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by

KARSTEN LAURSEN[1], STEFAN PIHL[1], JAN DURINCK[2], MOGENS HANSEN[3], HENRIK SKOV[2], JOHN FRIKKE[4] and FINN DANIELSEN[2]

Med et dansk resumé:

Vandfugles antal og udbredelse
i danske farvande 1987-1989

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INTRODUCTION

Danish coastal waters contain a great variety of marine habitats formed by a mosaic of bays, archipelagoes, lagoons, islands and shoals, and represent one of the most important staging and wintering areas for waterbirds in the Western Palearctic. Shallow water areas less than 10 metres deep (Fig. 1) cover to approximately 16,000 km^2 (Joensen 1986). Furthermore, Denmark is centrally situated in the passage flyways from Scandinavia and the northwestern Russia to the southern part of Europe.

The interface between the shallow and deep water areas of the North Sea and Skagerrak creates strong gradients in the physical properties of surface water masses. Due to the varied conditions, parts of Kattegat, Skagerrak and the North Sea have some of the world's highest production rates of plankton and fish (Bøhle 1989), attracting large numbers of seabirds from the breeding areas in the North Sea and the north Atlantic.

Especially the seaduck species Scaup *Aythya marila*, Eider *Somateria mollissima*, Long-tailed Duck *Clangula hyemalis*, Common Scoter *Melanitta nigra* and Velvet Scoter *Melanitta fusca* as well as the auks Razorbill *Alca torta* and Guillemot *Uria aalge* winter in these waters in large numbers (Joensen 1974, Danielsen et al. 1986, Laursen 1989, Skov et al. 1987). Other waterfowl species also occur in considerable numbers, e.g. Red-throated Diver *Gavia stellata*, Black-throated Diver *Gavia arctica*, Mute Swan *Cygnus olor*, Shelduck *Tadorna tadorna*, Teal *Anas crecca*, Tufted Duck *Aythya fuligula*, and Red-breasted Merganser *Mergus serrator.*

During 1965-73, the Game Biology Station, now National Environmental Research Institute, NERI, performed a number of aerial surveys of the Danish costal waters to determine the size and distribution of populations of waterbirds in spring, summer, autumn and winter (Joensen 1968, 1973, 1974, Jepsen & Joensen 1973). The results

Fig. 1. Distribution of salt and brackish waters of less than 10 m depth. Practically all other waters are less than 50 m deep. The Wadden Sea is the only Danish salt water area with a true tide; along all other coast changes in water levels of 1-2 m, caused by the wind, occur frequently.

of the midwinter counts were achieved in collaboration with the International Waterfowl and Wetlands Research Bureau (IWRB) and were included in the International Waterfowl Census (IWC) of the Western Palearctic (Atkinson-Willes 1976, Rüger et al. 1986, Pirot et al. 1989, Monval & Pirot 1989).

From 1973 to 1987 few attempts were made to census the total Danish populations of waterbirds. Tasker et al. (1987) summarised eight consecutive years of surveys in various parts of the North Sea using transect surveys from ships in regular service. The amount of data sampled in the Danish part of the North Sea was, however, limited. In the summers of 1985 and 1986, surveys of moulting seaducks were initiated and in 1986, transects from ships in regular service were initiated in offshore areas (Skov et al.

1987), although no attempts were made to survey all the areas traditionally holding high numbers of waterbirds.

Between 1985 and 1987, the Danish Ornithological Society advocated strongly the need to survey previously unsurveyed waters which were believed to house important concentrations of waterfowl in offshore areas.

In 1987, NERI and the National Forest and Nature Agency, NFNA, decided to jointly fund a complete census of all Danish waterbird areas. The need for relevant data on waterbird abundance and distribution was highlighted by a Danish Governmental decision to invite applications to carry out gas and oil exploitation in new areas in 1989. The data was needed, particularly because increasing documentation indicated oil as the single most serious cause of death for protected seabirds. It became clear that the surveys from 1968-73 had to be updated to provide current information on geographical distribution and number of waterbirds in coastal and shallow waters.

It was equally important to extend the coverage to offshore areas of the North Sea, Skagerrak, Kattegat and Baltic Sea especially for seabirds and seaducks, as even basic knowledge was lacking on species composition, numbers and distribution. Additionally, a parallel survey programme in offshore waters was executed, partly in collaboration with the Swedish Ornithological Society and the Scandinavian Seabird Group.

The results of these surveys were also meant to form the basis of an evaluation of the existing international bird areas in Denmark designated under the Ramsar Convention and the EU Directive of Wild Birds.

Aerial surveys of the coastal parts of Denmark and Kattegat (see Fig. 2 for all site names mentioned in the text) were conducted in late summer, autumn, winter and spring 1987-89 by NERI, which also performed transect surveys from aircraft in all parts of the offshore areas. Extensive coverage of the offshore areas by transects was carried out from ships by Ornis Consult A/S.

This paper presents the numbers and distributions of waterbird registered in aerial as well as ship surveys in Danish waters from 1987 to 1989. The synthesis of species presentation has been based on comparisons of results from aircraft and ships. Distribution of seabirds (see "Data used", p. 19) was based mainly on results obtained from ship surveys, whereas basic data on all coastal waterbirds was obtained from aerial surveys, except for Common and Velvet Scoter; for these two species results obtained from air and ship surveys were equally important.

Late summer surveys were scheduled to coincide with annual wing-feather moult time which a number of waterbird species undergo. The results from the 1987-1989 - study are compared with the results from aerial surveys conducted in 1968-1973 (Joensen 1974), and the results from ship surveys carried out during 1979-1986 (Tasker et al. 1987).

ACKNOWLEDGEMENTS

The National Forest and Nature Agency, NFNA, funded the ship surveys and shared the costs of the aerial surveys with NERI. We thank Henning Noer, Tony Fox and two anonymous referees for comments on the manuscript; Bjørn Molt Petersen for constructing computer programmes, the pilots Valther Jensen and Leif Petersen for their enthusiastic support in improving the aircraft survey techniques; the Royal Danish Airforce and the Army Air Corps for providing survey hours in the aircraft Saab T-17; Jens Lund Hansen for organising the landbased counts on Bornholm; and a great number of volunteers for their contributions to the surveys as observers from either aircraft or land.

We wish to thank the cruise leaders Olle

Hagström, Johan Modin and P-O Larson, Swedish Institute of Marine Research, Gunni Ærtebjerg, NERI, Peter Lewy, Henrik Sparholt, Vagn Olsen, Eskild Kirkegaard and Steen Munch-Petersen, Danish Institute of Marine & Fisheries Research and Lars Føyn, Norwegian Institute of Marine Research. The officers of the research ships Argos, Dana, Eldjarn and Gunnar Thorson are thanked for their support and cooperation. The costs of the ship surveys were paid for by NFNA, NERI, World Wide Fund for Nature Sweden and the Scientific Committee of the Danish Ornithological Society. Mærsk Olie & Gas A/S and the ferry companies Fred. Olsen Lines, Lion Ferry AS and Stena Line are thanked for their important cooperation. We sincerely thank the many observers who assisted us in carrying out the ship surveys: Per Andell, Bård Bredesen, Ole Kristoffer Bøhn, Tomas Bøhn, Jens Christensen, Rene Christensen, Thomas Kjær Christensen, Hans Christophersen, Jan Drachmann, Knut Eie, Tommy Engebretsen, Ulrika Ganning, Ole Goldsmidt, Roar Gustavsen, Terje Gustavsen, Lars-Bertil Gustavsen, Knut Arne Hansen, Jens Lund Hansen, Jens Gert Hansen, Lars Lund Hansen, Jimmi Skat Hansen, Per Hjalmarson, Anders Horneskøt, M. Hundide, Erik Mandrup Jacobsen, Lars Jakobsen, Annelise Jensen, Birger Jensen, Bjarke Huus Jensen, Erling Jirle, Ricard Jirle, Kurt Due Johansen, Michael Fink Jørgensen, Nils Kjellen, Niels M. Kofoed, Folmer Hjort Kristensen, Henning Kristensen, Jon Kyed, Xavier Lambin, Peter Lange, Thomas Larsen, Vagn Larsen, Bjarke Laubek, Kim Mouritsen, Morten Nielsen, Mikael Nord, Ib Helles Olsen, Kent Olsen, Jens Skovgaard Pedersen, Søren Petersen, John Grynderup Poulsen, Michael Køye Poulsen, Anders Rasmussen, Helge Rinden, Mikael Ritman, Frits Rost, Ejvind Rugland, Jan Erik Røer, B. Sakseid, Torben Sebro, Terje Seidenfaden, Hans Peter Stange, Jens Otto Svendsen, Rune Svensson, Cathrine Wist and Anders Østerby.

METHODS AND MATERIAL

Definitions of bird groups

The terminology concerning birds adapted to a life in or close to the water has varied, especially the terms seabirds and seaducks (e.g. Tasker et al. 1987, Croxall et al. 1984, Lloyd et al. 1991). In accordance with IWRB practises adjusted in November 1992 the term *waterbird* embraces all species associated with wetland or sea habitats; the term *seabirds* includes Gaviidae, Podicipedidae, Procellaridae, Sulidae, Stercorariidae, Laridae and Alcidae, and the term seaducks includes Scaup, Eider, Long-tailed Duck, Common Scoter, and Velvet Scoter.

Aerial survey techniques

Two different methods of aerial surveys were used:

- countrywide surveys covering all the coastal Danish waters and parts of Kattegat and the North Sea.
- transect surveys covering Danish offshore areas.

Only professional pilots with experience in low-altitude flying were hired in order to maintain a high level of navigation and safety during the surveys. The pilots decided whether the weather conditions allowed safe flights, while it was the responsibility of the observers to determine whether the weather conditions were good enough to conduct a satisfying survey.

Ideal weather conditions for aerial surveys were calm wind and sea, light cloud cover and visibility of >10 km. Optimal weather conditions were rarely experienced

during the surveys, so the limits of tolerable weather conditions were set at wind speeds of ≤6 m/sec. and a visibility of >5 km. Bright sunshine was avoided, as reflections from the water surface made observations difficult to perform.

Based on previous experience, it was intended to conduct all aerial surveys with two observers, each registering and counting on his or her specific side of the aircraft. The front-seat observer (chief-observer) counted the birds in front of and to the right of the aircraft, the co-observer to the left. The front-seat observer also recorded his own and the co-observers observations on a dictaphone according to count area, and navigated through the area, determining flight-altitude and distances from the coast. In areas with high densities of birds it was found advantageous to let both the chief-observer and the co-observer record separately on a dictaphone, each covering his separate side of the aircraft.

On most days, two aircraft were used in the surveys but on days with favourable weather conditions, up to four aircraft took part in the surveys. The permanent staff included four observers of whom one always was the chief-observer and navigator. The co-observer was either a member of the permanent staff or a hired observer. All observers were experienced in aerial surveys, except on a few occasions where co-observers with no or little experience were chosen when no alternatives existed. A complete national survey included transect flying and involved 10-12 observers. The large number of observers, of course, introduced more variation in the data collected, but the increased variation was minimised by maintaining at least one very experienced observer in each team adjusting the method and estimates obtained by the less experienced observer.

Countrywide surveys

The countrywide surveys aimed at covering all waterbird species occurring in the coastal waters, on the coast or in coastal lakes (Figs. 2 and 3).

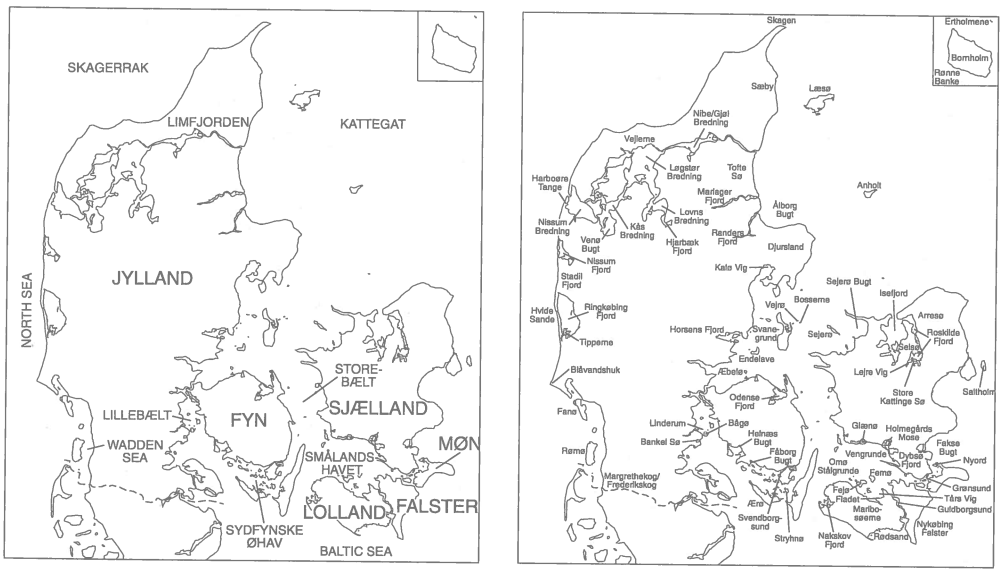

Fig. 2. Names of sites and areas mentioned in the text connected with presentation of results obtained in aerial surveys of waterbirds in Denmark 1987-1989.

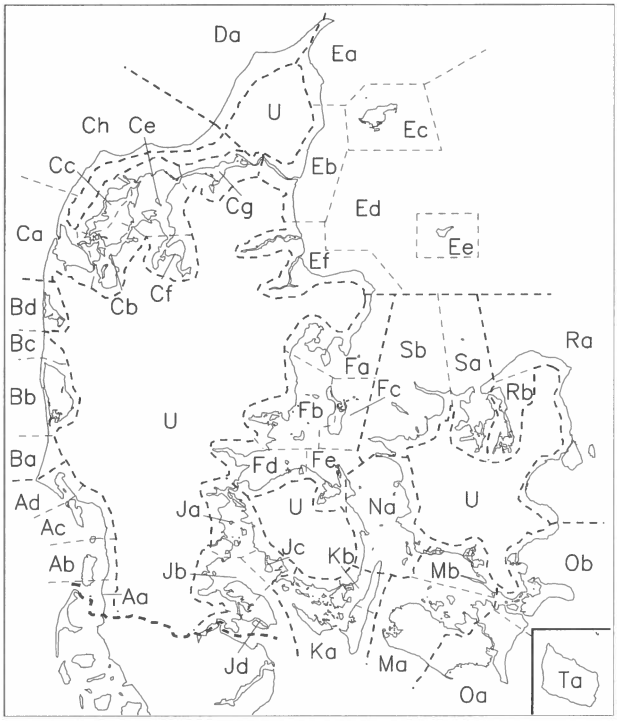

Fig. 3. Division of Danish waters into sections (A-F, J, K, M, N, O, R, S, T), and the sub-sections (small letters after main sections), used during aerial surveys of waterfowl in the periods 1968-1973 and 1987-1989. In addition to the 14 main sections the "U" section comprises a 15th containing land-based counts of lakes.

The Danish costal waters were divided into 14 main geographical sections which were divided into 44 sub-sections (Fig. 3); these were further divided in 900 count areas. A 15th geographical main section comprised c. 70 inland freshwater sites. The borders of the sub-sections and count areas were marked with their specific codes, reefs and shoals on portable 1:200,000 scale maps.

In countrywide surveys, complete coverage of all Danish coastal waters and Kattegat was attempted (App. I). This meant that all coastlines, reefs, shoals and other marine areas with maximum water depth of 10 m were surveyed. In addition, some areas with deeper water were covered.

All waterbirds were identified to the lowest possible taxon and counted, although gulls and terns, Laridae, were only recorded during the surveys from late summer 1987 to spring 1988. Whooper Swan *Cygnus cygnus* and Bewick's Swan *Cygnus bewickii* were often indistinguishable from the aircraft and were pooled as "Yellow-billed Swans". For the same reasons, Razorbill and Guillemot *Uria aalge* and divers were not identified to species. Little Auk *Alle alle* and Puffin *Fratercula arctica* were rarely identified but were often recorded as auk sp. All records of waterbirds consisted of species, number of birds and count area code.

Coastal water surveys were carried out from single-engined high-winged aircraft, four-seat Cessna 172 and Cessna 182, and two-seat Saab T-17. Survey flights were flown at 180 feet (60 m) altitude at speeds of 80-90 miles per hour (130-145 km/h).

Open sea surveys were conducted from twin-engined high-winged aircraft (Cessna 337 and Partenavia Observer). The flight altitude was the same as for the single-engined aircraft, while the speed was 90-110 miles per hour (145-175 km/h).

Only fast-flying aircraft were used. However, there are indications from both Sweden (L. Nilsson, pers. comm.) and Denmark (J. Madsen, pers. comm.) that slow-flying air-

crafts like Piper Cup, Rally Commodore and KZ-7 are somewhat more efficient for surveys of waterbirds than the fast-flying aircraft used in this study.

The degree of coverage and flight duration and effort depended on the topographical conditions in the survey area. In coastal areas with shallow water, the coastline was followed at a distance of 300-500 m. Additional surveys at distances of 1.5-2.0 km were conducted to complete the census. At open sea, far from coasts, routes were flown parallel at distances of 2.0-3.0 km, always including reefs and shoals. Finally, less survey effort was expended flying areas with water depths exceeding 10 m, as these areas often were associated with very low bird densities.

Surveys in the T-17 and, on a few occasions, in the Cessna 172 were carried out with only one observer. Under such circumstances areas chosen for surveys included those which had held comparatively low densities of waterbirds during previous surveys. In addition, the areas were covered more intensively to compensate for the lack of a co-observer. (See Pihl & Frikke (1992) for a detailed description of aircraft survey techniques).

Transect surveys

Transect surveys were conducted to obtain:

- coverage of open sea areas with water depths of >10 m by strip transect sampling,
- estimates of bird densities of widely dispersed and solitarily occurring species, and
- controls of count results of some sea duck species from areas covered by countrywide surveys.

For this purpose, the total Danish sea territory was divided into square units each 1/4 degree of longitude 1/8 degree of latitude, forming count areas of approximately 200 km^2.

Transects were exclusively performed in a Partenavia Observer aircraft with satellite navigation equipment (Omega). All observations of birds consisted of name of species, numbers observed and counting area code.

The waterbirds registered included Gaviidae, Podicipedidae, Procellaridae, Sulidae, Long-tailed Duck, Common Scoter, Velvet Scoter, Stercoraridae, Laridae and Alcidae.

Observers registered birds occuring within a 100 m zone on both sides of the aircraft (see Pihl & Frikke 1992). A zone of 20 m right below the aircraft was not covered due to limited viewing conditions in the aircraft, so the observed transect was 180 m. On a few occasions, results were only recorded from one side of the aircraft because sun reflections from the water surface hindered observations on the opposite side.

In the North Sea, Skagerrak and Kattegat all the transect routes were conducted in a south-north direction in sunny weather to avoid blurring reflections in the water (Fig. 4). In the western parts of the Baltic Sea, south-north transects were initiated, but such short transects proved impossible to fly and alternative routes with changing directions were chosen. For the same reason transects from Møn to Bornholm and in the surroundings of Bornholm were conducted west to east. Large numbers of Long-tailed Ducks had previously been recorded on Rønne Banke, southwest of Bornholm (Skov et al. 1987), and special attention was paid to this area by flying transects three times. The transects which are not indicated on figure 3 were conducted in a southwest-northeast direction according to the topography.

Ship survey technique

Ship surveys along strip transects were carried out following the methods suggested by Tasker et al. (1984). Ship surveys were used in preference to aircraft coverage to ensure adequate census of the important concentration of divers, grebes and auks in offshore

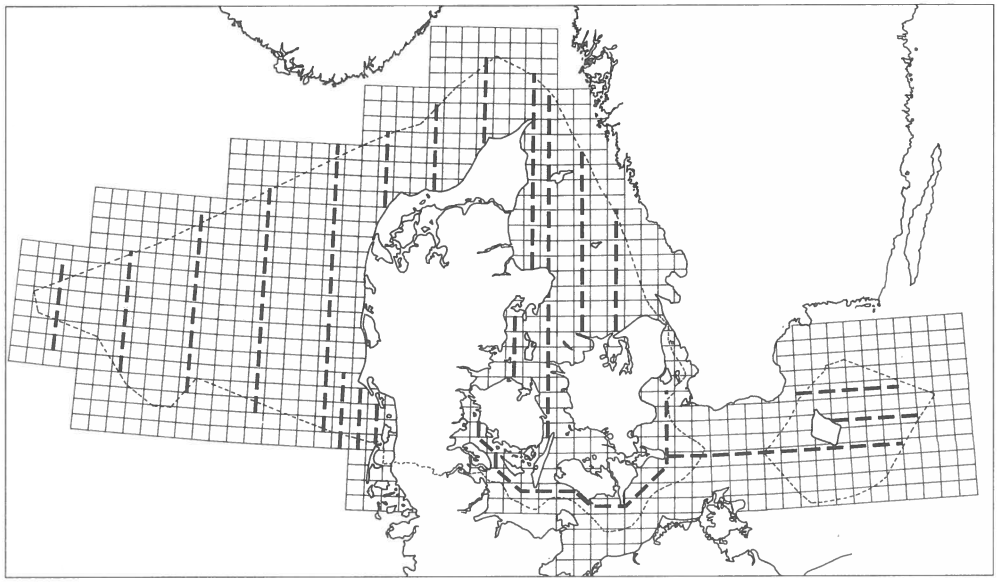

Fig. 4. Total net of transects in Danish waters indicating the transects surveyed from aircraft in 1987-1989, dotted lines.

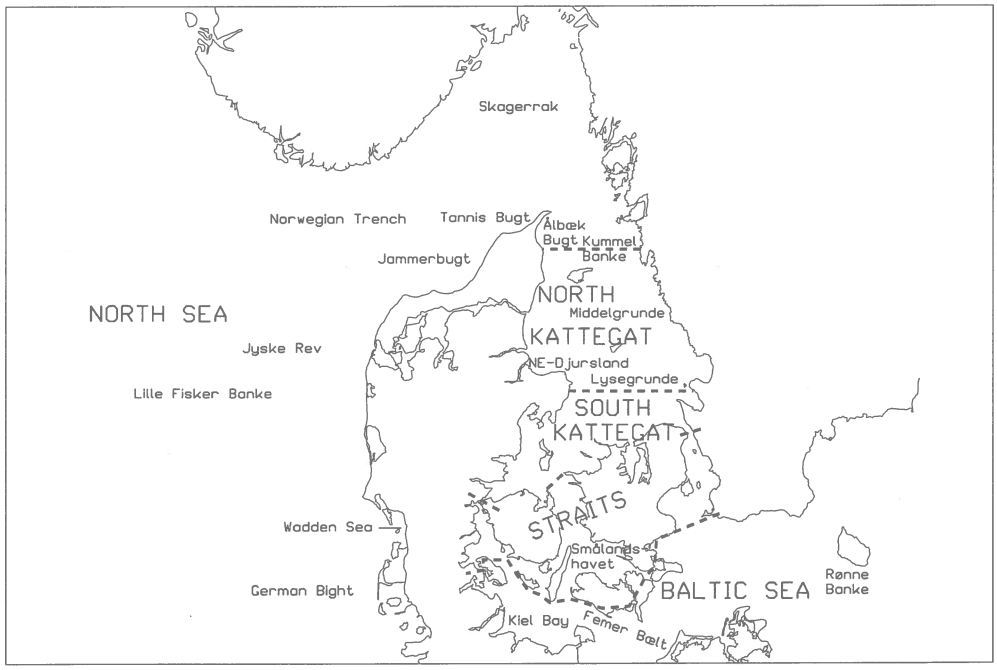

Fig. 5. Names of waters mentioned in the text connected with presentation of results obtained in ship surveys, 1987-1989. The dotted lines indicate demarcation of areas surveyed.

areas (Pihl et al. 1992). Transects using chartered vessels were planned on the basis of existing knowledge of seabird distribution to cover important habitats (Fig. 5), but also in areas likely to support important seabird concentrations (Schneider & Duffy 1985).

Birds were recorded in 300 m bands at one side of the ship along transects. At any time, the side of the vessel offering the best observation conditions was chosen, mainly to avoid the effects of sun glare and wind and wave direction.

On most cruises, the 300 m observation band was divided into two 150 m bands. Birds were recorded continuously in 10-minute intervals. All birds within the 300 m band were recorded with particular emphasis on birds on the water. Flying birds were recorded by scan samples (snapshot counts) every 10 minutes to reduce bias introduced by flying birds (Tasker et al. 1984). For species which are difficult to observe or identify, only observations from the inner 150 m band were used. Birds associated with ships (e.g. fishing vessels) were recorded separately.

For ten surveys, vessels employed in marine research (e.g. hydrographic studies) were used, while chartered vessels ranging from 30 to 400 tons were used during the remaining three surveys. Ferry routes were frequently used to supplement the coverage in areas with high densities of seabirds and in areas with little or no coverage. Both the chartered and research vessels were manned by professional crews and equipped with modern navigational aids.

Chartered ships were only used under good weather conditions, i.e. wind speed below 8 m/sec and visibility of more than 5 km. Data sampled during poor conditions from research ships was omitted from processing. The ship-based survey teams consisted of one to three observers, with up to two observers operating at the same time. No allowance has been made for the possible bias introduced by the varying number of observers. Observations took place from the top of the ships or from the open bridges of research vessels, three to eight metres above the sea surface. Vantage points were chosen to maximise the view ahead of the ship within a 90° sector to one side of the ship. On all chartered ships observation boxes were built to standardise observation conditions. Only experienced observers were chosen as the chief observer for each ship.

Ship position, speed, and course were recorded at the start and end of each transect, when changes occurred, and otherwise at hourly intervals. Bird and transect data were recorded on printed field sheets for subsequent database storage.

In order to cover all survey areas within the same periods between three and six ships were working simultaneously and each cruise lasted 12-25 days. A detailed description of ship survey techniques was published by Webb & Durinck (1992).

Surveys 1987-1989

Aerial countrywide surveys

During the period January 1987-September 1989, 10 countrywide surveys of waterbirds were carried out. They were conducted in: late summer, autumn, winter and spring (Table 1, Fig. 6).

The midwinter counts were performed in January/February 1987, 1988 and 1989. These surveys were supplemented by ground counts of approximately 70 inland freshwater sites (Fig. 7) and of the coastal waters of Bornholm. From the countrywide surveys and the ground counts, the total Danish populations of wintering waterbirds excluding seabirds were calculated and formed the Danish contribution to the International Waterfowl Counts (IWC) coordinated by IWRB.

The survey of the winter of 1987 was performed in a severe winter with extensive ice cover in all Danish waters except the North Sea and Skagerrak (Fig. 8). Mean weather severity indices (an index calculated on the basis of temperature and wind

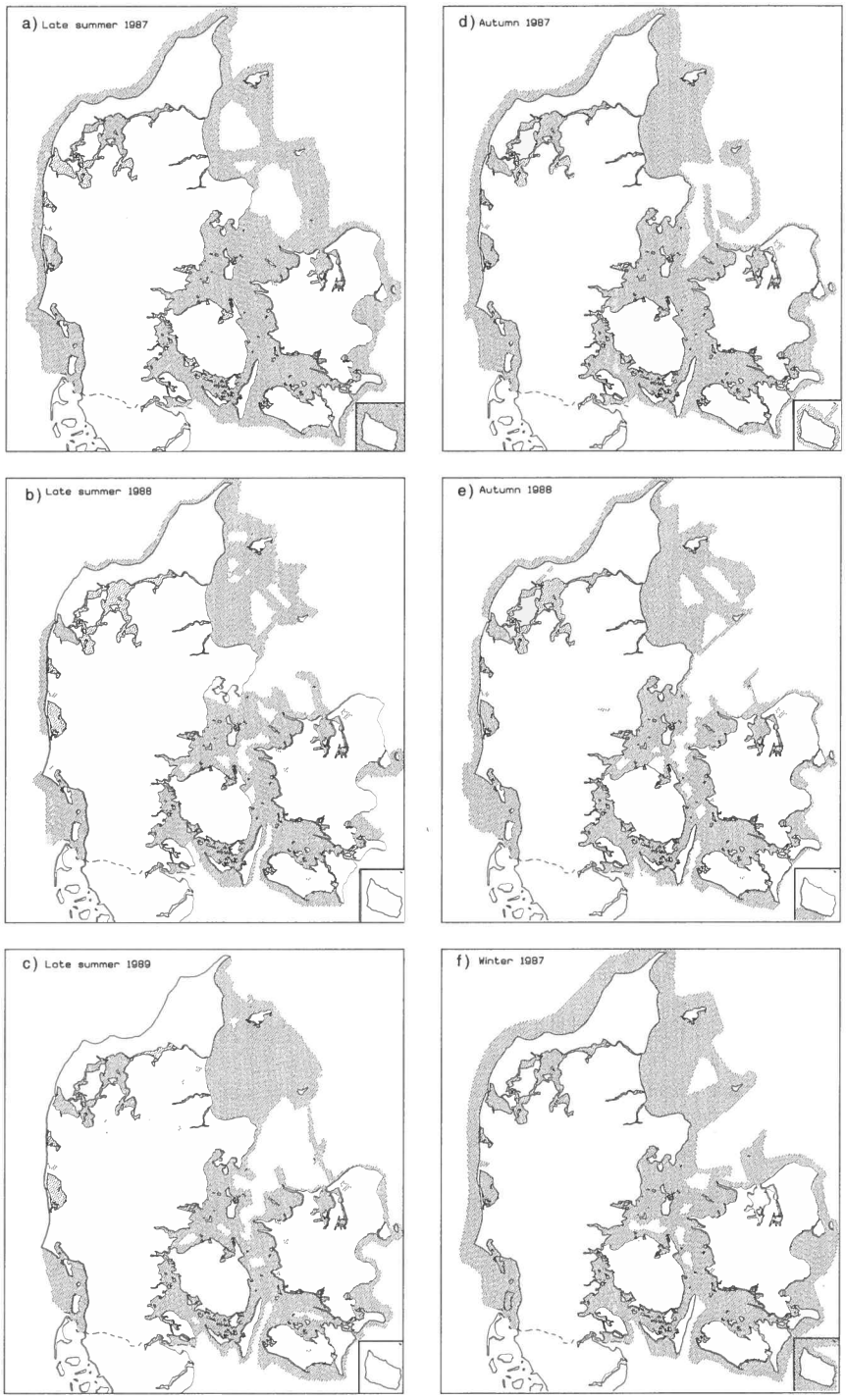

Fig. 6. Aerial coverage (shaded areas) of waterfowl in the Danish waters during the 10 surveys(a-j) in 1987-1989

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speed) scored 266 compared with an average of 104 (Anon. 1989). The surveys in winter 1988 and 1989 were conducted in very mild winters with mean indices of 11 and 8, respectively (Anon. 1989).

Late summer surveys were performed in August 1987, 1988 and 1989. The aim was primarily to elucidate numbers and distributions of wildfowl during wing-moult, but all observed waterbirds were registered (Table 1, Fig. 6a-c). Late summer surveys were conducted under almost identical weather conditions and use of survey hours (Table 1).

Autumn surveys were carried out in October/November 1987 and 1988, (Table 1, Fig. 6d, e). These surveys tended to cover the passage of autumn migrating waterbirds. In earlier studies, some species of waterbirds, e.g. Red-breasted Merganser and Coot *Fulica atra* were found to be most numerous at that time of the year (Joensen 1974). Autumn surveys were performed under almost identical weather conditions and expenditure of survey hours.

The weather in January 1987 was characterised by high pressure over Scandinavia and calm and sunny weather in Denmark, and the survey was completed during a short period (Table 1, Fig. 6f-h). The survey of 1988 was interrupted by several periods of unstable, windy or foggy weather. In January 1989, the weather conditions were dom-

inated by rapidly passing low pressures and the wind speed was too high throughout the month to perform countrywide surveys, and this survey was exclusively carried out in February.

Due to the different weather conditions, the three midwinter surveys were not performed during exactly the same periods of the year. These differences of more than two weeks between 1987 and 1988 and about one month between 1988 and 1989 may have affected the numbers and distribution of the waterbirds.

The spring surveys were carried out in March/April 1988 and 1989 (Table 1, Fig. 6i, j) with the aim to describe spring staging areas and numbers of migrating waterbirds, particularly of seaduck species concentrated in high densities at this time of the year (Skov et al. 1987). The survey of 1988 was carried out a week earlier than the survey of 1989. The weather conditions and cost of survey hours were very much alike in the two years (Table 1).

Fig. 7. Sites counted from the ground in the winters of 1987-1989.

Aerial transect surveys

In the period from January 1987 to September 1989, altogether four complete surveys and four reduced surveys were carried out.

In January 1987, an incomplete transect survey was performed covering the North Sea and Skagerrak where only scattered ice was recorded. Kattegat and the Baltic Sea were not surveyed due to heavy ice cover (Table 1, Fig. 9a).

Table 1. Survey periods and time (hour; minutes) spent surveying the Danish waters from ship and aircraft during autumn (A), winter (W), spring (SP) and late summer (LS)1987-1989.

Type of survey	Period/ time	W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	SP 89	LS 89	A 89
Ship surveys	Periods	11/01-20/03	27/04-30/05	03/08-07/09	29/09-01/12	14/01-17/03	04/04-16/05	20/07-24/08	10/10-09/12	19/01-19/03			06/10-11/12
	Time:h;min.	183;20	48;40	126;50	311;10	310;30	234;20	220	176;20	171;50			211;10
Aircraft surveys	Periods	16/01-18/02		11/08-24/08	20/10-18/11	05/01-22/02	07/03-27/04	18/08-31/08	24/10-15/12	11/01-28/02	18/03-27/04	14/08-12/09	
Total surveys	Main period	16/01-26/01		11/08-20/08	25/10-10/11	12/01-22/02	08/03-28/03	18/08-30/08	24/10-20/11	01/01-22/02	27/03-19/04	19/08-03/09	
	Median date	19/01		13/08	05/11	07/02	23/03	24/08	07/11	17/02	29/03	29/08	
	Time:h;min.	58;37		64;47	78;20	83;36	95;39	67;43	77;56	84;23	87;02	67;18	
	Coverage	97%		90%	96%	96%	96%	90%	98%	96%	97%	98%	
Transect surveys	Survey period	18/02-19/02		29/08	23/10-10/11	23/01-07/02	09/03-27/04	21/09-11/10	15/12		28/03-20/04		
	Time:h;min.	9;55		4;00	21;30	5;54	17;28	14;21	1;50		14;41		

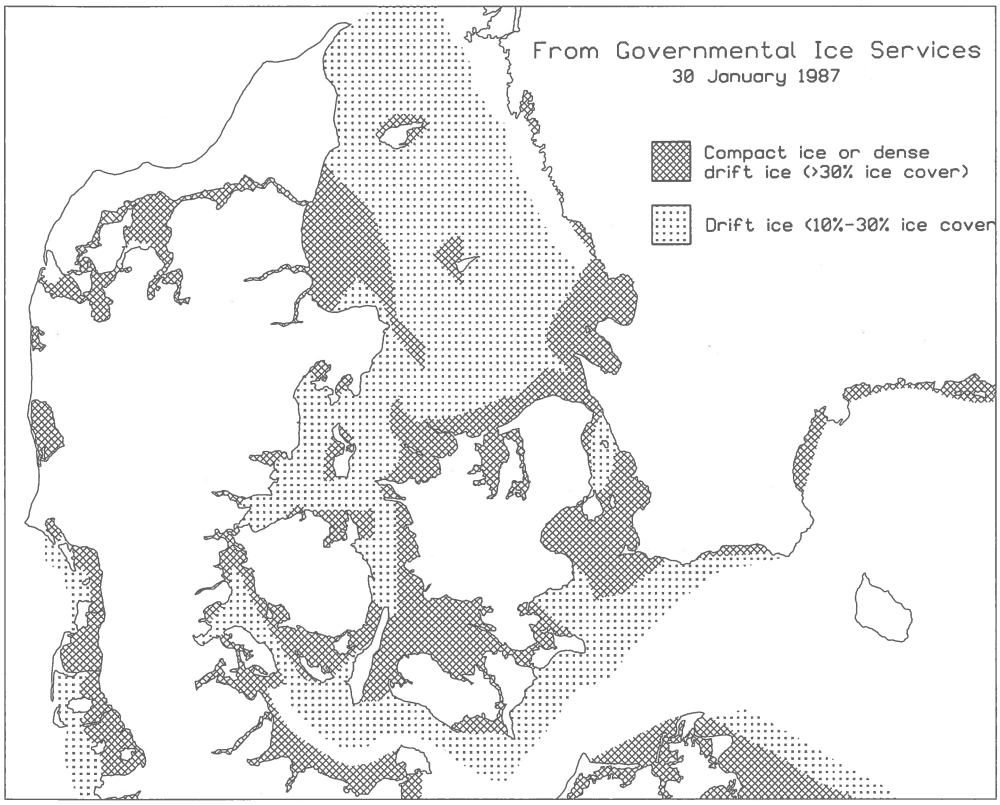

Fig. 8. Occurrence of ice cover in Danish waters on 30 January 1987 (after Anon. 1989).

In September 1987, an incomplete transect survey covering the Skagerrak was performed (Table 1).

In October/November 1987, an incomplete transect survey of all the Danish waters except the eastern parts of the Baltic Sea was performed. (Table 1, Fig. 9b).

In January 1988, an incomplete survey covered the western parts of the Baltic Sea (Table 1).

In March/April 1988, a complete transect survey of the Danish open sea areas was conducted (Table 1, Fig. 9c).

In September/October 1988, a complete transect survey of all Danish waters except Skagerrak was performed (Table 1, Fig. 9d).

In December 1988, an incomplete transect survey covered the eastern parts of the Baltic Sea (Table 1).

In March/April 1989, a complete transect survey of all Danish waters except the remote parts of the North Sea was conducted (Table 1, Fig. 9e).

Ship surveys

In the period January 1987 - November 1989, eight surveys covering large areas and two reduced surveys were carried out.

During January-February 1987, extensive surveys of all open water areas were made from the research ships Dana, Argos and Gunnar Thorson supplemented with observations from ferries in Skagerrak. Due to heavy ice cover in Kattegat and the Baltic Sea, the major part of the coverage of these two areas was directed into the deeper, ice-free areas (Fig. 10a).

In April-May 1987 scattered transects were made in the North Sea, Skagerrak, Kattegat and the western part of the Baltic Sea using the research ships Gunnar Thorson and Aurelia, supplemented with observations from ferries in Skagerrak (Fig. 10b).

In July-August 1987, most of the North Sea, Skagerrak and Kattegat was covered by surveys from the research ships Dana and Tridens supplemented with observations from ferries in Skagerrak. Less effort was used in the areas in the southern Kattegat and the inner part of the North Sea (Fig. 10c).

In October-November 1987, surveys from four chartered ships were performed in all areas with the exception of the Norwegian sectors and areas in the Baltic Sea and the Straits. These surveys were supported by results from several ferry routes (Fig. 10d).

In January-February 1988, complete coverage of offshore areas was obtained from five chartered ships and the research ships Dana, Argos, and Gunnar Thorson supple-

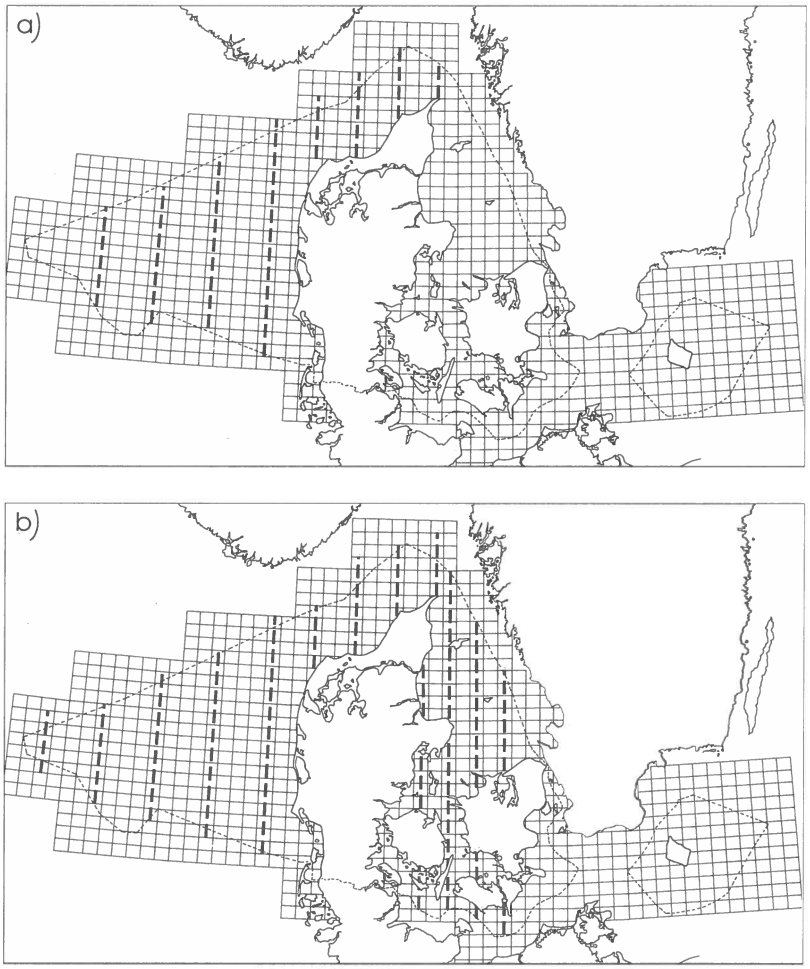

Fig. 9. Transect lines surveyed from aircraft in 1987-1989 given according to season: a) January/February 1987, b) October/November 1987, c) March/April 1988, d) September/October 1988 and e) March/April 1989 (compare Fig. 4).

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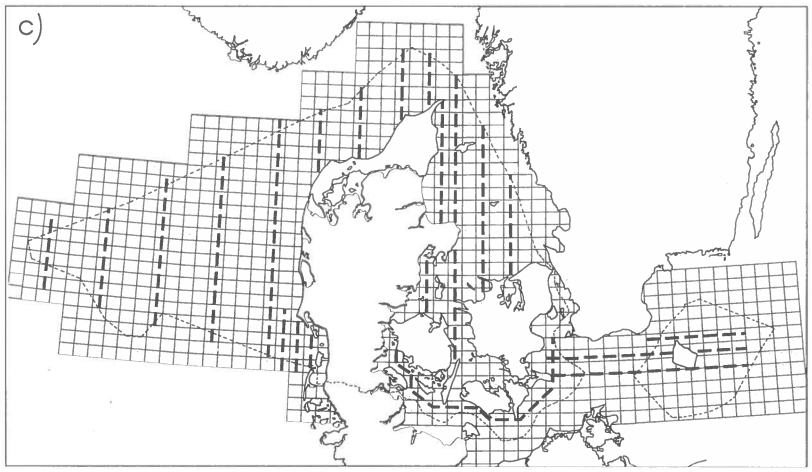
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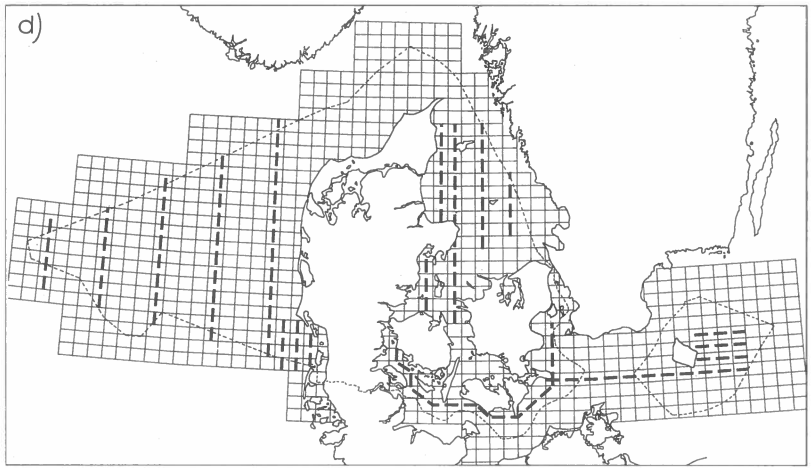
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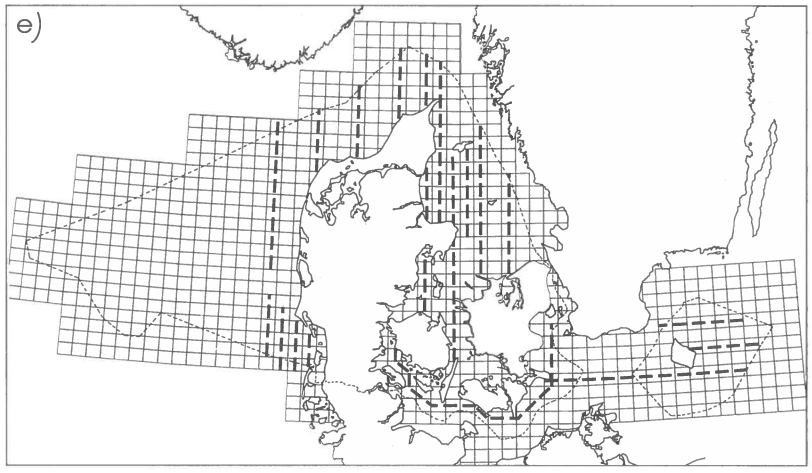
e)

mented with ferry route observations. Less effort was made in the Norwegian sectors (Fig. 10e).

In April-May 1988, complete coverage was obtained from four chartered ships, the research ship Gunnar Thorson and ferries. The western parts of the North Sea as well as Kattegat and the Norwegian sectors were not covered during this period (Fig. 10f).

In July-August 1988, complete coverage was established using the research ships Argos, Aurelia, Gunnar Thorson and supplementing ferry routes. The eastern part of the Baltic Sea received little attention during this period (Fig. 10g).

In October/November 1988, complete coverage of the North Sea, Skagerrak and Kattegat was gained by using the research ships Eldjarn and Dana and some ferry routes in addition (Fig. 10h).

All areas were covered during January-February 1989 using the research ships Argos and Gunnar Thorson, and by using ferries as support (Fig. 10i).

In October/November 1989, the North Sea and Kattegat were completely covered by using the research ships Tridens and Eldjarn, one chartered ship and ferry routes as support (Fig. 10j).

Reliability of the data

Data used

The source of results for each species varies, depending on how well the species was covered by the various methods and on the distribution and behaviour of the species.

Countrywide surveys from aircraft as well as transect surveys from both aircrafts and ships were used as methods, causing variations in coverage of relevant habitats

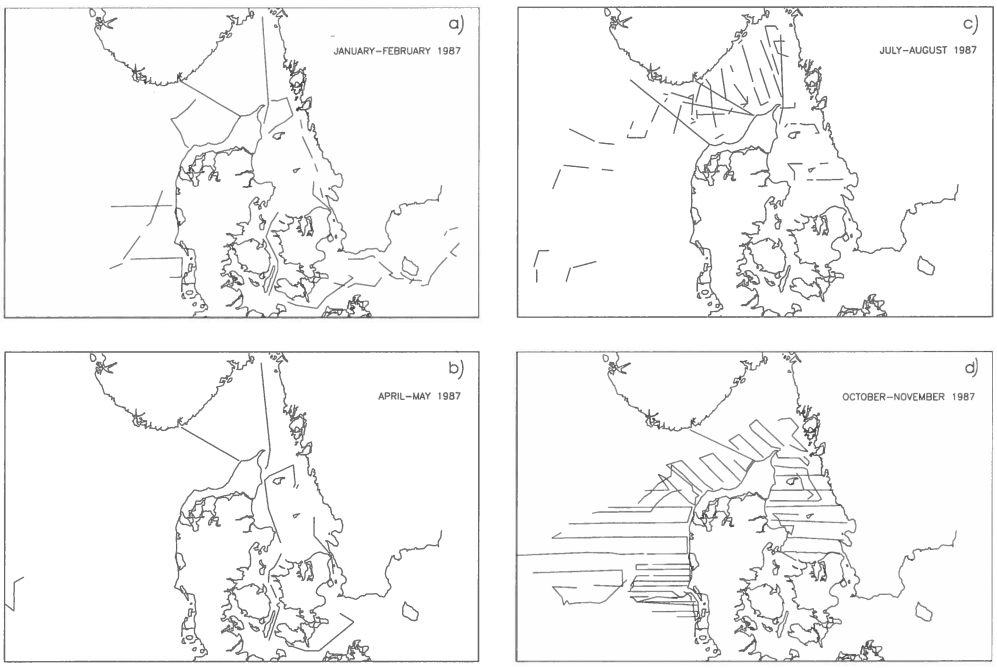

Fig. 10. Transect lines surveyed from ship 1987-1989 given according to season: a) January/February 1987, b) April/July 1987, c) July-August 1987, d) October/November 1987, e) January/February 1988, f) April/May 1988, g) July/August 1988, h) October/November 1988, i) January/February 1989 and j) October/November 1989.

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and identification difficulties. Comparisons of the results from the various survey techniques were evaluated on a species level to identify the best set of data:

The results of swans, Shelduck, dabbling ducks, small diving ducks Aythinae, Goldeneye and Mergansers Merginae, Coot and Black-headed Gull *Larus ridibundus* come exclusively from data from the countrywide aerial surveys, due to the birds' occurrence close to the coasts (Table 2).

The results for Common Scoter are based equally on countrywide aerial surveys and transect surveys from both ship and aircraft (Table 2).

The results for divers, grebes, Fulmar *Fulmarus glacialis*, Gannet *Sula bassana*, Long-tailed Duck, Velvet Scoter, Great Skua *Stercorarius skua*, Little Gull *Larus minutus*, Kittiwake *Rissa tridactyla* and auks were based primarily on ship transects due to their dispersed distribution in offshore waters and, where gaps occurred in space or time, on aerial transects (Table 2).

Table 2. The result of the 38 different species in Denmark, 1987-1989, were obtained in aircraft and ship surveys according to the methods used in the following way: +++ indicates that the presented results were primarily based on this method, ++ indicates that the respective method contributed extensively to the finally presented results, and + that only few data obtained by the respective method was included as a basis of the presented results.

	AIRCRAFT SURVEYS		SHIP SURVEYS	
Species	Total	Transect	Total	Transect
Red-/Black-throated Diver		+	+	+++
Great Crested Grebe	++	+	+	+++
Red-necked Grebe		++	+	+++
Fulmar		+++	+	+++
Gannet		+++	+	+++
Cormorant	+++			
Grey Heron	+++			
Mute Swan	+++			
Bewick's/Whooper Swan	+++			
Shelduck	+++			
Wigeon	+++			
Teal	+++			
Mallard	+++			
Pintail	+++			
Pochard	+++			
Tufted Duck	+++			
Scaup	+++			
Eider	+++			
Long-tailed Duck	+	++	+	+++
Common Scoter	+++	+++	+	+++
Velvet Scoter	+	++	+	+++
Goldeneye	+++			
Red-breasted Merganser	+++			
Goosander	+++			
Coot	+++			
Great Skua		+		+++
Little Gull		+		+++
Black-headed Gull	+++			
Commoll Gull	++	+	+	+++
Lesser Black-backed Gull	-	-	-	-
Herring Gull	++	+	+	+++
Great Black-backed Gull	++	+	+	+++
Kittiwake		+	+	+++
Guillemot		+		+++
Razorbill		+		+++
Black Guillemot			+	+++
Little Auk			+	+++
Puffin				+++

The results for the remaining species of gulls come from data from ship transect surveys and countrywide aerial surveys (Table 2).

Due to a rather heterogeneous occurrence, the seaducks were treated on an individual basis (see introductory remarks about Eider, Long-tailed Duck and Common and Velvet Scoter).

Aerial surveys

Aerial surveys were conducted at a speed which left very little time to identify and count the birds. Small flocks were counted one by one, but when the flocks exceeded 30-50 birds the numbers were estimated.

Joensen (1968, 1974) reported underestimation as the most common error in aerial surveys, especially when estimating huge flocks of 30,000-50,000 birds. Follestad et al. (1988) did not study very large flocks, but reported underestimation in flocks of 50-400 and overestimation in larger flocks. The tendency to overestimate was more pronounced for dispersed flocks than for dense flocks.

Nilsson (1975) compared results from aerial surveys with those of ground and boat counts in Swedish coastal waters. He found the efficiency of aerial surveys to be highest in Long-tailed Duck and Scoters. Only for Goosander (64%) and Red-breasted Merganser (39%) was the efficiency in aerial surveys lower than 75%.

A more detailed study of the reliability of surveying techniques and of the size of errors in data collected on basis of aerial surveys is currently being planned at NERI.

Experience in observing from aircraft was very important. With growing experience, the navigation and identification became easier, and the estimation of the numbers more reliable. Thus, it is likely that the best coverage was obtained in 1988 and 1989. Differences in plumage, numbers, habitat and behaviour caused unequal chances of registering the different species of waterbirds. This was not considered having affected comparisons between the aerial surveys as this bias was constant.

Similarities in plumage caused some identification problems. Whooper Swan *Cygnus cygnus* and Bewick's Swan *Cygnus*

bewickii were often indistinguishable and were recorded as Whooper Swan/Bewick's Swan ("Yellow-billed Swan"). Goldeneye, Red-breasted Merganser and Goosander *Mergus merganser* look similar from the air which may have led to misidentification in a few cases. In late summer, flying young Shelducks sometimes looked like gulls, and especially solitary birds in groups of gulls may have been overlooked. Correct separation of Common and Velvet Scoters needed some experience, particularly at distances larger than 300 metres. The shape of head and the behaviour are conspicuously different for the two species, which can be distinguished with experience. However, the bias in identification of the two species may have been unequal. Common Scoter was often scared off by the aircraft even at distances of several kilometres and more than 95% of the registered individuals of this species was recorded flying. Velvet Scoter tended to stay on the water and was, thus, possible to detect at a much shorter range from the aircraft; the coverage of Velvet Scoter was believed to be much less effective than that of Common Scoter.

Gadwall *Anas strepera*, Pintail *Anas acuta*, Garganey *Anas querquedula*, and Shoveler *Anas clypeata* were often mixed with more numerous species of waterbirds and difficult to detect, and were thus probably underestimated. In addition, the dabbling ducks often took off at some distance when the aircraft approached making identification more difficult. Pochard *Aythya ferina* mixed with huge flocks of Tufted Duck and was often hard to detect.

Teal, Mallard *Anas platyrhynchos*, Pochard, Tufted Duck, Goosander and Coot occurred in both freshwater and marine areas. As the freshwater sites were only covered to a limited extent by the surveys, the results did not reflect the numbers for the country as a whole.

For divers, grebes, Long-tailed Duck and auks which are widely dispersed, a country-wide survey was impossible.

Grebes, Long-tailed Duck, moulting Scoters and Goldeneye often dived when the aircraft approached. Cormorant *Phalacrocorax carbo* was predominantly registered when sitting on fish poles or on reefs, as it was difficult to detect when feeding solitarily often far from the coast. Special light conditions sometimes made even big flocks of Coot hard to observe especially when occurring in the shadow from woods close to the coast.

Gulls were only counted from late summer 1987 to spring 1988. Swans and ducks were always the primary objects and gulls in that respect secondary; gulls were recorded only when numbers exceeded 10 individuals of Great Black-backed Gull *Larus marinus*, 20 individuals of Common Gull *Larus canus* and 50 individuals of Black-headed Gull or Herring Gull *Larus argentatus*. This of course made the data less reliable and more vulnerable to errors.

Ship surveys

The ship-based surveys were conducted from several types of ships sailing at different speed and bearing the observation platform at different heigths. This may have affected recording efficiency and species identification leading to variations between surveys. Speed-induced errors in the density estimates were minimised by limiting the use of ships running at high speeds (principally ferries).

Although it was considered essential that the observer efficiency was kept at a constant high level, periods of prolonged observation in some cases could not be avoided. Crossing of high bird density areas created problems for the observer maintaining a high recording efficiency and rate of species identification. It is likely, that the numbers of birds actually recorded within these clusters are underestimated. The experience of the observers was therefore considered of primary importance.

Observations were carried out during several cruices onboard marine survey vessels involved in studies with different objects than seabirds. These ships covered marine areas by the use of different strate-

gies depending on aims of the surveys. However, only surveys that covered wide areas and a wide range of depth zones within the study area were chosen. Therefore, the results from research cruises as well as from chartered vessels were considered comparable for shallower as well as for deeper habitats.

The distance between transects from chartered ships varied both within and between surveys being smallest in areas with expected clustered distribution of the seabirds. For all species except divers (see these) more than 90% of the birds within transects were identified.

Because flying birds of some species are attracted by ships, the numbers of these species might have been overestimated. To analyse the amount of deviation from the mean abundance of birds in the area surveyed, the densities of flying Fulmar, Gannet, Great Skua and gulls were compared with the densities of birds observed on the water. These species are known to exploit fishery waste, and they were often recorded aggregated in proximity to fishing activities. Therefore, such flocks were excluded from the analyses.

Handling of data and statistics

Countrywide aerial surveys

All data was coded on computer and checked against the original tapes or sheets. Maps illustrating the survey routes were drawn, and information on the weather, airborne time, survey time, type of aircraft, observers, pilot and any additional information was recorded. Totals of all species in the count areas made up the basis for computerised mapping of the distribution.

Transect surveys

All data was coded on computer, and all files were controlled for errors against the original sheets or tapes.

The analyses of aircraft observations, which were used for the dispersed species of seaducks, e.g. scoters and Long-tailed Duck were made by calculating the mean density of each square unit (see chapter Methods and Material: Transect surveys) based on the assumption that the birds were evenly distributed within the square crossed. The calculation was:

$$D = \frac{N}{L \times W}$$

where D expresses mean density, N expresses number of birds recorded in the transect, L length of transect surveyed and W width of transect.

The analyses of data obtained from ship-based transects differed from the analysis of aerial transects. Although the same equation was used to calculate mean density within surveyed areas, the low value of L for ships made it possible to plot mean densities on a nautical map at a resolution of 2-3 km. The high precision of counts along sections of transect segments with different densities permitted the estimation of densities within relatively small areas. The number of hectares within each area was measured on the master map by a planimeter. Special emphasis was put on the high density areas in order to avoid over-extrapolation of the geographical extension of these areas. Linkage of high density segments between neighbouring transects was only carried out when the minimum distance between the transects did not exceed 10 nautical miles (18.5 km). Due to the limited structure of the sampling in most of the surveys, the densities are presented without confidence limits.

Areas bordering areas with low or no effort were marked by open isolines, while the zones with different densities were marked by solid lines.

All birds that were not associated with fishing activities, including flying individuals counted through snapshots, were included in density calculations. No adjustment of densities of birds on the water were made in order to make allowance for incomplete detection within the transect bands (Tasker et al. 1987). Instead, a comparison

was made between the 150 metre and the 300 metre transect strips for all species, and the most efficient strip was chosen as the basis for density calculation of the species. The estimates were then calculated, assuming that all birds within the more efficient strip had been counted.

Comparison with the results of the surveys in 1968-1973

In the period 1968-1973, the Game Biology Station conducted countrywide aerial surveys in November 1968 and 1969 and in January 1969, 1970, 1971 and 1973. An incomplete survey exists from March 1969, but is only compared with the 1987-1989 study in a few cases. Countrywide surveys were not conducted in August from 1965 to 1973, but smaller surveys throughout this period covered the Danish waters almost completely.

The method used to estimate the numbers and distribution of waterbirds during 1968-1973 was to combine countrywide aerial surveys and extensive ground counts. To make the results comparable to the 1987-1989 study, the data from the countrywide surveys in 1968-1973, omitting the ground counts, were computerised using the same method as for the countrywide surveys in 1987-1989. The numbers and distributions of waterbirds in 1968-1973 in this paper therefore differ from the results published by Joensen (1974).

The central parts of Kattegat were well covered by the 1987-1989 aerial surveys, but only superficially covered in 1968-1973. The west coast of Jylland from Blåvandshuk to Skagen and the surroundings of Bornholm were only occasionally covered during both sets of countrywide aerial surveys. These three areas are excluded from the calculations of the total coverage percentage for the countrywide aerial surveys (App. I). The method used to perform the surveys in 1987-1989 was practically the same as the method used in 1968-1973 including the division of the Danish waters, but the expenditure of survey hours and coverage differed somewhat. During 1968-1973, a total of 44-55 survey hours was used to conduct one countrywide survey and the coverage ranged from 84% to 91% of the Danish waters; during 1987-1989 a total of 58-95 surveys hours was used and the coverage ranged from 90% to 98% (see Table 1).

During 1968-1973, the autumn surveys were conducted later in the year than during 1987-1989. The survey periods included 5-25 November 1968 with 13 November as median date and 11 November-20 December 1969 with 26 November as median date (see Table 1). This difference in time affected the comparability of the results of species that arrive late in the year to the wintering grounds in Danish waters.

Of the four previous winter surveys, 1969 and 1971 were about normal with severe weather index (SWI) of 116 and 84, respectively, whereas 1970 was severe (SWI = 208) and 1973 was mild (SWI = 11). During the present study, 1987 was severe (SWI = 266) whereas the other two winters were mild, SWI = 11 and SWI = 8, respectively. The average SWI in Denmark is 104 (Anon. 1989).

RESULTS

The results are presented systematically in the following way:

- "Total numbers" outlines the range of the numbers of birds counted or estimated, and any possible trend in numbers appearing during the study.
- "Moult" is included in six species and describes in short the occurrence of often flightless birds moulting their wing-feathers in late summer.
- "Geographical distribution" describes the areas where species occurred most abundantly in each season and major differences in distribution between seasons. Results from countrywide aerial surveys are presented in figures showing distribution and total numbers recorded; results from transect surveys are presented in figures showing densities.
- "Numbers in the geographical sections" includes comparisons between seasons, years and/or areas. Waterbirds except gulls recorded on freshwater sites are included. For species where numbers at coastal and inland freshwater sites in winter exceed 5% of the total the proportion in winter 1989 when the coverage of inland sites was best is mentioned. Any sites or well defined areas with numbers classifying them as internationally important according to international standards (Rose & Scott 1994) are mentioned.
- "Dispersion" describes in few words the dispersion in Danish waters including flock structure.
- "Species composition" is added (divers and "Yellow-billed Swans") when identification to species level has been possible only in some of the observations.
- "General comments" includes a general species discussion. The proportion of the total population recorded in Danish waters is given. In species without available current estimates on the population size, the estimated number of breeding pairs in northern Europe including the northwest Atlantic Sea has been multiplied by a factor 3-4 for Fulmar, Gannet and gulls and $2^1/_2$-$3^1/_2$ for Auk to include juveniles and non-breeders.
- "Seasonal and geographical variation" includes discussion of these specific topics.
- "Comparison with the results of the surveys in 1968-1973" is presented only where the species have been surveyed during former aerial surveys.

Red-throated Diver *Gavia stellata* and Black-throated Diver *Gavia arctica*

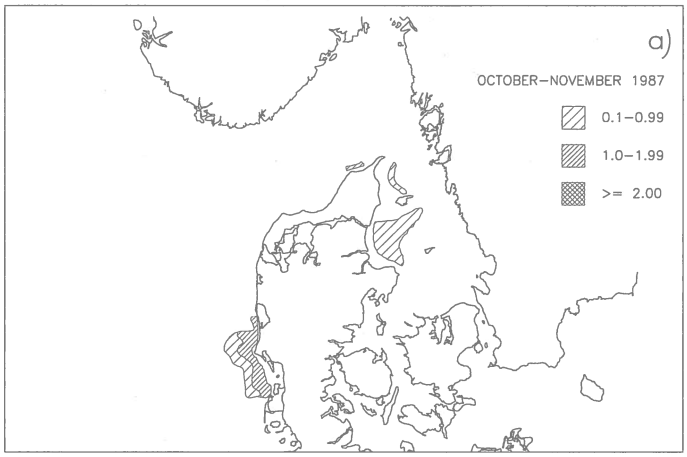
Total numbers

In autumn estimates of the total numbers (excluding Baltic Sea waters) varied from 3,000 to 7,500 birds, in winter from 12,500 to 39,000 birds and in spring from 28,000 to 39,000 birds (App. II).

During countrywide surveys, divers were additionally regularly recorded in late summer surveys when a few birds were observed in Sejerøbugten.

Geographical distribution

In general, divers were concentrated in areas of less than 30 m depth except in the severe winter of 1987.



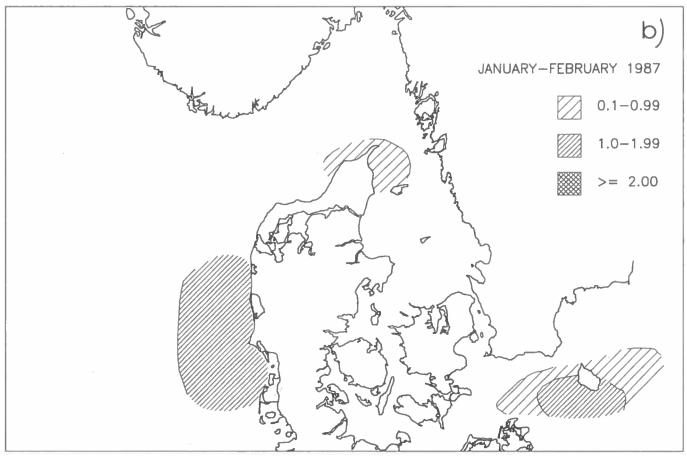


Fig. 11. Distribution and density of Red-throated/Black-throated Diver in Danish waters during autumn 1987 (a), winter 1987 (b), 1988 (c) and spring 1988 (d), based on surveys from ship.

