sheppard 1993). Since then, peak counts have almost doubled; around 800-1,000 birds have been recorded at this site since the mid 1990s, with highest numbers recorded during mid winter.

v) Seagrang Park

Five-year mean 95/96-99/2000: 626

Site conservation status

None

Site description and habitat

Seagrang Park (O2440; 53° 24'N 6° 08'W) is an alternative feeding area for Light-bellied Brent Geese from the Baldoyle Estuary (see above). It is an area of grassland just west of the estuary.

Numbers and trends

Since winter 1994/95, around 300-800 birds have been recorded at this site (Fig. 22). There are no data available prior to this. Peak counts are generally recorded during mid winter.

f) Skerries Islands

Five-year mean 95/96-99/2000: 242

Site conservation status

Proposed SPA

IBA (Skerries Islands: criteria B1i, C3)

Site description and habitat

The Skerries Islands (O2759; 53° 34'N 6° 05'W) are a group of three small islands (Shenick's, St. Patrick's and Colt) and surrounding sea. However, Light-bellied Brent Geese tend to congregate on the rocky shoreline in the vicinity of Skerries village on the mainland, and roost on the islands.

Numbers and trends

Around 200-300 Light-bellied Brent Geese have been recorded regularly at this site since the mid 1990s (Fig. 23). There are no data available prior to this. Peak counts are generally recorded during mid winter.

2.1.4.4 Other sites

Flocks of up to 100 birds have been recorded on the Delvin River, Ireland's Eye and Lambay Island (O3151) in recent years.

2.1.4.5 Key references

Jeffrey (1977), O'Briain (1989, 1991)

Figure 21. Light-bellied Brent Geese at Baldoye Bay, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)

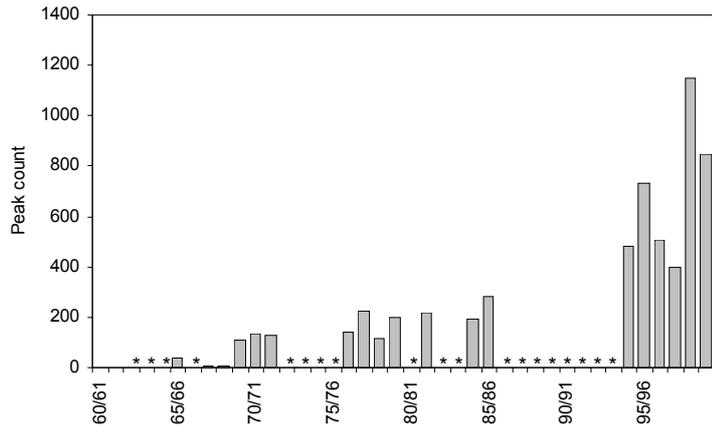


Figure 22. Light-bellied Brent Geese at Seagrage Park, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)

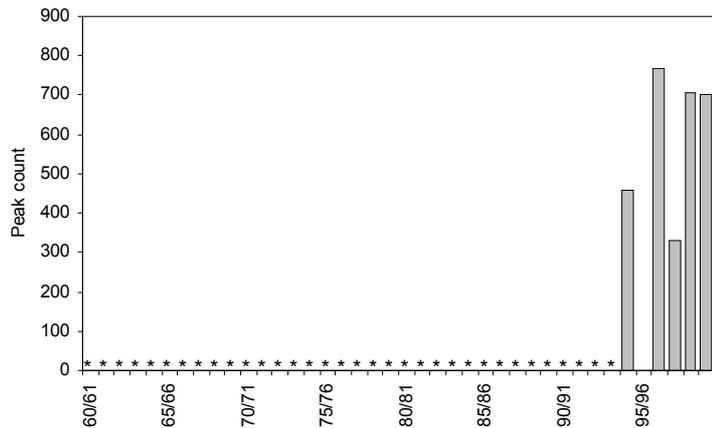
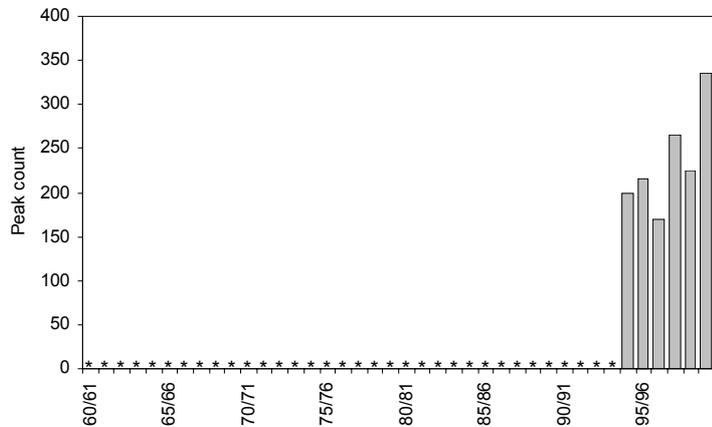


Figure 23. Light-bellied Brent Geese at The Skerries, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)



2.1.5 Wicklow

2.1.5.1 Background

The North Wicklow Coastal Marshes are a key resort for Light-bellied Brent Geese in eastern Ireland. The entire length of the marshes lies behind a shingle spit. Given the absence of any other suitable habitat in the area, there are no other important sites for Light-bellied Brent Geese in the county.

2.1.5.2 Historical status

There is little historical information on Light-bellied Brent Geese in Wicklow.

2.1.5.3 Internationally important sites

i) North Wicklow Coastal Marshes

Five-year mean 95/96-99/2000: 859

Site conservation status

SPA (Broad Lough; Kilcoole Marshes)

IBA (North Wicklow coastal marshes: criteria B1i, C3)

Site description and habitat

The North Wicklow Coastal Marshes (O3104; 53° 04'N 6° 03'W) is a coastal wetland complex, extending 18 km between Greystones and Wicklow. A shingle barrier extends the length of the site, protecting freshwater and brackish marshes, estuarine fen and wet grasslands. The key wetlands for Light-bellied Brent Geese at Kilcoole Marshes were partly empoldered in the late 1980s but still have tidal inflow.

Numbers and trends

Around 600-1,000 Light-bellied Brent Geese have been recorded regularly at the North Wicklow Coastal Marshes since the early 1990s (Fig. 24), primarily in the Kilcoole area. This is an increase on counts made during the late 1970s and early 1980s when fewer than 300 birds were recorded annually at this site (Sheppard 1993). Peak counts are recorded in mid winter or early spring. In recent winters, birds have been recorded feeding at a golf course near Greystones, at the northern end of the coastal marshes.

2.1.6 Wexford

2.1.6.1 Background

Between the North Wicklow Coastal Marshes and Wexford Harbour, there are few estuarine inlets of any note and, as a consequence, very few Light-bellied Brent Geese. However, from Wexford Harbour westwards, the coastline changes markedly and is indented with a series of large estuaries and brackish lagoons. Three of the estuaries located in the county support internationally important numbers of Light-bellied Brent Geese.

2.1.6.2 Historical status

Early in the 20th century, there were reports of 5,000 Light-bellied Brent Geese wintering at Wexford Harbour (Kennedy *et al.* 1954); much higher numbers than have been recorded in more recent decades. Small numbers were also recorded at Bannow Bay. However, numbers of Light-bellied Brent Geese using Wexford Harbour declined between the mid 1930s and early 1950s. This decline is thought to have been caused by erosion-related loss of mudflats with *Zostera*, which were covered by shifting sands. Around 300-600 birds were recorded regularly at the site from the mid 1940s up until the early 1970s (Ruttledge 1966, Hutchinson 1979), increasing to around 2,000 by the mid 1980s (Sheppard 1993). Bannow Bay increased in importance for Light-bellied Brent Geese over the same period, supporting around 50 birds in the early 1960s and up to 300 by the early 1970s and 900 in the mid 1980s (Sheppard 1993). Around 100 birds were also recorded at The Cull in the early 1970s, although data for this site are fewer (Hutchinson 1979).

Tacumshin Lake supported around 500 Light-bellied Brent Geese in the early 1970s and 1980s (Hutchinson 1979, Sheppard 1993). However, since the channel between the lake and the sea was blocked in 1974, and the intertidal mudflats lost, the site became less attractive to Light-bellied Brent Geese. The birds now prefer to feed on the saltmarshes at the western end of the lake.

2.1.6.3 Internationally important sites

i) Wexford Harbour & Slobs

Five-year mean 95/96-99/2000: 1,469

Site conservation status

SPA (The Raven; Wexford Wildfowl Reserve; Wexford Harbour)
Ramsar (The Raven; Wexford Wildfowl Reserve)
Nature Reserve (The Raven; Wexford Wildfowl Reserve)
IBA (Wexford Harbour and Slobs: criteria B1i, C3)

Site description and habitat

Wexford Harbour (T0824; 52° 19'N 6° 26'W) is a shallow estuary at the mouth of the Slaney river. The site includes intertidal mudflats and sandflats which are protected by Raven and Rosslare Points and behind which lie the north and south 'Slobs'. The Slobs are two flat areas of farmland, mainly arable and pasture, empoldered behind sea walls built in the mid 19th century. Previously, these areas had consisted of alluvial mud. There are partially afforested dunes at Raven Point. The main remaining intertidal areas are at Hopeland and Rosslare Backstrand on the south shore and between Ferrybank and Ferryraig on the inner north shore.

Numbers and trends

Between the mid 1940s and early 1970s, around 300-600 Light-bellied Brent Geese were recorded at Wexford Harbour (Fig. 25; Kennedy *et al.* 1954, Ruttledge 1966, Hutchinson 1979). In 1974, birds began to feed on the pastureland of the Slobs and since then numbers have climbed to around 1,700 on the North Slob and 940 at Wexford Harbour (Sheppard 1993). However, peak counts declined through the late 1990s from over 2,500 birds in 1994/95 to fewer than 1,000 birds in 1997/98 and 1998/99. However, higher numbers were present in 1999/2000, possibly as a consequence of increased productivity, and hence total population size. Peak counts are generally recorded in mid winter.

ii) Bannow Bay

Five-year mean 95/96-99/2000: 561

Site conservation status

SPA (Bannow Bay)
Ramsar (Bannow Bay)
IBA (Bannow Bay: criteria B1i, C3)

Site description and habitat

Bannow Bay (S8209; 52° 13'N 6° 48'W) is an extensive, sheltered sea bay and estuary, 20 km east of Waterford City. Over 75% of the sandflats and

mudflats are left exposed at low water together with small areas of saltmarsh. The Owenduff and Corock rivers discharge into the head of the bay which is constricted at its mouth by encroaching sandbars and dune systems.

