

DANISH REVIEW OF GAME BIOLOGY Vol. 5. no. 5

Edited by Anders Holm Joensen

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in November 1967 and January 1968
– Methods and Results

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ANDERS HOLM JOENSEN

(Med et dansk resumé: Andefugletællinger i
Danmark i november 1967 og januar 1968 –
metoder og resultater.)

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COMMUNICATION NO. 69 FROM VILDTBIOLOGISK STATION
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CONTENTS

Introduction	3
The Topography of Denmark and Wildfowl Counts	5
Material	5
November 1967	6
January 1968	6
Comparison between the two months	7
Method used in aerial surveys	10
Treatment of the material	10
The Accuracy of Wildfowl Counts, Particularly of Aerial Surveys	11
Accuracy in estimation of size of flocks and determination of species	12
Estimation of flock size	12
Determination of species	13
Estimates of mixed flocks	13
Efficiency of registration in the areas surveyed	14
Weather	14
Registration efficiency dependent on size of flocks	15
Conspicuousness of species and their reaction to aircraft	15
Wildfowl occurring in areas not surveyed	16
Freshwater areas	16
Salt water areas	16
The significance of movements of wildfowl during the surveys	17
The Value of Ground Counts and Monthly Counts	18
Ground counts	18
Monthly counts	18
Wildfowl Populations in November 1967 and January 1968	20
The total populations	20
November 1967	21
January 1968	30
<i>Anas platyrhynchos</i>	31
<i>Anas crecca</i>	35
<i>Anas querquedula</i>	36
<i>Anas strepera</i>	36
<i>Anas penelope</i>	36
<i>Anas acuta</i>	38
<i>Anas clypeata</i>	38
<i>Tadorna tadorna</i>	39
<i>Aythya ferina</i>	40
<i>Aythya fuligula</i>	41
<i>Aythya marila</i>	44
<i>Netta rufina</i>	44
<i>Clangula hyemalis</i>	45
<i>Melanitta nigra</i> and <i>Melanitta fusca</i>	46
<i>Somateria mollissima</i>	48
<i>Bucephala clangula</i>	49
<i>Mergus serrator</i>	54
<i>Mergus merganser</i>	56
<i>Mergus albellus</i>	57
SWANS	57
<i>Cygnus olor</i>	57
<i>Cygnus cygnus</i>	60
<i>Cygnus columbianus</i>	60
<i>Fulica atra</i>	61
<i>Phalacrocorax carbo</i>	64
Summary	65
Dansk resumé	67
Literature	70
Резюме на русском языке	70

Introduction

Although Denmark plays an important role for western palearctic wildfowl outside the breeding season, hitherto but little exact information has been published about the distribution and numbers of the majority of species occurring in our country.

In recent years, however, several investigatory projects have been initiated as part of investigations arranged by the International Wildfowl Research Bureau; thus in the period 1951–1957, monthly counts on selected localities similar to those undertaken in other European countries were carried out on the initiative of Professor H. M. THAMDRUP, Natural History Museum, Århus. Part of this material was used in studies on *Somateria mollissima* carried out at the Game Biology Station, Kalø (PALUDAN 1962). Since 1963 this institute has also undertaken monthly counts and other investigations on geese (Fog 1965, 1967).

In 1966 a new program of extensive monthly counts during the winter (September–April) was started in collaboration with the International Wildfowl Research Bureau. During the first year (1966/67) about 100 localities were covered regularly by a network of co-workers. In the second season (1967/68) the number of localities was augmented to nearly 400, including a great number of the principal resting grounds. Short preliminary reports have been published (JOENSEN 1967, 1968).

The object of monthly wildfowl counts has been outlined by ATKINSON-WILLES

(1963, 1966). The absolute size of wildfowl populations is clearly a question of primary importance, and in some countries this can be elucidated through monthly counts from the ground. Among such countries is Great Britain, where the peak populations of most species have been estimated (BOYD 1963).

The topography of a country and the manner of distribution of wildfowl within it may, however, impose limitations on the feasibility of estimating absolute population sizes by traditional methods. This is certainly the case with Denmark where many areas holding vast numbers of wildfowl can only be satisfactorily surveyed with aeroplanes. This is explained later (see page 5).

This paper describes the results of two investigations, carried out in November 1967 and January 1968. In both months the majority of wildfowl haunts in Denmark were surveyed by counters operating on land (covering the nearly 400 monthly count localities) and supplemented by intensive aerial surveys in most coastal areas.

The aims of the investigations were:

1) To get absolute population figures for as many species as possible in the months of peak populations of dabbling ducks (November) and diving ducks (January).

2) To compare the figures obtained from the whole country with the figures obtained at the 400 localities where monthly counts were carried out during

the whole winter, and thereby appraise the value of monthly counts.

During the winter, weather conditions in Denmark are generally poor for aerial surveys extending over several days. In this respect the two investigations were, however, successful, and the aim of the investigation was fulfilled to a greater extent than was expected.

In the chapter pages 20–65 the distribution and numbers recorded in the two months has been described for all species of wildfowl (*Anatidae*) except geese (*Anserinae*) and also for *Fulica atra* and *Phalacrocorax carbo*.

The two surveys are one part of a large continuous investigation, and it must be emphasized, firstly that only material collected in the two months is described, secondly that results obtained are preliminary, and thirdly that no major conclusions are drawn on the basis of this material as compared to information hitherto published.

Wildfowl counts in Denmark present significant problems, and in order to evaluate the material obtained some information on the errors involved is essential. Therefore also the problems concerning wildfowl counts and particularly aerial surveys are discussed in this paper (see pages 11–17). It must, however, be emphasized that after only two years' studies our knowledge of errors is too meagre for numerical correction of figures obtained, and the conclusions are preliminary.

This paper describes distribution and numbers of wildfowl in only two months, which may not be typical. There are still many problems unanswered in connection with the distribution of wildfowl in Denmark, and counting methods still present

problems; however, we feel that the material so far acquired should be presented now, primarily for the following reasons:

1) The investigations comprising both counts from the ground and intensive aerial surveys are the very first of their kind to be carried out in Denmark, and the results represent a great forward stride towards a wider knowledge of the distribution and numbers of wildfowl in Denmark.

2) We hope that the presentation of this material will stimulate similar investigatory projects in other European countries so that in future combined ground and aerial surveys may come to cover larger natural units, instead of being limited to small areas bounded by the frontiers of individual countries.

The material presented here is a result of co-operation between the Game Biology Station, Kalø, and a very large number of people among which are game advisers, forestry people, scientists and amateur ornithologists. More than 200 people contributed to the investigations in November 1967 and January 1968, and we need not say that without this enormous effort and help the surveys could not have been carried out. Though they are not named individually, I am most grateful to them all.

In particular I am indebted to Mr. PELLE ANDERSEN-HARILD, who organized ground counts on Sjælland, to Mr. BENNY GENSBOEL, who organized counts on Bornholm, to the Danish game advisers, who organized counts in all wetland reserves, and also to Mr. PALLE UHD JEPSEN and Mr. LEO KORTEGAARD, who were in charge of flying crews.

Thanks are also due to Mrs. OLGA VILSTRUP for linguistic corrections and improvements of the present paper.

The Topography of Denmark and Wildfowl Counts

With an area of only 43,000 square kilometres Denmark has a coastline of as much as about 7300 kilometres. With the sole exception of the west coast of Jutland, the coasts are serrated with inlets and bays and there are about 400 islands, 75 % of which are uninhabited. Coastal waters are generally very shallow, and in most places the shallow watered areas extend several kilometres from the coast. It is estimated that about 15,000 square kilometres of coastal waters have a depth of less than 10 metres.

Obviously birds in such areas cannot be accurately counted from the coasts. Although Denmark has a large number of amateur ornithologists willing to participate in such investigations it is only possible to arrange counts covering a small proportion of the 7300 kilometres of coastline. Furthermore observers can actually only register birds on the sea within 1–2 kilometres from the coast, while very many birds are in fact further out.

It was therefore necessary to use other means for investigating wildfowl populations in remote coastal waters, and here aeroplanes have proved very effective. In the last few years the Game Biology Station has used aeroplanes for special surveys, for example for counts of moulting *Melanitta nigra* (JOENSEN 1965) and surveys of *Branta bernicla* throughout Denmark (FOG 1967). When monthly counts of wildfowl were started in the autumn of 1966, aeroplanes were used on several occasions. In the first season material supplementary to the monthly counts was collected in this way, but the primary objective of these surveys was an appraisal of the value of the use of aeroplanes in wildfowl counts.

It is worth-while emphasizing here that although counts from aeroplanes have certain short-comings, especially for some species of wildfowl, the use of aeroplanes in Denmark still presents conspicuous advantages. With aeroplanes it is possible to get much information unattainable by any other means.

Material

In November 1967 and January 1968 the material was collected partly by ground counts, most of which were carried out by amateur ornithologists and game advisers, and partly by aerial surveys made by the staff of the Game Biology Station. In this chapter we shall briefly describe the geographical and temporal distribution of areas investigated as well as climatic circumstances of importance for the investigations.

In the enumeration of ground count localities the units used by the individual observer have usually been adopted. Al-

though differing much in size they are generally quite small, comprising, say, only one lake or a coastline of 2–3 kilometres. When comparing ground counts with aerial surveys, the latter consisting of continuous registration, we find that the most satisfactory basis is to consider one minute of flight equivalent to one ground-count unit. In one minute the aircraft covers 2,5–3,0 kilometres. Thus the sum of »ground-count units« and »flight minutes« gives a reasonably good impression of the activity in a certain part of the country (»total count units«).

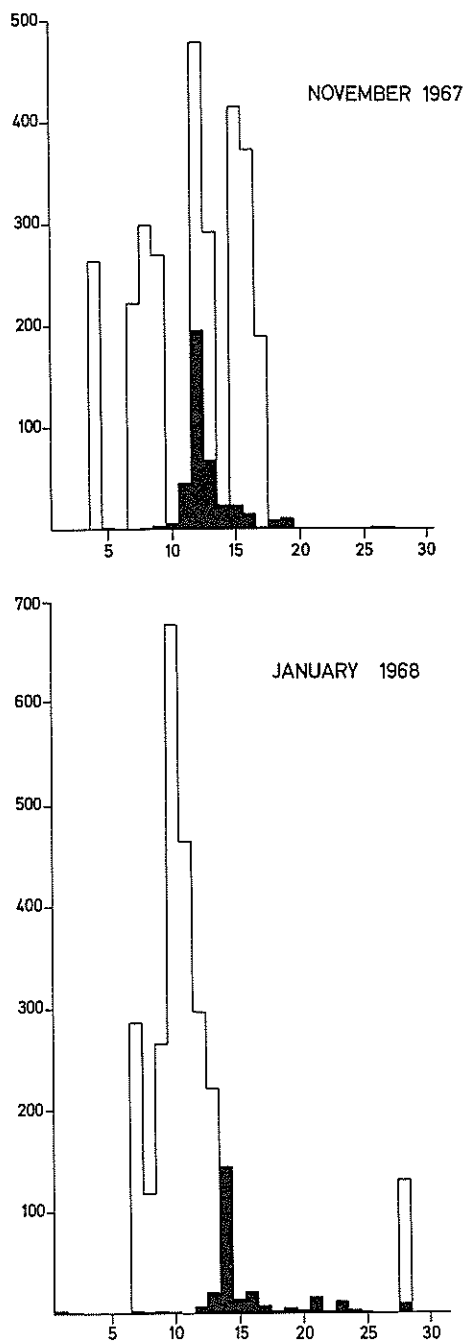


Fig. 1. The number of ground-count units (black columns) and flight minutes (open columns) day by day in November 1967 and January 1968.

Fig. 1 shows the distribution of counts day by day during the two months, and Table 1 gives details of the geographical distribution of counts. The maps, Figs. 2 and 3 show all ground count localities as well as the routes of aerial surveys, in November and January respectively.

November 1967

The total number of count units was 2903, comprising 404 ground counts and 2499 flight minutes (41 $\frac{2}{3}$ hours, corresponding to about 6900 kilometres of flight). Most counts were made during the first half of the month. Aerial surveys were carried out on most days during the period 4th–17th November. Most ground counts were made either on 12th (the international count day), or just before or after this date. The period 4th–17th (14 days) covers 99 % of all count units.