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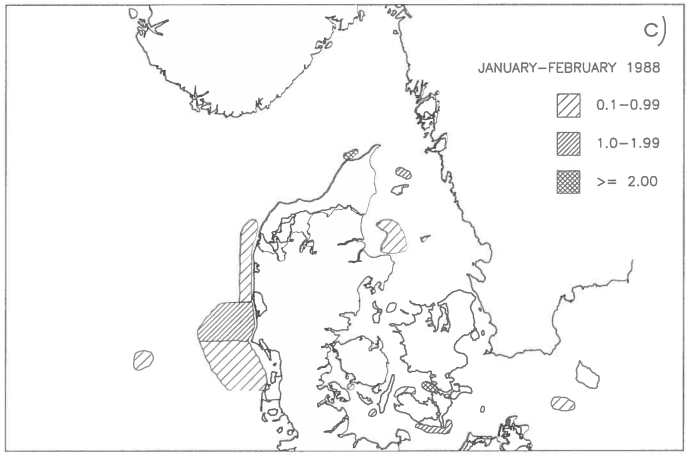
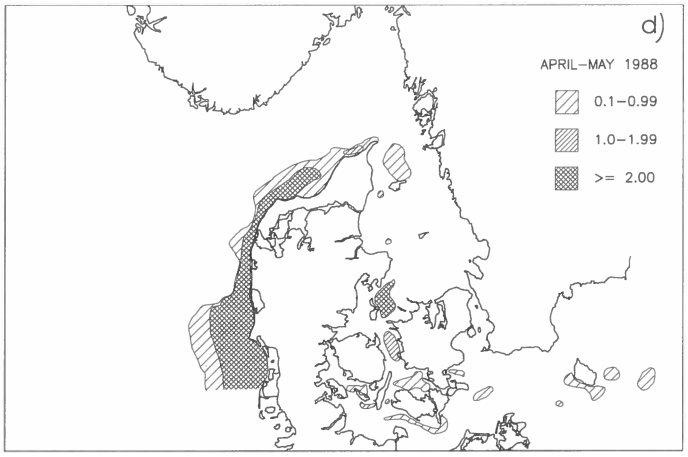




In all seasons, large densities of birds were recorded in two areas: off the Wadden Sea and in northern Kattegat (Fig. 11). Off the Wadden Sea, large concentrations were observed from Rømø to Hvide Sande up to 75 kilometres off the coast. In northern Kattegat, the birds were concentrated in a triangular area bordered by eastern Jylland, Læsø and Anholt. High densities were found in several localised areas, most notable during late spring along the northern part of Jylland and in Jammer Bugt in Skagerrak, and during the severe winter of 1987 (Fig. 11b) on Rønne Banke in the Baltic Sea.

Numbers in geographical sections

In almost all areas numbers increased from autumn to winter and in particular from winter to spring (App. II). In the area off the Wadden Sea the estimated numbers increased from 1,700-2,200 birds in autumn to 28,500 birds in spring.

In northern Kattegat, the estimated numbers were less variable ranging from 900-4,500 birds in autumn to 3,700-6,800 birds in spring.

Off the northern part of the west coast of Jylland and in Jammer Bugt, two surveys in late spring 1988 demonstrated the migration of divers through these areas. In late April,

500 birds were estimated, while in the middle of May, 4,300 birds were estimated along the west coast and 4,500 in Jammer Bugt. Observations of divers in lagoons and inlets were generally few, but one record was unique: on 28 March 1988 a flock of 420 Red-throated Divers were recorded in Nissum Bredning.

Internationally important numbers of >590 divers (Danielsen et al. 1993) were estimated in autumn, winter and spring off the Wadden Sea and in northwestern Kattegat, and in winter or spring in Jammerbugt, Tannis Bugt, Ålbæk Bugt, southwestern Kattegat, Skälderviken, Smålandshavet, Femer Belt and at Rønne Banke.

Dispersion
Within the areas, the birds were dispersed and usually recorded singly or very few together though flocks of more than ten birds were occasionally recorded especially in autumn.

Species composition
About 30% of the birds were identified to species. West of the Wadden Sea the proportion of Red-throated Divers decreased from 93% in autumn 1987 to 54% in the winter of 1988 and to 26% in the spring. A high proportion of Red-throated Diver (85%) was recorded along the northern part of the west coast during late spring 1988 and in the Straits and the Baltic Sea in winter (66%) and in spring (69%).

General Comments
Despite the variation in coverage, population estimates of the most important areas could be calculated, and it was considered possible to base a reliable total figure of divers in the Danish waters on these estimates.

The estimated midwinter population of divers is 59,000 individuals in northwestern Europe (Danielsen et al. 1993), and numbers in Danish waters comprised up to 13% of this total in autumn and 66% in winter and spring.

Seasonal and geographical variations
The distribution of divers was similar between seasons and years, with more than 70% occurring in the two main areas, i.e. the Wadden Sea and northwestern Kattegat, during the five extensive surveys.

The relatively low numbers off the Wadden Sea coast during all three autumn surveys may reflect the fact that most birds passing Blåvandshuk (Meltofte & Kiørboe 1973) in October-November do not stop there, but continue their southward migration. The prominence of the Red-throated Diver off the Danish part of the Wadden Sea in autumn indicates that this area was exploited by this species during the moulting period in September-December (Cramp & Simmons 1977).

The numbers of wintering divers seemed to vary with the severity of winter. Divers off the Wadden Sea coast were much more extensively distributed and the estimated numbers were much higher in severe winters than in subsequent mild winters. On Rønne Banke, in the Baltic Sea, the numbers of wintering divers were similarly much higher during severe winters compared with mild winters. Unfortunately, northern Kattegat was not covered in winter 1987.

Spring numbers of divers were generally larger than those in winter, especially off the Wadden Sea supporting the idea that divers concentrate in this area in late spring as indicated by the large numbers of migrating divers recorded at Blåvandshuk (Meltofte & Kiørboe 1973). A similar increase in numbers of divers off the Danish part of the Wadden Sea from winter to spring was recorded during 1979-1986 (Tasker et al. 1987). The data on species composition in 1988 indicated an influx of Black-throated Divers to the area off the Danish Wadden Sea during winter and spring. The numbers seemed to peak before the spring period, when at least 75% of the divers present were Black-throated. The large influx occurred immediately before the onset of the primary moult in this species during March-April (Ginn & Melville 1983, Il'icev 1985). The

lack of comparable numbers of Black-throated Divers in other parts of western Europe during spring indicates, that the species uses the waters off the Wadden Sea as an important area for the primary moult.

The large numbers recorded in spring further north along the west coast of Jylland and in Jammerbugt, correspond well with the large migration of Red-throated Divers along the northern parts of the west coast (Møller 1978, Danielsen et al. 1989), and former surveys in the area (Tasker et al. 1987, Ornis Consult A/S, unpubl. data 1986).

The two species of divers seemed to choose different routes when leaving the area off the Wadden Sea. Large-scale migration of Black-throated Diver has only been observed along the coasts of the eastern parts of the Baltic Sea (Il'icev 1985), probably entering the Baltic Sea area directly from the North Sea by flying over land. Red-throated Diver follows the west coast northwards according to Møller (1978) and Danielsen et al. (1989) which was supported by records of large numbers of divers, mostly Red-throated, in Jammerbugten during the 1987-1989 study.

Wintering divers in the North Sea may depend on concentrations of Herring *Clupea harengus*, Sprat *Sprattus sprattus* and Whiting *Merlangius merlangus* according to Durinck et al. (1993).

Great Crested Grebe *Podiceps cristatus*

Total numbers

The numbers of Great Crested Grebe recorded during countrywide surveys varied from 90 birds in the severe winter of 1987 to 853 birds in late summer (App. III). During transect surveys in winter 1987, 9,500 birds were estimated in the Baltic Sea (App. III). During all other transect surveys, the estimated numbers varied with up to 200 birds.

Geographical distribution

During countrywide surveys, the birds were particularly numerous in Limfjorden (section C). In winter, the majority of birds were recorded in Lillebælt (J), but in spring and late summer relatively high numbers were also recorded in Ringkøbing Fjord and Nissum Fjord (B).

Numbers in geographical sections

The large offshore concentrations in the Baltic Sea, estimated at 4,750 birds in Femer Bælt and 4,700 on Rønne Banke, were recorded in the winter of 1987 (Fig. 12) when numbers were at their lowest in all other parts of the Danish waters.

Great Crested Grebe was recorded at inland sites in numbers varying from none during the severe winter of 1987 to 368 birds in the mild winter of 1988, equivalent to 81% of the total from all inshore and freshwater sites in that season.

Internationally important numbers could not be derived from the observations, as a population estimate of northwestern Europe is lacking. However, it is evaluated, though, that the concentrations estimated on Rønne Banke and Femer Bælt in the Baltic Sea during winter 1987 were of international importance.

Dispersion

With a few exceptions, the birds were concentrated in many sheltered coastal sites. The occurrence of birds scattered in a large area in offshore Baltic Sea waters during winter 1987 marked a strikingly different dispersion and distribution pattern during severe conditions compared with mild winters.

General comments

Only a fraction of the potential freshwater

Fig. 12. Distribution and density of Great Crested Grebe in Danish waters during winter 1987, based on surveys from ship.

areas for Great Crested Grebe in Denmark was covered, hence it is not possible to describe seasonal patterns. The low numbers recorded during coastal surveys in winter indicate that a considerable proportion of the Danish population winters outside Danish waters (Cramp & Simmons 1977).

Due to the lack of recent estimates on the population size in Europe, the significance of the numbers found in Danish waters during the 1987-1989 study cannot be evaluated.

Seasonal and geographical variations

The much higher numbers recorded in offshore waters in the Baltic Sea during the severe winter of 1987 were probably caused by severe ice conditions elsewhere in the Baltic Sea and at inland sites in countries bordering the Baltic Sea. In Dutch waters, Camphuysen & Derks (1989) found a significant correlation between numbers of Great Crested Grebe in the IJsselmeer and severe winter conditions. The numbers in 1987-1989 indicate that only in severe winters, high numbers of this species are occurring in Danish waters.

The largest winter concentrations recorded in western Europe were 18,000 birds in the Delta-area in the Netherlands in January 1986 (van den Bergh 1988) and up to 22,000 birds wintering in Swiss lakes (Bauer & Glutz 1966).

Red-necked Grebe *Podiceps grisegena*

Total numbers

Four total estimates of all regions were calculated from transect surveys; in autumn 1987 and 1989: 1,300 and 3,600 birds, in winter 1988: 1,800 birds, and no birds in late summer 1988 (App. IV). During countrywide surveys Red-necked Grebe was regularly recorded in small numbers during all seasons including late summer when the maximum total was 115 birds in 1989.

Geographical distribution

During autumn, winter and spring, the

majority of birds were observed in northern Kattegat up to 30 km off the coast, but also to some extent off the Wadden Sea (up to 50 km off the coast), in the Straits and in the western parts of the Baltic Sea (Fig. 13). In late summer, Red-necked Grebe was confined to Smålandshavet (section M) and Sejerø-bugten (S).

Numbers in geographical sections

In Kattegat, the numbers estimated varied up to 700 birds outside winter and from 1,000 to 3,600 birds in winter. Off the Wadden Sea up to 650 birds were estimated in autumn, during winter in the Straits up to 350 birds and in the Baltic Sea up to 150 birds.

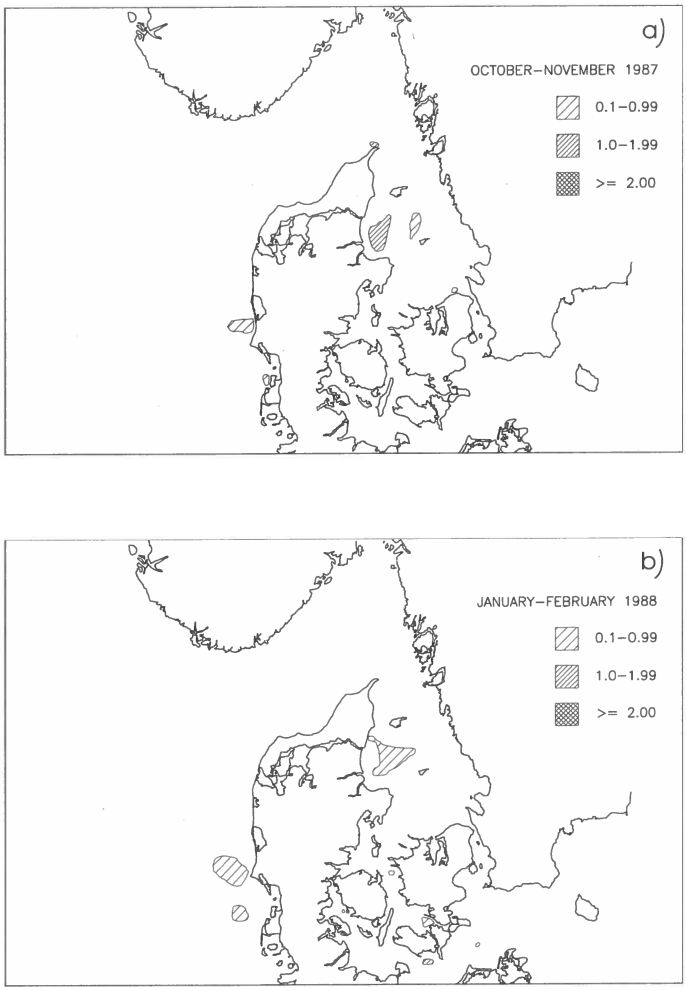


Fig. 13. Distribution and density of Red-necked Grebe in Danish waters during autumn 1987 (a) and winter 1988 (b), based on survey from ship.

During late summer 1989, two concentration areas were discovered: Sejerøbugten (subsection Sb) with a minimum of 410 birds and Omø Stålgrunde (N and M) with 250 birds. These areas were not satisfactorily covered with respect to this species during late summer surveys in 1987 and 1988.

Only one record was made at inland sites during the surveys. Internationally important numbers of >330, (Rose & Scott 1994) were recorded in Kattegat in winter, spring and autumn; off the Danish Wadden Sea in winter, and in Sejerøbugten in late summer.

Dispersion
The distribution of Red-necked Grebe was very clumped, with almost all birds being recorded within 5 to 6 small offshore areas of the Danish waters. Within these areas, the birds were recorded solitarily or very few birds together often associating with seaducks, especially Velvet Scoter.

General comments
The limited extent of the staging areas may have influenced the possibility of detecting all important areas due to the limitations in using transect techniques in offshore waters. The two concentration areas were found in late summer during countrywide surveys, but others might have been overlooked, thus, numbers should be regarded as minimum numbers (Pihl 1995). There are very few reports on concentrations of Red-necked Grebe in western Europe (Fjeldså 1982, Folkestad 1971, Suul 1976). The high numbers in northern Kattegat exceeding the entire Danish post-breeding population of Red-necked Grebes (Pihl 1995) and the composition of the birds in southern Kattegat (Fjeldså 1982) make it most probable that the birds in northern Kattegat, as well, consisted of a mixture of local birds from Denmark and southern Sweden and migrants from Finland and northwestern Russia.

Up to 9-14% of the northwest European winter population, which is estimated at 25,000-40,000 birds by Rose & Scott (1994) were estimated in the Danish waters during this study.

Seasonal and geographical variations
During the survey in late spring 1988, adult birds were starting to breed in freshwater lakes. Thus, it is likely that the birds recorded in Smålandshavet primarily consisted of immature birds and birds on migration to northern breeding sites.

Fulmar *Fulmarus glacialis*

Total numbers
The Fulmar was abundant in the North Sea and Skagerrak throughout the year and was estimated in numbers up to 368,000 birds in late summer, 445,000 birds in autumn and 377,000 birds in winter. During incomplete spring surveys, up to 35,700 birds were estimated to occur in the North Sea (App. V).

Geographical distribution
In all seasons, the majority of Fulmar was recorded in the North Sea, mainly concentrated in the area along the southern and western edges of the Norwegian Trench (Fig. 14). The birds were scarce close to the coast of Jylland and in northern Kattegat except in September 1988 to March 1989, rare in southern Kattegat and the Straits, and absent in the Baltic Sea.

Numbers in geographical sections
Large numbers of Fulmars (>100,000) were estimated in parts of the North Sea in all seasons except spring. Influxes mainly occurred after May, and densities generally remained high until late November. The numbers of wintering birds fluctuated highly with lowest estimates in the severe winter of 1987 and highest in 1989.

In Kattegat, only a single survey indicat-

ed the presence of more than 1,000 birds; it was in the winter of 1989 when 20,000 birds were estimated.

Internationally important numbers in relation to an estimate of the north European population (excluding Spitsbergen) of >100,000 birds were recorded only along the slopes of the Norwegian Trench.

Dispersion

In the North Sea, the birds were generally dispersed, while the distribution of Fulmar was very clustered towards the Norwegian Trench. Fulmar associations with trawlers were common in the North Sea, where flocks of up to 12,000 birds were recorded within such aggregations.

General comments

Compared with the European breeding population estimated at 6-10.5 million birds by multiplying the estimated number of breeding pairs (Koskimies 1991, Lloyd et al. 1991, Lorentsen 1991) by 3 (Rose & Scott 1994), the total Danish estimates constituted up to 4%-7% in the Norwegian Trench and the shelf south of this area in autumn and winter.

Seasonal and geographical variation

The distributions of Fulmar were similar between seasons and years, the birds becoming less numerous in moderate salinity areas such as the waters along the Danish west coast and Kattegat (Durinck et al. 1993) and avoiding areas of low salinity such as the inner Danish waters.

The great increase in numbers from spring to late summer was consistent with the results reported by Tasker et al. (1987), who found the main period of influx into the eastern parts of the North Sea to be midsummer. Tasker et al. (1987) also found the proportion of moulting Fulmars in the eastern parts of the North Sea to be higher than in the breeding areas. It is therefore likely that the bulk of the summer population present in the study area consisted of moulting non-breeders. No increase in the estimated numbers was recorded from summer to autumn, thus, it was not possible to document the existence of an influx of adults from the breeding grounds. The three very different results obtained during the winter surveys indicate highly variable winter populations, suggesting that numbers may be comparatively low during severe winters.

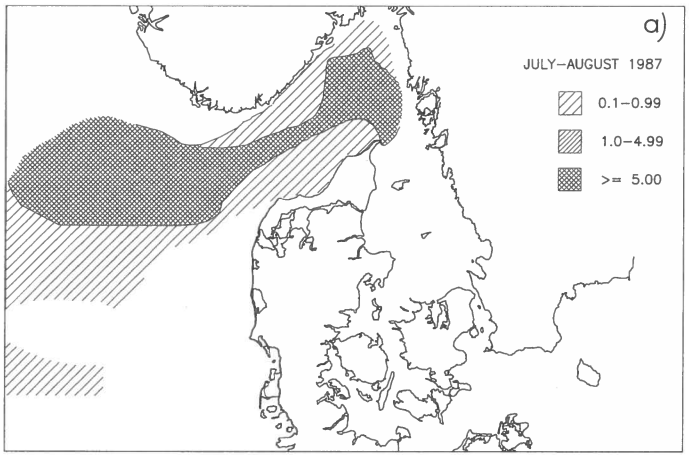
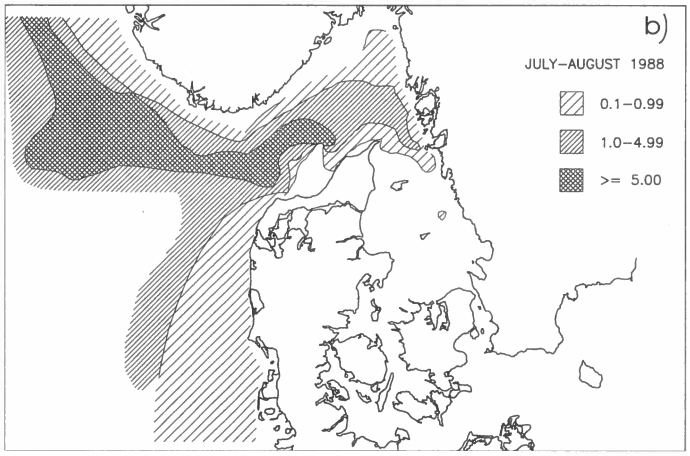


Fig. 14. Distribution and density of Fulmar in Danish waters during late summer 1987 (a), 1988 (b), autumn 1987 (c), 1988 (d), winter 1988 (e), 1989 (f) and spring 1988 (g), based on surveys from ship. ... continued next pages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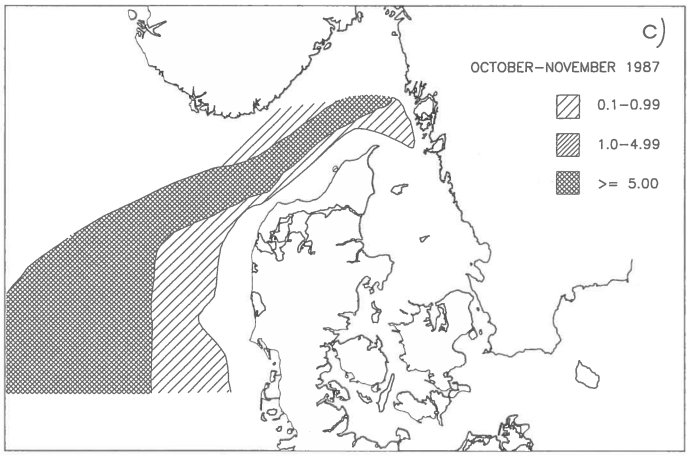
c)
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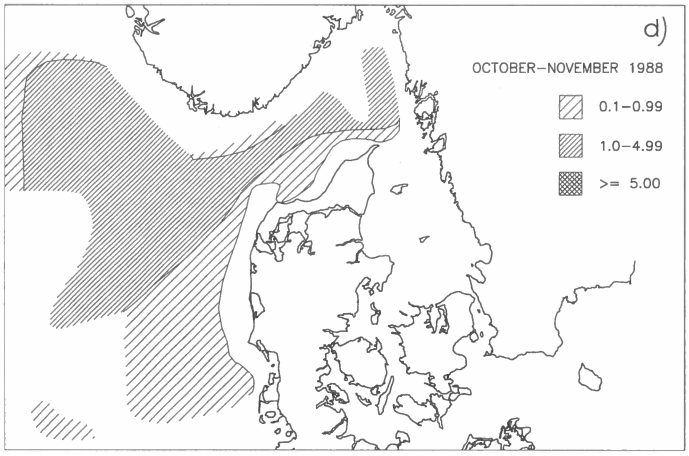
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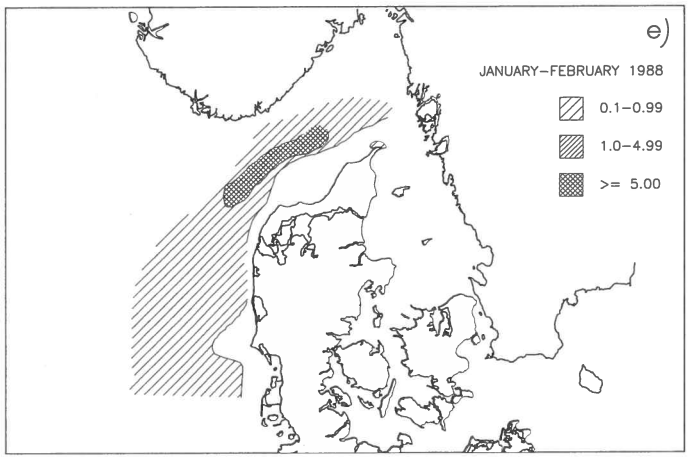
e)
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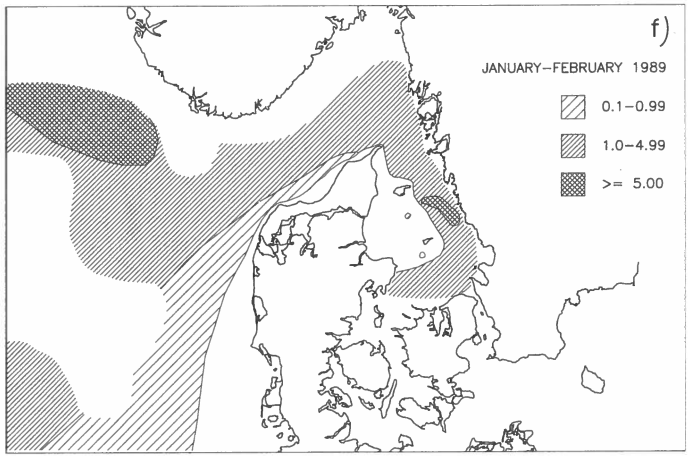
f)
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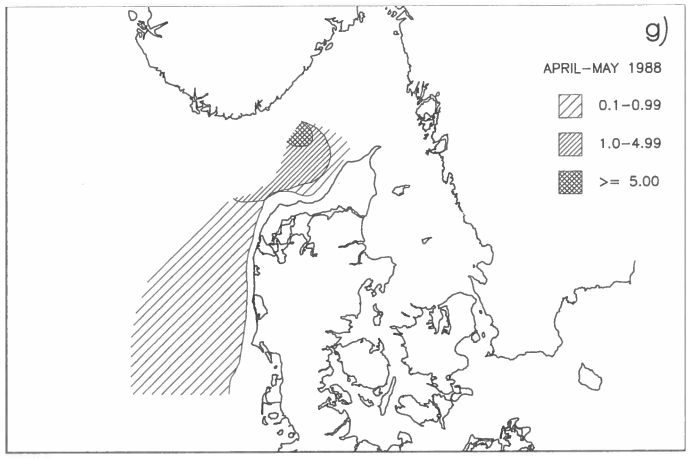
g)
APRIL–MAY 1988
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Gannet *Morus bassanus*

Total numbers
Five surveys covered the entire range of the species, and the estimated numbers ranged from no birds in winter to 22,000 birds in autumn. Birds were occasionally recorded in spring (App. VI).

Geographical distribution
Virtually all birds were recorded in the North Sea, scattered over wide areas and mainly occurring in the western parts. In summer, relatively high densities of immature birds were recorded in the eastern parts of Skagerrak, although densities within these parts were low in autumn. The birds were rare in Kattegat in all seasons and absent from the Straits and the Baltic Sea (Fig. 15).

Numbers in the geographical sections
Estimated numbers of birds were highest in late summer and autumn. In winter, all birds had abandoned the surveyed area, returning in spring in variable numbers.

Gannets occur rather dispersed in the North Sea, not concentrating in any particular area. The majority of birds occurred west of 6°E ranging from 74-87% of the total in summer to 59-87% in autumn.

Internationally important numbers of Gannet of >8.000 birds, were recorded only when very large areas were considered, and it is doubtful whether the densities were higher in the Danish waters than in the other parts of the eastern North Sea.

Dispersion
The birds were dispersed widely in the North Sea. The Gannet was usually observed solitarily and in small groups.

General comments
The total number of Gannets in the Danish part of the North Sea is very roughly estimated due to the fact that the birds are attracted to the ships, especially those engaged in fish surveys which frequently use trawls. The estimated 20,000-22,000 birds from July to November may be an overestimate, since the proportion of flying Gannet was high. On the other hand, the mean density of Gannet was 0.11 birds/km^2 from both platforms, recorded during the only simultaneously performed aerial and ship-based surveys along identical transects in the Danish sector of the North Sea in autumn 1987.

Compared with the European population which is estimated at 670,000-900,000 birds by multiplying the estimated number of breeding pairs (Barrett & Vader 1984, Koskimies 1991, Lloyd et al. 1991) by three (Rose & Scott 1994) up to 4% were estimated in the surveyed parts of the North Sea during this study.

Seasonal and geographical variation
The influx into the eastern parts of the North Sea in late summer was also recorded by Tasker et al. (1987), but is not reflected in the numbers recorded at Blåvandshuk (Meltofte & Overlund 1974) or northern Jylland (Møller 1978). The peak in numbers observed at Blåvandshuk in early October (Meltofte & Overlund 1974) probably reflects not only the North Sea population, but also birds migrating southwards along the Jylland west coast which are influenced by heavy westerly winds leading to concentrations of the birds along the coast.

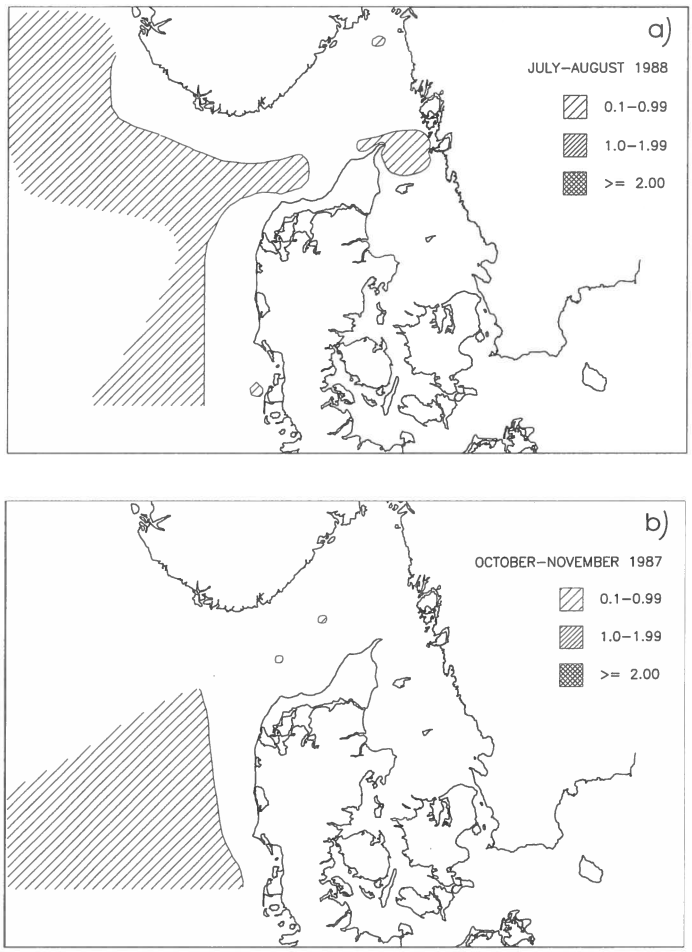

Fig. 15. Distribution and density of Gannet in Danish waters during late summer 1988 (a) and autumn 1987 (b), based on surveys from ship.

Cormorant *Phalacrocorax carbo*

Total numbers
The totals varied from 5,885 birds in winter to 44,040 in late summer (App. VII). During the study period, there was a steady increase within all seasons, highest in late summer and spring and lowest in autumn.

Geographical distribution
In all seasons, the majority of birds were recorded in the central sections of the Danish waters (E, F, J, K, M, N and S) (Fig. 16).

In late summer (Fig. 16a-c), Cormorant was observed in large parts of the country, and this was the only season where numbers exceeded a few hundreds in western Jylland (section B) and Limfjorden (section C).

In autumn (Fig. 16d, e) and during the mild winters (Fig. 16g, h) the majority of birds occurred in Kattegat (sections E, F and S) and Storebælt (section N). Southeast and east Denmark (sections O and R) made up exceptions and held high numbers in autumn and virtually no birds in winter.

In the severe winter of 1987 (Fig. 16f), relatively high numbers were recorded in southeastern Kattegat (section S) and Bornholm (section T) and small numbers in northern and southwestern Kattegat (sections E and F). In spring (Fig. 16i, j) the greater part of the birds was recorded in southwestern Kattegat (section F).

Numbers in geographical sections
The increase in total numbers recorded in autumn and winter during this study was solely ascribed to increases in the central sections: E, F, J, K, M and N. From 1987 to 1989 the numbers in these sections increased by 95% from 5,657 to 11,030 birds in autumn, and in winter with 145% from 3,945 to 9,661 birds. Contrary to this, the numbers in the remaining sections (A, B, C, D, O, R, S and T) decreased by 61% from 4,141 to 1,618 birds in autumn surveys and by 64% from 3,869 to 1,392 birds in the winter surveys.

In late summer, however, an increase was observed in both groups of sections, most pronounced in the central sections (163%), while the increase in the other group of sections was much smaller (34%). In spring, the increase in numbers in both groups of sections was at the same level (72% and 62%, respectively).

Up to 90 Cormorants were recorded on inland sites during midwinter; in the other seasons a maximum of 1,073 was estimated.

Internationally important concentrations (>3,200, Rose & Scott 1994) were regularly recorded at two sites: Svanegrund (section Fb) in late summer, and Bosserne (section Fc) in autumn and winter.

Dispersion
In late summer and spring, the birds were dispersed over most coastal areas, much more than in autumn and winter (App. VII). The birds were recorded feeding solitarily or resting in flocks of up to several thousands.

General comments
The birds recorded in late summer were evaluated to be almost exclusively local breeding birds of the continental race *P. c. sinensis* as the surveys were conducted before the autumn migration of the north Atlantic race *P. c. carbo* had commenced (Dybbro 1978). The increase in total numbers in the late summer period therefore seemed to be based on local breeding birds which corresponds well with the increases found in the Danish colonies during 1987-1989 (Bregnballe & Gregersen 1995). During the late summer surveys, the numbers recorded equalled 38% of the estimated post-breeding population in 1987, 48% in 1988 and 49% in 1989 (Gregersen, pers. comm.). Poor coverage of solitarily feeding birds and birds at freshwater sites contributes to the result that only half the Danish post-breeding populations were recorded during these studies.

In autumn, winter and spring, both races are present in Danish waters (Dybbro 1978,

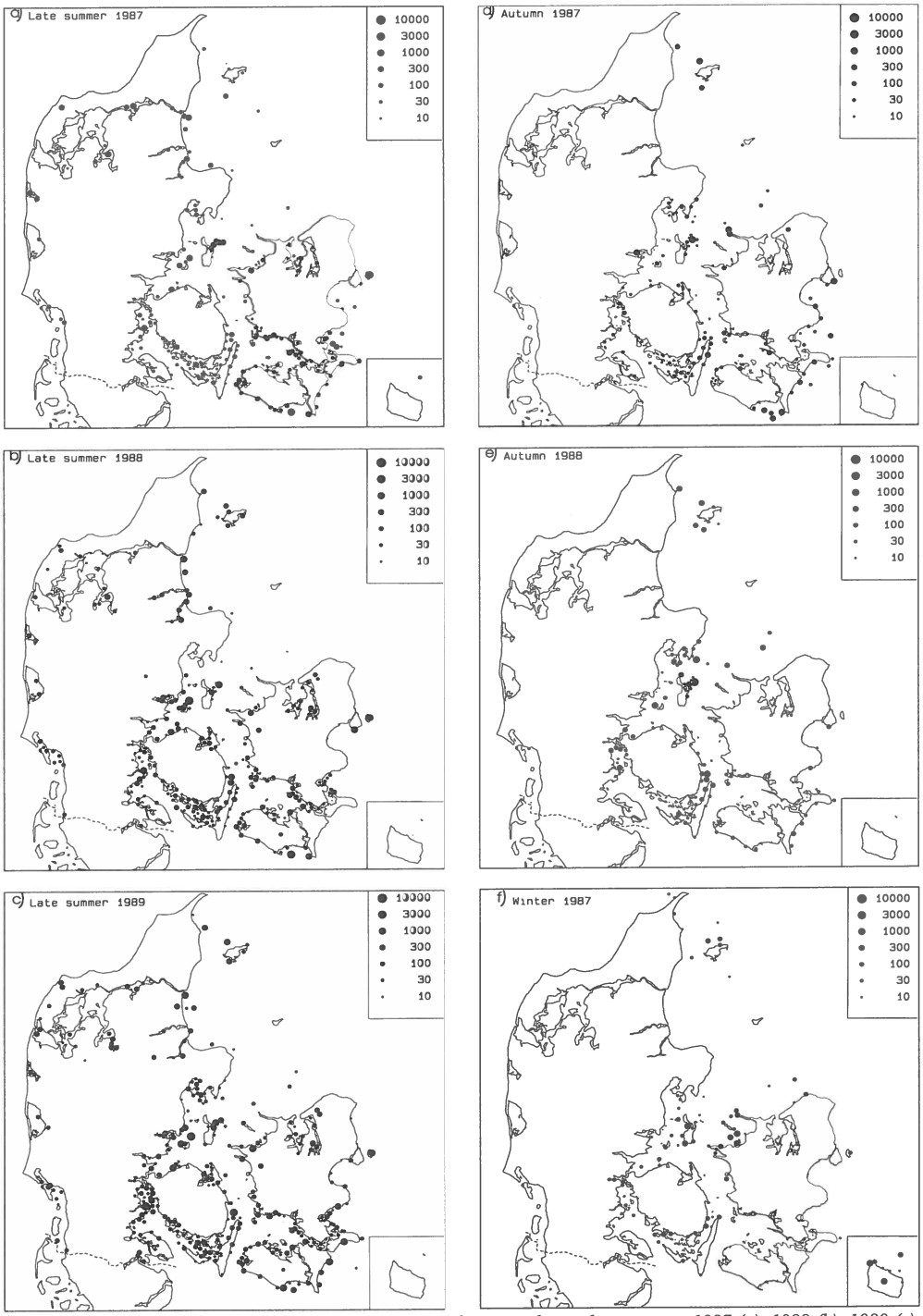

Fig. 16. Distribution and number of Cormorant in Danish waters during late summer 1987 (a), 1988 (b), 1989 (c), autumn 1987 (d), 1988 (e), winter 1987 (f), 1988 (g), 1989 (h) and spring 1988 (i), 1989 (j), based on results obtained from aerial surveys.

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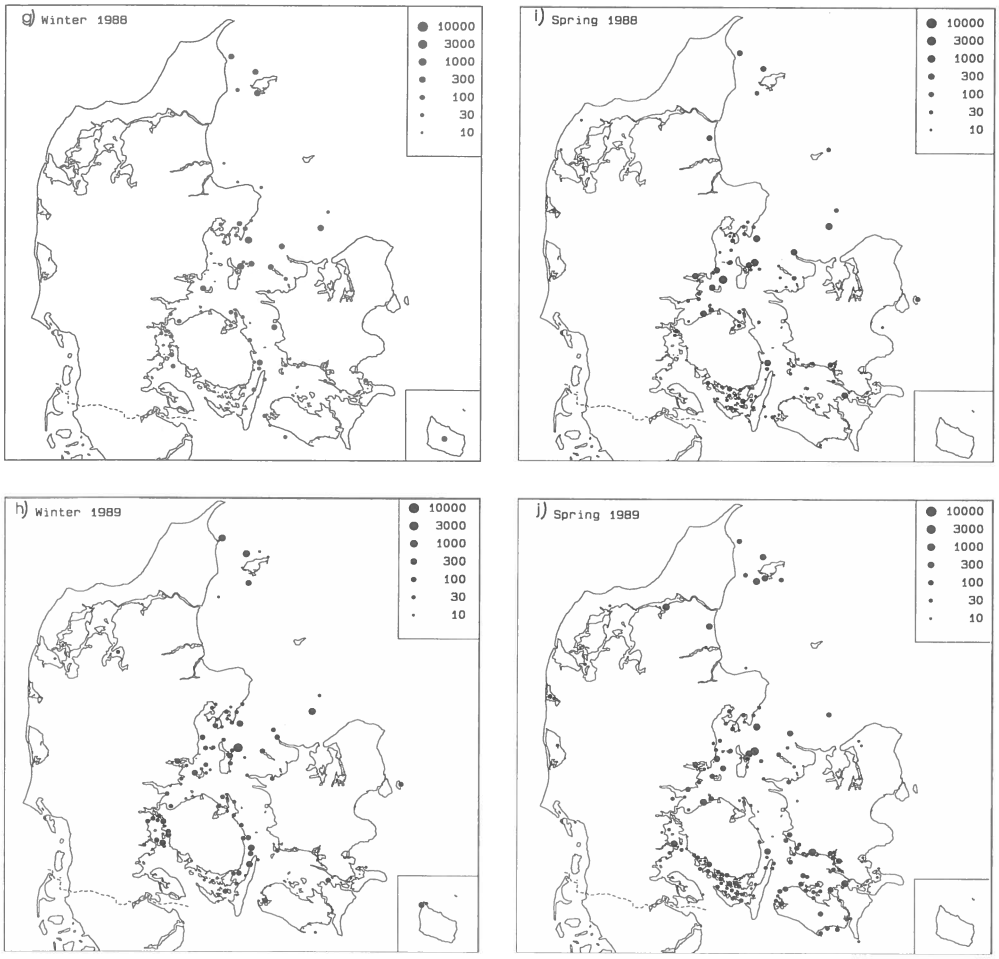

J. Gregersen, pers. comm.), but both presumably react differently to severe winters; the north Atlantic race moves into the Danish waters and the continental race migrates southwards out of Danish waters. This makes it difficult to compare total numbers during the two types of winters that were experienced during the study period.

Up to 13% of the total population of both races in northwestern Europe estimated at 320,000 birds by Rose & Scott (1994) was recorded in the Danish waters.

Seasonal and geographical variation

The decrease in numbers from late summer to autumn was probably caused by departure of the majority of the Danish breeding birds, although they may have been replaced to a limited extent by north Atlantic birds (Dybbro 1978). In recent years, an increasing number of the Danish breeding population winters in Danish waters, often rather close to the breeding sites (J. Gregersen, pers. comm.). This seems to be confirmed by the results from the aerial surveys. The increases in numbers recorded in autumn and winter were entirely contributed by the sections E, F, J, K, M and N. These sections are either holding or situated close to large breeding colonies of Cormorant. In contrast, the numbers decreased in the parts of Denmark with no major colonies (e.g. sections

A, B, C, D, O, R, S and T) in the same seasons.

The spring surveys were conducted after the Danish breeding birds had returned (J. Gregersen, pers. comm.) and before the birds of the north Atlantic race had completely returned to the breeding colonies. This led to a mix-up of birds of both races and to an overlap of the late summer and autumn/winter.

Comparison with the results of surveys in 1968-1973

Cormorant was recorded during the surveys in 1968-1973, although the results were not published. In 1968-73 the totals of surveys in autumn and midwinter ranged from 1,882 to 2,719 birds which is much less than during this study.

The continental race of Cormorant was expanding in this period, and the number of pairs breeding in Denmark was 300-400 (Bregnballe & Gregersen 1995). The birds were almost absent from Danish waters in midwinter.

The Norwegian population is thought to have been rather stable with app. 21,000 birds during 1975-1984 after a period of increase (Røv 1984, Røv & Strann 1986), but this increase presumably only explains a minor part of the increase of Cormorant in the Danish waters in autumn and midwinter. Thus, the increase in numbers in Danish waters in the winters between 1968-1973 and 1987-1989 is believed to be formed by the Danish breeding population.

Comparing the percentage distribution in geographical sections in southwestern Kattegat (section F), where the only Danish breeding colony existed during 1968-1973, the same percentage (43%) was found in both studies. Comparatively more birds in the former survey were recorded in northern Kattegat (section E) (28% versus 14%) and relatively fewer birds (2% versus 17%) in the three remaining areas (sections J, K and M) that now hold large breeding colonies.

Grey Heron *Ardea cinerea*

Total numbers

Numbers varied from 21 birds in the severe winter of 1987 to 2,203 birds in late summer (App. VIII). The results showed a steady increase within all seasons through the study period.

Geographical distribution

Highest numbers in any season in a single section were recorded from Limfjorden (section C). However, birds were generally widely distributed, and eight sections each held more than 10% of the total during at least one season (Fig. 17).

Numbers in geographical sections

In western Jylland, Limfjorden and northern Kattegat (sections B, C and E), relative numbers were highest in late summer (67%) and lowest in mild winters (36%); in the central sections F, J, K and M, numbers were highest in mild winters (48%) and lowest in late summer (16%). In the eastern sections O, R and S, numbers were highest in spring (32%) and lowest in late summer (13%).

Up to 240 individuals were recorded from inland sites. The proportion of Grey Herons at coastal and inland freshwater sites was 37% in winter 1989.

Internationally important numbers (>4,500, Rose & Scott 1994) were not recorded during this study.

Dispersion

The birds were rather dispersed in all sheltered coastal areas. Small numbers of birds feeding together were most common, but roosting flocks of up to 70 birds were encountered.

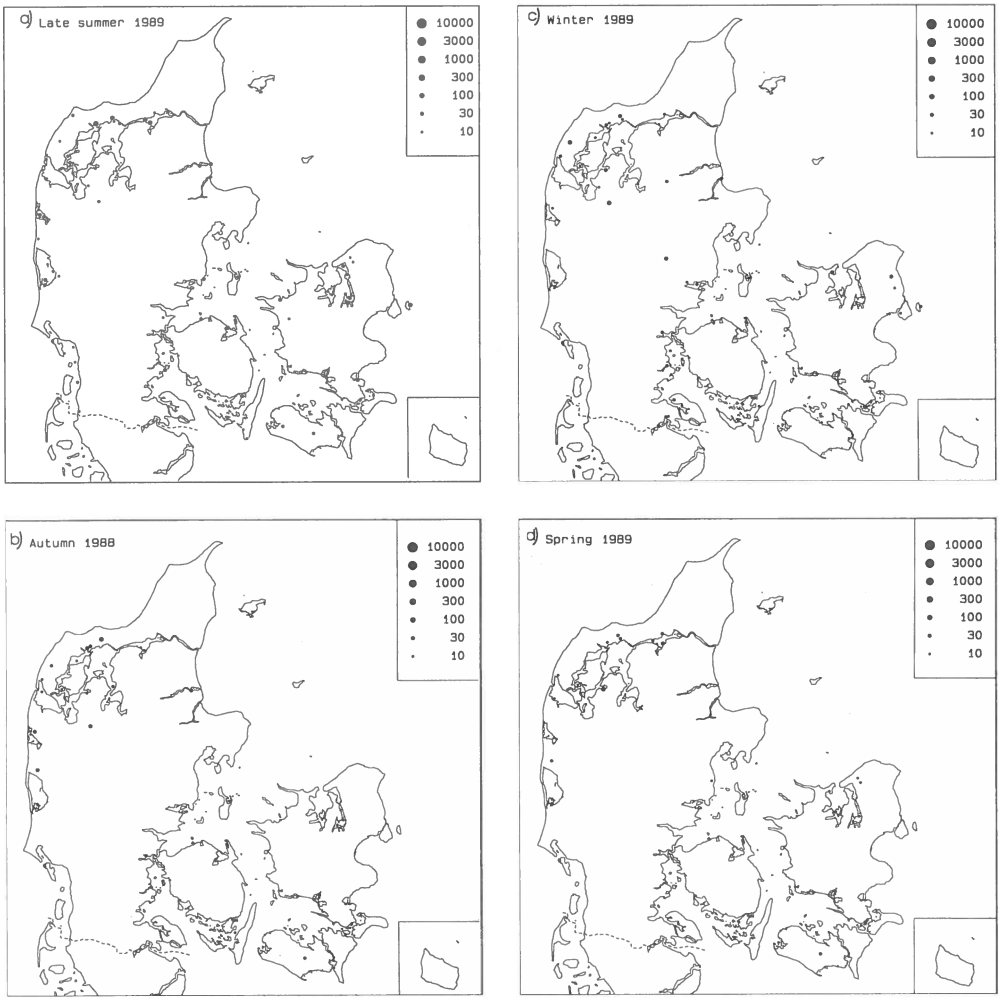

Fig. 17. Distribution and numbers of Grey Heron in Danish waters during late summer 1989(a), autumn 1988(b), winter 1989(c) and spring 1989(d), based on results obtained from aerial surveys.

General comments

The numbers and distribution in autumn, mild winters and spring were relatively stable, in spite of the fact that a considerable proportion of the birds stayed inland and therefore was not covered by the surveys. The increasing numbers in late summer seemed to be the result of better coverage and increased observer experience combined with an actual increase in numbers.

Less than 1% of the North African and European population of Grey Heron estimated at 400,000-500,000 by Rose & Scott (1994) was recorded during a single survey.

Seasonal and geographical variation

The shift in preference from the fiords in northwestern Denmark (sections B, C and E) during late summer and autumn to coastal waters with smaller islands in winter, seemed to be due to the fact that the lagoons freeze more quickly than coastal waters. The relatively high numbers recorded in the eastern parts in spring presumably included to a

great extent Scandinavian birds on migration (Dybbro 1978, Risberg 1990).

Comparison with the results of surveys in 1968-1973

Grey Heron was recorded during the 1968-1973 surveys, but the results were not published. In November 1968 and 1969, 411 and 173 birds were recorded. These numbers make up one third of the numbers found in the 1987-1989 study. In the mild winter of 1973, 215 birds were recorded versus an average of 950 during the mild winters of 1988 and 1989.

In 1968 the Danish breeding population amounted to 1,900 pairs (Dybbro 1970), in 1978 to 2,700 pairs (Møller & Olesen 1980) and to 6,000 pairs in 1990 (Frederiksen 1992). Also, the Swedish population is reported to have expanded in the recent decades (Risberg 1990). Thus, there seems to be a very good correspondence between the increase in numbers of Grey Heron in southern Scandinavia in winter (a factor of 3-4) and the increase in numbers from 1968-1973 to 1987-1989 (a factor of 2-4), even though only a minor part of the population was covered during the 1987-1989 study.

Mute Swan *Cygnus olor*

Total numbers

Mute swan moulted during late summer surveys and was recorded in increasing numbers throughout the study period, varying from 34,321 to 59,162 birds.

In other seasons, numbers ranged from 31,468 birds in spring to 58,281 birds in autumn, showing a steady increase in winter (App. IX).

Moult

The considerable increase in numbers observed from 1987 to 1989 was not reflected in the percentual distribution which was very stable during the study. The highest numbers were recorded for all three years in Smålandshavet (section M). Similarly high numbers were recorded south of Lolland, and 9-15% of the totals were additionally recorded in Sydfynske Øhav (section K), Øresund, Roskilde Fjord (section R) and in southwestern Kattegat (section F).

Geographical distribution

In all seasons the distribution in the Danish waters was very stable from year to year (App. IX).

The majority of birds were recorded in the eastern sections M, O and R (Fig. 18). Of these areas, Smålandshavet (section M) invariably held the highest percentage of birds, Lolland/Falster and Møn (section O) the second highest and northeastern Sjælland (section R) the lowest. Only small numbers of birds occurred along the coasts of Jylland (sections A, B, C, D, E, F and J).

Numbers in geographical sections

The totals in the sections A, B, C, D, E, F and J in Jylland varied from 10,200 to 10,500 birds during the three midwinter surveys. In the same sections, numbers increased in late summer from 8,500 birds in 1987, to 9,800 birds in 1988 and 10,900 birds in 1989.

In eastern Denmark (sections K, M, N, O, R, S and T), numbers steadily increased in all seasons except spring. In this part of the country, numbers increased in midwinter from 26,600 birds in 1987 to 30,200 in 1988 and 37,300 in 1989. In late summer, the tendency was more pronounced with numbers increasing from 25,800 birds to 32,900 and 48,200 birds in the respective years.

At some major moulting sites, numbers decreased rapidly between late summer and autumn, e.g. on Rødsand (section Oa) where

numbers dropped from 5,000-6,000 birds to 1,000. In the adjacent Guldborgsund in the same section numbers increased by 2,000-2,500 birds in the same period. Similarly, at the moulting sites Saltholm (section Ra), Odense Fjord (section Fe) and Sydfynske Øhav (section Fe), numbers decreased between the late summer and the autumn surveys.

Midwinter counts from ground-covered inland sites varied from 216 to 440 birds, with up to 266 birds in other seasons.

Internationally important numbers of >1,800 birds (Rose & Scott 1994) were regularly recorded throughout the year at 12 sites or areas (Sydfynske Øhav (section Ka), Nakskov Fjord (section Ma), northern Lolland (section Ma), Dybsø Fjord (section Mb), Nyord (section Oa) and Roskilde Fjord (section Rb)). Internationally important numbers occurred in all seasons except spring in Odense Fjord (section Fe), Glænø (section Mb) and Guldborgsund (section Oa), in the seasons autumn and winter in

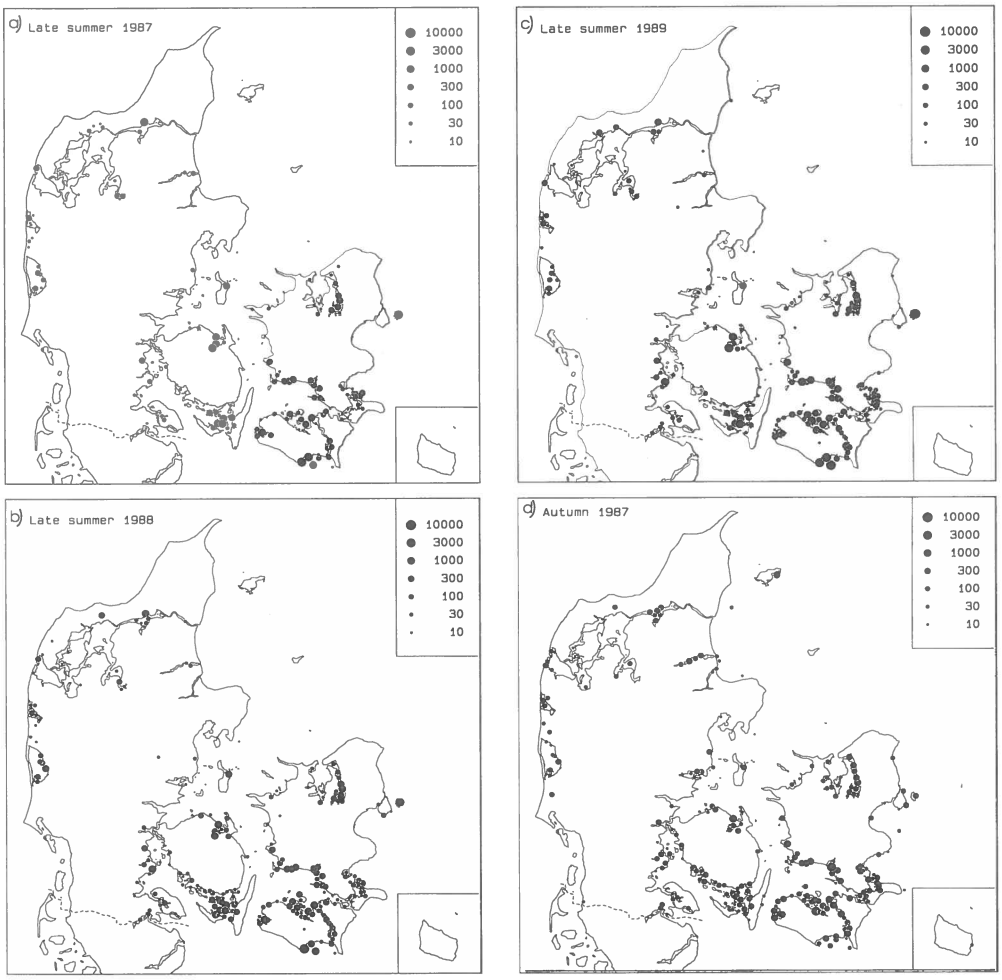

Fig. 18. Distribution and numbers of Mute Swan in Danish waters during late summer 1987 (a), 1988 (b), 1989 (c), autumn 1987 (d), 1988(e) winter 1987 (f), 1988 (g), 1989 (h) and spring 1988 (i) , 1989 (j), based on results obtained from aerial surveys.

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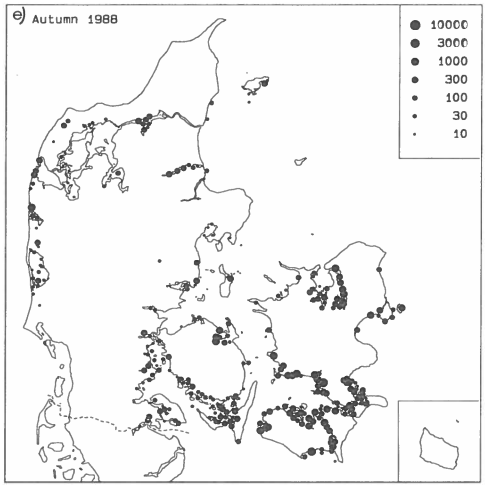
e) Autumn 1988
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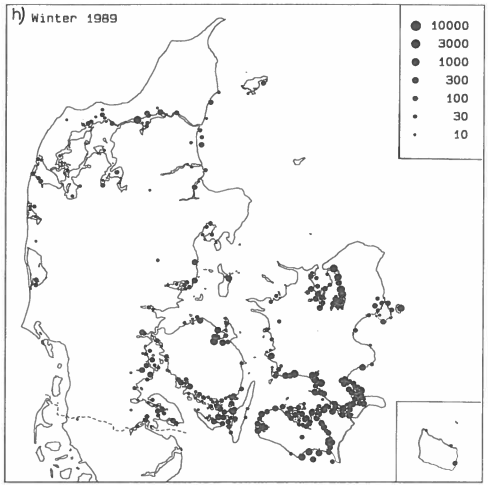
h) Winter 1989
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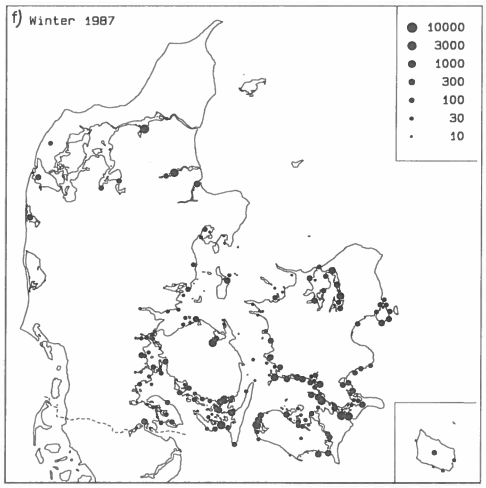
f) Winter 1987
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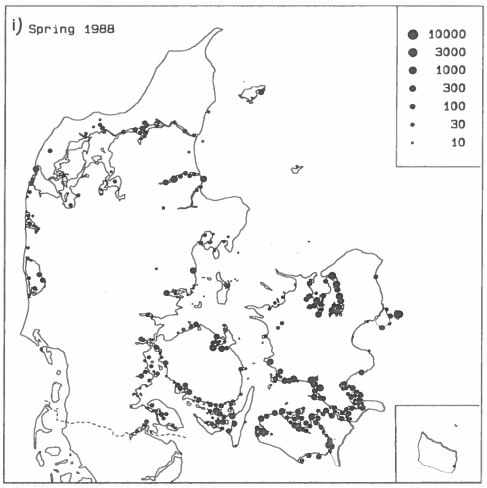
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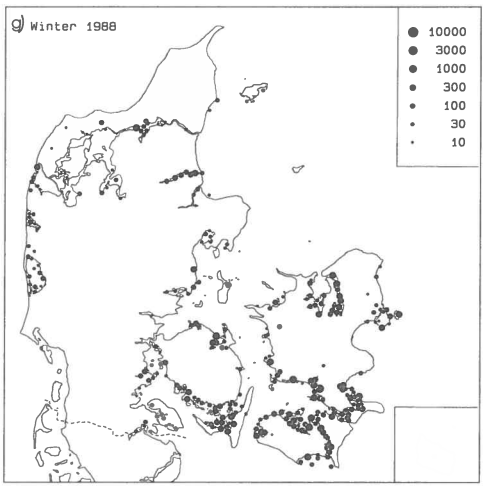
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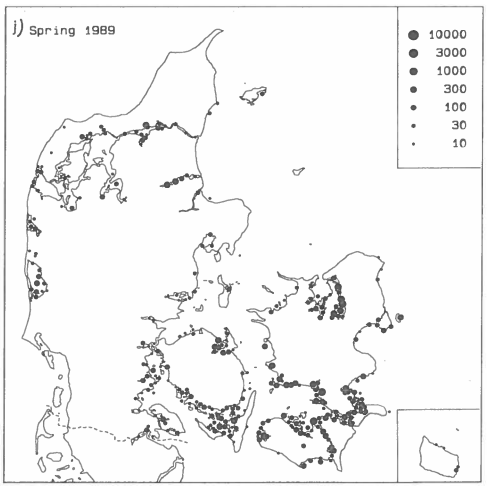
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Grønsund (section Oa) and in the late summer season in Rødsand (section Oa) and Saltholm (section Ra).

Dispersion
In late summer, birds were concentrated at their moulting grounds. During autumn and mild winters, the dispersion increased and a maximum dispersion was reached in spring when the numbers were lowest (App. IX). In severe winters, the birds aggregated in areas with open water.

General comments
In spring, numbers were considerably lower than in any other season, especially compared with the late survey in 1989. The results indicated that a large proportion of the birds had left the wintering grounds heading for the breeding sites in inland Denmark or in the Baltic Sea at the time of spring surveys. The remaining birds probably consisted of local breeding birds and younger non-breeders from the entire Baltic Sea region and Denmark. The great dispersion in spring compared with other seasons may have been due to the dispersed nature of solitary breeding pairs in sheltered marine areas.

Clear positive population trends were found in late summer, autumn and midwinter; the increases presumably being the result of low mortality in the two mild winters of 1988 and 1989 (e.g. Bacon & Andersen-Harild 1989) and favourable breeding conditions in these years (Clausager 1990). The Mute Swan may thus have recovered after three severe winters (1984/85 - 1986/87) with high expected mortality.

Up to 33% of the estimated 180,000 Mute Swans in northwestern Europe (Rose & Scott 1994) were recorded in Danish waters during this study.

Seasonal and geographical variation
The increase in numbers as well as dispersion from late summer to autumn was probably a result of local migration from inland waters to marine sites and dispersion from the moulting grounds.

Mute Swan is very traditional in its use of moulting and wintering grounds in Denmark (Andersen-Harild 1978). The stable numbers in western Denmark compared with the increasing numbers in the east most likely reflected changes in the different populations in the Baltic Sea. Unfortunately, ringing of Mute Swan has been performed almost exclusively in eastern Denmark, and even for these ringed birds, detailed analyses of recoveries have not been published. Thus, the basis for an attempt to explain the difference in population growth between eastern and western Denmark is not present.

Comparison with the results of surveys in 1968-1973

In the survey in late summer 1968, 28,444 birds were recorded in the Danish waters (Andersen-Harild 1971), where only large moulting areas were visited. The total numbers during the 1987-1989 countrywide surveys were expected to be higher, as the surveys included all small groups of birds.

In 1968, the Baltic Sea population was estimated at 43,000-48,000 Mute Swans, on a preliminary basis, and the population was in a period of increase (Andersen-Harild 1971). In 1986, this population was estimated at 127,000 birds (Monval & Pirot 1989). The increase was reflected by marked increases in four sections: Odense Fjord (Fe), Nakskov Fjord (Ma), southwestern Sjælland (Mb) and Roskilde Fjord (Rb), whereas a minor decrease was seen in Ringkøbing Fjord (Bb).

Numbers recorded in autumn 1968 and 1969 differed only slightly and averaged 48,800 birds. During the autumn surveys in the 1987-1989 study, numbers averaged 47,500 but large variations were seen between the two years. There were only small differences in the geographical distribution between the old surveys and the 1987-1989 study.

In the winters of 1969 and 1970, an average of 64,100 birds was recorded; the winter of 1970 became very severe with high mortality among Mute Swan after the survey

had been completed (Joensen 1974). During the two following midwinter counts the numbers recorded averaged 42,300 birds, practically the same number as recorded in midwinter during 1987-1989. Only minor differences in the geographical distribution in winter were found between the results from 1971-1973 and 1987-1989.

The similarity in the results from autumn and winter 1987-1989 and 1968-1973 is remarkable, considering that the population of Mute Swan is strongly affected by severe winters (Bacon & Andersen-Harild 1989) and, thus, very variable. The annual indices for Mute Swan in the Baltic Sea area have been increasing in the period between the studies (Monval & Pirot 1989).

Whooper Swan/Bewick's Swan *Cygnus cygnus/C. bewickii*

Total numbers
The numbers in winter were rather stable compared with numbers in autumn and spring, ranging from 3,121 to 5,582 birds, and increasing through the study period. In autumn and spring, the variation in numbers was large (App. X). No birds were recorded during late summer surveys.

Geographical distribution
During winter, the majority of the birds was recorded on the coasts of northern Kattegat (E) especially the Randers Fjord/Mariager Fjord Area (Ef), in Limfjorden (C) and in western Jylland (B). Notable numbers were also recorded in the southern sections J, K, M and O (Fig. 19). Swans positively identified as Bewick's Swan were primarily recorded in western Denmark in sections A, B and C, while Whooper Swan was present in all parts of the country. The distribution in 1987 obviously did not reflect the fact that the winter was severe.

Numbers in geographical sections
Occurrence varied greatly from year to year and from season to season. In autumn 1987, all 810 Yellow-billed Swans were recorded in the Danish Wadden Sea, western Jylland and Limfjorden (sections A, B and C); in autumn 1988, only 57% of the total was recorded in these areas even though the number of birds all over increased to 1,815 birds.

During the surveys, 82-100% of the identified Bewick's Swan were recorded in the Wadden Sea, western Jylland and Limfjorden (sections A, B and C). In the same sections 26-100% (averaging 59%) of the Whooper Swans was recorded. In the Kattegat sections E, F and S, 0-45% (averaging 15%) of the Whooper Swans was recorded; in the southeastern sections M and O, 0-30% (averaging 15%) of the Whooper Swans was recorded.

Between 11 and 1,021 Yellow-billed Swans were recorded at inland sites covered from the ground in midwinter with up to 523 birds in other seasons. The proportion of Yellow-billed Swans in coastal and inland freshwater sites in winter 1989 was 24%.

In mild winters, internationally important numbers (>250, Rose & Scott 1994), were recorded at Stadil Fjord (Bc), in Vejlerne (Ce), Gjøl Bredning and Ulvedybet (Cg), at Læsø (Ec), in Odense Fjord (Fe), Margrethe- and Frederikskog (southern Jylland) and Holmegårds Mose (southern Sjælland); in spring in Dybsø Fjord (Mb) and Tofte Sø (eastern Jylland). In the severe winter of 1987, internationally important numbers were found only in the Randers Fjord and Mariager Fjord area (Ef).