Numbers and trends

The importance of Bannow Bay for Light-bellied Brent Geese increased from the late 1950s when only 50 birds were recorded regularly at this site (Ruttledge 1966). In the early 1970s, the site regularly supported 300 birds (Fig. 26; Hutchinson 1979), rising to over 1,000 birds by the late 1980s/early 1990s (Sheppard 1993). Peak counts indicate that Bannow Bay may have become less attractive to Light-bellied Brent Geese over the late 1990s. In the most recent three winters, fewer than 500 birds have been recorded. Count coverage between years is, however, variable at this site and may explain this decline. Maximum numbers of Light-bellied Brent Geese are recorded during mid winter.

iii) The Cull & Killag

Five-year mean 95/96-99/2000: 290

Site conservation status

Nature Reserve
SPA (Ballyteigue Burrow; The Cull)
IBA (The Cull/Killag: criteria B1i, C3)

Site description and habitat

The Cull (S9307; 52° 12'N 6° 39'W) is a long narrow sea-inlet and estuary, protected from the open sea by a shingle-spit with dunes. The Killag, forming the eastern part of the site, was claimed in the last century by construction of the Cull Bank and is now polderland, most of which is intensively grazed or used as arable land.

Numbers and trends

In the mid to late 1970s, around 100 Light-bellied Brent Geese were recorded regularly at The Cull (Fig. 27; Hutchinson 1979). Peak counts have fallen markedly since the mid 1990s when between 400 and 1,000 birds were recorded. In recent years, peak counts of around 80-200 birds have been more frequent indicating a reduction in site use. Peak numbers are generally recorded during mid winter.

2.1.6.4 Other sites

Tacumshin Lake (T0506) and Lady's Island Lake (T1006) currently support up to 200 birds each at peak times during mid winter. Birds occasionally feed on the rocky shores near Kilmore Quay.

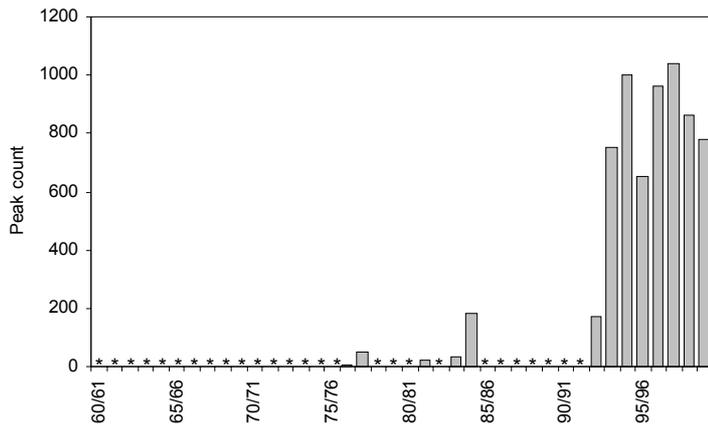


Figure 24. Light-bellied Brent Geese at the North Wicklow Marshes, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)

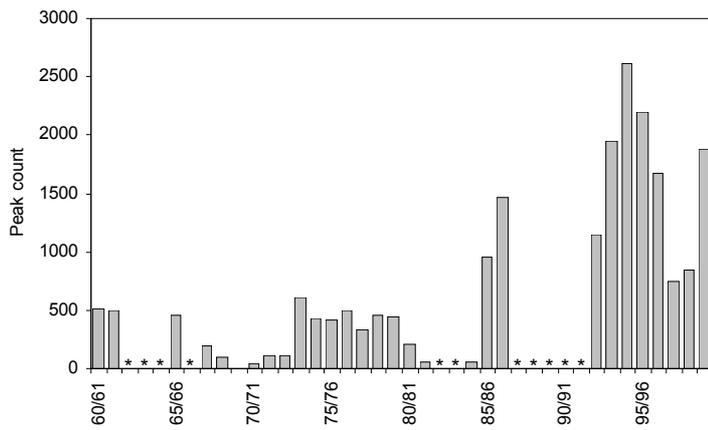


Figure 25. Light-bellied Brent Geese at Wexford Harbour & Slobbs, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)

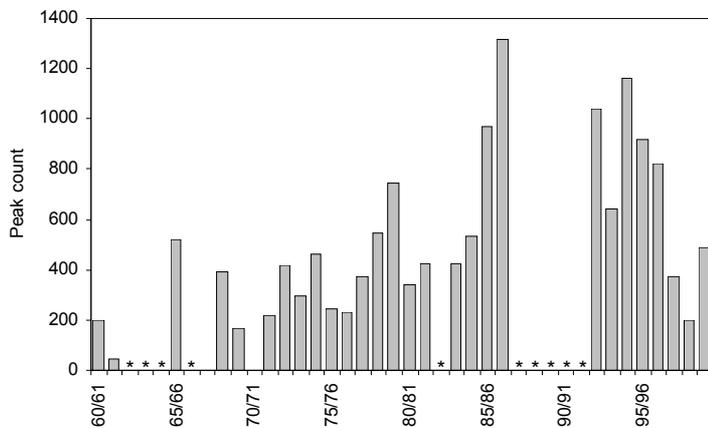


Figure 26. Light-bellied Brent Geese at Bannow Bay, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)

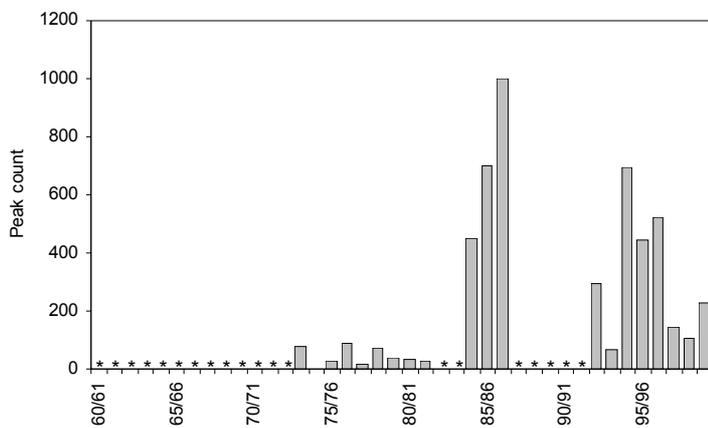


Figure 27. Light-bellied Brent Geese at The Cull & Killag, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)

2.1.7 Waterford

2.1.7.1 Background

Westwards from Wexford lie the estuarine sites of County Waterford. The two key sites for Light-bellied Brent Geese in the county are located at Dungarvan Harbour and Tramore Backstrand (see below), both of which are internationally important.

2.1.7.2 Historical status

Light-bellied Brent Geese have been regularly using the two key sites in Waterford since the early 1900s at least (Kennedy *et al.* 1954). Between the mid 1940s and early 1970s, around 200-300 birds were recorded at Dungarvan Harbour and 50-200 at Tramore Backstrand (Hutchinson 1979). By the mid 1980s, numbers at these sites had increased markedly, with around 690 and 480 birds recorded at Dungarvan Harbour and Tramore Backstrand respectively (Sheppard 1993).

2.1.7.3 Internationally important sites

i) Dungarvan Harbour

Five-year mean 95/96-99/2000: 723

Site conservation status

SPA (Dungarvan Harbour)
Ramsar (Dungarvan Harbour)
IBA (Dungarvan Bay: criteria B1i, C3)

Site description and habitat

Dungarvan Harbour (X2692; 52° 04'N 7° 34'W) is a large circular sea-bay on the south coast of Waterford. The site comprises large expanses of sandflats and mudflats at low water. The linear Cunnigar sand spit extends far into the bay, providing shelter to inner mudflats. A large *Zostera* bed is located on inter-tidal sands east of the Cunnigar and is a favoured feeding area for Light-bellied Brent Geese.

Numbers and trends

Between the mid 1940s and early 1980s, around 200-300 Light-bellied Brent Geese were recorded regularly at this site (Fig. 28; Ruttledge & Hall Watt 1958, Ruttledge 1966, Hutchinson 1979). By the mid 1980s, numbers had increased, the site supporting around 600-800 birds during peak times (Sheppard 1993). Around 500-1,000 birds have been recorded during peak periods at Dungarvan Harbour since the mid 1990s indicating a further increase in site use

over the early 1990s. Peak numbers are generally recorded during mid winter.

ii) Tramore Backstrand & Bay

Five-year mean 95/96-99/2000: 398

Site conservation status

SPA (Tramore Backstrand)
Ramsar (Tramore Backstrand)
IBA (Tramore Backstrand: criteria B1i, C3)

Site description and habitat

Tramore Backstrand (S6101; 52° 10'N 7° 06'W) is a small, shallow bay adjacent to Tramore village in Waterford. The site comprises mainly intertidal mudflats with some saltmarsh. The bay is sheltered from the sea by a long, shingle spit with sand dunes, leaving only a narrow opening to the sea which is never closed. Tramore Bay lies outside of the shingle spit, between Great Newtown and Brownstown Head.

Numbers and trends

Around 50 Light-bellied Brent Geese were recorded at Tramore Backstrand during the late 1940s and mid 1960s, increasing to around 200 birds by the early 1970s and 600+ by the mid 1980s (Fig. 29; Hutchinson 1979, Sheppard 1993). Some 300-600 Light-bellied Brent Geese have been recorded regularly at Tramore Backstrand since the mid 1990s, indicating a possible decline. Count coverage between years is, however, variable at this site and may explain this decline. Annual maxima are generally recorded during mid winter.

2.1.7.4 Other sites

The long and deep harbour of Waterford (S7007) supports 10-80 birds during mid winter. The species was recorded as 'numerous' at this site in the 19th century (Ussher & Warren 1900).

2.1.8 Cork

2.1.8.1 Background

Cork contains numerous wetlands, yet only two estuarine sites are regularly used by small numbers of Light-bellied Brent Geese. The first is at Ballymacoda (X0672), a small estuary of the Womanagh river. The site contains extensive areas of wet grassland, saltmarsh and mudflats which attract up to 100 birds during the winter. The second site is at Ballycotton (W9865) and consists of a shallow brackish lagoon situated behind a shingle bank with

several smaller reed-fringed pools and an extensive sandy beach. This site is less numerically important than the former, supporting 20-60 birds at peak periods.

2.1.8.2 Historical status

The literature suggests that the Light-bellied Brent Goose has been an uncommon winter visitor to the Cork coast since the beginning of the 20th century at least (Kennedy *et al.* 1954, Ruttledge 1966, Hutchinson 1979). Ussher & Warren (1900) mention that birds occurred in Cork Harbour and Youghal during hard winters in the 19th century.

2.1.9 Kerry

2.1.9.1 Background

In the southwest of Ireland, Kerry supports large numbers of Light-bellied Brent Geese through the autumn and winter. Sites in Kerry are often the first in Ireland to receive birds in the autumn. Castlemaine Harbour and the Tralee Bay complex are internationally important sites for Light-bellied Brent Geese in Kerry, both supporting extensive *Zostera* beds.

