NINA Report 201

The avifaunal value of the Lofoten Islands in a World Heritage perspective

Tycho Anker-Nilssen

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Tycho Anker-Nilssen

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Atlantic puffin (© Tycho Anker-Nilssen)

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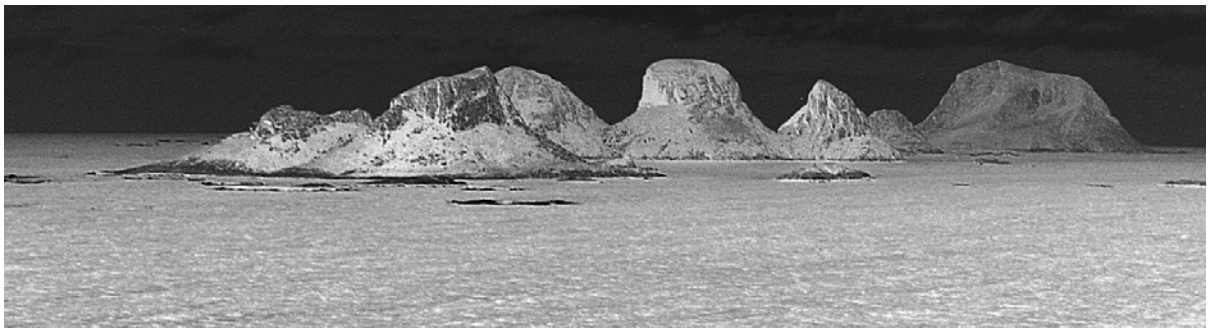

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Abstract

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This report describes the quality of the bird life in the Lofoten Islands, primarily assessed according to national and international criteria such as those outlined in the Norwegian Red List 1998 and by IUCN and BirdLife International. Few if any other places north of the Arctic Circle have a more diverse avifauna than this area. The most valued bird quality however is the huge breeding and wintering populations of seabirds, several of which occur in numbers of international importance or are for other reasons identified to be of special conservation concern. Røst, the outermost municipality of the Lofoten Islands, holds the largest aggregation of breeding seabirds on the European mainland and close to 20% of all seabirds breeding along the Norwegian coast. It qualifies as a global IBA (Important Bird Area) for breeding Atlantic Puffins and European Shags and as an European IBA for wintering King Eiders, which also winter in equally or more important numbers in several of the other municipalities. The report also presents a list of selected publications from seabird research in Røst, a facsimile summary of results from the research on Atlantic Puffins there and a list of bird species that are known or likely to breed in the Lofoten Islands.

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Sammendrag

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Denne rapporten beskriver kvaliteten på fuglelivet i Lofoten, i første rekke vurdert i henhold til nasjonale og internasjonale kriterier som er skissert i Nasjonal rødliste for truete arter i Norge 1998 og av IUCN og BirdLife International. Få om noen andre steder nord for polarsirkelen har høyere avifaunistisk diversitet enn dette området. Den mest verdsatte ornitologiske kvaliteten er likevel de store bestandene av hekkende og overvintrende sjøfugler, hvorav flere forekommer i antall av internasjonal betydning eller er av andre årsaker tillagt spesielle forvaltningshensyn. Røst, den ytterste av kommunene i Lofoten, har den største ansamlingen av hekkende sjøfugler på det europeiske fastlandet og nær 20 % av alle hekkende sjøfugler på norskekysten. Stedet kvalifiserer som globalt IBA (Important Bird Area) for hekkende lunde og toppskarv og som europeisk IBA for overvintrende praktærfugl, som også overvintrer i like store eller større antall i flere av de andre kommunene. Rapporten inneholder også en litteraturliste for sjøfuglforskningen på Røst, et faksimilesammendrag av resultater fra lundeforskningen samme sted og en liste over fuglearter som er konstatert hekkende eller sannsynligvis hekker i Lofoten.

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Foreword

This report was prepared on assignment for the Directorate for nature management (DN) during a week at the end of 2005. As there was no room for evaluating in detail all aspects of the ornithological qualities in the area, the document should not be read as a complete assessment in this regard. However, the most important conservation values and scientific qualities of seabirds are presented and briefly discussed. The report was first issued as an unpublished document in the series *NINA Minirapport*, but was recently reformatted to the present publication because of a need to make it more accessible to the public.

Trondheim, November 2006
Tycho Anker-Nilssen

Introductory note

This assessment is presented relatively concise and concentrated in order to serve as an expedient platform for decision support on ornithological values when assessing the quality of the Lofoten Islands as a World Heritage Site.

1 Sources and quality of bird data from the Lofoten Islands

The most comprehensive general source of information on the breeding distribution of birds in the area is the national atlas edited by Gjershaug et al. (1994), which was based on a national survey of breeding birds that was carried out by members of the Norwegian Ornithological Society (NOF) in the 1980s. However, the survey collected no quantitative data on population sizes and was made at a resolution of 10x10 km squares. Its coverage in the six municipalities in question was relatively good with at least some data collected from 42 (95%) of the 44 squares there. Later breeding records can now (since 2002) be entered directly into an online Internet database (Norsk Hekkefuglatlas; http://www.fugleatlas.no/), but except for those made by NINA's seabird scientists in Røst very few entries (4% of the total) have been added for the Lofoten Islands. As a result of another mapping project of NOF, a national atlas of wintering birds is soon to be printed. It is based on quantitative observations made in the same 10x10 km grid during the nine winters from 1994/95 to 2002/03 and contains information from 35 (80%) of the 44 squares in the six Lofoten municipalities.

The most important data source for seabirds is the National Seabird Registry (NSR; Det nasjonale sjøfuglkartverket) which is maintained by NINA as a national responsibility for the Ministry of Environment. It contains most site specific observations made of Norwegian seabirds since the 1960s. Each observation is entered with species name, numbers, counting unit (individuals, pairs or nests), date, geographical position, and (if known) sex and age of the bird(s). The database also contains supplementary information on methods, data accuracy, habitat type, weather conditions, identity of observer(s) and literature references. Unfortunately, its data for the Lofoten Islands are generally old and stem mostly from surveys made in the 1980s. With the exception of bird cliffs (which are planned to be counted in 2007), a new survey of the breeding seabirds in Lofoten & Vesterålen will be carried out as part of the national SEAPOP programme (Anker-Nilssen et al. 2005) in 2006. SEAPOP is currently being established to improve seabird mapping, monitoring and research in Norway and Svalbard. For the present assessment, however, it is fortunate that up-to-date data for Røst are available for most species of special concern, due to the annual monitoring and ecological studies of selected seabird species NINA conducts in that area.