Dispersion
In all seasons the birds were rather aggregated, often occurring on green pastures on the banks of sheltered bays.

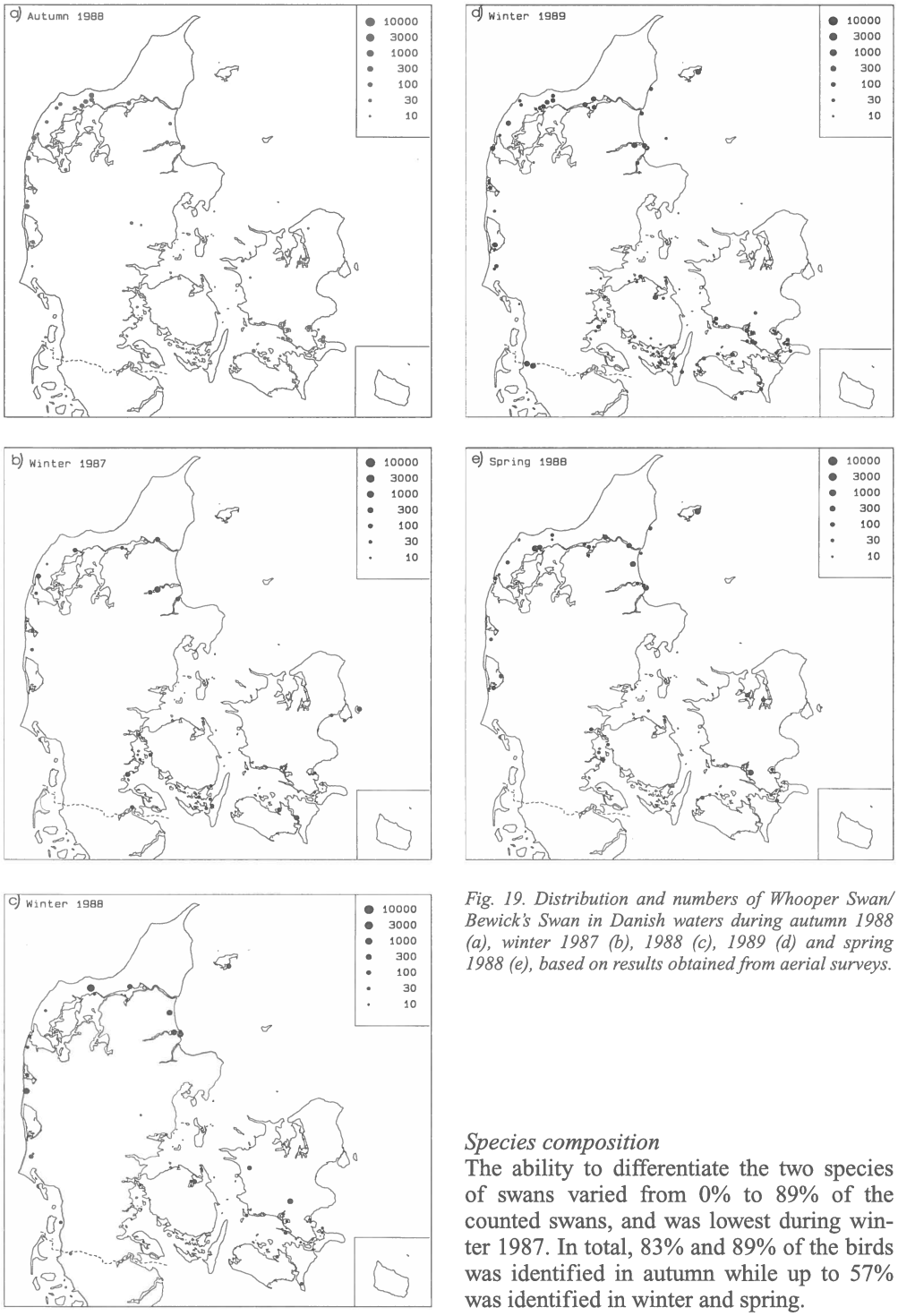

Fig. 19. Distribution and numbers of Whooper Swan/ Bewick's Swan in Danish waters during autumn 1988 (a), winter 1987 (b), 1988 (c), 1989 (d) and spring 1988 (e), based on results obtained from aerial surveys.

Species composition

The ability to differentiate the two species of swans varied from 0% to 89% of the counted swans, and was lowest during winter 1987. In total, 83% and 89% of the birds was identified in autumn while up to 57% was identified in winter and spring.

In winter, the majority of the identified birds was Whooper Swan (84% and 88%); during autumn and spring the relative numbers of Whooper Swan were smaller (28-76%).

The great majority of unidentified Yellow-billed Swans may have been Whooper Swan, particularly those in the eastern parts of the country.

General comments

The missing registration of Yellow-billed Swan in 1987 in all other sections but A, B and C was probably caused by lack of observer experience in paying attention to and identifying the two species. Numbers recorded in spring 1989 were small due to early departure from the wintering grounds combined with late completion of the survey.

Up to 16% of the combined continental northwest European population of both species estimated at 42,000 birds (Rose & Scott 1994) were recorded during this study.

Seasonal and geographical variation

The large variations in numbers recorded in autumn and spring made any comparison within each season very difficult. During 1987-1989, numbers recorded in the mid-winter surveys increased, which may be regarded as a reflection of the observers' growing experience rather than an actual trend.

The majority of Bewick's Swan was recorded during the autumn and spring migration, almost exclusively in western Jylland. Fewer Bewick's Swans than Whooper Swans seemed to winter within this area. The highest numbers of Whooper Swans were recorded in winter, and the birds were scattered all over the country.

Comparison with the results of surveys in 1968-1973

During the previous autumn surveys, totals of 3,100 and 2,800 Yellow-billed Swan were recorded in 1968 and in 1969. These totals were similar to the results in the autumn 1988. In 1968-1969, 77-83% of the birds were recorded in western Jylland and Limfjorden (B and C) compared with 55% in 1988.

The numbers in the winters have varied considerably depending on how large a proportion of the birds stayed in Denmark. In the 1968-1973 surveys, the numbers seemed to depend on the severity of the winter as 10,300 birds were recorded in the severe winter of 1970 compared with 3,500 - 7,000 birds in the mild and normal winters. This tendency was not confirmed during the 1987-1989 surveys with the numbers in both severe and mild winters being lower and more constant.

The overall distribution of the two species in this study did not differ essentially from the results obtained in the 1968-1973 surveys. The annual variations in distribution were great during winter surveys in 1968-1973. The birds were aggregated in the autumn staging areas B and C in the mild and normal winters but outside these areas in the severe winter (averaging 47% of the total versus 7% in the severe winter), a tendency that was also found during the 1987-1989 surveys (averaging 44% of the totals in the mild winters versus 18% in the severe winter of 1987).

Joensen (1974) described the Whooper Swan as being mainly recorded in shallow and sheltered salt and brackish water. During this study, Yellow-billed Swan was mainly recorded on grassland and in freshwater.

Because of the annual variation and the problems in distinguishing the two species of Yellow-billed Swan from Mute Swan, it is difficult to conclude anything on the trend in the populations between 1968-1973 and 1987-1989. The annual indices for Whooper Swan in northwestern Europe have been increasing in the period between the two studies, while the annual indices of Bewick's Swan have been rather stable (Monval & Pirot 1989).

Shelduck *Tadorna tadorna*

Total numbers

Total numbers varied from 103 birds in the severe winter 1987 to 32,310 birds in the autumn 1988 (App. XI). Late summer and midwinter total numbers increased during the study period, while autumn and spring counts remained rather stable.

Geographical distribution

The majority of birds were recorded in the Wadden Sea (section A) in late summer, autumn and winter (Fig. 20a-g, App. XI). On the coasts of northern Kattegat (E) smaller but substantial numbers were recorded in all seasons.

During mild winters (Fig. 20f, g), comparatively high numbers were additionally recorded in Limfjorden (C), southwestern Kattegat (F) and Smålandshavet (M). In the severe winter of 1987, practically all Shelducks left the country.

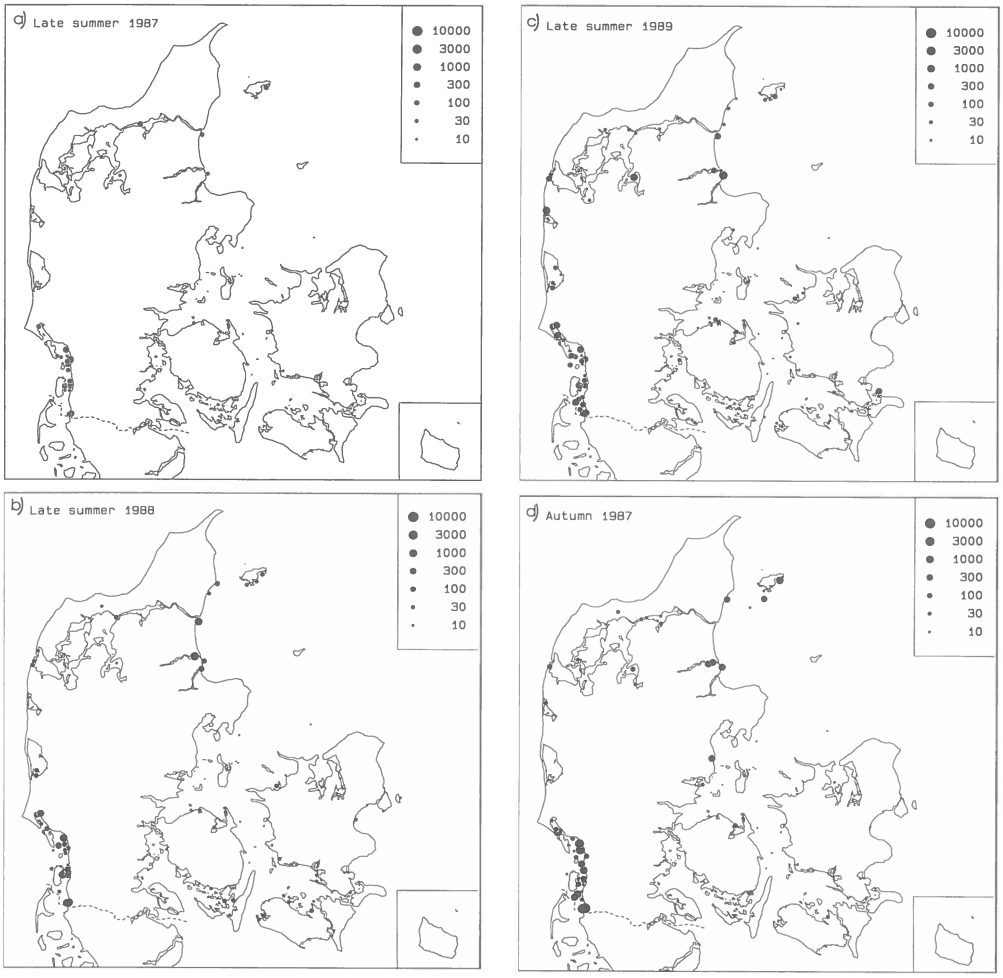

Fig. 20. Distribution and numbers of Shelduck in Danish waters during late summer 1987 (a), 1988 (b), 1989 (c), autumn 1987 (d), 1988 (e), winter 1988 (f), 1989 (g) and spring 1988 (h) , 1989 (i), based on results obtained from aerial surveys.

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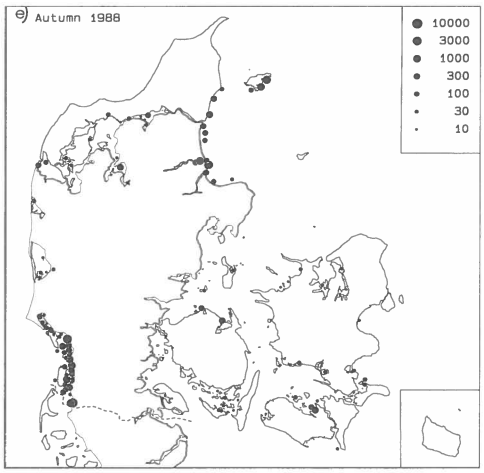

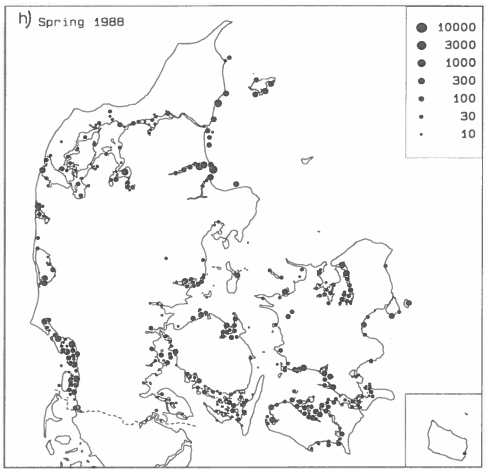

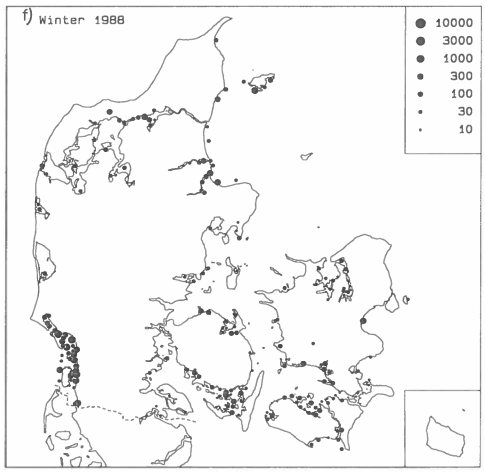

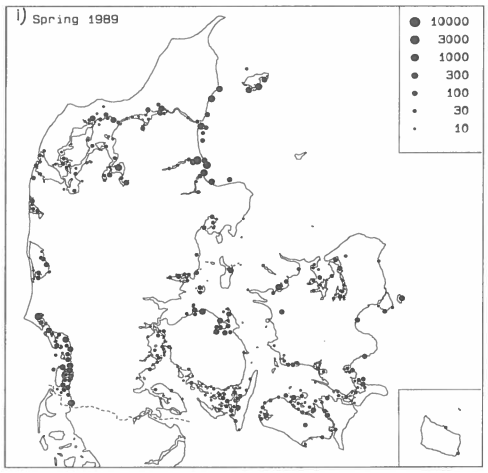

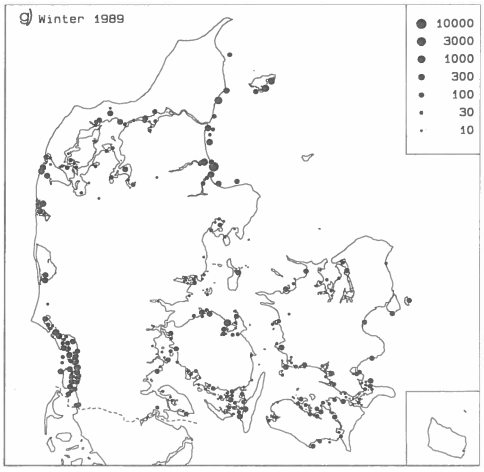

Numbers in geographical sections

Numbers recorded in the Wadden Sea were much higher than those in the rest of the country in late summer and autumn averaging 4,747 birds (61% of the Danish total) in late summer and 22,228 birds (75% of the total) in autumn.

In winter and spring, the numbers were highest in the other parts of the country averaging 10,860 birds (64% of the total in winter) and 22,872 birds (81% of the total in spring).

In two areas, in particular, numbers increased considerably from late summer to spring; in southwestern Kattegat (F) from an average of 150 birds to 2,565 (from 2% to

9% of the total) and in Smålandshavet (M) from 87 birds to 2,650 (from 1% to 9% of the total).

Up to 75 Shelducks were recorded in midwinter and up to 244 birds during other seasons at inland sites covered from the ground.

Internationally important numbers of >2,500 birds (Rose & Scott 1994) were recorded all year round in the Wadden Sea (A), in all seasons except late summer in the Randers Fjord/Mariager Fjord area (Ef), and in winter at Læsø (Ec).

Dispersion

In late summer and even more in autum the birds were very aggregated, while in mild winters and spring the birds became much more dispersed (App. XI).

General comments

The low numbers of late summer 1987 presumably resulted from early completion of the survey in 1987 (see App. I), late dispersion from the moulting grounds in the German Wadden Sea (Nehls 1988) and better coverage and experience in surveying in 1988 and 1989. The small numbers recorded in Kattegat (E) in 1988 compared with 1989 partly resulted from bad coverage of essential coastal stretches in this area.

The increase in numbers in winter during the study period reflects both a substantial population increase due to two mild winters, and great annual variations depending on the severity of the winter climate (Ridgill & Fox 1990). Compared with the winter population in northwestern Europe estimated at 250,000 birds (Rose & Scott 1994), up to 13% were recorded in the Danish waters during this study.

Seasonal and geographical variation

In the latter half of August, many birds are on the moulting grounds in the German Wadden Sea (Nehls 1988, Oelke 1969). Thus, the numbers recorded in Denmark were comparatively low. Most of the relatively few birds recorded outside the Wadden Sea (A) and Kattegat (E) were juveniles apparently remaining on the breeding grounds.

After moult, the Shelduck returns to the Danish Wadden Sea (Laursen et al. in press) and probably the coasts of Kattegat. At present, it is not known when the return to the latter area takes place, or whether any moulting sites exist within this area.

On Tipperne (Bb), numbers usually increase in late August/early September reflecting the dispersion from the Wadden Sea (Lilleør 1989), although this was not observed in 1987 (Kjeldsen 1988). Correspondingly, relative high numbers were recorded in the Wadden Sea in autumn 1987.

The decrease in numbers in the Wadden Sea (A) from autumn onwards in mild winters, and the increase in numbers outside the Wadden Sea during the same period presumably reflects a marked dispersion from the Wadden Sea between the two seasons. This dispersion corresponds with the large increase in numbers of count areas holding Shelduck from autumn to winter (App. XI).

This dispersion tendency continued during mild winters, and in springs leading to, less than one fourth of the birds being recorded in the Wadden Sea (A).

In Kattegat (E), numbers remained rather high in spring, which might indicate that birds were mainly Scandinavian breeding birds not yet having commenced spring migration when the surveys took place.

Apart from the birds in Kattegat, the spring distribution seems to reflect coastal breeding birds even though the birds in this season were probably a mixture of local breeders, one-year-old non-breeders and birds on migration (Joensen 1974).

The lowest recorded numbers in the Wadden Sea occurred in spring where the majority of the birds may have been one-year-old non-breeding birds.

Comparison with the results of surveys in 1969-1973

In autumn 1968, and particularly in 1969, fewer birds were recorded (18,099 and 7,945 birds, respectively) than during the present study. The very low numbers in 1969 preceeded a severe winter.

The percentages of birds recorded in the Wadden Sea in the autumns of 1968 and 1969 (79% and 75%, respectively) were similar to those of the 1987-1989 study, while numbers along the Kattegat coast (15% and 7%, respectively) were lower than in the 1987-1989 surveys.

Winter numbers varied from 2,355 birds in the severe winter of 1970 to 19,801 birds in 1969; the average of normal and mild winters was 16,667 birds. By comparison, an average of 24,767 birds was recorded during the mild winters 1988-1989. There was a distinct difference between the two main wintering sites, the Wadden Sea and the Kattegat coast. At the first site, the numbers were clearly affected by the severity of the winter, whereas the numbers along Kattegat coast were more stable (Table 3).

The numbers along the Kattegat coast varied between 1,946 in severe winters, when the area held the great majority of birds, and 4,007 in 1971. Thus, along the Kattegat coast the variation in numbers was much smaller than in the rest of the Danish winter population. If these Kattegat birds were eastern Scandinavian birds, they should be expected to migrate towards the breeding grounds late in spring due to the winter climate in the eastern Scandinavian countries. Furthermore, they should be expected to stay on the wintering grounds unless feeding conditions were so unfavourable because of the severity of the winter, that they were forced to leave. This was obviously what happened in 1987, when no birds were recorded on the Kattegat coast. The reason why this tendency was reflected only to a small extent in the 1987-1989 study may in part be ascribed to the inconvenient coverage of the Kattegat coast in 1988.

Table 3. Abundance of Shelduck in three differentiated parts (sections A, E, and outside these sections) of Denmark, and in total, during the winters of 1969-1971 and 1973, on the basis of count results obtained in aerial surveys.

Year	1969	1970	1971	1973
The Wadden Sea (A)	15,287	407	13,833	6,728
Kattegat coasts (E)	2,840	1,946	4,007	2,831
Outside section A and E	1,674	2	305	2,495
Denmark in total	19,801	2,355	18,145	12,054

During the incomplete survey in spring 1969, 26,000 birds were recorded leading to a total estimate of 30,000-35,000 birds (Joensen 1974) which is similar to the count results from this study. Joensen also found the birds greatly dispersed, although the distribution between major staging areas differed. Thus, a higher number of birds (15,700) was recorded in the Wadden Sea, but a much smaller number (1,700 birds) along the coast of Kattegat.

There seems to be little doubt that the population staging along the Kattegat coast has increased since the 1969-1973 surveys, as the numbers recorded have increased by a factor of 2-4 since 1968-1973. This increase is of the same magnitude as the increase in the Swedish and Finnish populations (Cramp & Simmons, 1977, Risberg 1990). A comparison of the numbers in the Wadden Sea between the earlier surveys and this study reveals substantial differences in all seasons and no overall conclusions can be drawn, although monthly surveys in the Wadden Sea indicate an increase in numbers during recent decades (Laursen et al., in press). The numbers outside the Wadden Sea and the coast of Kattegat showed a small increase in both seasons compared with the results of the earlier surveys. Thus, it seems reasonable to believe that there has been an increase in the Danish winter population of Shelducks compared with 1968-1973. The annual indices of northwestern Europe have been slightly increasing over the period between the two studies (Monval & Pirot 1989).

Wigeon *Anas penelope*

Total numbers

The totals varied between 9 birds in the severe winter of 1987 and 44,835 birds, peaking in autumn and spring, but they were very stable between years within each autumn and spring (App. XII).

Geographical distribution

In all seasons (Fig. 21), the majority of birds was recorded in the Wadden Sea and Limfjorden (sections A and C). High numbers were also recorded in late summer in western Jylland (section B).

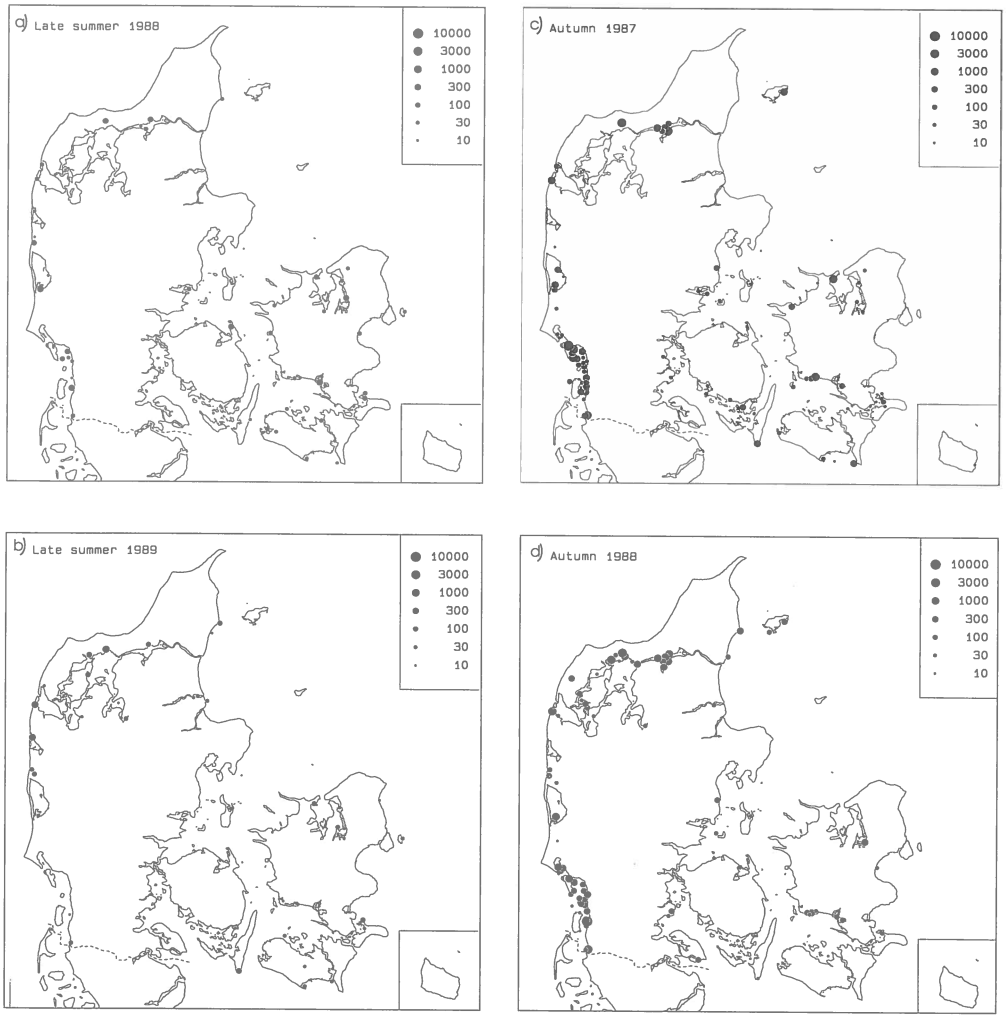

Fig. 21. Distribution and numbers of Wigeon in Danish waters during late summer 1988(a), 1989(b), autumn 1987 (c), 1988(d), winter 1988(e), 1989(f) and spring 1988(g) , 1989(h), based on results obtained from aerial surveys.

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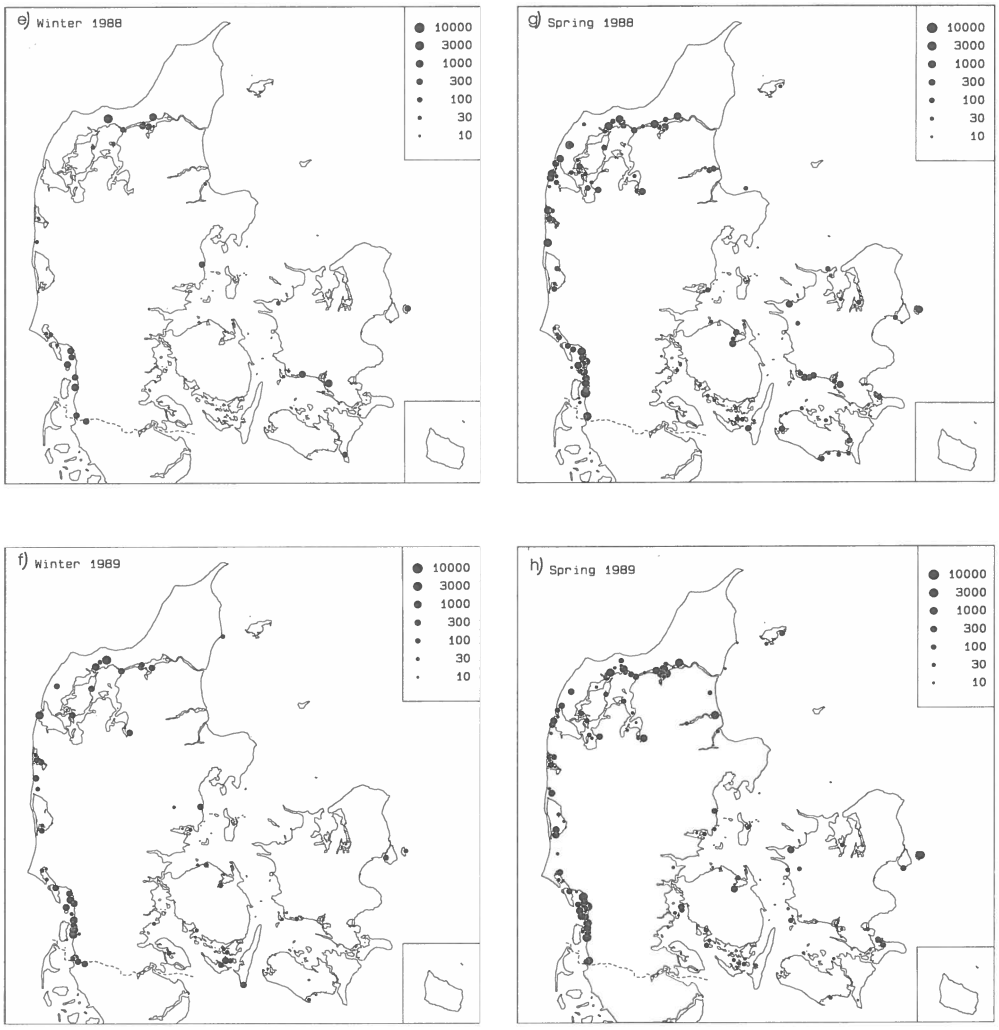

Numbers in geographical sections

The highest relative numbers were found in the Wadden Sea in autumn (averaging 52% of the total) and spring (39% of the total); in Limfjorden in late summer (averaging 36% of the total) and winter (42% of the total). These two areas and western Jylland, B, held from 74% to 86% of the birds in all seasons.

The birds in these three sections, A, B and C, were recorded comparatively later in autumn than in the rest of the country. The late summer totals compared with the autumn totals showed an average of 2,886 birds or 8% of the combined totals for these areas. For the rest of the country, the corresponding numbers were 1,068 birds or 16% in late summer (Table 4).

In the Wadden Sea (section A), a relatively larger proportion of the birds was recorded in autumn than in spring (averaging 20,081 birds and 16,936 birds, respectively) while in the southern sections, J, K, M and O, similar numbers were recorded in both autumn and spring (averaging 2,790 and 2,799 birds). Most birds were recorded in

Table 4. Relative occurrence of Wigeon, Teal, Mallard and Pintail recorded in late summer, 1987-1989, and autumn 1987-1988 in aerial surveys in the western sections A-C and the eastern sections E, F, J, K, M, N, O, R and S of the Danish waters.

Sections	Season	Wigeon	Teal	Mallard	Pintail
A, B, C:	Late summer	8%	25%	26%	0%
	Autumn	92%	75%	74%	100%
E, F, J, K, M, N, D, R, S:	Late summer	16%	71%	26%	23%
	Autumn	84%	29%	74%	77%

spring compared with autumn in the north-eastern sections E, R and S (averaging 3,366 birds compared with 2,429 birds in autumn), western Jylland (B) (averaging 3,455 birds and 1,198 birds, respectively) and Limfjorden, (C) (averaging 15,637 and 11,546 birds, respectively) (Table 5).

Wigeon was recorded at inland sites covered from the ground in midwinter in numbers up to 883 birds and in the other seasons in numbers up to 1,823 birds. The proportion of Wigeon at coastal and inland freshwater sites in winter 1989 was 22%.

Internationally important numbers of >7,500 birds (Rose & Scott 1994) were regularly recorded in spring and autumn at Rømø (Ab), Fanø (Ac) and in Nibe and Gjøl Bredning (Cg).

Dispersion

The birds were concentrated in a smaller number of areas in late summer, autumn and winter than in spring (App. XII).

Table 5. Relative occurrence (in % of annual totals) of Wigeon, Teal, Mallard and Pintail recorded in autumn and spring 1988-1989 in aerial surveys in the Wadden Sea (section A), western Jutland (section B), Limfjorden (section C), southern part (sections J, K, M and O) and northeastern part (sections E, R and S) of Denmark.

Sections	Season	Wigeon	Teal	Mallard	Pintail
A	autumn	52%	24%	12%	82%
	spring	39%	14%	12%	52%
B	autumn	3%	18%	8%	13%
	spring	8%	31%	18%	26%
C	autumn	30%	50%	31%	2%
	spring	36%	43%	20%	12%
J,K,M,O	autumn	7%	6%	31%	1%
	spring	5%	5%	15%	3%
E,R,S	autumn	6%	1%	11%	1%
	spring	8%	4%	28%	4%

General comments

The early completion of the late summer surveys prior to the main period of autumn migration (Dybbro 1978) may explain why the numbers recorded were comparatively low. Up to 6% of the wintering population of Wigeon in northwestern Europe estimated at 750,000 birds by Rose & Scott (1994) was recorded in Danish waters during this study.

Seasonal and geographical variation

During midwinter, the variation in numbers was large, due to a pronounced sensitivity of Wigeon to severe winters (Ridgill & Fox 1990). Dybbro (1978) describes the Wigeon as a "scarce" (100-1,000 birds) to "rather common" (1,000-10,000 birds) winter visitor in Denmark, but the birds are apparently "common" (10,000-100,000 birds) in very mild winters.

The results seem to show that the birds had a slight tendency to prefer southern sections including the Wadden Sea, A, J, K, M and O, in autumn and northern and eastern sections, C, E, R and S, in spring, although the tendency was less pronounced than in Mallard.

Comparison with the results of surveys in 1968-1973

During the earlier autumn surveys, 32,401 and 14,939 birds were recorded in 1968 and 1969 averaging 60% of the numbers count-

ed in the 1987-1989 surveys. However, peak numbers in autumn, which were found in October were much higher. It is, therefore, probable that the higher numbers recorded during the 1987-1989 surveys were a result of the earlier completion of the surveys, rather than a reflection of any real in-crease in numbers. In normal and mild winters during 1968-1973, totals ranged from 372 to 3,422 birds, being much lower than during the 1987-1989 surveys.

In the 1969-1973 and 1987-1989 surveys, birds concentrated in sections A, B and C (App. XII). In autumn and mild winters, 89% and 87% of the birds were recorded in the sections in the 1969-1973 study compared with 86% and 81% in the 1987-1989 surveys.

The marked increase in winter totals does not necessarily indicate an increase in the breeding population north of Denmark. It seems more likely that an increasing number of the migrants stayed in Danish waters to winter during very mild winters. The annual indices of northwestern Europe have been rather stable in the period between the two studies (Monval & Pirot 1989).

Gadwall *Anas strepera*

In total, 149 Gadwalls were recorded during the ten surveys, and all occurred in late summer, autumn and spring (Fig. 22). Gadwalls were not recorded during autumn and winter surveys in 1968-1973.

The increase in numbers of Gadwall reflected the expansion in the Danish breeding population from 10-12 pairs in the mid 1970s to about 150 pairs in 1988 (Dybbro 1978, Christensen et al. 1990).

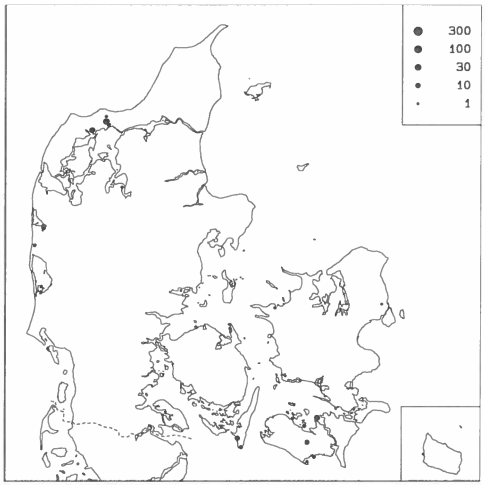

Fig. 22. Summarised observations of Gadwall (N = 149) in Danish waters in the period 1987-1989, based on results obtained from the 10 aerial surveys.

Teal Anas crecca

Total numbers

Numbers varied from 56 birds in the severe winter of 1987 to 33,672 birds in autumn being very variable in all seasons except mild winters (App. XIII).

Geographical distribution

In all seasons, the majority of the birds were recorded in the Wadden Sea (A), Western Jylland (B) and Limfjorden (C) (Fig. 23, App. XIII). However, there were variations between the seasons, as Limfjorden (C) held the highest numbers of birds in autumn and spring, western Jylland (B) in late summer and the Wadden Sea (A) in winter. Outside these areas, high numbers were recorded in late summer in Smålandshavet (M).

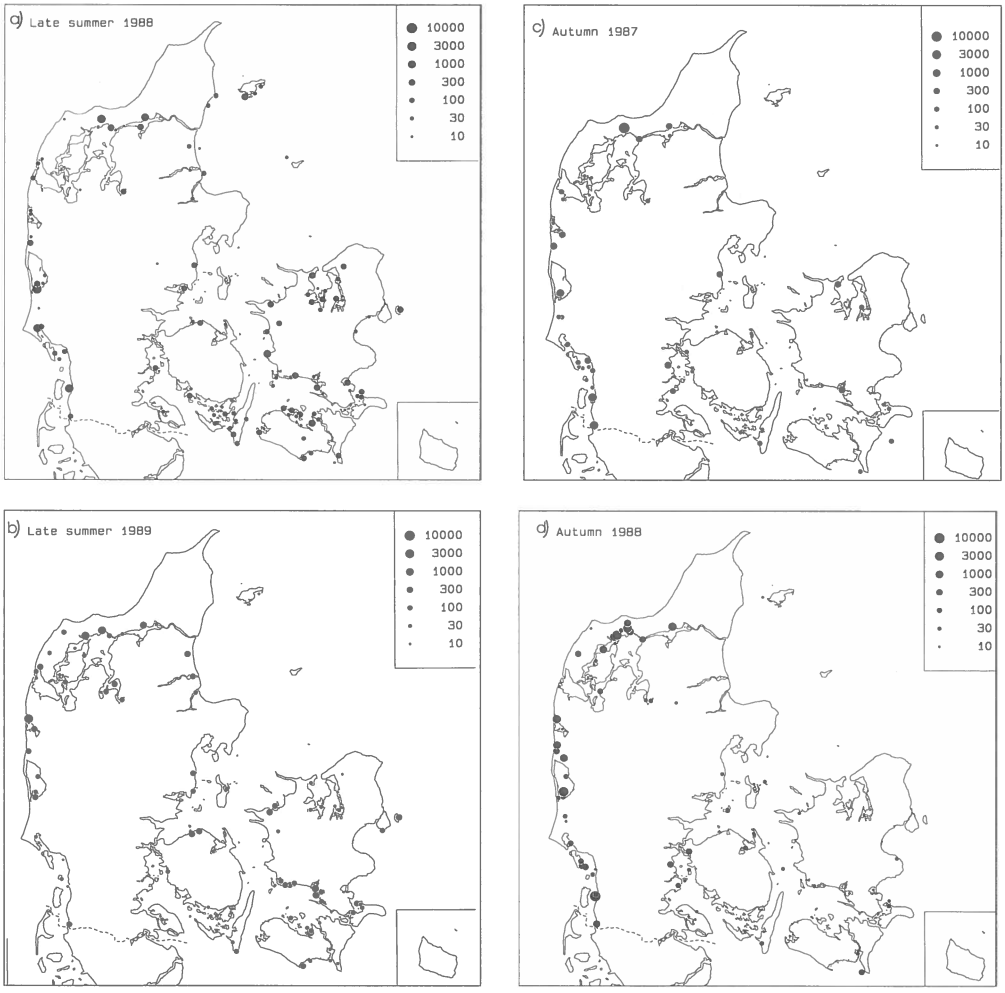

Fig. 23. Distribution and numbers of Teal in Danish waters during late summer 1988(a), 1989(b), autumn 1987(c), 1988(d), winter 1988(e), 1989(f) and spring 1988(g), 1989(h), based on results obtained from aerial surveys.

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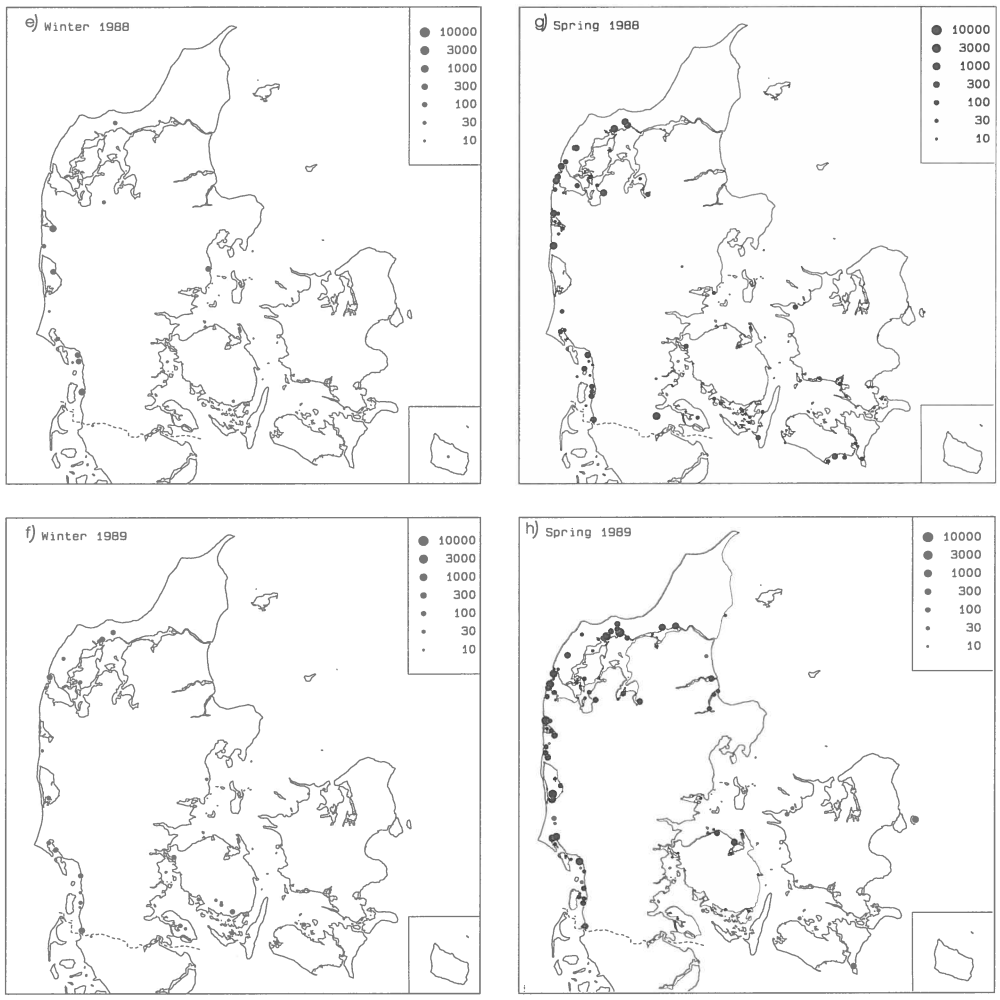

Numbers in geographical sections

Between 70% and 92% of the countrywide totals were recorded in the Wadden Sea, western Jylland and Limfjorden (A, B and C). In these areas, higher numbers were recorded in autumn than in late summer (averaging 26,108 birds in autumn and 8,829 in late summer). In the other parts of the country, numbers in late summer were higher than in autumn (averaging 5,485 birds in summer and 2,205 in autumn). Thus, 25% of the total number of birds recorded in sections A, B and C in the second half of the year were recorded in late summer, while the corresponding numbers from the other parts of the country amounted to 71% (see Table 4).

Proportionally more birds were recorded in autumn than in spring in the southern sections, J, K, M and O, (1,658 birds compared with 975 birds in spring) and Limfjorden (C) (14,227 birds compared with 7,858 birds in spring). In contrast, peak numbers in the northeastern sections, E, R and S, were recorded in spring (732 individuals compared with 226 in autumn) (Table 5).

Between 1 and 235 Teal were recorded on inland sites covered from the ground in midwinter and in the other seasons in numbers up to 1,242 birds.

Internationally important numbers of >4,000 birds (Rose & Scott 1994) were recorded on Tipperne (Bb) in spring and late summer, in Vejlerne (Ce) in spring and autumn and in the central part of the Wadden Sea (Ab) in autumn.

Dispersion
In late summer and spring, the dispersion was equally high, while the birds occurred most concentrated in autumn (App. XIII). The low numbers of birds recorded in winter occurred in rather few areas.

General comments
The relatively low numbers recorded in late summer 1987 were probably due to the early completion of the survey, resulting in most areas being covered before the autumn migration was initiated. The count data from Tipperne summarised for the period 1979-1988 showed an average of 3,700 birds around 13 August (median date for the survey in 1987) and 8,800 birds around 29 August (median date for the survey in 1989) (Lilleør 1989). The large annual variations in numbers in autumn and spring were caused by a varying degree of overlap between the timing of the migration and the surveys.

Up to 9% of the northwestern European winter population estimated at 400,000 birds by Rose & Scott (1994) was recorded in the Danish waters during this study.

Seasonal and geographical variation
During midwinter, the variation in numbers was large, due to a pronounced sensitivity of Teal to severe winters (Ridgill & Fox 1990). Even the similarity in numbers recorded during mild winters hides large geographical variations between the two years. Dybbro (1978) describes the Teal as a "scarce" (100-1,000 birds) winter visitor in Denmark, but judging from the 1987-1989 study, it is "rather common" (1,000-10,000 birds) in mild winters.

The large difference in the migration pattern in late summer and autumn between western and eastern Denmark suggests that different flyway populations may be involved. Faster turnover at the staging sites in eastern than in western Denmark could explain at least some of the differences. Less attractive feeding opportunities, excessive disturbance or hunting might cause a rapid passage. In eastern Denmark, numbers tended to be relatively higher in autumn in the southern sections J, K, M and O, and in spring in the northeastern sections E, R and S.

Comparison with the results of surveys in 1968-1973

In the autumns of 1968 and 1969, 16,259 and 11,489 birds were recorded. These figures are lower than the results of the 1987-1989 study, but not fully comparable, as the earlier autumn surveys were conducted somewhat later in the season than the 1987-1989 surveys (median dates 13 November 1968 and 26 November 1969).

In the severe and normal winters of 1969, 1970 and 1971, total numbers included up to 82 birds. In the mild winter of 1973, 575 birds were recorded compared with about 2,000 birds during the 1987-1989 study.

The distributions in autumn and winter differed from the results of the 1987-1989 study, as 98% and 100%, respectively, were recorded in sections A, B and C in 1968-1973 compared with 92% and 78%, respectively, during the 1987-1989 surveys.

Because of the differences in survey period, coverage and winter climate, the results from the earlier surveys are not comparable to those of the 1987-1989 surveys. Nevertheless, there is reason to believe that the numbers of Teal have not decreased since 1968-1973. The annual indices for the northwest European population increased in the period between the two studies (Monval & Pirot 1989).

Mallard *Anas platyrhynchos*

Total numbers

The Mallard was rather variable in numbers in all seasons being most numerous in autumn and winter and recorded in numbers from 11,926 to 124,480 birds (App. XIV). Numbers increased in all seasons except spring during the study period.

Geographical distribution

Mallards were widely distributed and heavily variable in their occurrence in the Danish waters (Fig. 24). The highest numbers occurred in Limfjorden (section C) in late summer, autumn and the mild winters (Fig. 24a-e, g, h). In Jylland, high numbers also

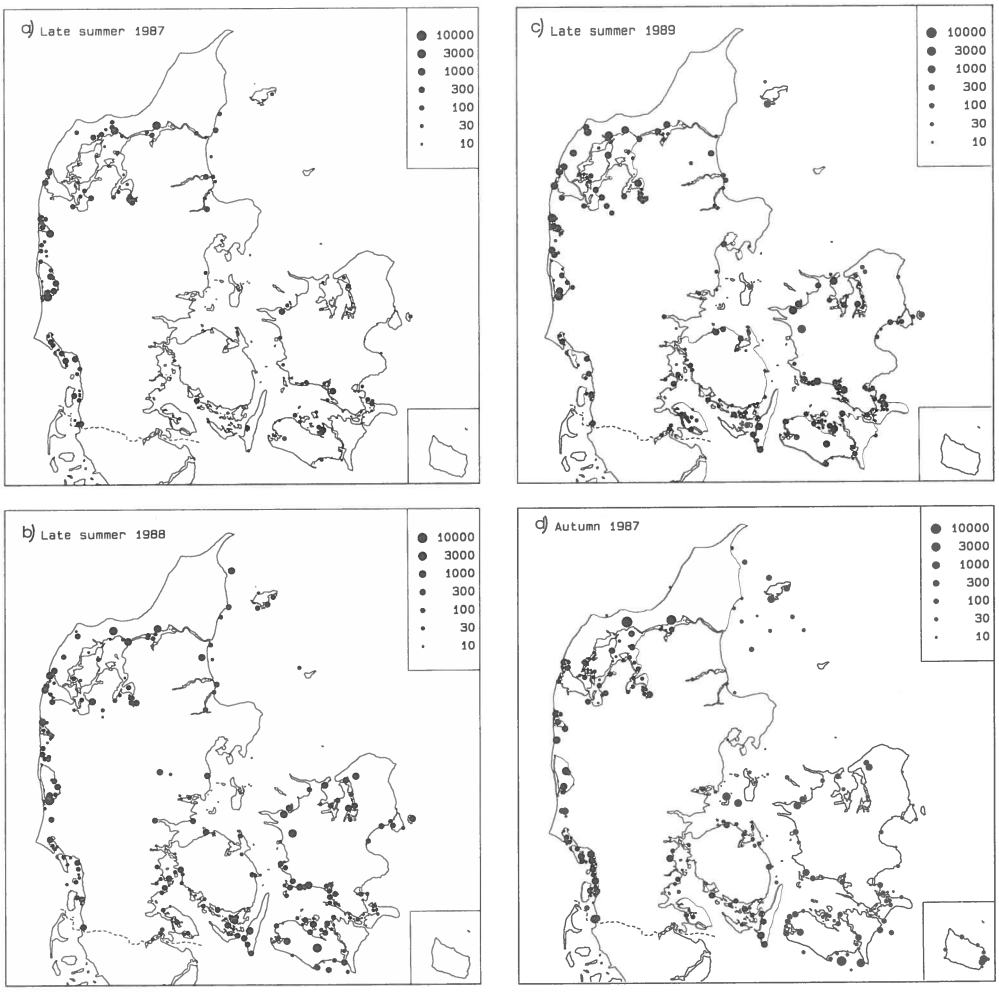

Fig. 24. Distribution and numbers of Mallard in Danish waters during late summer 1987 (a), 1988 (b), 1989 (c), autumn 1987 (d), 1988 (e), winter 1987 (f), 1988 (g), 1989 (h) and spring 1988 (i), 1989 (j), based on results obtained from aerial surveys.

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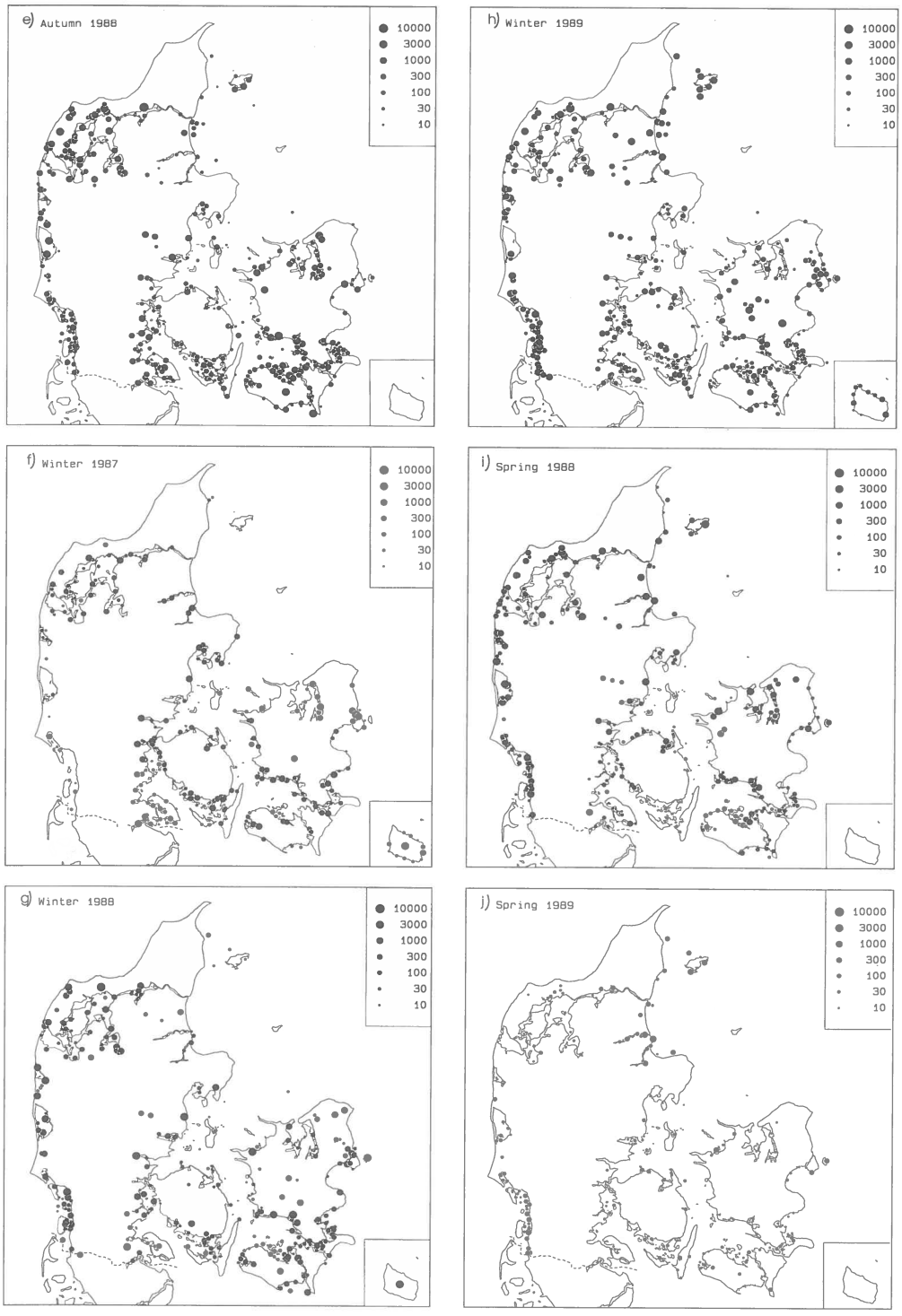
e) Autumn 1988
h) Winter 1989
f) Winter 1987
i) Spring 1988
g) Winter 1988
j) Spring 1989
10000
3000
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occurred in the Wadden Sea (A) and in the western parts (B). During the severe winter of 1987 (Fig. 24f), relatively high numbers of Mallards were registered in southern Kattegat (F), southwest of Fyn (J and K) and in northeastern Sjælland (R). Comparatively few birds were recorded in the Wadden Sea (A) and western Jylland (B).

During the spring survey of 1988 (Fig. 24i), Mallards were widely distributed much the same way as in winter. During the spring survey of 1989 (Fig. 24j), the birds were primarily counted in the Wadden Sea and northern Kattegat (E).

Numbers in the geographical sections

In the Wadden Sea, western Jylland and Limfjorden (A, B and C), 17,476 birds recorded in late summer amounted to 26% of the late summer/autumn totals in these areas. The corresponding number from the rest of the country was 16,433 birds amounting to 26% in the eastern sections (Table 4).

In autumn, a large proportion of the total numbers was recorded in Limfjorden (C) and the southern sections, J, K, M and O, (31% compared with 15% in spring) and Limfjorden (C) (31% compared with 20% in spring). In spring, a larger proportion was observed in the northeastern sections, E, R and S, (28% compared with 11% in autumn) and western Jylland (B) (18% compared with 8% in autumn) (Table 5).

Between 7,151 and 20,179 Mallards were recorded at inland sites covered from the ground at midwinter with up to 10,870 birds at other times. The proportion of Wigeon in coastal and inland freshwater sites in winter 1989 was 31%.

Internationally important numbers of >20,000 birds (Rose & Scott 1994) were not recorded at any sites.

Dispersion

Dispersion was similar in autumn, winter and spring, although there were large differences in distribution within each season (App. XIV). The dispersion in late summer was comparatively smaller.

General comments

In late summer, most of the birds were still on the breeding grounds inland, so totals were comparatively small. During the late summer survey of 1987 the numbers were lower than the almost equally high numbers in the two following years, perhaps because the early survey in 1987 was carried out before the birds had moved to the brackish and marine areas (App. I).

In autumn as well as in spring, the numbers were very variable probably as a consequence of the timing of the migration in relation to the surveys.

In spring 1989 numbers were small compared with 1988, probably due to late completion of the survey combined with early spring migration of the birds.

Up to 3% of the estimated winter population in northwestern Europe estimated at 5 million birds by Rose & Scott (1994) was recorded during this study.

Seasonal and geographical variation

In mild winters, the totals were on the same level and distribution much the same as in autumn; in severe winters, numbers were somewhat lower probably due to southward migration caused by unfavourable feeding conditions (Ridgill & Fox 1990, Nilsson 1984) and the birds were mainly concentrated in the southern and eastern sections, J, K, M, O and R.

The results do not reveal differences between the western sections, A, B and C, and the rest of Denmark in the progress of the autumn migration (see Numbers in the geographical sections) as was pointed out for the other species of dabbling ducks, in particular Teal.

The birds seemed to exploit mainly Limfjorden and the southern sections, J, K, M and O, as stopover sites in autumn and concentrated in western Jylland and the northeastern sections, E, R and S, in spring, while the Wadden Sea (A) was equally important as a staging area in all seasons except autumn.

Comparison with the results of surveys in 1968-1973

During the autumn surveys in 1968 and 1969, an average of 103,400 birds was recorded, with considerable variation within approximately the same range as the 1987-1989 study. The distribution had changed slightly, as 65% of the birds in the 1968-1973 study were recorded in sections A, B and C, compared with 54% in the 1987-1989 study. While more birds were recorded in western Jylland (B, 22% compared with 9% in the 1987-1989 study) and the Wadden Sea (A, 20% compared with 14%), less birds occurred in Limfjorden (C, 23% compared with 32%). Monthly surveys at the Wadden Sea also revealed a decrease in numbers (Laursen et al. in press).

In mild winters, similar average numbers were obtained in the surveys. During 1968-1973, 94,400 birds were counted compared with 102,800 in the 1987-1989 study. The distribution was almost identical (49% and 48%, respectively), recorded in sections A, B and C; in other parts of the country, the majority of birds were recorded in sections E, M and O in both studies.

In the severe winter of 1970, the number was 67,200, and, as found in the 1987-1989 surveys, it was lower than the average counted in mild winters. The relative numbers in sections A,B and C were 22% in 1970 and 15% in the severe winter of 1987.

During this study, the numbers were about the same as observed in the 1968-1973 surveys, although some changes in geographical distribution were found. The annual indices of the northwest European population increased slightly in the period between the two studies (Monval & Pirot 1989).

Pintail *Anas acuta*

Total numbers
The numbers recorded varied between 16 birds in the severe winter of 1987 and 8,455 birds, numbers being highest in autumn and spring, but fluctuating greatly in all seasons (App. XV).

Geographical distribution
During all seasons, the majority of birds were recorded in the Wadden Sea and Western Jylland (sections A and B). In addition, high numbers were recorded in Limfjorden (section C) in spring (Fig. 25). In the severe winter of 1987 no birds were recorded.

Numbers in the geographical sections
In the Wadden Sea (section A), the numbers in autumn and spring (except 1989, see later) were within the same range while in the rest of the country, numbers were highest in spring (average 2,910 individuals) compared with 1,151 in autumn.

In the main part of the country (outside sections A, B and C) 11-15% of the total numbers were recorded in late summer and spring, but only 2-3% in autumn and the mild winters (Table 5).

Up to 18 Pintail were recorded at inland sites during ground counts.

Internationally important numbers of >700 birds (Rose & Scott 1994) were regularly recorded in the southern part of the Wadden Sea (section Aa), at Rømø (section Ab), Fanø (section Ac), and in spring at Tipperne (section Bb), Nissum Fjord (section Bd) and Harboøre Tange (section Ca).

Dispersion
The birds were concentrated in comparatively few areas in all seasons (see App. XV).

General comments
The high numbers recorded in midwinter 1989 were most likely a result of the late performance of the survey combined with early spring movements of the birds due to

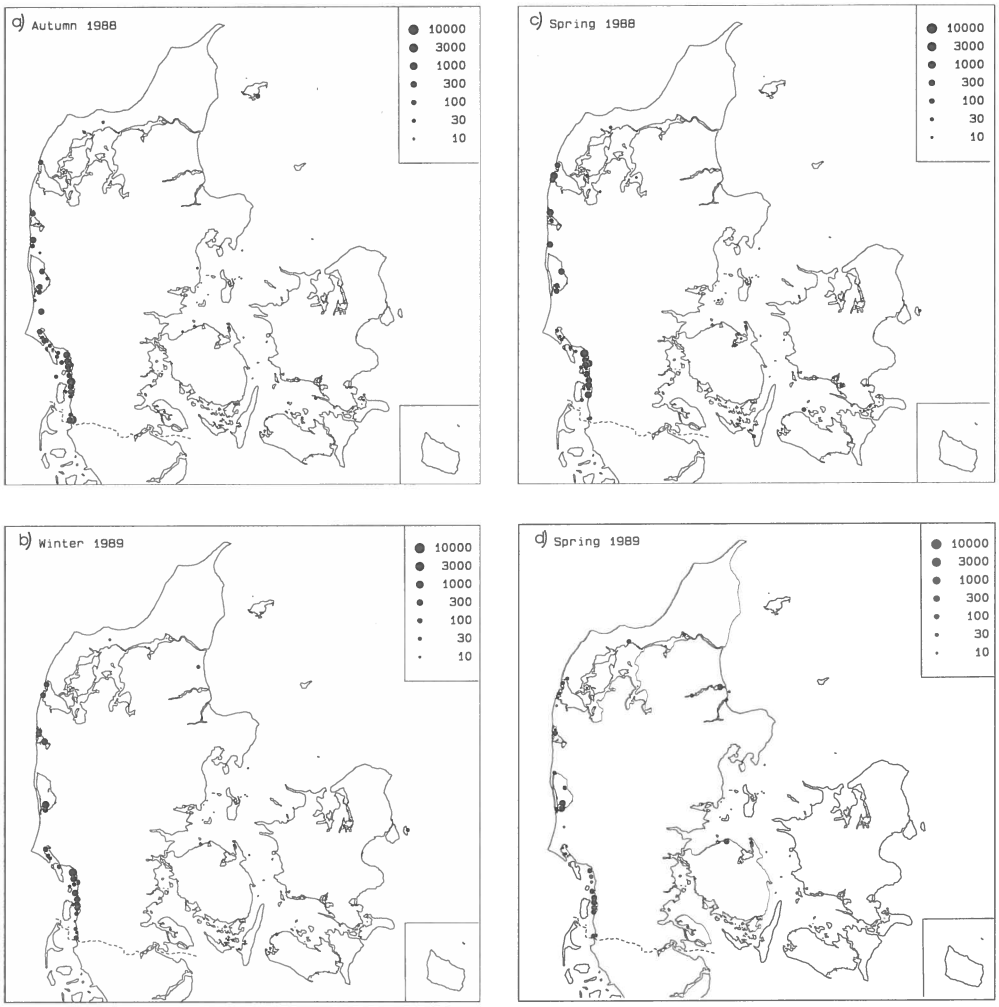

Fig. 25. Distribution and numbers of Pintail in Danish waters during autumn 1988(a), winter 1989(b) and spring 1988(c) , 1989(d), based on results obtained from aerial surveys.

mild winter conditions. The rather low numbers recorded in the subsequent spring was probably caused by a late performance of the survey in relation to the spring migration.

Up to 13% of the winter population in northwestern Europe estimated at 70,000 birds by Rose & Scott (1994) was recorded in the Danish waters during this study.

Seasonal and geographical variation

During midwinter, the variation in numbers was large, due to a pronounced sensitivity of Pintail to severe winters (Ridgill & Fox 1990). Dybbro (1978) mentions Pintail as a "scarce winter visitor" (100-1,000 birds), but the species is apparently a "rather common" winter visitor (1,000-10,000 birds) in mild winters.

Comparison with the results of surveys in 1968-1973

During the 1968-1973 surveys, up to 1,499 Pintail were recorded in autumn and 272 in mild winters; the corresponding figures from the 1987-1989 study were 6,769 and 3,199 birds. Despite the difficulties in identification, differences in the survey period and winter conditions between the two periods, it seems likely that the numbers have increased in autumn. The annual indices of the northwest European population have been stable in the period between the two surveys (Monval & Pirot 1989).

Garganey *Anas querquedula*

Altogether 95 individuals were recorded during the 10 surveys, exclusively in late summer and spring (Fig. 26). During the autumn and winter surveys in 1968-1973, Garganey was not recorded.

Fig. 26. Summarised observations of Garganey (N = 95) in Danish waters in the period 1987-1989, based on results obtained from the 10 aerial surveys.

Shoveler *Anas clypeata*

Total numbers
During the 10 surveys, a total of 1,856 birds was recorded; 3 were observed during midwinter. In late summer, numbers varied from 2 to 455 birds, in autumn from 224 to 369 birds and in spring from 79 to 390 birds (Fig. 27).

Geographical distribution
The majority of the birds were registered in the Wadden Sea (section A), Western Jylland (section B) and Limfjorden (section C) ranging from 47% in late summer and 67% in spring to 90% in autumn.

Comparison with the results of surveys in 1968-1973

During the surveys from 1968-1973, 20-40 birds were recorded in autumn and 0-2 birds in winter. Due to difficulties in identifying this species from the aircraft, comparisons with the results of the 1968-1973 surveys cannot be made.

Fig. 27. Summarised observations of Shoveler in Danish waters during late summer (a, N = 792), autumn (b, N = 572) and spring (c, N = 484) based on the 10 aerial surveys from the period 1987-1989.