2.1.9.2 Historical status

Ussher & Warren (1900) described the Light-bellied Brent Goose as 'abounding in Tralee Bay' in the 19th century but made no mention of it occurring in Castlemaine Harbour. The species has remained numerous in Kerry since the beginning of the 20th century when over 1,000 birds were recorded regularly (Kennedy *et al.* 1954). Between 2,000 and 3,500 birds were recorded at Castlemaine Harbour and Tralee Bay between the mid 1940s and the early 1960s (Ruttledge & Hall Watt 1958, Ruttledge 1966). Up to 4,200 and 3,200 birds were recorded at Castlemaine Harbour and Tralee Bay respectively in the early to mid 1970s indicating an increase in numbers over the mid to late 1960s (Hutchinson 1979). However, by the mid 1980s, numbers had fallen to around 770 and 1,400 at Castlemaine Harbour and Tralee Bay respectively (Sheppard 1993).

2.1.9.3 Internationally important sites

i) Castlemaine Harbour & Rossbehy Creek

Five-year mean 95/96-99/2000: 694

Site conservation status

SPA (Castlemaine Harbour and Rossbehy Creek)
Ramsar (Castlemaine Harbour and Rossbehy Creek)
Nature Reserve
IBA (Castlemaine Harbour and Rossbehy Creek: criteria B1i, C3)

Site description and habitat

Castlemaine Harbour (V6694; 52° 07'N 9° 55'W) is a large, shallow estuary at the head of Dingle Bay and drains the rivers Maine and Laune. The estuary is sheltered from the sea by sand- and shingle-spits on the north and south sides. The estuary supports extensive intertidal mudflats with extensive swards of *Zostera*, especially in the northwest corner behind the sand-spit at Inch, and fringes of saltmarsh. There are extensive dune systems on the north and south shores. Rossbehy Creek is a smaller bay, protected by a sand-dune spit, southwest of Castlemaine Harbour.

Numbers and trends

Between 2,000 and 3,500 birds were recorded regularly at Castlemaine Harbour between the mid 1940s and early 1960s, rising to 4,200 in winter 1969/70 (Fig. 30; Ruttledge & Hall Watt 1958, Ruttledge 1966, Hutchinson 1979). Since then, numbers have declined with only 770 birds recorded during the mid 1980s (Sheppard 1993). Around 600-1,000 Light-bellied Brent Geese have been recorded at this site since the mid 1990s. Reductions in the amount of *Zostera* available to the birds at this site may explain this decline. Although this site is located in the south of Ireland, peak counts of Light-bellied Brent Geese are generally recorded in the early autumn.

ii) Tralee Bay and Barrow Harbour

Five-year mean 95/96-99/2000: 1,412

Site conservation status

SPA (Akeragh Lough, Banna Starnd and Barrow Harbour; Tralee Bay)
Ramsar (Inner Tralee Bay)
Nature Reserve (Inner Tralee Bay)
IBA (Tralee Bay and Barrow Harbour: criteria B1i, C3)

Site description and habitat

Tralee Bay (Q6812; 52° 16'N 9° 48'W) is a large, shallow sea bay on the north coast of Kerry, including intertidal

areas at the mouth of the River Lee and Barrow Harbour. The Lee Estuary is protected from the sea by Derrymore Island, a spit formed of shingle ridges, while Barrow Harbour is protected by land with only a small inlet to the sea.

Numbers and trends

Light-bellied Brent Geese 'abounded' in Tralee Bay in the 19th century (Ussher & Warren 1900). Around 2,000-3,500 Light-bellied Brent Geese were recorded regularly at Tralee Bay between the mid 1940s and mid 1970s (Fig. 31; Ruttledge & Hall Watt 1958, Ruttledge 1966, Hutchinson 1979). Between the mid 1970s and early 1990s, numbers declined; peak counts in the mid 1980s averaging at around 1,400 (Sheppard 1993). Although around 500 birds were recorded in the mid 1990s, the site has hosted a flock comprising around 2,500 birds in the most recent two winters of the review suggesting use of the site is increasing again. Recent peak counts have been recorded in the autumn; the site has traditionally been the first in Ireland to receive Light-bellied Brent Geese in the autumn, as early as the end of August.

2.1.9.4 Other sites

Brandon Bay (Q5313) hosts a flock comprising fewer than 30 birds in most years.

2.1.10 The Shannon Estuary (Cos. Kerry, Clare and Limerick)

2.1.10.1 Background

At Limerick, the River Shannon broadens out into a large estuary with extensive mudflats, especially in the area where the Fergus river meets the Shannon. The estuary itself stretches for 80 km and is a key resort for Light-bellied Brent Geese on the west coast of Ireland (see below).

2.1.10.2 Historical status

There is little information on the Light-bellied Brent Goose on the Shannon and Fergus Estuary prior to the early 1970s although Ussher & Warren (1990) stated that the species did not occur at the site in the 19th century. Hutchinson (1979) reported that around 300 birds were recorded regularly during the early 1970s.

2.1.10.3 Internationally important sites

i) Shannon & Fergus Estuary

Five-year mean 95/96-99/2000: 494

Site conservation status

SPA (Shannon and Fergus Estuary)

IBA (Shannon and Fergus Estuary: criteria B1i, C3)

Site description and habitat

The Shannon and Fergus Estuary (R2052; 52 40'N 9 04'W) is a large estuarine complex of islands, saltmarsh, and mudflats, stretching approximately 80 km and varies from less than one to over 15 km in width. The site comprises the Fergus river estuary from Clarecastle to the junction with the Shannon Estuary and is a drowned river valley. The estuary actually lies within Clare, Limerick and Kerry and contains the largest port and most extensive areas of industrial development in west Ireland. It is edged with sand- and mud-banks and has extensive areas of intertidal mudflats in the inlets on both sides of the estuary.

Numbers and trends

In the early 1970s, the Shannon and Fergus Estuary supported up to 300 Light-bellied Brent Geese (Fig. 32; Hutchinson 1979). The numbers fell to around 60 by the mid 1980s (Sheppard 1993). Since the mid 1990s, counts have increased yet fluctuated markedly between years, from 46 in winter 1996/97 to 1,000 in winter 1997/98. Maxima are generally recorded in the late winter or early spring indicating the importance of this site for birds migrating northwards on dispersal from other sites as food resources are depleted.

2.1.11 Clare

2.1.11.1 Background

The key resort for Light-bellied Brent Geese in Clare, away from the Shannon and Galway Estuaries, is Ballyvaughan Bay (M2410), a strip of coast between Ballyvaughan and New Quay containing areas of sand and mudflats and stony shore. Up to 164 birds have been recorded at this site in recent years.

2.1.11.2 Historical status

Early records (late 19th century) of Light-bellied Brent Geese at Mutton Island in Clare most probably refer to mis-identified Barnacle Geese *Branta leucopsis* (Kennedy *et al.* 1954). Hutchinson (1979) indicated that Ballyvaughan Bay was a well-known haunt of 50-70 birds in the early 1970s.

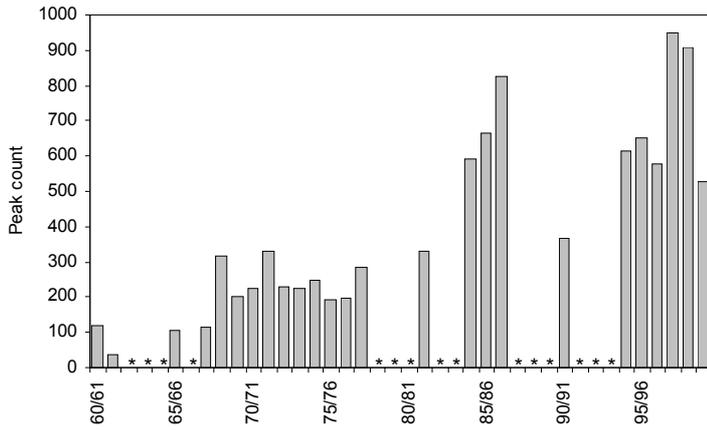


Figure 28. Light-bellied Brent Geese at Dungarvan Harbour, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)

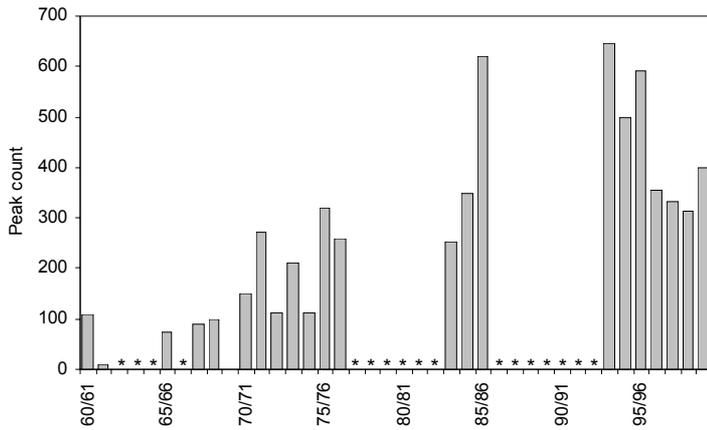


Figure 29. Light-bellied Brent Geese at Tramore Backstrand, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)

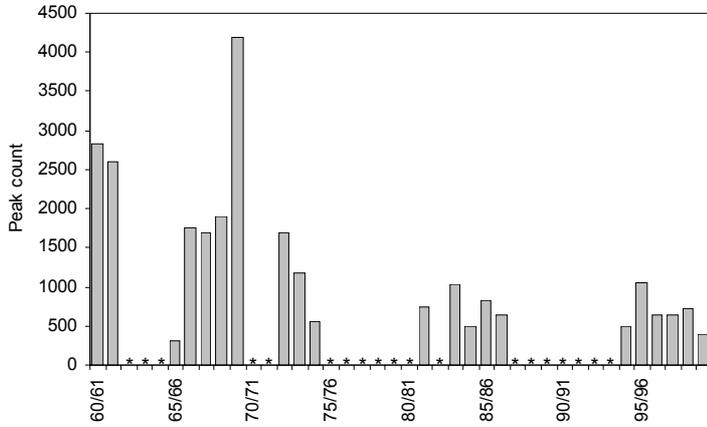


Figure 30. Light-bellied Brent Geese at Castlemaine Harbour, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)

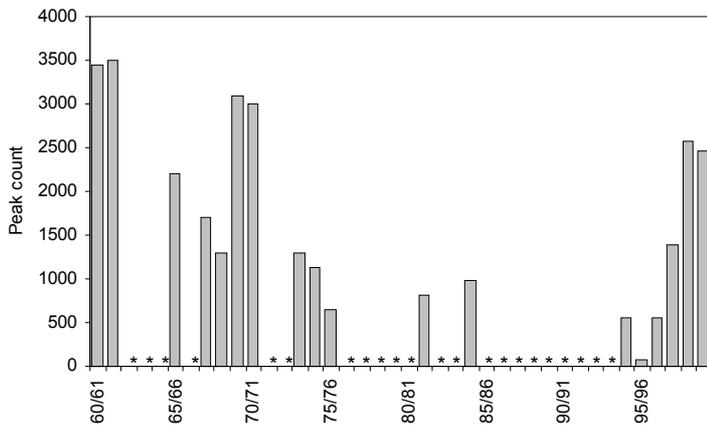


Figure 31. Light-bellied Brent Geese at Tralee Bay & Barrow Harbour, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)

2.1.12 Galway

2.1.12.1 Background

The coastline of Galway is dominated by Galway Bay which is a very broad bay with a series of narrow, shallow inlets at its eastern and southern sides, protected from the Atlantic Ocean by the Aran Islands. Inner Galway Bay is the only resort of note for Light-bellied Brent Geese in the county and currently supports internationally important numbers.

