# Midwinter distribution and numbers of Swedish Anatidae

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Extensive counts of wintering Anatidae (including aerial surveys in coastal waters) were made in 1967–1974 as part of the International Waterfowl Counts. Total populations in 1971–1973 were estimated to be 233,000–297,000 for all Swedish waters, excluding offshore areas of the Baltic and the northern part of the west coast. Marked annual variations in numbers were found in relation to the severity of the winter. *Bucephala clangula, Somateria mollissima, Mergus merganser,* and *Cygnus olor* showed increasing trends, whereas *Cygnus cygnus* decreased after the hard 1969/70 winter. The increasing trends may be due partly to a shift in distribution during milder winters, and partly to a recovery after the hard winters of 1962/63, 1965/66, and 1969/70. The midwinter distribution of different species in relation to feeding ecology is discussed.

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## INTRODUCTION

Regular counts of wintering waterfowl at selected localities in South Sweden were commenced in 1959/60 with the aim of studying annual and seasonal fluctuations, habitat selection, and distribution (Nilsson 1968a). The counts formed part of the International Waterfowl Counts promoted by the International Waterfowl Research Bureau (cf. Requate 1954, Atkinson-Willes 1963, Szijj 1963, Leuzinger 1964, Geroudet 1969, Bezzel 1972). In 1967, the International Midwinter Counts scheme in January each year, aiming at coverage of all waterfowl localities of any importance, was added to the research programme. The purpose of this scheme is to obtain detailed knowledge of the distribution, habitat selection, population strength, fluctuations in numbers, and population trends of the Anatid populations in Europe and adjacent parts of Africa and Asia (Atkinson-Willes 1969, 1972).

As the midwinter counts have now been running for eight years, sufficient data have been accumulated for an analysis of midwinter distribution, habitat selection, and fluctuations in numbers of the populations in most areas, whereas the detection of trends is a more long-term project. This paper reports on the main results of the first phase for Sweden.