Pochard *Aythya ferina*

Total numbers
Pochard was recorded in numbers varying from 262 birds in late summer to 8,441 birds in autumn being variable in all seasons except winter (App. XVI).

Geographical distribution
In late summer (Fig. 28a), nearly all Pochards were recorded in western Jylland and Limfjorden (sections B and C) and in the southeastern sections (sections M and O).

In autumn (Fig. 28b), the majority of birds was recorded in Limfjorden (section C) and in the southern sections (J, K and M).

Pochard was most widely distributed in mild winters, as 8 geographical sections each held more than 5% of the birds compared with 4 sections in both late summer and autumn and 5 in spring. Most birds were recorded in Limfjorden (section C), southwestern Kattegat (section F), Lillebælt

Fig. 28. Distribution and numbers of Pochard in Danish waters during late summer 1989 (a), autumn 1988 (b), winter 1987 (c), 1988 (d), 1989 (e) and spring 1988 (f), based on results obtained from aerial surveys.

(section J) and the southeastern section O. In all seasons, Limfjorden was the marine area where most birds were recorded (App. XVI). During the severe winter of 1987 (Fig. 28c), the birds had almost abandoned Limfjorden, the vast majority being recorded in the sections south of Fyn (J and K). In spring (Fig. 28f), most birds were recorded in the northwestern sections B and C.

Numbers in geographical sections
The numbers varied greatly from year to year and from season to season with the sections A, D, E and T constantly holding low numbers.

During the severe winter of 1987, 3,275 birds or 85% of the total was recorded in Lillebælt (section J) and adjacent Sydfynske Øhav (section K), compared with 530 birds or 17% in winter 1988 and 653 birds or 25% in winter 1989.

Between 63 and 3,264 Pochards were recorded at inland sites counted from the ground in midwinter; in other seasons inland site numbers of up to 1,068 birds were recorded. The proportion of Pochard at coastal and inland freshwater sites in the winter of 1989 was 73%.

Internationally important numbers of >3,500 birds (Rose & Scott 1994) were not recorded at any time.

Dispersion
Birds were generally concentrated at a few sites especially in late summer. Pochard occurred in all seasons in association with Tufted Duck mainly in small coastal brackish or freshwater lakes and very sheltered lagoons; in the severe winter of 1987, thick ice cover on the favoured habitats forced the birds to move to marine sites.

General comments
The comparatively low numbers in late summer 1987 were probably caused by early completion of the survey combined with insufficient coverage and lack of observer experience. The relatively small total recorded in spring 1989, most likely resulted from the late spring survey performed after the spring migration to the breeding grounds had started.

Even though the totals varied comparatively little through the year, the numbers of birds in each section varied greatly. A large part of this variation was probably caused by poor coverage of this species, as it often mixed with huge flocks of Tufted Duck and, therefore, was easily neglected. Furthermore, the species was, apart from the severe winter, almost exclusively recorded in freshwater, and only the larger sites were covered through the aerial surveys. Thus, it is believed that the results reflect the population size to a small extent.

Up to 3% of the wintering population in northwestern Europe estimated at 350,000 birds by Rose & Scott (1994) was recorded during the surveys.

Seasonal and geographical variation
It was expected that much higher numbers would be recorded in mild winters than in severe winters, due to the sensitivity of Pochard to severe winters (Ridgill & Fox 1990, Nilsson 1984). It would probably have been shown in aerial counts, if numbers from freshwater sites had been included. In severe winters, the Pochard at first moves from the favoured wintering site in freshwater lakes to nearby marine sites (Joensen 1974), before commencing a southward migration (Ridgill & Fox 1990).

This local migration, which was observed during winter 1987, affected the geographical distribution, as the Pochard was mainly recorded in sections J and K in the winter of 1987. In mild winters, Pochard winters on inland freshwater lakes on Fyn, and it is likely that the birds from these sites moved to nearby marine sites, of which the nearest were sections J and K. In 1987 these lakes were frozen, but in 1989 they held 1,260 birds.

Comparison with the results of surveys in 1968-1973

The numbers recorded during the aerial surveys in autumn 1968 and 1969 were 2,957

and 1,803 birds, respectively. In addition, about 5,300 and 3,900 birds, respectively, were recorded from the ground. The figures clearly show the difficulty in surveying Pochard from aircraft, particularly when freshwater sites are not included.

In winter, numbers varied from 7,439 birds in the severe winter of 1970 and 3,166 birds in the mild winter of 1973 to 575 and 848 birds, respectively, in the two normal winters (1969 and 1971). In addition, 2,200-3,900 birds were recorded at fresh-water sites observed from the ground during the four surveys.

The difference in the coverage of freshwater sites from aircraft, the great variation in numbers and the problems in identifying the birds made comparisons between the old and the new surveys difficult. Despite this, the figures do not indicate any trends. The annual indices of the northwest European population have fluctuated widely, but varied only little between the two survey periods (Monval & Pirot 1989).

Tufted Duck *Aythya fuligula*

Total numbers

In late summer, the total numbers ranged up to 2,365 birds; in all other seasons, the totals varied from 26,251 to 96,606 birds (App. XVII).

Numbers were rather stable between years in late summer (except 1987, see later) and in winter with the late performed autumn survey and the early performed spring survey in 1988 at the same level as the midwinter counts.

Geographical distribution

In late summer (Fig. 29a, b), nearly half of the birds were recorded in Limfjorden (section C) and less in the southern and eastern sections J, M, O and R.

During autumn (Fig. 29c, d), most birds were recorded in the eastern sections O and R, while the southern and eastern sections J, M, O and R held the majority of birds in winter and spring (Fig. 29f-i).

In the severe winter of 1987 (Fig. 29e), large numbers were also recorded in Lillebælt (J) and Sydfynske Øhav (K).

Numbers in geographical sections

The relative numbers in the southern and eastern sections, J, K, M, O and R, were rather stable from autumn to spring comprising 83% to 91% of the totals. The figures indicated some movements within the sections: the relative numbers in the southern sections, J, K and M, increased from 16% of the totals in autumn to 42% in spring; the numbers in the eastern sections, O and R, decreased from 68% to 45% in the same periods.

In the severe winter of 1987, the highest numbers were recorded in sections J, K and O, while in the mild winters the highest numbers were recorded in sections M, O and R. In Lillebælt (J) and Sydfynske Øhav (K), 44,765 birds were recorded in the winter of 1987 compared with an average of 11,495 birds in the two mild winters.

The species was recorded at inland sites in midwinter in numbers from 12,470 to 53,053 birds and in all other seasons in numbers up to 5,081 birds. The proportion of Tufted Duck at coastal and inland freshwater sites in the winter of 1989 was 75%.

Internationally important numbers of >7,500 birds (Rose & Scott 1994) were regularly recorded in all seasons except late summer in Fladet, Sakskøbing (Ma), Gavnø and Dybsø Fjord (Mb), Maribo-søerne (Oa), Nykøbing Falster (Oa), København South (Ra), Store Kattinge Sø (Rb), Selsø (Rb) and Lejre Vig (Rb). In severe winter it was found that, in addition to these sections, the above-mentioned internationally important numbers were also recorded in southern Lillebælt (Ja), south of Ærø (Ka), Svendborgsund (Ka and Kb) and Grønsund (Ob).

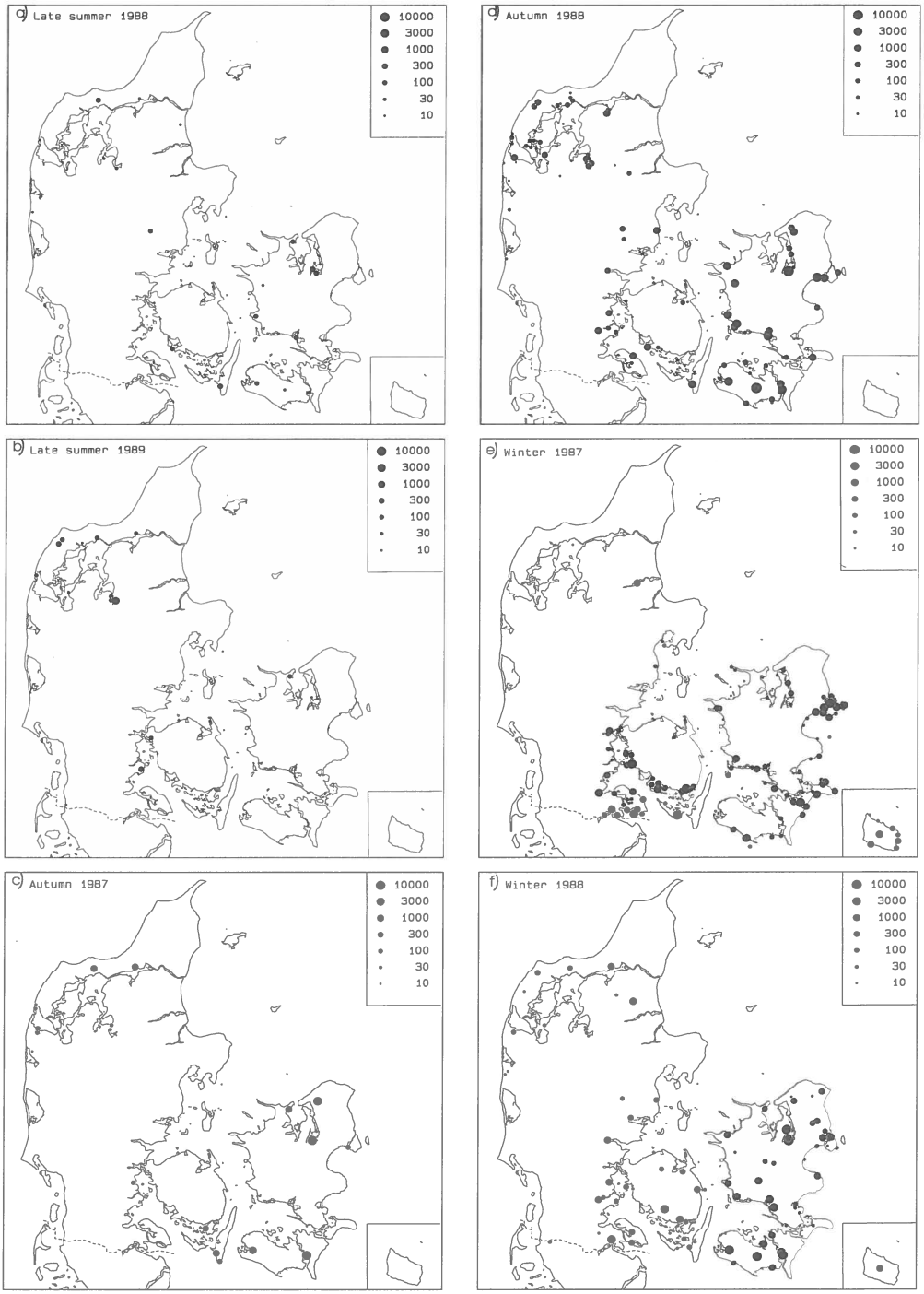

Fig. 29. Distribution and numbers of Tufted Duck in Danish waters during late summer 1988 (a), 1989 (b), autumn 1987 (c), 1988 (d), winter 1987 (e), 1988 (f), 1989 (g) and spring 198 8(h), 1989 (i), based on results obtained from aerial surveys.

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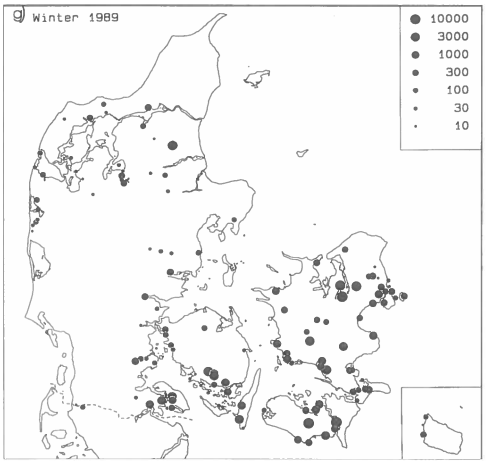

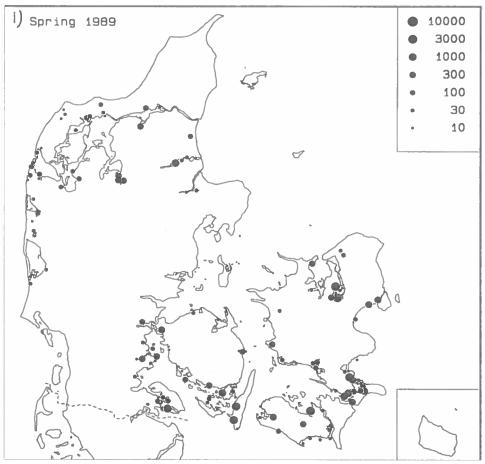

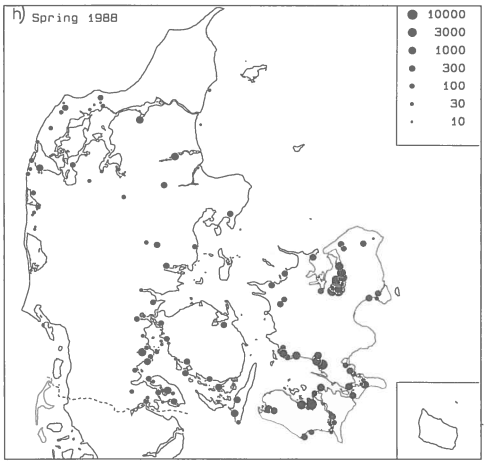

Dispersion

The birds were in all seasons concentrated at a small number of sites, often very small, undisturbed lakes close to the coast (App. XVII). The birds occurred in all seasons mainly in the same type of habitat as Pochard and often associating with it. Tufted Duck was similarly forced to brackish or marine habitats during the severe winter of 1987, due to heavy ice cover on the freshwater lakes.

General comments

The numbers in late summer 1987 were comparatively low probably because of early completion of the survey and insufficient coverage.

The low numbers in late summer compared with other seasons presumably represent local, moulting males, whereas the birds in all other seasons were a mixture of winter visitors, migrants and to a lower extent local birds.

The species occurred in much higher numbers than the Pochard and as identification was much easier, the numbers recorded were probably a good reflection of the numbers in coastal lakes and marine areas in all seasons.

The Tufted Duck roosts during daytime and feeds only at night, as described from Sweden (Nilsson 1969a) and Switzerland (Pedroli 1982). The least disturbed site (including hunting activity) within reach of the feeding areas would most likely be selected for day time roosting.

Up to 19% of the winter population in northwestern Europe estimated at 750,000 birds by Rose & Scott (1994) were recorded during this study.

Seasonal and geographical variation

The highest numbers of wintering birds were recorded in the severe winter of 1987, as was the case for Pochard. There are probably two reasons for this: birds staging north and east of Denmark have been forced to move south and west due to ice cover, and

birds wintering in Danish freshwater sites have moved to brackish and marine sites, also as a response to ice cover.

The same effect was observed on numbers of Tufted Duck in sections J and K as in Pochard (see above), probably partly caused by an influx from nearby lakes on Fyn. During the winter of 1987, these lakes were frozen; in 1989, 8,300 birds were recorded here.

It seems most likely that the birds recorded in all seasons in the northern and western sections (B, C, E and F) were of different origin than the birds in the southern and eastern sections (J, K, M, O and R). The numbers varied comparatively little through the year in the former sections being highest in spring at the beginning of the breeding season. Numbers showed an increase between the two spring surveys when the numbers in the southern and eastern sections were decreasing.

This decrease was presumably a result of the birds having commenced the spring migration, i.e. birds that to a great extent had left the area before the survey. As the Danish breeding population is rather small (Dybbro 1978), the greatest part of Tufted Duck recorded in the southern and eastern sections are birds of foreign origin.

The observed increase in relative numbers in the southern sections J, K and M from autumn to spring and the decrease in relative numbers in the eastern sections O and R in the same period have no obvious explanation.

Comparison with the results of surveys in 1968-1973

The numbers recorded in autumn 1968 and 1969 amounted to 46,413 and 62,067, respectively, well within the variation in autumn during this study. The distributions were much the same during the two studies as 77% of the birds were recorded in sections J, K, M, O and R in the 1968-1973 surveys and 83% during the 1987-1989 surveys.

The winter total in the 1968-1973 surveys ranged from 40,347 birds in the mild winter to 149,188 birds in one of the normal winters averaging 96,218 birds compared with 88,974 in 1987-1989.

The relative numbers in the southern and eastern sections, J, K, M, O and R, in winter increased from 63%-79% during 1968-1973 to 87%-91% in the 1987-1989 study.

The figures indicate that the numbers have been stable in the period between the two studies with rather large annual variations. The annual indices of the northwest European population showed the same stability regarding large fluctuation in the period between the two studies (Monval & Pirot 1989).

Scaup *Aythya marila*

Total numbers

Scaup was only recorded once in late summer, while numbers in all other seasons were highly variable ranging from 2,097 birds in autumn to 38,311 in winter (App. XVIII).

Geographical distribution

In all seasons except the severe winter, the majority of birds were recorded in the eastern coastal waters of Jylland from Djursland to Sæby (subsections Ef and Eb). Also in southwestern Kattegat (F) and in Lillebælt (J), large numbers were recorded (Fig. 30).

In the severe winters (Fig. 30b), most of the birds were recorded in the sections J and K southwest of Fyn and in southwestern Kattegat (F). In all seasons, comparatively few birds were recorded in the westernmost (A and B) and the easternmost sections (M, N, O, R, S and T).

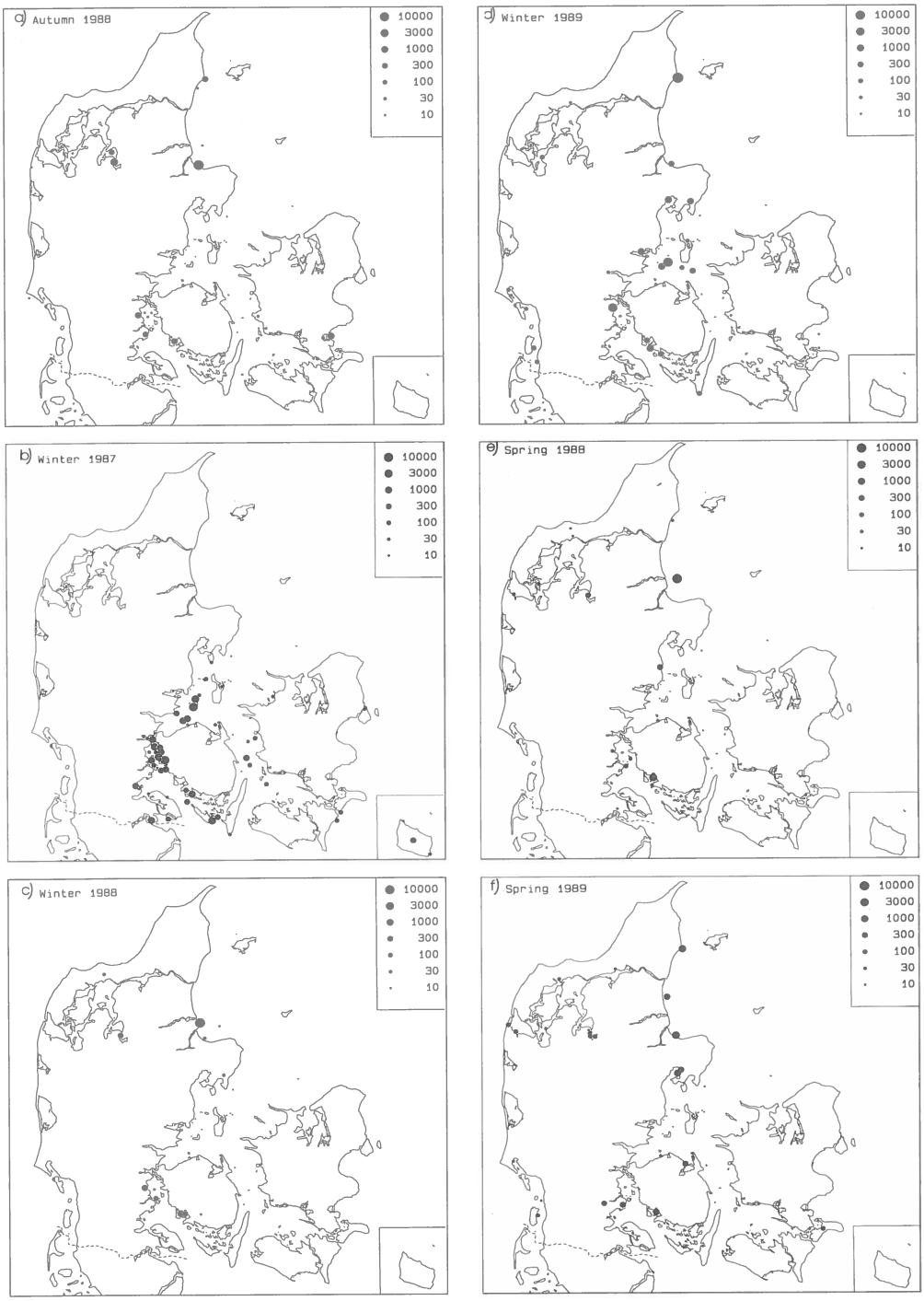

Fig. 30. Distribution and numbers of Scaup in Danish waters during autumn 1988 (a), winter 1987 (b), 1988 (c), 1989 (d) and spring 1988 (e), 1989 (f), based on results obtained from aerial surveys.

Numbers in the geographical sections
The numbers in the geographical sections varied a great deal throughout the study period. From autumn 1987 to spring 1988, flocks of more than 1,000 birds were recorded at practically the same sites in each survey; in the same period in 1988/1989, the location of large flocks varied greatly from survey to survey.

Scaup was recorded in midwinter at inland sites in numbers from 35 to 612 birds and in the other seasons in numbers of up to 200 birds. The proportion of Scaup at coastal and inland freshwater sites in winter 1989 was 5%.

Internationally important numbers of >3,100 birds (Rose & Scott 1994) were regularly recorded in winter from Ålborg Bugt (Ef), at Endelave (Fb) and in Lillebælt (Ja). In addition, numbers exceeded the 1% level in the severe winter south of Ærø (Ka) and in the last mild winter south of Sæby (Eb).

Dispersion
In all seasons, birds were very concentrated, less so in the severe winter. Scaup occurred in great dense flocks, most often out of sight from land. Smaller flocks were recorded mixing with Tufted Duck and Pochard in coastal lakes.

General comments
The comparatively small numbers recorded in autumn 1987 and spring 1989 were probably caused by bad timing of the aerial survey in relation to the spring migration of the birds. The totals of the species varied a great deal, but as the majority of the birds were recorded in huge flocks of up to 18,000 birds, often several kilometres from the coast, the omission of one flock could affect the totals seriously.

The occurrence of large flocks indicated nocturnal feeding and diurnal roosting as recorded for Scaup in Sweden (Nilsson 1969b). The roosting sites would predictably be the safest (e.g. from hunting activity) and most undisturbed sites within range of feeding areas. The nomadic occurrence of Scaup, as registered during this study, may be explained by changes in disturbances from hunting and other recreational activities.

Up to 13% of the winter population in northwestern Europe estimated at 310,000 birds by Rose & Scott (1994) was recorded during this study.

Seasonal and geographic variation
The rather large difference in numbers between the two autumn surveys, and furthermore between autumn and winter surveys, indicated that the main migration was taking place very late in autumn (November/December).

Comparison with the results of surveys in 1968-1973

The numbers of Scaup recorded in autumn 1968 and 1969 were 43,590 and 38,267 birds, respectively; these numbers are much higher than those observed in the 1987-1989 study, where decreases occurred in all sections except Kattegat (E). In Limfjorden (C), the numbers in 1968 and 1969 were 18,945 and 6,751 birds respectively, which is more than 13 times the numbers of the 1987-1989 study. As the numbers within this area in winter were only 582 birds on average, the high numbers in autumn were presumably birds staging on the migration from Fenno-Scandia to the winter quarters. If the ultimate wintering grounds of these birds was the IJsselmeer area in the Netherlands, this migration should have been reflected in higher numbers along the Danish west coast or in the Danish Wadden Sea. The number of Scaup passing Blåvand (section A) on migration was up to 100 per autumn during 1963-71 (Petersen 1974) and numbers were comparatively small in the Wadden Sea as well (Laursen et al., in press). The decrease in Limfjorden from a maximum of almost 19,000 in 1968 to a little less than 2,000 in 1988 occurred simultaneously with the disappearance of up to 25,000 birds from the wintering sites at the Firth of Forth, Britain (Salmon 1988). These birds were believed to be mostly of

Scandinavian and/or Russian origin, if not entirely, and it seems likely that the birds recorded in Lim-fjorden in November were of the same population that were found wintering in the Firth of Forth in January/February (Campbell 1984).

In Limfjorden, the decrease happened in a period of serious reduction in the quality of the water (Christensen 1988). It seems most likely that these birds have now been assimilated into the west Baltic Sea winter population. Numbers in the adjacent Kattegat have increased since 1968-1973, although this increase was of smaller magnitude (this study).

In winter, the numbers observed during the 1968-1973 surveys ranged from 41,981 to 95,240, being highest in severe winters. The average was 66,349 birds, 2.5 times the 1987-1989 counts. The birds were distributed differently in former times, with the majority recorded in Lillebælt (J). In this section, the average number decreased by a factor of 5.8 from 43,428 birds in 1968-1973 to 7,515 birds in 1987-1989. In the adjacent Sydfynske Øhav (K), numbers decreased by a factor of 5.4 from an average of 6,983 to 1,303 birds. In southwestern Kattegat (F), the numbers decreased by a factor of 1.6 from 10,533 to 6,453 birds, whereas in northern Kattegat (E) the numbers increased by a factor of 7.7 from 1,240 to 9,564.

The principal food of Scaup in Danish waters is molluscs (Madsen 1954). There is no indication that the amount of molluscs has decreased in Danish waters; probably, it is not a lack of food that has led to these decreases in the numbers of Scaup. In the IJsselmeer area, up to 160,000 Scaup now winter, mainly feeding on Zebra Mussels *Dreissena polymorpha* (van Eerden & Zijlstra 1986), and it is possible that the rapid colonisation of this mussel has provided better feeding opportunities than Danish waters, resulting in birds moving their winter quarters to IJsselmeer.

During the period of population declines in Scaup in Danish waters, numbers increased along the eastern part of the German Baltic Sea coast (the former GDR) reaching a level of 60,000 birds in mild winters from January 1988 (Struwe & Nehls 1992). The birds are presumably only present at these German sites in very mild winters (H.W. Nehls, pers. comm.) and it seems most likely that the western Baltic Sea forms one wintering area for this nomadic species; the result is large annual variations in the numbers in both Denmark and Germany.

The decrease in total numbers and redistribution of the birds might have been further affected by the level of hunting and other recreational activities at sea. Unfortunately, no studies of the effects of human disturbance at sea in these areas have been published. In the period between the two studies, the estimates of the Western Palearctic Scaup population has been judged to be stable (Atkinson-Willes 1976, Laursen 1989). On the basis of 1987-1989 figures from the Netherlands (van den Bergh 1992), Poland (Meissner & Kozakiewicz 1992) and the Baltic Sea coast of Germany (the former GDR; Struwe & Nehls 1992), the population estimate was raised to 360,000 birds (Laursen et al. 1992).

Eider *Somateria mollissima*

The majority of Eiders were recorded in shallow water areas where survey ships could not operate. Thus, the results for Eider were exclusively based on aerial surveys.

Total numbers

Eider was recorded in the moulting season during late summer in numbers from 70,518 to 135,287 birds. From autumn to spring, the numbers ranged from 419,592 in autumn to 779,360 birds in winter (App. XIX). Numbers increased throughout the study period in all seasons except spring.

Moult

During the moulting period in late summer,

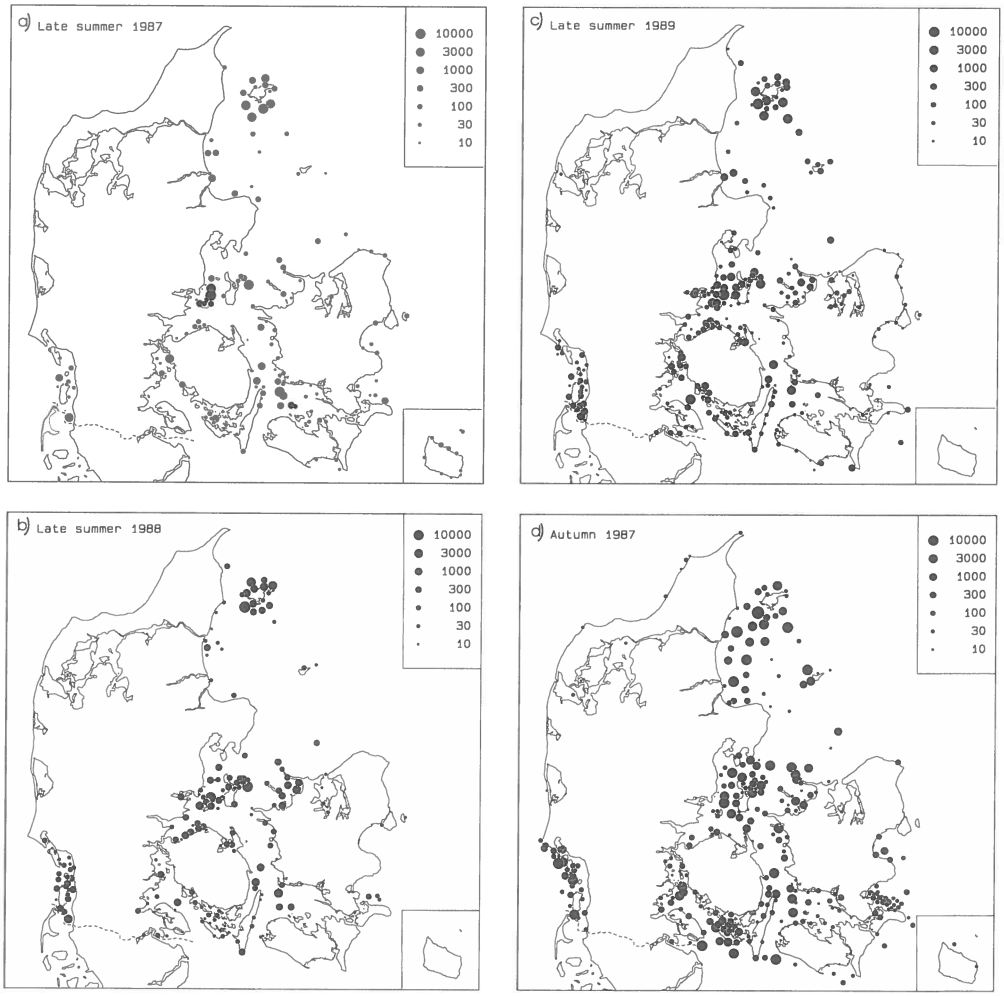

Fig. 31. Distribution and numbers of Eider in Danish waters during late summer 1987 (a), 1988 (b), 1989 (c), autumn 1987 (d), 1988 (e), winter 1987 (f), 1988 (g), 1989 (h) and spring 1988 (i), 1989 (j), based on results obtained from aerial surveys.

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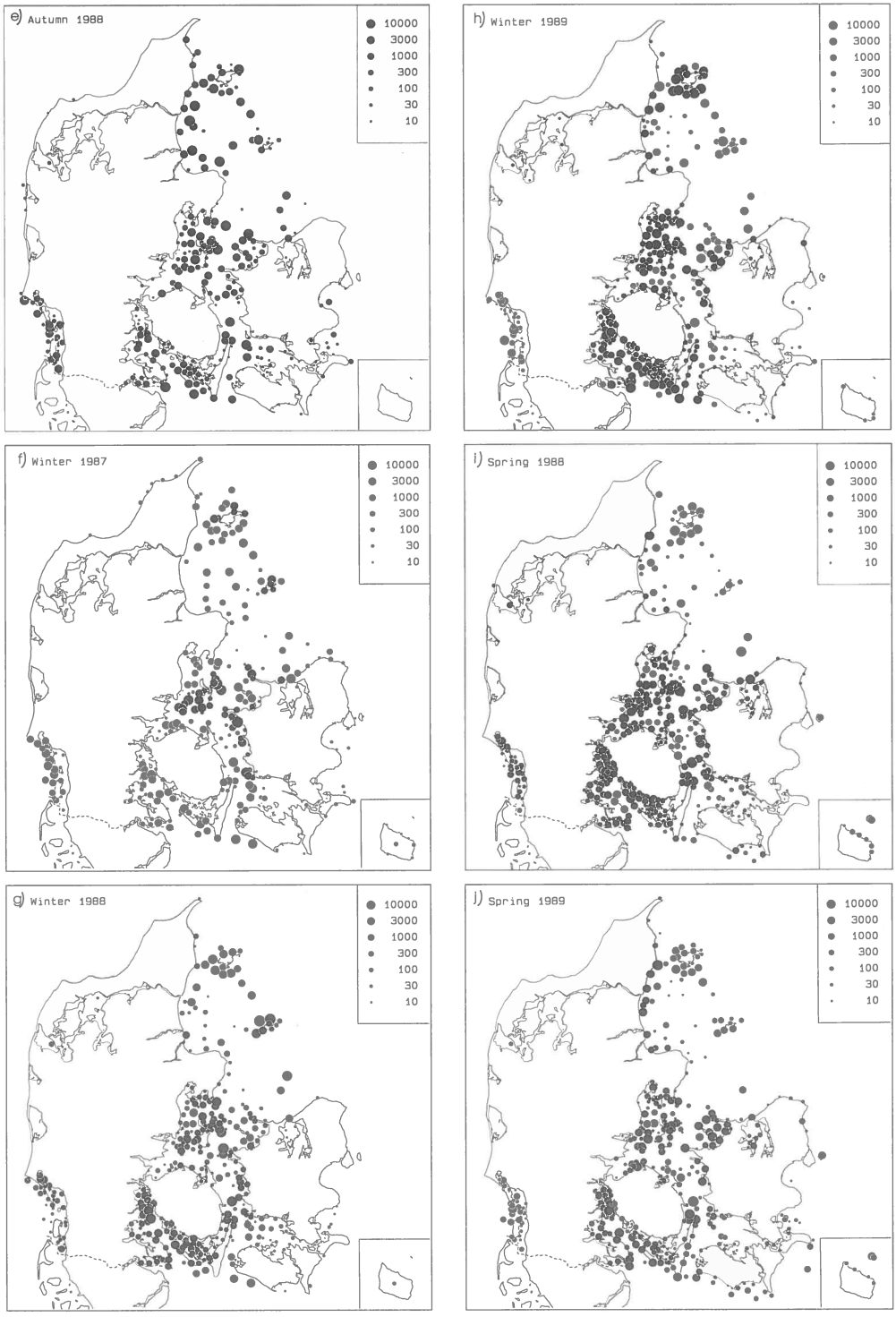
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the behaviour of the birds did not differ from that in the other seasons. The eclipse plumage being less conspicuous than the breeding plumage might have led to a minor underestimation of the numbers in late summer. The large majority of birds was recorded in Kattegat (sections E, F and S) where the numbers amounted to more than 100,000 birds in 1989. Numbers exceeding 5,000 birds were additionally recorded in the Wadden Sea (A), Lillebælt (J) and Storebælt (N). Most birds were recorded on shoals often connected with small sandy islands or sandy beaches, e.g. at Læsø (Ec) and Svanegrund (Fb).

Geographical distribution

In all seasons, the great majority of birds was recorded in the Wadden Sea (A) and the central parts of the Danish waters (E, F, J, K, N and S) (Fig. 31).

In autumn as well as in winter (Fig. 31d-h), most birds were recorded in northern Kattegat (E), while in spring (Fig. 31i, j) the highest numbers were recorded in the southern parts of Kattegat (F and S).

Large numbers of birds were also recorded in Lillebælt (J) and Storebælt (N) in winter and spring.

Numbers in geographical sections

In the Wadden Sea (A) and northern Kattegat (E), the relative numbers decreased from autumn to spring, in southwestern Kattegat (F) numbers were relatively stable in that period, while in sections J, K, N and S, numbers increased from autumn to spring (see also Noer 1991).

Up to five Eiders were twice counted at inland sites covered from the ground.

Internationally important numbers of >20,000 birds (Rose & Scott 1994) were recorded in 21 areas (Fig. 32).

Dispersion

The species showed an increasing dispersion from late summer to spring (App. XIX).

General comments

In spring, especially in 1989, the survey was performed so late that a considerable proportion of the birds had already left the wintering grounds (Dybbro 1978), and therefore, the spring totals are not believed to reflect the total spring population.

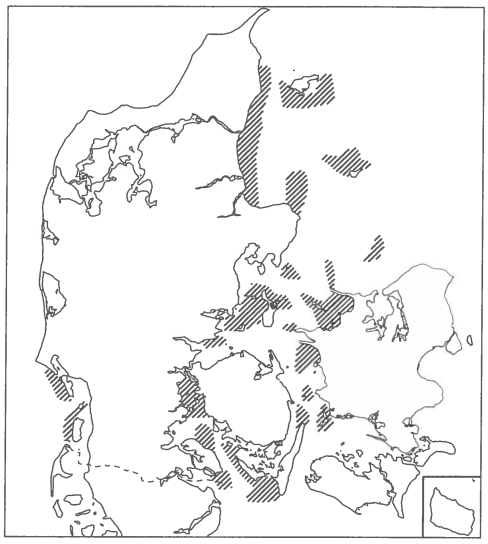

Fig. 32. Twentyone Danish water areas of International importance for Eider(hatched) in 1987-1989.

The increase in numbers recorded probably not only reflects an increase in numbers in Danish waters, but also, to a lower extent, the growing experience in surveying the offshore waters.

Up to 26% of the winter population in the Western Palearctic estimated at 3 million birds by Rose & Scott (1994) were recorded in the Danish waters during the 1987-1989 study. This represents 39% of the Baltic Sea-North Sea population.

Seasonal and geographical variation

The average total in winter was about 140,000 birds more than in autumn indicating that a considerable migration took place after the autumn survey in the middle of November and before the winter survey in January. A late autumn migration has also been indicated by ringing recoveries by Noer (1991).

The autumn peak in numbers in the Wadden Sea recorded during the 1987-1989

study does not correspond well with those of other studies (Swennen et al. 1989, Laursen et al. in press), in which maximum numbers were recorded in winter. However, the numbers recorded in November 1987 were about three times as large as the average for the month (Laursen et al. in press). It is unknown whether this was merely a coincidence, or whether it was correlated to a late occurrence of Eiders in the adjacent German Wadden Sea where numbers peak in October (Nehls 1991, Swennen et al. 1989).

In northern Kattegat, Eiders mainly originate from western Sweden and Norway. The decline in relative numbers from autumn to spring support the suggestion by Noer (1991), that these populations arrive earlier in the winter quarters and depart earlier in spring than other Eider populations in Danish waters. Late winter movements of Eider from the Wadden Sea to the inner Danish waters seem to be the main reason for the decline from winter to spring observed in this area (Swennen at al. 1989).

In southwestern Kattegat, Eiders from the Danish population mix with Eiders from the Kattegat and Baltic Sea populations. Numbers were comparatively stable in the southwestern Kattegat area despite emigration and immigration of Eiders from the populations involved during winter and spring (see Noer 1991).

The increase in relative numbers in sections J, K, N and S is presumably caused by immigration of Eider from both the Kattegat and the Wadden Sea during winter (Noer 1991).

Comparison with the results of surveys in 1968-1973

The results from the incomplete surveys in late summer 1967-1971 are comparable with those of the 1987-1989 study only for the Wadden Sea (A) and Kattegat (E, F, S), but they indicate no significant change in the numbers of moulting birds in Danish Waters. The numbers recorded in autumn 1968 and 1969 were on average 433,409 compared with 487,459 during the 1987-1989 study, with large annual differences during both study periods. The geographical distribution showed large differences between the two studies. Most obviously in northern Kattegat (E), the numbers increased by about 91,000 birds, and the Wadden Sea numbers increased by about 11,000 birds compared with 1968-1969. In southwestern Kattegat (F) numbers decreased by about 42,000 birds and in the sections J, K, N and S numbers decreased from 35,000-40,000 birds to about 30,000.

Given the expansion of the species (Almkvist & Anderson 1972, Stjernberg 1982, Laursen 1989, Franzmann 1989), higher autumn survey totals were expected. However, the survey periods during the 1968-1973 study were somewhat later (median dates 13 November and 26 November compared with 5 November and 7 November during the 1987-1989 study) and a larger part of the birds were probably present in the Danish waters during 1968-1969.

Birds in northern Kattegat (E) are the first to arrive in Danish waters in autumn (Noer 1991); so the observed increase in this area results from increases in the west Swedish population (Franzmann 1989). However, the increase might also partly be due to a redistribution of the birds from section F where a pronounced decrease was recorded in autumn. The improved coverage of section E during the 1987-1989 surveys is believed to be of only minor significance in the increase of this species, as Eider is usually found rather close to the coasts and considered well covered by the 1968-1973 surveys (Joensen 1974).

Due to the difference in survey periods, it seems most likely that the decreases in sections J, K, N and S were caused by a small proportion of the Baltic Sea Eider reaching Danish waters at the time of the surveys.

During the winters of 1969-1973, an average of 455,643 birds was recorded compared with 627,487 birds during the 1987-1989 study. Important differences in the winter distributions between the two study periods were observed.

In the Wadden Sea (A) numbers decreased (by about 24,000 birds) compared with 1969-1973, a decrease that was also noticed by Laursen et al. (in prep) and which was suggested mainly to be caused by poor feeding conditions due to heavy exploitation of Blue Mussel *Mytilus edulis* in this area.

In all other sections, numbers were stable (sections F and N) or increasing compared with earlier surveys. In northern Kattegat (E), an increase of about 97,000 birds were recorded, and in sections J, K and S the increases included 16,000-25,000 birds.

From the results of the winter surveys in north-western Europe 1967-1973, the total Eider population was estimated at 2 million birds by Atkinson-Willes (1976), and this estimate was increased to 3 million on the basis of recent surveys (Laursen 1989). If the results of the latest winter survey of 1989 (779,360 birds) are compared with the 1969-1973 surveys, the increase is about 60% or close to the estimated increase (50%) in the northwest European winter population (Laursen 1989).

Steller's Eider *Polysticta stelleri*

All of the 13 observed individuals were recorded during the severe winter of 1987; 12 were registered in one flock at Ertholmene (T) and one at Bornholm (T).

The flock at Ertholmene was the largest ever recorded in Danish waters. It occurred in a period of great expansion in winter in the eastern Baltic Sea (Kuresoo 1992, Petraitis 1992). The species was not recorded during the 1968-1973 surveys.

Long-tailed Duck *Clangula hyemalis*

The species occurred in aggregations scattered over large offshore areas often very far from the coasts. Since there was no apparent preference for shoals and reefs, the results were based on transect data and to a small degree on data from countrywide aerial surveys.

Total numbers

All regions where Long-tailed Duck occurred were covered by transect surveys from ship on three occasions and the total numbers of birds in Danish waters were estimated at: 425,000 birds in the severe winter of 1987, 165,000 in the mild winter of 1988 and 265,000 in late spring 1988 (App. XX).

During countrywide surveys, numbers varied from 277 birds in autumn to 19,208 birds in spring. Long-tailed Duck was not recorded in late summer (App. XXI).

Geographical distribution

The majority of birds were recorded in the Baltic Sea, especially in Femer Bælt and on Rønne Banke. In Kattegat, comparatively small numbers of birds were recorded, while in the North Sea, the species was only recorded occasionally (Fig. 33).

Numbers in geographical sections

The only area that was satisfactorily covered by aerial transects in autumn, winter and spring was Rønne Banke. In late autumn 1988, the estimated numbers were 27,000 birds, in winter 1989 77,000 birds and in spring 1989 86,000 birds. During the winter of 1989, Rønne Banke was covered from both ship and aircraft leading to similar estimates (76,000 birds from ship and 77,000 birds from aircraft).

During the severe winter of 1987 and the

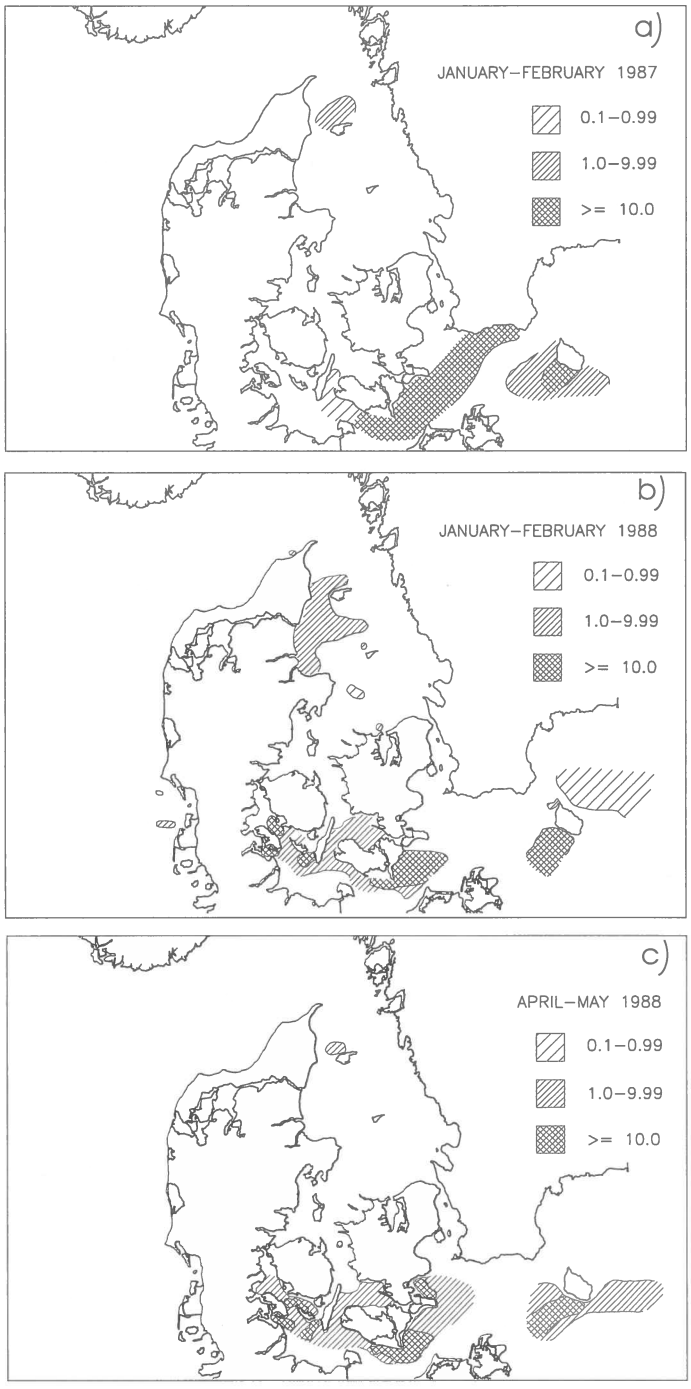

Fig. 33. Distribution and density of Long-tailed Duck in Danish waters during winter 1987 (a), 1988 (b) and spring 1988 (c), based on results obtained from ship surveys.

subsequent spring, numbers recorded from ship transects were similar in the only area in the Baltic Sea, i.e. Femer Bælt, that was surveyed. During surveys in the mild winters, numbers in the Baltic Sea areas increased from winter to spring. In 1988, the estimated numbers recorded from ship transects increased from 130,000 to 228,000 birds. On Rønne Banke, the only Baltic Sea area surveyed in winter and spring in both years, the estimated increases were the same (from 50,000 to 59,000 birds and from 77,000 to 86,000 birds) from winter to spring.

Northern Kattegat was covered from ship in autumn and winter; the numbers estimated varied between 4,000 and 30,000 birds in autumn and 3,000 and 12,000 birds in winter.

During countrywide aerial surveys, the numbers increased from an average of 425 birds in autumn to 3,640 birds in winter and 11,628 birds in spring. Long-tailed Duck was not recorded from ground covered inland sites.

Internationally important numbers of >20,000 birds (Rose & Scott 1994) were estimated on Rønne Banke, in Femer Bælt, Kieler Bay, Lillebælt and northern Kattegat.

Dispersion

Even though the birds were scattered over large offshore areas, the vast majority of Long-tailed Duck was recorded in a few rather small areas. The distribution, thus, resembled that of Razorbill and Guillemot in the 1987-1989 study.

General comments

Due to the offshore distribution, the diving behaviour at the approach of an aircraft and optical problems in detecting the birds, the species was very difficult to survey from aircraft, and the majority of results derives from transect surveys from ship.

The results from the countrywide aerial surveys indicated that the Long-tailed Duck appeared relatively late (i.e. November) in Danish waters, and this was the most probable explanation for the large difference in numbers in Kattegat in autumn. The survey in autumn 1987 was performed in October whereas that of 1988 was performed in November.

Up to 21% of the winter population in northwestern Europe, roughly estimated at 2 million birds by Rose & Scott (1994), was estimated in Danish waters during this study.

Seasonal and geographical variation

The results of the countrywide surveys indicated increasing populations in the Baltic Sea from autumn to spring. The results from the transect surveys showed the same tendency from winter to spring, although, unfortunately, no subsequent surveys in autumn and winter were conducted in the Baltic Sea. In the severe winter, birds were concentrated in the western parts of the Baltic Sea probably due to decreasing feeding opportunities in the central and eastern parts of the Baltic Sea caused by extensive ice. The results indicated that these concentrations were maintained during spring until spring migration in May (Bergman & Donner 1964). In the mild winters, the maximum numbers appeared much later (i.e. in spring) without reaching the same level as in the severe winter.

Comparison with the results of surveys in 1968-1973

The 1968-1973 surveys were all countrywide aerial surveys and as such comparable only to the similar surveys performed during the 1987-1989 study.

During the countrywide surveys of November 1968 and 1969, 2,078 and 1,820 birds, respectively, were recorded. This is four to five times as many as during the 1987-1989 surveys, even though the coverage of the offshore waters was much better during 1987-1989. The results of the 1987-1989 study indicated a later appearance of the species in autumn in Danish waters. Similar results have also been found in other seaduck species.

The numbers in midwinters 1969-1973

ranged from 9,191 birds in the severe winter of 1970 to 2,903 birds in the normal winter of 1969. The average of 5,648 birds was close to the numbers in the severe winter of 1987 but much higher than in the subsequent mild winters.

The results of both studies covered only a minor part of the birds wintering in Danish waters due to their dispersed distribution in offshore waters. However, the small numbers during the 1987-1989 surveys, with a much better coverage than during 1969-1973, may indicate that numbers of Long-tailed Ducks in Danish coastal waters have decreased since 1969-1973.

The lack of transect results from offshore waters during the 1968-1973 surveys does not allow any comparisons with the results obtained by transect surveys during the 1987-1989 study.

Common Scoter *Melanitta nigra*

Due to their occurrence over large areas and their aggregating behaviour leading to the formation of huge flocks, the results of counts of Common Scoter were based on both countrywide aerial surveys and the transect surveys from both ship and aircraft (see Table 2).

A noteworthy part of the birds using the northern Kattegat occurred in a band parallel to the coast at a distance of a few kilometres, forming huge concentrations in several areas. The remainder was scattered in flocks of varying size in offshore areas. These flocks were often huge, e.g. >101,000 birds in a flock observed between Læsø and Anholt on 17 February 1989.

West of the Wadden Sea, the birds mainly occurred in flocks rather close to the islands. This Wadden Sea distribution pattern hampered the calculations of densities and totals from the transect surveys, hence, the results for Common Scoter from this area were mainly based on the countrywide aerial surveys supported by information from ship transects.

Moult

During the late summer moulting period the Common Scoters were more vulnerable to disturbance than during other seasons. The birds reacted by diving at the approach of the aircraft. Judging from a few observations, made under ideal weather conditions, less than 20% of the birds remained on the water surface when the aircraft passed. Thus, the numbers of the species recorded in late summer were severely underestimated. In the late summer nearly all birds were recorded on shoals far from the coast off the Wadden Sea (A) and in Kattegat (E, F and S).

Total numbers

During the late summer moulting season, the total numbers ranged from 32,591 to 123,929 birds. From autumn to spring the numbers recorded from countrywide aerial surveys ranged from 135,605 to 396,319 birds, numbers being very variable in all seasons (App. XXII).

From ship transects, the numbers in Danish waters were estimated at 545,000 birds in autumn 1987, 385,000 birds in winter 1988 and 120,000 birds in late spring 1988 (App. XXIII).

The results obtained from ship transects supplemented by numbers from aerial surveys lead to the following total estimates for the Danish waters: 625,000 birds in autumn 1987, 400,000 birds in winter 1988 and 385,000 birds in spring 1988.

Geographical distribution

During countrywide aerial surveys, the great majority of birds were recorded in four sections (A, E, F and S) in all seasons (Fig. 34). In late summer, autumn and the severe winter of 1987 (Fig. 34a-f) the highest numbers

of birds were recorded west of the Wadden Sea (A), whereas in the mild winters and spring (Fig. 34g-j), the highest numbers were recorded in northern Kattegat (E).

In addition, comparatively large numbers were recorded in southwestern and southeastern Kattegat (F and S) in spring.

During ship transect surveys, the highest densities were recorded in the area west of the Wadden Sea and in northern Kattegat in all seasons (Fig. 35).

Numbers in the geographical sections

West of the Wadden Sea (A), an average decrease was recorded during countrywide surveys from 113,213 birds in autumn to 78,547 birds in winter and 27,481 birds in spring. The opposite trend was observed during countrywide surveys in northern and southeastern Kattegat (E and S). In northern Kattegat (E), an average of 54,036 birds was recorded in autumn, 124,475 birds in winter and 148,090 birds in spring; and in south-

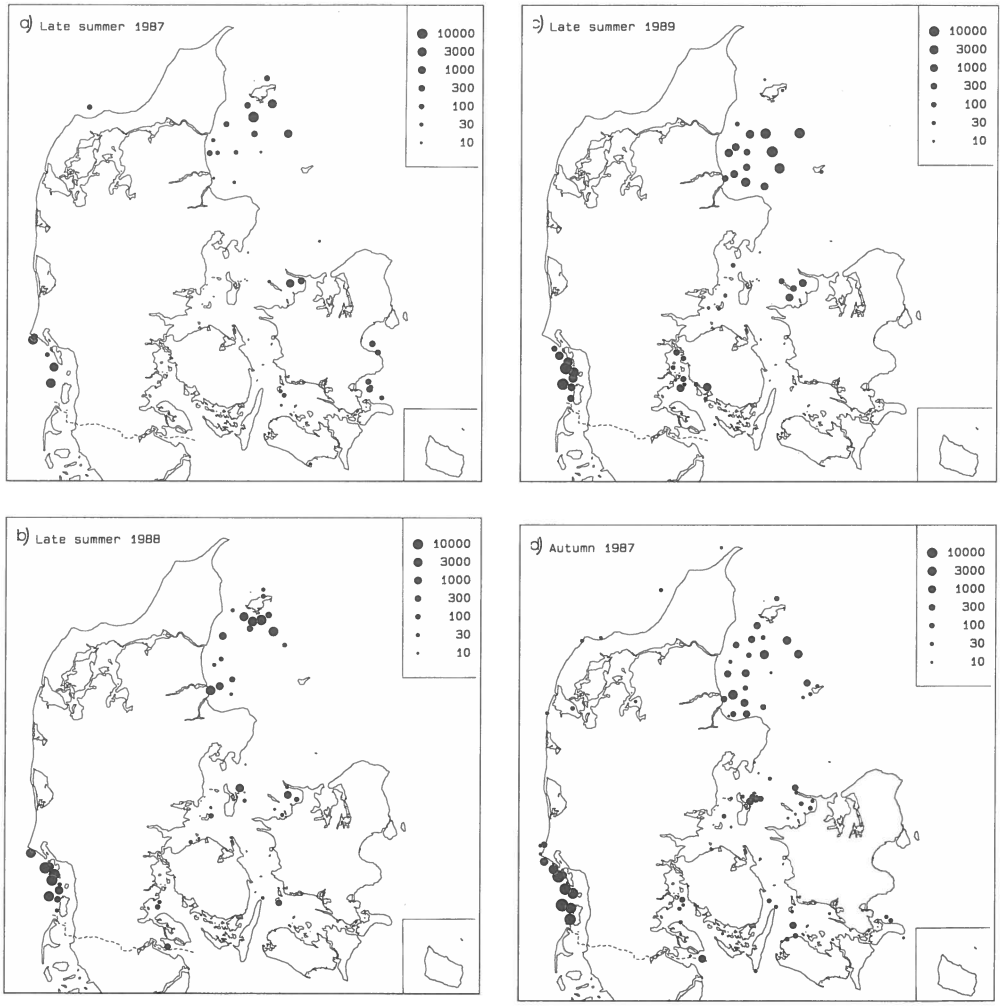

Fig. 34. Distribution and numbers of Common Scoter in Danish waters during late summer 1987 (a), 1988 (b), 1989 (c), autumn 1987 (d), 1988 (e), winter 1987 (f), 1988 (g), 1989 (h) and spring 1988 (i), 1989 (j), based on results obtained from aerial surveys.

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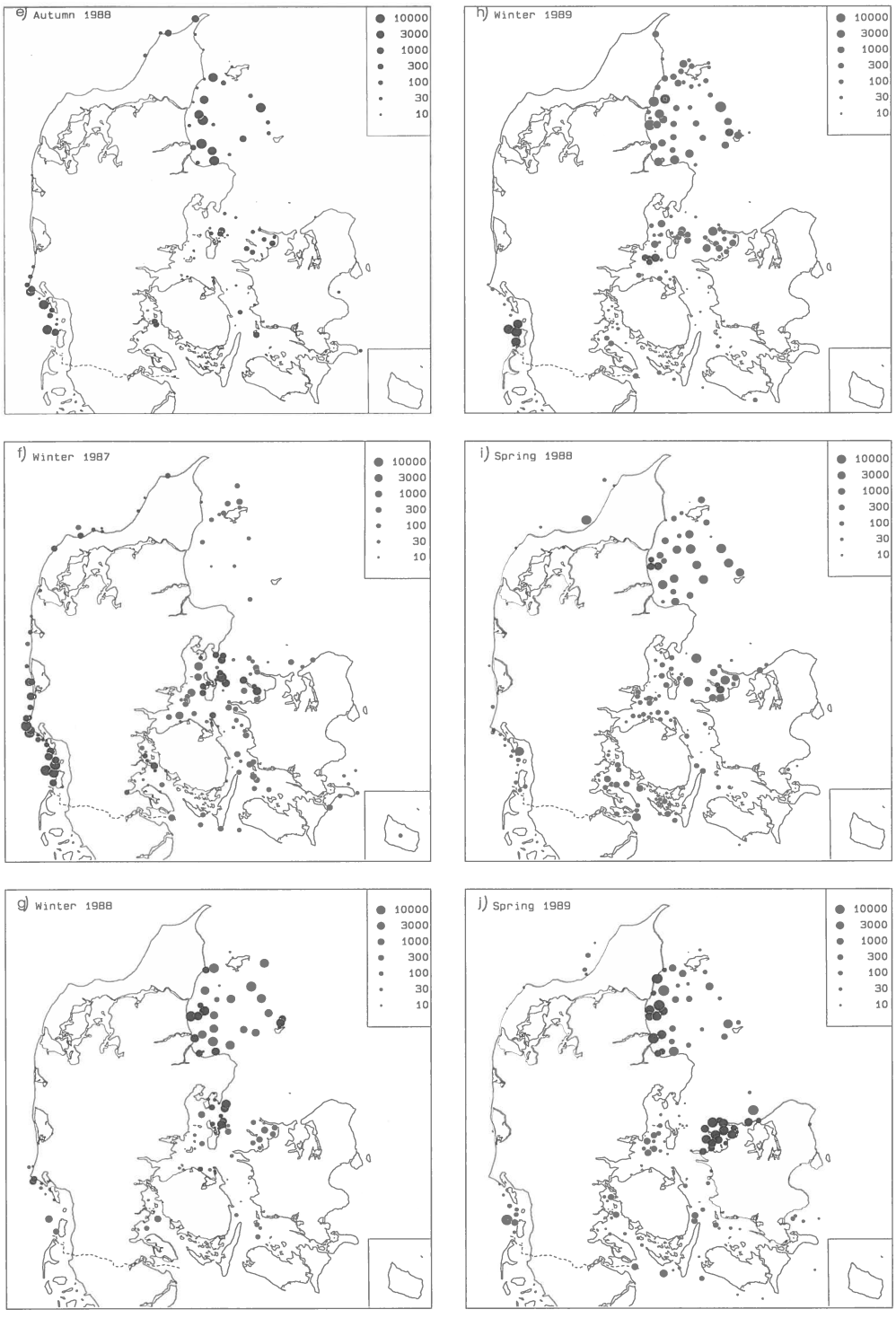
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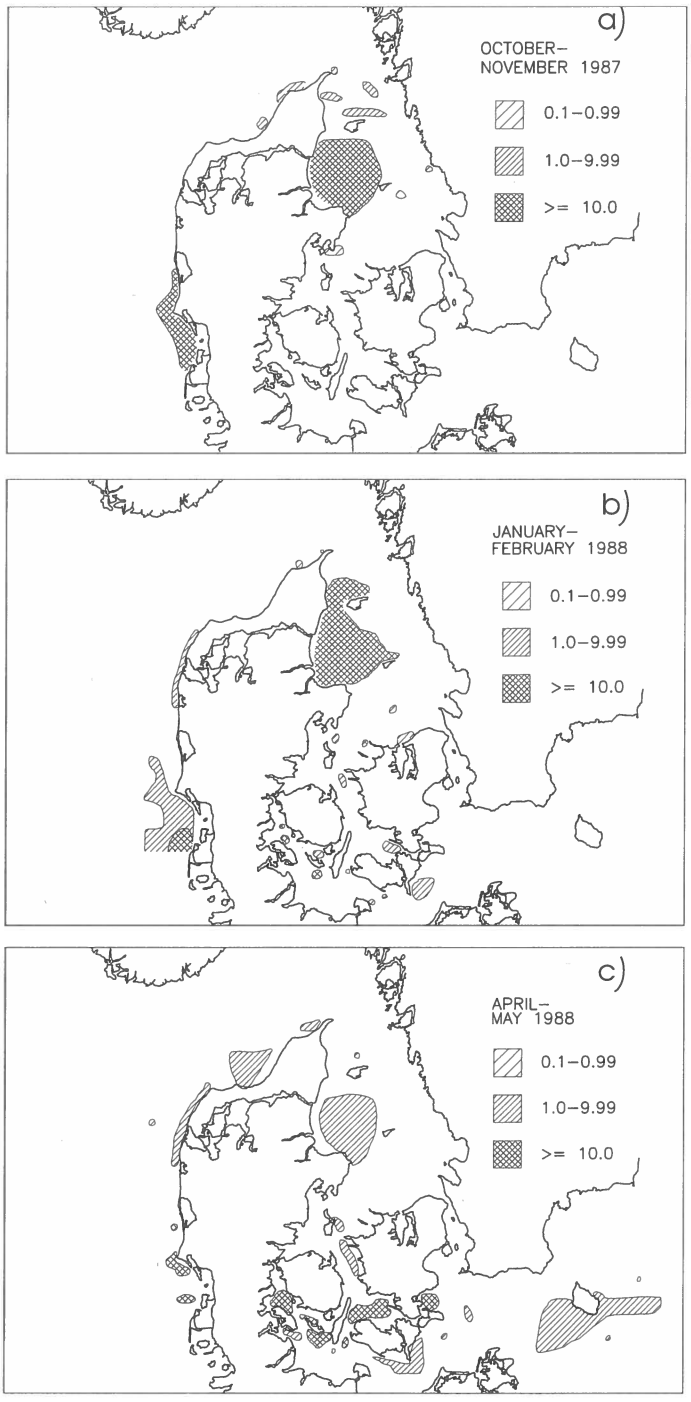

Fig. 35. Distribution and density of Common Scoter in Danish waters during autumn 1987 (a), winter 1988 (b) and spring 1988 (c), based on results obtained from ship surveys.

eastern Kattegat (S) an average of 721 birds was recorded in autumn, 8,550 birds in winter and 69,178 birds in spring.

In northern Kattegat, the numbers estimated from ship transects varied between 337,000 and 420,000 birds, being highest in autumn. Aerial transects were only conducted during autumn and spring when numbers ranged from 156,000-275,000 birds (Table 6).

The inshore Danish waters south of Kattegat were surveyed by ship in winter and spring 1988; rather high numbers of 10,000-20,000 birds were recorded in spring in Lillebælt and Faxe Bugt.

The total estimate based on ship transects of the inner waters (including southern Kattegat) in winter was on average 11,350 birds compared with 57,250 birds in spring. By comparison, 48,313 birds were recorded in the inner waters during countrywide counts from aircraft in winter 1988 and 60,890 birds during spring 1988. Common Scoter was not recorded from ground covered inland sites.

Internationally important numbers of >8,000 birds (Rose & Scott 1994) were recorded in nine areas (Fig. 36).

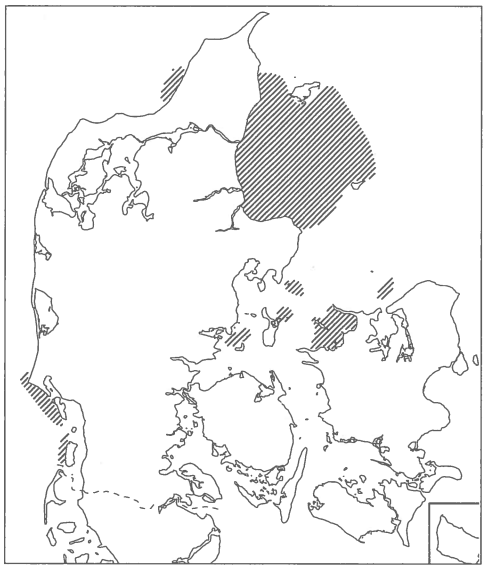

Fig. 36. Nine Danish water areas of International importance for Common Scoter (hatched) in 1987-1989.