2.1.12.2 Historical status

Ussher & Warren (1900) mentioned the occurrence of Light-bellied Brent Geese at Hare Island, in Galway Bay, in the 19th century. Kennedy *et al.* (1954) indicated that around 150 birds were recorded near Tawin in Galway Bay during the middle of the 20th century but that elsewhere in the county the species was uncommon. Around 70 birds were recorded in Galway Bay during the late autumn/early winter in the late 1950s and early 1960s (Ruttledge 1969). Up to 130 birds were recorded in the bay during the early 1970s (Hutchinson 1979), increasing to around 540 by the mid 1980s (Sheppard 1993).

2.1.12.3 Internationally important sites

i) Inner Galway Bay

Five-year mean 95/96-99/2000: 676

Site conservation status

SPA (Inner Galway Bay)

Ramsar (Inner Galway Bay)

IBA (Inner Galway Bay: criteria B1i, C3)

Site description and habitat

Inner Galway Bay (M3218; 53° 12'N 9° 03'W) is the shallow, more sheltered part of a large sea-bay, which is partly protected from the sea by the Aran Islands. On the eastern and southern sides of the site there are numerous shallow tidal inlets including the smaller bays of Kinarva, Aughinish, Corranroo and Ballyvaughan (in Clare).

Numbers and trends

This site supported 100-150 Light-bellied Brent Geese regularly between the mid 1940s and early 1970s (Fig. 33; Ruttledge & Hall Watt 1958, Ruttledge 1966, Hutchinson 1979). Around 500 birds were recorded regularly during the mid 1980s as numbers increased (Sheppard 1993). During the 1990s, Inner Galway Bay has supported around 400-

800 birds during mid winter or early spring indicating a sustained increase over this period. The reasons for this increase, however, remain unclear.

2.1.13 Mayo

2.1.13.1 Background

Killala Bay (G2530) is a large triangular bay on the north Mayo coast. The site supports around 100-300 Light-bellied Brent Geese, most birds feeding on the intertidal mudflats situated at the southern corner of the estuary and at Bartragh Island. Clew Bay (L9090), Blacksod Bay and Broadhaven Bay (F7030) are the other key sites in the county, each supporting 100-170 birds in most years.

2.1.13.2 Historical status

Ussher & Warren (1900) mentioned the occurrence of Light-bellied Brent Geese at Killala Bay, Broadhaven and Blacksod Bay in the 19th century. The numbers of birds wintering in Mayo were low in the early 1900s, with the key resorts identified as Broadhaven, Blacksod Bay and Clew Bay (Kennedy *et al.* 1954, Ruttledge & Hall Watt 1958). Jointly, these sites supported around 20-50 birds between the mid 1940s and early 1950s. There is a paucity of data for Mayo for the period between the late 1950s and early 1980s. However, around 270-300 birds were recorded at each of Broadhaven Bay and Killala Bay during the mid 1980s (Sheppard 1993), indicating an increase in the number of Light-bellied Brent Geese in Mayo sometime between the late 1950s and early 1980s.

2.1.14 Sligo, Leitrim and Donegal

2.1.14.1 Background

The coastline of Sligo, Leitrim and Donegal is deeply indented, and many of the inlets are small or deep with stony or rocky edges. The estuarine habitats at Sligo Bay, Drumcliff, Cummeen Starnd, Ballysadare Bay and Trawbreaga Bay are the most important sites for Light-bellied Brent Geese in the county, reaching peak numbers during the mid to late winter.

2.1.14.2 Historical status

The species was reported from Drumcliff and Sligo Bays in the 19th century (Ussher & Warren 1900). Kennedy *et al.* (1954) stated that Drumcliff and Ballysadare Bays in Sligo were frequented by small numbers of birds in the early 1900s and that the species was considered common at Lough Swilly. Around 500 and 50 birds were recorded regularly at Sligo Bay and Trawbreaga Bay, respectively, during autumn passage periods in the late 1950s and early 1960s (Ruttledge 1966). Hutchinson (1979) indicated that during the early 1970s transitory concentrations of up to 2,000 birds were recorded at Cummeen Strand, Sligo Bay in the autumn with 50-140 birds present at Donegal Bay (G8973), Gweebarra Bay (G7899), and Lough Swilly. Between 70-240 Light-bellied Brent Geese were also recorded regularly at Trawbreaga Bay during the early 1970s. In the mid 1980s numbers had increased markedly in the northwest of Ireland; around 620, 350 and 270 birds were recorded at Cummeen Strand, Trawbreaga Bay and Lough Swilly, respectively (Sheppard 1993).

2.1.14.3 Internationally important sites

i) Lough Foyle

(see Londonderry)

ii) Trawbreaga Bay

Five-year mean 95/96-99/2000: 362

Site conservation status

SPA (Trawbreaga Bay)

Ramsar (Trawbreaga Bay)

IBA (Trawbreaga Bay: criteria B1i, C3)

Site description and habitat

Trawbreaga Bay (C4448; 55° 17'N 7° 18'W) is a broad, land-locked bay with a narrow exit situated west of Malin Head. At low tide, large areas of mudflats and sandflats are exposed with some rocky substrate.

Numbers and trends

Between 70-240 Light-bellied Brent Geese were recorded regularly at Trawbreaga Bay during the late 1960s and early 1970s, rising to 350 by the mid 1980s (Fig. 34; Hutchinson 1979, Sheppard 1993). Peak counts fell during the early 1990s but then increased again, remaining relatively stable at 300-400 through the late 1990s. The reasons for the recent increase remain unclear. Numbers generally peak in January or February.

iii) Sligo Bay Complex

Five-year mean 95/96-99/2000: 405

Site conservation status

SPA (Cummeen Strand, part of Drumcliff Bay, proposed at Ballysadare Bay)

Ramsar (Cummeen Strand)

IBA (Cummeen Strand (Sligo Harbour): criteria B1i, C3. Ballysadare Bay: criteria B1i, C3)

Site description and habitat

Sligo Bay is a broad bay comprising three estuaries, separated from each other by relatively narrow peninsulas. Cummeen Strand (G6537; 54° 18'N 8° 32'W) is the middle estuary and lies at the mouth of the river Garavogue. At low water, large expanses of mudflats and sandflats are exposed. Ballysadare Bay (G6230; 54 13'N 8 35'W) is located 7 km south of Sligo town and is the most southerly of the three estuaries. The site comprises large expanses of mudflats with well-developed saltmarsh in places. Drumcliff Bay (G6443; 54 20'N 8 33'W) is the most northerly of the three estuaries and, although it contains large areas of intertidal mudflats, it is less attractive to Light-bellied Brent Geese than the other two estuaries.

Numbers and trends

Around 500 birds were recorded regularly at Sligo Bay during the late autumn in the late 1950s and early 1960s (Fig. 35; Ruttledge 1966). Hutchinson (1979) indicated that autumn passage flocks of up to 2,000 birds were recorded at Cummeen Strand during the early 1970s, although these may have been unusual. However, around 100-600 birds have been counted at the site since then. Annual maxima are generally recorded in the late winter and early spring.

2.1.14.4 Other sites

South of Trawbreaga Bay lies Lough Swilly (C3025) which typically supports up to 200 birds during the winter. Elsewhere, Ballyness Bay (B9133), Travenagh Bay (B7804), Dunmorán Strand (G5135), Inshfree Bay (B7621) and Mullaghmore Bay (G7158) support 30-150 birds each during the winter.

Figure 32. Light-bellied Brent Geese at the Shannon & Fergus Estuary, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)

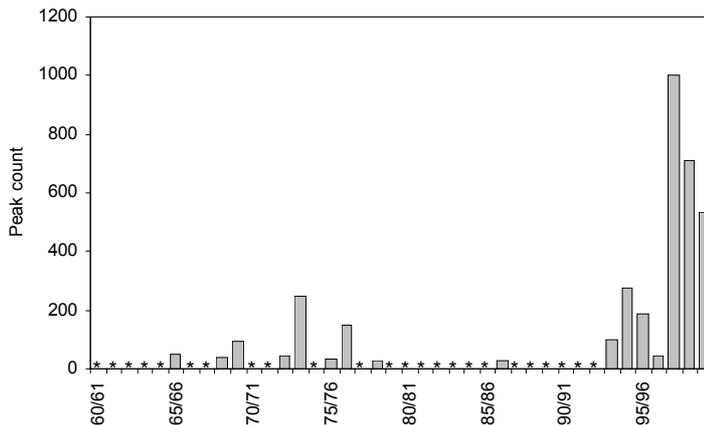


Figure 33. Light-bellied Brent Geese at Inner Galway Bay, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)

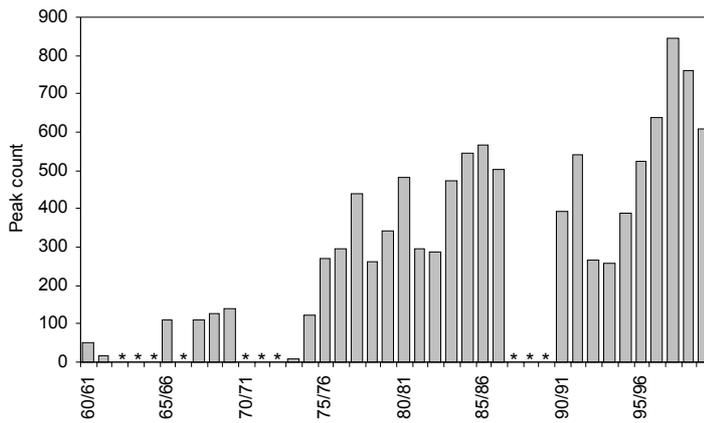


Figure 34. Light-bellied Brent Geese at Trawbreaga Bay, 1960/61-1999/2000: peak counts (asterisks denote years with no known data)