On most days during this period the weather was suitable for counts, i.e. with excellent visibility and little precipitation or wind. On November 12th (the most important day for ground counts), however, large parts of the country had rather strong winds and heavy precipitation, so the results obtained in many ground counts and in one of the two aerial surveys made on that day (see page 15) were unsatisfactory.

January 1968

The total number of count units was 2696, comprising 276 ground counts and 2420 flight minutes (40 $\frac{1}{3}$ hours, corresponding to about 6600 kilometres of flight). Apart from one district, Bornholm, which was surveyed in the latter half of

Fig. 1. Antallet af landtællesteder (sorte søjler) og flyve minutter (åbne søjler) på hver dag i november 1967 og januar 1968.

Wildfowl counts in Nov. 1967 and Jan. 1968

District	November 1967			January 1968		
	Ground count loca- lities	Flight minutes	Total count units	Ground count localities	Flight minutes	Total count units
	<i>Landtælle- steder</i>	<i>Flyve- minutter</i>	<i>I alt</i>	<i>Landtælle- steder</i>	<i>Flyve- minutter</i>	<i>I alt</i>
I W Jylland	19	228	247	14	225	239
II Limfjorden	16	689	705	10	350	360
III N Kattegat	19	475	494	9	325	334
IV Central Jylland	72	0	72	41	240	281
V E Jylland	20	157	177	12	170	182
VI SE Jylland	33	96	129	30	142	172
Total Jylland	179	1645	1824	116	1452	1568
VII Fyn	47	348	395	36	396	432
VIII W Sjælland	21	166	187	11	117	128
IX N + E Sjælland	84	0	84	33	106	139
X S Sjælland	54	285	339	36	229	265
XI Bornholm	19	55	74	44	120	164
Total islands	225	854	1079	160	968	1128
Total Denmark	404	2499	2903	276	2420	2696

Table 1. The number of ground-count localities and flight minutes in each district in November 1967 and January 1968.

Tabel 1. Antallet af landtællesteder og flyve-minutter i de forskellige distrikter i november 1967 og januar 1968.

the month, the whole country was covered within a much shorter period than in November. Thus all aerial surveys and most ground counts were carried out during a period of eight days (7th–14th January, the latter being the international count day), this period covering 92 % of all count units.

The weather was very changeable during the month of January. For the first days of the month temperatures were just below zero, but then hard frost set in, lasting until the middle of the month. During this period all lakes and very many shallow-watered coastal areas were iced over. During the period 7th–13th January

the weather was suitable for aerial surveys. On 14th, however, there was very poor visibility, and heavy snowfall which prevented many counters from reaching their areas. Consequently many localities were not covered at all, while in some of those covered the material obtained was unsatisfactory.

Comparison between the two months

Our aim was to cover the same areas in the two months, and this we were on the whole successful in doing, as will be seen from the maps Figs. 2 and 3. It would thereby be permissible to make a

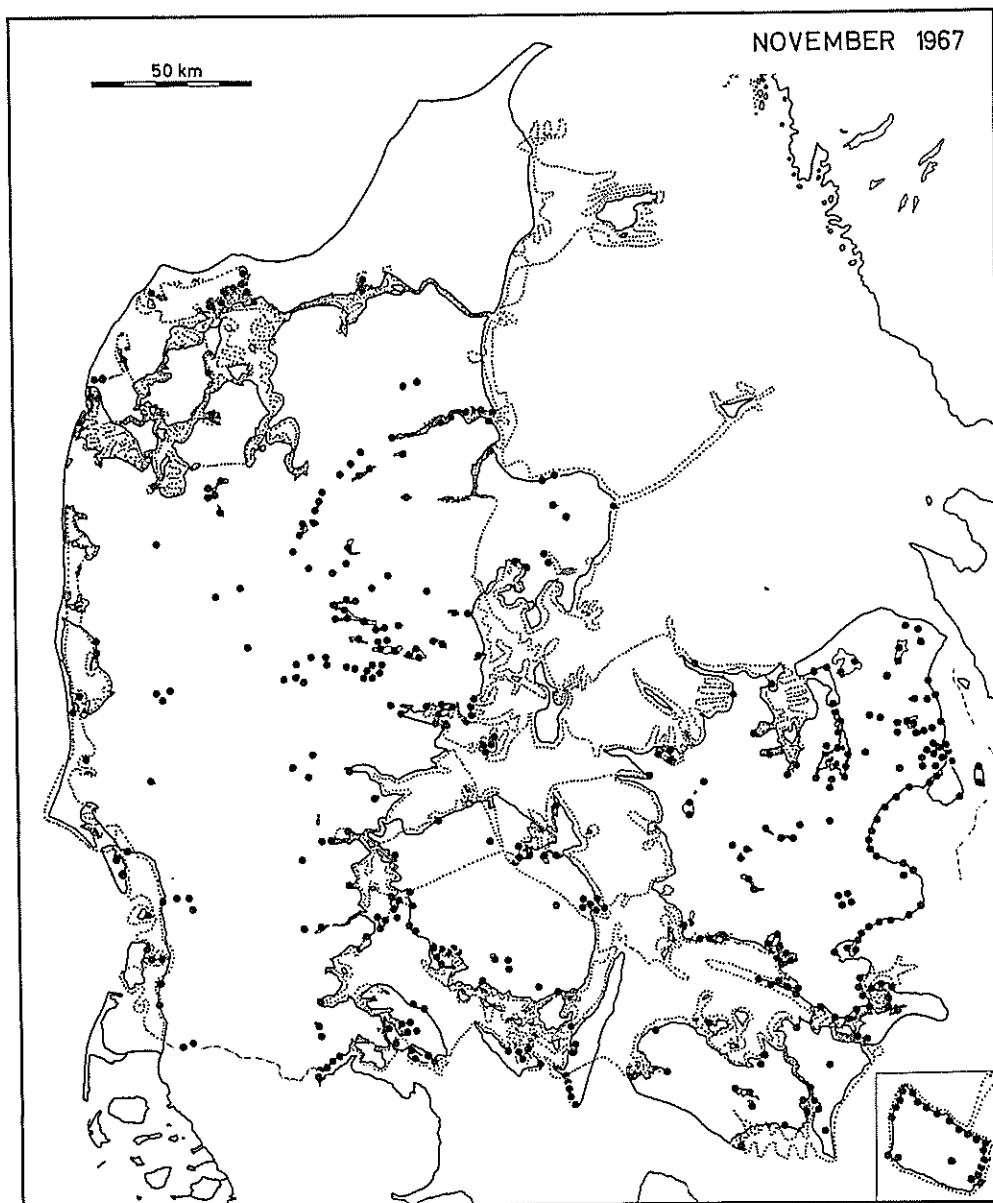


Fig. 2. Ground-count localities (dots) and flight routes (dotted lines) in November 1967. Not all details of flight routes are shown.

Fig. 2. Landtællesteder (pletter) og flyveruter (stiplede linier) i november 1967. Ikke alle detaljer i flyveruter er vist.

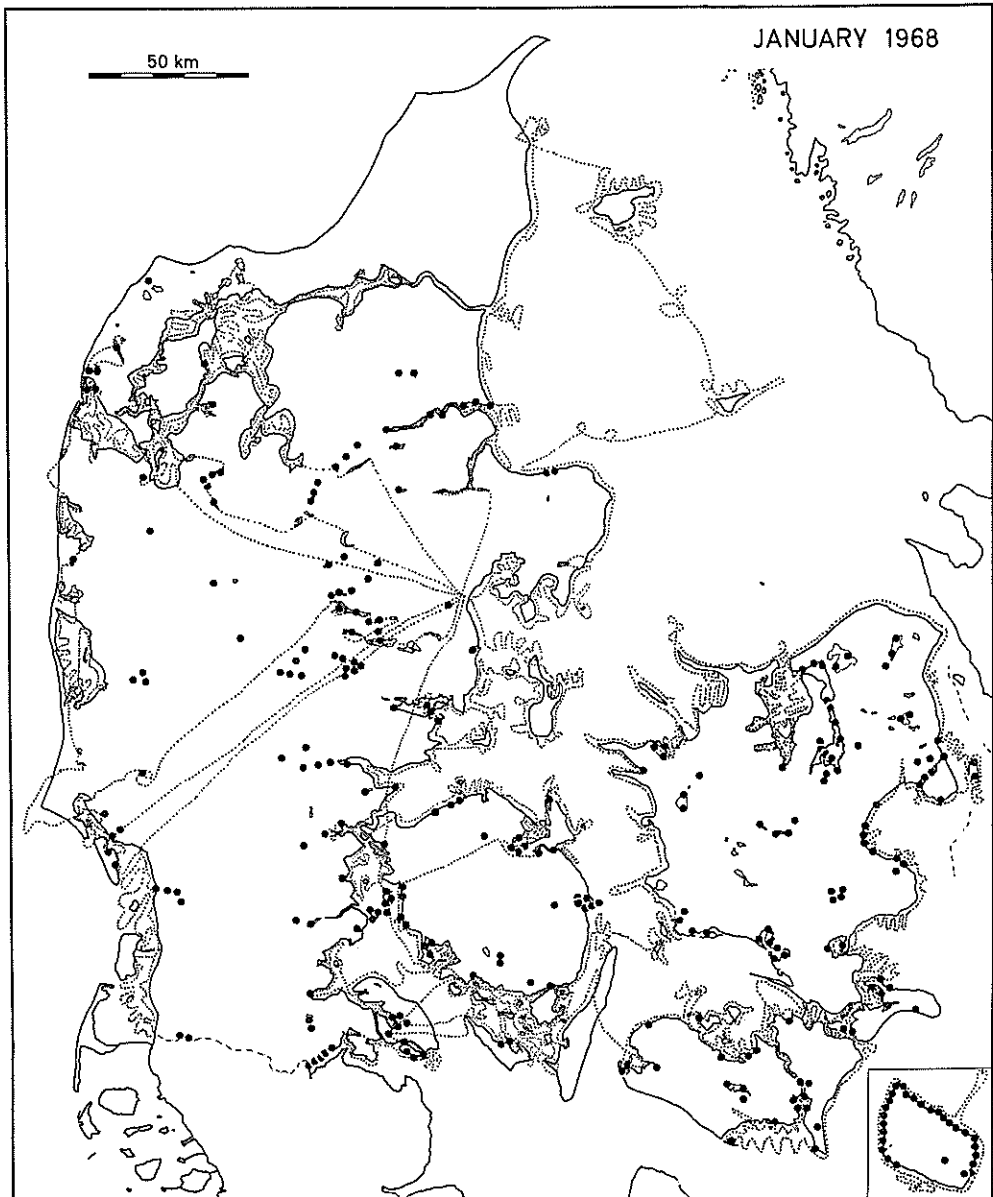


Fig. 3. Ground-count localities (dots) and flight routes (dotted lines) in January 1968. Not all details of flight routes are shown.

Fig. 3. Landtællesteder (pletter) og flyveruter (stiplede linier) i januar 1968. Ikke alle detaljer i flyveruter er vist.

comparison of the materials collected in the two months. Differences from one month to another in the number of count units in the various parts of the country (Table 1) are regarded as insignificant for the following reasons: 1) There were altogether fewer ground counts in January than in November; the counts for the latter month, however, included many areas in which there were very few birds in January, owing to ice. 2) Differences in the number of flight minutes in certain areas (for example Limfjorden) are due to ice cover in January which made many areas easier to survey.

Method used in aerial surveys

For all aerial surveys a taxiplane, mostly a four-seated single-engined CESSNA model was used, the cruising speed of which is about 175 km per hour. During the surveys the speed was 150–175 km per hour. In addition to the pilot, at least two observers were employed, one sitting beside the pilot and covering areas in front and to the right of the plane, the other sitting behind the pilot and covering areas to the left of the plane. Sometimes a third observer or a photographer was employed as well.