Besides the distribution data, results of the long-term seabird research that has been carried out in Røst since the late 1950s forms a very important data source in this context. A selection of publications from this work is presented as a separate list of references before that of other references used in this document. The main focus has been the population ecology of the Atlantic Puffin *Fratercula arctica*, which have been studied annually in Røst since 1964. Over the last 25 years, the work has gradually been developed into a multi-species monitoring project of seabird ecology and presently includes annual data series on population trends (P), reproductive success (R), adult survival rates (S) and/or food choice (F) of the following nine species: Northern Fulmar *Fulmarus glacialis* (P), Great Cormorant *Phalacrocorax carbo* (PR), European Shag *Phalacrocorax aristotelis* (PRS), Black-legged Kittiwake *Rissa tridactyla* (PRS), Common Eider *Somateria mollissima* (P), Common Guillemot *Uria aalge* (PS), Rrazorbill *Alca torda* (P), Atlantic Puffin (PRSF) and Black Guillemot *Cepphus grylle* (PRSF). These species represent different ecological groups of seabirds as defined by their feeding ecology, and Røst serves as one of the ten geographical key sites assigned for the programme SEAPOP (Anker-Nilssen et al. 2005).

2 Bird diversity

Few if any other places of corresponding size north of the Arctic Circle have a more diverse bird life than the Lofoten Islands. This is to a large extent explained by

- the constant inflow of warm Atlantic water that leads to a mild oceanic climate with relatively little variation in temperatures between summer and winter,
- an extreme landscape topography that provides a rich gradient of bird habitats, ranging from offshore shelf waters and shallow tidal mudflats to a wide variety of beaches, wetlands, woodlands and alpine areas,
- the high marine production in the convergence zone between the Atlantic Current and the adjacent Norwegian Coastal Current over the edge of the continental shelf, and
- the effects on these currents of the wide continental shelf that surrounds the archipelago and serves as a retention area for plankton and fish larvae.

Considering its latitudes, an impressing number of bird species have been recorded in the Lofoten Islands. Up to 1997/98 the official list counted 233 species (Stenersen 1998). Since then, the increasing attraction of the area for ornithologists has already caused the number to increase to at least 282 species. The tapering shape of the Lofoten Islands towards the southwest and the extreme offshore position of the outermost islands clearly have a concentrating effect on migrant species. Indeed, the bulk of new species added to the list in recent years have been observed on Røstlandet, the largest island in the Røst archipelago where also most of the 600 local people live. Parts of this very flat island are dominated by wetlands with a mosaic of ponds and marshes separated by drier ridges, and are excellent staging areas for waders and waterfowl. The western part of the wetlands was established as the Røstlandet Nature Reserve in 1997. There are no shrubs and trees in Røst except in the islander's gardens, which provide the only shelter for passerine migrants and have a reputation for rarities. Actually, by October 2005 the bird list for Røst alone, which counted 215 species in 1990 (Baines & Anker-Nilssen 1991), unofficially held as many as 265 species (see list complied by Thor Edgar Kristiansen at *http://www.fuglesiden.com/Rostkryss.pdf*).

At least 119 species have been documented to breed within the borders of the six municipalities addressed in this report, with another nine species characterised as either probable (two spp.) or possible (seven spp.) breeders (**Appendix 1**; Løvenskiold 1947, Haftorn 1971, Baines & Anker-Nilssen 1991, Gjershaug et al. 1994, Stenersen 1998, pers. comm., S.J. Baines pers. comm.).

3 Conservation status of bird populations in the Lofoten islands

BidLife International (2004) groups the European bird species into five categories according to their status in relation to the SPEC (Species of European Conservation Concern) concept:

- **SPEC 1 –** European species of global conservation concern, i.e. classified as Critically Endangered, Endangered, Vulnerable, Near Threatened or Data Deficient under the IUCN Red List Criteria at a global level (BirdLife International 2004, IUCN 2004).
- **SPEC 2 –** Species whose global populations are concentrated in Europe, and which have an Unfavourable conservation status in Europe.
- **SPEC 3 –** Species whose global populations are not concentrated in Europe, but which have an Unfavourable conservation status in Europe.
- **Non-SPEC** [E] **–** Species whose global populations are concentrated in Europe, but which have a Favourable conservation status in Europe.
- **Non-SPEC** - Species whose global populations are not concentrated in Europe, and which have a Favourable conservation status in Europe.

Table 1 *Global (A) and European (B) IBA criteria that are fulfilled by species in the Lofoten Islands, as listed in Table 1. (After BirdLife International 2000)*

A Global

A4 Congregations

- **A4i –** The site is known or thought to hold, on a regular basis, ≥ 1% of a biogeographic population of a congregatory waterbird species.
- **A4ii –** The site is known or thought to hold, on a regular basis, ≥ 1% of the global population of a congregatory seabird or terrestrial species.
- **A4iii –** The site is known or thought to hold, on a regular basis, ≥ 20,000 waterbirds or ≥ 10,000 pairs of seabird of one or more species.

B European

B1 Congregations

- **B1i –** The site is known or thought to hold ≥ 1% of a flyway or other distinct population of a waterbird species.
- **B1ii –** The site is known or thought to hold ≥ 1% of a distinct population of a seabird species.
- **B1iii –** The site is known or thought to hold ≥ 1% of a flyway or other distinct population of other congregatory species.

B2 Species with an unfavourable conservation status in Europe
The site is one of the 'n' most important in the country for a species with an unfavourable conservation status in Europe (SPEC 2, 3) and for which the site-protection approach is thought to be appropriate.

B3 Species with a favourable conservation status in Europe
The site is one of the 'n' most important in the country for a species with a favourable conservation status in Europe but concentrated in Europe (SPEC 4) and for which the site-protection approach is thought to be appropriate.

The SPEC status of the species found (or expected to be) breeding in the Lofoten Islands are indicated in **Appendix 1** together with their European Threat Status (ETS). The eight threat categories are (see BirdLife International 2004 for details): *Critically Endangered* (CR), *Endangered* (EN), *Vulnerable* (VU), *Declining* (D), *Rare* (R), *Depleted* (H), *Localised* (L) and *Secure* (S). BirdLife International (2000) also identifies Important Bird Areas (IBAs) on the global and European level according to a specific set of criteria, some of which are listed in **Table 1**. For simplicity and to serve the purpose of this report, I have defined the Lofoten Island population of any species to be of international importance if it constitutes ≥ 1% of the minimum estimate for the European or world population.

Among the breeding species of the Lofoten Islands (**Appendix 1**), the White-tailed Eagle *Haliaeetus albicilla* and the Corn Crake *Crex crex* are the only two currently on the global IUCN red list, which list them both as Near Threatened (NT). Consequently, both species are listed as SPEC 1 (see above). However, there exists only one breeding record of the Corn Crake, which was made on Skomvær (the outermost vegetated island with the famous lighthouse) as far back as in 1942 (Haftorn 1971). The White-tailed Eagle *Haliaeetus albicilla*, however, breeds in internationally important numbers (here) in the Lofoten Islands, with at least 1.8% of its minimum European estimate (**Figure 1, Table 2**).