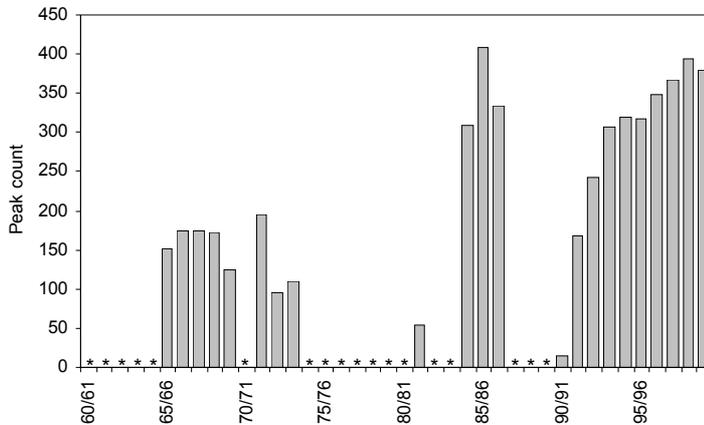
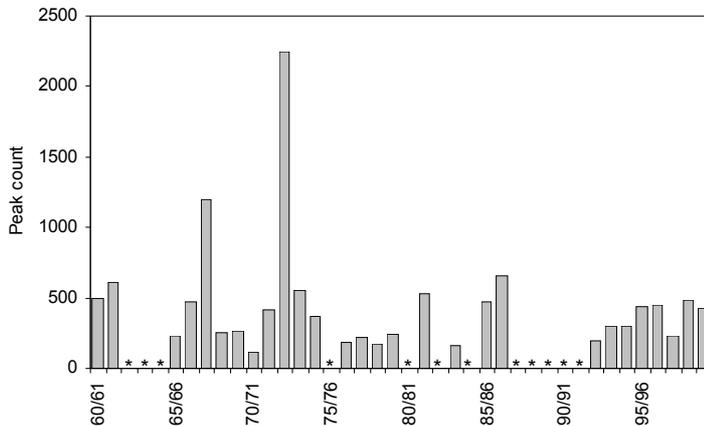


Figure 35. Light-bellied Brent Geese at Sligo Bay, 1960/61-1999/2000: peak counts (asterisks mark seasons with no known data)



2.2 Iceland

Light-bellied Brent Geese are restricted to the west coast of Iceland in spring and autumn, from Stokkseyri on the southwest coast northwards to central Breiðafjörður (Fig. 36). Birds occur irregularly outside this region, apart from those on passage. Labels a-j in Fig. 36 refer to site descriptions in the text. These sites are of international importance, supporting more than 200 individuals in spring.

2.2.1 Internationally important sites

a) Skerjafjörður

Region:

Kjósarsýsla; Reykjavík, Kópavogur, Gardabær, Bessastadahreppur, Seltjarnarnesbær

Site conservation status

None

Other conservation status

IBA (Skerjafjörður)

Site description and habitat

Skerjafjörður (64° 06' N, 22° 00' W) is a coastal area close to Reykjavík, with sea bays, shingle and stony beaches, peninsulas, intertidal flats, brackish lagoons, saltmarshes, agriculturally-improved grasslands near the seashore, and golf courses.

Numbers and trends

Regular counts are made in the spring. There has been a steady increase in Light-bellied Brent Goose numbers in the area since early 1970s, from 200 in 1974 to a historical peak of 2,500 in 2002, recorded at the site during the spring. In autumn, the number of Light-bellied Brent Geese using this area has been almost an order of magnitude lower than in the spring, but a similar pattern of increase has been observed.

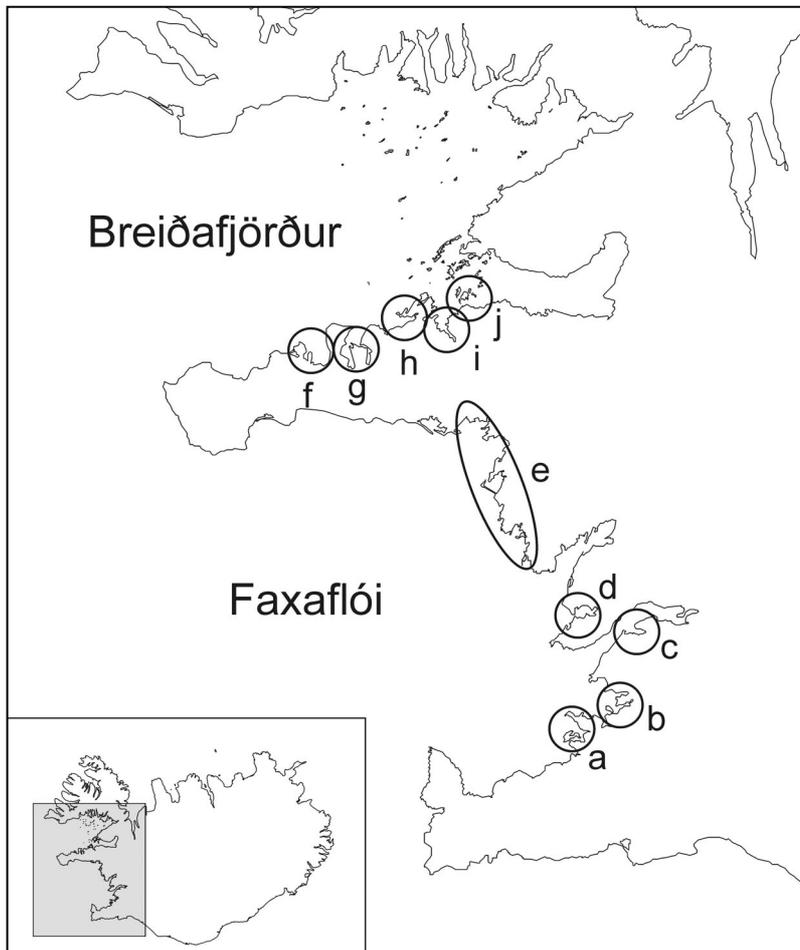


Figure 36. Distribution of Light-bellied Brent Geese along the west coast of Iceland 1974-1995. (Labels a-j refer to site descriptions in the text.)

b) Leiruvogur*Region:*

Kjósarsýsla, Mosfellsbær

Site conservation status

Nature Reserve (partial; Varmárósar)

Site description and habitat

Leiruvogur (64° 11' N, 21° 42' W) is an area of intertidal mudflats and saltmarshes.

Numbers and trends

Regular counts are made at this site in the spring.

This is a newly established site (used since 1999). A peak count of 260 birds was recorded in spring 2002.

c) Hvalfjardareyri–Laxárvogur*Region:*

Kjósarsýsla

Site conservation status

IBA (Hvalfjardareyri–Laxárvogur)

Site description and habitat

The area between Hvalfjardareyri and Laxárvogur (64° 20' N, 21° 4 0' W) contains the large embayment of Hvalfjörður which comprises extensive intertidal mudflats.

Numbers and trends

This site is regularly counted in the spring. There has been a continuous increase in numbers recorded during the spring over the past 10 years, from around 200 in 1990 to 750 in 2002.

d) Bautós–Grunnafjörður*Region:*

Borgarfjardarsýsla

Site conservation status

Nature Reserve (Grunnafjörður)

Ramsar (Grunnafjörður)

IBA (Innstavogsnes-Grunnafjörður)

Site description and habitat

The area between Bautós and Grunnafjörður (64° 22' N, 21° 55' W) comprises estuarine bays with small offshore islands, beaches, saltmarshes, intertidal flats and agriculturally-improved grasslands near the seashore.

Numbers and trends

Counts of the whole area have been made from the air in the spring of nine years. Numbers of Light-bellied Brent Geese in the spring have increased

from 1,300-1,700 in the 1980s to 3,300-5,680 in the 1990s. A peak count of 5,680 was made in 1999.

e) Straumfjörður–Löngufjörur*Region:*

Mýrarsýsla

Site conservation status

IBA (Álftanes–Akkrar)

Site description and habitat

The area between Straumfjörður and Löngufjörur (64° 40' N, 22° 24' W) comprises extensive intertidal mudflats and numerous islands, lagoons, freshwater marshes, salt marshes and standing pools of fresh and brackish water.

Numbers and trends

Counts of the whole area have been made from the air in the spring of nine years. Up to 10,000 birds congregate in this area during the autumn (mainly near Hjörsey). In the spring 1986 and 1990, the numbers were close to 5,200 (mainly at Akraós) but since 1995 have dropped to 1,000-3,400 birds.

f) Grundarfjörður*Region:*

Snæfellsnes og Hnappadalssýsla

Site conservation status

Conservation Area (Breidafjörður)

Site description and habitat

Grundarfjörður (64° 56' N, 23° 18' W) is an area of intertidal mudflats and rocky shores.

Numbers and trends

Counts of the whole area have been made from the air in the spring of eight years. Up to 850 birds have been recorded during the spring (average 440 in six counts 1990-2000).

g) Kolgrafarfjörður–Hraunsfjörður*Region:*

Snæfellsnes og Hnappadalssýsla

Site conservation status

Conservation Area (Breidafjörður)

Site description and habitat

The area between Kolgrafarfjörður and Hraunsfjörður (64° 57' N, 23° 06' W) comprises intertidal mudflats, lagoons and saltmarshes.

Numbers and trends

Counts of the whole area have been made from the air in the spring of eight years. Up to 1,450 birds have been recorded during the spring (average 830 in six counts 1990-2000).

h) Hofstadavogur–Jónsnes

Region:

Snæfellsnes og Hnappadalssýsla

Site conservation status

Conservation Area (Breidafjörður)
IBA (Álftafjörður–Hofstadavogur)

Site description and habitat

The area between Hofstadavogur and Jónsnes (65° 00' N, 22° 51' W) is made up of a complex of coastal bays with extensive intertidal mudflats, rocky outcrops and small offshore islands.

Numbers trends

Counts of the whole area have been made from the air in the spring of nine years. Up to 3,300 Light-bellied Brent Geese have been recorded during the spring (average 1,280 in six counts 1990-2000).

i) Vigrafjörður–Álftafjörður

Region:

Snæfellsnes og Hnappadalssýsla

Site conservation status

Conservation Area (Breidafjörður)
IBA (Álftafjörður–Hofstadavogur)

Site description and habitat:

The area between Vigrafjörður and Álftafjörður (65° 00' N, 22° 40' W) comprises intertidal mudflats, rocky outcrops and small islands.

Numbers and trends

Nine aerial counts of the whole area have been made during the spring. Up to 4,960 Light-bellied Brent Geese have been recorded during the spring (average 1,950 in six counts 1990-2000).

j) Brokeyjarlönd, Hvammsfjörður

Region: Snæfellsnes og Hnappadalssýsla

Site conservation status

Conservation Area (Breidafjörður)

Site description and habitat

Brokeyjarlönd, Hvammsfjörður, (65° 05' N, 22° 30' W) comprises a complex of islands with small bays and sheltered intertidal mudflats mixed with rocky shores and skerries rich with seaweeds.

Numbers and trends

Counts of the whole area have been made from the air in the spring of eight years. Up to 1,380 Light-bellied Brent Geese have been recorded during the spring (average 650 in six counts 1990-2000).