The time taken in different areas varied greatly with the type of habitat and the number of birds present. Along many coasts the route taken was either a straight line or a zig-zag course so as to take in shallow-watered banks offshore. In large areas of shallow water with many birds the route often followed parallel lines with a few kilometres in between and whenever a flock was discovered, the course was altered so that it could be examined at close range. In areas where there were large numbers of wildfowl, surveys were often repeated until satisfactory figures had been obtained. Often a general impression and a

preliminary figure was obtained first from so high an altitude, as not do disturb the birds; details were later observed at closer range. Binoculars with a magnification of 7 or 8 were used. During the flight all observations were recorded on a tape recorder by the observer on the front seat. This is the most satisfactory way of collecting a sufficient number of details within the very short time at disposal during aerial surveys. When using a tape recorder the observer can also make continuous observation, which is not possible when notes have to be made during the flight.

Treatment of the material

The material collected during the two months comprises a very large number of registrations, each of which consists of information as to species, estimated number and locality. The treatment of this material for the present paper has been confined to the plotting of flocks on maps and a summing up of the numbers recorded of each species in each district. Two points in the treatment should be emphasized here.

1) As will be seen in Figs. 2 and 3, many localities were covered by both ground counts and aerial surveys. In such cases the figures obtained in the aerial survey have usually been used, because this included also large surrounding areas. Figures obtained by ground counts were, however, used in preference to those of aerial surveys for those areas where they were obviously more satisfactory.

2) Population estimates are often given, 100–150, 500–600, for example. For simplification purposes a mean figure has been adopted. In the case of an estimate of 100–150 thus a figure of 125 has been used. This has been done consistently, whereby the figures presented in this paper will often seem peculiarly exact, for

example the total number registered: 656,586 and 698,425 in the two months respectively. This should not lead to the

assumption that the figures obtained are actually so precise. They are all orders of magnitude.

The Accuracy of Wildfowl Counts, Particularly of Aerial Surveys

In European literature on wildfowl hitherto published, little attention has been paid to the questions of the accuracy and value of material obtained in surveys. This is probably mainly due to the fact that in areas easily surveyed these problems are rightly considered insignificant, and also because the investigations are very difficult, owing to the problem of obtaining control figures which are not influenced by human factors.

Large scale aerial surveys have only been carried out in a few countries in Europe so far. ELTRINGHAM (1960), in an unpublished report, has described the results and experience from three years' aerial investigations in Great Britain. His assessment of the utility and accuracy of aerial surveys under British conditions is extremely valuable although further investigations particularly on accuracy would seem desirable. ELTRINGHAM also gives a review of aerial surveys in North America, which have been carried out for many years and include both breeding ground surveys and wintering ground surveys. The accuracy of breeding ground surveys has been subject to investigations, whereas little work has been done on this aspect in connection with winter surveys (ELTRINGHAM 1960 p. 5).

In Denmark where wildfowl habitats are both numerous and large and many areas can only be surveyed satisfactorily from aeroplanes, the problems of accuracy of the material obtained are so conspi-

cuous that they have to be taken into consideration in any assessment of the results.

In the two seasons of monthly winter counts the results of simultaneous observations in the same areas have often been compared. Thus comparisons have been made for example between: 1) Aerial surveys and ground counts. 2) Estimates made by two or three observers independently in the same aerial survey. 3) Two aerial surveys with an interval of at the most a few hours. 4) Estimates made by observers and the evidence of photographs of flocks made during aerial surveys. 5) Ground counts lasting only a few seconds (corresponding to the conditions of the aerial survey) and subsequent prolonged and careful counts. 6) Two or more independent ground counts made on the same day or with an interval of a few days.

An absolute control figure can only be obtained by means of photographs (4). In other types of comparisons (1 and 5) figures obtained in a quick ground count or by aerial survey are compared with figures which, although more reliable, are not necessarily absolute. In 2 and 6 the estimates of two or more observers are compared, while 3 and 6 throw light on the short-term fluctuations in numbers of wildfowl.

The material obtained so far is insufficient for a satisfactory evaluation of all kinds of errors, and it cannot form the

basis of numerical corrections of the figures obtained in the surveys in November 1967 and January 1968. The material does, however, give some general idea of the most important types of errors, particularly those connected with aerial surveys. In the following the most conspicuous tendencies will be described, and later (see pages 31–64) this experience will be applied in connection with an evaluation of the figures obtained for each species.

It will appear that the discussion is important for understanding the material collected in the two surveys. At the same time it should be remembered, however, that the conclusions are preliminary and may be subject to adjustment after the

next few years' methodological investigations. Further studies on methodological problems are planned.

Owing to prevailing conditions for wildfowl surveys in Denmark, the following questions are of particular importance for the assessment of the material:

1) Accuracy in estimation of size of flocks and determination of species. (See below).

2) The efficiency of registration in the areas investigated. (See page 14).

3) The number of birds in areas not surveyed. (See page 16).

4) The significance of movements of wildfowl during the surveys. (See page 17).

ACCURACY IN ESTIMATION OF SIZE OF FLOCKS AND DETERMINATION OF SPECIES

Estimation of flock size

An analysis of nearly five hundred comparisons on medium sized flocks (100–2000 birds) consisting of only one species showed that in about 75 % of cases the figures obtained in aerial counts or in quick ground counts (see page 11) diverged less than 33 % from the control figures. In about 25 % of cases the error was larger, in only very few cases, however, diverging more than 50 % from control figures.

Throughout the material overestimates and underestimates seem to occur equally frequently. Large flocks of 1000–2000 birds, were, however, more often underestimated. This was particularly the case with very compact flocks. There were thus several cases of underestimation of flocks of *Aythya fuligula*, *Somateria mollissima* and *Fulica atra*. Also in species characteristically well camouflaged, numbers were often underestimated. This

applied to *Melanitta nigra*, *Bucephala clangula* and *Mergus serrator*.

Overestimates were frequent, but do not seem to be connected with particular species, and throughout the material the numerical value of overestimates seems to be much less than that of underestimates.

So far very few comparisons have been made on flocks of more than 2000 birds. Such large flocks are, however, exceptional. In areas where several thousand birds gather the population generally consists of many small and medium sized flocks, so the accuracy in estimating the total number is equivalent to the error involved in estimating smaller flocks. But few species, such as *Aythya fuligula*, *Somateria mollissima* and *Fulica atra*, characteristically occur in huge, continuous flocks. The tendency to underestimate medium sized flocks might lead to the assumption that huge assemblies of these species are

generally underestimated. This, however, needs further investigation.

MATTHEWS (1960) is of the opinion that when a large number of people contribute to a survey, underestimates will compensate overestimates, so that total figures will probably be in the right order of magnitude. He further suggests that this will not be the case with aerial surveys when a large material is collected by a few observers; here the error will be consistent, either an underestimate or an overestimate. In the investigations considered here the major part of the data was collected in aerial surveys by a very few people who had much experience of aerial surveys and estimates of flock-size. In preceding surveys control figures (see page 11) had been carefully studied in order to improve the accuracy of estimates. Aerial surveys demand much experience, and although errors may be consistent we find that the best results are obtained when the surveys are made by only a very few people who have been training together.

Determination of species

In many areas aeroplanes can get much closer to the birds than can observers on the ground. Most wildfowl species are easily identified although the field characters used for identification in aerial surveys may be different from those used in ground counts. Some species are even recognized with more certainty from the air. Thus in flocks consisting of one species only the identification in general involves no great problems.

With some species, however, observation at rather close range is required for certain identification. This goes especially for the three species of swan, and in particular for *Cygnus cygnus* and *Cygnus columbianus*. Also *Anas platyrhynchos* and *Anas acuta*, *Bucephala clangula* and

Mergus serrator, *Melanitta nigra* and *Melanitta fusca*, may occasionally be confused, but in flocks consisting of only one of the species errors due to false identification of species seem to be insignificant.

Estimates of mixed flocks

When there are several species of wildfowl in the same area, as is often the case, the birds mostly lie in separate flocks, each of which consists mainly, if not exclusively, of one species only. When the species are separate, the results obtained in aerial surveys are generally representative.

In certain areas, however, including some of the most important haunts of dabbling ducks in N. and W. Jylland, many species often occur together in mixed flocks of thousands of birds. The observer must here, within a very short time, 1) determine the species, 2) estimate the total number, and 3) estimate the proportion of the total number of each species.

It was often found that where several species of dabbling ducks occurred in mixed flocks, the figures obtained in aerial surveys were not so satisfactory as those collected in most other areas. Since the areas in question constitute some of the most important resting grounds, it was of decisive importance that reliable figures should be obtained. Therefore in most such cases aerial surveys were combined with the safer ground counts, and the combination of the two types of surveys proved to provide very good results.

The problems of estimating mixed populations are indeed very great in the important dabbling duck haunts. The errors involved with censuses of other mixed populations are nothing like so significant. In coastal areas, for instance, where ice cover may cause many species to concentrate in some very limited areas

the figures obtained in aerial surveys are generally much more representative, because the species concerned (swans, *Bucephala clangula*, *Mergus merganser*, *Fulica atra* and others) are more easily distinguished.

Comparisons between results from areas which have been covered both by ground counts and by aerial surveys show a marked difference in the number of species registered. Thus most aerial surveys miss some of the species which occur in very small numbers or constitute a minority of the total number of birds present.

A species is thus liable to be overlooked not only when it occurs in very small numbers (see also page 15), but also when it occurs in quite large num-

bers, if these constitute only a few per cent of a very large assembly. Thus in a large concentration of *Anas platyrhynchos* a flock of one hundred *Anas acuta* might well be overlooked, although a hundred *Anas acuta* occurring separately, would almost certainly have been registered. This is probably due to the very short time available to the observer for registering and recording the birds. Even the trained observer will unconsciously concentrate his attention on species which evidently form the majority of a flock.

The tendency to overlook species occurring as minority members in mixed flocks undoubtedly causes an under-emphasis of these species as compared with the characteristically dominant species.

EFFICIENCY OF REGISTRATION IN THE AREAS SURVEYED

When evaluating material collected in aerial surveys a very important question arises: What proportion of the birds present in the areas investigated has actually been registered? So far we have little material to elucidate this problem, but some facts may be presented.

First it must be emphasized that a number of wildfowl in the areas investigated from the air will almost invariably be overlooked, so that provided an area can be satisfactorily surveyed from the ground, this method gives more reliable figures. The proportion of birds overlooked in an area investigated from the air varies a great deal and is dependent, for instance, on the weather and on the gregariousness, conspicuousness and behaviour of the individual species.

Weather

The most representative results from aerial surveys are obtained when there is

a calm sea and no wind and when there is excellent visibility and not too bright sunshine. When the sea is dead calm a continuous layer of cloud often provides the best conditions, whereas when the sea is rough sunshine is preferable. Under the very best conditions even relatively small groups of most species can be registered at a distance of at least one kilometre from the flight route, and large assemblies are often seen at distances of 2-6 kilometres, dependent on the species concerned. When weather conditions are poor the distance from the flight route within which birds can be registered is much diminished, and under very bad conditions even birds directly below the flight route may quite often be missed. This happens during heavy precipitation and when the sea is very rough, and under such conditions the material obtained is often of little value for comparative studies.

In the investigations described in the present paper all the aerial surveys but two were carried out during good or excellent weather conditions. Two surveys covering Bornholm and W. Jylland were made on November 12th when there was a strong wind in both areas. In the case of Bornholm hardly any wildfowl were registered at all. In W. Jylland, however, the storm caused the wildfowl to concentrate in very few areas. Although the weather made it impossible to cover all parts of Vadehavet, no doubt the great majority of birds present in this area were counted as they were concentrated in a few localities which could be investigated.

Registration efficiency dependent on size of flocks

Large assemblies of wildfowl are more conspicuous than small groups or birds lying singly on the water. Comparisons between counts indicate that in general, and particularly in aerial surveys, 1) more birds are overlooked in areas with dispersed populations than in areas where the birds tend to concentrate in flocks, 2) species occurring characteristically in small flocks are under-emphasized as compared with gregarious species, and 3) within a single species gregariousness may vary from place to place and from time to time causing corresponding variations in registration efficiency.

Conspicuousness of species and their reaction to aircraft

Species which are large and/or have very distinct white plumage patterns are much more conspicuous than species of small size and with a uniform dark plumage, the latter generally providing good camouflage on the sea.