Eight other local breeding species are assigned to the SPEC 2 category: Northern Lapwing *Vanellus vanellus*, Ruff *Philomachus pugnax*, Eurasian Curlew *Numenius arquata*, Common Redshank *Tringa totanus*, Mew Gull *Larus canus*, Atlantic Puffin, Black Guillemot and Common Redstart *Phoenicurus phoenicurus*. However, when considering their estimated Norwegian and European population sizes (Gjershaug et al. 1994, Anker-Nilssen et al. 2000, Barrett et al. in manuscript), only the Black Guillemot and the Atlantic Puffin (both listed as Depleted) occur in internationally significant populations in the Lofoten Islands with about 1.7% and 8.4% of their minimum European estimates, respectively (**Figure 1, Table 2**). Both Røst and Værøy qualify as Global and European IBAs (Important Bird Areas) for the Atlantic Puffin (criteria A4ii+A4iii and B1ii+B2), and Røst is also an European IBA (criteria B1ii+B2) for Black Guillemot (BirdLife International 2000).

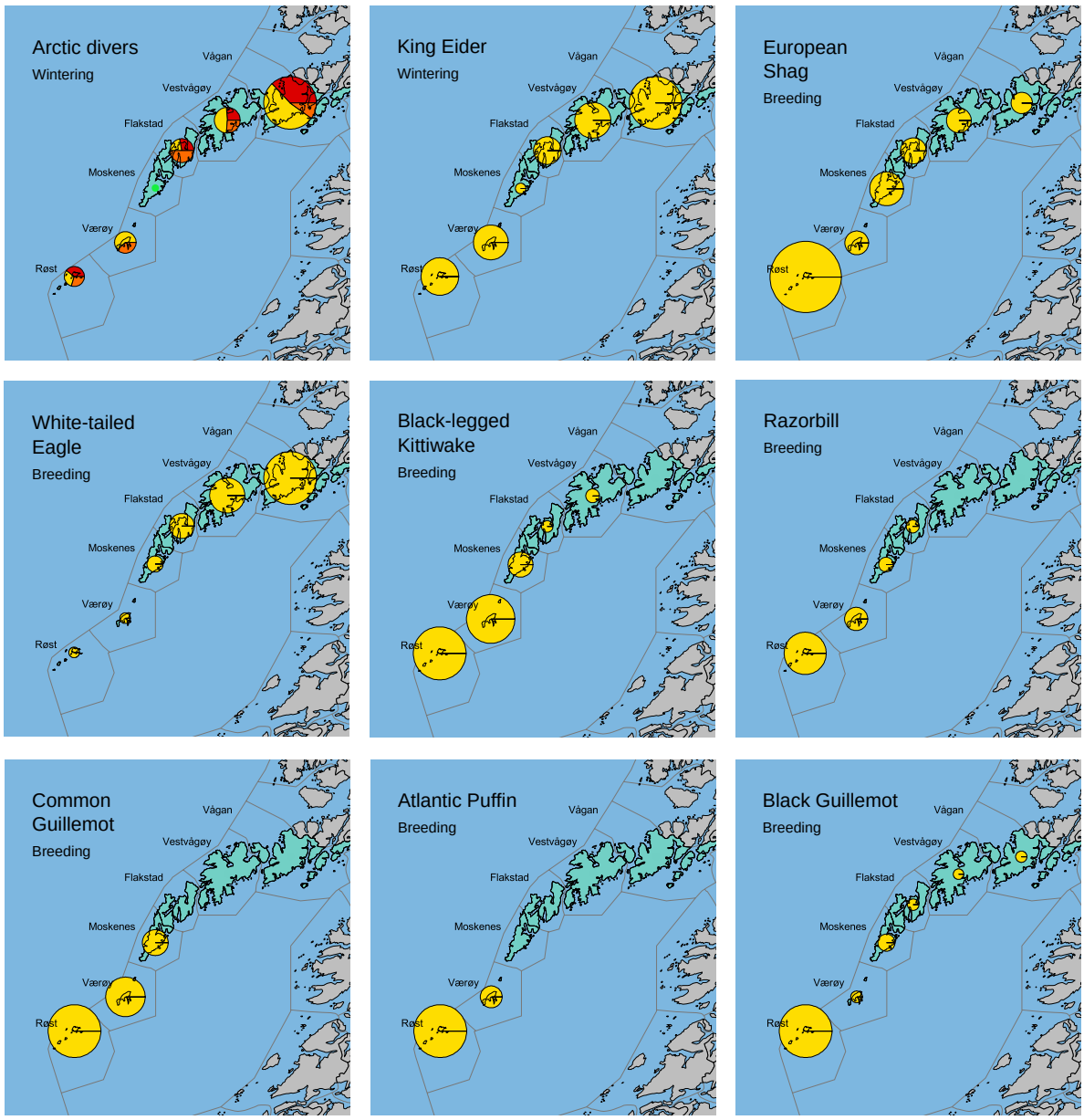

Figure 1 *The distribution of ten seabird species divided by the six outermost municipalities of the Lofoten Islands, North Norway. The multicoloured symbols in the map at top left show wintering Great Northern Diver (red), Yellow-billed Diver (yellow) and either of the two species (orange). The population estimates and other details are given in Table 2.*

Thirty-one of the local breeders are listed as SPEC 3. For two of them, the Greater Scaup Aythya *marila* (Endangered) and the Steller's Eider *Polysticta stelleri* (Localised), this is due to concerns for their wintering numbers in Europe, but neither winters in significant numbers in the Lofoten Islands. The Steller's Eiders have their winter strongholds much farther to the northeast (in the Varangerfjord and on the north coast of the Kola Peninsula). The only record of Steller's Eider breeding in Norway was made on Skomvær in 1929 (i.e. where the Corn Crake bred in 1942), but this was probably an incident of hybridization with Common Eider *Somateria mollissima* (Dons et al., op. cit. Løvenskiold 1947) and is best treated as a curiosity. None of the 29 other species listed as SPEC 3 are breeding or wintering in internationally important numbers in the Lofoten area.