2.3 Greenland

Due to the lack of systematic surveys, it is very difficult to identify sites of international importance for Light-bellied Brent Geese in Greenland. Counts probably underestimate the total number of birds using key staging sites and there are undoubtedly more important sites that have yet to be identified. The locations of each of the key known autumn staging sites in northwest Greenland are shown in Fig. 37. The numbers on the map refer to those presented in the following text.

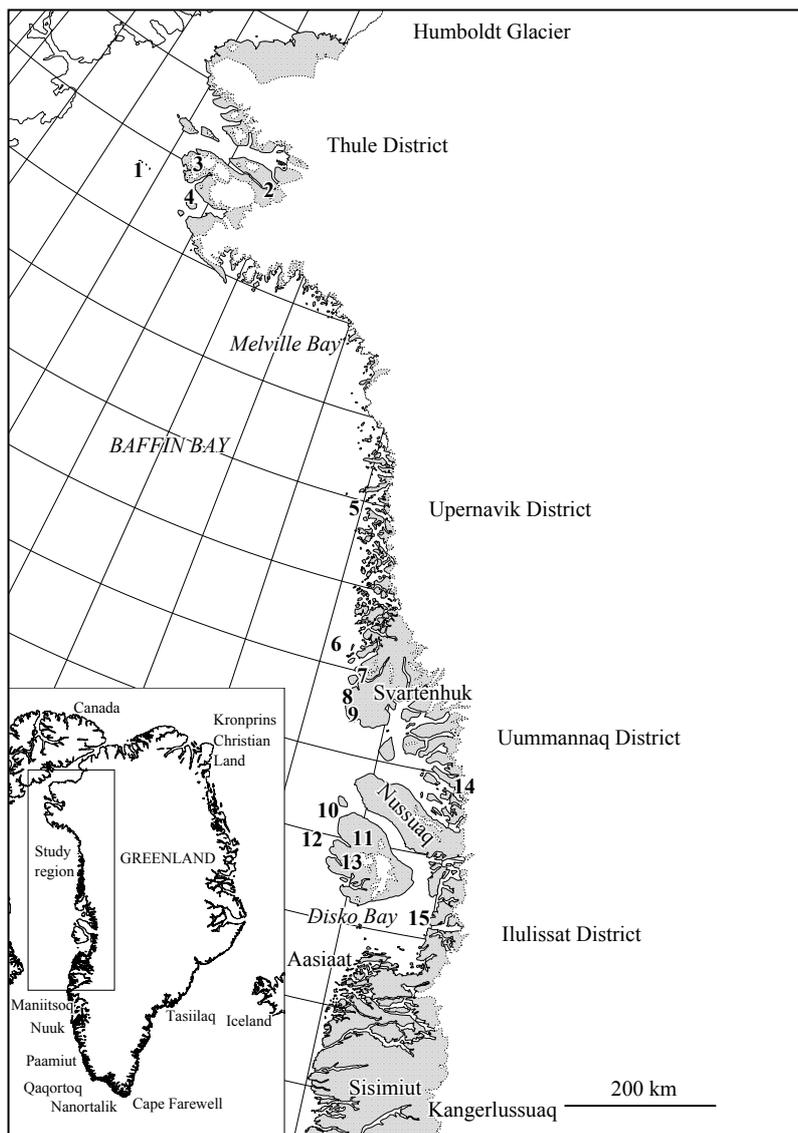
In the Thule District, the Carey Islands (76° 43' N, 73° 04' W; Site number 1) are a small group of offshore and inaccessible islands that support small flocks of Light-bellied Brent Geese in the summer and autumn. An average of 26, and up to 48, birds have been recorded at this site in late August.

Elsewhere in Thule, 35 birds were recorded at Orlik Fjord (Site number 2) in August 1994, three birds at Booth Sound (Site number 3) and two birds on Manson Island (Site number 4) in August 1995.

On Disko Island, the largest concentrations of Light-bellied Brent Geese have been recorded at Mellemfjord (69° 42' N 54° 32' W; Site number 13), a fjord with extensive saltmarsh coasts and a shallow delta area. This is probably one of the most important autumn staging areas in west Greenland. On average the site holds 186 birds, although around 300 birds were recorded in August 1992 and 1994.

Nordfjord (69° 55' N, 54° 18' W; Site number 11) is a fjord with a shallow delta area and some saltmarsh. It is a Ramsar site (Qinguata Marraa-Kuussuaq). This site is perhaps as important as Mellemfjord during the autumn. An average of 68 and up to 156 birds have been recorded during early September.

Figure 37. Distribution of Light-bellied Brent Geese along the northwest coast of Greenland during the autumns of 1987 and 1991-1995 (from Boertmann *et al.* 1997)



On the northwest coast of Disko Island (Site number 10), most Light-bellied Brent Geese occur at an extensive shallow lagoon (70° 05' N, 54° 49' W) behind an exposed barrier beach. Birds have been recorded here in the summer (maximum count 4) and autumn (maximum count of 90 birds in September 1995). The only other site identified on Disko Island is located at Qasigissat (Site number 12), where 10 birds were recorded in September 1995.

In Illulissat District, 15 birds were recorded around the town (Site number 15) in September 1987 and in Uummannaq District, 45 birds were recorded at Sermelat Kangerluat (Site number 14) in September 1995.

In the Upernavik Municipality, Ederfugleøer (74° 02' N, 57° 48' W; Site number 5) is a group of small offshore islands used by Light-bellied Brent Geese in the summer and autumn. Of the two counts made at this site, five birds were recorded in the early summer and 55 in late August. Elsewhere in this Municipality, Svartenhavn (71° 39' N, 55° 35' W; Site number 8) is probably an important autumn staging area. A single count of 90 birds was made at this site in September 1995. Up to 30 birds have also been recorded at Milloorfik (Site number 7), Narsaq (Site number 9) and Store Fladø (Site number 6).

The shallow head of the fjord at Angujatorfik, Søndre Strømfjord (66° 43' N, 51° 26' W), in the Maniitsoq Municipality, is probably an important autumn staging area. Around 75 birds have been recorded there in September.

Of those sites where Light-bellied Brent Geese are known to stage in Greenland, the Carey Islands, Booth Sound, Nordfjord, and Ederfugleøer have been identified as IBAs by BirdLife International.

2.4 France

Several hundred Light-bellied Brent Geese spend part of the non-breeding season along the northwest coast of France between November and March. This section is based primarily on information on Important Bird Areas for Light-bellied Brent Geese as identified by BirdLife International (Heath & Evans 2002).

2.4.1 Internationally important sites

i) Baie des Veys et Marias du Contenin

Site conservation status

SPA (Basses vallées du Contenin et baie des Veys)
Ramsar (Baie des Veys et Marias du Contenin)
Nature Reserve
IBA (Baie des Veys et Marias du Contenin: criteria A4i, B1i, C3)

Site description and habitat

Baie des Veys et Marias du Contenin (49° 20' N, 1° 15' W) is a bay with mudflats, sandflats, rocky shores, saltmarshes, wet meadows, aquatic vegetation and peatbogs.

Numbers and trends

Up to 1,350 birds have been recorded at the site during passage periods. Havre de Regenville, where flocks of up to 800 birds have occurred in recent years, is the chief resort, with up to 100 birds at Portbail and Granville associating with larger flocks of Dark-bellied Brent Geese. As in the Channel Islands, Canadian-marked birds have been seen in France, so the presumption is that most of these birds are from the East Canadian High Arctic population. There are no known re-sightings of birds from the Svalbard/NE Greenland population. However, provenance of French birds deserves further attention. In the whole of western France, Light-bellied Brent Geese are greatly outnumbered by Dark-bellied Brent Geese (Schricke 1999), with 137,000 of the latter present in December 1991 and over 100,000 in nearly all winters since, using more than 30 sites and seven of international importance (>3,000 birds).

2.5 Scotland

At present, there are no sites in Scotland with internationally important concentrations of Light-bellied Brent Geese. Sites on Islay, in the Outer Hebrides, from Barra to the Sound of Harris, and on the west coast of the mainland, e.g. Loch Ryan, are visited annually by small groups of Light-bellied Brent Geese on passage between Iceland and Ireland. Very occasionally, large numbers stop briefly, notably 4,000 at Loch Indaal, Islay in 1971. The Scottish haunts generally serve as temporary staging sites, probably when unfavourable weather conditions develop during migration, or when some geese find themselves under stress. However, small flocks spend the entire winter at these sites in some years.

2.6 Wales

There are no internationally important sites for Light-bellied Brent Geese in Wales. Small flocks occur regularly at several sites, chiefly in late winter, and have increased during the 1990s, especially at Inland Sea, Anglesey, Forjd Bay and the Dee Estuary (England/Wales). Small flocks (up to around 20 birds) are recorded regularly at Carmarthen Bay during the autumn.

2.7 England

There are no internationally important sites for Light-bellied Brent Geese in England. Small flocks (< 30 birds) occur in autumn or winter in several estuaries in the southwest, most often on the estuaries of the Exe (maximum 72) and Camel (maximum 26), where they are joined by larger flocks of Dark-bellied Brent Geese. These birds may be some of those moving to sites further south in the Channel Islands and northern France.

2.8 The Channel Islands

Although there are no internationally important sites, around 100 Light-bellied Brent Geese are recorded annually on Jersey and Guernsey, staying from November through until early April. These birds are presumably from the East Canadian High Arctic population, given that a colour-marked bird ringed on Melville Island in 1974 was seen at St. Aubins Bay, Jersey, in January 1975. They are joined by larger flocks of Dark-bellied Brent Geese. It seems unlikely that birds from the Svalbard/NE Greenland population stray as far south as the Channel Islands.

2.9 Spain

Although there were no documented records of Light-bellied Brent Geese before 1985, up to around 50 Light-bellied Brent Geese have been recorded in the Galicia region of northwest Spain in recent winters (Salaverri 2002). These birds are presumed to be from the East Canadian High Arctic population, although there have been no sightings of colour-marked birds. Notable peak counts are of 31 birds in the Ría del Eo, Lugo-Asturias and seven birds in the Ría de Foz, Lugo, both in September 1999. Generally, only individuals are recorded elsewhere. Numbers peak in September and decline as the winter progresses and may involve birds which have 'overshot' traditional sites on the southwest coast of Ireland. It is likely that these birds move north to sites in the south of Ireland or northern France as the winter progresses.