Dispersion

Taking the high numbers of this species into account, the birds were relatively concentrated in all seasons (App. XXII).

General comments

Results from the area west of the Wadden Sea were difficult to compare, because the potential area for Common Scoter extends into the German waters and because military controlled areas often restrict aerial surveys. The results indicated that the area west of the Wadden Sea is an important staging area during autumn migration and in winter but is less important as staging area in spring.

Due to the distribution pattern, it is believed that the countrywide surveys and the transects only to some extent have been covering the same birds in northern Kattegat. The countrywide counts provided good coverage of birds close to the coast but poor

Table 6. Numbers of Common Scoter counted and estimated in northern Kattegat from ship and aircraft.

	Survey method				
	SHIP TRANSECT		AERIAL TRANSECTS		AIRCRAFT
Period	Counted	Estimated	Counted	Etimated	Country
October/November 1987	30,066	420,000	2,000	275,000	17,346
January/February 1988	29,575	337,000			151,195
March/May 1988			1,552	245,000	79,254
March/April 1989			1,805	156,000	216,925

coverage of the central parts of the area. The transects were not situated close to the coastline, so birds close to inshore areas were missed. On the other hand, the survey method used covered the birds well in the central parts. The difference in the coverage of the whole area caused problems with the calculation of densities from transect data as well as difficulties when combining and interpreting the results obtained with the two different methods.

The 1988 spring transect survey of Kattegat was conducted in late May at a time when the majority of Common Scoters had left the area.

Up to 78% of the winter population in Europe estimated at 800,000 birds by Rose & Scott (1994) were estimated in Danish waters during the 1987-1989 study.

Seasonal and geographical variations

The area west of the Danish Wadden Sea is one of the most important moult areas known for Common Scoter (Joensen 1973). Variable numbers of birds remain within this area after the moult of wing feathers or move to other winter quarters further south. This may explain the same trend for large numbers in autumn and small numbers in winter and spring from both types of survey, despite large differences in results and difficulties in comparing these directly. In the Wadden Sea, the numbers recorded during spring migration have been highly variable with a maximum of about 177,000 birds in March 1987 (Laursen et al. in press). It seems likely that large numbers of this species only reach Danish waters in some springs before passing into the Baltic Sea. In most years, the passage may have occurred further south, resulting in small spring maxima off the Danish Wadden Sea.

The results from Kattegat indicated that a rather stable number of 300,000-500,000 Common Scoter occurs within this area, based on results from both countrywide and transect surveys from autumn to spring. In the same seasons, 100,000-340,000 birds have actually been recorded during countrywide counts (leaving out the results of autumn 1987 due to insufficient coverage). The numbers of Common Scoters wintering in Kattegat may be much larger, as the estimates during transect surveys were rather conservative. Kattegat is very difficult to cover completely during countrywide counts, since flocks of >100,000 birds have been recorded.

Comparison with the results of surveys in 1968-1973

Numbers and distribution of the Common Scoter seemed to change significantly between years as in former studies (Joensen 1973, Owen et al. 1986). Thus, it remains an open question whether the results reflect the actual situation in late summer and whether it is possible to monitor moulting Common Scoter from the air. The results from the incomplete surveys in the late summers of 1967-1971 were not comparable to the results of this study, due to great differences in the coverage.

The 1968-1973 aerial surveys were performed in single-engined aircraft and, for this reason, the offshore waters were not as well covered as during the 1987-1989 surveys. During November 1968 and 1969, 113,975 and 88,229 Common Scoter, respectively, were recorded. In the winters 1969-1973, numbers varied from 76,045 to 139,318 birds.

The great similarity in the results obtained in 1987-1989 with the 1968-1973 autumn and midwinter surveys indicated that the winter distribution had been reached by the time the autumn surveys were performed. The results of both sets of survey show that normally in winter, half of the birds are in Kattegat and less than a third is west of the Wadden Sea. The 1987-1989 autumn surveys differ noticeably from this, with two thirds of Common Scoter recorded west of the Wadden Sea and only about one third in Kattegat. Even though the 1968-1973 surveys were conducted somewhat later (median dates 13 November and 26 November compared with 5 November and 7 November during 1987-1989), this could

indicate that the 1987-1989 autumn surveys were performed whilst the autumn migration was still going on. It could also be that the autumn migration of Common Scoter occurs later in autumn in 1987-1989 years compared with the 1970s.

Due to the increased coverage of the offshore waters during 1987-1989, a comparison of the numbers with the results from 1968-1973 is not possible. However, it should be noted that the numbers have increased very little in the inner Danish waters, which is probably the area with most overlapping coverages during the two periods.

Velvet Scoter *Melanitta fusca*

The results of counts of Velvet Scoter in northern Kattegat were primarily based on transect estimates, whereas the results from southern Kattegat and the inner Danish waters were based on both transect estimates and countrywide aerial surveys (see Table 2).

Moult

During the moulting period the species reacted by diving at the approach of an aircraft, though it dived much less frequently than Common Scoter.

The majority of the birds was recorded in late summer in northern Kattegat (E) in 1987 and 1989, whereas in 1988, equal numbers were recorded in northern Kattegat and Storebælt (N). Comparatively large numbers were additionally recorded in southwestern Kattegat (S). The birds were all recorded on shoals far from the coasts like the Common Scoter.

Total numbers

During transect surveys, total estimates amounted to 100,000 birds in autumn 1987, 125,000 birds in winter 1988 and 76,000 birds in spring 1988, although the latter number should be interpreted with caution (see later, App. XXIV).

Up to 7,606 birds were recorded from countrywide surveys in late summer, when the birds were undergoing wing moult. In all other seasons, total numbers varied from 1,676 birds in autumn to 40,885 birds in the severe winter of 1987 (App. XXV).

The results from the countrywide aerial surveys showed increasing numbers in all seasons except winter; numbers were much higher in the severe winter of 1987 than in subsequent mild winters.

Results from ship transects supplemented by numbers from aerial surveys generated the best obtainable estimates for the Danish waters: 100,000 birds in autumn 1987, 130,000 birds in winter 1988 and 90,000 birds in spring 1988.

Geographical distribution

In all seasons, the majority of the birds were recorded in Kattegat based on countrywide surveys (sections E, F and S) (Fig. 37).

In late summer and autumn (Fig. 37a-e), most birds were observed in northern Kattegat (E), whereas in winter and spring (Fig. 37f-j) the highest numbers were recorded in Sejerøbugten (S).

In the severe winter, the distribution differed from that of the mild winters as 20% of the birds were recorded in southwestern Kattegat (F) compared with 3% in mild winters, and 14% in Storebælt (N) compared with 1% in mild winters. In contrast, only 0.3% of the birds were recorded in northern Kattegat compared with an average of 39% in the mild winters.

The majority of birds were recorded in northern Kattegat in autumn and winter during transect surveys (Fig. 38a, b). In spring, rather large concentrations were recorded in Kieler Bay and Smålandshavet (Fig. 38c).

Numbers in geographical sections

In northern Kattegat, three autumn, one winter and three spring transect surveys were conducted.

In autumn, the estimated numbers ranged from 22,000 to 100,000 birds. A ship and an aircraft survey were performed in the same season giving estimates of 100,000 and 24,000 birds respectively. In winter, a total of 109,000 birds was estimated. In spring, the estimated numbers ranged from 27,000 to 76,000 birds.

Off the Wadden Sea (A), numbers of Velvet Scoter during countrywide surveys were highest in autumn, when the countrywide totals were lowest. In northern Kattegat (E), the numbers recorded were relatively stable through the year being highest in the mild winters. In southern Kattegat (F and S), numbers were highest in spring.

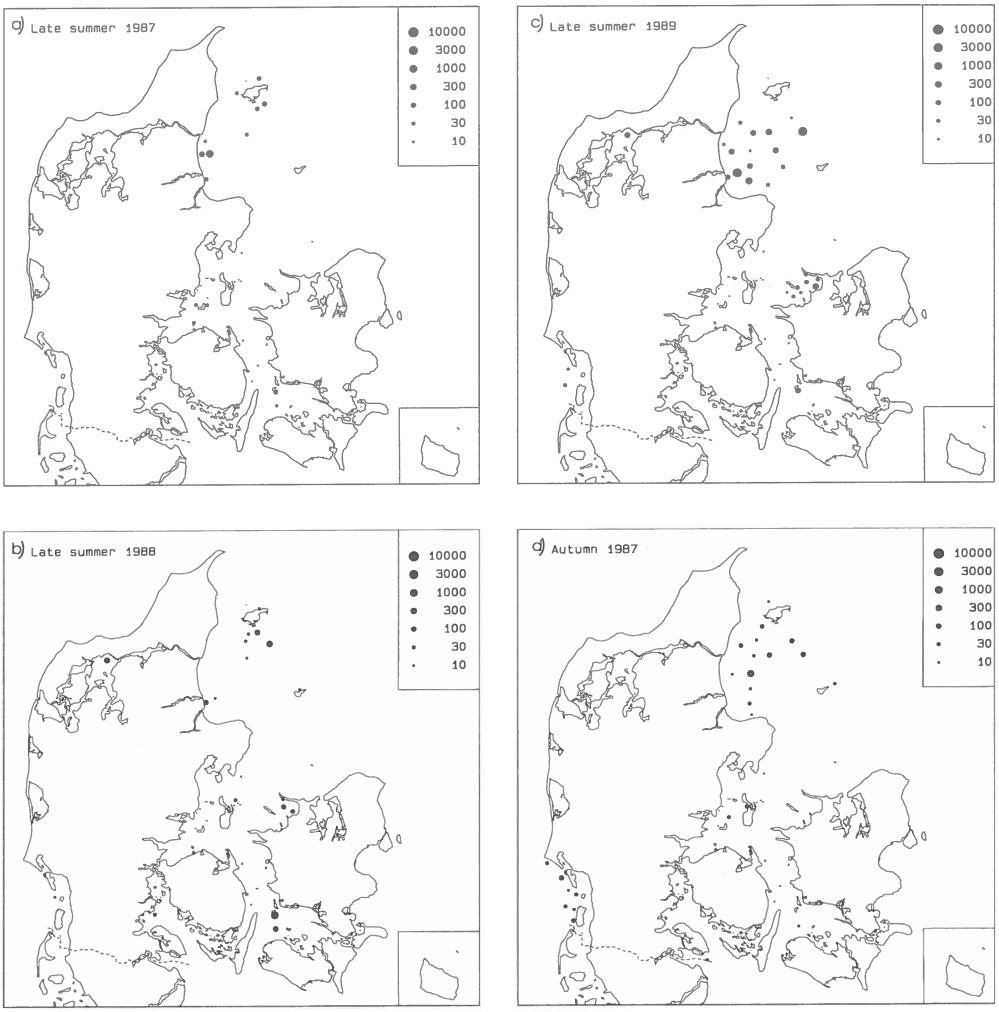

Fig. 37. Distribution and numbers of Velvet Scoter in Danish waters during late summer 1987 (a), 1988 (b), 1989 (c), autumn 1987 (d), 1988 (e), winter 1987 (f), 1988 (g), 1989 (h) and spring 1988 (i), 1989(j), based on results obtained from aerial surveys.

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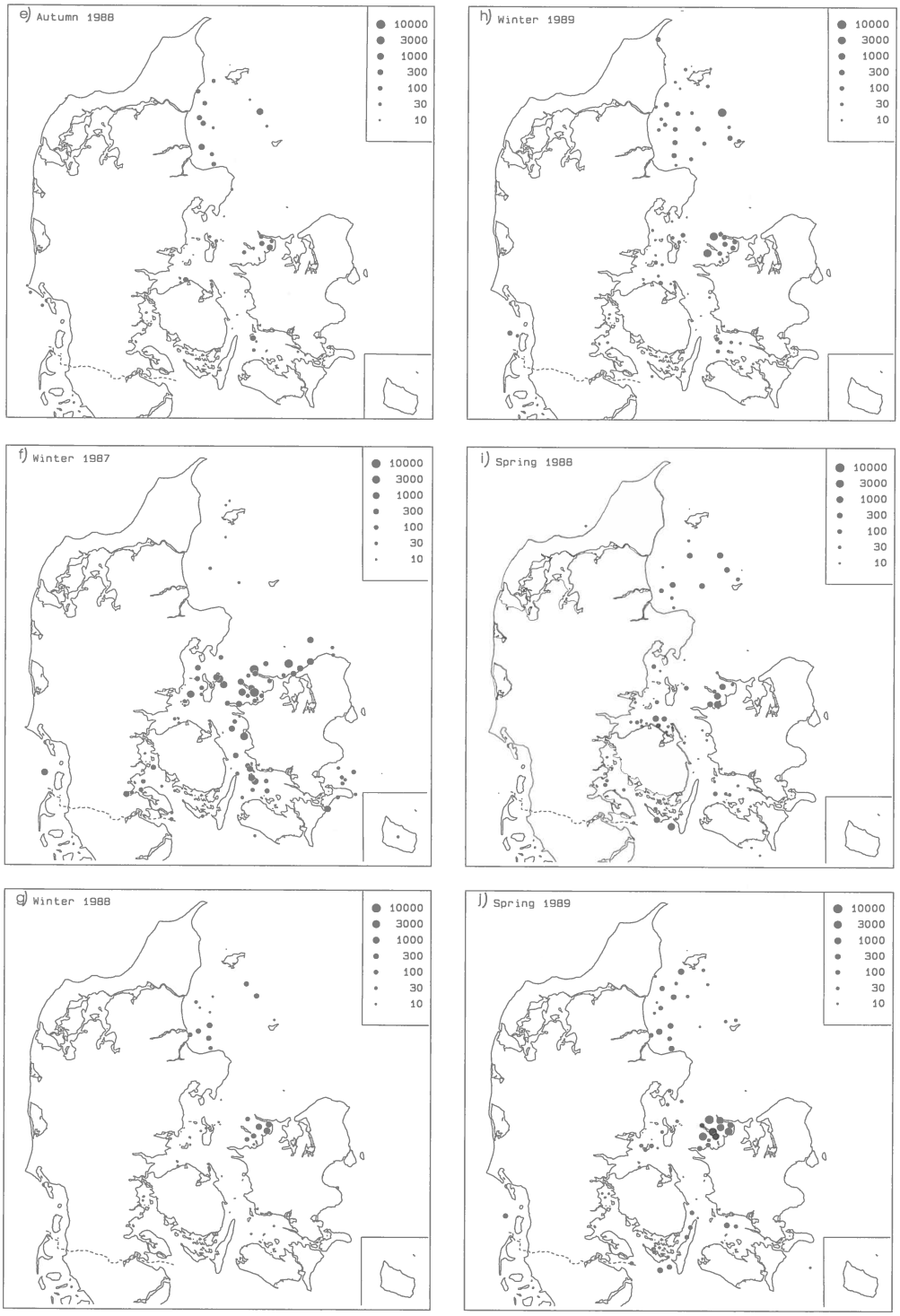
e) Autumn 1988
h) Winter 1989
f) Winter 1987
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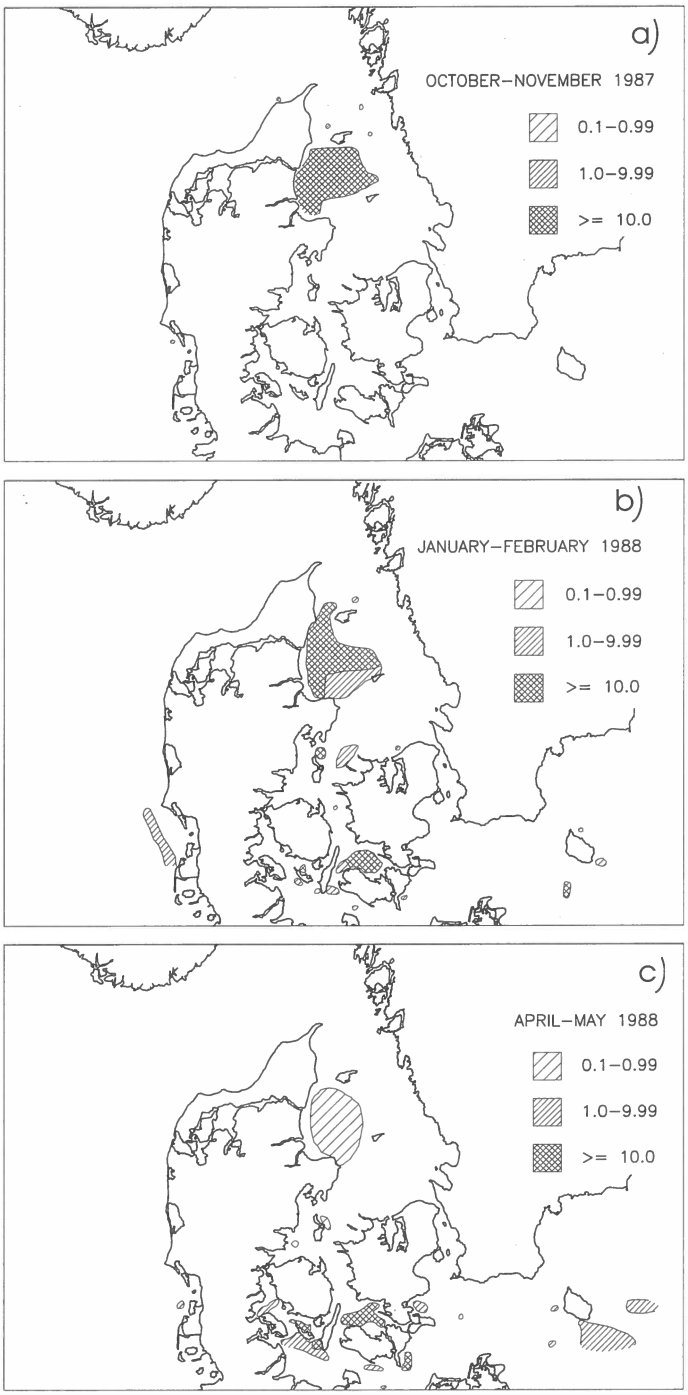


Fig. 38. Distribution and density of Velvet Scoter in Danish waters during autumn 1987 (a), winter 1988 (b) and spring 1988 (c), based on results obtained from ship surveys.

In Sydfynske Øhav (K), numbers increased from no birds in autumn to an average of 1,019 in spring and in southeastern Kattegat (S) numbers increased from an average of 523 birds in autumn to 9,469 birds in spring. Velvet Scoter was not recorded from ground covered inland sites.

In Danish waters, internationally important numbers of >2,500 birds (Rose & Scott 1994) were estimated in four areas during countrywide counts (Fig. 39). During spring 1988, the estimated total in the southern parts of the Danish waters exceeded 50,000 birds.

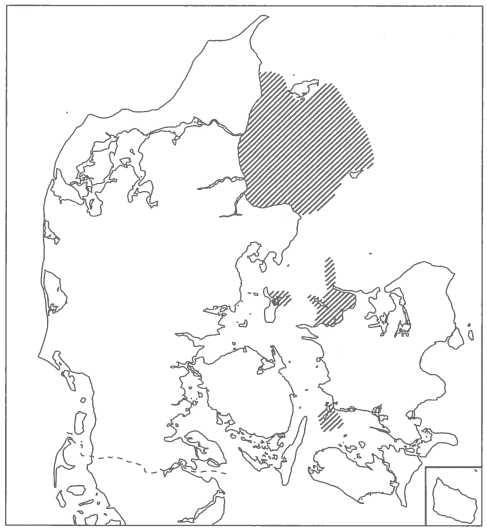


Fig. 39. Four Danish water areas of International importance for Velvet Scoter (hatched) in 1987-1989.

Dispersion

In all seasons, birds were confined to a small number of offshore count areas, but widely distributed within these (App. XXIV).

General comments

Velvet Scoter tended to stay on the water while Common Scoter took to the wing at the approach of a ship or an aircraft. During the first years of aerial surveys, this behaviour was unknown, so a large number of Velvet Scoter has been recorded as Common Scoter. Also, during later surveys, birds identified at distances of >300 metres from the aircraft were probably to some extent misidentified (Pihl & Frikke 1992).

The transect surveys in spring 1988 in Kattegat were conducted in May when most of the birds probably had left the area for the breeding grounds.

The underestimation of numbers during countrywide aerial surveys was underlined during the severe winter of 1987. In that winter, extensive ice cover in Kattegat forced the birds to aggregate in small ice-free areas, so, flocks were much larger, and the numbers recorded were five times the average for mild winters. However, an influx into Danish waters from the eastern Baltic Sea due to extensive ice cover might also have contributed.

The transects in Kattegat in the spring of 1988 were performed in May, too late to reflect the numbers in the area prior to the spring migration. Countrywide surveys and transect surveys in all other areas indicated increasing numbers from winter to spring, thus, a survey performed in spring before the migration could be expected to produce estimates at least at the same level as in winter.

Compared with the winter population of the Western Palearctic estimated at 250,000 birds by Rose & Scott (1994), up to 52% was estimated in Danish waters during the 1987-1989 study.

Seasonal and geographical variations

The numbers recorded during late summer and autumn varied little (on average 3,773 and 3,016 birds respectively), perhaps indicating that very little migration took place between late August and early November. Birds occurring before mid November probably moulted in Danish waters.

The late south and westward migration of the species combined with the increasing numbers towards spring probably reflects a slow movement through the Baltic Sea due to increasing ice cover in the northern parts of this area.

In autumn and winter, Velvet Scoter was

mainly occurring in northern Kattegat where ship surveys indicated a wintering population of more than 100,000 birds. Due to the late performance of transect surveys in spring, numbers were probably underestimated. In spring, birds also occurred in large numbers in southern Danish waters (App. XXV); considering this fact, the total number of Velvet Scoter in Danish waters in spring probably reached 130,000 birds.

Comparison with the results of surveys in 1968-1973

Numbers and distribution of the Velvet Scoter changed significantly in the late summer during the 1987-1989 study.

The results of the surveys in late summer 1968-1973 were incomparable with those of the 1987-1989 study, as a whole, due to great differences in the coverage. The inner part of Limfjorden (C), however, constituted an isolated moulting area well covered during both studies, and in this area, the numbers decreased from more than 10,000 birds to a few hundreds.

Despite the less extensive coverage of offshore waters, numbers were much higher during the 1968-1973 autumn surveys than during the 1987-1989 surveys. In the autumn of 1968 and 1969, 37,538 birds and 19,426 birds, respectively, were recorded. During the 1968-1973 surveys, greater numbers of moulting Velvet Scoter were recorded in Danish waters (Joensen 1974, Laursen et. al. in press), and it seems likely that the reduced numbers of birds recorded in autumn were a result of this.

The numbers recorded in the winters during 1968-1973 varied from 5,525 birds to 21,520, being highest in a normal winter. On average, 14,639 birds were recorded, almost twice the total of mild winters during the present study. If the severe winter of 1987 was included, the average of the present study was the highest.

Given the much better coverage of Kattegat (E) during the 1987-1989 surveys, it seems most likely that numbers had decreased in the period between the two surveys.

Joensen (1974) stated: "The species is generally found closer to the coast and on shallower water than *Melanitta nigra*.", and also: "This species is very gregarious, and in countrywide surveys, three-quarters of the birds were in a few flocks each of more than one thousand, and occasionally more than ten thousand." This is completely different from the dispersed occurrence that has been observed during the 1987-1989 study.

Goldeneye *Bucephala clangula*

Total numbers

In late summer, moulting numbers were comparatively stable varying between 1,425 and 1,996 birds. From autumn to spring, numbers varied from 13,005 birds in spring to 55,394 birds in winter (App. XXVI).

The totals were rather stable in winter with the spring and autumn surveys in 1988 at the same level as the midwinter counts.

Moult

In late summer the birds were recorded exclusively in sheltered inlets and coastal lakes. Numbers exceeding 100 individuals were found only in Hjarbæk Fjord (subsection Cf), Bankel Sø (Ja) and Isefjord (Sa).

Geographical distribution

In late summer, the great majority of birds assembled in moulting flocks in Hjarbæk Fjord (Cf) and Bankel Sø (Ja). Most birds in 1987-1989 were in Limfjorden (C) during autumn to spring (Fig. 40). In winter, large numbers were also recorded in southwestern Kattegat (F) as well as in the sections south-

west of Fyn and in spring in northern and southwestern Kattegat (E and F).

In the severe winter, a smaller proportion of the birds was recorded in closed inlets such as Limfjorden (C).

Numbers in geographical sections

Numbers in Limfjorden were higher in autumn than in spring (on average 19,753 birds compared with 8,676 birds in spring). In all other sections, numbers were highest in spring (total on average 21,498 birds compared with 12,813 birds in autumn).

Between 27 and 1,140 Goldeneye were recorded at inland sites at midwinter and up to 622 birds in the other seasons. The proportion of Goldeneye at coastal and inland freshwater sites in winter 1989 was 5%.

Internationally important numbers of >3,000 birds (Rose & Scott 1994) were regularly recorded at Lovns Bredning (Cf) except in late summer. Single records of internationally important numbers were made in autumn in Kås Bredning (Cb), Skive Fjord (Cf) and Horsens Fjord (Fb), in the severe winter in Fåborg Bugt (Ka) and in the mild winters around Stryhnø (Ka).

Dispersion

In late summer, birds were very concentrated in sheltered inlets, although the birds were very dispersed in all other seasons, especially in winter, in all types of coastal areas except the west coast of Jylland (App. XXVI).

General comments

The low numbers in autumn 1987 and spring 1989 were probably caused by the timing of the surveys prior to the arrival and after the departure of the majority of the birds.

Up to 19% of the winter population in northwestern Europe estimated at 300,000 birds by Rose & Scott (1994) was recorded during the 1987-1989 study.

Seasonal and geographical variation

The high autumn numbers recorded in Limfjorden compared with winter and spring and the fact that few birds were seen on migration at Blåvand (Petersen 1974) or staging in the Wadden Sea (Laursen et al., in press) confirmed the autumn migration pattern from Scandinavia to the United Kingdom including a staging area in Limfjorden as shown by Nilsson (1969b). Numbers in Kattegat (E) peaking in spring perhaps indicate that birds stage in this area in spring on their way from Great Britain to the breeding grounds of Scandinavia.

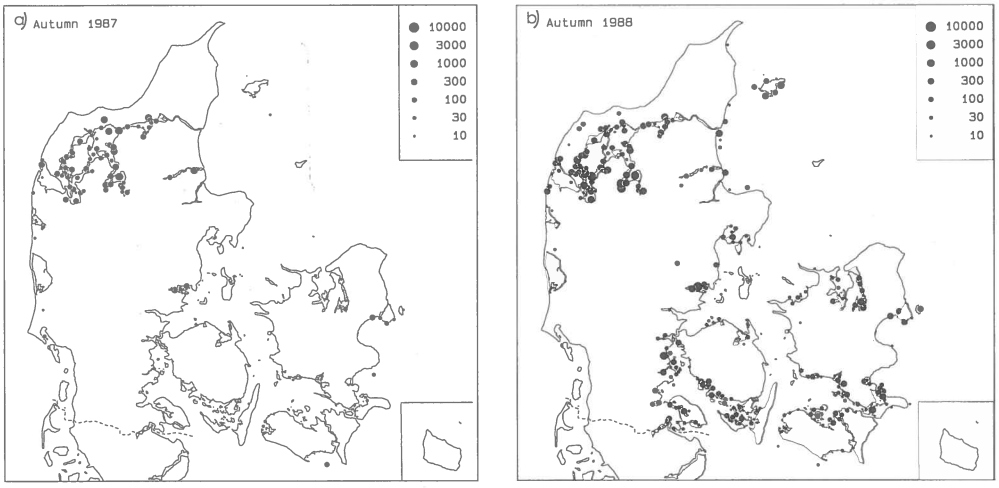
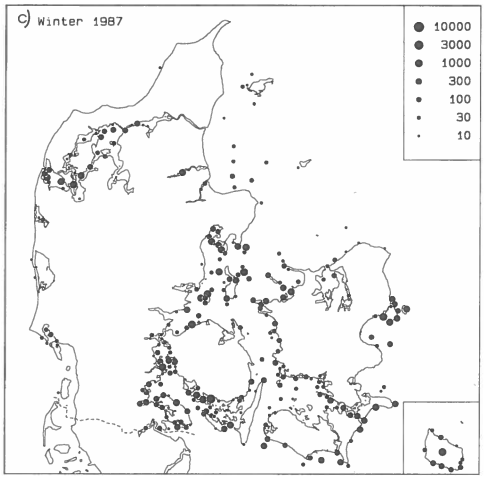
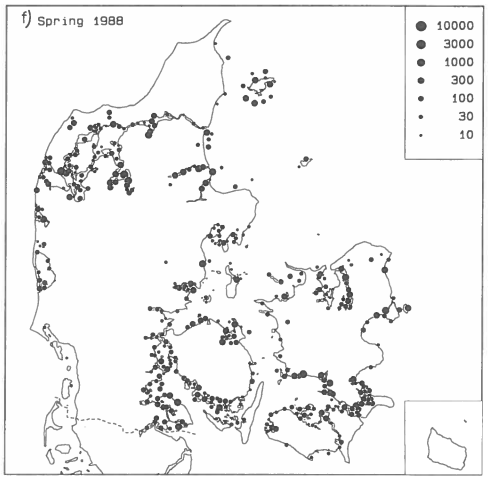
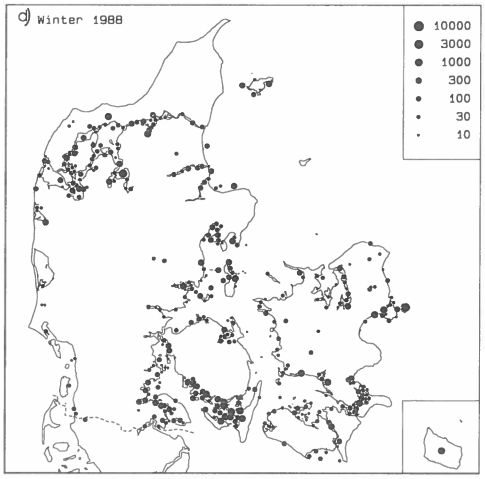
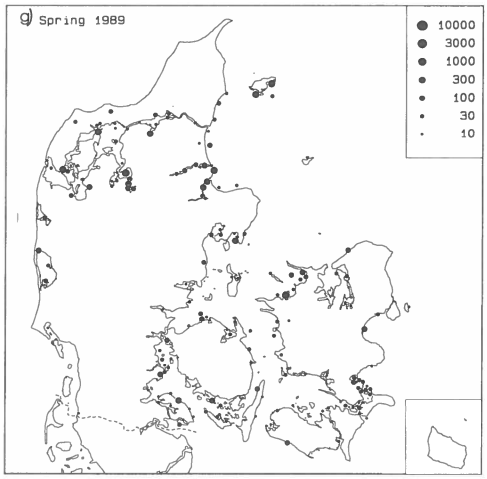


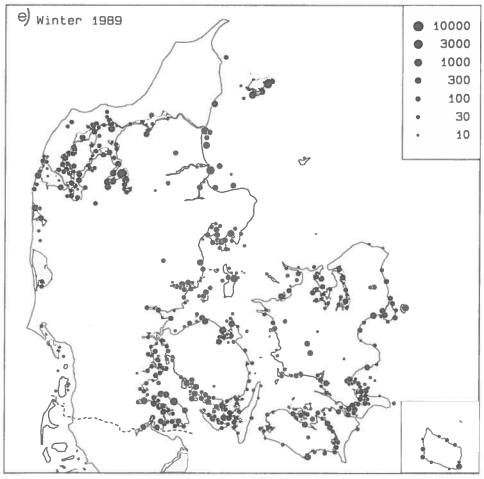
Fig. 40. Distribution and numbers of Goldeneye in Danish waters during autumn 1987 (a), 1988 (b), winter 1987 (c), 1988 (d), 1989 (e) and spring 1988 (f), 1989 (g), based on results obtained from aerial surveys. ... continued next page











The high numbers recorded during the late performed winter survey in 1989 indicated that spring migration had commenced in February. This was at least a month earlier than spring migration stated by Dybbro (1978), and was most likely due to the mild winter climate in 1989.

Comparison with the results of surveys in 1968-1973

In 1972, a particular study of the species in the moulting period reported 12,000-14,000 moulting birds in Danish waters (Jepsen 1973). The decrease of about 10,000 birds compared with the 1987-1989 study was mainly observed in Limfjorden (C) and Ringkøbing Fjord (Bb), sections which no longer constitute moulting areas for Goldeneye.

In autumn 1968 and 1969, 72,416 and 33,045 birds, respectively, were recorded, being on average about 20,000 birds more than during the 1987-1989 surveys. As both studies were carried out during the autumn migration, a considerable part of this difference may be ascribed to the differences in the survey periods (median dates 13 November and 26 November in 1968-1969 compared with 5 November and 7 November 1987-1988).

Autumn numbers in Limfjorden were about 10,000 birds higher during the 1968-1973 surveys than during the 1987-1989 surveys, but smaller proportions of the totals were recorded there (67% and 38% of the birds, respectively). This decline in numbers was not reflected in the numbers in Great Britain where numbers were increasing during winter in the period between the two studies (Kirby et al. 1991). In 1969, higher numbers (10%) were recorded in western Jylland (B) than during the 1987-1989 surveys.

In winter, the numbers ranged from 32,113 birds to 87,434 in the severe winter of 1970 with an average of 56,304 birds or almost 10,000 birds more than the average of the 1987-1989 study. On average, 24,425 birds or 37% of the total were recorded in Limfjorden, almost 15,000 birds more than during 1987-1989. There seems to be no doubt that the numbers wintering in Limfjorden have decreased since the survey of 1968-1973.

The results of the 1968-1973 surveys indicated that the highest totals were recorded in severe winters. Although the average winter climate during 1968-1973 was more severe than during the 1987-1989 study, it is doubtful whether this influenced the difference in numbers of Goldeneye in Danish waters. The difference is therefore believed to have been stable or slightly decreasing from 1968-1973 to 1987-1989. The annual indices of the winter population in northwestern Europe have been slightly increasing in the same period (Monval & Pirot 1989).

Smew *Mergellus albellus*

Total numbers

In total 750 birds were recorded from autumn to spring (Fig. 41). The majority, 580 birds, was recorded in the severe winter while 55 and 61 birds, respectively, were recorded in the mild winters. In autumn, three and 44 birds, respectively, were observed compared with up to seven birds in spring. Smew was recorded on ground covered inland sites in winter in numbers up to 53 birds.

Internationally important numbers of >150 individuals (Rose & Scott 1994) were recorded during the severe winter in the southern harbour of Copenhagen (subsection Ra).

Smew was recorded during the 1968-1973 surveys in autumn in numbers up to 30 birds and in winter in numbers up to 33 birds.

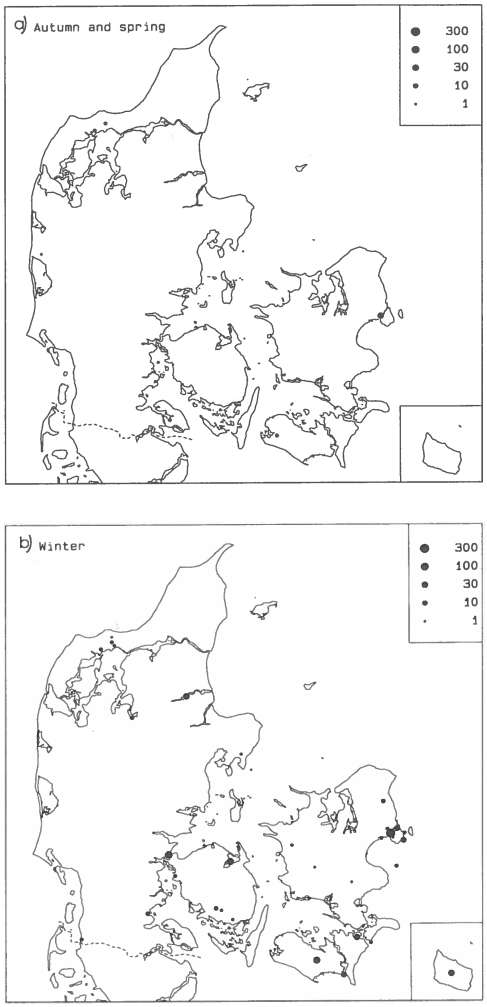


Fig. 41. Summarised observations (N = 750) of Smew in Danish waters during autumn/spring (a) and winter (b) for the period 1987-1989, based on results obtained from aerial surveys.

Red-breasted Merganser *Mergus serrator*

Total numbers

In the moulting season during late summer, the totals varied from 1,366 to 6,876 birds increasing during the 1987-1989. Between the two autumns, the numbers varied from 5,203 to 27,617 birds which was more than the variation between winter and spring (App. XXVII). The totals were rather variable, although the numbers in winter and spring in the same year were rather stable.

Moult

Almost all birds were flightless during the late summer surveys. The large moulting groups were recorded several kilometres

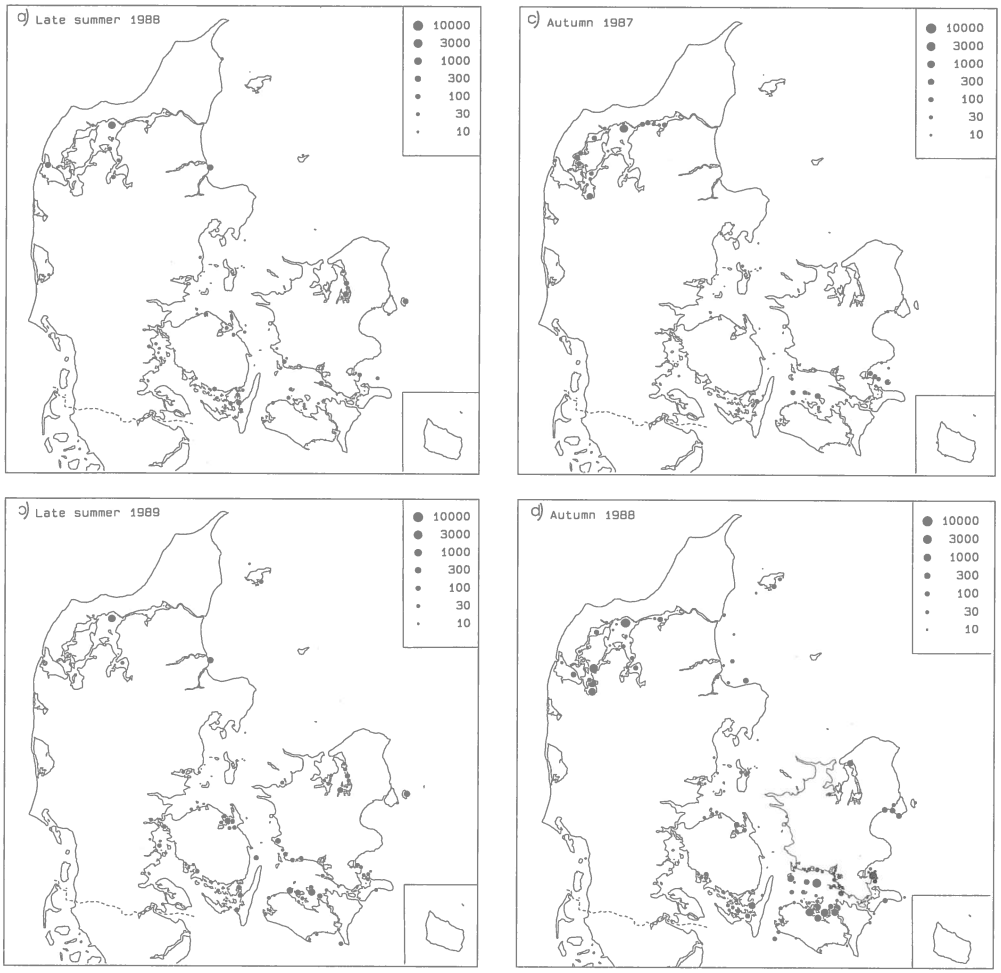


Fig. 42. Distribution and numbers of Red-breasted Merganser in Danish waters during late summer 1988 (a), 1989 (b), autumn 1987 (c), 1988 (d), winter 1987 (e), 1988 (f), 1989 (g) and spring 1988 (h), 1989 (i), based on results obtained from aerial surveys.

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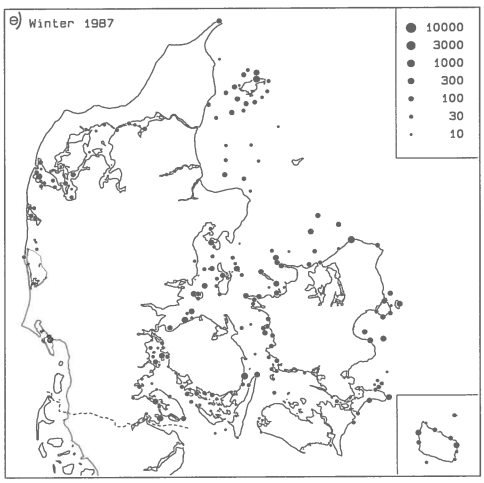

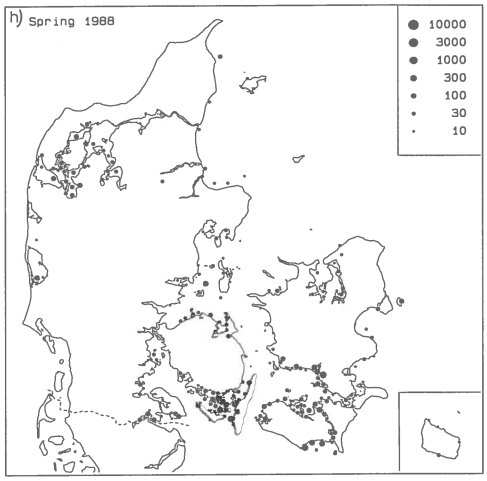

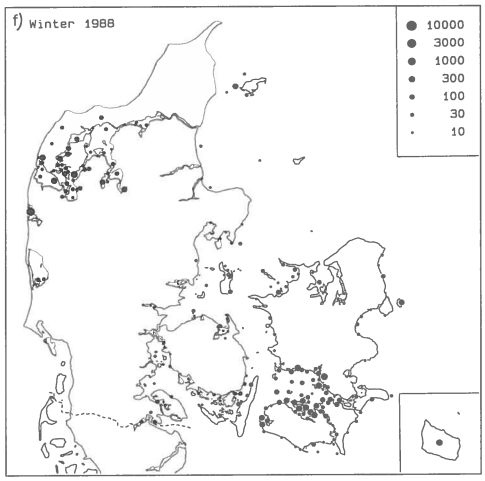

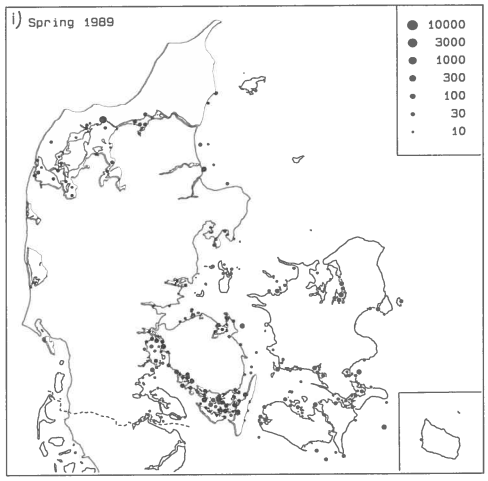

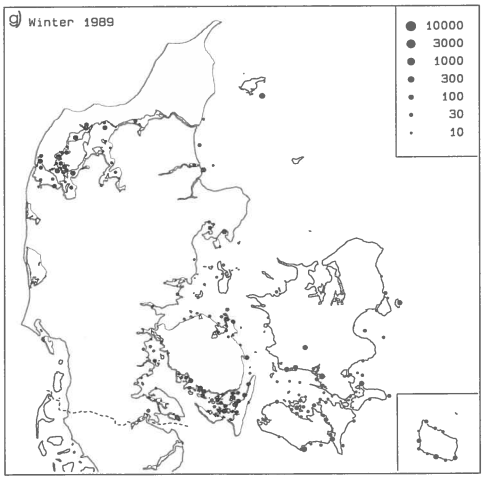

from the coast on practically the same sites in 1988 and 1989. The small flocks seemed to be family groups found close to the coast at varying sites between years. Most birds were recorded in Limfjorden (section C), except in 1989 when the majority was recorded in Smålandshavet (M).

Geographical distribution

At all times, except during the severe winter of 1987, the majority of birds were recorded in Limfjorden (C) and Smålandshavet (M) (Fig. 42). Considerable numbers were also recorded in northeastern Sjælland (R) in late summer, in Sydfynske Øhav (K) in winter and spring, and in the southeastern section

(O) in spring. In addition, large numbers were recorded from ship in Femer Bælt in winter and spring. In the severe winter, birds were widely distributed and six sections held more than 10% of the total.

Numbers in the geographical sections
Most birds were recorded in flocks of less than 50 birds, but in autumn 1988, large flocks probably consisting of migrating birds were recorded in Limfjorden (C) and Smålandshavet (M). In Limfjorden, seven flocks ranging from 150 to 3,000 birds amounted to a total of 9,110 birds and in Smålandshavet, 21 flocks ranging from 110 to 2,000 birds amounted to 10,300 birds. In all, 70% of the birds recorded during the specific survey belonged to these flocks and the total number of the survey was much higher than during the other surveys.

In autumn, 77% of the birds were recorded in Limfjorden and Smålandshavet (C and M). The relative numbers decreased to 48% in mild winters and 32% in spring.

In mild winters, birds were more concentrated and only sections C and M held more than 10% of the totals. In spring, the birds were more evenly distributed, and more than 10% of the totals were recorded in sections C, J, K, M and O. The Red-breasted Merganser was recorded at ground covered inland sites in winter in numbers up to 106 birds and in all other seasons in numbers up to 23 birds.

Internationally important numbers of >1,000 individuals (Rose & Scott 1994) were recorded in late summer and autumn at Løgstør Bredning (Ce), in autumn in Venø Bugt (Cb), Kås Bredning (Cb), at Femø (Ma), Fejø (Ma), Tårs Vig (Ma), Venegrunde (Mb) and Fakse Bugt (Oa), in mild winters in Nissum Fjord (Bd) and in the severe winter of 1987 at Læsø (Ec), and finally in spring at Stryhnø (Ka).

Dispersion
The birds were concentrated in relatively few counting areas in late summer and autumn. The number of count areas with registrations of the species increased over winter to spring when the birds occurred in small flocks or in pairs (App. XXVII).

General comments
Red-breasted Merganser is one of the most difficult species to survey from aircraft. Nilsson (1975) found the efficiency compared with ground counts to be only 39%.

Moulting flocks in late summer were often hard to detect and identify and the growing skill of the observers seemed to be the most probable explanation of the increasing numbers registred during late summer.

Up to 28% of the northwest European winter population estimated at 100,000 birds by Rose & Scott (1994) was recorded during the 1987-1989 study.

Seasonal and geographical variations
The numbers in autumn 1987 were relatively low as only one large flock was recorded in section C. Joensen (1974) stated that the numbers increased considerably in November, and it seems most likely that the survey in autumn 1987 was conducted prior to the November influx.

The reduced numbers from autumn to winter in the two major areas (C and M) probably had two independent causes: a migration to other winter quarters as well as a local dispersion. The large flocks in autumn were easier to survey than the small flocks in winter, especially as the birds in winter seemed to occur comparatively further off the coast. Underestimation of the numbers in winter was, thus likely. The migration from Smålandshavet (M) has most probably drawn the birds to the North Sea area where considerable numbers occur in the IJsselmeer in the Dutch Wadden Sea (van den Bergh 1992), whereas the winter quarters of the birds staging in Limfjorden are unknown. However, three flocks were recorded as migrants in the middle of the North Sea between the Danish northwest coast and Scotland (Tasker et al. 1987). Peak numbers in Scotland occurred in December (Kirby et al. 1993) when numbers in Limfjorden were declining. The

numbers recorded in Great Britain in winter suggested a small decline in the period between the two studies (Kirby et al. 1991). Records of three flocks in the Danish Wadden Sea (Tasker et al. 1987) and birds recorded at Blåvandshuk (Petersen 1974) indicated some migration along the west coast of Jylland.

Comparison with the results of surveys in 1968-1973

The results from the late summer surveys in 1968-1971 were comparable only for Limfjorden (C) and northern Kattegat (E). The results seemed to indicate a decrease in these areas from a level of 6,000 birds to a level of 1,700. The recent number probably includes Danish breeding birds, only, estimated at 1,500-2,000 pairs in 1980 (Ferdinand 1980). If so, the former results must have included birds of foreign origin, probably Fenno-Scandian.

During the autumn surveys, 29,113 birds were recorded in November 1968 and 18,195 birds in November 1969. Given the large annual variations in all the survey data, results of the 1987-1989 surveys probably do not differ from the results of the 1968-1973 surveys.

The geographical distribution in autumn differed considerably between the two studies. During the 1968-1973 surveys an average of 19,928 birds, or 83% of the total, was recorded in Limfjorden (C) compared with 6,996 birds, or 53% of the total, during the 1987-1989 survey. In Smålandshavet (M), only an average of 249 birds or 1% of the total was recorded during 1968-1969 compared with 5,698 birds (24% of the total) during the 1987-1989 study. In all other sections, the differences were small with a tendency of higher numbers during the present study.

In winter, totals ranged from 9,573 birds in the mild winter of 1973 to 18,873 in the normal winter of 1969 with an average of 15,064 individuals compared with an average of 12,805 during 1987-1989. The geographical distribution showed major differences from year to year in both studies and between the two study periods.

During both studies, the lowest totals were recorded in mild winters, and it seems likely that the lower numbers from the 1987-1989 study was a result of milder winters during 1987-1989.

Goosander *Mergus merganser*

Total numbers

Goosander was recorded from autumn to spring in numbers varying between 61 and 21,396 birds (App. XXVIII).

The highest numbers were recorded during the severe winter of 1987 but the variations were large in all seasons. Goosander was not recorded during late summer surveys.

Geographical distribution

During mild winters, the majority of birds were recorded in Limfjorden (C), the eastern sections (M, O and R) and Lillebælt (J) (Fig. 43c, d).

During the severe winter of 1987, a proportionally smaller part of the birds was recorded in sheltered bays like Limfjorden (C) and the birds were widely distributed over the Danish waters with eight sections each holding 8-23% of the total.

The distribution during spring and autumn 1988 resembled that of mild winters.

Numbers in geographical sections

In autumn and spring, the differences in numbers between the two years were large in all sections. In mild winters, the numbers were rather stable except in Smålandshavet

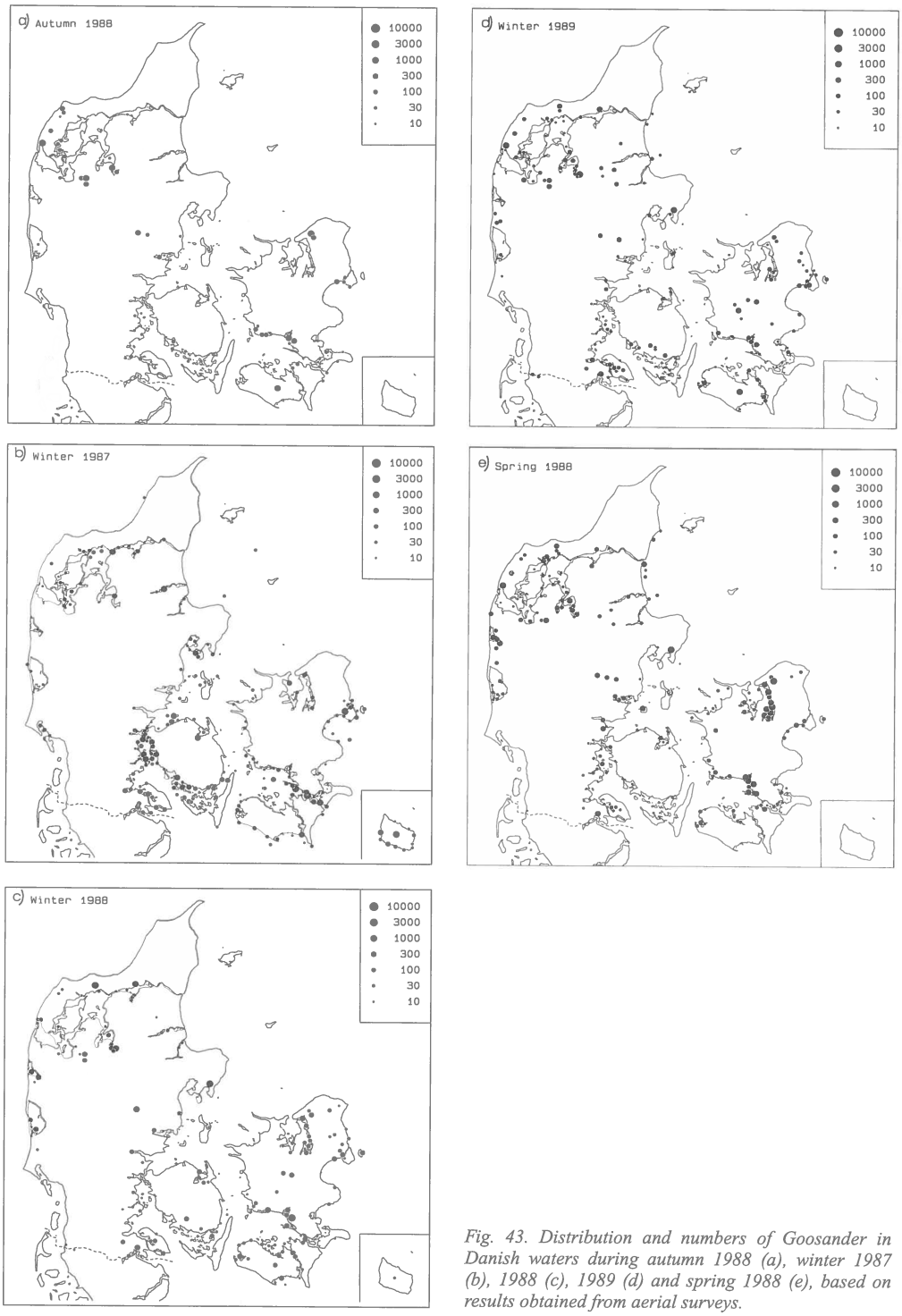

Fig. 43. Distribution and numbers of Goosander in Danish waters during autumn 1988 (a), winter 1987 (b), 1988 (c), 1989 (d) and spring 1988 (e), based on results obtained from aerial surveys.

(M) where the total in 1988 was 3,289 birds compared with 830 birds in 1989.

Goosander was recorded on ground covered inland sites in midwinter in numbers up to 3,357 birds and in the other seasons in numbers up to 2,300 birds. The proportion of Goosander in coastal and inland freshwater sites in winter 1989 was 43%.

Internationally important numbers of >1,500 individuals,(Rose & Scott 1994) were recorded in winter and spring at Gavnø and Dybsø Fjorde (Mb) and in spring in both the inner and central parts of Roskilde Fjord (Rb).

Dispersion

Though the total numbers in winter varied considerably, the dispersion (measured by the number of counting areas supporting this species) remained the same in all three winters (App. XXVIII). The birds occurred in more sheltered areas than Red-breasted Merganser.

General comments

The small numbers in autumn 1987 and spring 1989 were probably caused by the surveys being conducted before the birds had arrived in the Danish waters (1987) and after they had left them again (1989).

Up to 14% of the northwest European winter population estimated at 150,000 birds by Rose & Scott (1994) was recorded during the 1987-1989 study.

Seasonal and geographical variations

The reason for the large annual variations in distribution is most likely the changing feeding conditions of the species due to varying ice conditions and movements of the food items (i.e. fish).

The higher numbers in the severe winter of 1987 compared with the mild winters were probably caused by migration to coastal Danish waters from both Danish inland sites and wintering sites north of Denmark where extensive ice had made the feeding conditions difficult or even impossible. This was probably also the reason why comparatively few birds were recorded in Limfjorden during the survey in the severe winter of 1987.

Comparison with the results of the surveys in 1968-1973

During the November surveys, 861 birds were recorded in 1968 and 2,382 birds in 1969, both figures lying within the highly variable autumn numbers recorded during the 1987-1989 study.

During the 1968-1973 winter surveys, the numbers varied from 18,833 to 26,020 birds. The average was 21,465 birds compared with an average number of 14,310 birds during the 1987-1989 surveys. During both studies, the numbers were highest in severe winters and it is possible that the decreasing trend in numbers from 1968-73 to 1987-89 was merely caused by very mild winters in 1988 and 1989.

In the 1968-1973 surveys, the majority of the birds was recorded in winter in Limfjorden (C), western Jylland (B), southwestern Kattegat (F) and the southeastern section (O) but the annual variations were large and 11 sections each held more than 5% of the birds during at least one of the four surveys.

Although Dybbro (1978) states that the main migration period is October/November, the results from 1968-1973 and from 1987-1989 indicated that only a small part of the Danish winter population had reached the Danish waters by the end of November.

The northwest European population is believed to be increasing (Rüger et al. 1986), but this was not reflected in the Danish winter population, which has been varying.

Coot *Fulica atra*

Total numbers

The totals varied between 8,934 birds in late summer and 153,017 birds in autumn showing large increases in all seasons except spring during the study period (App. XXIX). A decrease was observed in average numbers from 96,475 birds in autumn to 49,194 birds in winter and 19,933 birds in spring.

Geographical distribution

In late summer (Fig. 44a-c), most birds were recorded in Limfjorden (section C) and western Jylland (B).

During autumn, winter and spring (Fig. 44d-j), seven sections each held on average more than 10% of the totals during at least one season; within the two eastern sections

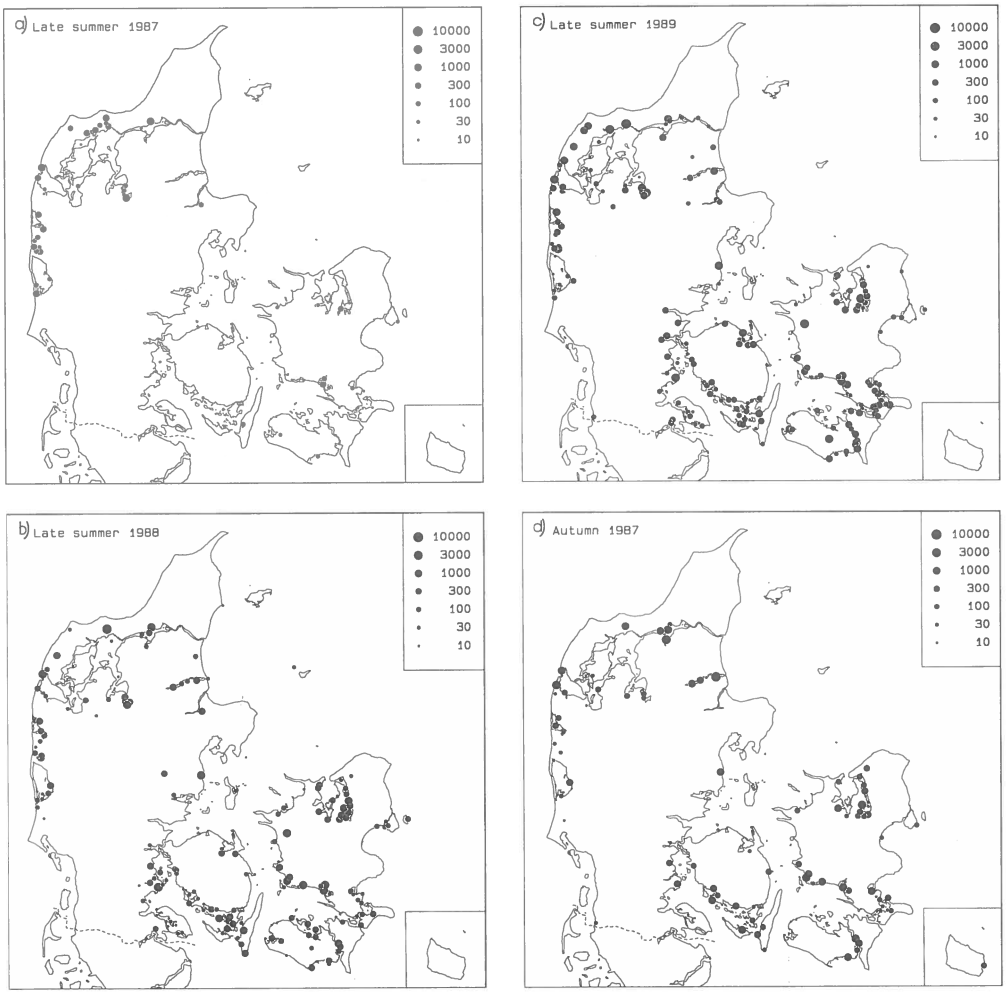

Fig. 44. Distribution and numbers of Coot in Danish waters during late summer 1987 (a), 1988 (b), 1989 (c), autumn 1987 (d), 1988 (e), winter 1987 (f), 1988 (g), 1989 (h) and spring 1988 (i), 1989 (j), based on results obtained from aerial surveys,

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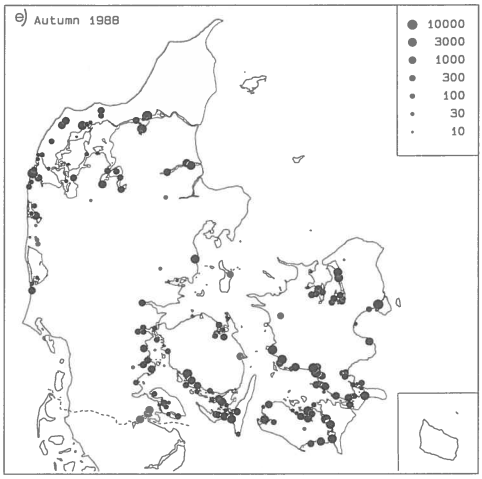
e) Autumn 1988
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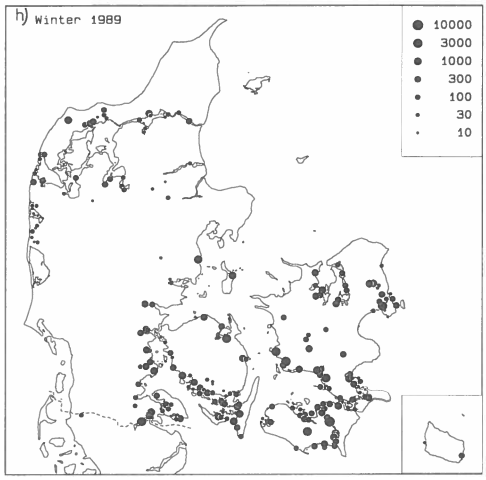
h) Winter 1989
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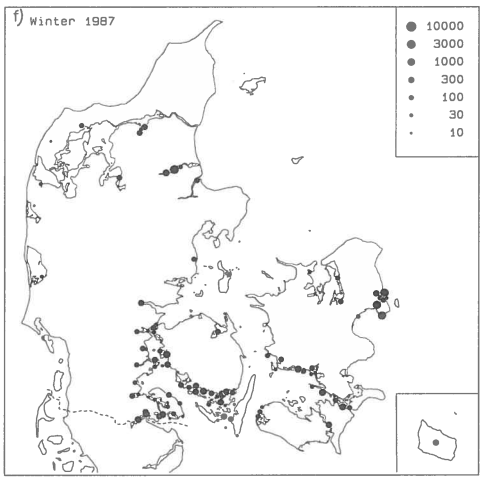
f) Winter 1987
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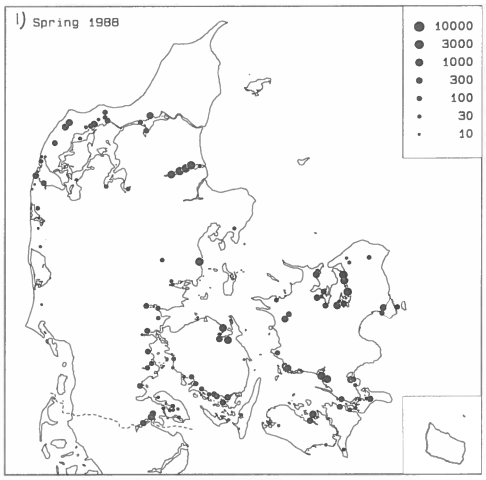
i) Spring 1988
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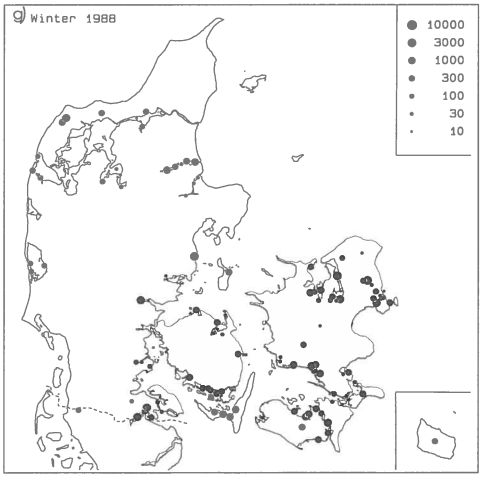
g) Winter 1988
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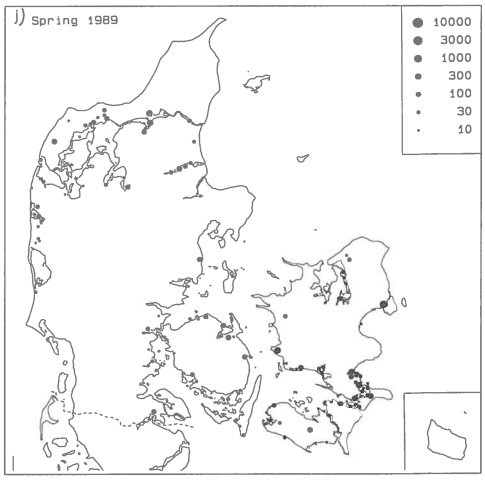
j) Spring 1989
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O and R, more than 10% of the totals were recorded in all seasons.