Table 2 *Most recent population estimates of some seabirds whose (with the exception of the Common Guillemot) breeding or wintering numbers in the Lofoten Islands have been reported as to be of international importance. Both Røst and Værøy qualify as global and European IBAs for the species whose numbers are indicated by prefix G (global IBA) and E (European IBA), respectively (BirdLife International 2005). Where this qualification is probably no longer justified, the prefix is given in brackets, whereas an asterisk indicates that the IBA quality was identified in the current analysis and has not (yet) been assigned by BirdLife International.*

	Popu-		Numbers by municipality						Lofoten	European	
Species	**lation**	**Unit**	*Vågan*	*Vestvågøy*	*Flakstad*	*Moskenes*	*Værøy*	*Røst*	**total**	**minimum**	**%**
Great Northern Diver	Wintering	Indiv	50	6	5	—	—	4	**65**	5,400	1.2
Yellow-billed Diver	Wintering	Indiv	72	11	4	—	8	3	**98**	500	19.6
G.N./Y-b. Diver	Wintering	Indiv	14	6	9	—	5	3	**37**		
King Eider	Wintering	Indiv	E* 7,407	E* 3,612	2,183	271	3,386	E* 3,920	**20,779**	350,000	5.9
European Shag	Breeding	Pair	83	135	155	317	117	GE 1,700	**2,507**	75,000	3.3
White-tailed Eagle	Breeding	Pair	42	22	13	7	4	4	**92**	5,000	1.8
Black-legged Kittiwake	Breeding	Pair	0	138	16	1,992	(G) 10,788	(G) 13,059	**25,993**	2,100,000	1.2
Razorbill	Breeding	Pair	0	0	7	16	(E) 118	(E) 592	**733**	430,000	0.2
Common Guillemot	Breeding	Pair	0	0	0	101	309	600	**1,010**	2,000,000	0.1
Atlantic Puffin	Breeding	Pair	0	0	0	0	(GE) 43,000	GE 433,092	**476,092**	5,700,000	8.4
Black Guillemot	Breeding	Pair	85	73	87	197	90	1,642	**2,174**	130,000	1.7

Of the remainder 89 local species that are listed as Non-SPEC (and thus are assigned the status Secure), 35 are listed as Non-SPEC E. Among these species, only the European Shag is currently known to breed in internationally important numbers in the Lofoten Islands (about 3.3% of the minimum world estimate; **Figure 1, Table 2**). Røst is both a global and European IBA for this species (criteria A4ii and B1ii+B3; BirdLife International 2000). The Razorbill is also listed as Non-SPEC E. Although it probably no longer meets the 1% criteria in the Lofoten area, both Røst and Værøy have been listed as European IBAs for the species (criteria B1ii+B3; BirdLife International 2000). However, the origin of the population estimates of 2000-3000 pairs in Røst in 1997 and 800 pairs in Værøy in 1989, on which these IBA identities are based, are unknown and the estimates are definitely not valid for the present day situation. The corresponding estimates used in this report (**Figure 1**, **Table 2**) are primarily based on a coarse and subjective assessment of the Røst population (T. Anker-Nilssen & T. Aarvak, unpublished), assuming that the 1:5 ratio in numbers between Røst and Værøy in the early 1980s (Røv et al. 1984) have remained constant in later years.

Other species that are listed as Non-SPEC but which occur in internationally important numbers, include the wintering populations of the two Arctic diver species (Great Northern Diver *Gavia immer* and Yellow-billed Diver *Gavia* adamsii) and the King Eider *Somateria spectabilis*, possibly also the breeding population Black-legged Kittiwake (**Figure 1, Table 2**). For the kittiwake (as for the Razorbill), the lack of more recent population surveys for Værøy made us decide to use the former ratio of 19:23 between Værøy and Røst (Røv et al. 1984) to produce an estimate we consider more fit for the current purpose than the data contained in the databases. As it turns out, the global IBA statuses (criterion A4iii) of these two sites for kittiwakes are now dubious, but an ongoing and seemingly global decrease in population numbers of the species (unpubl. review by CAFF/CBird) does throw some doubt on the current estimates for its European and global breeding populations.

Of the top two seabirds on the Norwegian Red List (now under revision), the endangered northern subspecies of the Lesser Black-backed Gull *Larus fuscus fuscus* (nordlig sildemåke) can now probably be considered locally extinct in the Lofoten Islands. The other one is the Common Guillemot, which still breed in the Lofoten Islands but only in numbers less than 5% of those in the early 1960s (e.g. Barrett et al. in manuscript). It is put up as '*vulnerable*' on the Norwegian List, and

for this reason it has been included in **Figure 1** and **Table 2**. Røst was the third largest colony of Common Guillemots in Norway in the 1960s (Brun 1969).

4 The seabird capital of mainland Europe

From the chapter above it should be evident that, in terms of birds, the most visual consequence of the high marine production and the unique features of the sea areas surrounding the Lofoten Islands is the huge numbers of seabirds that breed in the area. In general, the farther out, the more seabirds are found breeding. In addition to the general suitability of the area for seabirds that was mentioned above, this is explained by a parallel steep increase in offshore shelf waters per area land available as feeding areas for pelagic seabirds within reach of their colonies in the peak of the breeding season.

At the true tip of the Lofoten Islands, an 11 km long row of five steep islands in the Røst archipelago is home for the largest congregation of breeding seabirds in mainland Europe. This is despite the fact that the two most numerous seabirds in Røst when monitoring was initiated in 1979, the Atlantic Puffin and the Black-legged Kittiwake, have since dropped by 70% and 51% in numbers, respectively (Lorentsen 2005). Moreover, the Common Guillemot has dropped by about 95% since the early 1960s (Tschanz & Barth 1978, Brun 1969, 1979, T. Anker-Nilssen & T. Aarvak unpubl. data). In only 26 years, the seabird community of Røst has dropped from almost 1.5 million pairs to 455.000 pairs in 2005, mainly due to the drop in numbers of puffins, which nevertheless constitutes 95% of the total.

The current estimate implies that Røst holds 10% of the 4.5 million pairs of seabirds that are breeding on the coasts of the Norwegian Sea when including the Shetlands, Faeroes, eastern Iceland and Jan Mayen (Anker-Nilssen & Lorentsen 2004). These puffins all breed within the Røstøyan Landscape Protection Area, which enclose the Nykan Nature Reserve, both protected in 2002. This reserve is divided by three islands and holds an estimated 39% of the puffin population of Røst (Anker-Nilssen & Øyan 1995).

5 Lofoten seabirds as key components of a very valuable coastal ecosystem

Very few areas on the planet have been studied equally well over such a long period of years in terms of exploring the dynamics and position of seabirds as components of a coastal ecosystem. In particular this goes for the Atlantic Puffin population. Although only a small part of the population has been subjected to these studies, i.e. mainly those breeding on the island of Hernyken within the Nykan Nature Reserve in Røst, there is no doubt that the ecological understanding that has been built from these studies applies to most puffins in the Lofoten Islands and helps explain the development for other species in the area, fish as well as seabirds.