The number of swans registered by aerial surveys is in most cases very close

to figures obtained by ground counts, and also *Tadorna tadorna*, *Mergus merganser* and adult males of *Somateria mollissima* are very conspicuous and discovered even at very great distances. In contrast to these we find that *Melanitta nigra*, *Melanitta fusca* and juvenile males of *Somateria mollissima* are well camouflaged and accordingly overlooked quite often in aerial surveys.

Some species, such as swans and *Fulica atra*, hardly ever react to the approach of an aeroplane. Dabbling ducks mostly take off but only when the plane is quite close, and in many cases it was found easier to count ducks when they were flying in a line than when they were sitting on the water forming a more or less compact group.

Some species of diving ducks nearly always stay on the water on the approach of an aeroplane, e.g. *Somateria mollissima* and the *Melanitta* species. The *Aythya* species are more liable to react, but mostly take off only when the plane is quite close.

Only in very few species had the reaction to the plane any significance for the registration efficiency. This applies particularly to *Clangula hyemalis*; very often flocks at great distances were observed to take off, and as the birds are very well camouflaged and alter course all the time, it was often impossible to find them again for closer examination. In all probability many flocks were not discovered at all, so that a large proportion of *Clangula hyemalis* present in areas surveyed may well have been overlooked.

Flocks of *Bucephala clangula* also occasionally take off and vanish before satisfactory records have been obtained, although this circumstance probably does not affect the registration efficiency so much as in the case of *Clangula hyemalis*.

In most waterfowl other than *Anatidae* the reaction to aircraft in combination with dispersed distribution results in a large proportion of the birds being overlooked, *Fulica atra* being the only exception (see above). *Phalacrocorax carbo*, though a large bird, is no doubt missed in a number of cases because the birds dis-

appear long before they can be discerned from the aeroplane. Species of *Gaviidae*, *Podicipedidae* and *Alcidae* very often dive when disturbed, and being at the same time widely scattered and generally well camouflaged they have only in very few cases been recorded during aerial surveys.

WILDFOWL OCCURRING IN AREAS NOT SURVEYED

Freshwater areas

Nearly all lakes larger than 20 hectares were investigated in both months. In the country there are, however, a large number of small freshwater habitats such as ponds, rivulets, and temporarily flooded fields, the majority of which were not covered. Freshwater habitats of this type are regularly visited by only two species, viz. *Anas crecca* and, more particularly, *Anas platyrhynchos*, in most cases, however, in very small numbers. It is our impression that the total number of wildfowl present in such areas comprises only a comparatively small proportion of the total population (see page 31).

Salt water areas

The intensity of surveys in salt water areas varied much in the different parts of the country. Thus in some areas, which were known to be very important resting grounds, not only the coasts were searched, but investigations encompassed also shallow water further from the coast. This was for instance the case for Vadehavet, Limfjorden, the area between Samsø and Jylland, south of Fyn, and around the islands of Lolland, Falster and Møn.

In most other parts of the country, however, only the coastline was surveyed, usually only once, which means that in these areas only birds within a few kilo-

metres of the coast could be registered. Intensive surveys and single coastline flights were made along nearly all coasts with the exception of the North Sea coast. This area provides little shelter and from ground counts and irregular aerial surveys we know that comparatively few wildfowl are found here, *Melanitta nigra* being probably the only plentiful species.

We know, however, that in eastern waters including the Kattegat, Storebælt, Lillebælt, Øresund, and part of Østersøen (the Baltic sea), some unsurveyed areas hold large numbers of diving ducks, viz. *Somateria mollissima*, *Melanitta nigra*, *Melanitta fusca*, and *Clangula hyemalis*. Particularly the last mentioned species is believed to be mostly confined to open waters. In the northern Kattegat particularly, the surveys covered only a small proportion of the habitats used by marine diving ducks, but figures obtained for other waters also are undoubtedly too low because of insufficient investigations.

A few other species regularly occur in the open sea, although the majority of birds are probably found in the coastal areas which were surveyed. This is true of *Aythya marila*, *Bucephala clangula* and *Mergus serrator*. Thus for these species an unknown but probably fairly small proportion of the habitats was not covered.

Also species characteristically confined

to lakes and coastal waters may occasionally be found well offshore. This is the case with *Anas platyrhynchos*, but the numbers missed in this way are probably insignificant compared with the total population.

Apart from the few typically marine species mentioned above, the great majority of species and their populations are confined to coastal areas which were almost completely surveyed in November 1967 and January 1968.

THE SIGNIFICANCE OF MOVEMENTS OF WILDFOWL DURING THE SURVEYS

The most satisfactory picture of wildfowl distribution is obviously achieved when all surveys are carried out on the same day, which virtually eliminates errors caused by movements of populations. Owing to the limited number of people qualified for aerial surveys and the great number of areas to be investigated the surveys must, however, of necessity be rather prolonged. The surveys in November took a full fortnight, while in January all parts of the country with the exception of Bornholm were investigated within eight days.

The spacing of investigations may give rise to errors. Movements may cause some birds to be missed and others to be counted twice. In a large material underestimates are likely to compensate for overestimates, but in small samples such as those considered here one type of error may well predominate.

In Denmark this problem is without doubt a significant one. The exposed situation of many important coastal resting

grounds combined with the unstable weather conditions may cause large numbers of wildfowl to move long distances within a single day. We have many observations of large scale movements caused by changes in the weather situation (see for example *Anas platyrhynchos* page 34).

In order to reduce this bias, aerial surveys were planned to cover natural geographical units within one day or two successive days, and most flights were carried through according to the program.

Although we are fully aware of the possibility of errors due to movement, our experience is as yet inadequate to provide a basis for a satisfactory evaluation of such errors occurring in the surveys of November 1967 and January 1968. Consequently in the further assessment of the material the figures obtained have been treated as if they had been collected simultaneously in all parts of the country.

The Value of Ground Counts and Monthly Counts

In order to elucidate the representativeness of ground counts and more particularly of regular monthly counts in nearly 400 localities in 1967/68 we divided wildfowl habitats into three categories: I: freshwater areas, II: salt water areas within 2 kilometres of the coast, and III: salt water areas more than 2 kilometres from coasts and also the entire coastal area around uninhabited islands. Categories I and II comprise areas which under optimal circumstances can be surveyed from land. In what measure it is feasible for observers to cover such areas sufficiently naturally varies much from area to area, with weather conditions and with the type of binoculars used. When the sea is rough it will in most cases not be possible to get accurate information from the entire area within the 2 kilometre limit.

Table 2 shows the distribution (percentage of total populations) of seven of the most numerous species in the three categories of habitat and also the numbers present in monthly count localities (column MC). These seven species together comprise 85 % and 91 % of the total number of wildfowl registered in the two months respectively.

Allowance must be made for the fact that distances from the coast are only estimated, whereby the figures in columns II and III are only moderately accurate; they do, however, serve to give some idea of the approximate distribution. It should be noted also that all figures are percentages of the number registered, which is not equivalent to the absolute numbers present (see previous chapter). Since species characteristically occurring well offshore are more under-represented in the material than species confined to freshwater and coastal areas, the figures

for category III for marine species are too low. Accordingly the percentages in the column MC are too high, particularly for *Somateria mollissima*.

Ground counts

By adding together the percentages in column I and II (Table 2) we get an impression of the proportion of the populations which would have been registered if all lakes and coasts had been surveyed from the ground. Considering the seven species as a whole we find that 60 % and 37 % would have been counted in November and January respectively. The striking discrepancy is due to displacement by frost in the latter month.

In November the most representative material would presumably have been obtained for *Aythya fuligula*, since all birds were in lakes and in the sea within 2 kilometres of the coasts. Reasonably good figures would also have been obtained for *Anas platyrhynchos*, *Anas penelope*, *Cygnus olor* and *Fulica atra* (between 72 % and 83 %). However, only half the *Bucephala clangula* would have been counted, while the lowest figures would have been obtained for *Somateria mollissima* (12 %).

In January much smaller proportions of the populations were present in categories I and II. 58 % of *Fulica atra* were found in these areas, and for three species about half the populations would have been counted. For *Bucephala clangula* only 27 % and for *Somateria mollissima* only 5 % would have been registered in ground counts.

Monthly counts

Of the total number of birds registered in the large scale survey in November 1967, about half was found in the 400

Wildfowl counts in Nov. 1967 and Jan. 1968

	November 1967							January 1968						
	Number	I %	II %	I+II %	III %	II+III %	MC %	Number	I %	II %	I+II %	III %	II+III %	MC %
All species	656,586	22					48	698,425	4					16
1. <i>Anas platyrhynchos</i>	121,636	43	29	72	27	57	63	91,853	25	29	54	46	75	37
2. <i>Anas penelope</i>	47,598	25	48	73	27	76	69	-	-	-	-	-	-	-
3. <i>Aythya fuligula</i>	50,897	54	46	100		46	55	125,359	2	51	53	47	98	24
4. <i>Somateria mollissima</i>	153,658		12	12	88	100	3	185,638		5	5	95	100	2
5. <i>Bucephala clangula</i>	18,533	11	36	47	53	89	29	63,675	1	26	27	73	99	7
6. <i>Cygnus olor</i>	41,099	5	70	75	24	94	52	42,240	1	51	52	48	99	21
7. <i>Fulica atra</i>	126,334	19	64	83	17	81	52	124,881	4	52	56	43	95	21
1-7 total	559,755	22	39	60	40	79	42	633,646	5	32	37	63	95	17

Table 2. The percentage distribution of seven species in three categories of habitat: I - freshwater areas, II - salt water areas within 2 kilometres of the coast, and III - salt water areas more than 2 kilometres from the coast. MC: percentage of population present in nearly 400 monthly count localities.

Tabel 2. Den procentvise fordeling af syv arters bestande på I - ferskvandsområder, II - havområder mindre end 2 kilometer fra kysterne, og III - havområder mere end 2 kilometer fra kysterne. MC: De næsten 400 faste månedlige tællesteders andel af bestandene.

areas covered by the monthly surveys. This was also the case with five species in Table 2 taken individually. The percentages for *Bucephala clangula* and more particularly for *Somateria mollissima* were, however, much lower. In January only 16 % of the total number of birds was found in these areas, the highest percentages for a single species being 37 % (*Anas platyrhynchos*).

The following conclusions can be reached:

1) Ground counts covering all lakes and all coasts would provide absolute or nearby absolute figures only for a few species and only in months with no ice. Large numbers are found in open sea and in marine species ground counts can only

cover very small proportions of the populations.

2) Within the 400 monthly count localities only about half the populations of some very numerous species are found, and for other species only very small proportions.

3) Ground counts covering all lakes and coasts are impracticable, but if about 100 more localities were covered every month probably well over half the total populations of the majority of species would be counted.

4) In periods of ice cover, wildfowl move to areas far from the coasts so that only a very small proportion of the birds may be present in the monthly count localities.

Wildfowl Populations in November 1967 and January 1968

In this chapter the results of the investigations in November 1967 and January 1968 will be described. We shall first examine the general distribution pattern of all species, after which each species will be described separately in relation to material obtained, distribution and numbers. General information on the occurrence of the various species in Denmark is not given here, but has been described by for example SALOMONSEN (1963, 1967).

In the present treatment of the material the country has been divided into eleven districts, each comprising a suitable geographical unit. In the following these districts will be referred to by Roman numerals (I to XI). The names of the districts used are generally the names of provinces. District X, called S Sjælland, includes, however, also the islands of Lolland, Falster, and Møn. The borders of the districts are shown on the map Fig. 4.

In Tables 3 and 4 the numbers of each species recorded in the various districts are given. The distribution of all species is marked on the maps Figs. 6 and 7, and the maps Figs. 8–33 show the distribution of separate species.

In Figs. 6 and 7 comprising all species, only concentrations of 100 or more birds are shown. In the maps for separate species smaller concentrations are also included.

For very numerous species large maps have been used and here the lowest category comprises concentrations within the range of 20–49 birds. For less plentiful species the scale of the maps is only half of that used for the numerous species, and here the lowest category comprises concentrations of 5–49 birds. In the two kinds of maps the same size signs have been used in order to facilitate direct visual comparison.