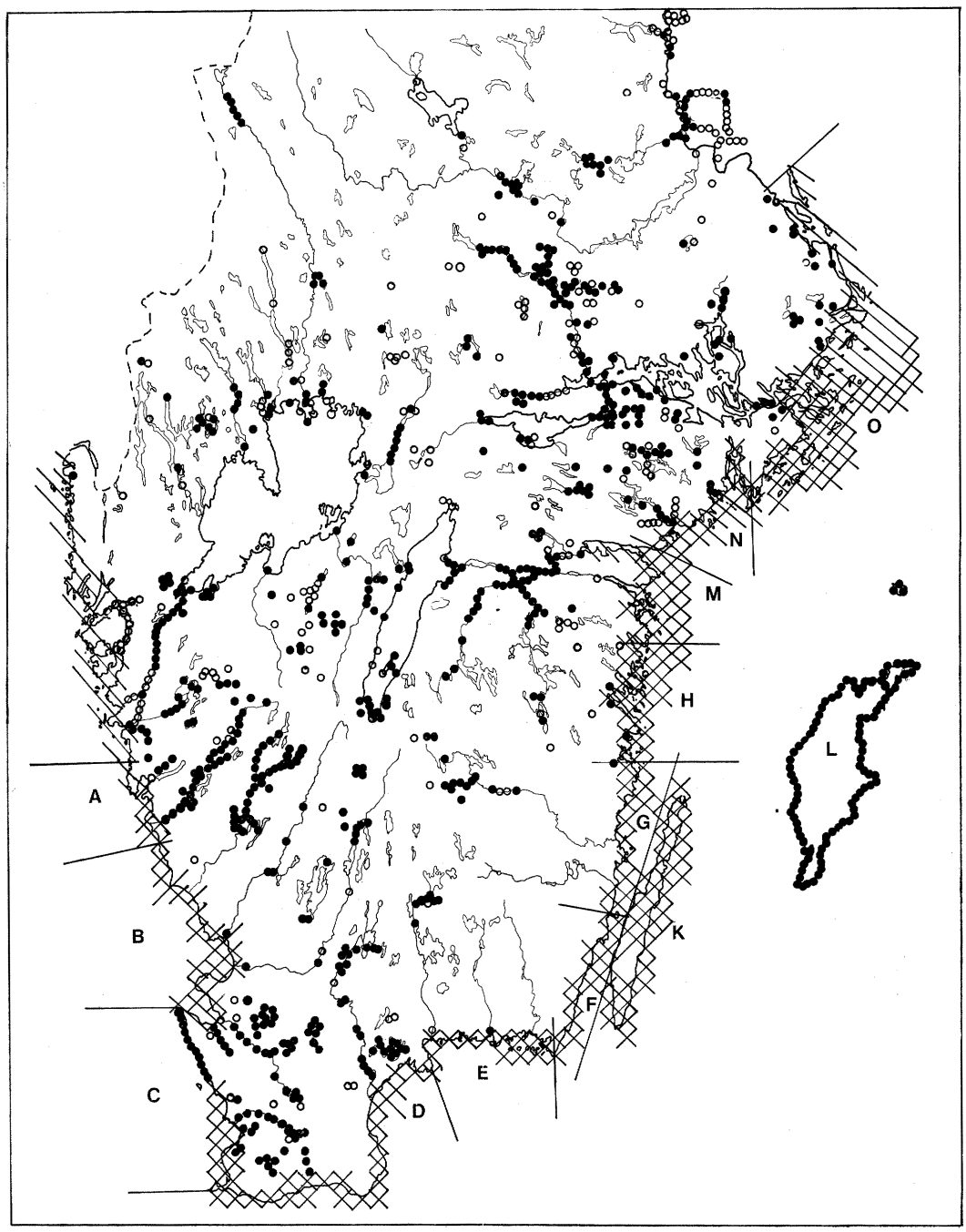
## METHODS

### *Coverage of counts*

The counts have been concentrated in the southernmost parts of the country (Fig. 1) as other parts are generally ice-bound with no or very few waterfowl in January. The northern parts of the west coast are not included as they are surveyed in another project (Pehrsson in litt.).

In 1967 and 1968 complete coverage of coastal areas was obtained for the inshore waters of Scania; in 1969 and 1970 the coverage was almost complete for the south of Halland, Scania, Blekinge, Öland, and Gotland. Inland areas and other coastal districts were covered by a network of localities counted by voluntary counters near their homes. Inland this yielded a good coverage of the most important areas, whereas the coverage was uneven in coastal districts.

In January 1971, ground counts were augmented by counts from boats in the offshore areas of the Baltic and by aerial surveys in coastal areas. Aerial surveys covered the coast from the north of Bohuslän to Södermanland in 1971, from Halland to the south of the Stockholm archipelago in 1972, and from Scania to the northern part of the Stockholm



archipelago in 1973. In all years Öland was covered by aerial surveys, whereas Gotland was covered by ground counts on all shores. In 1974, aerial surveys were restricted to Scania and the archipelagoes of Stockholm and Södermanland because of poor flying conditions. In January 1971–1974, coastal areas not covered from the air were covered by extensive boat and ground counts. Inland areas were covered at a large number of well-distributed localities.

Most parts of the country, including the whole coast, were divided into small counting units of homogeneous habitat before the count. Small inland lakes etc. constituted single units. In the first two years, 355 and 392 units (localities) were surveyed; in 1969 and 1970, 670–700 units were included in the sample; in 1971–1974, the number of units surveyed varied between 1200 and 1700. Further details on the coverage of counts, etc., can be found in Nilsson (1968b, 1970a, 1973).

*Counting methods*

The International Midwinter Counts were performed during a fourteen-day period centred around the Sunday nearest to 15 January. The majority of the counts were undertaken in the middle of the counting period.

During the first years almost all counts were made by voluntary observers covering one or more units from the ground. In 1971, surveys were also made from boats belonging to the Swedish Coast Guard. In archipelago areas the boat team surveyed several units in such a manner that all suitable waterfowl habitats were investigated, whereas only a sample of line transects could be undertaken in vast areas of open sea.