The story of the Atlantic Puffins in Røst has drawn international attention for more than 25 years and is well known among scientists, amateur ornithologists and many others. The core of these results is the close link between the Atlanto-Scandian herring *Clupea harengus*, or more precisely the first-year (0 group) herring of the Norwegian spring-spawning stock, and the reproduction and survival of the puffins at Hernyken. The details of these interactions and other noteworthy results of the seabird research in Røst are reported in annual reports (latest by Anker-Nilssen & Aarvak 2004) and a large number of international and national publications. The most important are listed below, the titles of which give some idea of the variety of topics that are or has been covered. A

short summary of this puffin research, which was published fairly recently by Anker-Nilssen & Lorentsen (2004), is reproduced as a facsimile in **Appendix 2** of this report.

Only over the last couple of years, a lot more knowledge has been added to the scientific story of the Røst seabirds. There is no room here to describe the results in any detail, but much of the focus has been put on how the Atlantic Puffin and the European Shag are affected by climate variation and the availability of young saithe *Pollachius virens* (e.g. Anker-Nilssen 2005, Durant et al. 2005, submitted, Harris et al. 2005), and how the Common Guillemot and Black-legged Kittiwake that normally are prospering when herring is available are now negatively affected by disturbance from an increasing population of White-tailed Eagles (unpubl. analyses). The role of the lesser sandeel *Ammodytes marinus* as prey for puffins have also been highlighted, and the first survival estimates for Black Guillemot (1997-2005), European Shag (2002-05) and Black-legged Kittiwake (2003-05) in this region have been produced from capture-recapture studies of colour-ringed birds.

The variety of these results increases our abilities to put the seabirds of Røst into use as sensitive, cost-efficient, and early warning indicators of important marine processes in the Norwegian and Barents Seas. As such, they will also provide important input for multi-species modelling of the most likely scenarios associated with the different management options always faced by our society with respect to the utilization of marine resources such as commercial fish stocks and offshore petroleum reserves. In addition to the great educational value implicit when unveiling the full chain of underlying physical and trophical processes that build, transform and move energy from sea to land, the value of these findings for a sound and sustainable management of our coastal ecosystems is therefore likely to be great.

In a world heritage perspective, the value of these results becomes even more evident when considering how close the link is between the wellbeing of these seabird populations and the wellbeing of the local people. Not only were seabirds formerly one of their most important food resources (e.g. Wold 2004), but before the times of echo sounders, radars and GPS navigation they were also guiding the islanders to the best fishing areas and helping them to find the way home in foggy weather. Furthermore, the high quality of the islands as pastures for grazing sheep is largely due to the fertilising effect of the seabird populations (e.g. Nordhagen 1925). For these reasons seabirds have therefore played an important role in determining the pattern of coastal settlements. With the help of science we also can demonstrate that the link between local seabirds and the main resources utilized by man in the Lofoten area is closer than one might expect. When combined with parameters of ocean climate, the size of herring brought to puffin chicks by their parents is one of the best (and the most cost-effective) predictor of herring year class strength in its nursery areas in the Barents Sea (Sætre et al. 2002, Durant et al. 2003). During the first three years of life, this herring is the staple food for the stock of Northeast-Arctic Cod *Gadus morhua*, which migrates to spawn around the Lofoten Islands where it forms the basis for the traditional cod fishery in late winter and early spring (Bakketeig et al. 2005). Thus, the food choice and breeding performance of the Atlantic Puffins in Røst can predict rather accurately the feeding conditions for the cod and thereby the prosperity of the cod fisheries in later years.

Adding to this is the fact that young herring feed heavily on capelin *Mallotus villosus*, which also is a commercially important fish stock and another important prey of the cod in the Barents Sea. Both capelin and second-year herring (1 group) are staple food of many seabirds breeding on the southern coasts of the Barents Sea (Anker-Nilssen et al. 2000). Similarly, the breeding performance of the Black Guillemot and European Shag on Røst, which spend their whole life within the Norwegian Coastal Current, proves to be strong indicators of recruitment to the stock of two years or older saithe (Anker-Nilssen 2005), the target of Norway's fourth most valuable fishery. Thus it seems that ecosystem processes in the Norwegian Sea during the first spring and summer of the young herring and saithe are determinants of the production of living resources utilized or valued by man in the Barents Sea as well as in the Norwegian Sea. The latter also holds a large and very visible population of killer whales that has specialised in feeding on adult herring when the herring migrate into the Vestfjorden area in late autumn. In years when adult herring also stay around the

Lofoten Islands in summer, these killer whales are an extra attraction for tourists on guided boat tours in the Lofoten Islands.

The interest in seabirds is increasing with the increasing pressures put on marine areas from man's activities. The value of seabirds in this context can briefly be summarised as:

- They form a key ecological group (top predators, combining sea and land) and may serve as excellent indicators of important environmental changes (early, sensitive, cost-efficient).
- Being the most visible of marine animals they are highly valued, charismatic ecosystem components for the purpose of nature experiences, scientific research, education at all levels and cultural traditions (the latter not discussed here).

The argument given in this chapter alone makes it reasonable to claim that the bird life of the Lofoten Islands, and especially that found in the Røst municipality, fulfil the UNESCO criteria (ix) of outstanding universal value. In addition to this comes the area's great diversity of species and natural habitats for birds that are rather unique for these latitudes.

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Nykan Nature Reserve in Røst with its famous island Hernyken (left), Trenyken and Ellefsnyken (right). The research station is situated on Hernyken. © T. Anker-Nilssen (2005)

Appendix 1 List of breeding bird species

List of bird species documented to breed or having shown indications of breeding (commented as not verified) in the six outermost municipalities of the Lofoten Islands. English and scientific names are according to the British List (http://www.bou.org.uk/) as of 31/12/2005. Sources: Løvenskiold (1947), Haftorn (1971), Gjershaug et al. (1994), Stenersen (1998 and pers. comm.), Steve Baines (pers.comm.), Norsk hekkefuglatlas (http://www.fugleatlas.com/) and own unpublished observations. The list contains 129 species, of which 15 are not verified as breeders. SPEC category and European threat status are given according to BirdLife International (2004) (see Table 1). Status in brackets is provisional.