THE TOTAL POPULATIONS

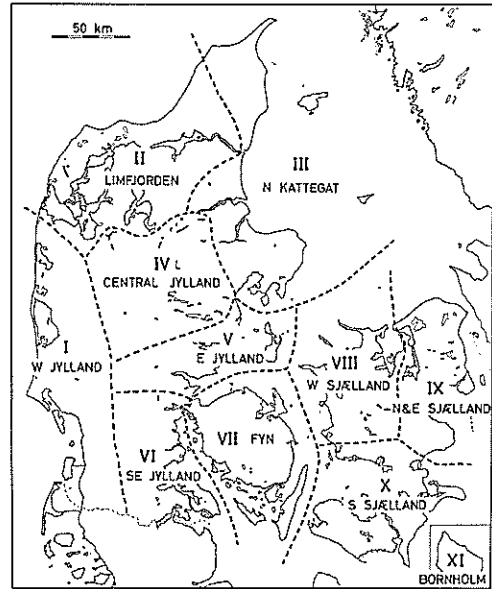
In November 1967 nearly 660,000 and in January nearly 700,000 wildfowl were counted throughout Denmark. The presentation of these figures raises the question: Do these figures stand for the actual populations present in Denmark and surrounding waters in the two months concerned? The answer to this is no. The fact has already been mentioned, and will later be gone into in more detail, that the figures obtained for some species are not far from being representative, while for other species the numbers are greatly underestimated. We know that the figures obtained for the most plentiful of all species *Somateria mollissima* are far be-

low those of the actual population, an underestimate of the order of some hundred thousand birds (see page 48). And we believe that in the case of *Melanitta nigra* and *Melanitta fusca*, tens of thousands have not been registered. This means that the total population in the two months was probably close on a million. At present, however, there is insufficient basis for any reasonable guess at the size of the total populations.

This conclusion raises the next question: Are the total figures for the various districts comparable; in other words, are there some districts for which numbers recorded constitute an exceptionally small

Fig. 4. The division of Denmark into 11 districts.
 Fig. 4. Inddelingen af Danmark i 11 distrikter.

part of the actual populations? The uninvestigated areas in most districts are considered relatively unimportant. Only for one district, III - N Kattegat, do we feel that investigations did not satisfactorily cover banks well offshore. This means that for marine diving ducks this district is probably greatly under-represented. For the most easterly district, XI - Bornholm, the figures obtained in November are also unrepresentative. For all other districts we do, however, consider the figures fairly comparable although the discrepancy in registration efficiency of the different species does not allow a detailed comparison between all species.



NOVEMBER 1967

In November large numbers of wildfowl were found in all parts of the country (Fig. 5). 55 % were in Jylland and 45 % in the eastern districts. In two districts more than 100,000 birds were counted, i.e. I - W Jylland and X - S Sjælland. Four districts had from fifty to a hundred thousand birds, and five had less than fifty thousand.

Although distribution seems very uniform throughout the country we find that a large proportion of the birds was found in quite a few localities. The technique used in drawing the maps masks the degree of concentration to some extent, since the signs for large flocks cover far larger areas on the map than they did in reality. There were nine concentrations of 10,000 birds or more, and a further fifteen concentrations within the range of 5,000-9,999 birds. These 23 localities accounted for about 40 % of all wildfowl recorded,

and the size of the areas in which they were counted probably amounts to less than 1 % of the area of lakes and coastal waters in Denmark. Although the areas regularly used by these birds are probably much larger, the figures still bear ample witness to the gregariousness of wildfowl.

Whereas the distribution of all species is fairly uniform, the composition of species making up the major part of the total population varies greatly from west to east. This is illustrated in Table 5.

In the west, particularly in I - W Jylland and II - Limfjorden, dabbling ducks constituted the majority of wildfowl. Though *Anas platyrhynchos* was the most widely distributed wildfowl, ranging among the four most plentiful species in all districts, 58 % of this and other *Anas*-species were found in the two districts mentioned, making up about 66 % of the wildfowl populations there.

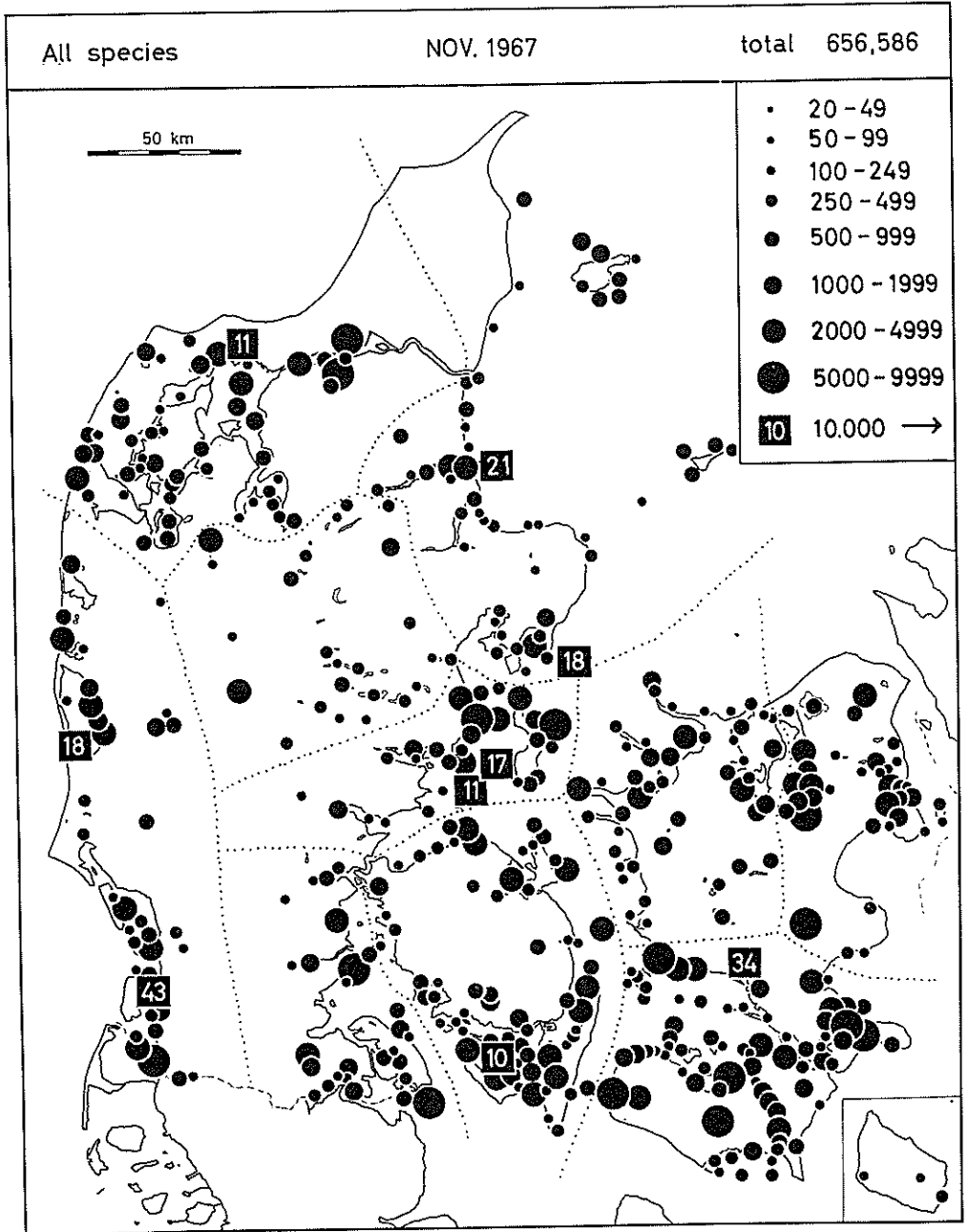


Fig. 5

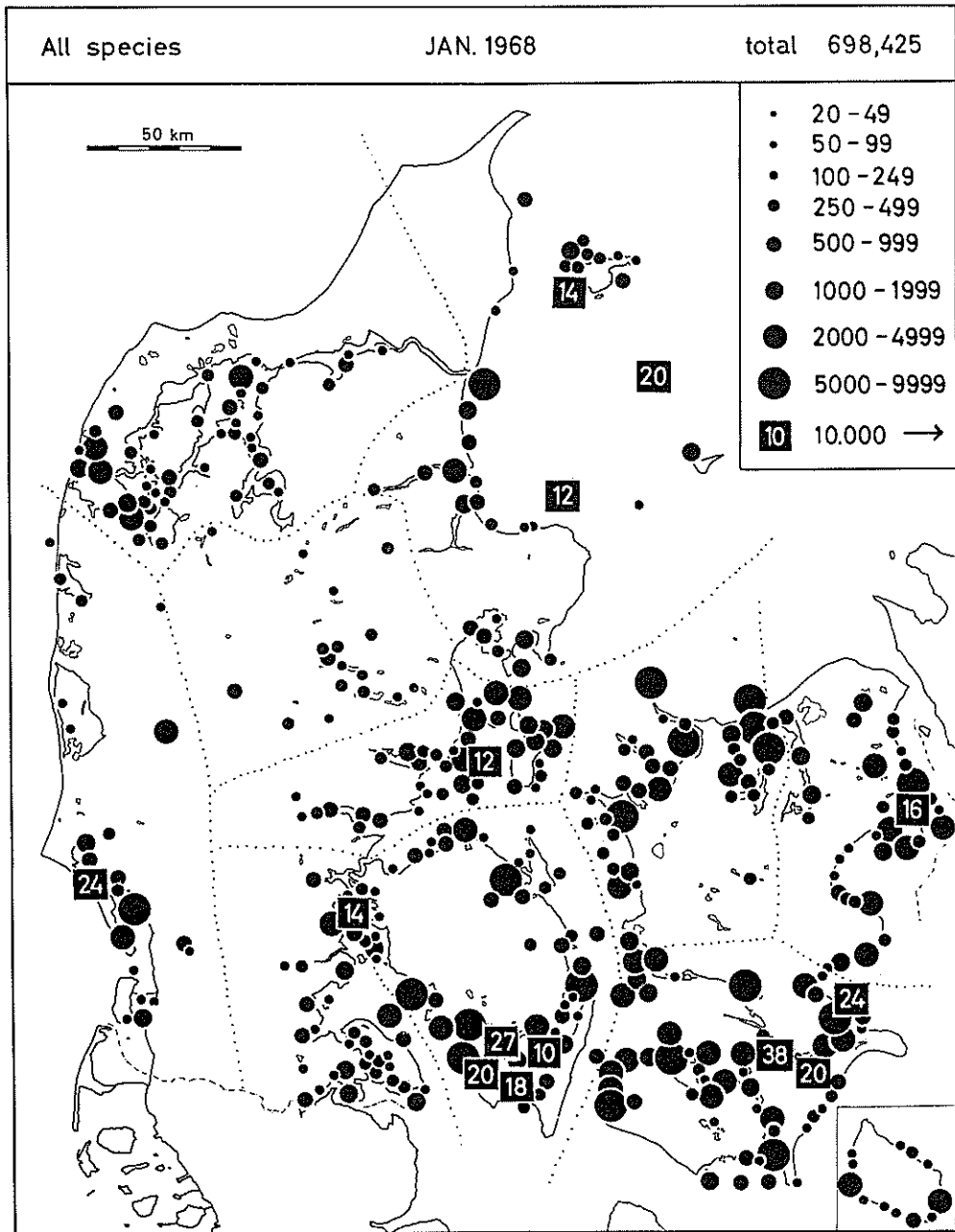


Fig. 6

Table 3. Results of the investigation in November 1967. The numbers of each species recorded in all districts.