Only small differences in bird distribution occurred between the severe winter of 1987 and the mild winters.

Numbers in geographical sections
A decrease in numbers from autumn to winter was general for all areas except southern Kattegat (F and S). The average total numbers decreased by 37% from 96,745 birds in autumn to 60,673 birds in the subsequent winter (does not include 1987).

The decrease in numbers from winter to spring was observed in the central, southern and eastern sections (F, J, K, M, N, O, R and S) with the average numbers decreasing from 43,796 birds to 14,535. In the western and northern sections (B, C and E), almost equal numbers (5,017 birds in winter and 5,398 birds in spring) were recorded.

Coot was recorded at ground covered inland sites in winter in numbers up to 5,923 birds and in the other seasons in numbers up to 5,050 birds. The proportion of Coot in coastal and inland freshwater sites in winter 1989 was 14%.

Internationally important numbers of >15,000 birds (Rose & Scott 1994) were not recorded.

Dispersion
Despite the large seasonal variations in numbers, Coot was rather similarly distributed in all seasons (App. XXIX).

General comments
The comparatively low numbers recorded in late summer 1987 could probably be ascribed to insufficient coverage, whereas the comparatively small totals of autumn 1987 and spring 1989 may be ascribed to the timing of the surveys. Thus, the autumn survey was conducted before the majority of the Coot had arrived in Danish waters, and the spring survey after the majority of the Coot had left the Danish marine waters for the breeding grounds.

Dybbro (1978) stated the autumn migration period to be September/October, although Joensen (1974) had recorded the highest numbers of Coot in November. The large numbers in autumn 1988 indicated that considerable migration movement is going on in November.

Up to 11% of the winter population in northwestern Europe estimated at 1.5 million birds (Rose & Scott 1994) was recorded during the 1987-1989 study.

Seasonal and geographical variations
The numbers of Coot in southern Sweden were reduced in severe winters (Nilsson 1984) probably mainly due to high mortality as the effect was maintained in the following winters. In addition, reductions have been found in the breeding population in Denmark after a severe winter (Braae & Laursen 1980). As the 1987 winter survey was performed during severe weather, and as the two previous winters were severe, too, the numbers recorded then were believed to represent a very low population level of Coot. Thus, the increase in numbers in winter during the study period most likely reflected a recovery of the population after three severe winters. The surveys in winter 1988 and 1989 might have been performed in the beginning of the spring migration period (Dybbro 1978) and therefore in a period of increasing numbers of birds in the Danish waters. This could have contributed to the interpretation of an increase in the population.

Comparison with the results of surveys in 1968-1973

In autumn 1968 and 1969, 252,425 and 176,859 birds, respectively, were recorded which was far more than during the 1987-1989 surveys. The low population level due to high mortality in severe winters before and during this study is considered to be the main reason for this difference. The geographical distribution resembled that of the surveys of 1987-1989, and the difference between the two studies were in fact smaller than the year to year variations in the latter study.

During the winter surveys of 1969-1973, numbers recorded ranged from 73,626 birds in 1971 to 168,007 birds in 1969. The numbers decreased from an average of 216,142 birds in autumn to 158,882 birds in winter (26%) similar to the pattern of the 1987-1989 study.

The winter of 1970 was severe, causing a reduction in numbers, e.g. 168,007 birds in 1969 was followed by an average of 111,457 during 1970-1973 with the lowest numbers in the winter that followed the severe winter. The average of all four surveys was 125,595 birds compared with 49,194 birds during the 1987-1989 study. Most of the differences in geographical distribution between the two studies were small and fell within the yearly variations in the latter study; but in Smålandshavet (M), a decline was observed from 29.4% of the total in the 1968-1973 study to 12.9% in the 1987-1989 and in section R, an increase from 6.4% to 16.3%.

There is no doubt that the numbers of Coot in Danish waters have actually decreased from 1968-1973 to 1987-1989, but as the numbers fluctuate widely, it is not possible to decide whether this decrease reflects a long-term decline in Coot or merely population levels influenced by the severity of the winters in the two periods that were compared. The annual indices for north-western Europe have been rather stable in the period (Monval & Pirot 1989).

Great Skua *Stercorarius skua*

Total numbers

Five ship transect surveys covered the entire range of the species within Danish waters with estimates in late summer of 11,000-13,000 birds and in autumn of 0-1,200 birds (App. XXX).

No birds were recorded during winter and spring in the study area.

Geographical distribution

The majority of the birds was recorded at the Norwegian Trench in the North Sea. In Kattegat, the Straits and the Baltic Sea, Great Skua was rare (Fig. 45).

Numbers in geographical sections

During the late summer surveys when numbers peaked, 64-78% of the birds was recorded in the Norwegian Trench. In September, numbers were much lower, while in October/November the birds had abandoned this area. In this season, some birds remained in the southern part of the Danish sector of the North Sea.

Internationally important numbers (>470 birds (from Tasker et al. 1985, 1987, Lloyd et al. 1991) were not recorded in any of the counting areas, but a significant part of the population was recorded along the Norwegian Trench in July-September.

Dispersion

Great Skuas were very dispersed in the North Sea, and were predominantly recorded as solitary individuals or in small groups. The birds were often observed near trawlers.

General comments

Due to the attraction of this species to the survey ships, the total estimates presented here are likely to be over-estimates.

The occurrence in the eastern parts of the North Sea was most certainly consisting of non-breeding birds (Tasker et al. 1987), and this idea is further supported by the predominance of immatures among recoveries from south Scandinavian waters (Thomson 1966).

Given an estimation of 40,000-54,000 birds in northern Europe (from Tasker et al. 1985, 1987, Lloyd et al. 1991), 24-33% was recorded in the area surveyed during the study.

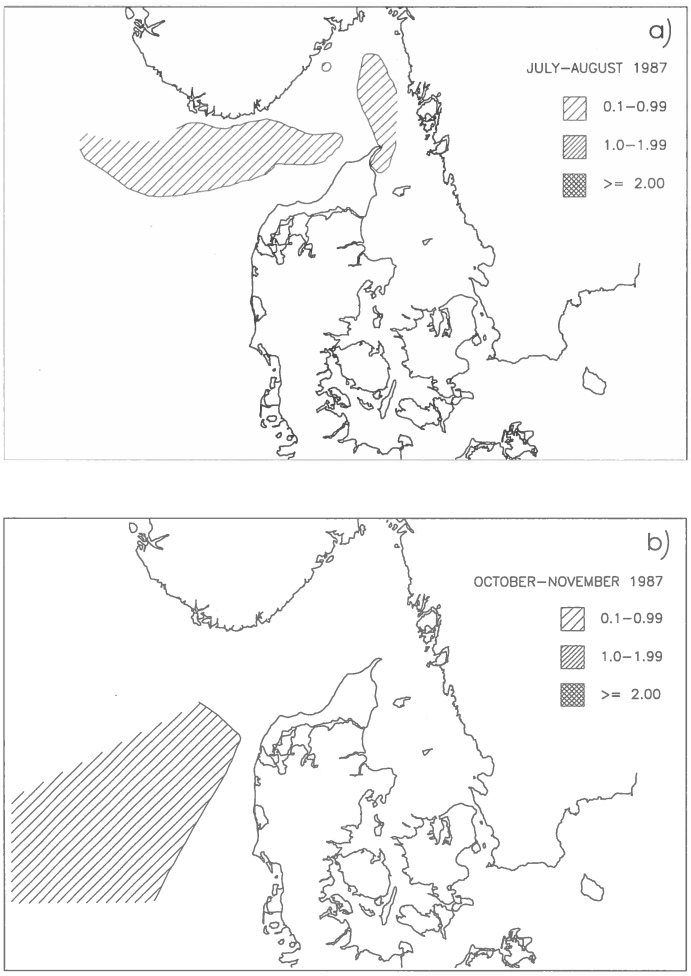


Fig. 45. Distribution and density of Great Skua in Danish waters during late summer 1987 (a) and autumn 1987 (b), based on results obtained from ship surveys.

Seasonal and geographic variations

Rasmussen (1981) found a migration peak in September/October for Great Skua occurring in southern Scandinavia, but suggested that this peak did not reflect the abundance of the species in the North Sea. The results from this study supported this suggestion.

Little Gull *Larus minutus*

Total numbers

Four transect surveys covered regions which were expected to be important for this species with estimates in winter from no birds in the severe winter of 1987 to 1,200 birds in the mild winter of 1988 and in spring of 4,000-13,500 birds (App. XXXI).

Surveys of the Baltic Sea were not performed in autumn, at which time the birds were recorded in numbers up to 3,100 in the

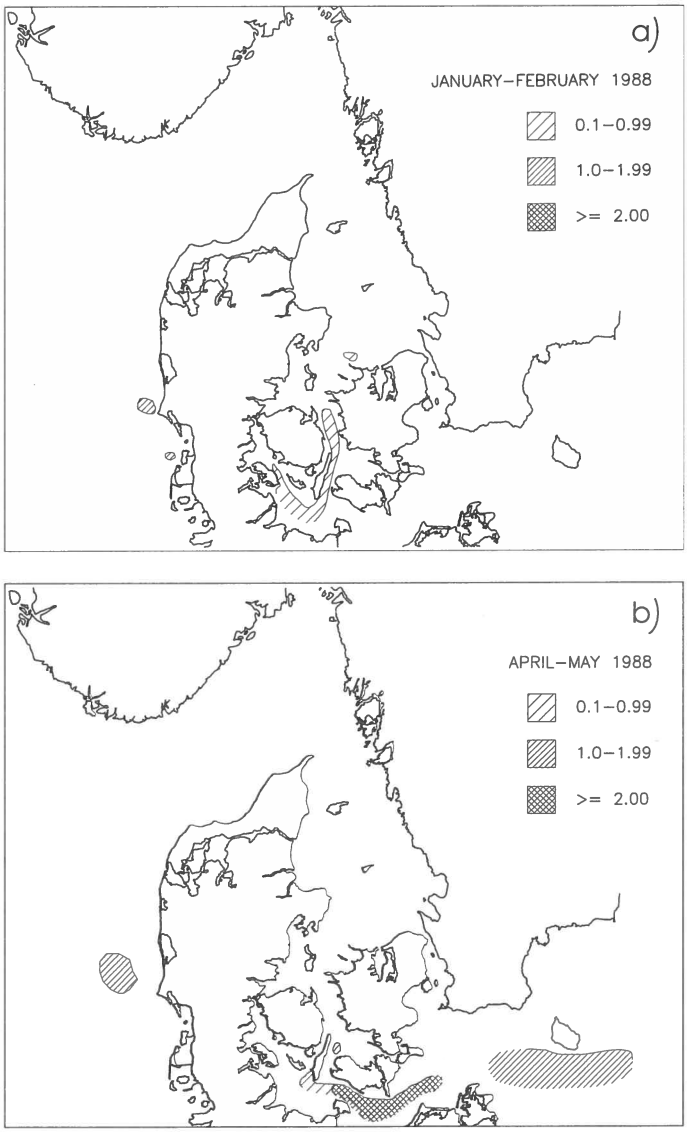


Fig. 46. Distribution and density of Little Gull in Danish waters during winter 1988 (a) and spring 1988 (b), based on results obtained from ship surveys.

North Sea. Little Gull was not recorded in late summer.

Geographical distribution.
The birds had a very southerly distribution, with the majority of the birds recorded in the Baltic Sea in spring and off the Wadden Sea in autumn. Very few birds were recorded in the offshore areas of the North Sea, Skagerrak and Kattegat (Fig. 46).

Numbers in geographical sections
In the North Sea, numbers were highest in autumn ranging up to estimates of 3,100 birds, while in winter and spring, estimated numbers reached 850 birds. The majority of the birds in the North Sea (48-100% of the total) were recorded just north of the Wadden Sea.

Internationally important numbers (>750 birds, Rose & Scott 1994) were estimated in Femer Bælt and at Bornholm in spring and just north of the Danish Wadden Sea in autumn.

Dispersion
In the North Sea, the birds were concentrated north of the Wadden Sea, while in the Baltic Sea, the birds were widely dispersed. Most often, small flocks were observed.

General comments
Due to the lack of surveys in the Baltic Sea in autumn, no comparable data were available. If performed, it may have been expected that a late but small migration (Bruun 1968) would have been refelected in the observations.

Up to 15-23% of the central and east European breeding population estimated at 60,000-90,000 birds (Rose & Scott 1994) were estimated in Danish waters during this study.

Seasonal and geographical variation
The numbers of birds wintering in the Danish parts of the North Sea seemed to fluctuate with the severity of the winter, as no birds were recorded in the severe winter of 1987, compared with 2,000 birds in subsequent mild winters.

The discovery of birds wintering in the Baltic Sea adds to recent records of Little Gull along the Swedish Baltic Sea coasts (Breife 1987) and supports the idea that many Little Gulls spend the winter in the Baltic Sea (Hutchinson & Neath 1978). The numbers in the Baltic Sea in winter are probably fluctuating, depending on mild winters.

Black-headed Gull *Larus ridibundus*

During countrywide aerial surveys, the species was only recorded in flocks of more than 50 birds from late summer 1987 to spring 1988.

Total numbers
During countrywide surveys numbers ranged from 63,052 birds in winter to 161,118 birds in spring (App. XXXII). The species was regularly recorded in small numbers in transect surveys.

Geographical distribution
In late summer (Fig. 47a), the majority of birds was recorded in the Wadden Sea (section A), western Jylland (B) and Limfjorden (C). During autumn and winter (Fig. 47b, c) most birds were recorded in Kattegat (E, F and S), while in spring (Fig. 47d) almost equal numbers were recorded in Limfjorden, the western sections (A, B and C) and Kattegat (E, F and S) accounting for two thirds of the numbers recorded.

Numbers in geographical sections
The Wadden Sea (A), western Jylland (B) and Limfjorden (C) were the only sections where annual numbers peaked in late sum-

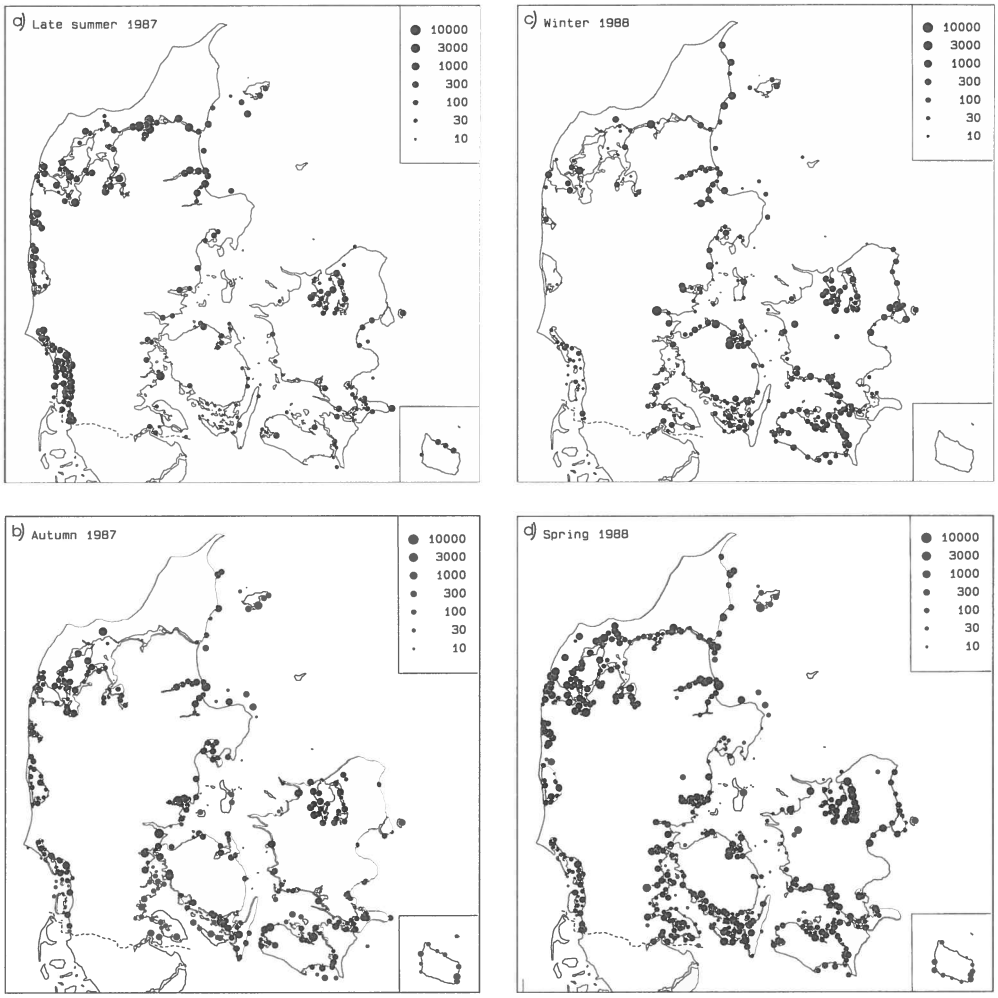


Fig. 47. Distribution and numbers of Black-headed Gull in Danish waters during late summer 1987 (a), autumn 1987 (b), winter 1988 (c) and spring 1988 (d), based on results obtained from aerial surveys.

mer, all together accounting for 71% of the total. In the Wadden Sea, in particular, the difference between late summer and other seasons was prominent, as 31% of the total was recorded in late summer compared with 2-6% in all other seasons. At Bornholm (T), countrywide surveys were not performed during winter.

Internationally important numbers of >20,000 birds (Rose & Scott 1994) were not recorded at any coastal site or in any smaller area during the study.

Dispersion

The birds were widely dispersed in sheltered inlets (particularly in late summer), bays and archipelagoes, but rare offshore.

General comments

The 1987-1989 study only dealt with birds in marine areas. Black-headed Gull has very opportunistic feeding habits exploiting a great variety of inland as well as marine resources (Meltofte & Faldborg 1987). A large proportion of the birds was most likely

feeding on inland areas; furthermore, it is doubtful whether a stable proportion of the birds was feeding at marine sites in different seasons. Thus, the numbers recorded do not necessarily reflect the total Danish population.

A serious bias arose from the fact that the surveys were not timed with the roost aggregations occuring immediately before sunset. These roosts included both coastal birds and birds coming from inland sites, and records from one roosting site were often enough to dominate the number in the whole section.

The total population of Black-headed Gull in the western Palearctic is estimated at 5.0 million birds by Rose & Scott (1994), and the numbers recorded during the 1987-1989 study amounted to less than 4%.

Seasonal and geographical variation
The comparatively high numbers in spring reflected the spring migration and fitted well with results of staging birds at sites where the species has been recorded (Meltofte & Faldborg 1987).

The high numbers recorded in the Danish Wadden Sea in late summer is in accordance with Laursen et al. (in press), and reflected the migration of adult Black-headed Gulls to the area in late summer to undergo the wing-feather moult (Meltofte & Faldborg 1987).

Common Gull *Larus canus*

During countrywide surveys, this species was only recorded in flocks of more than 20 birds from late summer 1987 to spring 1988.

Total numbers
During four countrywide surveys, the numbers ranged from 19,508 birds in autumn to 46,395 birds in spring (App. XXXIII).

In offshore areas, four total estimates varied from no birds in late summer to 62,000 birds in winter; numbers being rather stable in winter and spring (App. XXXIV).

Geographical distribution
The majority of birds recorded during the countrywide counts in coastal areas were found in the Wadden Sea (section A) and Limfjor-den (C) (Fig. 48).

In transect surveys, Common Gull was primarily recorded in the eastern parts of the Baltic Sea and in the shallow parts of the North Sea: the German Bight, the west coast of Jylland, Jammer Bugt and Tannis Bugt. Highly fluctuating numbers were recorded in Kattegat and the Straits (Fig. 49).

Numbers in geographical sections
In late summer, the birds were almost exclusively recorded in coastal waters; the Wadden Sea (A) and Limfjorden (C) held 65% of the birds.

In autumn, comparatively few birds were recorded in coastal areas. The North Sea and Kattegat were the only offshore areas well covered by transects. In the North Sea, the number estimated in autumn 1987 was higher than in any other season.

Through winter and spring, the total numbers from both countrywide surveys and transect surveys seemed rather stable. Countrywide surveys of Bornholm (T) were not carried out during winter.

Internationally important numbers of >16,000 birds (Rose & Scott 1994) were not recorded at any coastal site or any smaller area during the 1987-1989 study.

Dispersion
Common Gull were often rather concentrated in coastal areas. In offshore waters, the birds were dispersed over shallow waters in western Denmark and over deeper waters in the Baltic Sea.

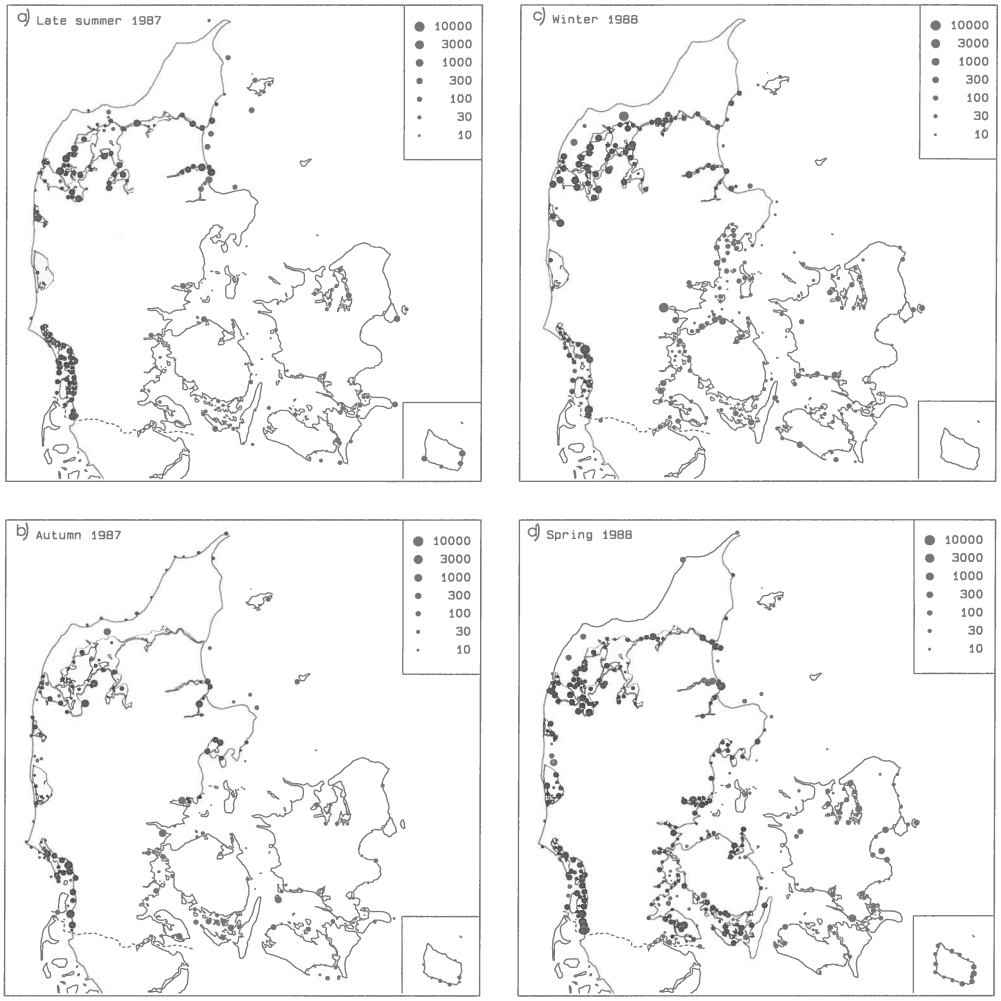


Fig. 48. Distribution and numbers of Common Gull in Danish waters during late summer 1987 (a), autumn 1987 (b), winter 1988 (c) and spring 1988 (d), based on results obtained in surveys from aerial surveys.

General comments

For the same reason as for Black-headed Gull, it is doubtful whether the results presented reflect the total Danish population. The aggregating behaviour at nighttime roost sites furthermore introduced a serious bias (see Black-headed Gull).

Of the total population of Common Gull in the Western Palearctic being estimated at 1.6 million birds by Rose & Scott (1994) the sum of countrywide and transect numbers recorded during this study amounted to less than 8%.

Seasonal and geographical variation

The comparatively stable numbers recorded in coastal areas reaching a minimum in autumn fit well with the occurrence reported at Blåvand (Meltofte & Faldborg 1987). The results indicated that postbreeding dispersal affected coastal areas moderately, and

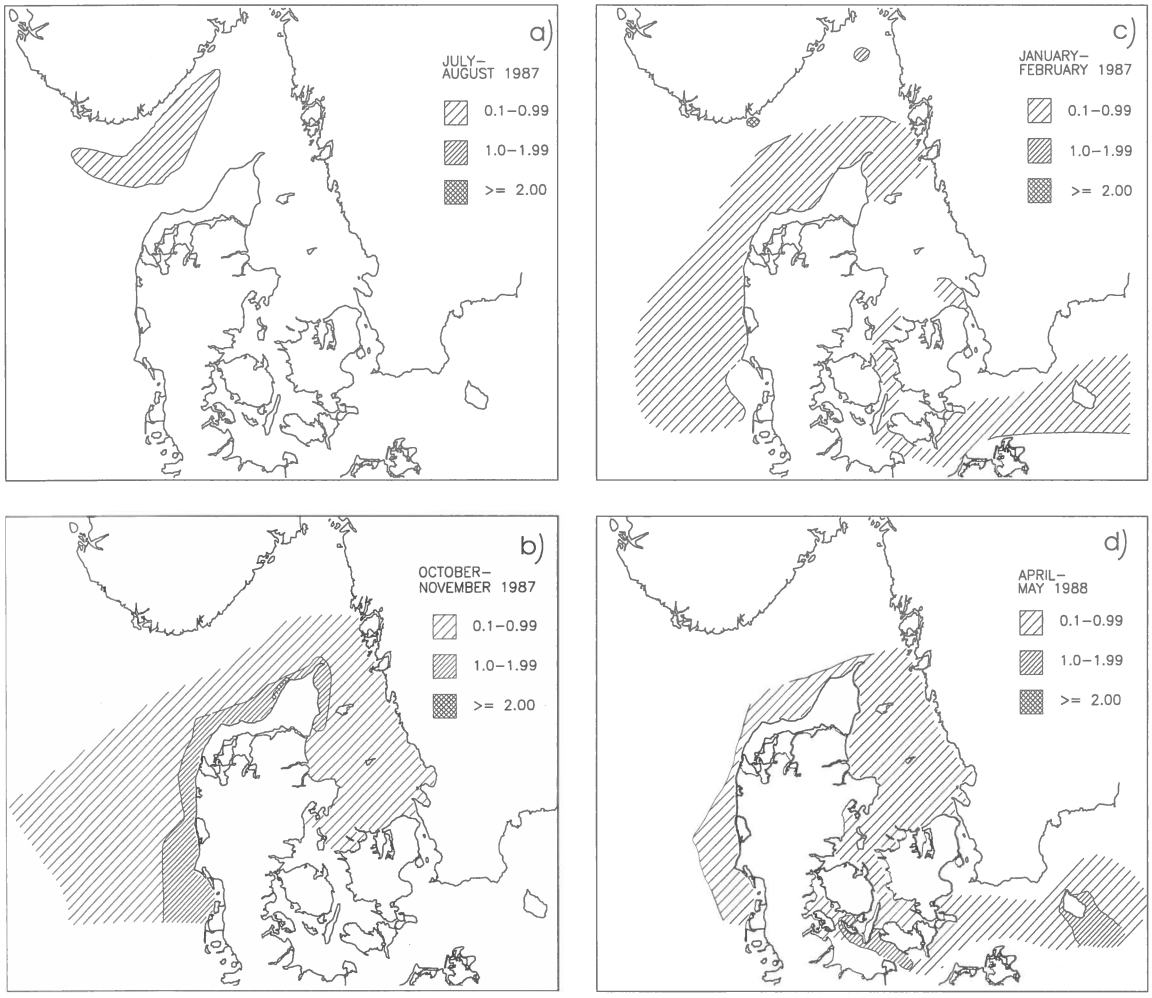


Fig. 49. Distribution and density of Common Gull in Danish waters during late summer 1987 (a), autumn 1987 (b) winter 1987 (c) and spring 1988 (d), based on results obtained from ship surveys.

that few birds exploited offshore areas in late summer.

The high numbers recorded in the North Sea in transect surveys during autumn, and the rather low numbers recorded in coastal areas at the same time correspond well with the occurrence at Blåvand (Meltofte & Faldborg 1987) where an extensive autumn migration of Common Gull was recorded simultaneously with the smallest number of birds roosting on the beach. The results indicated that the Common Gull became pelagic in the postbreeding period.

The winter culmination in both coastal and offshore numbers was also found at Blåvand, and was interpreted as a weather dependent movement from inland pastures and fields to marine habitats (Meltofte & Faldborg 1987).

Lesser Black-backed Gull *Larus fuscus*

Total numbers

Estimated totals from ship transect surveys in late summer were 8,500-17,500 birds and in spring 101,000 birds (App. XXXV). The birds were not recorded in transect surveys in autumn and winter.

During countrywide surveys, more than 1,000 birds were recorded in western Denmark in late summer. In spring, the birds were recorded occasionally in small numbers in all Danish waters.

Geographical distribution

In both late summer and spring the majority of birds was recorded in the North Sea, particularly in Skagerrak (Fig. 50).

In spring (Fig. 50b), high densities were

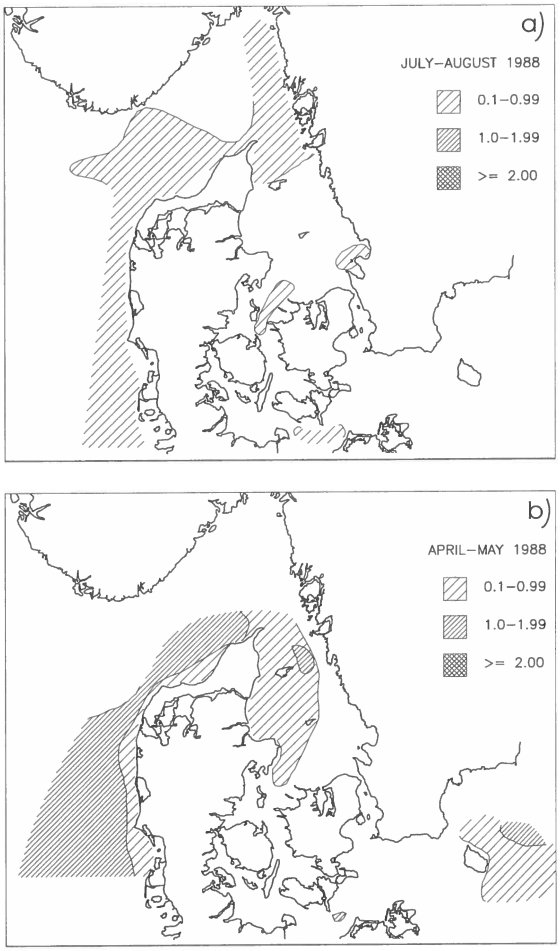


Fig. 50. Distribution and density of Lesser Black-backed Gull in Danish waters during late summer 1988 (a) and spring 1988 (b), based on results obtained from ship surveys.

also recorded east of Bornholm, an area which was not surveyed in late summer.

The birds were widely distributed in Kattegat in spring, while in late summer, the occurrence within this area and in the Straits seemed patchy.

Numbers in geographical sections
During spring 1988 (the only complete survey of all areas), 86% of the birds were estimated in the North sea, 9% in Kattegat and 5% in the Baltic Sea.

Internationally important numbers of >2,500 birds of *L. f. fuscus* (Rose & Scott 1994) were only recorded at the shelf edge in Skagerrak prior to the 1987-1989 study in spring 1986 (Ornis Consult A/S, unpubl. data).

Dispersion
In both seasons, birds occurred dispersed over large areas in offshore waters.

General comments
Following the racial characteristics described by Barth (1975), all adults identified in the North Sea were identified to *L. f. intermedius*. Birds in Kattegat and the Baltic Sea were not identified to subspecies, but it is most likely that birds in Kattegat were *L. f. intermedius* (Dybbro 1978) and the birds in the Baltic Sea belonged to *L. f. fuscus* (Dybbro 1978, Lyngs et al. 1990).

During late summer, the birds were observed aggregating near fishing vessels; thus, the summer totals may have been overestimated.

The population of Lesser Black-backed Gulls in the Western Palearctic is estimated at 600,000-800,000 birds by Rose & Scott (1994), and the numbers estimated during the 1987-1989 study amounted to up to 17% of the population.

Seasonal and geographical variation
During 1987-1989, far higher numbers of birds were recorded in spring than in autumn. This was in opposition to the occurrence at Blåvand (Meltofte & Faldborg 1987), Ertholmene in the Baltic Sea (Lyngs et al. 1990) and elsewhere onshore.

Our results indicate that the spring migration of Lesser Black-backed Gull is a concentrated and quick passage performed in offshore waters directly towards the breeding grounds. Autumn migration was more coastal than spring-migration and less concentrated in offshore waters (Meltofte & Faldborg 1987, Skov et al. 1980). Both surveys showed that considerable numbers appeared in offshore waters in autumn. This might also have been the case in the Baltic Sea where large numbers of birds appeared at Ertholmene during periods of hard winds (Lyngs et al. 1990).

Herring Gull *Larus argentatus*

During countrywide surveys the species was only recorded in flocks of more than 50 birds from late summer 1987 to spring 1988.

Total numbers
During four countrywide surveys from late summer 1987 to spring 1988, the numbers varied from 55,438 birds in late summer to 156,478 birds in spring (App. XXXVI).

During six transect surveys from ship in offshore waters, the total estimates amounted to 24,000 birds in late summer and varied between 205,000 and 381,000 birds from autumn to spring, with the lowest counts in spring (App. XXXVII).

Geographical distribution
The majority of birds in coastal areas were recorded in late summer (Fig. 51a) in the Wadden Sea (section A), in Limfjorden (C) and at Bornholm (T); in autumn most birds

were recorded in Limfjorden (C) (Fig. 51b).

During winter, the birds were widely distributed and 10 sections out of 14 each held 6% or more of the total (Fig. 51c). The majority of the birds were recorded in Kattegat(E, F and S). During spring (Fig. 51d), most birds were recorded in Limfjorden (C) and Kattegat (E, F and S).

In offshore waters, the majority of birds were recorded in the North Sea in late summer and autumn; in winter and spring most birds were recorded in the Baltic Sea east of Bornholm, but high numbers were also recorded in Skagerrak and in eastern Kattegat (Fig. 52).

Numbers in geographical sections

During late summer, the majority of birds were recorded in coastal waters whereas in other seasons, numbers were highest in offshore waters, though not much higher in spring.

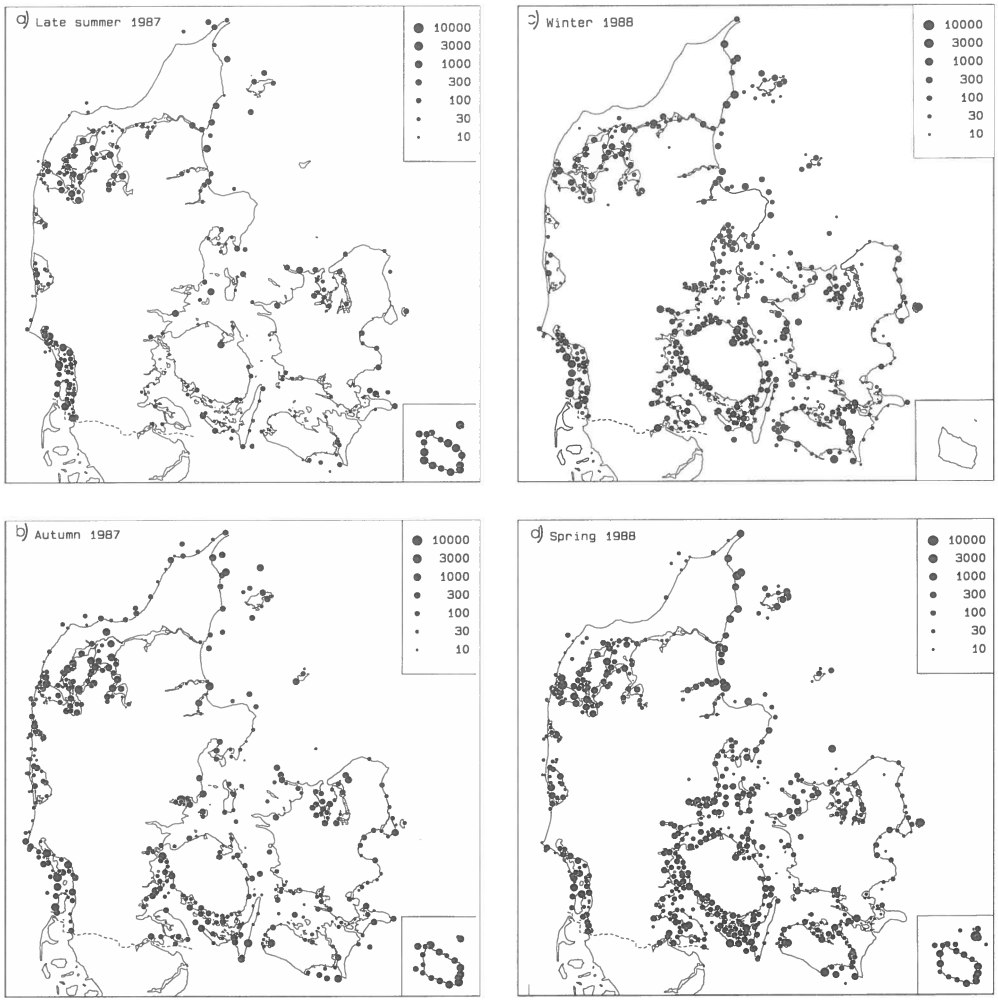


Fig. 51. Distribution and numbers of Herring Gull in Danish waters during late summer 1987 (a), autumn 1987 (b), winter 1988 (c) and spring 1988 (d), based on results from aerial surveys.

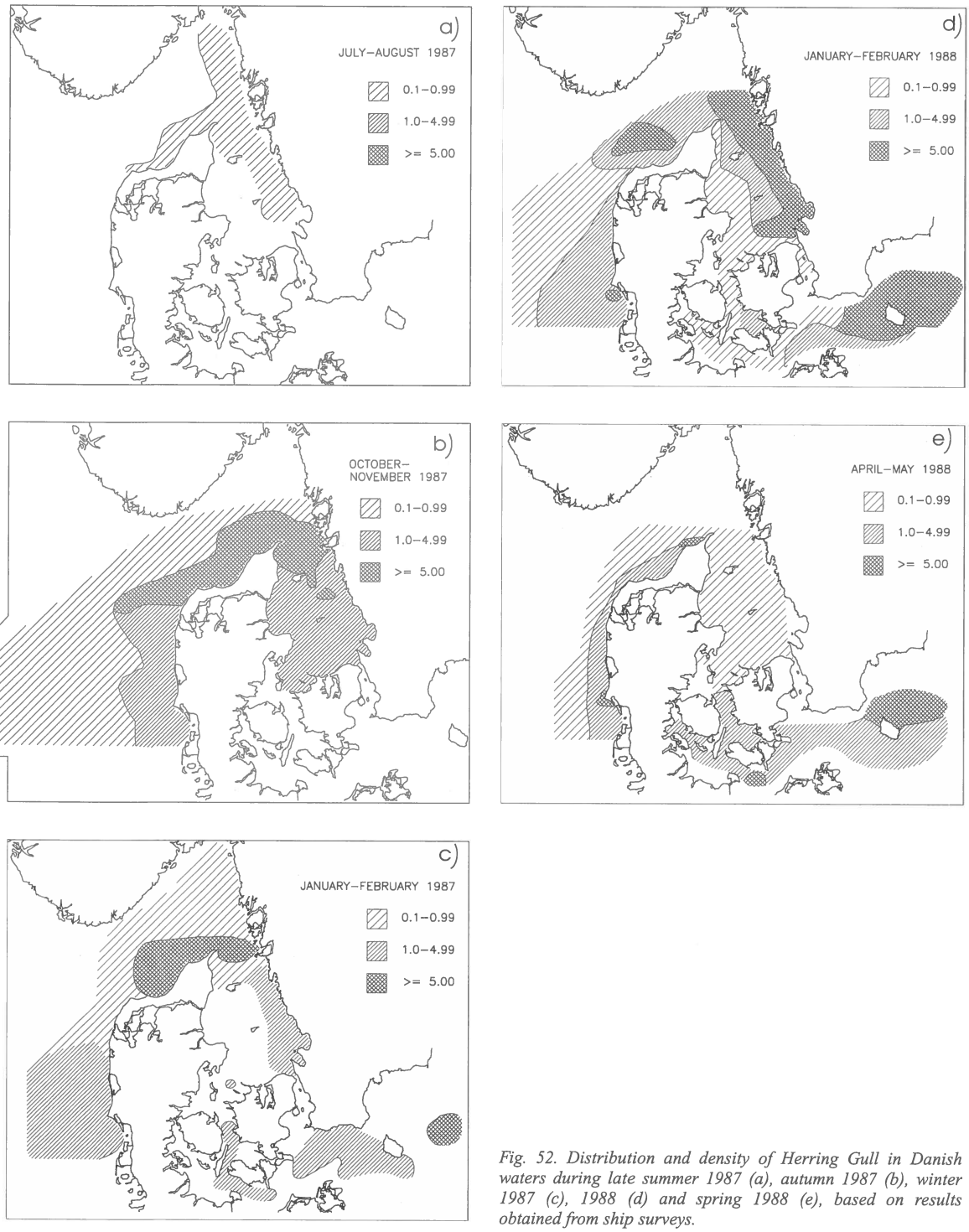


Fig. 52. Distribution and density of Herring Gull in Danish waters during late summer 1987 (a), autumn 1987 (b), winter 1987 (c), 1988 (d) and spring 1988 (e), based on results obtained from ship surveys.

In late summer and autumn, the relative numbers were highest in the western coastal sections (A, B and C), amounting to 40-47% of the total numbers compared with 17-22% in Kattegat (E, F and S). In winter and spring, the relative numbers were highest in Kattegat (E, F and S) with 35-38% of the total compared with 26-28% in the western sections (A, B and C). Bornholm (T) was not covered by countrywide surveys in winter.

During the severe winter of 1987, 53% of the birds estimated in offshore waters were recorded in the North Sea, 5% in Kattegat and 42% in the Baltic Sea. In the subsequent mild winters, 18-23% were recorded in the North Sea, 15-35% in Kattegat and 42-62% in the Baltic Sea. No transect surveys covered the Straits and the Baltic Sea during autumn.

Internationally important numbers of >14,000 birds (Rose & Scott 1994) were only recorded in large areas during the study.

Dispersion

Herring Gull was recorded at all Danish coasts, often in large flocks. The birds were concentrated in coastal and shallow offshore areas in the North Sea and Kattegat while the birds were dispersed in large numbers in the deeper parts of the Baltic Sea.

General comments

The often very large roosts in the late afternoon on sandy beaches and small islands were only occasionally covered by the aerial surveys. The bias created in this way was considered less important than that of Black-headed Gull and Common Gull, as the Herring Gulls were mainly gathering from marine sites.

Herring Gulls are very much attracted to fishing wessels (Camphuysen et al. 1993) and together with Great Black-backed Gull, are regarded as the most common gull species exploiting fishery waste in Danish waters (Camphuysen et al. 1993). The attraction to the survey vessels most probably resulted in overestimated numbers of flying birds. Thus, flocks recorded in connection with trawlers were omitted from the estimates and the final estimate should only be considered an indication of the population size.

As the total population of Herring Gull in the Western Palearctic is estimated at 2.7 million birds by Rose & Scott (1994) the sum of countrywide and transect numbers recorded during the 1987-1989 study amounted up to 18% of the population.

Seasonal and geographical variation

In the Wadden Sea (A), numbers peaked in late summer as for the other species of gull. This peak was not observed in a detailed study of the area in 1980-1990 (Laursen et al. in press.), and was probably coincidental, though.

The occurrence in late summer of rather small numbers in offshore areas was similar to that of Common Gull. Late summer is the period of post-breeding moult of adults, and the results indicated a preference for coastal areas at this time of year.

The occurrence of the species at Blåvand was largely dependent on the availability of beached food items (Meltofte & Faldborg 1987), and, therefore cannot be compared with the results of the 1987-1989 study.

Great Black-backed Gull *Larus marinus*

During countrywide aerial surveys, this species was only recorded in flocks of more than five birds from late summer 1987 to spring 1988.

Total numbers

During four countrywide surveys, the numbers ranged from 2,572 birds in late summer to 7,044 birds in autumn (App. XXXVIII).

In offshore areas, six total estimates from ship based transects varied from 9,000 birds in spring to 46,000 birds in winter (App. XXXIX).

Geographical variation

In all seasons except autumn (Fig. 53), the majority of birds was recorded in Kattegat (sections E, F and S). In autumn, most birds

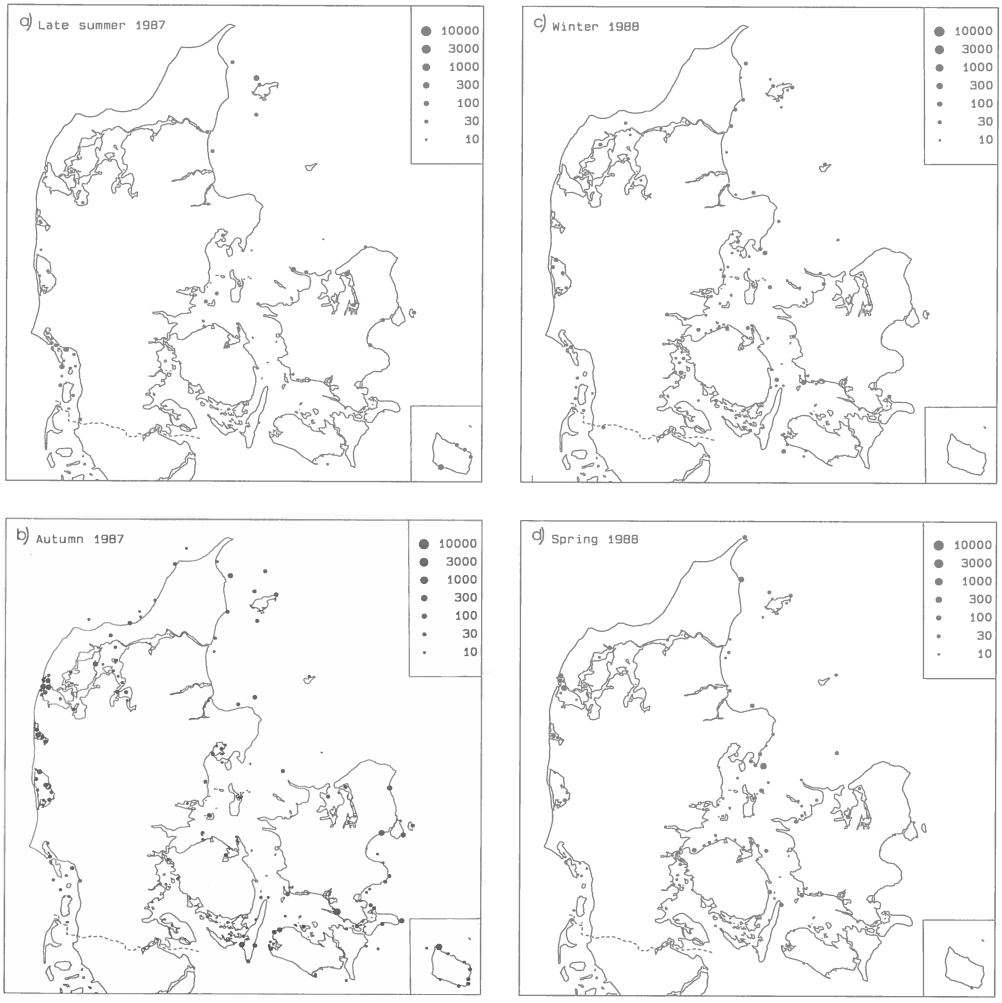


Fig. 53. Distribution and numbers of Great Black-backed Gull in Danish waters during late summer 1987 (a), autumn 1987 (b), winter 1988 (c) and spring 1988 (d), based on results obtained from aerial surveys.

were recorded in western Jylland (B) and Limfjorden (C) (Fig. 53b). The birds were widely distributed, and 13 out of 14 sections each held at least 5% of the total during one or more seasons.

Offshore, the majority of the birds was recorded in the North Sea, especially in Skagerrak, particularly in the deep waters along the Swedish Skagerrak coast. Comparatively high numbers were also recorded in eastern Kattegat and the eastern Baltic Sea. During all surveys, very few birds were recorded west of 7°E (Fig. 54).

Numbers in geographical sections
In coastal waters, numbers were rather small and fluctuated from season to season. During late summer and autumn, more than 80% of the offshore birds were recorded in the North Sea/Skagerrak and during winter and spring, 40-70% of the birds were recorded in this area. In the severe winter of 1987, the numbers in Skagerrak, eastern Kattegat and the eastern Baltic Sea amounted to 41,000 birds compared with 11,700 and 16,500 birds in the subsequent mild winters. Bornholm (T) was not covered during countrywide surveys in winter.

Internationally important numbers of >4,800 birds (Rose & Scott 1994) were not recorded in the specific sections during the study.

Dispersion
Great Black-backed Gull occurred in small flocks in coastal areas apart from a few roosting aggregations. In offshore waters, they occurred rather concentrated in eastern Skagerrak, eastern Kattegat and the deeper parts of the Baltic Sea while the birds occurred in a very dispersed manner in the remaining study area.

General comments
The great differences in numbers between seasons in the coastal sections arose in part as a result of occasional coverage of roosts similar to those of Herring Gull. The same reservations and possible biases as mentioned for Herring Gull applied to the estimates of Great Black-backed Gull in Danish offshore waters as well. This species is generally highly associated with fishing activities at sea (Camphuysen et al. 1993). The final estimate of up to 46,000 birds should only be considered a vague indication of the offshore population outside the breeding season.

The total population of Great Black-backed Gulls in the Western Palearctic is estimated at 480,000 birds by Rose & Scott (1994); thus, the sum recorded from countrywide counts and transect surveys amounted to 10% of the estimated population.

Seasonal and geographical variation
The occurrence in late summer with relatively large numbers of Great Black-backed Gull in offshore Skagerrak differed rather much from the patterns seen for other gull species, and the birds present are mainly of Norwegian origin (Bruun 1963, Kuschert & Witt 1985).

The large and stable numbers in offshore waters from late summer to late spring were at all times much greater than the numbers recorded in coastal areas indicating a rather stable Danish population outside the breeding season. During previous surveys in the North Sea, high numbers of birds have been recorded from September to April (Tasker et al. 1987).

The autumn maximum found in coastal areas has previously been demonstrated in the western parts of Denmark (Meltofte & Faldborg 1987, Laursen et al. in press., Lilleør 1989, Møller 1978), although the timing has varied from August to November. The different local maxima might be ascribed to changes in local feeding conditions rather than being a reflection of the migratory movements.

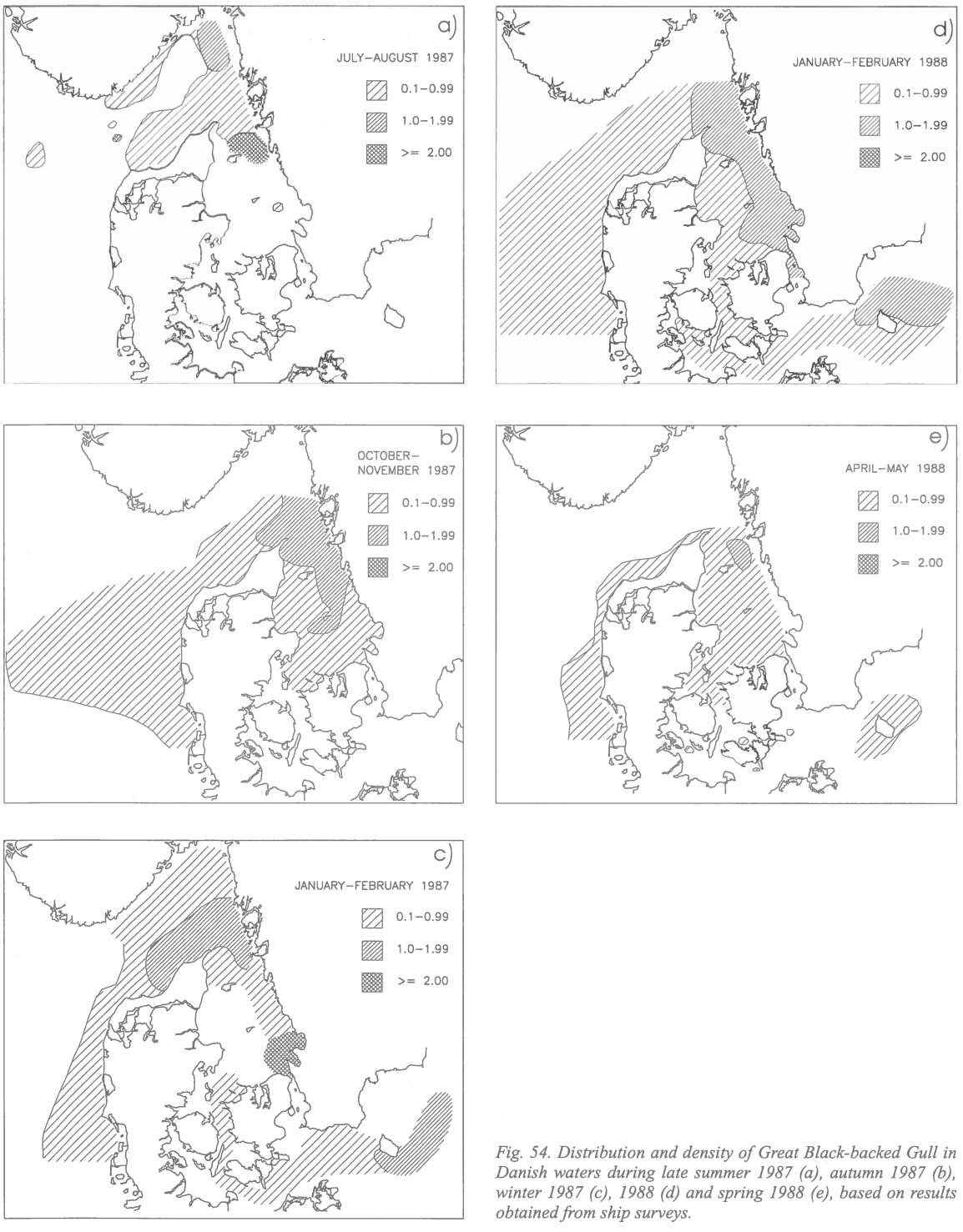


Fig. 54. Distribution and density of Great Black-backed Gull in Danish waters during late summer 1987 (a), autumn 1987 (b), winter 1987 (c), 1988 (d) and spring 1988 (e), based on results obtained from ship surveys.

Kittiwake *Rissa tridactyla*

Total numbers
The estimated totals in the entire area were up to 34,000 birds in late summer, 315,000 birds in autumn and winter and unknown in spring (App. XL).

Geographical distribution
The birds were confined to the North Sea in late summer and spring while in autumn and winter, large numbers also occurred in Kattegat (Fig. 55).

The numbers in the North Sea peaked in autumn and were mainly concentrated along an extensive area of the southern shelf of the Norwegian Trench while in Kattegat, most birds were recorded in winter mainly concentrating on Middelgrunde.

Numbers in geographical sections
In the North Sea, between 44% and 71% of the birds were recorded on the shelf of the Norwegian Trench while in Kattegat, be-

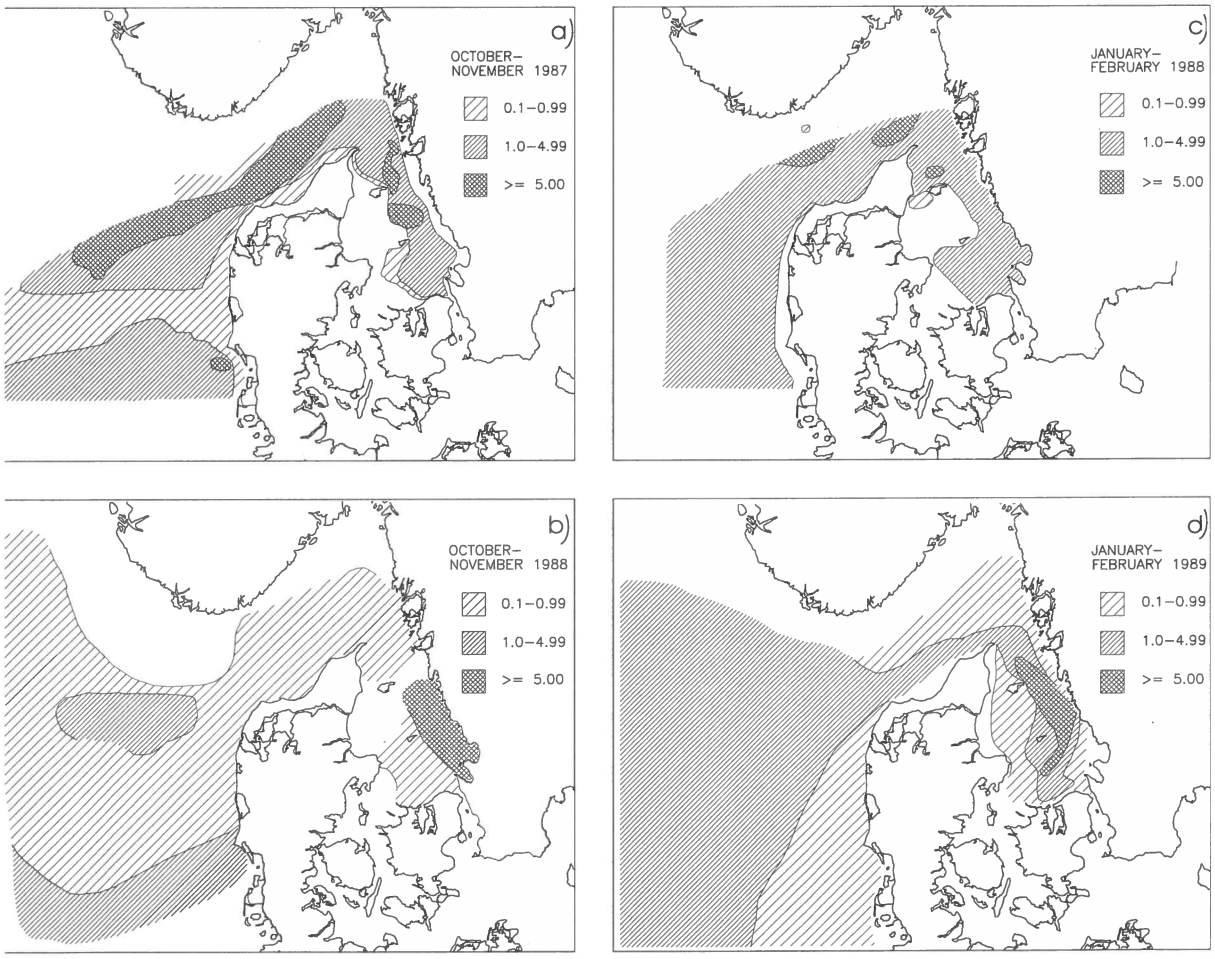


Fig. 55. Distribution and density of Kittiwake in Danish waters during autumn 1987 (a), 1988 (b) and winter 1988 (c), 1989 (d), based on results obtained from ship surveys.

tween 76% and 98% were recorded on Middelgrunde. Numbers were highly variable in Kattegat, ranging in autumn from 5,000 to 200,000 birds and in winter from 50,000 to 215,000 birds. The numbers in the North Sea were less variable ranging from 13,000 to 34,000 birds in late summer, 45,000 to 115,000 birds in autumn and from 34,000 to 95,000 birds in winter.

Despite the great variations from year to year within each season, the variation from autumn to the subsequent winter was small along the Norwegian Trench and on Middelgrunde.

Internationally important numbers of >20,000 birds (Rose & Scott 1994) were recorded on Middelgrunde in Kattegat in autumn and winter.

Dispersion
The distribution in offshore areas was generally very clustered. Most often, solitary birds or small parties were observed, although flocks of up to 8,000 individuals were recorded. Kittiwake aggregations close to trawlers were only recorded on a few occasions.

General comments
Compared with the total population of Kittiwake in the Western Palearctic estimated at 8.4 million birds by Rose & Scott (1994) the numbers estimated from transect surveys amounted up to 4% of the population.

Seasonal and geographical variation
The very small variation in numbers from autumn to the subsequent winter along the Norwegian Trench and on Middelgrunde suggested that once the birds had chosen a site in autumn, they remained there through winter (App. XL). As sufficient data were only available from the mild winters, it is unknown whether this was also the case in the severe winter. The results from the same two areas also indicated that the numbers exploiting these areas vary greatly from year to year.

Guillemot *Uria aalge*

Total numbers
Six transect surveys from ship covered the regions of this species with total estimates up to 285,000 birds (two surveys) in late summer, up to 310,000 birds (three surveys) in autumn and 295,000 birds (one survey) in winter (App. XLI). During an incomplete survey in late spring, 40,000 birds were estimated whereas in June the species was not recorded.

Geographical distribution
Guillemot was recorded within two separate regions: the North Sea-Kattegat region and the Baltic Sea region, numbers being much higher in the North Sea-Kattegat region than in the Baltic Sea region. The Straits and the southwestern part of Kattegat where birds only occurred in very small numbers constituted a border zone (Fig. 56).

In the North Sea, numbers were highest in late summer and autumn while maximum numbers in Kattegat were reached in winter. The large majority of birds was concentrated in a few core areas: the Norwegian Trench and Kummel Banke in the North Sea, Middelgrunde in Kattegat and the waters in the Baltic Sea. Local concentrations were recorded in the Danish part of Dogger Banke and in the German Bight in the North Sea and on Lysegrundene/Kullen in Kattegat.

Numbers in geographical sections
The proportion of birds estimated in the North Sea and Kattegat changed from late summer to winter. In late summer and autumn, 83-97% of the total (167,000-280,000 birds) were estimated in the North Sea compared with 3-17% in Kattegat

(7,000-37,000 birds); in autumn, 82-84% of the total were estimated in the North Sea (160,000-298,000 birds) and 16-18% in Kattegat (30,000-45,000 birds), while during the only complete winter survey in 1989, 41% (120,000 birds) were estimated in the North Sea and 59% (175,000 birds) in Kattegat.

The Baltic Sea was surveyed twice during summer (but not in autumn), however, no birds were recorded. During the six complete surveys, up to 2,000 birds (<1% of the total) were estimated in the Baltic Sea, but during the incomplete surveys of winter and spring, totals of up to 30,000 birds were estimated. The birds mainly occurred in the waters off Bornholm.

In the North Sea, 78-88% of the birds occurred on the shelf of the Norwegian Trench in late summer, 44-66% in autumn and 50% in winter, while on Kummel Banke, 1-8% occurred in late summer and autumn, and 21% in winter. In Kattegat, the proportions estimated on Middelgrunde were much more variable being highest in winter (63%).

Within defined areas, internationally important numbers of >56,000 birds (calculated on the basis of 1% of the estimated North Atlantic breeding population in pairs from Koskimies (1991), Lloyd et al. (1991), Lyngs (1992), Risberg (1990) multiplied by a factor 3 according to Rose & Scott (1994)) were estimated in areas along the Norwegian Trench in late summer, autumn and winter, and on Middelgrunde in winter.

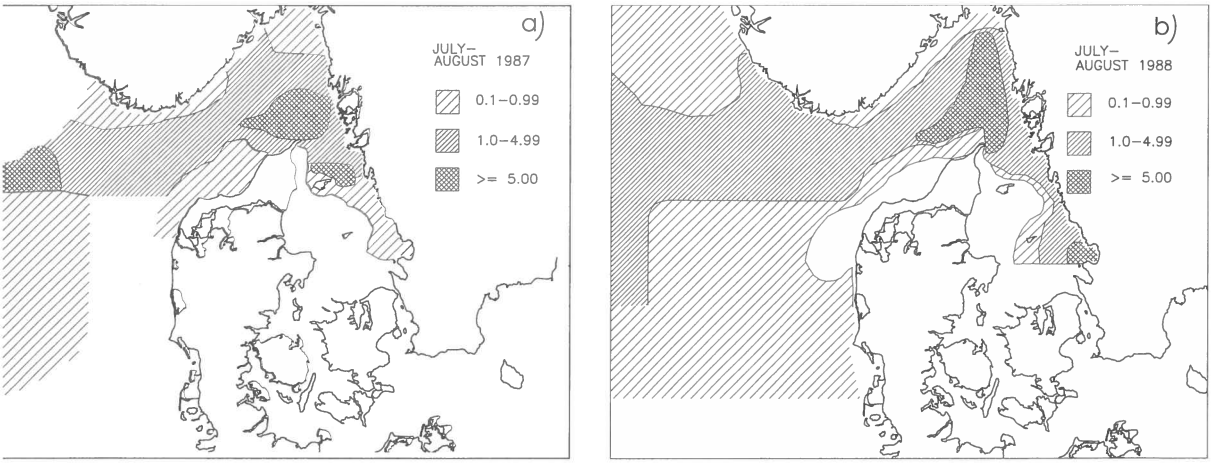
Dispersion

The bulk of the birds was concentrated in a few areas whereas a minority of the birds was dispersed throughout almost the entire survey area. Solitary birds and small flocks were usually observed, although flocks of up to 3,000 birds were recorded.