English name	Norwegian name	Scientific name	SPEC category	European status	Comment
Red-throated Diver	Smålom	*Gavia stellata*	3	(H)	
Black-throated Diver	Storlom	*Gavia arctica*	3	(VU)	
Slavonian Grebe	Horndykker	*Podiceps auritus*	3	D	
Northern Fulmar	Havhest	*Fulmarus glacialis*	—	S	
European Storm-petrel	Havsvale	*Hydrobates pelagicus*	— E	(S)	
Leach's Storm-petrel	Stormsvale	*Oceanodroma leucorhoa*	3	(L)	
Northern Gannet	Havsule	*Morus bassanus*	— E	S	
Great Cormorant	Storskarv	*Phalacrocorax carbo*	—	S	
European Shag	Toppskarv	*Phalacrocorax aristotelis*	— E	(S)	
Grey Heron	Gråhegre	*Ardea cinerea*	—	S	
Greylag Goose	Grågås	*Anser anser*	—	S	
Common Shelduck	Gravand	*Tadorna tadorna*	—	S	
Eurasian Wigeon	Brunnakke	*Anas penelope*	— EW	S	
Gadwall	Snadderand	*Anas strepera*	3	(H)	
Eurasian Teal	Krikkand	*Anas crecca*	—	(S)	
Mallard	Stokkand	*Anas platyrhynchos*	—	(S)	
Northern Pintail	Stjertand	*Anas acuta*	3	(D)	
Garganey	Knekkand	*Anas querquedula*	3	(D)	
Northern Shoveler	Skjeand	*Anas clypeata*	3	(D)	
Tufted Duck	Toppand	*Aythya fuligula*	3	(D)	
Greater Scaup	Bergand	*Aythya marila*	3W	EN	
Common Eider	Ærfugl	*Somateria mollissima*	— E	S	
Steller's Eider	Stellerand	*Polysticta stelleri*	3W	L	Only 1 record (1929, Røst), most probably hybridising with *S. mollissima*
Long-tailed Duck	Havelle	*Clangula hyemalis*	—	(S)	Not verified
Velvet Scoter	Sjøorre	*Melanitta fusca*	3	(D)	
Common Goldeneye	Kvinand	*Bucephala clangula*	—	(S)	Not verified
Red-breasted Merganser	Siland	*Mergus serrator*	—	(S)	
Goosander	Laksand	*Mergus merganser*	—	(S)	Not verified
White-tailed Eagle	Havørn	*Haliaeetus albicilla*	1	R	
Rough-legged Buzzard	Fjellvåk	*Buteo lagopus*	—	(S)	
Common Kestrel	Tårnfalk	*Falco tinnunculus*	3	D	
Merlin	Dvergfalk	*Falco columbarius*	—	(S)	
Gyr Falcon	Jaktfalk	*Falco rusticolus*	3	(R)	
Peregrine Falcon	Vandrefalk	*Falco peregrinus*	—	S	
Willow Ptarmigan	Lirype	*Lagopus lagopus*	—	S	
Rock Ptarmigan	Fjellrype	*Lagopus muta*	—	S	
Black Grouse	Orrfugl	*Tetrao tetrix*	3	H	
Corn Crake	Åkerrikse	*Crex crex*	1	H	Only 1 record (1942, Røst)
Common Coot	Sothøne	*Fulica atra*	—	(S)	
Eurasian Oystercatcher	Tjeld	*Haematopus ostralegus*	— E	(S)	
Ringed Plover	Sandlo	*Charadrius hiaticula*	— E	(S)	
Eurasian Dotterel	Boltit	*Charadrius morinellus*	—	(S)	
European Golden Plover	Heilo	*Pluvialis apricaria*	— E	(S)	
Northern Lapwing	Vipe	*Vanellus vanellus*	2	VU	
Temminck's Stint	Temmincksnipe	*Calidris temminckii*	—	(S)	
Purple Sandpiper	Fjæreplytt	*Calidris maritima*	— E	(S)	Not verified
Dunlin	Myrsnipe	*Calidris alpina*	3	(H)	
Ruff	Brushane	*Philomachus pugnax*	2	(D)	
Common Snipe	Enkeltbekkasin	*Gallinago gallinago*	3	(D)	
Eurasian Woodcock	Rugde	*Scolopax rusticola*	3	(D)	
Bar-tailed Godwit	Svarthalespove	*Limosa lapponica*	—	(S)	
Whimbrel	Småspove	*Numenius phaeopus*	— E	(S)	
Eurasian Curlew	Storspove	*Numenius arquata*	2	D	
Common Redshank	Rødstilk	*Tringa totanus*	2	D	
Wood Sandpiper	Grønnstilk	*Tringa glareola*	3	H	
Common Sandpiper	Strandsnipe	*Actitis hypoleucos*	3	(D)	