Species Art	I W Jylland	II Lim- fjorden	III N Kattegat	IV Central Jylland	V E Jylland	VI SE Jylland	I-VI Jylland total
<i>Anas platyrhynchos</i>	42,734	16,837	6,677	8,017	3,350	9,296	86,911
<i>Anas crecca</i>	5,851	4,517	150	2,202	520	901	14,141
<i>Anas querquedula</i>		2					2
<i>Anas strepera</i>							
<i>Anas penelope</i>	28,762	9,719	415	211	1,305	1,310	41,722
<i>Anas acuta</i>	2,400	245	2		350	500	3,497
<i>Anas clypeata</i>	1,165	197			50		1,412
<i>Tadorna tadorna</i>	3,831	281	2,525		51	18	6,706
<i>Aythya ferina</i>		3,965	50	144	20	750	4,929
<i>Aythya fuligula</i>	54	891	80	2,101	400	2,849	6,375
<i>Aythya marila</i>	1	3,003		4	260	12	3,280
<i>Netta rufina</i>							
<i>Clangula hyemalis</i>		1	5		1	75	82
<i>Melanitta nigra</i>	3	528	11,675		2,398	126	14,730
<i>Melanitta fusca</i>	794	175	11,662	5	5,662	906	19,204
<i>Somateria mollissima</i>	6,498		29,197		54,030	10,114	99,839
<i>Bucephala clangula</i>	575	8,994	1,525	97	627	2,223	14,041
<i>Mergus serrator</i>	19	5,649	380	24	112	268	6,452
<i>Mergus merganser</i>		3	2	282	19	52	358
<i>Mergus albellus</i>		2					2
<i>Cygnus olor</i>	2,435	564	2,409	113	617	878	7,016
<i>Cygnus cygnus</i>	49	511	61	2	160		783
<i>Cygnus columbianus</i>		196					196
<i>Anatidae total</i>	95,171	56,280	66,815	13,202	69,932	30,278	331,678
<i>Fulica atra</i>	7,485	10,619	1,087	1,382	1,722	5,758	28,053
<i>Phalacrocorax carbo</i>			155		680	4	839
All species total	102,656	66,899	68,057	14,584	72,334	36,040	360,570
The share of each district of the total population <i>Distriktets andel af den samlede bestand</i>	15.6 %	10.2 %	10.4 %	2.2 %	11.0 %	5.5 %	54.9 %

Wildfowl counts in Nov. 1967 and Jan. 1968

Tabel 3. Resultatet af undersøgelsen i november 1967. For hver art er antallet af fugle registreret i hvert distrikt anført.

VII Fyn	VIII W Sjælland	IX N & E Sjælland	X S Sjælland	XI Bornholm	VII-XI Islands total	I-XI All Denmark	The share of each species of the total population <i>Arternes andel af den samlede bestand</i>
7,633	5,363	6,747	14,219	763	34,725	121,636	18.5%
292	723	533	1,760		3,308	17,449	2.7%
20					20	22	
		1	5		6	6	
902	566	1,844	2,563	1	5,876	47,598	7.3%
11	107	5	184		307	3,804	
20	157	5	196		378	1,790	
195	112	37	112		456	7,162	1.1%
121	223	747	6,441		7,532	12,461	1.9%
1,408	1,020	12,568	29,494	32	44,522	50,897	7.8%
6	62	95	63	11	237	3,517	
		2	2		4	4	
11	8	1	414	44	478	560	
975	1,450	1	56		2,482	17,212	2.6%
1,738	1,335		124		3,197	22,401	3.4%
32,661	16,317	462	4,344	35	53,819	153,658	23.4%
1,613	612	419	1,848		4,492	18,533	2.8%
242	108	371	441	34	1,196	7,648	1.2%
27	18	5	4	8	62	420	
	1	5	3		9	11	
9,450	1,673	4,122	18,822	16	34,083	41,099	6.3%
48	36	38	91	3	216	999	
	15		2		17	213	
57,373	29,906	28,008	81,188	947	197,422	529,100	
17,225	6,855	16,593	57,595	13	98,281	126,334	19.2%
173	57	1	82		313	1,152	
74,771	36,818	44,602	138,865	960	296,016	656,586	
11.4%	5.6%	6.8%	21.2%	0.1%	45.1%		

Table 4. Results of the investigation in January 1968. The numbers of each species recorded in all districts.

Species Art	I W Jylland	II Lim- fjorden	III N Kattegat	IV Central Jylland	V E Jylland	VI SE Jylland	I-VI Jylland total
<i>Anas platyrhynchos</i>	6,730	5,212	7,386	4,443	5,383	5,288	34,442
<i>Anas crecca</i>	58		20		20		98
<i>Anas querquedula</i>							
<i>Anas strepera</i>							
<i>Anas penelope</i>		72					72
<i>Anas acuta</i>	1						1
<i>Anas clypeata</i>							
<i>Tadorna tadorna</i>	5	83	832		2		922
<i>Aythya ferina</i>		2	8				10
<i>Aythya fuligula</i>	61	296	695	123	612	11,722	13,509
<i>Aythya marila</i>			94		88	4,202	4,384
<i>Netta rufina</i>							
<i>Clangula hyemalis</i>						2	2
<i>Melanitta nigra</i>	50	8	604		997	240	1,899
<i>Melanitta fusca</i>	1,130	80	14,795		2,061		18,066
<i>Somateria mollissima</i>	31,718	70	42,393		35,405	5,535	115,121
<i>Bucephala clangula</i>	929	12,455	2,465	14	2,944	3,025	21,832
<i>Mergus serrator</i>		254	44		83	24	405
<i>Mergus merganser</i>	330	3,769	769	23	519	277	5,687
<i>Mergus albellus</i>		4	1		3		8
<i>Cygnus olor</i>	516	189	869	104	429	715	2,822
<i>Cygnus cygnus</i>	216	1,589	991	179	38	65	3,078
<i>Cygnus columbianus</i>		40					40
<i>Anatidae total</i>	41,744	24,123	71,966	4,886	48,584	31,095	222,398
<i>Fulica atra</i>	1,006	2,266	1,025	529	1,130	3,492	9,448
<i>Phalacrocorax carbo</i>	7		125		231		363
All species total	42,757	26,389	73,116	5,415	49,945	34,587	232,209
The share of each district of the total population <i>Distriktets andel af den samlede bestand</i>	6.1 %	3.8 %	10.5 %	0.8 %	7.2 %	4.9 %	33.2 %

Wildfowl counts in Nov. 1967 and Jan. 1968

Tabel 4. Resultatet af undersøgelsen i januar 1968. For hver art er antallet af fugle registreret i hvert distrikt anført.

VII Fyn	VIII W Sjælland	IX N & E Sjælland	X S Sjælland	XI Bornholm	VII-XI Islands total	I-XI All Denmark	The share of each species of the total population <i>Arternes andel af den samlede bestand</i>
13,475	6,445	11,482	21,497	2,587	55,486	89,928	7.9 %
7		30		11	48	146	
			5		5	5	
	300		4	3	307	379	
1			3		4	5	
			3		3	3	
32	50	12	4	1	99	1,021	
23		628	1,966	23	2,640	2,650	
23,933	5,317	33,489	46,931	2,180	111,850	125,359	17.9 %
1,705	580	259	515	42	3,101	7,485	1.1 %
50	631	14	360	1,568	2,623	2,625	
882	1,452	85	256	178	2,853	4,752	
1,497	1,043	167	579	108	3,394	21,460	3.1 %
29,645	31,697	54	8,828	293	70,517	185,638	26.6 %
14,766	10,677	2,204	13,896	300	41,843	63,675	9.1 %
437	111	119	439	90	1,196	1,601	
1,432	1,385	2,227	2,427	60	7,531	13,218	1.9 %
		302	47		349	357	
11,680	1,967	3,814	21,884	73	39,418	42,240	6.1 %
984	781	160	4,857	1	6,783	9,861	1.4 %
50	38		120		208	248	
100,599	62,474	55,046	124,621	7,518	350,258	572,656	
38,397	3,439	8,665	63,974	958	115,433	124,881	17.9 %
254	209		38	24	525	888	
139,250	66,122	63,711	188,633	8,500	466,216	698,425	
19.9 %	9.5 %	9.1 %	27.0 %	1.2 %	66.8 %		

District	Grand total all species Den totale bestand af alle arter	1	2	3	4	Share of the four species of the total population De fire arteres samlede andel af hele bestanden
I W Jylland	102,656	Anas platyrhynchos 42 % Anas platyrhynchos 25 % Somateria mollissima 44 % Anas platyrhynchos 55 %	Anas penelope 28 % Fulica atra 16 % Melanitta nigra 17 % Anas crecca 15 %	Fulica atra 7 % Anas penelope 16 % Melanitta fusca 17 % Aythya fuligula 14 % Anas platyrhynchos 5 %	Somateria mollissima 6 % Bucephala clangula 13 % Anas platyrhynchos 10 % Fulica atra 9 % Fulica atra 2 %	83 % 70 % 88 % 93 % 90 %
II Limfjorden	66,899	Somateria mollissima 44 % Anas platyrhynchos 28 %	Anas penelope 28 % Fulica atra 16 % Melanitta nigra 17 % Anas crecca 15 %	Fulica atra 7 % Anas penelope 16 % Melanitta fusca 17 % Aythya fuligula 14 % Anas platyrhynchos 5 %	Somateria mollissima 6 % Bucephala clangula 13 % Anas platyrhynchos 10 % Fulica atra 9 % Fulica atra 2 %	83 % 70 % 88 % 93 % 90 %
III N Kattegat	68,057	Somateria mollissima 44 % Anas platyrhynchos 28 %	Anas penelope 28 % Fulica atra 16 % Melanitta nigra 17 % Anas crecca 15 %	Fulica atra 7 % Anas penelope 16 % Melanitta fusca 17 % Aythya fuligula 14 % Anas platyrhynchos 5 %	Somateria mollissima 6 % Bucephala clangula 13 % Anas platyrhynchos 10 % Fulica atra 9 % Fulica atra 2 %	83 % 70 % 88 % 93 % 90 %
IV Central Jylland	14,584	Somateria mollissima 44 % Anas platyrhynchos 28 %	Anas penelope 28 % Fulica atra 16 % Melanitta nigra 17 % Anas crecca 15 %	Fulica atra 7 % Anas penelope 16 % Melanitta fusca 17 % Aythya fuligula 14 % Anas platyrhynchos 5 %	Somateria mollissima 6 % Bucephala clangula 13 % Anas platyrhynchos 10 % Fulica atra 9 % Fulica atra 2 %	83 % 70 % 88 % 93 % 90 %
V E Jylland	72,334	Somateria mollissima 44 % Anas platyrhynchos 28 %	Anas penelope 28 % Fulica atra 16 % Melanitta nigra 17 % Anas crecca 15 %	Fulica atra 7 % Anas penelope 16 % Melanitta fusca 17 % Aythya fuligula 14 % Anas platyrhynchos 5 %	Somateria mollissima 6 % Bucephala clangula 13 % Anas platyrhynchos 10 % Fulica atra 9 % Fulica atra 2 %	83 % 70 % 88 % 93 % 90 %
VI S E Jylland	36,040	Somateria mollissima 44 % Anas platyrhynchos 28 %	Anas penelope 28 % Fulica atra 16 % Melanitta nigra 17 % Anas crecca 15 %	Fulica atra 7 % Anas penelope 16 % Melanitta fusca 17 % Aythya fuligula 14 % Anas platyrhynchos 5 %	Somateria mollissima 6 % Bucephala clangula 13 % Anas platyrhynchos 10 % Fulica atra 9 % Fulica atra 2 %	83 % 70 % 88 % 93 % 90 %
VII Fyn	74,771	Somateria mollissima 44 % Anas platyrhynchos 28 %	Anas penelope 28 % Fulica atra 16 % Melanitta nigra 17 % Anas crecca 15 %	Fulica atra 7 % Anas penelope 16 % Melanitta fusca 17 % Aythya fuligula 14 % Anas platyrhynchos 5 %	Somateria mollissima 6 % Bucephala clangula 13 % Anas platyrhynchos 10 % Fulica atra 9 % Fulica atra 2 %	83 % 70 % 88 % 93 % 90 %
VIII W Sjælland	36,818	Somateria mollissima 44 % Anas platyrhynchos 28 %	Anas penelope 28 % Fulica atra 16 % Melanitta nigra 17 % Anas crecca 15 %	Fulica atra 7 % Anas penelope 16 % Melanitta fusca 17 % Aythya fuligula 14 % Anas platyrhynchos 5 %	Somateria mollissima 6 % Bucephala clangula 13 % Anas platyrhynchos 10 % Fulica atra 9 % Fulica atra 2 %	83 % 70 % 88 % 93 % 90 %
IX N + E Sjælland	44,602	Fulica atra 37 % Fulica atra 41 % Anas platyrhynchos 79 %	Anas penelope 28 % Fulica atra 16 % Melanitta nigra 17 % Anas crecca 15 %	Fulica atra 7 % Anas penelope 16 % Melanitta fusca 17 % Aythya fuligula 14 % Anas platyrhynchos 5 %	Somateria mollissima 6 % Bucephala clangula 13 % Anas platyrhynchos 10 % Fulica atra 9 % Fulica atra 2 %	83 % 70 % 88 % 93 % 90 %
X S Sjælland	138,865	Fulica atra 37 % Fulica atra 41 % Anas platyrhynchos 79 %	Anas penelope 28 % Fulica atra 16 % Melanitta nigra 17 % Anas crecca 15 %	Fulica atra 7 % Anas penelope 16 % Melanitta fusca 17 % Aythya fuligula 14 % Anas platyrhynchos 5 %	Somateria mollissima 6 % Bucephala clangula 13 % Anas platyrhynchos 10 % Fulica atra 9 % Fulica atra 2 %	83 % 70 % 88 % 93 % 90 %
XI Bornholm	960	Fulica atra 37 % Fulica atra 41 % Anas platyrhynchos 79 %	Anas penelope 28 % Fulica atra 16 % Melanitta nigra 17 % Anas crecca 15 %	Fulica atra 7 % Anas penelope 16 % Melanitta fusca 17 % Aythya fuligula 14 % Anas platyrhynchos 5 %	Somateria mollissima 6 % Bucephala clangula 13 % Anas platyrhynchos 10 % Fulica atra 9 % Fulica atra 2 %	83 % 70 % 88 % 93 % 90 %
All districts	656,586	Somateria mollissima 23 %	Fulica atra 19 %	Anas platyrhynchos 19 %	Aythya fuligula 8 %	69 %

Table 5. The four most plentiful species and their share in percentages of the total population in each of the districts in November 1967.