General comments

The birds recorded in late summer in the North Sea were predominantly moulting adults accompanied by chicks which made up 34% of the total. The probable origin of these birds was the United Kingdom and possibly also Runde in southwest Norway (Skov et al. 1992). The late summer surveys in 1987 were conducted almost a month later than in 1988, which may partly explain the comparatively low numbers in 1988.

Apart from minor visits in the autumn, breeding Guillemots return to the vicinity of their colonies in February/March (Tasker et al. 1987) and the comparatively low num-



ig. 56. Distribution and density of Guillemot in Danish waters during late summer 1987 (a), 1988 (b), autumn 1987 (c), 1988 (d), 1989 (e), inter 1988 (f), 1989 (g) and spring 1988 (h), based on results obtained from ship surveys.

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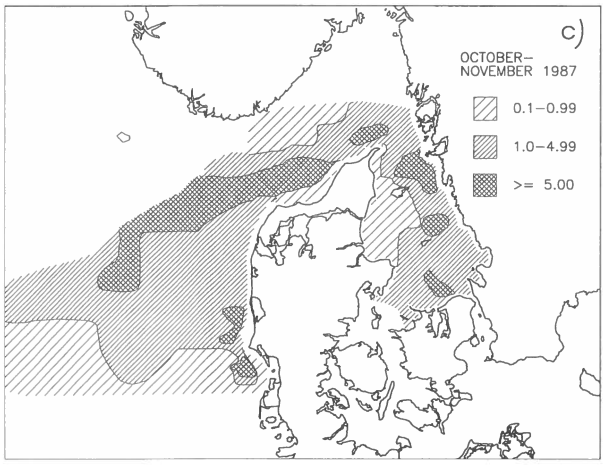
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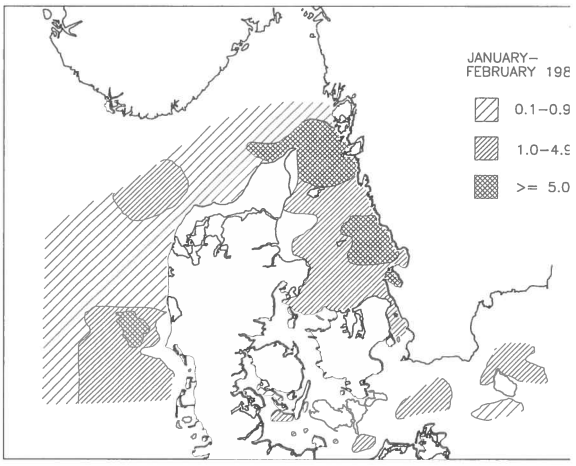
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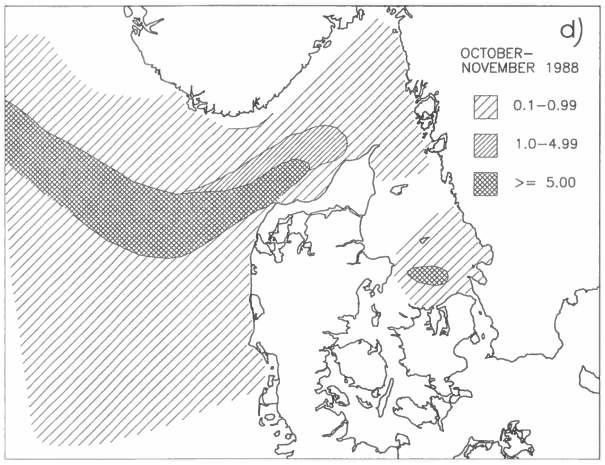
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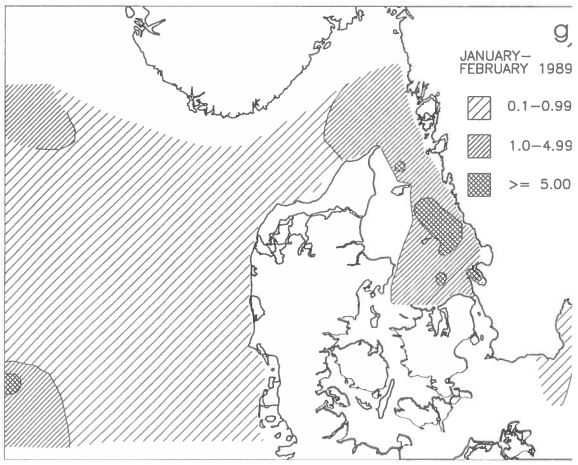
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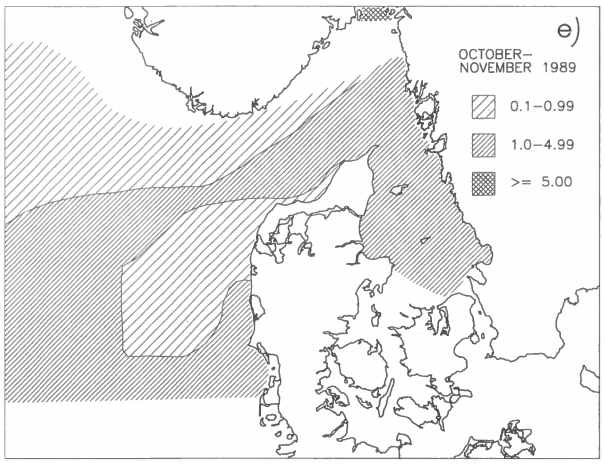
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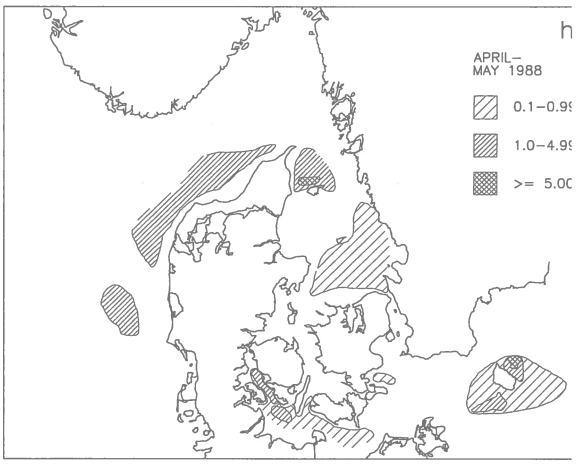
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bers recorded in spring presumably consisted mainly of immature birds.

Compared with the north European population of Guillemot estimated at 3.7-7.5 million birds (based on data in Koskimies 1991, Lloyd et al. 1991, Lyngs 1992, Risberg 1990), up to 8% was estimated in Skagerrak and up to 5% in Kattegat.

Seasonal and geographical variation
Ringing recoveries have shown that birds of the Baltic Sea remain and migrate only within this area (Lyngs 1992). The results of the 1987-1989 study indicated that almost the entire Baltic Sea population of Guillemot wintered close to Bornholm in the severe winter of 1987. The Baltic Sea breeding population is estimated at 12,000 pairs (Risberg 1990, Lyngs 1992, Koskimies 1991) which is equivalent to 38,400 birds as a factor 3.2 has been used to calculate the population size (P. Lyngs pers. comm.).

The large numbers of birds estimated particularly in autumn in the Skagerrak areas are probably related to the presence of large stocks of young Herring and Sprat in the area (Durinck et al. 1991, Skov et al. 1992). It is unknown whether the Herring migration influenced the gradual movements of the Guillemots from western Skagerrak in late summer into eastern Skagerrak and Kattegat in winter, as indicated by these studies.

Estimates of the numbers of Guillemots in Skagerrak late summer 1987 and 1988 have previously been published (Skov et al. 1992). The numbers differ considerably from the data presented in the 1987-1989 study, primarily because Skov et al. (1992) included Kattegat in the Skagerrak sector.

Razorbill *Alca torda*

Total numbers

Six transect surveys covered the regions used by this species leading to total estimates of up to 175,000 birds (three surveys) in autumn and 395,000 birds (three surveys) in winter (App. XLII). During late spring, only 400 birds were estimated, whereas in late summer, the species was only occasionally recorded.

Geographical distribution
Razorbills were recorded in two separate regions: the North Sea/Kattegat region and the Baltic Sea region (Fig. 57).

In autumn, the majority of birds in the North Sea/Kattegat area was recorded in a well defined and small area in the central Kattegat, northeast of Djursland. Large numbers were also recorded on the Norwegian Trench and on Middelgrunde in Kattegat. The area around Bornholm in the Baltic Sea was not surveyed in autumn.

In winter, most birds were recorded on Middelgrunde, on the Norwegian Trench and in the severe winter of 1987 around Bornholm.

The few birds recorded in spring were close to the breeding colony at Ertholmene in the Baltic Sea.

Numbers in geographical sections
In the North Sea, numbers increased from an estimated 7,000-31,000 birds in autumn to 87,000-120,000 birds in winter, with larger numbers in the severe winter of 1987 than in the mild winters. During the severe winter of 1987, all birds in the study area were recorded on the eastern shelf of the Norwegian Trench, while in the mild winters, the majority of the birds were recorded on Kummel Banke.

Numbers in Kattegat fluctuated a great deal, and the total numbers in autumn varied from 49,000 to 165,000 birds and in winter from 32,000 to 290,000 birds. Unfortunately, the areas northeast of Djursland and Middelgrunde in Kattegat were not surveyed during the severe winter of 1987. Within

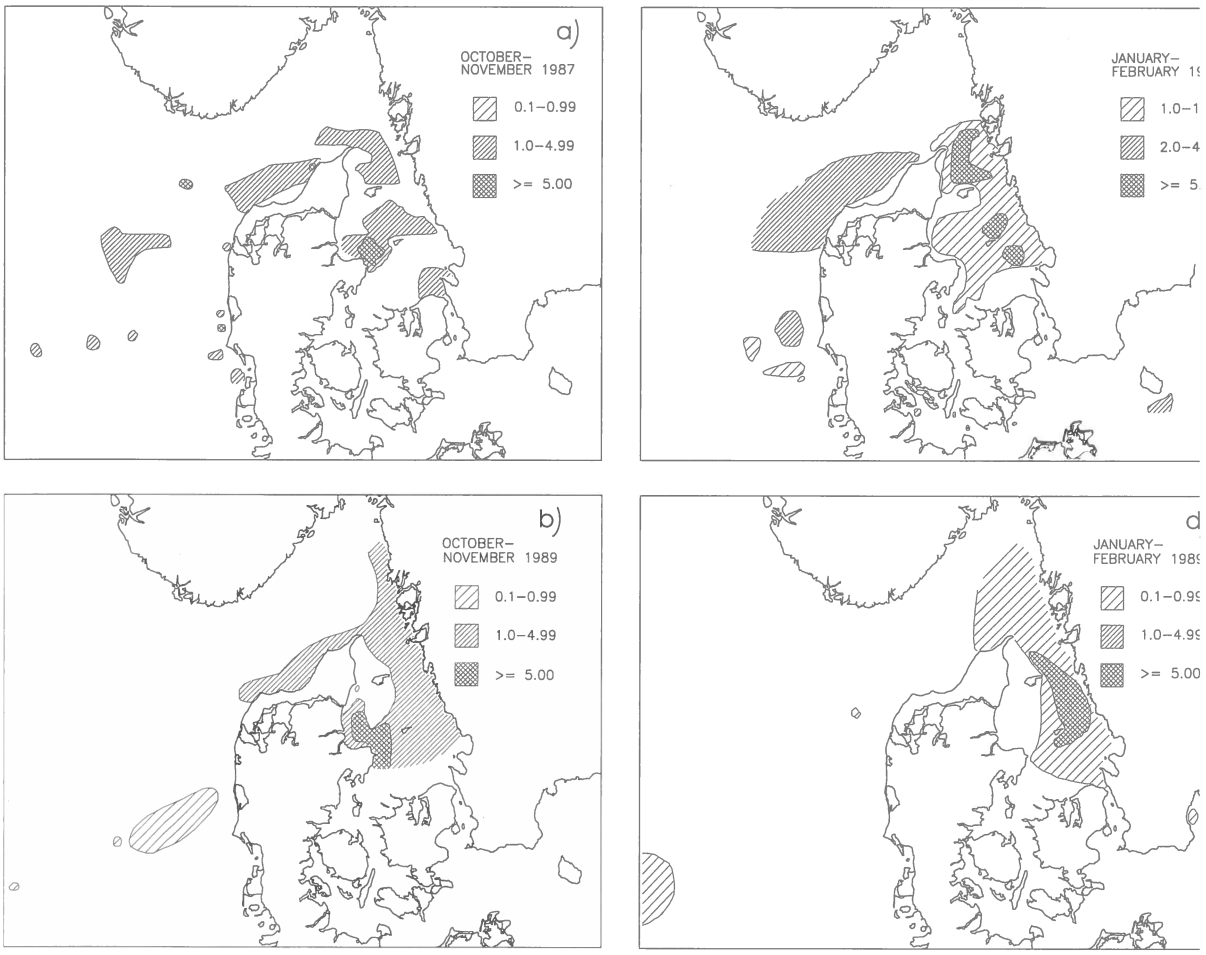

Fig. 57. Distribution and density of Razorbill in Danish waters during autumn 1987 (a), 1989 (b), and winter 1988 (c), 1989 (d), based o results obtained from ship surveys.

Kattegat, the highest numbers in autumn were recorded off northeast Djursland which, on average, held 89,000 birds compared with an average of 25,000 birds on Middelgrunde. The opposite pattern was observed in the winter when an average of 161,000 birds was recorded on Middelgrunde compared with only 500 birds off northeast Djursland. In the Baltic Sea, Razorbill was only recorded in high numbers during winter. In the severe winter of 1987, 30,000 birds were recorded compared with an average of 3,400 birds in the mild winters.

Internationally important numbers of >11,000 birds (calculated on the basis of 1% of the estimated northwest European breeding population in pairs from data in Koskimies (1991), Lloyd et al. (1991), Lyngs (1992), Risberg (1990) and multiplied by a factor 3 according to Rose & Scott 1994)) were estimated in the northeast Djursland area and Middelgrunde in autumn and on Kummel Banke, Middelgrunde and the Norwegian Trench in winter.

Dispersion

The species was very concentrated in a few

small and larger areas, outside of which very few birds were recorded. In general, the birds were observed individually or in small flocks, but flocks of up to 5,000 birds were recorded. Razorbills more often occured in flocks than Guillemot.

General comments
No birds were observed in late summer as the entire North Sea population of Razorbill moults in an area off northeast Scotland (Tasker et al. 1987). The large numbers recorded northeast of Djursland supported land-based observations at Fornæs, from where up to about 100,000 Razorbills were recorded in one day in autumn 1988 (Christensen et al. 1990) and 115,000 in autumn 1989 (C. M. Olsen pers. com.).

Due to aggregation of birds in a few relatively small areas and difficulties in achieving satisfactory coverage of these areas, the numbers estimated during 1987-1989 must be regarded as a minimum. Only in the winter of 1989, the areas seemed to be well covered.

The high numbers in the Danish waters coincide temporarily with comparatively small numbers in other known areas for Razorbills in the Atlantic (Tasker et al. 1987, Webb et al. 1990).

Compared with the north European post-breeding population estimated to number 0.8-1.4 million birds (from Koskimies 1991, Lloyd et al. 1991, Lyngs 1992, Risberg 1990), up to 15% was estimated in the studied part of the North Sea and up to 36% were estimated in Kattegat.

Seasonal and geographical variations
The results showed larger movements of Razorbill into eastern Skagerrak and Kattegat than for Guillemot, even though Razorbill mainly comes from outside Danish waters.

Black Guillemot *Cepphus grylle*

Total numbers
The estimated totals in the entire area were up to 12,500 birds in winter and 3,400 birds in spring. In autumn, only the North Sea and Kattegat were surveyed leading to estimates of up to 1,250 birds, whereas in late summer, Black Guillemot was not recorded (App. XLIII). Black Guillemot was only occasionally recorded in countrywide aerial surveys.

Geographical distribution
In all seasons, the birds were confined to Kattegat and the Baltic Sea with a few additional recordings in the North Sea. No birds were recorded in the Straits (Fig. 58). The birds in Kattegat were concentrated mainly around Læsø, whereas in the Baltic Sea, the birds were concentrated on Rønne Banke and to some extent in Femer Bælt.

In Kattegat, the autumn and winter populations gathered as well in the large shallow areas south of Læsø as around the breeding sites north of Læsø, while in spring, the birds were restricted to near the colonies north of Læsø. The southwestern part of Kattegat, with breeding colonies on Vejrø and Sejrø (Asbirk 1988), was not surveyed.

Numbers in geographical sections
In Kattegat, the numbers were fairly constant apart from the winter of 1988 (2,150 birds estimated) ranging from 720 to 1,350 birds.

The numbers in the Baltic Sea were much higher in the severe winter of 1987 (12,500 birds) than during the mild winter or spring surveys (1,250 and 1,750 birds, respectively). The Baltic Sea was not surveyed in autumn.

Internationally important numbers of >2,800 birds (calculated on the basis of 1% of the number of breeding pairs in northern Europe (from Golovkin 1984, Koskimies

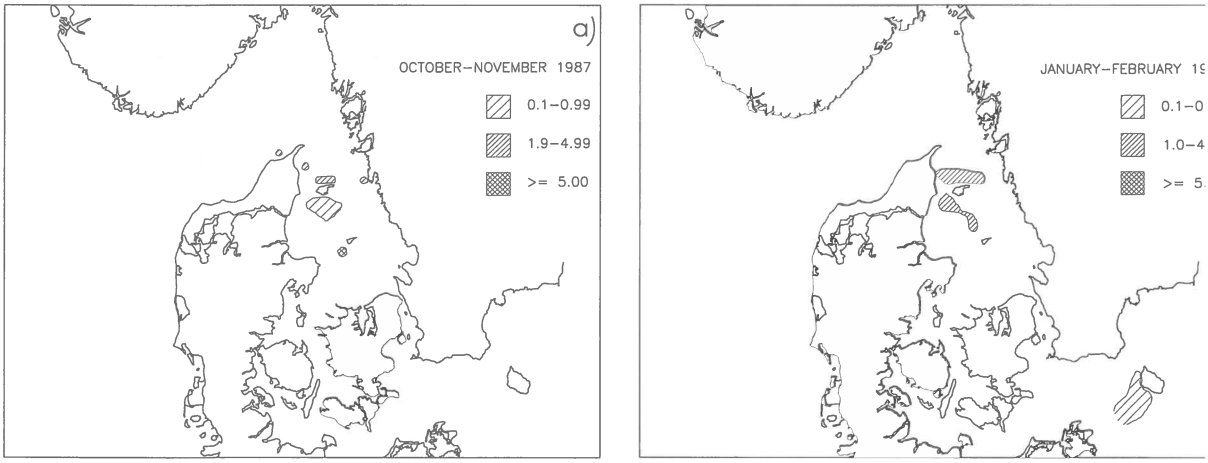

Fig. 58. Distribution and density of Black Guillemot in Danish waters during autumn 1987 (a) and winter 1988 (b), based on results obtaine from ship surveys.

(1991), Lloyd et al. (1991) multiplied by a factor 3 according to Rose & Scott (1994)) were recorded on Rønne Banke in the severe in 1987.

Dispersion
The birds were generally dispersed within well defined and limited areas.

General comments
The Black Guillemots breeding in Kattegat form a relatively isolated population of the sub-species *C. g. atlantis* estimated at 1,100 pairs (Jönsson 1989) equalling about 3,300 birds when multiplied by a factor 3 according to Rose & Scott (1994). Up to 65% of this population was estimated in Kattegat during the 1987-1989 study. Compared with the northwest European population of Atlantic Black Guillemot *C. g. atlantis* estimated at 275,000 birds on the basis of data in Golovkin (1984), Koskimies (1991) and Lloyd et al. (1991), less than 1% occurred in Danish waters.

The birds occurring in the Baltic Sea belong to the sub-species *C. g. grylle* estimated at c. 18,000 pairs (Koskimies 1991, Risberg 1990) and equalling 54,000 birds when multiplying with a factor 3. The birds recorded in the Baltic Sea were believed to be almost exclusively birds belonging to the nominate race. In the severe winter of 1987, 22% of the estimated population were recorded in the surveyed area.

Seasonal and geographical variation
An analysis of recoveries of ringed Black Guillemots showed that the Kattegat population is largely sedentary with local movements only within the Kattegat area (Jönsson 1989). Even though some essential areas in southwest Kattegat were not covered during the 1987-1989 study, it seems that numbers obtained in a total coverage would not have surpassed the numbers in the Kattegat population. This supports the idea that there is no measurable influx of birds from other populations into Kattegat (Jönsson 1989).

The results from the Baltic Sea indicated that the birds assemble in the western parts particularly on Rønne Banke (Skov et al. 1987) in severe winters when extensive ice covers the eastern and northern parts of the Baltic Sea. In mild winters and springs, the birds are dispersed all over of the Baltic Sea.

Little Auk *Alle alle*

Total numbers
The estimated totals in the entire area were up to 250,000 birds in autumn and 1.1 million birds in winter. In late summer and spring, the species was rarely recorded (App. XLIV).

Geographical distribution
The birds were in all seasons confined almost to the North Sea mainly concentrated in the convergence zone of the Norwegian Trench with a sharp decline in numbers in the shelf area south of the Trench (Fig. 59). Comparatively small numbers were also recorded in Kattegat.

Numbers in geographical sections
In the Norwegian Trench area, the estimated totals were 30 birds in summer and up to 250,000 in autumn, while an unknown number occurred here during winter. The lack of

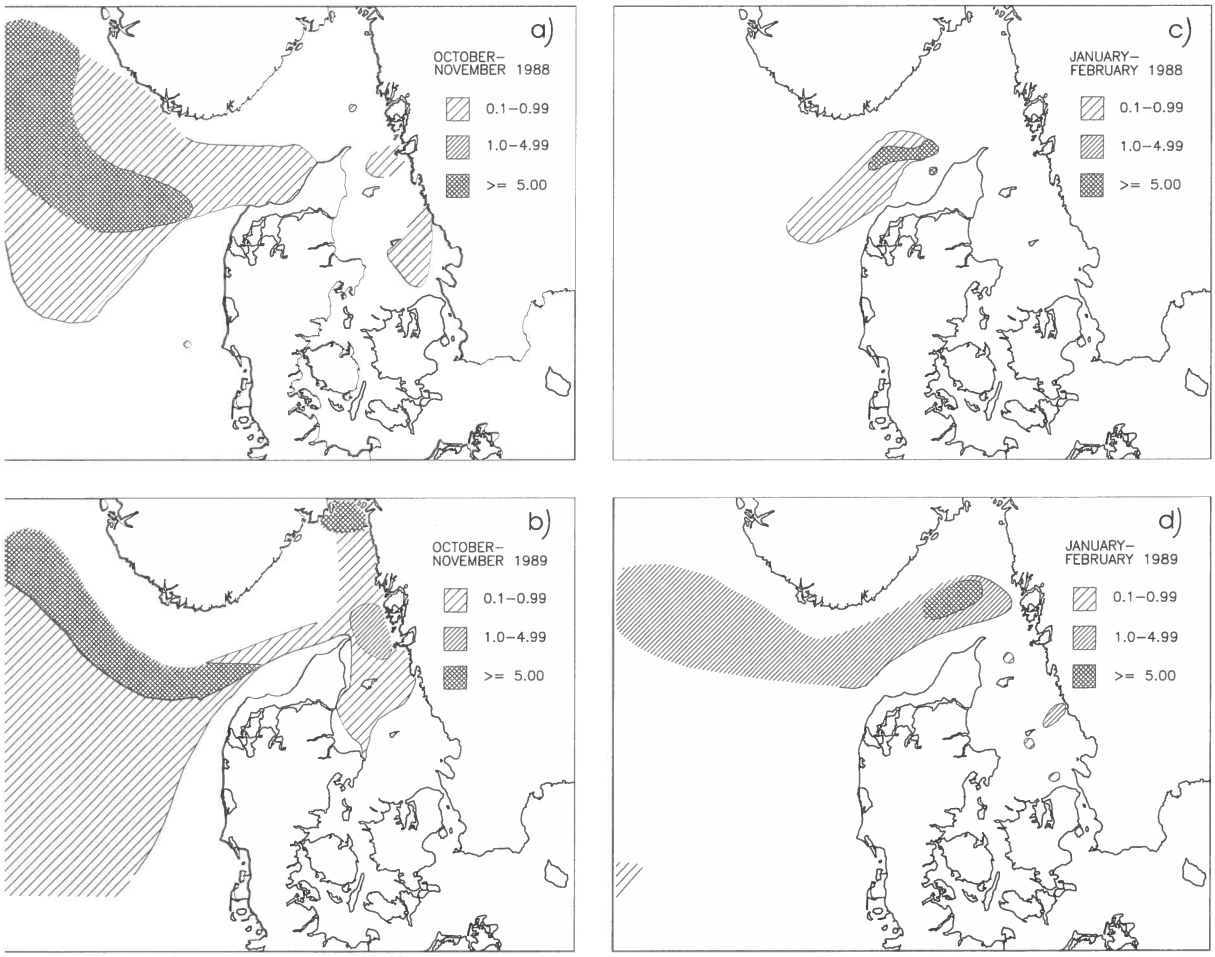

Fig. 59. Distribution and density of Little Auk in Danish waters during autumn 1988 (a), 1989 (b), and winter 1988 (c), 1989 (d), based on results obtained from ship surveys.

a winter estimate is due to insufficient coverage during this season. Maximum densities were 1600 birds/km² in the winter of 1989 which indicate a clearly higher total number than in any of the autumn surveys.

During both autumn surveys, the core of the concentrations was recorded in the western part of the Norwegian Trench west of 9°E., while in winter 1989, the birds were concentrated in the central parts of the Trench.

Due to the lack of a Western Palearctic population estimate in winter, the international importance of these numbers could not be derived from the results. We believe, however that the concentrations in parts of the Norwegian Trench area were of international importance.

Dispersion
The species was generally dispersed within well defined and limited areas. Most birds were observed solitary or in small flocks.

General comments
The variation in the estimated numbers during the study period does not necessarily reflect any changes in numbers of birds in the study area. The higher numbers estimated in late 1988 and 1989 were most likely merely results of better coverage of the study area in these two years.

Large numbers of Little Auk have recently been observed from land in southern Norway and northern Denmark (Pedersen & Christoffersen 1987). Anecdotal information from fishermen in Skagerrak indicates that Little Auk has been abundant in the area for decades, suggesting that there has been no recent changes in the numbers of Little Auk in the study area.

Compared with the total breeding population in the northeast Atlantic estimated at 2-4 million birds by Nettleship & Evans (1985), up to approximately 25% were recorded in the Norwegian Trench area.

Seasonal and geographical variation
Apparently, the first birds arrive in late summer, with numbers building up through autumn and peaking in winter.

Puffin *Fratercula arctica*

Total numbers
The estimated totals in the entire area were up to 150 birds in late summer, 900 birds in autumn and 10,000 birds in winter, while no complete survey of the relevant waters was performed in spring (App. XLV).

Geographical distribution
Almost all birds were confined to the North Sea and mainly west of 5°E in all seasons. Low numbers were also recorded in Skagerrak. In Kattegat, the species was rarely recorded, and it was not recorded in the Straits and the Baltic Sea.

Numbers in geographical sections
In the western parts of the North Sea, an increase in numbers was recorded from 25-100 birds in late summer to 500-900 birds in autumn and 10,000 birds in winter.

Internationally important numbers of >180,000 birds (calculated on the basis of 1% of the number of breeding pairs in northern Europe (from Lloyd et al. (1991) multiplied by a factor 3 (according to Rose & Scott 1994)) were not recorded during the 1987-1989 study.

Dispersion
In general, the birds occured in a dispersed manner and were observed solitarily or in small flocks.

General comments
The majority of birds was recorded in the westernmost part of the Danish sector,

which was the poorest covered area during the study. The numbers estimated should thus be considered an indication of the presence of Puffin only.

Compared with the estimated total breeding population in northern Europe which is counted in millions of pairs (Lloyd et al. 1991), much less than 1% was recorded during the 1987-1989 study.

Seasonal and geographical variation
The estimated totals were too small to show conclusive seasonal variations. Earlier British surveys in the North Sea showed that Puffins are distributed furthest to the east in the period October-May (Tasker et al. 1987).

CONCLUSIONS AND CLOSING REMARKS

The numbers of waterbirds in coastal areas have generally changed very little since aerial surveys were conducted in 1968-1973. Offshore waters have only been surveyed superficially prior to the 1987-1989 study, but particularly the inner sections of the Danish Sea area have, during our study, proven to be extremely important in all seasons to a large number of different European waterbird species.

Changes in total numbers

Compared with the results of former aerial surveys, Scaup, Long-tailed Duck, Velvet Scoter, Goosander and Coot have decreased in numbers. However, only in Long-tailed Duck and Velvet Scoter, the decreases are larger than may be ascribed to annual variations or redistribution to sites outside Danish waters. Even in Long-tailed Duck, the decrease was somewhat uncertain, as only a minority of the birds were surveyed during the aerial surveys.

In Velvet Scoter, there seemed to be a correlation between the decline in numbers moulting in Danish waters and the decline in numbers recorded in autumn. This indicated a change in strategy considering moult and autumn migration for the species. Thus, the decreasing numbers in Danish waters in autumn did not necessarily reflect a decrease in the northwest European winter population of Velvet Scoter.

The following species has been increasing in the period between the 1968-1973 and the 1987-1989 studies: Cormorant, Grey Heron, Shelduck, Eider and Common Scoter. The remaining coastal species were either stable: Mute Swan, Mallard, Pochard, Tufted Duck, Goldeneye and Red-breasted Merganser, or the trends were unknown. The latter group mainly consisted of species either migrating through the country and staying only in mild winters (dabbling ducks except Mallard) or species occurring in very small numbers (Steller's Eider, Smew).

The increases in numbers in Cormorant and Grey Heron reflected increased numbers in the Danish breeding population. The Danish breeding population of Shelduck was not monitored in the period, but the wintering numbers in western Europe have increased (Monval & Pirot 1989). The Baltic Sea Eider population including Danish birds has also been increasing (Franzmann 1989).

In offshore waters, the surveys established a base-line of knowledge concerning population levels in formerly little known areas. The population sizes of species of divers, grebes, seaducks, gulls and auks in Skagerrak, Kattegat and the shallow parts of the Baltic Sea were clearly higher than in the North Sea and in the deeper parts of the Baltic Sea. The important species include mussel-feeders, piscivores and planktivores.

Changes in geographical areas

Compared with the results of aerial surveys in 1968-1973, fewer birds were recorded

during the 1987-1989 study in only one section: Limfjorden (C). In this area, the numbers of several species had decreased, either in numbers of wing-feather moulting birds in late summer (Velvet Scoter, Goldeneye, Red-breasted Merganser), or in numbers of birds on migration (Scaup, Goldeneye) or in numbers of wintering birds (Goldeneye, Red-breasted Merganser). A huge eutrophication of Limfjorden, e.g. the outlet of nitrogen was doubled from 1974 to 1984 when it reached a level of 140 kg/ha (Christensen 1988), has caused annual oxygen decreases in summer. The total amount of fish caught in Limfjorden has decreased to about the half between the two studies (Hoffmann 1988) and the catch of Blue Mussels has doubled in the same period (Kristensen 1988). The eutrophication and the consequences described above may in part explain the decrease in numbers of birds between the two study periods. In all other sections of the Danish waters, the numbers of waterbirds were at least as large as during the 1968-1973 surveys, though the numbers of some species decreased in some sections or sub-sections, e.g. Mute Swan in Ringkøbing Fjord (Bb), Scaup in Lillebælt (Ja) and Sydfynske Øhav (Ka) and Eider in Storebælt (N) and the Wadden Sea (A).

In offshore waters, the most significant finding may be the strong gradient in the abundance of several pelagic species (except Gannet and Great Skua) from areas of low density in the large central part of the North Sea to high density areas in Skagerrak and Kattegat.

A number of species were found in high densities relatively far from land in extended shallow areas, both along the west coast and in the inner Danish waters. The surveys established that Red-throated and Black-throated Diver, Red-necked Grebe, Long-tailed Duck and Common and Velvet Scoter, inside their specific areas of concentration, occurred more or less evenly within areas of water depths from 5 to 25 m. Areas that held at least internationally important numbers are shown in Fig. 60 and 61.

Changes in time of migration

The results indicated a prolonged or later autumn migration for some seaduck species i.e. Eider, Common Scoter, Velvet Scoter (see also Noer (1991)). In the dabbling ducks, an earlier peak was found in eastern Denmark than in western Denmark for all species except Mallard. This might indicate that in the 1980's the birds stayed for a shorter period on the staging sites in eastern regions during autumn migration than they did in the 1960's. Among the reasons for a faster migration through eastern Denmark we hypothesise that human disturbance, with particular focus on hunting activities is included and this hypothesis is supported by results from a newly created study area without hunting activities where the time of rest of the dabbling ducks increased substantially (Madsen et al. 1992a, 1992b).

Migration routes

The flyway from Scandinavia/Russia via Limfjorden to United Kingdom is well known for species such as Light-bellied Brent Goose *Branta bernicla hrota* and Goldeneye. The results of the 1987-1989 study indicate that a similar migration pattern may be found in Scaup and possibly also in Red-breasted Merganser.
Winter and spring surveys off the Wadden Sea and along the west coast of Denmark indicated that Red-throated and Black-throated Divers use different routes during their spring migration; Red-throated Divers move along the northern coast of Denmark and Black-throated Divers move directly from the concentration area off the Wadden Sea into the Baltic Sea.

Wintering sites

The increase in numbers of Cormorants in Danish waters in winter indicates that a proportion of the Danish breeding population has started wintering in Denmark instead of migrating to the traditional winter quarters in the Mediterranean.

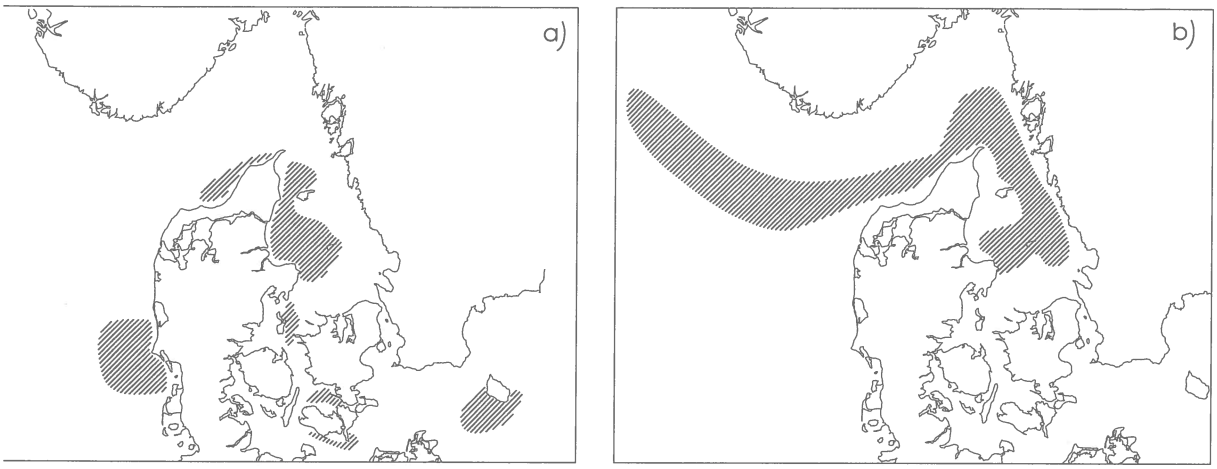

Fig. 60. Danish water areas of International importance for divers (a), auks (b).

The occurrence of Shelduck in Randers Fjord was differing greatly from the birds in the Wadden Sea during the 1987-1989 study as well as during the 1968-1973 aerial surveys; the difference concerned timing and stability in numbers, particularly in severe winters. This could indicate that the Randers Fjord population was discrete in relation to the rest of the Danish wintering population. The Scaup occurred nomadically in the Danish waters and generally in smaller numbers than during the 1968-1973 aerial surveys although an increase was recorded in Kattegat. We suggest that this increase should be ascribed to the influx of birds that formerly wintered in Scotland.

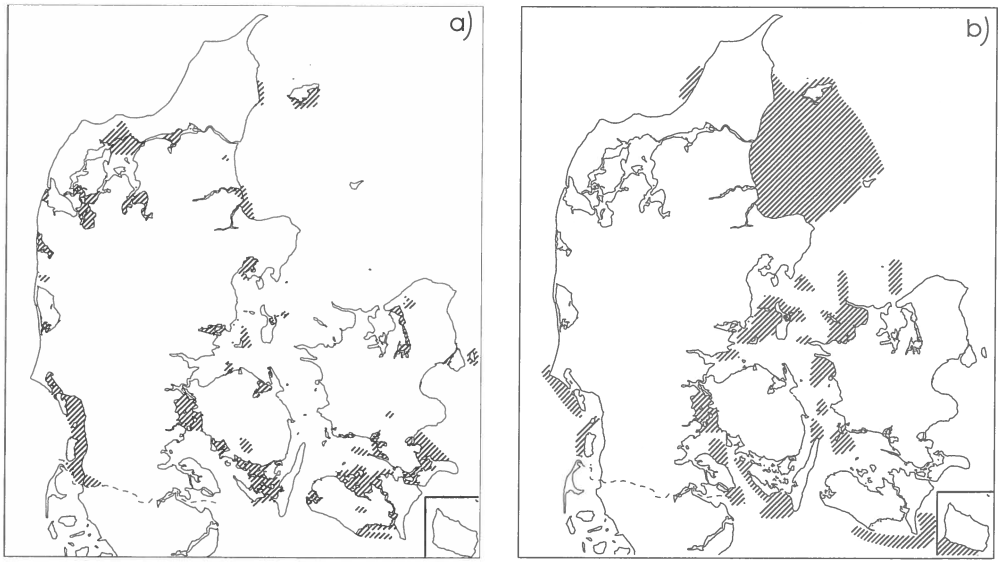

Fig. 61. Danish water areas of International importance for coastal waterbirds (a) and seaducks (b).

DANSK RESUME

Vandfugles antal og udbredelse i danske farvande 1987-1989

Indledning

De lavvandede kyst- og havområder omkring Danmark er et knudepunkt på vandfuglenes trækruter fra Skandinavien og Rusland til Sydeuropa og Afrika. Samtidig udgør de nogle af de allervigtigste overvintringspladser for vandfugle i Europa - for enkelte arter de vigtigste.

I perioden 1969-1973 gennemførtes seks landsdækkende optællinger af vandfugle fra flyvemaskine suppleret med tællinger fra land (Joensen 1974). Målet med disse optællinger var dels at få en talmæssig opgørelse af de enkelte vandfuglearters forekomst, dels at få kortlagt de vigtigste træk og overvintringsområder for vandfugle. Resultaterne dokumenterede Danmarks betydning for vandfugle og udgjorde senere en central del af grundlaget for udpegningen af Ramsarområder og EF-fuglebeskyttelsesområder.

Et øget behov for viden om vandfuglenes udbredelse bl. a. i relation til stigende olieefterforskning førte til, at Danmarks Miljøundersøgelser (den daværende Vildtbiologisk Station) i samarbejde med Skov- og Naturstyrelsen og Dansk Ornitologisk Forening i 1987 indledte et samarbejde. Formålet med dette samarbejde var i første omgang at få opdateret den eksisterende viden om størrelsen af de rastende vandfuglebestande i Danmark, da forandringer kunne være sket i den mellemliggende 15-års periode, hvor forurening og intensiveret olieefterforskning var blevet realiteter.

Derudover ønskedes en fornyet og mere detaljeret kortlægning af områdernes betydning for fuglene, og det var centralt at få belyst eventuelle ændringer i fuglenes udnyttelse af de enkelte områder.

Undersøgelsen i 1968-1973 havde kun i begrænset omfang dækket farvande uden for kystzonen, og det kunne ikke udelukkes, at der i de åbne havområder fandtes vigtige fugleområder, som ikke var beskrevet.

Den opfølgende kortlægning af fuglene i kystzonen skulle foretages med optællinger fra fly; i de indre danske farvande skulle vandfuglene optælles fra fly såvel som fra skib, mens vandfuglene i alle åbne havområder primært skulle optælles fra skib. Danmarks Miljøundersøgelser gennemførte optællinger af vandfugle fra flyvemaskine, mens Ornis Consult A/S udførte optællinger fra skib.

Metode og materiale

Optællinger af vandfugle fra flyvemaskine blev i perioden 1987-89 gennemført vinter (januar/februar), forår (marts/april), sensommer (august) og efterår (oktober/november). Om vinteren blev disse optællinger suppleret med optællinger fra land af søer og enkelte lukkede fjordafsnit, som var vanskelige at dække fra fly.

Den anvendte metode ved optællingerne var i det væsentlige den samme, som blev anvendt i 1968-1973, men der er i perioden 1987-1989 anvendt hurtigere fly med større tankkapacitet og flere siddepladser end i 1968-1973. Det gjorde det muligt at optælle med to observatører under alle flyvninger i 1987-1989. Optællingerne blev gennemført som totaloptællinger af samtlige fugle, som blev observeret, og så vidt muligt kun under optimale vejrbetingelser (jf. Pihl & Frikke 1992). Resultaterne blev indtastet på EDB, hvorefter udbredelseskort og forekomsttabeller blev udskrevet.

Optællingerne af vandfugle fra skib blev foretaget i hele det danske søterritorium i de samme perioder som optællingerne fra fly. Optællingerne fra skib blev gennemført som transektoptællinger, d.v.s. at fuglene blev optalt inden for et bånd af 150 meters bredde i 10 minutters intervaller. De opnåede resultater blev omregnet til fugletætheder, som senere dannede grundlag for beregning af antallene af fugle i givne områder (jf. Webb & Durinck 1992). Data opnået ved skibstællingerne blev lagret i en database, hvorefter tætheds- og antalsberegninger af de enkelte fuglearter i de enkelte delområder blev udført.

Resultater

Sensommer

I sensommeren fælder mange vandfugle deres fjer. Andefuglene fælder deres svingfjer på én gang (afslåede fugle) og er derefter ude af stand til at flyve i en periode på 4-7 uger, indtil nye

svingfjer vokser ud. Optællingerne fra fly resulterede i færre registrerede fugle end det kunne forventes for denne årstid på grundlag af punktvise optællinger af de danske kystområder fra 1965-74. Det gjaldt specielt for arterne fløjlsand, hvinand og toppet skallesluger. Det var først og fremmest i Limfjorden, at bestandene var mindre talrige, men det er tvivlsomt om disse faldende antal afspejler den reelle udvikling i fuglenes samlede ynglebestande.

Vi ved, at fuglenes krav til føde er store i fældningsperioden, men også at fuglene let lader sig forstyrre og skræmme bort. I de 15-20 år, der er gået siden undersøgelserne i 1968-1973, er vandkvaliteten gennem eutrofiering blevet stærkt forringet i Limfjorden og meget tyder på, at forøgede rekreative aktiviteter har skabt et højt forstyrrelsesniveau, som kan have været medvirkende til at presse de fældende fugle væk fra de traditionelt anvendte områder.

I områderne fjernt fra kysten har der derimod været indikationer på stigninger i antallene af fældende dykænder.

I disse havområder blev der fundet store koncentrationer af fældende mallemuk, lomvie og sildemåge i Skagerrak. Lomvierne blev allerede fra sidst i juli registreret som "familieflokke", der formentlig kommer fra kolonier i Skotland. Sule og storkjove var almindeligt forekommende i Nordsøen.

Efterår og forår

I træktiden flyver millioner af vandfugle igennem Danmark. Nogle bliver her hele vinteren, andre kun i få dage. En stor udskiftning blandt fuglene gør, at de øjebliksbilleder, der opnås ved optælling fra fly eller skib, ikke nødvendigvis er repræsentative for fuglenes antal i trækperioderne.

Optællinger efterår og forår er derfor også først og fremmest udført for at få en mere detaljeret viden om fuglenes foretrukne opholdssteder i Danmark, og kun i mindre grad for at få præcise oplysninger om antallene af fugle.

Vinter

Midvinteroptællinger giver for de fleste vandfuglearter den bedste mulighed for at vurdere de enkelte arters bestandsforhold; dels fordi fuglene om vinteren er mere stationære end på andre årstider, dels fordi de er koncentreret på relativt små områder.

Før resultaterne fra de to optællingsserier sammenlignes, er det vigtigt at præcisere, at specielt de klimatiske forhold om vinteren kan have indvirket på antal og fordeling af de enkelte arter. Milde vintre uden is giver fuglene et rigt udvalg af områder, hvor de kan overvintre. Den spredning af fuglene, som karakteriserer milde vintre, gør det samtidigt vanskeligere at foretage dækkende optællinger.

I strenge vintre med tilfrysning af søer, fjorde og lejlighedsvis også havområder flyver en række arter væk fra Danmark til sydligere områder. De tilbageværende fugle samles i åbentvandsområder, hvor de bliver suppleret med tilflyvende fugle, der fra nordlige og østlige områder "presses" herned af isdække. Optællinger fra skib er selvsagt vanskelige at gennemføre ved tilfrysning af større havområder.

Der er stor forskel på, hvor godt optællingerne dækker de enkelte vandfuglearters foretrukne opholdssteder. En art som ederfugl, som udelukkende findes ved kysten og i lavvandede områder, er særdeles godt dækket ved optællingerne, mens en art som krikand, der udover søer og kystområder, også opholder sig på en lang række indlandslokaliteter, kun bliver delvist dækket ved optællingerne.

Ændringer i antal

Om vinteren var antallet af vandfugle i kystområderne i perioden 1987-1989 ikke væsentligt forskelligt fra de resultater, der blev opnået fra fly i 1968-1973. De åbne havområder har tidligere kun været sporadisk undersøgt, men den foreliggende undersøgelse påviser, at specielt de indre farvande er vigtige for en lang række europæiske vandfuglearter.

Om efteråret blev nedgange i antal registreret for bjergand, havlit, fløjlsand og blishøne, om vinteren for bjergand og stor skallesluger ved en sammenligning med resultaterne af optællingerne i 1968-1973. Kun for fløjlsand er disse ændringer større end, hvad der kan forklares som årlige variationer eller omfordeling mellem Danmark og andre nordeuropæiske lande.

For fløjlsand synes der at være en forbindelse mellem det mindre antal fældende fugle og det faldende antal om efteråret. Det kunne tolkes som en ændring i artens "strategi" i forbindelse med fældning og efterårstræk. De mindre antal afspejler derfor ikke nødvendigvis en faldende population i Nordvesteuropa.

Forøgede antal i forhold til resultaterne fra optællingerne i 1968-1973 er registreret for: skarv, fiskehejre, gravand, ederfugl og sortand. Blandt de øvrige kystfuglearter forekom følgende i uændrede antal: knopsvane, gråand, taffeland, troldand, hvinand og toppet skallesluger, mens bestandsudviklingen for de resterende må

betragtes som værende ukendt. De sidstenævnte arter omfatter først og fremmest de arter, som trækker igennem Danmark i store tal, og som kun bliver i landet i milde vintre, dvs. de øvrige svømmeandearter, og dem, der forekom i meget små antal, f. eks. stellersand og lille skallesluger.

De større antal af skarv og fiskehejre, som blev registreret ved optællingerne fra fly, afspejler en stigning i antallet af ynglepar i Danmark af de to arter. Den danske ynglepopulation af gravand er ikke optalt i 1987-1989, men arten er forøget i antal i det vestlige Europa. Østersøbestanden af ederfugl har indtil for få år siden været stigende.

I de åbne havområder blev der ved denne undersøgelse opnået et grundlæggende kendskab til fuglenes fordeling og antal i disse dårligst kendte områder. Bestandene af lommer, lappedykkere, havdykænder, måger og alkefugle var langt højere i Skagerrak, Kattegat og de lavvandede dele af Østersøen end i Nordsøen og de dybe dele af Østersøen. Koncentrationer af lommer, gråstrubet lappedykker, sortand og dværgmåge blev registreret i området ud for Vadehavet.

Ændringer i enkeltområder

Kun i Limfjorden (Fig. 3, område C) blev der konstateret en tilbagegang i antallet af fugle i forhold til resultaterne af undersøgelsen i 1968-1973. Dette gjaldt såvel for fældende fuglearter i sensommeren (fløjlsand, hvinand, toppet skallesluger) som fuglearter på træk (bjergand, hvinand) og for overvintrende fuglearter (hvinand, toppet skallesluger). En øget udledning af næringssalte, hvoraf f. eks. kvælstof blev fordoblet fra 1974 til 1984 (Christensen 1988), har ført til omfattende iltsvind i flere områder af Limfjorden i sensommeren. Det totale antal fisk fanget i Limfjorden er i perioden mellem de to serier af vandfugleoptællinger fra fly halveret (Hoffmann 1988), mens den totale mængde landede blåmuslinger er fordoblet i den samme periode (Kristensen 1988). Dette har formodentlig bidraget til, at antallet af fugle er faldet fra 1968-1973 til 1987-1989.

Mens antallene af vandfugle i alle andre danske kystområder var på de samme eller højere niveauer end i 1968-1973, udviste enkelte arter faldende antal i enkelområder eller delområder, f. eks. knopsvane i Ringkøbing Fjord (Fig. 3, område Bb), bjergand i Lillebælt (Fig. 3, område Ja) og Det Sydfynske Øhav (Fig. 3, område Ka), ederfugl i Storebælt (Fig. 3, område N) og i Vadehavet (Fig. 3, område A).

I de åbne havområder var de vigtigste resultater fundene af meget store koncentrationer af mallemuk, ride, alk, lomvie og søkonge. Den sidstnævnte art blev i det centrale Skagerrak estimeret til mere end 1 million fugle.

Flere arter blev registreret i store tætheder relativt langt fra land langs Jyllands vestkyst og i de indre danske farvande. Optællingerne viste, at rødstrubet og sortstrubet lom, gråstrubet lappedykker, havlit, sortand og fløjlsand inden for deres udbredelsesområde forekom ligeligt på vanddybder på 5-25 m. De områder, hvor internationalt betydningsfulde antal forekom, er angivet i Fig. 60 og 61.

Ændring i træktider

Resultaterne af optællingerne i 1987-1989 antyder en forlænget efterårstrækperiode for ederfugl, sortand og fløjlsand i forhold til i 1968-1973 (se også Noer 1991).

For alle arter af svømmeænder undtagen gråand forekom maksimumsforekomster om efteråret tidligere i Østdanmark end i Vestdanmark. Dette kunne antyde, at opholdstiden på rastepladserne i Østdanmark er kortere end i Vestdanmark. En mulig forklaring på denne antydede forskel kunne være forstyrrelse foranlediget af jagt. Denne fortolkning støttes af resultater opnået i forsøgsområderne på Møn/Nyord og i Nibe/Gjøl Bredning, hvor et jagtforbud dels forøgede antallet af tilstedeværende fugle, dels forlængede den tid de rastede i de jagtfri områder (Madsen et al. 1992a, 1992b).

Trækruter

Resultaterne af denne undersøgelse indikerer, at den trækrute fra Skandinavien/Rusland via Limfjorden til De Britiske Øer, som benyttes af lysbuget knortegås og hvinand også bruges, eller snarere har været brugt, af bjergand og måske af toppet skallesluger.

Vinter- og forårsoptællinger fra skib af området ud for Vadehavet og langs Jyllands vestkyst synes at vise, at rødstrubet og sortstrubet lom anvender forskellige trækruter om foråret. Mens rødstrubet lom følger den jyske vestkyst nordpå, flyver sortstrubet lom fra koncentrationsområdet ud for Vadehavet østpå over land til Østersøen.

Alkene foretager i modsætning til lomvierne fældningen i nærheden af ynglepladserne og ankommer først i november til de danske overvintringsområder i Kattegat.

Overvintringsområder

Den store stigning i antal skarver i de danske farvande om vinteren tyder på, at en del af de

danske ynglefugle er begyndt at overvintre i Danmark, snarere end at flyve til de traditionelle overvintringspladser i Middelhavet.

Forekomsten af gravand i Randers Fjord/Mariager Fjord fulgte et ganske andet mønster end fuglene i Vadehavet under såvel denne som den tidligere undersøgelse. Forskellen kom til udtryk i den tidsmæssige forekomst og stabiliteten i antal, specielt i hårde vintre. Resultaterne tyder på, at fuglene ved Randers Fjord er isoleret set i forhold til resten af den danske vinterbestand.

Bjergand forekom nomadisk i de danske farvande og generelt i mindre antal end i perioden 1968-1973. Kun i Kattegat blev der registreret større antal end i 1968-1973, og det anses for sandsynligt, at stigningen skyldes tilgang af fugle, som tidligere overvintrede i det østlige Skotland.

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APPENDICES

Appendix I. Coverage (in %) of the 14 sections of Danish waters in countrywide aerial surveys during late summer (LS), autumn (A), winter (W) and spring (SP) 1968-1973 and 1987-1989. A coverage of 100% indicates that all count areas in the section are surveyed.

		Coverage in % according to season and year															
Section count	No. of count areas	A 68	W 69	A 69	W 70	W 71	W 73	W 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	SP 89	A 89
A	52	73%	77%	85%	92%	87%	87%	100%	100%	100%	100%	98%	98%	98%	100%	100%	100%
B	31	87%	94%	97%	94%	97%	94%	94%	81%	94%	94%	100%	100%	100%	52%	100%	100%
C	91/95	96%	90%	92%	95%	93%	96%	98%	91%	98%	98%	98%	96%	100%	99%	99%	100%
E	59	85%	81%	85%	90%	90%	92%	98%	93%	98%	98%	98%	97%	98%	93%	98%	97%
F	116	81%	84%	69%	87%	90%	92%	98%	84%	98%	99%	98%	72%	94%	97%	98%	97%
J	78	94%	90%	99%	99%	94%	96%	95%	85%	95%	91%	94%	99%	96%	99%	100%	100%
K	56	91%	93%	96%	93%	84%	98%	91%	98%	98%	89%	95%	96%	100%	100%	100%	98%
M	55	82%	91%	93%	89%	85%	95%	100%	96%	93%	98%	98%	95%	100%	98%	95%	96%
N	33	61%	97%	97%	88%	97%	94%	94%	100%	91%	100%	100%	97%	100%	91%	91%	94%
O	52/86	85%	92%	96%	92%	92%	98%	99%	93%	95%	98%	88%	84%	99%	97%	98%	98%
R	36	75%	81%	67%	47%	75%	47%	100%	69%	100%	100%	100%	67%	94%	97%	100%	97%
S	44	75%	91%	86%	89%	91%	86%	95%	95%	93%	91%	98%	95%	95%	98%	84%	93%
In total	703/741	84%	88%	87%	89%	90%	91%	97%	90%	96%	96%	96%	90%	98%	96%	97%	98%

Appendix II. Numbers of Red-throated/Black-throated Diver estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS) and autumn (A), winter (W), spring (SP) 1987-1989. Estimates are obtained by multiplying density results (birds/km²) with size of area covered (in km²). Estimated numbers in brackets indicate that the surveyed area is only partly covered. Density indicates mean density in areas where the birds are actually found.

		Estimated numbers according to season and year									
Areas surveyed		W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
NORTH SEA											
Off the Wadden Sea	*Density*	*1.4*			*1.0*	*1.1*	*5.0*	*0*	*1.2*	*1.7*	*6.8*
	Estimate	27,000			1,700	7,500	28,500	0	2,200	(2,040)	(510)
Westcoast of Jutland	*Density*				*0*	*0.2*	*2.0*	*0*	*0*	*0*	*1.1*
	Estimate				0	750	4,300	0		0	80
Jammerbugt	*Density*			*0*	*0.6*	*0.7*	*1.7*	*0*			*0.5*
	Estimate			0	30	150	4,500	0			160
Tannisbugt	*Density*	*0.7*		*0*	*1.2*	*3.4*	*1.1*	*0*		*0.3*	
	Estimate	1,000		0	210	240	190	0		340	
Ålbæk Bugt	*Density*	*0.7*	*1.6*	*0*	*0.6*	*1.5*	*0.5*	*0*		*0.3*	
	Estimate	1,800	(180)	0	140	100	380	0		1,000	
Residual population		200				460			500		
In total		30,000		0	2,080	9,200	37,870		2,700	3,380	750
KATTEGAT											
Kattegat NW	*Density*		*0.7*	*0*	*0.4*	*0.6*		*0*	*2.0*		*0.9*
	Estimate		5,320	0	870	700		0	4,500		4,400
Middelgrunde	*Density*		*0.9*	*0*	*0*	*0*		*0*	*0*	*0*	*0*
	Estimate		(40)	0	0	0		0	0	0	0
Kattegat SW	*Density*		*1.2*		*0*	*1.1*	*2.2*	*0*		*0*	*0*
	Estimate		(1,140)		0	100	1,600	0		0	0
Kullen/Skälderviken	*Density*		*0.5*		*0*	*1.2*		*0*	*0.9*	*0.9*	
	Estimate		(270)		0	(30)		0	(100)	1,400	
Residual population					30	70	(100)	0	(0)		
In total			6,770	0	900	900	(1,700)	0	4,600	1,400	4,400
STRAITS											
Smålandsfarvandet	*Density*					*4.5*	*0.5*				
	Estimate					1,200	350				
Residual population						200	1,050				
In total		0	0			1,400	1,400	0			
BALTIC											
Femer Belt	*Density*	*0*	*0.5*			*1.5*	*0.6*	*0*			
	Estimate	0	20			700	350	0			
Rønne Banke	*Density*	*1.4*				*0.4*	*0.5*			*0.9*	
	Estimate	(6,400)				(200)	(350)			(180)	
Residual population		(2,300)				20	900				
In total		(8,700)				920	1,600	0			
OVERALL TOTAL ~		38,700			2,980	12,420	42,570	0	7,300	4,960	5,150

Appendix III. Numbers of Great Crested Grebe estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 12).

		Estimated numbers according to season and year									
Areas surveyed		W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
NORTH SEA											
Off the Wadden Sea	*Density*	*0*			*0.7*	*0.5*	*0*	*0*	*0*	*0*	*0*
	Estimate	0			20	40	0	0	0	0	0
Residual population		0		0	0	60	0	0	0		
In total		0		0	20	100	0	0	0		
KATTEGAT											
Kattegat NW	*Density*		*0*	*0*	*0*	*0.6*		*0*			*0*
	Estimate		0	0	0	10		0			0
Residual population		0	0	0	0	40		0			0
In total		0	0	0	0	50	(0)	0			0
STRAITS, in total		0	0			10	0	0			
BALTIC											
Femer Belt	*Density*	*1.2*	*0*			*0*	*0.1*	*0*			
	Estimate	(4,750)	0			0	20	0			
Rønne Banke	*Density*	*1.1*				*0*	*0*			*0*	
	Estimate	(4,700)				0	0			(0)	
In total		(9,450)				0	20	0			
OVERALL TOTAL ~		9,500			20	160	20	0	0	(0)	(0)

Appendix IV. Numbers of Red-necked Grebe estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 13).

		Estimated numbers according to season and year									
Areas surveyed		W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
NORTH SEA											
Off the Wadden Sea	*Density*	*0*			*0.6*	*0.4*	*0*	*0*	*0*	*0*	*0*
	Estimate	0			320	650	0	0	0	(0)	(0)
In total		0		0	320	650	0	0	0	0	
KATTEGAT											
Kattegat NW	*Density*		*0.25*	*0*	*0.9*	*0.5*		*0*			
	Estimate		500	0	960	700		0			3,600
											0
Residual population			0	0	20	0	(0)	0			0
In total			500	0	980	700	(0)	0			3,600
STRAITS, in total		0	190			290	360	0			
BALTIC											
Femer Belt	*Density*	*0*	*0*			*0.8*	*0*	*0*			
	Estimate	0	0			130	0	0			
Rønne Banke	*Density*	*0*				*0*	*0*			*0*	
	EstiMate	0				0	0			(0)	
Residual population		0				0	170	0		(0)	
In total		0				130	170	0			
OVERALL TOTAL ~			690		(1,300)	1,070	530	0			3,600

Appendix V. Numbers of Fulmar estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 14).

		Estimated numbers according to sason and year									
Areas surrveyed		W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
NORTH SEA											
Norske Rende-convergense	*Density*	*0.8*	*0.3*	*7.5*	*9.3*	*7.7*	*8.5*	*7.5*	*2.4*	*6.8*	*3.7*
	Estimate	(8,000)	(5,000)	(230,000)	(95,000)	(20,000)	(25,700)	223,500	72,000	290,000	215,000
Norske Rende-coastal	*Density*	*0*	*0*	*1.0*	*1.0*	*0.2*	*0.2*	*0.4*	*0*		
	Estimate	0	0	(10,000)	(10,000)	(1,000)	(1,000)	4,000	0		
Norske Rende-edgeW	*Density*	*0.8*		*7.5*	*9.3*	*7.7*		*7.5*	*2.4*	*1.1*	*3.7*
	Estimate	(4,000)		(90,000)	(95,000)	(16,000)		112,500	70,000	25,000	140,000
Residual population		(20,000)	(10,000)	(5,000)	(180,000)	(35,000)	(9,000)	28,000	70,000	42,000	90,000
In total		(32,000)	(15,000)	(335,000)	(380,000)	(72,000)	(35,700)	368,000	212,000	357,000	445,000
KATTEGAT, in total		0	0	0	0	0	0	100	0	20,000	100
OVERALL TOTAL ~		(32,000)	(15,000)	(335,000)	(380,000)	(72,000)	(35,700)	368,000	212,000	377,000	445,000

Appendix VI. Numbers of Gannet estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 15).