Ruddy Turnstone	Steinvender	*Arenaria interpres*	—	(S)	
Red-necked Phalarope	Svømmesnipe	*Phalaropus lobatus*	—	(S)	
Arctic Skua	Tyvjo	*Stercorarius parasiticus*	—	(S)	
Great Skua	Storjo	*Stercorarius skua*	— E	S	
Black-headed Gull	Hettemåke	*Larus ridibundus*	— E	(S)	
Mew (Common) Gull	Fiskemåke	*Larus canus*	2	(H)	
Lesser Black-backed Gull	Sildemåke	*Larus fuscus*	— E	S	
Herring Gull	Gråmåke	*Larus argentatus*	— E	S	
Great Black-backed Gull	Svartbak	*Larus marinus*	— E	S	
Black-legged Kittiwake	Krykkje	*Rissa tridactyla*	—	(S)	
Common Tern	Makrellterne	*Sterna hirundo*	—	S	
Arctic Tern	Rødnebbterne	*Sterna paradisaea*	—	(S)	
Common Guillemot	Lomvi	*Uria aalge*	—	(S)	
Brünnich's Guillemot	Polarlomvi	*Uria lomvia*	3	(VU)	Disappeared
Razorbill	Alke	*Alca torda*	— E	(S)	
Black Guillemot	Teist	*Cepphus grylle*	2	H	
Atlantic Puffin	Lunde	*Fratercula arctica*	2	(H)	
Domestic (Rock) Pigeon	Bydue	*Columba livia*	—	(S)	
Common Cuckoo	Gjøk	*Cuculus canorus*	—	S	
Eagle owl	Hubro	*Bubo bubo*	3	(H)	Disappeared
Northern Hawk Owl	Haukugle	*Surnia ulula*	—	(S)	
Short-eared Owl	Jordugle	*Asio flammeus*	3	(H)	
Tengmalm's Owl	Perleugle	*Aegolius funereus*	—	(S)	
Great Spotted Woodpecker	Flaggspett	*Dendrocopos major*	—	S	Not verified
Lesser Spotted Woodpecker	Dvergspett	*Dendrocopos minor*	—	(S)	Not verified
Sky Lark	Sanglerke	*Alauda arvensis*	3	(H)	
Sand Martin	Sandsvale	*Riparia riparia*	3	(H)	
Barn Swallow	Låvesvale	*Hirundo rustica*	3	H	
House Martin	Taksvale	*Delichon urbicum*	3	(D)	
Tree Pipit	Trepiplerke	*Anthus trivialis*	—	S	Not verified
Meadow Pipit	Heipiplerke	*Anthus pratensis*	— E	(S)	
Rock Pipit	Skjærpiplerke	*Anthus petrosus*	— E	(S)	
Yellow Wagtail	Gulerle	*Motacilla flava*	—	(S)	
Citrine Wagtail	Sitronerle	*Motacilla citreola*	—	(S)	Only 1 record (1997, Røst), hybridising with *M. flava*
White/Pied Wagtail	Linerle	*Motacilla alba*	—	S	
White-throated Dipper	Fossekall	*Cinclus cinclus*	—	S	
Winter Wren	Gjerdesmett	*Troglodytes troglodytes*	—	S	
Hedge Accentor	Jernspurv	*Prunella modularis*	— E	S	
European Robin	Rødstrupe	*Erithacus rubecula*	— E	S	
Bluethroat	Blåstrupe	*Luscinia svecica*	—	S	
Common Redstart	Rødstjert	*Phoenicurus phoenicurus*	2	(H)	
Whinchat	Buskskvett	*Saxicola rubetra*	— E	(S)	
Northern Wheatear	Steinskvett	*Oenanthe oenanthe*	3	(D)	
Ring Ouzel	Ringtrost	*Turdus torquatus*	— E	S	
Common Blackbird	Svarttrost	*Turdus merula*	— E	S	
Fieldfare	Gråtrost	*Turdus pilaris*	— EW	(S)	
Song Thrush	Måltrost	*Turdus philomelos*	— E	S	
Redwing	Rødvingetrost	*Turdus iliacus*	— EW	(S)	
Sedge Warbler	Sivsanger	*Acrocephalus schoenobaenus*	— E	S	
Garden Warbler	Hagesanger	*Sylvia borin*	— E	S	Not verified
Blackcap	Munk	*Sylvia atricapilla*	— E	S	
Common Chiffchaff	Gransanger	*Phylloscopus collybita*	—	S	
Willow Warbler	Løvsanger	*Phylloscopus trochilus*	—	S	
Goldcrest	Fuglekonge	*Regulus regulus*	— E	S	
Spotted Flycatcher	Gråfluesnapper	*Muscicapa striata*	3	H	
Pied Flycatcher	Svarthvit fluesnapper	*Ficedula hypoleuca*	— E	S	
Willow Tit	Granmeis	*Parus montanus*	—	S	
Blue Tit	Blåmeis	*Parus caeruleus*	— E	S	
Great Tit	Kjøttmeis	*Parus major*	—	S	
Black-billed Magpie	Skjære	*Pica pica*	—	S	
Hooded Crow	Kråke	*Corvus cornix*	—	S	
Common Raven	Ravn	*Corvus corax*	—	S	
Common Starling	Stær	*Sturnus vulgaris*	3	D	
House Sparrow	Gråspurv	*Passer domesticus*	3	D	
Chaffinch	Bokfink	*Fringilla coelebs*	— E	S	
Brambling	Bjørkefink	*Fringilla montifringilla*	—	S	
European Greenfinch	Grønnfink	*Carduelis chloris*	— E	S	
Eurasian Siskin	Grønnsisik	*Carduelis spinus*	— E	S	Not verified
Twite	Bergirisk	*Carduelis flavirostris*	—	S	
Common Redpoll	Gråsisk	*Carduelis flammea*	—	(S)	
Common Bullfinch	Dompap	*Pyrrhula pyrrhula*	—	(S)	
Lapland Longspur	Lappspurv	*Calcarius lapponicus*	—	(S)	
Snow Bunting	Snøspurv	*Plectrophenax nivalis*	—	(S)	
Reed Bunting	Sivspurv	*Emberiza schoeniclus*	—	S	

Appendix 2 Results from the research on Atlantic Puffins in Røst

This is a text facsimile of chapter 16.4 from Anker-Nilssen &Lorentsen (2004, pp 438-443) describing some of the main results from the puffin research in Røst over the past 40 years.

The population ecology of Atlantic puffins at Røst; a 40-year study

Intensive studies of the breeding biology of Atlantic puffins (Figure 16.1) in Røst (67030'N), a small and remote archipelago situated at the outermost tip of the Lofoten Islands, were initiated in 1964 by Dr. Svein Myrberget of the Norwegian State Game Research Institute. Since then, the studies have continued annually and have gradually developed into a fully-fledged monitoring project focussing on the long-term population ecology of the Røst puffins, run by the Norwegian Institute for Nature Research (NINA). The wide range of parameters that are measured every year includes population size, timing of breeding, egg size, hatching success, duration of the nestling period, chick diet (by prey species, size and mass), chick growth, fledging success and recruitment rate, as well as the attendance, body condition and survival rate of adults (Anker-Nilssen and Aarvak 2003). The project is coordinated with the National Monitoring Programme for Seabirds, which has also been run by NINA since its foundation in 1988 (Lorentsen 2003).

Røst has one of the largest aggregations of breeding puffins in the world, and until very recently it was the largest seabird 'colony' in mainland Europe. The extreme offshore position of Røst, which is located more than 100 km off the mainland coast and over the northern part of the wide continental shelf, partly explains this status. An enormous foraging area is within reach of puffins from this colony throughout the breeding season. An estimated 1.44 million pairs of puffins bred in Røst when the monitoring of their population trend started in 1979. By 2003, the number had dropped by 72% to only 406,000 pairs (Figure 16.2). The loss of more than a million pairs of puffins at Røst corresponds to about 15% of the estimated world population of the species and 30% of all seabirds breeding along the Norwegian coast. Recent calculations for the Norwegian Sea indicate that about 60% of an estimated total biomass of approximately 400,000 tonnes of fish consumed annually by seabirds in Norwegian waters are taken by puffins (Barrett et al. 2002).

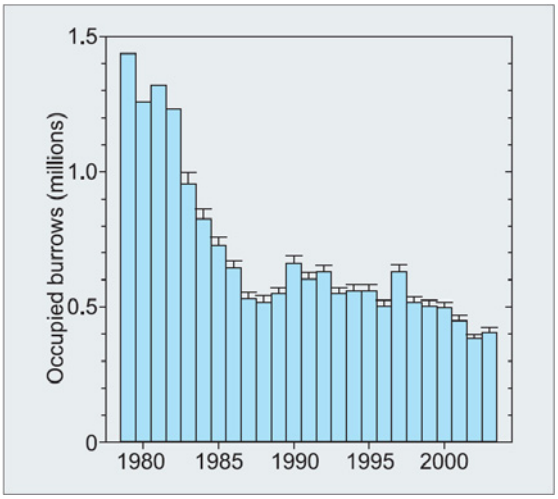

Figure 16.2 *Annual numbers (+ 1 SE) of apparently occupied burrows (reflecting the number of breeding pairs) of Atlantic puffins at Røst in 1979-2003. (From Anker-Nilssen and Aarvak 2003, updated with unpublished data)*

The puffin project at Røst has documented that the development of this population has largely been determined by the availability of first-year (0-group) herring produced by the Norwegian spring-spawning stock (e.g. Anker- Nilssen 1992, Durant et al. 2003). When a strong year-class of young herring drifts northwards with the coastal current towards their nursery grounds in the Barents Sea, first-year herring are the principal prey brought to the puffin chicks by their parents. Since the herring stock collapsed in 1968, the puffin population at Røst has experienced only ten good

breeding seasons. In the 24 other years, most chicks starved to death long before they were able to leave the nest. As established breeders are very faithful to their nest burrow from year to year and young puffins usually return to breed in their natal colony, extensive recruitment failure and population decline was an unavoidable consequence of the long-lasting depression of the herring stock.