Tabel 5. De fire talrigeste arter og deres procentvise andel af den totale bestand i de forskellige distrikter i november 1967.

District	Grand total all species Den totale bestand af alle arter	1	2	3	4	Share of the four species of the total population De fire arters samlede andel af hele bestanden
I W Jylland	42,757	Somateria mollissima 74 %	Anas platyrhynchos 16 % Anas platyrhynchos 20 %	Melanitta fusca 3 %	Fulica atra 2 %	95 %
II Limfjorden	26,389	Bucephala clangula 47 % Somateria mollissima 58 %	Anas platyrhynchos 20 %	Mergus merganser 14 % Anas platyrhynchos 10 %	Fulica atra 9 % Bucephala clangula 4 %	90 %
III N Kattegat	73,116	Anas platyrhynchos 82 %	Melanitta fusca 20 %	Cygnus cygnus 3 %	Aythya fuligula 2 %	97 %
IV Central Jylland	5,415	Somateria mollissima 71 %	Fulica atra 11 % Anas platyrhynchos 18 %	Bucephala clangula 6 % Anas platyrhynchos 15 %	Melanitta fusca 4 %	92 %
V E Jylland	49,945	Aythya fuligula 34 %	Somateria mollissima 21 %	Aythya fuligula 17 %	Aythya marila 12 %	79 %
VI S E Jylland	34,587	Fulica atra 28 % Somateria mollissima 48 %	Somateria mollissima 25 %	Anas platyrhynchos 10 %	Bucephala clangula 11 %	77 %
VII Fyn	139,250	Aythya fuligula 53 %	Bucephala clangula 16 % Anas platyrhynchos 18 %	Fulica atra 14 %	Aythya fuligula 8 %	82 %
VIII W Sjælland	66,122	Fulica atra 34 % Anas platyrhynchos 30 %	Aythya fuligula 25 %	Cygnus olor 12 %	Cygnus olor 6 % Anas platyrhynchos 11 %	91 %
IX N+E Sjælland	63,711	Aythya fuligula 30 %	Aythya fuligula 26 %	Clangula hyemalis 18 %	Fulica atra 11 %	82 %
X S Sjælland	188,633	Fulica atra 27 %	Aythya fuligula 18 %	Fulica atra 18 %	Anas platyrhynchos 13 %	76 %
XI Bornholm	8,500	Somateria mollissima	Aythya fuligula	Fulica atra	Fulica atra	85 %
All districts	698,425					

Table 6. The four most plentiful species and their share in percentages of the total population in each of the districts in January 1968.

Table 6. De fire talrigeste arter og deres procentvise andel af den totale bestand i de forskellige distrikter i januar 1968.

In coastal waters in the central part of the country, *Somateria mollissima* was the most plentiful species.

Three very numerous species, *Aythya fuligula*, *Cygnus olor* and *Fulica atra*, were chiefly found in the eastern parts of

the country where they accounted for altogether one third of the wildfowl present.

In November nearly a quarter of all wildfowl recorded were in fresh water habitats.

JANUARY 1968

The distribution in January was greatly influenced by the presence of ice in all lakes and along most sheltered coasts, see Fig. 7. Consequently only about 4 % of all wildfowl were found in fresh water, and many of the coastal areas favoured by wildfowl in November were virtually deserted in January. Gregariousness was far more marked in the latter month

through a paucity of suitable habitats. There were fourteen concentrations of 10,000 birds or more, and nineteen within the range of 5,000–9,999. Altogether these 33 areas held nearly 400,000 birds or 57 % of the total population.

Only 33 % of the wildfowl were in Jylland and there were much smaller numbers than in November, particularly in I – W Jylland, II – Limfjorden and V – E Jylland. 67 % of wildfowl were in the eastern parts of the country. Here 100,000 or more were counted in VII – Fyn and X – S Sjælland, the latter district accounting for about 27 % of the total population.

The general distribution pattern was very similar to that of November. Dabbling ducks were scarcer, however, *Anas platyrhynchos* was the only numerous species, being incidentally more plentiful in the east than in the west. Some species showed higher figures than in November, viz. *Aythya fuligula*, *Bucephala clangula*, *Mergus merganser*, and *Cygnus cygnus*. The largest concentrations of these species were in the eastern parts of the country.

The amount of ice in Denmark greatly varies from year to year. Most winters are comparatively mild with little ice, as was the winter of 1967–1968 on the whole. Only for a few weeks in January there was much ice, and this had obviously a great influence not only on the distribution of wildfowl, but possibly also on their numbers. It seems likely that

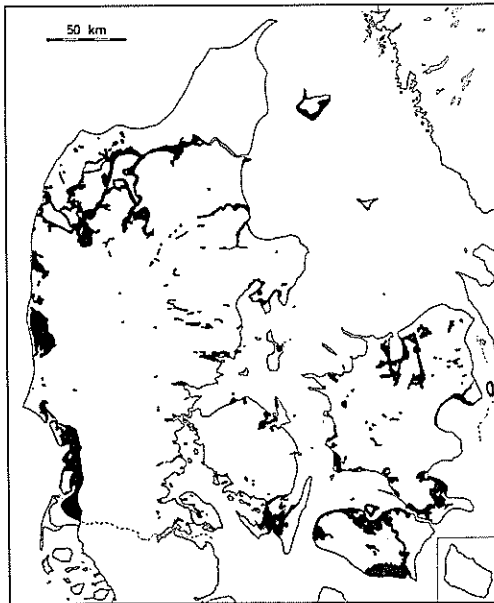


Fig. 7. The distribution of continuous ice with only small areas of open water (black) during the surveys in January 1968.

Fig. 7. Udbredelsen af sammenhængende is med kun mindre våger (sort) under optællingen i januar 1968.

many birds had fled to Denmark from even worse conditions further north, so that the large concentrations of some of the species may actually have been un-

sual for our country. This problem can, however, only be elucidated after some years of investigations similar to that of January 1968.

Anas platyrhynchos – Mallard

November 1967: Total 121,636. Fig. 8.

January 1968: Total 89,928. Fig. 9.

The mallard is one of the most numerous wildfowl in Denmark and by far the most ubiquitous.

Material

Like other dabbling ducks, mallards generally take off when approached by an aeroplane, but usually at quite short distances so that counts are easily made. Identification of the species involves no great problems although in some cases other species of dabbling ducks, occurring in much smaller numbers, are taken for mallards (see page 13).

In evaluating the numbers recorded in the two surveys as compared to the total number of birds present in Denmark it must, however, be considered that the species occurs in a very large number of localities and very often in small flocks. A number of small flocks in the areas surveyed will undoubtedly have been overlooked (see page 15). Furthermore, owing to the dispersed distribution of the species, there must have been a number of flocks, mostly small ones, in areas not surveyed (see page 16).

It is impossible to estimate with any certainty the number of birds overlooked. However, from our experience of the likelihood of flocks being overlooked during an aerial survey, and our more detailed knowledge of the number of birds present in ponds and along rivulets in some limited parts of the country we may

suggest that the number of flocks which were not registered in November probably does not exceed 1,000 and is certainly less than 2,000. Even if flock size is put rather high, for example at 20 birds on average (this would compensate for overlooking some large flocks too), we find that the number of birds not registered is small as compared to the number of birds recorded.

This is, of course, purely speculative, but yet we think it reasonable to conclude that the population in November was probably of the order of 150,000, and that it is most unlikely to have been as large as 200,000.

Since suitable habitats were much scarcer in January we suggest that the number of birds overlooked was relatively smaller than in November. It is thus assumed that in January the population was in the range 100,000–110,000; it is most unlikely to have been as large as 150,000.

Distribution

Figs. 8 and 9 give a good impression of the dispersed distribution of the species and the variety of habitats frequented by mallards. The maps show only localities with 20 or more birds. In Fig. 8 (November) about 360 localities of occurrence, representing 99 % of all birds recorded, are shown, whereas about 100 localities, representing only 1 % of the birds, are