3 FUTURE RESEARCH NEEDS

East Canadian High Arctic Light-bellied Light-bellied Brent Geese are listed under the African-Eurasian Waterbird Agreement (AEWA). This Agreement was drawn up under the Bonn Convention to provide a focused framework for the conservation of migratory waterbirds. The Agreement encourages co-operation between Parties on the conservation management of shared populations of migratory waterbirds, and in particular the need to co-ordinate efforts to ensure a network of suitable habitats is maintained throughout the entire migratory range of such species. For this population of Brent Geese, the Action Plan of the Agreement requires Parties to prepare national action plans 'with a view to improving...overall conservation status'. In light of the small numbers of countries involved, and given the history of co-operative international conservation and research initiatives, it would seem appropriate that in this case an international approach is taken, with the production of a Flyway Management Plan. To this end, WWT and the IBGRG have initiated a programme of research aimed to underpin the production of this FMP. Successful production will involve Brent Goose specialists and governmental agencies from all countries which play host to this population of geese during different times of the year. It is also hoped that the CWS 'Sister Reserves' project can be revived and extended to include new sites used throughout the annual cycle, to assist conservation of this population and increase public awareness.

There is much to be learnt about the flyway of these Light-bellied Brent Geese and particularly the importance and use of staging sites in Iceland, Greenland and Canada. Satellite telemetry provides a method for tracking the migration routes of species such as Light-bellied Brent Geese which pass through large areas uninhabited by human observers. WWT used this technology to track migratory routes of six individuals in spring and autumn 2002 and it is hoped that some ground-truthing of the results of these studies will follow. Continued colour-marking of individuals will also enable observers to determine the phenology of migration and assist in delimiting the flyway with more accuracy. In addition, the flexibility of migration needs to be addressed, to assess the importance of staging sites along the flyway.

Although much is known about the movements, feeding ecology and effects of disturbance on this population of geese on the wintering grounds, there are many gaps in our knowledge. The use of *Zostera*

at intertidal areas in Ireland requires further attention, with a more site-specific focus on spatial depletion of *Zostera* and consequential switching to alternative foods, such as agricultural crops. The foraging behaviour of birds elsewhere along the flyway also requires some attention. An economic appraisal of the potential effects of Light-bellied Brent Geese moving onto agricultural land would help plan future management procedures.

The potential effects and impacts of changes in global climate also require attention. On the breeding grounds, short-term effects of increased temperatures will melt the upper permafrost under vegetated areas, eventually leading to soil slumping and vegetational die-back (S. Edlund unpubl. report). As mentioned above, the effects of climate change on the wintering and staging grounds, e.g. loss of intertidal habitat due to sea level rise and erosion due to increased frequency of storms, may also be damaging. In order to be able to predict the impacts of change on the Light-bellied Brent Goose population it will be necessary to build an individuals-based population model.

Individuals-based population models have focused on the impacts of habitat loss on waterbird populations previously and provide a conceptual framework for predicting its consequences (e.g. Goss-Custard *et al.* 1995, Pettifor *et al.* 2000). In simplistic terms, habitat loss gives rise to a reduction in food availability and therefore increased density (e.g. Sutherland & Goss-Custard 1991). Increased density, in turn, results in increased food depletion and/or competitive interference so that food intake is affected, reducing the optimality of the habitat and hence its 'carrying capacity' (Goss-Custard 1985). The consequence of this at the metapopulation scale is to reduce productivity and increase mortality as birds drop below a critical body mass threshold for survival, leading to flyway-scale population declines as habitat is increasingly lost. As habitat is lost there may be no effects on bird numbers until a threshold density is reached. Beyond this density, density-dependent mortality occurs (Zwarts 1976). By adopting this method, we may learn much about the potential impacts of threats facing Light-bellied Brent Geese.

To build the population model it will be necessary to monitor productivity and survival in relation to density-dependent and state-dependent (to account for changing priorities according to current state and anticipated prospects) factors. Measures of productivity, survival, and movements will be

required together with intensive studies of behaviour, especially foraging. As this review has shown, there is an urgent requirement to validate and probably improve the estimation of population size, possibly by undertaking autumn counts in Iceland, where birds are more concentrated, or by improving the methodology of counting on the wintering grounds.

4 ACKNOWLEDGEMENTS

This review of monitoring information would not have been possible without the efforts of dedicated volunteer and professional ornithologists who monitor and research Light-bellied Brent Geese throughout their range. We are extremely grateful for their efforts and strongly encourage them to continue their valuable work into the future. Luis José Salaverri Leiras, Bertram Bree, and Gérard Debout provided invaluable information. We also wish to thank the Irish Brent Goose Research Group, Helen Baker, David Stroud, Mark Pollitt, Colette Hall and Peter Cranswick for their support

and assistance during the production of this review and Carl Mitchell who reviewed an earlier draft. This work was part-funded by The Heritage Council, Ireland.

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.

5 REFERENCES

- Alerstam, T., Gudmundsson, G.A., Jönsson, P.E., Karlsson, J. & Lindström, A. 1990. Orientation, migration routes and flight behaviour of Knots, Turnstones and Brent geese departing from Iceland in spring. *Arctic* 43: 201-204.
- Andrews, D.J., Mathers, R.G. & Rainey, E. 1996. Brent Geese feeding on agricultural land around Strangford Lough, Co. Down. *Irish Birds* 5: 407-412.
- Bennike, O. 1990. Observations of geese and other birds in West Greenland, 1989 and 1990. *Danske Orn. Foren. Tidsskr* 84: 145-150.
- Berry, J. 1939. *The status and distribution of wild geese and wild duck in Scotland*. Cambridge.
- Bertelsen, A. 1921. Fulene i Umánaq Distrikt. *Meddr Grønland* 62: 139-214.
- Boertmann, D., Mosbech, A. & Frimer, O. 1997. Autumn migration of Light-bellied Brent Geese *Branta bernicla hrota* through north-west Greenland. *Wildfowl* 48: 98-107.
- Boyd, H. 1980. Importance of Ireland's Brent Geese. *British Birds* 73: 363-364.
- Boyd, H. & Maltby, L.S. 1979. The Brant of the western Queen Elizabeth islands, N. W. T. Pp 5-21. In R.L. Jarvis, & J.C. Bartonek (eds.) *Management and Biology of Pacific Flyway Geese*. OSU Book Stores, Corvallis, Oregon.
- Brown, R.A. 1988. Is there competition between Light-bellied Brent Geese and Wigeon on Strangford Lough? In J. Harradine (ed.) *Wigeon - current trends and future needs*: 76-84. British Association for Shooting and Conservation.
- Cabot, D. 1965. *The Pale-bellied Brent Goose (Branta b. hrota) in Ireland, 27th/28th November 1965*. Irish Wildbird Conservancy Publication No. 1.
- Cabot, D. 1966. *The status and distribution of the Pale-bellied Brent Goose (Branta b. hrota) in Ireland, 5th/6th February 1966*. Irish Wildbird Conservancy Publication No. 2.
- Cabot, D. 1967. *The status and distribution of the Brent goose (Branta b. hrota) in Ireland, 1966/67*. Irish Wildbird Conservancy Publication No. 6.
- Cabot, D. 1968. *The status and distribution of the Brent Goose in Ireland, 1967/68*. Irish Wildbird Conservancy Publication No. 10.
- Cabot, D. 1973. *National Brent Goose Census, 1972/73*. Unpubl. report.
- Cabot, D. 1974. *National Brent Goose Census, 1973/74*. Unpubl. report.
- Cabot, D. 1975. *National Brent Goose Census, 1974/75*. Unpubl. report.
- Clausen, P. & Bustnes, J.O. 1998. Flyways of the North Atlantic light-bellied Brent geese *Branta bernicla hrota* reassessed by satellite telemetry. In F. Mehlum, J.M. Black & J. Madsen (eds.) *Research on Arctic Geese. Proceedings of the Svalbard Goose Symposium, Oslo, Norway, 23-26 September 1997*. *Norsk Polarinstitutt Skrifter* 200: 235-251.
- Clausen, P., Madsen, J., Percival, S.M., O'Connor, D. & Anderson, G.Q.A. 1998. Population development and changes in winter site use by the Svalbard Light-bellied Brent Goose *Branta bernicla hrota* 1980-94. *Biological Conservation* 84: 157-165.
- Colhoun, K. 2001. *I-WeBS Report 1998-99: Results of the fifth winter of the Irish Wetland Bird Survey*. BirdWatch Ireland.
- Colhoun, K. & Newton, S.F. 2000. Winter waterbird populations on non-estuarine coasts in the Republic of Ireland: results of the 1997-98 Non-Estuarine Coastal Waterbird Survey (NEWS). *Irish Birds* 6: 527-542.
- Cranswick, P.A., Kirby, J.S., Salmon, D.G., Atkinson-Willes, G.L., Pollitt, M.S. & Owen, M. 1997. A history of wildfowl counts by WWT. *Wildfowl* 47: 217-229.
- Debout, G. & Leclerc, F. 1990. La Bernache cravant à ventre clair *Branta bernicla hrota*, en France: Précisions sur son statut. *Alauda* 58: 209-215.
- Dúchas 2002. *Special Protection Areas for Birds in Ireland*. Dublin.
- Fahy, E., Goodwille, R., Rochford, J. & Kelly, D. 1975. Eutrophication of a partially enclosed estuarine mudflat. *Marine Pollution Bulletin* 6: 29-31.