The spawning stock remained critically low for two decades, but has since restored to more normal levels. Nevertheless, the puffins' problems do not seem to be over. Indeed, the biology of herring makes it very unlikely that even a large spawning stock will guarantee a stable food supply for puffins every year. Furthermore, the herring are still producing many more weak than strong year-classes. The life histories of puffins and herring in the Norwegian Sea appear to be very similar and are characterised by delayed maturity, long life-spans and a very variable reproduction from year to year. In spite of this, total breeding failures of puffins at Røst were not known to occur before the herring crash. This suggests that the puffins then were able to sustain their young on alternative prey species that recently seem to have become much less available. In only one of the last 25 breeding seasons (1979-2003), when chick diet was monitored throughout the nestling period, did prey other than first-year herring (namely lesser sandeel, haddock (*Melanogrammus aeglefinus*) and whiting (*Merlangius merlangus*)) secure a reasonable fledging success (in 1999, e.g. Anker-Nilssen and Aarvak 2003).

For the puffins at Røst, the abundance of 0-group herring at metamorphosis (i.e. contemporary with the nestling period of puffins) as estimated by VPA analysis (ICES 2002a) explains 63% of the variation in annual fledging success of chicks in 1975-1999 and 76% of the variation in annual adult survival rates in 1990-1999 (Anker-Nilssen and Aarvak 2003). For fledging success, the relationship is increased to 66% by substituting the VPA estimates with the average body length of herring brought to the chicks, which again explains 77% of the variation in the VPA data (Figure 16.3). Moreover, 84% of the variation in fledging success can be explained when we add to this model the mean sea temperature in the coastal current during March-July, the first period of growth of young herring (Durant et al. 2003). Typically, the relationship is sigmoidal in shape, with a steep threshold zone in herring abundance or size separating good and bad puffin years. In the threshold years, fledging success is highly variable, and the survival of adults to the next breeding season is at its lowest (Anker-Nilssen and Aarvak 2003). The latter phenomenon indicates that the puffins adjust their breeding effort optimally according to both the prospects of their offspring and their own chances of survival. This fits the theory of how a long-lived seabird with a low reproductive rate (clutch size only 1 egg) should balance its reproductive effort in a stochastic environment (Erikstad et al. 1998).

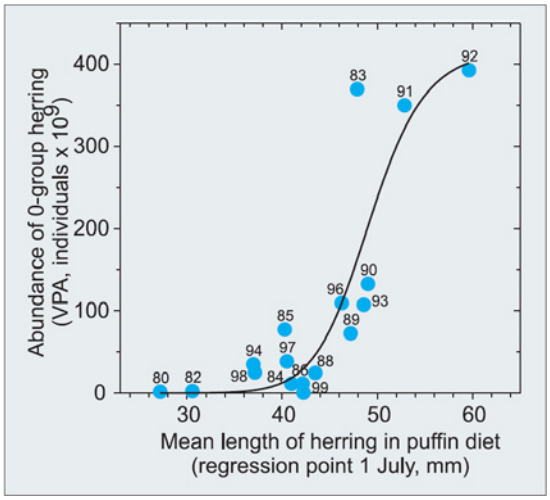

Figure 16.3 *The year-class strength of 0-group herring (VPA estimates, ICES 2002a) in relation to the contemporary size of herring in the diet of Atlantic puffin chicks at Røst in 1980-1999. The logistic regression curve fitted to the data set explains 77% of the variation in herring numbers. (From Anker-Nilssen and Aarvak 2003).*

The use of satellite telemetry has shown that adult puffins move from Røst to the Barents Sea immediately after the breeding season (Anker-Nilssen et al. in manuscript). It is possible that they

follow the young herring northwards in order to feed on them for a longer period. However, if very few herring reach the Barents Sea, the adults might soon experience a severe food shortage. In some of the threshold years the adults' body condition is at its lowest level at the end of breeding and, combined with a poor food supply, this could therefore be a very critical period for adult survival.

The main objective for the puffin project at Røst is not only to identify the mechanisms that determine the population dynamics of this internationally important seabird population. The study also addresses general patterns of trophic interactions between important groups of species in the marine environment on these latitudes, and how they are affected by both natural variation and man-induced factors (e.g. pelagic fisheries). The key to answers lies in long-term and systematic monitoring of the most important population parameters. The results are analysed in relation to parallel data series from the physical and biological environment experienced by these puffins, focusing on how they are affected by variations in ocean climate and the abundance of their main prey in the Norwegian Sea (herring, sandeel and young gadoids). The annual data series for population trends and breeding success of a number of other seabirds at Røst (including the European shag (*Phalacrocorax aristotelis*), black-legged kittiwake, common guillemot and black guillemot (*Cepphus grylle*)), which are different in terms of fecundity, habitat choice, diet and/or foraging range, are also important input to the analyses.

Along with the long-term monitoring, a number of shorter-term puffin studies have been carried out at Røst, including an experimental study of adaptive growth allocations in chicks as response to poor food supply (Øyan and Anker-Nilssen 1996). Several at-sea surveys in collaboration with the Institute of Marine Research have studied details of the interactions between young herring and puffins in their foraging areas off Røst (e.g. Axelsen et al. 2001). As specialised top predators in the marine food web, the Atlantic puffin and several other seabird species are now emerging as excellent and early indicators of important changes in the marine environment. This has clearly been demonstrated for puffins in the Norwegian Sea (e.g. Sætre et al. 2002, Anker-Nilssen and Aarvak 2003, Anker-Nilssen et al. 2003, Durant et al. 2003 and 2004). Results from long-term studies of selected populations provide a platform on which we can understand how they, and similar but less studied components of the same environment, respond to natural changes and various man-induced factors such as fisheries and the petroleum industry. Consequently, the information is important to ensure that our use of marine resources is managed in as sustainable a manner as possible. Many of the naturally occurring cycles in this environment are so long-term that it may take many decades or even centuries to complete a full cycle. In this perspective, 40 years of puffin studies at Røst can only be regarded as a starter for the large-scale ecosystem monitoring needed to be established for future generations.

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