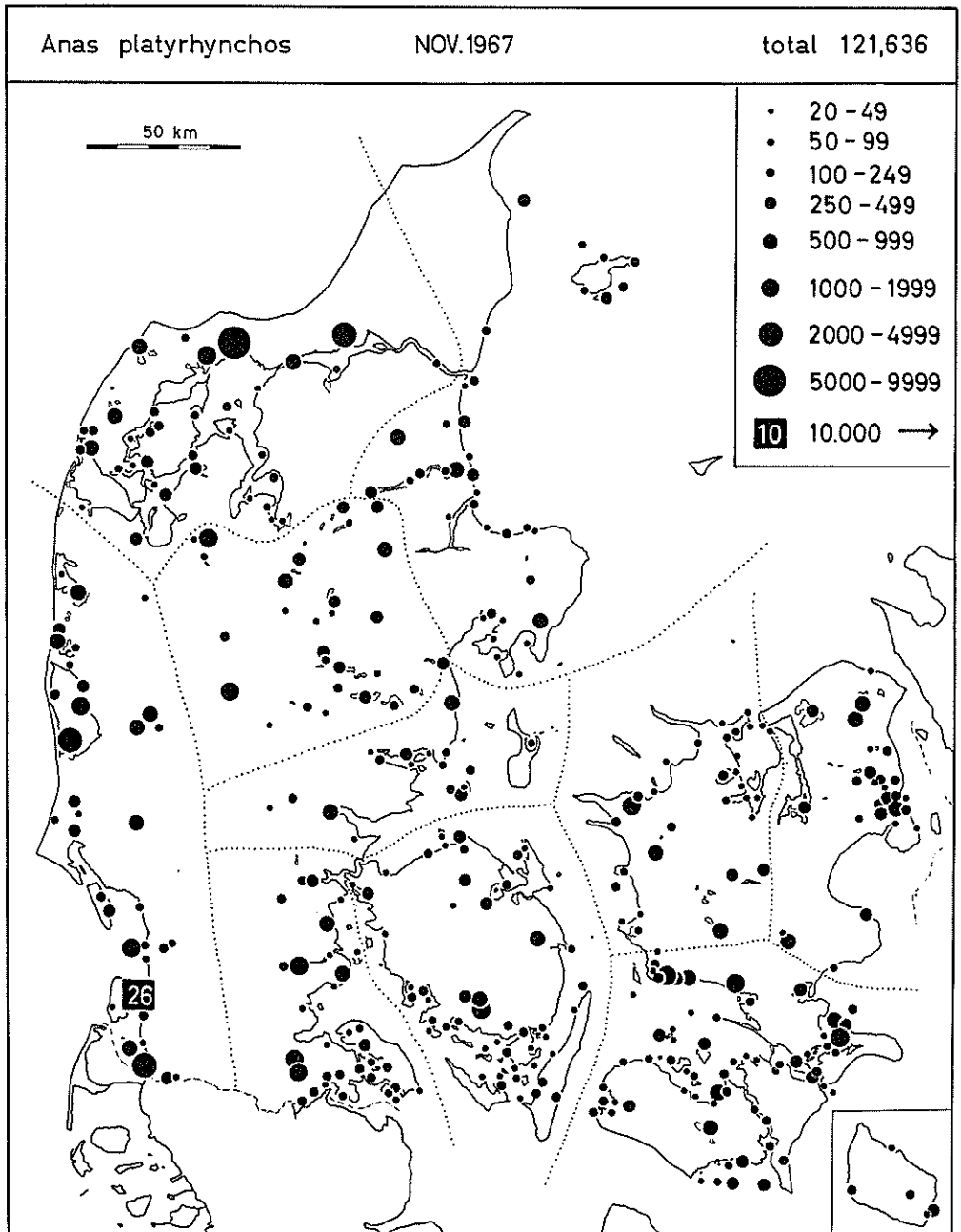


Fig. 8

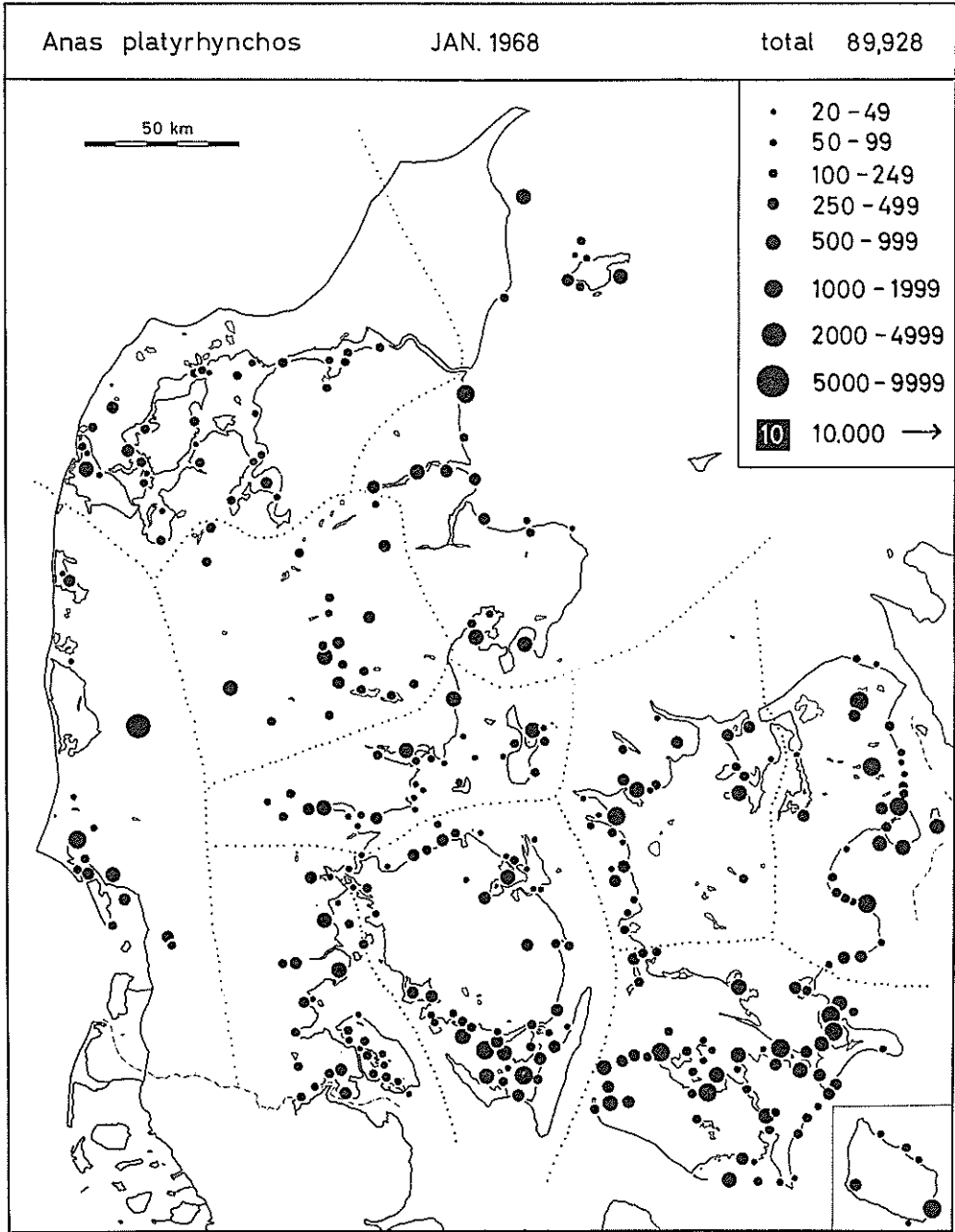


Fig. 9

not shown. In Fig. 9 (January) 313 localities of occurrence representing 99.3 % of the birds are shown, whereas 67 localities representing only 0.7 % are not shown.

Although the mallard is more widely dispersed throughout the country than any other wildfowl species, we find that the great majority of birds are concentrated in a few areas. Thus in November, 500 or more birds were registered in nearly 50 localities, altogether comprising 66 % of the mallards. In January, also, there were 500 or more birds in nearly 50 localities, which altogether accounted for 51 % of the birds.

November

70 % of the birds registered were in Jylland and 30 % were in the islands.

One third of all mallards were found in I – W Jylland, and most of the birds, 32,000, were in Vadehavet. A notably large assembly estimated to about 26,000 was recorded in the waters around Rømø dæmningen. This locality had about 21 % of the total Danish population. It must be emphasized that the figure for this locality is based on an aerial survey on November 12th under rather rough weather conditions, and it must be regarded an order of magnitude rather than an absolute figure. During autumn and spring several thousand dabbling ducks stay in Vadehavet. Under normal conditions, i.e. when weather is calm, the birds are dispersed over very large areas of coastal flats in the tidal zone. At high tide the birds concentrate along the coasts in areas suitable for feeding. Particularly along the dam between the mainland and the island of Rømø very many birds assemble, and concentrations of about 20,000 birds are often seen here. When there is a strong wind the birds concentrate in a few sheltered areas, and at

Rømø dæmningen concentrations close on 50,000 dabbling ducks have been counted on such occasions. This was also the case on November 12th when about 26,000 mallards and about 13,000 wigeon (*Anas penelope*) were observed. Although such large concentrations do occasionally occur they consist in reality of populations which would normally be dispersed over very large parts of Vadehavet. It is worthy of note that on November 10th, when the weather was calm, only about 16,000 mallards and wigeon were counted at Rømø dæmningen. No other place has such large concentrations of dabbling ducks, and the fluctuations in numbers from one day to the next are probably greater here than in any other locality in Denmark.

Rømø dæmningen is the only single locality in Denmark in which more than 10,000 mallards were counted in November. As will be seen from Fig. 8, the species occurred in large or small concentrations in all districts. Nearly half the mallards (43 %), including 34 concentrations of 500 or more birds, were found on lakes and in freshwater marshland habitats.

57 % of the mallards were found in the sea. Of these the majority were in I – W Jylland, in Vadehavet and Ringkøbing Fjord.

About half the mallards found in the sea were less than 2 kilometres from the coast (Table 2). The other half, i.e. about 27 % of the total population, was found in areas of shallow water more than two kilometres from the coast. The great majority of these were in Vadehavet, but small numbers were found in this type of habitat in nearly all districts.

January

38 % of the birds registered were in Jylland and 62 % were in the islands.

VII – Fyn and X – S Sjælland accounted for altogether one third of the population.

Only a quarter of the mallards were on lakes (Table 2). About a quarter of the mallards were found in the sea less than two kilometres from the coast, and nearly half the total population was found in the sea more than two kilometres offshore. This distribution is due to displacement by frost.

The annual bag compared to the population in November

The mallard is the most popular game

species among wildfowl in Denmark. According to STRANDGAARD (1968) the annual kill in 1961–1966 was 350,000–400,000 birds. This means that even when populations reach their peak in November, the number amounts to less than half the number shot during the open season (August 16th–December 31st). This indicates that the number of mallards passing through Denmark during the autumn is very large, probably many times larger than the number occurring within the country at any one time.

Anas crecca – Teal

November 1967: Total 17,449. Fig. 10.

January 1968: Total 146.

Material

The distribution is dispersed, and the species is mostly found in areas with emerged vegetation. Being small, the teal is less conspicuous than most other wildfowl, and as it flies very fast, often in dense flocks, numbers are generally difficult to estimate. It is therefore likely that the number of birds recorded is low compared with the actual populations.

Distribution

In November the species was plentiful both on the coast and on lakes. More than half the birds were found in Jylland in 7 localities which had more than 500 birds each. In the eastern part of the country, the teal was found in very few localities in only small numbers.

In January the teal was very scarce, the total number recorded being 146.

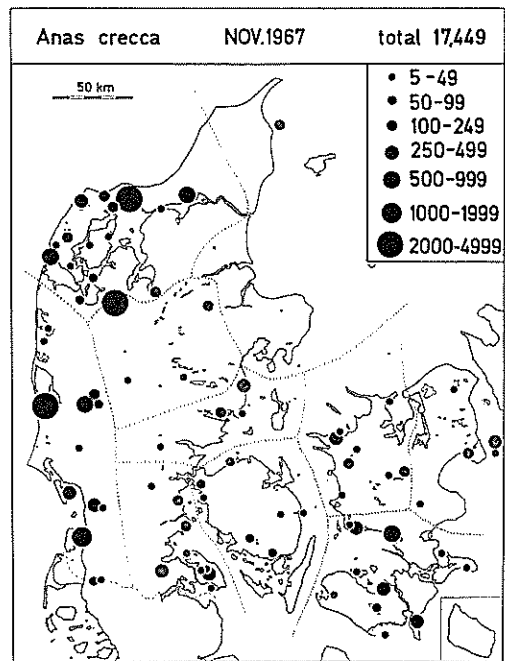


Fig. 10

Anas querquedula – Garganey

November 1967: Total 22.

January 1968: Nil.

The garganey often occurs together with teal, and the two species are generally difficult to distinguish. The garganey, being the least plentiful, is without doubt overlooked quite often. Although numbers may have been underestimated, the species is certainly very scarce in Denmark in late autumn and winter.

Anas strepera – Gadwal

November 1967: Total 6.

January 1968: Total 5

The gadwal is very scarce in Denmark. In the investigations only 11 birds were recorded: In November, 1 in Frederiksborg Slotssø (IX), 1 in Bøtø Nor reservat (X) and 4 in Nakskov Indrefjord reservat (X). In January, 5 were seen in Nakskov Indrefjord reservat.

Anas penelope – Wigeon

November 1967: Total 47,598. Fig. 11.

January 1968: Total 379.

Material

The wigeon is very conspicuous and the most easily identified dabbling duck. Although it usually takes off when approached by an aeroplane it normally does so only at short distances. So the species can be counted quite effectively from aeroplanes. The species is very gregarious and chiefly confined to a few localities. It is therefore assumed that the great majority of birds present in Denmark were recorded in the two months. A very large assembly of about 13,000 birds was observed at Rømø dæmningen on November 12th in rather rough weather, so this figure must be regarded as rather inaccurate (see discussion under mallard page 31).

Distribution

In November nearly fifty thousand wigeon were recorded, the species being the second most plentiful dabbling duck. Most birds were in I – W Jylland with the largest concentrations found in Vadehavet and in Tipperne Reservat, and in II – Limfjorden with the largest number found in Vejlerne Reservat. In the eastern parts of Denmark the wigeon was present only in a few places.

Nearly all wigeon were in coastal areas or in freshwater marshlands very close to the coast. Only on flats in Vadehavet (I) large assemblies were observed more than 2 kilometres from the coast.

In January the species was very scarce. Altogether 379 birds were registered, a flock of 300 being the largest seen (Karlundborg Fjord in VIII – W Sjælland).