- Fox, A.D., Norriss, D.W., Stroud, D.A. & Wilson, H.J. 1994a. *Greenland White-fronted Geese in Ireland and Britain 1982/83-1993/94*. Greenland White-fronted Goose Study Research Report No. 8.
- Fox, A.D., Bell, M.C., Brown, R.A., Mackie, P. & Madsen, J. 1994b. An analysis of the abundance and distribution of Brent Geese and Wigeon at Strangford Lough, 1965/6-1988/9. *Irish Birds* 5: 139-150.
- Gardarsson, A. 1974. Islenskir votlendisfuglar. *Votlendi: Rit Landverndar* 4: 100-134.
- Gardarsson, A. 1979. *Sites of major importance to Branta bernicla hrota in Iceland*. Proceedings of First Technical Meeting on Western Palearctic Migratory Bird Management, Paris 1977.
- Gardarsson, A. & Gudmundsson, G.A. 1997. Numbers of Light-bellied Brent Geese *Branta bernicla brota* staging in Iceland in spring. *Wildfowl* 47: 62-66.
- Gilbert, G., Gibbons, D.W. & Evans, J. 1998. *Bird Monitoring Methods*. RSPB, Sandy.
- Goss-Custard, J.D. 1985. Foraging behaviour of wading birds and the carrying capacity of estuaries. In R.M. Sibly & R.H. Smith (eds.). *Behavioural ecology: Ecological consequences of Adaptive Behaviour*: 169-188. Blackwell Scientific Publications, Oxford.
- Goss-Custard, J.D., Clarke, R.T., Durell, S.E.A. Le V. Dit, Caldwell, R.W.G. & Ens, B.J. 1995. Population consequences of winter habitat loss in a migratory shorebird. *Journal of Applied Ecology* 32: 337-351.
- Gray, D.R. 1990. Winter studies of birds and mammals in the Canadian Arctic islands. In C.R. Harrington (ed.) *Canada's missing dimension. Science and History in the Canadian Arctic Islands. Vol. II*: 564-569. Canadian Museum of Natural History.
- Gregory, R.D., Wilkinson, N.I., Noble, D.G., Robinson, J.A., Brown, A.F., Hughes, J., Procter, D., Gibbons, D.W. & Galbraith, C.A. 2002. The population status of birds in the United Kingdom, Channel Islands and Isle of Man: an analysis of conservation concern 2002-2007. *British Birds* 95: 410-448.
- Gudmundsson, G.A., Benvenuti, S., Alerstam, T., Papi, F., Lilliehdahl, K. & Åkesson, S. 1995. Examining the limits of flight and orientation performance: satellite tracking of brent geese migrating across the Greenland ice-cap. *Proceedings of the Royal Society, London B* 261: 73-79.
- Heath, M.F. & Evans, M.I. (eds.) 2000. *Important Bird Areas in Europe: Priority sites for conservation. I: Northern Europe*. Cambridge, UK: BirdLife International (BirdLife Conservation Series No. 8).
- Hjort, C. 1995. Brent geese in northeasternmost Greenland. *Dansk Ornithologisk Forenings Tidsskrift* 89: 89-91.
- Hjort, C., Hakansson, E. & Molgaard, P. 1987. Brent Geese *Branta bernicla*, Snow Geese *Anser caerulescens* and Barnacle Geese *Branta leucopsis* on Kilen, Kronprins Christian Land, Northeast Greenland, 1985. *Dansk Ornithologisk Forenings Tidsskrift* 81: 121-128.
- Hutchinson, C.D. 1979. *Ireland's wetlands and their birds*. Irish Wildbird Conservancy, Dublin.
- Jeffrey, D. (ed.) 1997. *North Bull Island Dublin Bay - a modern coastal natural history*. Royal Dublin Society, Dublin.
- Kennedy, P.G., Ruttledge, R.F. & Scroope, C.F. 1954. *Birds of Ireland*. Oliver & Boyd, Edinburgh.
- Lambeck, R.H.D. 1977. Het voorkomen van Rotgans *Branta bernicla* ondersooten in het Nederlandse Waddengebied tijdens het voorjaar van 1976. *Limosa* 50: 92-97.
- Mathers, R.G. & Montgomery, W.I. 1997. Quality of food consumed by over-wintering Pale-bellied Brent Geese *Branta bernicla brota* and Wigeon *Anas penelope*. *Biology and Environment: Proceedings of the Royal Irish Academy* 97B: 81-97.
- Mathers, R.G., Montgomery, W.I. & Portig, A.A. 1998a. Exploitation of intertidal *Zostera* species by Brent Geese (*Branta bernicla brota*): why dig for your dinner? *Biology and Environment: Proceedings of the Royal Irish Academy* 98B: 147-152.
- Mathers, R.G., Montgomery, W.I., Portig, A.A. & Stone, R. 1998b. Winter habitat use by Brent Geese *Branta bernicla brota* and Wigeon *Anas penelope* on Strangford Lough, Co. Down. *Irish Birds* 6: 257-268.

- Mathers, R.G., Portig, A.A. & Montgomery, W.I. 1998c. Distribution and abundance of Pale-bellied Brent Geese and Wigeon on Strangford Lough, Northern Ireland. *Bird Study* 45: 18-34.
- Mathers, R.G., Watson, S., Stone, R. & Montgomery, W.I. 2000. A study of the impact of human disturbance on Wigeon *Anas penelope* and Brent Geese *Branta bernicla* on an Irish sea loch. *Wildfowl* 51: 67-81.
- Meltofte, H. 1976. Ornithological observations in Southern Parry Land, North Greenland 1973. *Meddelelser om Grønland* 205.
- Meltofte, H., Elander, M. & Hjort, C. 1981. Ornithological observations in Northeast Greenland between 74 30' and 76 00'N, 1976. *Medelser om Grønland, Bioscience* 3.
- Merne, O.J., Boertmann, D., Boyd, H., Mitchell, C., O'Briain, M., Reed, A. & Sigfusson, A. 1999. Light-bellied Brent Goose *Branta bernicla brota*. Canada. In: J. Madsen, G. Cracknell, & A.D. Fox (eds.) *Goose populations of the Western Palearctic. A review of status and distribution*: 298-311. Wetlands International Publ. No. 48, Wetlands International, Wageningen, The Netherlands and National Environmental Research Institute, Rønde, Denmark.
- Musgrove, A.J., Pollitt, M.S., Hall, C., Hearn, R.D., Holloway, S.J., Marshall, P.E., Robinson, J.A. & Cranswick, P.A. 2001. *The Wetland Bird Survey 1999-2000: Wildfowl & Wader Counts*. BTO/WWT/RSPB/JNCC, Slimbridge.
- Newton, S., Donaghy, A., Allen, D. & Gibbons, D. 1999. Birds of Conservation Concern in Ireland. *Irish Birds* 6: 333-342.
- O'Briain, M. 1989. *The social organisation, population ecology and distribution of Light-bellied Brent Geese (Branta bernicla brota) wintering in Ireland*. Unpubl. PhD Thesis, National University of Ireland.
- O'Briain, M. 1991. Use of a *Zostera* bed in Dublin by Light-bellied Brent Geese, 1981/82 to 1990/91. *Irish Birds* 4: 299-316.
- O'Briain, M. & Healy, B. 1991. Winter distribution of Light-bellied Brent Geese *Branta bernicla brota* in Ireland. *Ardea* 79: 317-326.
- O'Briain, M., Reed, A. & MacDonald, S.D. 1998. Breeding, moulting, and site-fidelity of Brant (*Branta bernicla*) on Bathurst and Seymour Islands in the Canadian High Arctic. *Arctic* 51: 350-360.
- Owen, M. 1976. Factors affecting the distribution of geese in the British Isles. *Wildfowl* 27: 143-147.
- Percival, S.M., Sutherland, W.J. & Evans, P.R. 1996. A spatial depletion model of the responses of grazing wildfowl to the availability of intertidal vegetation. *Journal of Applied Ecology* 33: 979-992.
- Pettifor, R.A., Caldow, R.W.G., Rowcliffe, J.M., Goss-Custard, J.D., Black, J.M., Hodder, K.H., Houston, A.I., Lang, A. & Webb, J. 2000. Spatially explicit, individual-based, behavioural models of the annual cycle of two migratory goose populations. *Journal of Applied Ecology* 37 (Suppl. 1): 103-135.
- Porsild, M.P. 1922. Migration of the Brant *Branta bernicla* in Greenland. *Canadian Field Naturalist* 36: 144-145.
- Portig, A.A., Mathers, R.G., Montgomery, W.I. & Govier, R.N. 1994. The distribution and utilisation of *Zostera* species in Strangford Lough, Northern Ireland. *Aquatic Botany* 47: 317-330.
- Ramsar. 1999. *Strategic Framework for the List of Wetlands of International Importance*. Ramsar Bureau, Gland, Switzerland.
- Rasmussen, E. 1977. The wasting disease of eelgrass (*Zostera marina*) and its effects on environmental factors and fauna. In C.P. McRoy & C. Helfferich (eds.) *Seagrass ecosystems – a scientific perspective*: 1-15. Marcel Dekker Inc., New York.
- Rutledge, R.F. 1966. *Ireland's Birds*. Witherby, London.
- Rutledge, R.F. 1985. Brent Geese feeding on grain. *Irish Birds* 3: 103-104.
- Rutledge, R.F. & Hall Watt, R. 1958. The distribution and status of wild geese in Ireland. *Bird Study* 5: 22-23.
- Salaverri, L. 2002. Os Gansos de Cara Negra (*Branta bernicla*) en Galicia. *A Carrizxa* 2: 9-15.
- Salmon, D., Moser, M.E. & Kirby, J.S. 1987. *Wildfowl & Wader Counts 1985-86*. The Wildfowl Trust, Slimbridge.
- Salomonsen, F. 1950. *Grønlands Fugle, The Birds of Greenland*. Munksgaard, Copenhagen.
- Salomonsen, F. 1967. *Fuglene på Grønland*. Rhodos, København.

- Schricke, V. 1999. Status in France. In A. Czajkowski & V. Schricke (eds.) *International Scientific Workshop 'Towards European management of the Dark-bellied Brent Goose Branta b. bernicla as a game species'*, Vannes, Morbihan-France: 5-7 November 1998: 5-9. FACE/OMPO/ONC, Paris, France.
- Scott, D.A. & Rose P.M. 1996. *Atlas of Anatidae Populations in Africa and Western Eurasia*. Wageningen, The Netherlands, Wetlands International Publication No. 44.
- Sheppard, R. 1993. *Ireland's Wetland Wealth*. Irish Wildbird Conservancy.
- Shields, G.F. 1990. Analysis of mitochondrial DNA of Pacific Black Brant *Branta bernicla nigricans*. *Auk* 107: 620-623.
- Smiddy, P. 1987. Brent geese feeding on potatoes. *Irish Birds* 3: 452-453.
- Stroud, D.A., Chambers, D., Cook, S., Buxton, N., Fraser, B., Clement, P., Lewis, I., McLean, I., Baker, H. & Whitehead, S. (eds.) 2001. *The UK SPA network: its scope and content*. JNCC, Peterborough. 3 volumes.
- Summers, R.W. 1990. The effect of grazing on winter wheat by Brent Geese *Branta b. bernicla*. *Journal of Applied Ecology* 29: 35-40.
- Sutherland, W.J. & Goss-Custard, J.D. 1991. Predicting the consequence of habitat loss on shorebird populations. *Acta XX Congressus Internationalis Ornithologici*. 2199-2207.
- Tucker, G.M. & Heath, M.F. 1994. *Birds in Europe: their Conservation Status*. BirdLife International, Cambridge, UK (BirdLife Conservation Series No. 3).
- Ussher, R.J. & Warren, R. 1900. *The Birds of Ireland*. Gurney & Jackson, London.
- Veiga, J. 1999. Conditions of a possible resumption of shooting of the Dark-bellied Brent Goose in France. In A. Czajkowski & V. Schricke (eds.) *International Scientific Workshop 'Towards European management of the Dark-bellied Brent Goose Branta b. bernicla as a game species'*, Vannes, Morbihan-France: 5-7 November 1998. FACE/OMPO/ONC, Paris, France. Pp. 55-62.
- Vickery, J.A. & Sutherland, W.J. 1992. Brent Geese: a conflict between conservation and agriculture. In Clarke, J. (ed.) *Set-Aside*. BCPC Monograph 50: 187-192. Lavenham Press, Lavenham.
- Wetlands International. 2002. *Waterbird Population Estimates – Third Edition*. Wetlands International Global Series No. 12, Wageningen, The Netherlands.
- Zwarts, L. 1976. Density-related processes in feeding dispersion and feeding activity in teal (*Anas crecca*). *Ardea* 64: 192-209.