		Estimated numbers according to season and year									
Areas surveyed		W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
NORTH SEA											
North Sea W	*Density*	*0*	*0.08*	*0.26*	*0.1*	*0.6*		*0.26*	*0.05*	*0*	*0.15*
	Estimate	(0)	(160)	14,300	(6,000)	(50)		10,500	3,500	0	13,000
Residual population		(0)	(0)	6,300	(100)	(0)	(0)	4,000	100	0	9,000
In total		(0)	(160)	20,600	(6,100)	(50)	(0)	14,500	3,600	0	22,000
KATTEGAT, in total		(0)	(0)	0	0	0	0	30	0	0	0
OVERALL TOTAL		(0)	(160)	20,600	(6,100)	(50)	(0)	14,530	3,600	0	22,000

Appendix VII. Numbers of Cormorant estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year including % of total in section																							
Section	LS 87	%	LS 88	%	LS 89	%	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	Mean LS	Mean A	Mean* W	Mean SP
A	281	1	518	2	868	2	1	0	24	0	0	0	0	0	0	0	0	0	19	0	1.6	0.1	0	0.1
B	829	4	397	1	470	1	1	0	4	0	0	0	0	0	3	0	80	1	113	1	2.1	0	0	0.8
C	1,764	8	885	3	2,098	5	9	0	9	0	0	0	8	0	60	1	24	0	727	4	5.3	0.1	0.3	2.3
D	0	0	0	0	0	0	0	0	0	0	44	1	0	0	0	0	0	0	0	0	0	0	0	0
E	2,104	10	3,702	12	3,026	7	937	10	1,155	9	537	7	963	17	1,290	12	616	6	1,939	12	9.5	9.4	1.1	9.0
F	3,180	15	7,960	25	12,139	28	2,148	22	5,884	47	1,757	23	2,311	39	5,243	47	5,646	58	5,462	33	22.6	34.2	43.4	45.5
J	1,455	7	2,730	9	6,033	14	461	5	853	7	344	4	432	7	1,200	11	134	1	1,365	8	9.7	5.7	9.1	4.8
K	1,623	8	3,193	10	2,507	6	1,029	10	999	8	899	12	154	3	671	6	854	9	1,678	10	7.8	9.2	4.4	9.5
M	2,615	12	2,830	9	4,032	9	557	6	243	2	9	0	231	4	376	3	724	8	3,229	19	10.1	3.8	3.7	13.4
N	824	4	2,310	7	3,301	7	525	5	1,896	15	399	5	698	12	881	8	532	6	969	6	6.2	10.2	10.0	5.7
O	4,105	19	3,609	11	5,504	12	2,164	22	655	5	14	0	63	1	37	0	35	0	521	3	14.4	13.7	0.7	1.8
R	1,805	8	2,549	8	2,197	5	846	9	136	1	251	3	4	0	127	1	122	1	27	0	7.2	4.9	0.6	0.8
S	842	4	835	3	1,865	4	1,105	11	790	6	2,060	26	785	13	985	9	966	10	574	4	3.6	8.8	11.1	6.7
T	59	0	0	0	0	0	15	0	0	0	1,500	19	236	4	180	2	0	0	3	0	0.1	0.1	2.8	0
Total	21,486	100	31,518	100	44,040	100	9,798	100	12,648	100	7,814	100	5,885	100	11,053	100	9,733	100	16,626	100	100.2	100.2	100.2	100.4
No. of areas hosting the species	311		353		452		166		172		133		131		189		214		316		372	169	160	265

* Except winter 1987

Appendix VIII. Numbers of Grey Heron estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year including % of total in section																							
Section	LS 87	%	LS 88	%	LS 89	%	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	Mean LS	Mean A	Mean W	Mean SP
A	43	5	31	2	99	5	13	2	2	0			6	1	3	0	4	1	12	2	4.0	1.1	0.5	1.0
B	254	32	290	20	312	14	42	6	120	15			27	3	62	6	40	5	84	10	21.9	10.5	4.5	7.7
C	282	35	465	32	715	32	261	40	294	36	7		213	25	307	29	152	20	402	48	33.1	37.8	27.2	34.1
D	0	0	0	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0
E	91	11	262	18	116	5	14	2	39	5			40	5	33	3	30	4	27	3	11.5	3.4	4.0	3.6
F	22	3	102	7	210	10	72	11	90	11	1		172	21	124	12	46	6	34	4	6.4	11.0	16.1	5.1
J	13	2	66	4	74	3	24	4	115	14			83	10	264	25	112	15	35	4	3.2	8.9	17.4	9.5
K	7	1	45	3	86	4	13	2	14	2			3	0	40	4	13	2	13	2	2.6	1.9	2.1	1.7
M	0	0	65	4	122	6	40	6	18	2			173	21	38	4	56	7	32	4	3.3	4.2	12.1	5.6
N	6	1	18	1	3	0	17	3	10	1			1	0	0	0	0	0	0	0	0.7	1.9	0.1	0
O	18	2	30	2	113	5	69	11	61	7			31	4	85	8	65	8	103	12	3.1	9.0	5.9	10.5
R	9	1	72	5	264	12	8	1	36	4			77	9	58	5	90	12	43	5	6.0	2.8	7.4	8.5
S	56	7	29	2	89	4	82	12	24	3			11	1	44	4	155	20	49	6	4.3	7.7	2.7	13.1
T	0	0	0	0	0	0	0	0	0	0	13		2	0	3	0	0	0	0	0	0	0	0.3	0
Total	801	100	1,475	100	2,203	100	655	100	823	100	21		839	100	1,061	100	763	100	834	100	100.1	100.2	100.3	100.4

Appendix IX. Numbers of Mute Swan estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year including % of total in section																							
Section	LS 87	%	LS 88	%	LS 89	%	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	Mean LS	Mean A	Mean* W	Mean SP
A	3	0	7	0	28	0	21	0	5	0	0	0	11	0	2	0	4	0	4	0	0	0	0	0
B	1,076	3	1,708	4	1,194	2	1,031	3	1,845	3	310	1	1,030	3	280	1	658	2	1,015	3	3.0	3.0	1.3	2.5
C	2,497	7	1,987	4	2,128	3	1,794	5	2,667	5	3,266	9	2,167	5	2,745	6	2,198	6	2,278	7	5.2	4.8	6.6	6.7
D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	163	0	127	0	102	0	1,485	4	1,411	2	1,759	5	1,594	4	807	2	1,648	5	1,244	4	0.3	3.2	3.5	4.3
F	4,115	12	3,812	9	5,191	9	3,081	8	4,026	7	2,662	7	3,635	9	3,416	7	3,011	8	2,143	7	9.9	7.7	7.8	7.6
J	658	2	2,237	5	2,265	4	2,384	6	3,560	6	2,345	6	2,100	5	2,967	6	2,215	6	1,911	6	3.6	6.3	5.9	6.2
K	4,646	14	6,307	15	5,892	10	3,228	9	3,718	7	5,434	15	4,444	11	3,460	7	2,334	6	2,525	8	12.7	7.6	10.9	7.3
M	8,146	24	11,178	26	17,175	29	12,392	34	17,919	31	7,925	21	10,308	25	12,110	26	10,334	29	7,460	24	26.3	32.2	24.0	26.3
N	475	1	731	2	997	2	1,046	3	1,775	3	1,893	5	1,117	3	905	2	1,013	3	1,122	4	1.6	2.9	3.2	3.2
O	7,793	23	9,757	23	15,291	26	6,289	17	11,916	20	6,763	18	8,336	20	12,738	27	4,710	13	6,042	19	23.8	18.8	21.8	16.2
R	4,501	13	4,690	11	8,487	14	3,223	9	7,816	13	3,373	9	4,477	11	6,366	13	5,585	16	4,688	15	12.8	11.1	11.1	15.3
S	240	1	322	1	412	1	775	2	1,623	3	994	3	1,507	4	1,599	3	2,131	6	919	3	0.7	2.5	3.3	4.4
T	8	0	0	0	0	0	32	0	0	0	244	1	71	0	171	0	33	0	117	0	0	0	0.4	0.3
Total	34,321	100	42,863	100	59,162	100	36,781	100	58,281	100	36,968	100	40,797	100	47,566	100	35,874	100	31,468	100	99.9	100.1	99.8	100.3
No. of areas hosting the species	208		311		314		308		382		234		411		470		476		509		278	345	441	493

* Except winter 1987

Appendix X. Numbers of Whooper Swan/Bewick's Swan estimated from countrywide aerial surveys in the 14 sections of the Danish waters during autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year including % of total in section																
Section	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	Mean A	Mean W	Mean SP
A	2		55		5	0	35	1	26	0	0		15			0.5	
B	239		502		111	4	907	18	495	9	252		0			10.3	
C	569		1,258		443	14	1,784	37	1,300	23	1,325		2			24.7	
D	0		0		0	0	0	0	0	0	0		0			0	
E	0		190		1,138	37	1,348	28	1,200	22	1,394		45			28.9	
F	0		23		9	0	280	6	396	7	58		92			4.4	
J	0		43		443	14	37	1	269	5	261		2			6.6	
K	0		12		277	9	0	0	374	7	23		20			5.2	
M	0		391		198	6	199	4	720	13	458		9			7.8	
N	0		15		0	0	41	1	132	2	0		0			1.1	
O	0		449		222	7	225	4	643	12	172		4			7.8	
R	0		130		265	9	0	0	21	0	141		0			3.0	
S	0		113		8	0	20	0	6	0	172		0			0.3	
T	0		0		2	0	2	0	0	0	0		0			0	
Total	810		3,181		3,121	100	4,878	100	5,582	100	4,256		189			100.6	
No. of areas hosting the species	13		91		58		56		189		90		19		52	77	55

Appendix XI. Numbers of Shelduck estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year including % of total in section																							
Section	LS 87	%	LS 88	%	LS 89	%	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	Mean LS	Mean A	Mean* W	Mean SP
A	2,492	78	5,970	59	5,779	47	23,560	85	20,896	65	85		8,290	45	8,682	28	5,351	18	5,432	21	61.2	74.7	36.4	19.4
B	36	1	182	2	1,394	11	67	0	248	1	0		161	1	1,836	6	1,657	5	741	3	4.7	0.5	3.4	4.1
C	278	9	281	3	1,211	10	479	2	1,299	4	0		1,619	9	3,117	10	3,134	10	3,562	14	7.1	2.9	9.4	12.0
D	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0
E	230	7	2,766	27	2,687	22	2,928	10	7,519	23	0		2,654	14	8,486	28	7,136	23	7,133	28	18.8	16.9	20.9	25.5
F	25	1	80	1	344	3	722	3	674	2	12		846	5	2,168	7	2,648	9	2,482	10	1.5	2.4	5.8	9.1
J	4	0	65	0	105	1	0	0	18	0	0		416	2	949	3	1,296	4	773	3	0.5	0.1	2.7	3.6
K	34	1	66	1	113	1	0	0	204	1	5		1,322	7	1,336	4	1,151	4	1,071	4	0.9	0.3	5.7	4.0
M	31	1	77	1	153	1	52	0	1,052	3	0		1,749	9	1,334	4	3,987	13	1,313	5	1.0	1.8	6.9	9.0
N	23	1	196	2	22	0	0	0	25	0	0		260	1	584	2	307	1	94	0	0.6	0.1	1.7	0.7
O	14	0	311	3	395	3	0	0	208	1	0		507	3	1,333	4	1,210	4	1,149	5	2.2	0.3	3.5	4.2
R	12	0	52	0	11	0	0	0	55	0	0		526	3	581	2	2,009	6	852	3	0.3	0.1	2.4	4.9
S	34	1	80	1	80	1	14	0	112	0	0		250	1	515	2	1,038	3	880	4	0.9	0.2	1.5	3.4
T	0	0	0	0	0	0	0	0	0	0	1		1	0	11	0	50	0	70	0	0	0	0	0.3
Total	3,213	100	10,126	100	12,294	100	27,822	100	32,310	100	103		18,601	100	30,932	100	30,974	100	25,552	100	99.7	100.3	100.3	100.2
No. of areas hosting the species	62		137		178		61		126		6		248		370		464		490		126	94	309	477

* Except winter 1987

Appendix XII. Numbers of Wigeon estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year including % of total in section																							
Section	LS 87	%	LS 88	%	LS 89	%	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	Mean LS	Mean A	Mean* W	Mean SP
A	1,007	28	887	21	90	2	21,590	54	18,572	50	0		3,055	29	7,519	39	14,523	34	19,348	43	17.0	52.2	34.1	38.8
B	797	22	786	19	930	23	1,005	3	1,390	4	0		56	1	1,647	9	4,179	10	2,730	6	21.2	3.2	4.5	8.0
C	1,830	50	560	13	1,771	45	9,827	25	13,264	36	0		4,804	46	7,332	38	16,125	38	15,149	34	35.9	30.2	42.0	36.0
D	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0
E	5	0	40	1	239	6	850	2	1,140	3	0		30	0	76	0	480	1	1,989	4	2.3	2.6	0.4	2.8
F	0	0	338	8	77	2	390	1	330	1	9		427	4	709	4	1,201	3	1,150	3	3.3	1.0	3.9	2.7
J	0	0	25	1	8	0	180	0	345	1	0		0	0	190	1	116	0	606	1	0.3	0.7	0.5	0.8
K	5	0	62	1	239	6	1,152	3	37	0	0		0	0	1,422	7	630	2	425	1	2.5	1.5	3.7	1.2
M	5	0	610	14	129	3	1,783	5	1,281	3	0		1,388	13	101	1	2,124	5	112	0	5.9	4.0	6.9	2.6
N	0	0	70	2	15	1	80	0	0	0	0		20	0	26	0	120	0	205	1	0.7	0.1	0.2	0.4
O	0	0	278	7	240	6	737	2	65	0	0		200	2	60	0	938	2	647	2	4.2	1.0	1.1	1.8
R	0	0	338	8	128	3	158	0	593	2	0		410	4	224	1	1,064	3	1,960	4	3.7	1.0	2.6	3.5
S	0	0	224	5	129	3	2,111	5	6	0	0		82	1	0	0	724	2	514	1	2.8	2.7	0.4	1.4
T	0	0	0	0	0	0	16	0	0	0	0		0	0	1	0	0	0	0	0	0	0	0	0
Total	3,649	100	4,218	100	3,995	100	39,879	100	37,023	100	9		10,472	100	19,307	100	42,224	100	44,835	100	99.8	100.2	100.3	100.0
No. of areas hosting the species	31		66		65		93		88		1		40		74		151		143		54	91	57	147

* Except winter 1987

Appendix XIII. Numbers of Teal estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year including % of total in section																							
Section	LS 87	%	LS 88	%	LS 89	%	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	Mean LS	Mean A	Mean* W	Mean SP
A	1,185	23	3,615	16	374	3	3,985	17	9,435	28	0		925	47	608	30	1,484	14	3,515	14	13.8	22.7	38.3	13.9
B	2,419	48	6,473	28	3,459	24	2,304	10	8,038	24	0		741	37	95	5	2,035	20	9,439	36	33.0	17.0	21.1	28.0
C	1,303	26	3,486	15	4,173	29	13,954	61	14,499	43	0		92	5	672	33	5,260	51	10,455	40	23.1	52.0	18.8	45.5
D	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0
E	0	0	1,028	4	294	2	4	0	11	0	0		4	0	0	0	0	0	632	2	2.1	0	0.1	1.2
F	100	2	580	2	1,084	7	320	1	271	1	20		207	10	37	2	72	1	752	3	4.0	1.1	6.1	1.8
J	45	1	255	1	114	1	1,034	5	890	3	30		0	0	273	13	156	2	42	0	0.9	3.6	6.7	0.9
K	0	0	1,171	5	279	2	194	1	73	0	0		0	0	87	4	346	3	150	1	2.3	0.5	2.2	2.0
M	10	0	2,314	10	2,660	18	500	2	73	0	0		0	0	200	10	152	2	74	0	9.5	1.2	4.9	0.9
N	0	0	1,200	5	130	1	0	0	51	0	0		0	0	10	1	15	0	25	0	2.0	0.1	0.2	0.1
O	20	0	1,205	5	781	5	246	1	305	1	0		3	0	14	1	650	6	380	2	3.7	1.0	0.5	3.9
R	15	0	819	4	471	3	110	1	3	0	1		0	0	4	0	26	0	606	2	2.7	0.3	0.1	1.3
S	0	0	1,138	5	743	5	300	1	23	0	0		0	0	30	1	90	1	109	0	3.3	0.7	0.7	0.7
T	0	0	0	0	0	0	1	0	0	0	5		10	1	4	0	6	0	0	0	0	0	0.4	0.1
Total	5,097	100	23,284	100	14,562	100	22,952	100	33,672	100	56		1,982	100	2,034	100	10,292	100	26,179	100	100.4	100.2	100.1	100.3
No. of areas hosting the species	45		120		117		54		83		4		22		54		92		125		94	69	38	109

* Except winter 1987

Appendix XIV. Numbers of Mallard estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring(SP) 1987-1989.

	Counted numbers according to season and year including % of total in section																							
Section	LS 87	%	LS 88	%	LS 89	%	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	Mean LS	Mean A	Mean* W	Mean SP
A	2,105	11	1,937	5	1,509	4	13,209	19	9,775	8	655	1	10,187	12	14,902	17	7,107	10	2,400	20	6.3	13.7	14.5	15.2
B	7,497	37	6,390	16	8,000	19	5,830	9	10,277	8	275	1	10,270	13	11,581	13	13,697	20	496	4	24.1	8.5	12.8	12.0
C	6,007	30	7,888	19	11,095	27	24,562	36	34,234	28	6,251	13	16,309	20	18,602	21	15,313	22	974	8	25.4	31.9	20.4	15.2
D	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	1,015	5	1,753	4	969	2	1,883	3	3,078	2	1,318	3	660	1	13,384	15	7,636	11	4,351	36	3.9	2.7	7.9	23.8
F	60	0	1,359	3	1,714	4	3,141	5	6,060	5	5,627	11	5,840	7	4,662	5	5,072	7	565	5	2.6	4.8	6.2	6.0
J	255	1	1,878	5	1,331	3	1,485	2	8,922	7	8,773	18	3,692	5	6,371	7	1,792	3	229	2	3.0	4.7	5.8	2.3
K	187	1	3,165	8	2,093	5	1,870	3	3,972	3	4,465	9	1,217	2	3,015	3	377	1	553	5	4.6	3.0	2.4	2.6
M	1,887	9	5,057	12	5,807	14	2,715	4	22,087	18	5,278	11	11,923	15	4,692	5	6,638	10	584	5	12.0	10.9	9.9	7.3
N	65	0	1,084	3	444	1	1,238	2	1,535	1	1,852	4	593	1	1,445	2	645	1	145	1	1.4	1.5	1.2	1.1
O	363	2	4,341	11	2,286	6	7,330	11	10,913	9	3,632	7	8,493	10	5,361	6	1,351	2	602	5	6.0	9.8	8.2	3.5
R	257	1	2,924	7	1,582	4	1,085	2	8,668	7	5,722	12	5,217	6	2,657	3	3,512	5	542	5	4.1	4.3	4.7	5.0
S	343	2	2,740	7	4,335	11	1,649	2	4,949	4	1,591	3	4,425	5	1,208	1	5,884	8	471	4	6.3	3.2	3.3	6.2
T	5	0	0	0	0	0	1,725	2	10	0	3,640	7	2,730	3	2,168	2	13	0	14	0	0	1.3	2.9	0
Total	20,046	100	40,516	100	41,165	100	67,732	100	124,480	100	49,079	100	81,556	100	90,048	100	69,037	100	11,926	100	99.7	100.3	100.2	100.2
No. of areas hosting the species	165		260		285		268		443		257		301		414		394		334		237	356	358	364

* Except winter 1987

Appendix XV. Numbers of Pintail estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year									
Section	LS 87	LS 88	LS 89	A 87	A 88	W 87	W 88	W 89	SP 88	SP 89
A	53	115		4,613	6,538		344	3,704	5,119	1,271
B		566	82	490	1,318			1,759	1,720	1,470
C		27	19	56	181		6	399	1,153	259
D										
E		17	10		133			50	10	441
F		21	5	50	26	16			158	178
J		1	4	15	15		5		6	11
K			16				5	70	59	9
M		8	18	15	48			25	183	8
N										20
O					26				22	67
R			49	4				31	25	4
S										16
T										
Total	53	755	203	5,243	8,285	16	360	6,038	8,455	3,753
No. of areas hosting the species	3	22	19	24	55	1	7	38	76	66

Appendix XVI. Numbers of Pochard estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year including % of total in section																							
Section	LS 87	%	LS 88	%	LS 89	%	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	Mean LS	Mean A	Mean* W	Mean SP
A	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
B	61	23	83	3	30	1	100	5	0	0	0	0	450	14	10	0	411	14	44	7	9.0	2.4	7.4	10.8
C	201	77	1,269	45	2,201	50	1,537	73	4,262	51	10	0	583	18	807	31	1,448	49	242	42	57.1	61.5	24.7	45.6
D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0	0	0	0	175	5	4	0	5	0	0	0	0	0	0	0	0.2	0
F	0	0	0	0	0	0	30	1	150	2	11	0	649	21	318	12	444	15	5	1	0	1.6	16.4	8.0
J	0	0	20	1	20	0	200	9	845	10	1,540	40	530	17	563	33	325	11	65	11	0.4	9.7	19.2	11.2
K	0	0	115	4	0	0	0	0	1,500	18	1,735	45	0	0	90	4	20	1	40	7	1.3	8.9	1.7	3.8
M	0	0	1,140	40	1,333	30	200	9	939	11	128	3	60	2	25	1	0	0	50	9	23.4	10.3	1.5	4.3
N	0	0	70	2	0	0	0	0	253	3	0	0	250	8	205	8	150	5	0	0	0.8	1.5	7.9	2.6
O	0	0	30	1	787	18	50	2	355	4	75	2	250	8	320	12	0	0	115	20	6.3	3.3	10.1	9.9
R	0	0	7	0	0	0	0	0	20	0	103	3	20	1	265	10	55	2	0	0	0.2	0.1	5.4	1.0
S	0	0	115	4	25	1	0	0	109	1	0	0	350	11	0	0	80	3	20	3	1.5	0.7	5.6	3.1
T	0	0	0	0	0	0	0	0	0	0	64	2	0	0	9	0	0	0	0	0	0	0	0.2	0
Total	262	100	2,849	100	4,396	100	2,117	99	8,441	100	3,841	100	3,146	100	2,617	100	2,933	100	581	100	100.0	100.1	100.3	100.3
No. of areas hosting the species	10		18		18		16		46		40		30		40		42		28		15	31	35	35

* Except winter 1987

Appendix XVII. Numbers of Tufted Duck estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year including % of total in section																							
Section	LS 87	%	LS 88	%	LS 89	%	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	Mean* LS	Mean A	Mean W	Mean SP
A	0		2	0	10	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0	0.3	0	0	0
B	1		84	4	6	0	15	0	75	0	5	0	39	0	493	0	276	0	353	1	2.4	0.1	0.3	0.7
C	10		305	16	1,837	78	2,383	9	6,545	7	62	0	1,456	2	2,427	3	2,349	3	2,923	9	47.0	8.0	2.3	6.0
D	0		0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	0		0	0	0	0	0	0	0	0	1,765	2	40	0	52	0	1,092	1	1,495	5	0	0	0.1	3.0
F	0		10	1	0	0	0	0	1,657	2	320	0	1,917	2	1,413	2	967	1	68	0	0.3	0.9	2.0	0.7
J	0		127	7	397	17	100	0	3,200	3	21,891	23	6,840	8	10,378	12	6,099	7	3,663	12	11.8	1.9	10.0	9.3
K	0		158	8	0	0	1,750	7	2,553	3	22,874	24	580	1	5,192	6	2,692	3	4,310	14	4.2	4.7	3.3	8.5
M	0		354	19	0	0	1,350	5	12,308	13	2,970	3	15,995	19	10,382	12	33,507	36	3,554	12	9.5	8.9	15.5	24.0
N	0		126	7	0	0	0	0	9,270	9	1,960	2	1,830	2	3,750	4	1,875	2	539	2	3.4	4.8	3.3	1.9
O	0		90	5	2	0	7,003	27	26,720	28	21,665	23	18,975	23	25,150	28	6,197	7	6,549	21	2.5	27.2	25.6	14.0
R	0		520	28	13	1	12,650	48	31,775	33	16,724	18	33,495	40	25,811	29	34,992	38	7,077	23	14.2	40.6	34.7	30.6
S	0		92	5	100	4	1,000	4	2,500	2	1,125	1	1,370	2	1,540	2	1,675	2	322	1	4.6	3.2	1.7	1.4
T	0		0	0	0	0	0	0	0	0	3,978	4	1,051	1	1,445	2	0	0	0	0	0	0	1.5	0
Total	11		1,868	100	2,365	100	26,251	100	96,606	100	95,340	100	83,548	100	88,033	100	91,721	100	30,853	100	100.2	100.3	100.3	100.1
No. of areas hosting the species	2		34		19		28		107		131		73		117		138		147		27	68	95	143

* Except late summer 1987

Appendix XVIII. Numbers of Scaup estimated from countrywide aerial surveys in the 14 sections of the Danish waters during autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year including % of total in section																
Section	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	Mean A	Mean* W	Mean SP
A	0	0	14	0	0	0	0	0	406	1	0	0	80	1	0.1	0.6	0.6
B	0	0	0	0	0	0	10	0	0	0	0	0	2	0	0	0.1	0
C	57	3	1,874	11	0	0	341	3	112	0	256	2	561	8	7.1	1.5	5.4
D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	2,000	95	11,828	73	0	0	10,145	78	18,547	49	7,525	73	3,223	48	84.1	63.0	60.2
F	0	0	13	0	6,981	27	14	0	12,365	32	375	4	1,801	27	0.1	16.2	15.1
J	10	1	1,575	10	13,634	53	2,529	19	6,382	17	2,155	21	941	14	5.1	18.0	17.4
K	0	0	0	0	3,560	14	0	0	350	1	15	1	20	0	0	0.5	0.2
M	0	0	14	0	1	0	0	0	25	0	10	0	0	0	0.1	0.1	0.1
N	0	0	20	0	830	3	10	0	14	0	0	0	0	0	0.1	0.1	0
O	0	0	913	6	180	1	20	0	84	0	0	0	125	2	2.8	0.2	0.9
R	30	1	10	0	5	0	0	0	0	0	0	0	12	0	0.8	0	0.1
S	0	0	10	0	52	0	5	0	10	0	0	0	0	0	0.1	0	0
T	0	0	0	0	340	2	7	0	16	0	0	0	0	0	0	0.1	0
Total	2,097	100	16,271	100	25,583	100	13,081	100	38,311	100	10,336	100	6,765	100	100.4	100.4	100.0
No. of areas hosting the species	5		33		57		20		37		18		34		19	29	26

* Except winter 1987

Appendix XIX. Numbers of Eider (x 1,000) estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers (x 1,000) according to season and year including % of total in section																							
Section	LS 87	%	LS 88	%	LS 89	%	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	Mean LS	Mean A	Mean W	Mean SP
A	33	5	73	6	65	5	501	12	467	8	446	8	134	3	460	6	123	2	179	4	5.2	10.2	5.5	3.0
B	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	0	0	0	0	0	0	1	0	1	0	1	0	3	0	1	0	6	0	1	0	0	0	0	0.1
D	0	0	0	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
E	220	31	417	36	457	34	1,646	39	2,446	44	763	14	1,878	33	3,171	40	901	13	708	16	33.8	41.7	29.4	14.5
F	256	36	461	40	527	39	701	17	1,140	21	1,634	31	980	17	1,001	13	1,515	21	756	18	38.4	18.6	20.2	19.4
J	26	4	25	2	119	9	254	6	354	6	363	7	841	15	1,185	15	1,318	18	660	15	4.9	6.3	12.3	16.9
K	18	3	16	2	33	2	352	8	282	5	216	4	385	7	1,067	14	384	5	344	8	2.1	6.8	8.2	6.7
M	15	2	11	1	9	1	182	4	94	2	323	6	202	4	67	1	26	0	48	1	1.3	3.0	3.5	0.8
N	109	15	59	5	84	6	240	6	387	7	1,092	20	467	8	225	3	1,190	17	860	20	9.0	6.4	10.5	18.3
O	9	1	3	0	12	1	48	1	8	0	4	0	2	0	6	0	25	0	38	1	0.8	0.6	0.1	0.7
R	5	1	1	0	4	0	18	1	6	0	10	0	0	0	7	0	10	0	38	1	0.4	0.3	0.1	0.5
S	10	1	85	8	43	3	250	6	367	7	528	10	752	13	601	8	1,616	23	648	15	4.0	6.3	10.3	18.8
T	4	1	0	0	0	0	1	0	0	0	3	0	1	0	3	0	46	1	41	1	0.2	0	0	0.8
Total x 100	705	100	1,151	100	1,353	100	4,196	100	5,553	100	5,386	100	5,645	100	7,794	100	7,160	100	4,321	100	100.1	100.2	100.1	100.5
No. of areas hosting the species	156		203		287		321		292		281		372		366		425		391		215	307	340	403

Appendix XX. Numbers of Long-tailed Duck estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 33).

		Estimated numbers according to season and year									
Areas surveyed		W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
NORTH SEA, in total		20		0	100	1,300	0	0	0	0	0
KATTEGAT											
Kattegat NW	*Density*		*0.5*	*0*	*3.7*	*3.8*		*0*			*11.9*
	Estimate		1.500	0	4,000	11,500		0			30,000
Residual population		3,000	0	0	0	500	(0)	0			0
In total		3,000	1,500	0	4,000	12,000	(900)	0			30,000
STRAITS											
Lille Bælt	*Density*					*60.9*	*6.2*				
	Estimate					17,500	7,000				
Residual population		(0)	(0)			6,000	4,100	0			
In total		(200)	(50)			23,500	11,500	0			
BALTIC											
Kieler Bay	*Density*					*30.9*	*10.2*				
	Estimate					25,000	35,000				
Femer Belt	*Density*	*55.0*	*68.4*			*15.0*	*26.0*	*0*			
	Estimate	275,000	250,000			46,000	134,000	0			
Rønne Banke	*Density*	*113.0*				*35.0*	*49.3*			*42.4*	
	Estimate	102,000				50,000	59,000			76,000	
Residual population		46,000				9,000	0	0		10,000	
In total		423,000				130,000	228,000	0		86,000	
OVERALL TOTAL ~		426,000	251,000		4,000	165,000	240,000	0		86,000	30,000

Appendix XXI. Numbers of Long-tailed Duck estimated from countrywide aerial surveys in the 14 sections of the Danish waters during autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year including % of total in section													
Section	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%
A	10	4	0	0	0	0	5	0	717	18	5	0	29	0
B	0	0	0	0	0	0	6	1	6	0	0	0	0	0
C	0	0	13	2	0	0	8	1	35	1	0	0	8	0
D	0	0	0	0	0	0	0	0	0	0	0	0	10	0
E	15	5	226	39	215	4	63	5	853	22	823	20	776	5
F	26	9	29	5	96	2	15	1	80	2	54	1	86	1
J	80	29	106	19	697	13	349	29	544	14	1,070	26	2,024	14
K	0	0	60	10	180	3	222	19	405	10	853	21	2,107	15
M	65	24	16	3	964	17	252	21	174	5	137	3	169	1
N	0	0	9	2	352	6	39	3	44	1	18	1	378	3
O	81	29	69	12	1,930	35	186	16	871	22	960	24	8,539	59
R	0	0	35	6	1	0	0	0	17	0	63	2	227	1
S	0	0	10	2	124	2	51	4	143	4	30	1	100	1
T					982	18					34	1	29	0
Total	277	100	573	100	5,541	100	1,196	100	3,889	100	4,047	100	19,208	100
No. of areas hosting the species	22		70		68		91		119		117		105	

Appendix XXII. Numbers of Common Scoter estimated from ship transect surveys in the four main areas of the Danish waters during autumn (A), winter (W) and spring (SP) 1987-1989.

Estimated numbers according to season and year including % of total in section			
Areas surveyed	A 87	W 88	SP 88
NORTH SEA			
Off the Wadden sea	121,000	30,000	24,000
West Coast	700	8,000	5,000
In total	121,000	38,000	29,000
KATTEGAT			
Kattegat N	424,000	337,000	34,000*
Kattegat S	500	3,000	400
In total	425,000	340,000	34,000*
STRAITS, in total	-	6,000	23,000
BALTICS			
Denmark S	-	2,000	26,000
Bornholm	-	0	7,000
In total	-	2,000	33,000
OVERALL TOTAL ~	546,000	386,000	119,000

* Surveys performed in May after that a great proportion of the wintering ducks had commenced the spring migration

Appendix XXIII. Numbers of Common Scoter (x 1,000) estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 35).

	Counted numbers (x 1,000) according to season and year including % of total in section																							
Section	LS 87	%	LS 88	%	LS 89	%	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	Mean LS	Mean A	Mean W	Mean SP
A	114	35	685	69	709	57	1,887	89	377	28	1,205	53	33	2	1,118	31	71	4	479	12	53.6	58.3	28.7	8.3
B	0	0	0	0	0	0	4	0	3	0	409	18	0	0	0	0	1	0	0	0	0	0.2	6.0	0
C	1	0	0	0	0	0	2	0	0	0	12	1	0	0	0	0	105	7	2	0	0.1	0.1	0.2	3.3
D	0	0	0	0	0	0	1	0	28	2	2	0	0	0	0	0	1	0	2	0	0	1.1	0	0
E	174	53	276	28	466	38	173	8	907	67	18	1	1,512	85	2,204	61	792	50	2,169	55	39.5	37.6	48.9	52.5
F	0	0	17	2	1	0	27	1	16	1	420	19	192	11	141	4	310	20	37	1	0.6	1.3	11.4	10.3
J	0	0	4	0	37	3	14	1	6	0	40	2	10	1	9	0	79	5	23	1	1.1	0.6	0.9	2.8
K	0	0	0	0	0	0	1	0	0	0	8	0	0	0	2	0	27	2	23	1	0	0	0.1	1.2
M	0	0	0	0	0	0	8	1	0	0	5	0	2	0	1	0	1	0	3	0	0	0.2	0.1	0.1
N	1	1	3	0	0	0	2	0	9	1	37	2	3	0	1	0	7	0	22	0	0.2	0.4	0.6	0.5
O	7	2	0	0	0	0	1	0	1	0	7	0	0	0	1	0	1	0	2	0	0.7	0.1	0.1	0.1
R	6	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0.6	0	0	0
S	23	7	14	1	26	2	5	0	9	1	93	4	28	1	135	4	183	12	1,200	30	3.6	0.5	3.1	21.0
T	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
Total x 100	326	100	999	100	1,239	100	2,125	100	1,356	100	2,259	100	1,780	100	3,612	100	1,578	100	3,963	100	100.0	100.4	99.8	100.1
No. of areas hosting the species	32		55		42		124		81		140		99		117		163		136		43	103	119	150

Appendix XXIV. Numbers of Velvet Scoter estimated from ship transect surveys in the four main areas of the Danish waters during autumn (A), winter (W) and spring (SP) 1987-1988. (See App. II, Figs. 5 and 38).

	Estimated numbers according to season and year		
	A	W	SP
Areas surveyed	87	88	88
NORTH SEA			
Off the Wadden sea	800	1,100	100
West Coast	0	0	0
In total	800	1,100	100
KATTEGAT			
Kattegat N	100,000	109,000	23,000*
Kattegat S	0	2,000	1,000
In total	100,000	111,000	24,000*
STRAITS, in total	-	9,000	16,000
BALTICS			
Denmark S	-	700	30,500
Bornholm	-	2,000	4,500
In total	-	3,000	35,000
OVERALL TOTAL ~	100,000	124,000	75,000

* Surveys performed in May after that a great proportion of the wintering ducks had commenced the spring migration

Appendix XXV. Numbers of Velvet Scoter estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year including % of total in section																				Mean	Mean	Mean	Mean
Section	LS 87	%	LS 88	%	LS 89	%	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	LS	A	W	SP
A	0	0	10	0	69	1	325	20	87	2	735	2	0	0	200	2	4	0	175	1	0.5	10.7	1.1	0.4
B	0	0	0	0	0	0	0	0	20	1	15	0	0	0	0	0	0	0	0	0	0	0.2	0	0
C	0	0	200	9	162	2	0	0	15	0	0	0	0	0	0	0	14	0	0	0	3.8	0.2	0	0.1
D	0	0	0	0	0	0	2	0	0	0	4	0	0	0	0	0	3	0	0	0	0	0.1	0	0
E	1,285	84	717	33	6,550	86	1,221	73	2,477	57	107	0	1,371	33	5,741	45	2,185	23	2,702	13	67.8	64.9	26.3	17.7
F	115	7	57	3	10	0	90	5	265	6	8,083	20	82	2	558	5	1,540	16	498	2	3.5	5.8	8.7	9.2
J	0	0	62	3	1	0	20	1	0	0	1,403	3	18	0	45	0	186	2	93	0	1.0	0.6	1.4	1.2
K	0	0	0	0	0	0	0	0	0	0	70	0	0	0	24	0	2,239	23	1,183	6	0	0	0.1	14.4
M	20	1	176	8	8	0	10	1	53	1	409	1	24	1	175	1	332	4	364	2	3.2	0.9	1.0	2.6
N	115	7	723	33	206	3	0	0	393	9	5,586	14	22	1	212	2	92	1	114	0	14.5	4.5	5.3	0.8
O	0	0	0	0	4	0	4	0	4	0	1,326	3	2	0	7	0	36	0	25	0	0	0.2	1.1	0.3
R	0	0	0	0	0	0	0	0	0	0	1,555	4	32	1	0	0	0	0	0	0	0	0	1.5	0
S	5	0	228	11	596	8	4	0	1,042	24	21,561	53	2,551	62	5,712	45	3,017	31	15,921	76	6.2	12.1	53.3	53.4
T	0	0	0	0	0	0	0	0	0	0	31	0	1	0	8	0	0	0	0	0	0	0	0.1	0
Total	1,540	99	2,173	100	7,606	100	1,676	100	4,356	100	40,885	100	4,103	100	12,682	100	9,648	100	21,075	100	100.5	100.2	100.2	100.1
No. of areas hosting the species	16		28		35		43		49		90		44		79		94		79		26	46	71	87

Appendix XXVI. Numbers of Goldeneye estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn(A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year including % of total in section																							
Section	LS 87	%	LS 88	%	LS 89	%	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	Mean LS	Mean A	Mean* W	Mean SP
A	0	0	0	0	0	0	44	0	7	0	336	1	270	1	233	0	85	0	52	0	0	0.2	0.5	0.3
B	1	0	0	0	0	0	92	1	57	0	133	0	423	1	817	1	1,689	4	393	3	0	0.4	1.2	3.3
C	1,473	78	1,082	54	1,245	87	10,814	83	28,692	55	4,422	11	9,014	21	15,320	28	13,300	28	4,052	31	73.1	68.9	24.6	29.7
D	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0
E	0	0	4	0	0	0	681	5	3,985	8	1,259	3	2,425	6	7,062	13	4,879	10	2,948	23	0.1	6.5	9.3	16.5
F	0	0	0	0	0	0	676	5	4,588	9	9,263	22	5,756	14	7,817	14	6,729	14	1,086	8	0	7.0	13.9	11.3
J	400	21	800	40	12	1	0	0	4,710	9	6,419	16	4,461	11	8,574	16	5,238	11	1,004	8	20.6	4.6	13.1	9.4
K	4	0	0	0	0	0	35	0	1,760	3	5,453	13	8,536	20	3,394	6	1,682	4	509	4	0.1	1.9	13.2	3.8
M	0	0	1	0	2	0	84	1	2,486	5	1,814	4	2,101	5	2,089	4	4,667	10	185	2	0.1	2.7	4.4	5.7
N	0	0	70	4	10	1	7	0	79	0	1,701	4	425	1	674	1	624	1	252	2	1.4	0.2	1.1	1.6
O	0	0	9	0	2	0	230	2	1,884	4	3,278	8	3,466	8	4,051	7	3,178	7	805	6	0.2	2.7	7.8	6.5
R	0	0	20	1	1	0	417	3	3,180	6	3,279	8	3,982	9	3,036	6	3,922	8	443	3	0.4	4.7	7.5	5.9
S	20	1	10	1	153	11	35	0	588	1	2,589	6	682	2	1,792	3	1,336	3	1,275	10	4.1	0.7	2.4	6.3
T	0	0	0	0	0	0	0	0	0	0	1,748	4	531	1	535	1	13	0	1	0	0	0	1.2	0
Total	1,898	100	1,996	100	1,425	100	13,115	100	52,016	100	41,706	100	42,072	100	55,394	100	47,342	100	13,005	100	100.1	100.5	100.2	100.3
No. of areas hosting the species	12		17		17		128		347		305		421		532		491		270		15	238	477	381

* Except winter 1987

Appendix XXVII. Numbers of Red-breasted Merganser estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year including % of total in section																				Mean	Mean	Mean	Mean
Section	LS 87	%	LS 88	%	LS 89	%	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	LS	A	W	SP
A	6	0	2	0	0	0	26	1	27	0	312	2	0	0	5	0	0	0	7	0	0.1	0.3	0.7	0.1
B	10	1	31	1	0	0	0	0	0	0	295	2	1,886	12	10	0	271	2	24	0	0.5	0	4.8	1.2
C	942	69	1,478	36	1,322	19	3,512	68	10,480	38	1,068	7	3,585	23	1,896	23	1,856	14	1,545	18	41.6	52.7	17.8	15.9
D	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
E	12	1	383	9	385	6	24	0	613	2	2,074	14	377	2	573	7	377	3	363	4	5.3	1.4	7.8	3.6
F	0	0	144	4	721	11	122	2	706	3	2,400	16	846	6	774	9	1,234	9	856	10	4.7	2.4	10.4	9.6
J	2	0	143	4	427	6	75	1	307	1	1,422	10	427	3	578	7	1,027	8	1,387	16	3.3	1.3	6.5	11.9
K	32	2	609	15	468	7	208	4	1,130	4	500	3	487	3	1,291	16	2,741	21	1,620	19	8.0	4.1	7.4	19.7
M	46	3	350	9	1,774	26	464	9	10,931	40	124	1	5,505	36	1,158	14	3,020	23	780	9	12.6	24.3	16.9	16.0
N	0	0	140	3	347	5	26	1	568	2	1,472	10	255	2	256	3	303	2	297	3	2.8	1.3	4.9	2.9
O	106	8	157	4	501	7	646	12	1,918	7	629	4	772	5	862	11	1,477	11	946	11	6.3	9.7	6.6	10.6
R	185	14	611	15	787	11	43	1	850	3	1,892	13	449	3	326	4	520	4	523	6	13.4	2.0	6.6	5.0
S	20	2	5	0	144	2	19	0	80	0	1,867	13	471	3	98	1	246	2	316	4	1.2	0.3	5.6	2.8
T	5	0	0	0	0	0	50	1	7	0	712	5	322	2	419	5	100	1	48	0	0.1	0.5	4.0	0.7
Total	1,366	100	4,053	100	6,876	100	5,205	100	27,617	100	14,787	100	15,382	100	8,246	100	13,172	100	8,712	100	99.9	100.3	100.0	100.0
No. of areas hosting the species	33		95		148		137		259		260		359		389		447		464		92	198	336	456

Appendix XXVIII. Numbers of Goosander estimated from countrywide aerial surveys in the 14 sections of the Danish waters during autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year including % of total in section														
Section	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	Mean W
A			0	0	186	1	22	0	0	0	18	0	6	1	0.4
B	20		27	0	115	1	899	7	277	3	1,237	7	182	23	3.6
C	1		1,762	28	1,757	8	2,678	21	3,278	37	3,498	19	188	24	22.1
D			0	0	21	0	0	0	0	0	0	0	0	0	0
E			0	0	706	3	150	1	208	2	754	4	90	11	2.3
F			201	3	2,782	13	676	5	480	6	1,293	7	102	13	7.9
J			413	7	4,865	23	1,058	8	1,549	18	1,030	5	55	7	16.2
K			115	2	2,279	11	198	2	151	2	73	0	10	1	4.7
M			1,152	19	1,972	9	3,938	31	830	10	3,289	18	0	0	16.5
N			152	3	233	1	182	2	124	1	241	1	5	1	1.3
O			585	9	2,754	13	1,110	9	884	10	519	3	5	6	10.6
R	2		1,772	28	1,633	8	1,686	13	941	11	6,229	33	79	10	10.5
S	38		38	1	312	1	154	1	28	0	594	3	20	3	1.0
T			18	0	1,781	8	18	0	16	0	2	0	1	0	2.9
Total	61		6,235	100	21,396	100	12,769	100	8,766	100	18,777	100	783	100	100.0
No. of areas hosting the species	5		104		255		219		260		328		74		248

Appendix XXIX. Numbers of Coot estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989.

	Counted numbers according to season and year including % of total in section																				Mean	Mean	Mean	Mean
Section	LS 87	%	LS 88	%	LS 89	%	A 87	%	A 88	%	W 87	%	W 88	%	W 89	%	SP 88	%	SP 89	%	LS	A	W	SP
A	0	0	0	0	90	0	45	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0.1	0	0
B	2,398	27	3,612	7	4,188	6	1,390	3	3,171	2	55	2	553	1	321	0	158	1	430	5	13.4	2.8	0.6	2.6
C	5,146	57	12,095	24	18,804	29	10,057	25	27,527	18	1,182	5	2,093	5	4,464	6	2,734	9	1,756	19	36.7	21.4	5.0	14.1
D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	140	1	1,787	3	1,777	3	5,645	14	5,763	4	3,160	12	2,800	6	421	1	5,109	17	609	7	2.6	8.9	6.2	11.6
F	0	0	2,440	5	5,340	8	800	2	5,773	4	800	3	5,882	13	6,574	9	3,744	12	695	8	4.3	2.9	8.2	9.9
J	0	0	5,372	11	5,809	9	2,740	4	18,815	12	5,510	21	5,673	12	12,662	17	2,612	9	458	5	6.5	9.6	16.7	6.8
K	170	2	5,255	10	3,434	5	3,185	8	13,165	8	4,779	18	5,630	12	6,766	9	1,357	4	264	3	5.8	7.8	13.1	3.7
M	515	6	6,211	12	6,266	10	2,670	7	30,807	20	1,805	7	8,320	18	10,286	14	3,808	12	611	7	9.2	13.4	12.9	9.6
N	0	0	2,405	5	1,655	2	2,730	7	10,925	7	335	1	720	2	8,425	11	1,324	4	394	4	2.4	6.9	4.7	4.3
O	240	3	3,049	6	11,028	17	5,339	13	19,440	13	1,230	5	3,895	9	17,734	23	1,888	6	2,691	29	8.5	13.0	12.2	17.8
R	235	3	6,772	13	5,762	9	4,440	11	14,750	10	6,975	27	6,963	15	5,236	7	6,416	21	1,207	13	8.2	10.3	16.3	17.1
S	90	1	1,910	4	1,617	2	1,282	3	2,881	2	60	0	2,672	6	2,588	3	1,553	5	48	0	2.4	2.6	3.2	2.8
T	0	0	0	0	0	0	150	0	0	0	345	1	421	1	242	0	0	0	0	0	0	0.2	0.8	0
Total	8,934	100	50,908	100	65,770	100	40,473	100	153,017	100	26,236	100	45,622	100	75,724	100	30,703	100	9,163	100	100.0	99.9	99.9	100.3
No. of areas hosting the species	64		185		200		88		179		104		119		222		154		203		156	134	148	179

Appendix XXX. Numbers of Great Skua estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 45).

		Estimated numbers according to season and year									
Areas surveyed		W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
NORTH SEA											
Norwegian Trench	*Density*	*0*	*0*	*0.21*	*0*	*0*	*0*	*0.13*	*0*	*0*	*0*
	Estimate	(0)	(0)	10,500	(0)	(0)	(0)	7,000	0	0	0
Residual population		(0)	(0)	2,500	(1,200)	(0)	(0)	4,000	0	0	0
In total		(0)	(0)	13,000	(1,200)	(0)	(0)	11,000	0	0	0
KATTEGAT, in total		(0)	(0)	0	0	0	0	0	0	0	0
OVERALL TOTAL ~		(0)	(0)	13,000	(1,200)	(0)	(0)	11,000	0	0	0

Appendix XXXI. Numbers of Little Gull estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 46).

		Estimated numbers according to season and year									
Areas surveyed		W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
NORTH SEA											
Off the Wadden sea	*Density*	*0*	*2.3*	*1.3*	*1.0*	*0*	*1.2*	*0*	*6.8*	*0.9*	*0*
	Estimate	0			1,500	400	600	0	2,200	(100)	(0)
Residual population		0	(0)	(0)	1,600	0	0	0	500	(100)	(0)
In total		0	(0)	(0)	3,100	400	600	0	2,700	(100)	0
KATTEGAT, in total		0	0	0	0	20	0	0	(0)		
STRAITS, in total		0	0			300	100	0			
BALTIC											
Femer Belt	*Density*	*0*	*1.0*			*0*	*2.6*	*0*			
	Estimate	0	4,000			0	7,000	0			
Bornholm	*Density*	*0*				*0*	*1.0*			*0.9*	
	Estimate	0				0	6,000			(180)	
In total		0	(4,000)	(0)		500	13,000	0		(180)	
OVERALL TOTAL ~		0	(4,000)	(0)	(3,100)	1,200	13,700	0	(2,700)	(280)	(0)

Appendix XXXII. Numbers of Black-headed Gull estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1988.

	Counted numbers according to season and year including % of total in section							
	LS	%	A	%	W	%	SP	%
Section	87		87		88		88	
A	26,290	31	5,867	6	1,165	2	4,496	3
B	9,795	11	3,003	3	222	0	8,802	5
C	24,319	29	11,668	13	4,858	8	36,578	23
D	0	0	15	0	0	0	0	0
E	9,858	12	11,202	12	8,120	13	28,367	17
F	2,270	3	20,375	22	17,854	28	15,948	10
J	2,250	3	9,265	10	3,166	5	12,959	8
K	504	0	6,105	7	3,495	6	12,775	8
M	850	1	8,440	9	8,871	14	13,921	9
N	362	0	1,492	2	1,605	3	1,343	1
O	2,305	3	5,635	6	5,074	8	5,135	3
R	2,820	3	3,085	3	4,617	7	14,350	9
S	2,353	3	5,124	6	4,005	6	5,309	3
T	505	1	1,332	1	0	0	1,185	1
Total	84,481	100	92,608	100	63,052	100	161,168	100

Appendix XXXIII. Numbers of Common Gull estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1988.

	Counted numbers according to season and year including % of total in section							
	LS	%	A	%	W	%	SP	%
Section	87		87		88		88	
A	10,443	36	6,587	34	7,511	16	11,502	25
B	1,228	4	489	3	1,247	3	2,212	5
C	8,147	28	3,405	17	19,243	42	8,726	19
D	39	0	73	0	0	0	237	0
E	5,270	18	1,356	7	2,580	6	4,483	10
F	450	2	3,642	19	9,222	20	4,951	11
J	170	1	960	5	1,650	3	4,302	9
K	520	2	1,220	6	805	2	2,700	6
M	105	0	325	2	1,175	2	945	2
N	145	0	630	3	425	1	64	0
O	1,132	4	250	1	282	1	2,016	4
R	644	2	170	1	850	2	2,397	5
S	307	1	206	1	765	2	915	2
T	560	2	195	1	0	0	945	2
Total	29,160	100	19,508	100	45,755	100	46,395	100

Appendix XXXIV. Numbers of Common Gull estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 49).

	Estimated numbers according to season and year									
Areas surveyed	W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
NORTH SEA	45,000	20,000	1,000	55,000	15,000	14,000	(0)	(0)	(2,300)	(6,000)
KATTEGAT	(500)	15,000	(0)	7,000	14,000	5,000	0	(0)	(4,000)	(1,500)
STRAITS	3,000	14,000			4,000	1,500	0			
BALTIC	13,500				20,000	36,000	(0)		57,000	
OVERALL TOTAL ~	62,000	(49,000)		(62,000)	53,000	56,500	0		(63,000)	(7,500)
Aircraft total			29,160	19,508	45,755	46,395				

Appendix XXXV. Numbers of Lesser Black-backed Gull estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 50).

		Estimated numbers according to season and year									
Areas surveyed		W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
NORTH SEA											
Skagerak	*Density*	*0*	*1.5*	*0.35*	*0*	*0*	*1.7*	*0.15*	*0*	*0*	*0*
	Estimate	0	44,000	14,000	0	0	28,000	4,400	0	0	0
Residual population		0	(0)	(0)	0	0	57,000	0	0	0	0
In total		0	(44,000)	(14,000)	0	0	85,000	4,400	0	0	0
KATTEGAT, in total		0	16,000	(3,500)	0	0	9,000	2,500	0	0	0
STRAITS, in total		0	3,500			0	0	0		0	
BALTIC											
Bornholm E	*Density*	*0*				*0*	*1.5*			*0*	
	Estimate	0				0	5,000			0	
In total		0				0	5,000	(500)		0	
OVERALL TOTAL ~		(0)	(64,500)	(17,500)	(0)	0	99,000	7,400	0	0	0

Appendix XXXVI. Numbers of Herring Gull estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1988.

	Counted numbers according to season and year including % of total in section							
Section	LS 87	%	A 87	%	W 88	%	SP 88	%
A	15,644	28	10,457	12	13,474	14	8,446	5
B	1,299	2	3,540	4	766	1	4,274	3
C	9,289	17	21,262	24	10,574	11	30,832	20
D	468	1	821	1	0	0	301	0
E	4,456	8	7,976	9	12,972	14	30,209	19
F	2,637	5	7,850	9	16,945	18	17,596	11
J	653	1	6,320	7	7,818	8	10,682	7
K	1,248	2	6,288	7	5,550	6	11,750	8
M	208	0	2,217	2	5,445	6	6,325	4
N	523	1	1,418	1	6,089	6	3,042	2
O	1,626	3	3,225	4	6,965	7	7,876	5
R	1,178	2	3,225	4	3,251	3	4,864	3
S	1,909	4	3,879	4	5,281	6	7,119	5
T	14,300	26	10,490	12	0	0	13,162	8
Total	55,438	100	88,978	100	95,130	100	156,478	100

Appendix XXXVII. Numbers of Herring Gull estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 52).

		Estimated numbers according to season and year									
Areas surveyed		W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
NORTH SEA											
Skagerrak < 30 m	*Density*	*1.0*			*2.5*	*1.2*	*2.3*	*0.14*	*0.5*	*1.8*	*0.5*
	Estimate	15,000			35,000	17,000	16,000	1,500	5,000	25,000	16,000
Skagerrak > 30 m	Density	10.3	0.7	0.4	7.6	4.2	2.3	0.9	2.5	2.0	0.4
	Estimate	(60,000)	(20,000)	4,000	100,000	55,000	12,000	11,000	33,000	18,000	14,000
Residual population		54,000	(0)	(3,000)	67,000	(16,000)	3,000	6,500	50,000	17,000	5,000
In total		129,000	(20,000)	(7,000)	202,000	(88,000)	(31,000)	19,000	88,000	60,000	35,000
KATTEGAT											
Kattegat E	*Density*	*1.6*	*4,0*	*0.5*	*4.6*	*6.0*		*0.4*	*5.9*	*22.8*	*0.3*
	Estimate	12,000	20,000	1,000	55,000	46,000		2,700	44,000	87,000	4,000
Residual population		(0)	19,000	(0)	25,000	11,000		300	20,000	10,000	4,000
In total		(12,000)	39,000	(1,000)	80,000	57,000		3,000	64,000	97,000	8,000
STRAITS, in total		(2,000)	8,400			(1,000)	4,000	(200)		0	
BALTIC											
Baltic E	*Density*	*19.0*				*16.8*	*17.6*			*5.3*	
	Estimate	(57,000)				190,000	134,000	(2,300)		106,000	
Residual population		(45,000)				45,000	34,000	(0)		21,000	
In total		(102,000)				235,000	(168,000)	(2,300)		127,000	
OVERALL TOTAL ~		(245,000)	67,400	(8,000)	(282,000)	381,000	203,000	(24,500)	(152,000)	284,000	(43,000)

Appendix XXXVIII. Numbers of Great Black-backed Gull estimated from countrywide aerial surveys in the 14 sections of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1988.

	Counted numbers according to season and year including % of total in section							
Section	LS 87	%	A 87	%	W 88	%	SP 88	%
A	651	25	224	3	174	5	114	3
B	107	4	1,084	15	239	7	206	5
C	123	5	1,524	22	318	10	727	18
D	19	1	110	2	0	0	12	0
E	513	20	607	9	670	20	665	16
F	210	8	370	5	827	25	1,111	27
J	43	2	110	2	201	6	282	7
K	35	1	350	5	129	4	66	2
M	8	0	871	12	201	6	88	2
N	2	0	146	2	286	9	333	8
O	41	2	450	6	49	1	31	1
R	272	10	565	8	63	2	101	3
S	198	8	126	2	162	5	296	7
T	350	14	507	7	0	0	33	1
Total	2,572	100	7,044	100	3,319	100	4,065	100

Appendix XXXIX. Numbers of Great Black-backed Gull estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 54).

		Estimated numbers according to season and year									
		W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
Skagerrak	*Density*	*0.8*	*0.6*	*0.7*	*0.7*	*0.4*	*0.3*	*0.4*	*0.2*	*0.2*	*0.2*
	Estimate	(16,000)	(16,500)	25,000	23,000	(7,000)	(3,500)	14,000	(7,000)	(7,000)	(5,500)
NorthSea/residual pop.		(2,000)	(1,500)	(2,000)	(17,000)	(3,000)	(1,500)	9,000	(28,000)	(28,000)	(12,000)
NORTH SEA		(18,000)	(18,000)	(27,000)	40,000	(10,000)	(5,000)	23,000	(35,000)	(35,000)	(17,500)
E Kattegat	*Density*	*1.9*	*0.6*	*0.1*	*0.5*	*0.5*		*0.2*	*0.2*	*1.3*	*0.2*
	Estimate	14,000	3,000	200	2,500	2,500		1,500	1,000	6,500	1,000
Kattegat residual pop.		(1,000)	2,000	(0)	700	500		1,500	500	3,500	3,500
KATTEGAT		(15,000)	5,000	(200)	3,200	3,000		3,000	1,500	10,000	4,500
STRAITS		(700)	2,200			500	800	(250)			
E Baltic	*Density*	*1.0*				*0.2*	*0.3*			*0.2*	
	Estimate	(11,000)			2,500	2,500				3,000	
Baltic residual pop.		(3,500)				3,800	(500)	(1,500)		(1,000)	
BALTIC		(14,500)				6,000	(3,000)	(1,500)		(4,000)	
TOTAL ~		(48,000	25,000	27,000	43,000	(19,500)	(9,000)	(27,500)	36,500	49,000	22,000

Appendix XL. Numbers of Kittiwake estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 55).

		Estimated numbers according to season and year									
Areas surveyed		W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
NORTH SEA											
Norwegian Trench shelf W	*Density*			*0*	*6.1*	*1.6*		*0.2*	*1.0*	*1.5*	*0.3*
	Estimate			0	(50,000)	(8,000)		7,000	37,000	45,000	10,000
Norwegian Trench shelf E	*Density*	*3.1*	*0.3*	*1.3*	*6.1*	*3.0*	*0.1*	*0.4*	*0.6*	*1.0*	*0.3*
	Estimate	(20,000)	(100)	13,000	50,000	40,000	1,000	10,000	15,000	15,000	10,000
Residual population		(10,000)	(26,900)	(0)	(67,000)	(30,000)	(2,800)	(17,000)	63,000	35,000	25,000
In total		(30,000)	(27,000)	(13,000)	(167,000)	(78,000)	(3,800)	34,000	115,000	95,000	45,000
KATTEGAT											
Middelgrunde	*Density*				*1.7*	*3.5*	*0*	*0*	*39.3*	*104.0*	*0.3*
	Estimate				25,000	40,000	0	0	195,000	208,000	1,000
Residual population			(100)	0	8,000	10,000	0	0	5,000	7,000	4,000
In total			(100)	0	33,000	50,000	0	0	200,000	215,000	5,000
OVERALL TOTAL ~		30,000	(27,000)	(13,000)	(200,000)	(128,000)	(3,800)	34,000	315,000	310,000	50,000

Appendix XLI. Numbers of Guillemot estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 56).

		Estimated numbers according to season and year									
Areas surveyed		W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
NORTH SEA											
Dogger Banke NE	*Density*		*0.6*	*1.4*	*0.8*			*1.1*		*1.6*	*1.7*
	Estimate		2,700	32,000	6,000			6,600		23,000	45,000
German Bight	*Density*	*0,5*			*1.5*	*1.9*	*1.0*	*0.3*	*0.8*	*0.5*	*1.7*
	Estimate	(5,000)		20,000	20,000	20,000	2,700	4,500	15,000	9,000	30,000
Norwegian Trench	*Density*			*3.8*	*5.4*	*2.0*		*2.5*	*6.6*	*0.5*	*1.7*
shelf W	Estimate			75,000	(70,000)	(15,000)		67,000	190,000	35,000	60,000
Norwegian Trench	*Density*	*1.3*	*0*	*1.6*	*5.4*	*0.8*	*1.1*	*3.0*	*1.3*	*2.3*	*1.0*
shelf E	Estimate	15,000	0	142,000	65,000	10,000	6,500	80,000	16,000	25,000	10,000
Kummel Banke	*Density*		*0*	*16.5*	*9.1*	*6.1*	*2.2*	*1.0*	*0.2*	*42.9*	*1.7*
	Estimate		0	21,000	16,000	35,000	4,600	2,000	700	25,000	2,500
Residual population				(0)	(28,000)	(27,300)	(2,200)	13,000	76,300	3,000	12,500
In total		(20,000)		290,000	(205,000)	(107,000)	(16,000)	173,100	298,000	120,000	160,000
KATTEGAT											
Middelgrunde	*Density*				*3.2*	*11.0*	*1.7*	*3.9*	*0.9*	*42.6*	*1.7*
	Estimate				15,000	37,000	3,500	15,000	2,000	110,000	5,000
Lysegrund-	*Density*				*9.3*	*1.8*	*1.0*	*0*	*3.0*	*26.2*	*1.7*
Kullen	Estimate				10,000	15,000	1,500	0	5,000	17,000	2,500
Residual population				7,000	20,000	18,000	5,000	22,000	(5,000)	48,000	22,500
In total				7,000	45,000	70,000	10,000	37,000	(12,000)	175,000	30,000
STRAITS											
Lille Bælt	*Density*					*2.1*	*2.7*				
	Estimate					600	1,400				
Residual population				(0)		50	100	(0)			
In total				(0)		650	1,500	(0)			
BALTIC											
Bornholm	*Density*	*1.3*				*1.2*	*3.9*			*0.6*	
	Estimate	6,150				5,000	7,700			2,000	
Residual population		0		(0)		5,000	3,300	(0)		(2,000)	
In total		6,150		(0)		10,000	11,000	(0)		(4,000)	
OVERALL TOTAL ~		26,100	(2,700)	297,000	(250,000)	(188,000)	(38,500)	210,000	310,000	299,000	190,000

Appendix XLII. Numbers of Razorbill estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 57).

		Estimated nunbers according to season and year									
Areas surveyed		W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
NORTH SEA											
Dogger Banke NE	*Density*		*0*	*0*	*2.6*			*0*		*2.7*	*0.4*
	Estimate		0		100			0		14,000	2,000
German Bight	*Density*	*0*			*2.8*	*1.8*	*0*	*0*	*0.7*	*0*	*0.03*
	Estimate	(0)			1,700	4,200	0	0	100	0	350
Norwegian Trench	*Density*			*2.1*	*2.8*	*2.9*		*0*	*0.6*	*0*	*0*
shelf W	Estimate			100	8,200	(12,000)		0	1,500	0	0
Norwegian Trench	*Density*	*8.6*	*0*	*0*	*4.1*	*2.9*	*0*	*0*	*0.6*	*1.0*	*1.0*
shelf E	Estimate	120,000	0	0	17,000	24,000	0	0	4,000	20,000	6,000
Kummel Banke	*Density*		*0*	*0*	*1.1*	*9.2*	*0*	*0*	*0.6*	*94.6*	*0.7*
	Estimate		0	0	4,000	43,000	0	0	1,500	65,000	2,000
Residual population		0	0	0	0	3,800	0	0	0	1,000	0
In total		120,000	0	100	31,000	87,000	0	0	7,100	100,000	10,350
KATTEGAT											
Djursland NE	*Density*		*0*	*0*	*9.3*	*0*			*28.0*	*0.7*	*80.6*
	Estimate		0	0	45,000	0			69,000	1,000	152,000
Middelgrunde	*Density*				*0*	*19.7*	*0*	*0*	*28.0*	*94.6*	*1.5*
	Estimate				0	23,000	0	0	69,000	285,000	4,700
Residual popupation			0	100	4,000	9,000		0	2,000	4,000	8,300
In total			0	100	49,000	32,000		0	140,000	290,000	165,000
STRAITS											
Lille Bælt	*Density*					*1.0*	*1.2*				
	Estimate					250	110				
In total				(0)		250	110	(0)			
BALTIC											
Bornholm	*Density*	*2.1*				*2.8*	*1.8*			*0.5*	
	Estimate	30,000				1,400	300			4,700	
Residual population		0		(0)		200	0			300	
In total		30,000		(0)		1,600	300	(0)		5,000	
OVERALL TOTAL ~		(150,000)		200	80,000	121,000	410	0	147,000	395,000	175,000

Appendix XLIII. Numbers of Black Guillemot estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 58).

		Estimated numbers according to season and year									
Areas surveyed		W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
NORTH SEA, in total		30		0	30	0	0	0	0	0	0
KATTEGAT											
Læsø N	*Density*	*1.0*	*0.8*		*1.2*	*1.2*	*2.7*			*0*	
	Estimate	(450)	720		360	1,300	1,350			(0)	
Kattegat NW	*Density*		*0*	*0*	*1.0*	*1.1*		*0*			*0.3*
	Estimate		0	0	900	850		0			1,050
Residual population		(65)	0	0	0	0	0	0		760	0
In total		(515)	720	0	1,260	2,150	1,350	0		(760)	1,050
STRAITS, in total		0	0			0	0	0			
BALTIC											
Femer Belt	*Density*	*0.35*	*0*			*0*	*1.5*	*0*			
	Estimate	250	0			0	750	0			
Rønne Banke	*Density*	*1.7*				*0.7*	*0.4*			*0*	
	Estimate	2,550				1,200	600			0	
Residual population		9,200				50	400	0		(20)	
In total		12,000				1,250	1,750	0		(20)	
OVERALL TOTAL ~		12,500	720		1,250	3,400	3,100	0		(780)	(1,050)

Appendix XLIV. Numbers of Little Auk estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II, Figs. 5 and 59).

		Estimated numbers according to season and year									
Areas surveyed		W 87	SP 87	LS 87	A 87	W 88	SP 88	LS 88	A 88	W 89	A 89
NORTH SEA											
NorvegianTrench	*Density*	*8.9*	*0*	*0*	*0.5*	*17.2*	*0*	*0*	*7.0*	*35.0*	*7.2*
convergense	Estimate	(160,000)	(0)	0	(1,500)	(86,000)	0	0	238,000	1.050,000	216,000
Norwegian Trench	*Density*	*0*	*0*	*0*	*1.0*	*5.4*	*0*	*0*	*0.3*	*2.0*	*0.7*
coastal	Estimate	0	0	0	(200)	(600)	0	0	2,000	20,000	(8,000)
Norwegian Trench	*Density*			*0.6*	*0.5*	*0.5*		*0*	*0.3*	*2.0*	*0.2*
shelf W	Estimate			30	(1,000)	(4,000)		0	8,000	20,000	20,000
Residential population		(0)		0		(0)	(0)	0	2,000	10,000	4,000
In total		(160,000)		30	2,700	(90,000)	(0)	0	250,000	1,100,000	248,000
KATTEGAT, in total			0	0	100	0	0	0	1,000	800	600
OVERALL TOTAL ~		160,000		30	2,800	90,000		0	251,000	1,100,000	249,000

Appendix XLV. Numbers of Puffin estimated from ship transect surveys in the four main areas of the Danish waters during late summer (LS), autumn (A), winter (W) and spring (SP) 1987-1989. (See App. II and Fig. 5).

		Estimated numbers according to season and year									
		W	SP	LS	A	W	SP	LS	A	W	A
Areas surveyed		87	87	87	87	88	88	88	88	89	89
NORTH SEA											
North Sea W	*Density*		*1.1*	*0.5*	*1.0*	*0.6*		*3.0*	*0.2*	*0.25*	*0.4*
	Estimate		(50)	25	(50)	(70)		150	500	10,000	400
Residual population		(100)	(0)	0	(30)	(930)	(250)	0	20	0	500
In total		(100)	(50)	25	(80)	(1,000)	(250)	150	500	1,000	900
KATTEGAT			0	0	30	0	0	0	0		0
OVERALL TOTAL ~		(100)	(50)	25	(110)	(1,000)	(250)	150	520	10,000	900

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