Aerial surveys were made from small, slow aircraft such as Rally Commodore, Saab Safir, and Piper Super Cub. (The Rally and Super Cub are both excellent for this type of work, whereas Saab Safir, being somewhat faster, yields a lower efficiency for some species.) Two observers were generally employed in the aerial surveys. The front observer was responsible for navigation and registration of observations. The counting units were surveyed at slow speed and at an altitude of about 50 m, higher over open sea, in such a manner that all areas of possible importance for waterfowl could be inspected at close range. The plane flow around large flocks to obtain better estimates. Photographs of flocks were taken where possible, and the number of birds were counted on the photographs to check estimates. Aerial surveys were only undertaken in favourable weather.

Various aspects of ground counts of wintering ducks such as errors and calculation of indices have been discussed by Nilsson (1970b). Comparisons between aerial surveys and ground/boat counts have been undertaken by Nilsson & Pehrsson (in prep.), see also Nilsson (1972a, 1973). A general description of aerial survey methods for wintering waterfowl has been presented by Joensen (1968, 1974). The different methods will therefore not be further discussed here.

Comparisons between aerial surveys and ground counts showed that the efficiency of aerial surveys varied between different species and also between habitat types, aircraft used, and observers. The efficiency of the aerial surveys was therefore regularly checked by parallel ground/air counts in control areas.

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Fig. 1. Coverage of the International Midwinter Counts in Sweden, 1967–1974. Hatched = areas surveyed from the air once, cross-hatched = areas surveyed from the air twice or more. Filled circles = localities counted from ground or boat two or more times, unfilled circles = localities counted from ground or boat once. Localities counted from the ground or boat in areas surveyed from the air are not marked out on the map. The map also shows the division of the coast into sectors used in the tables. A = northern Halland; B = south Halland and northwest Scania; C = Öresund; D = south and east Scania; E = archipelago areas of Blekinge; F = south Kalmarsund; G = north Kalmarsund; H = north Småland archipelago; K = Öland; L = Gotland; M = Östergötland archipelago; N = Södermanland archipelago; O = Stockholm (with Södermanland and Uppland) archipelago; the northern part of the west coast, province of Bohuslän, lacks designation.

Table I. Monthly mean temperatures for ten meteorological stations in South Sweden

| Month | 66/67 | 67/68 | 68/69 | 69/70 | 70/71 | 71/72 | 72/73 | 73/74 |
|---|---|---|---|---|---|---|---|---|
| Nov | 3.2 | 4.8 | 2.7 | 2.6 | 2.2 | 2.7 | 4.4 | 0.9 |
| Dec | 0.2 | −2.1 | −0.7 | −3.6 | 0.6 | 3.0 | 3.7 | −0.6 |
| Jan | −3.3 | −4.2 | −1.9 | −5.4 | −0.4 | −3.2 | 0.6 | 1.5 |

## RESULTS

*General weather characteristics of the winters*

The first three winters in the series were characterized by normal weather. 1969/70 was cold with low temperatures in early December (Table I). 1970/71 was quite mild, 1971/72 had normal January temperatures, but December was milder than normal. The last two winters were exceptional: 1972/73 had the mildest January recorded this century in many parts of the country; 1973/74 was cold in December, whereas January was exceptionally mild.

All lakes, except the largest, were frozen during the first five winters, whereas some lakes were open in the southernmost parts in 1972–1974. In all years open water was available to a varying extent on rivers.

In 1967, the inner parts of South Swedish archipelagoes were covered by ice. In 1968, most of the archipelagoes were ice-bound, and there was much ice in the Öresund and on the west coast. In 1969 there was little ice except in the innermost parts of the archipelagoes. In January 1970, most inshore areas in the Baltic (except small parts of Öland) and most of Gotland and Scania were covered by ice. In 1971 and 1972, ice occurred in the innermost parts of the archipelagoes, whereas almost no ice formed in coastal areas in 1973 and 1974. In the areas north of the Stockholm archipelago, most inshore areas were ice-bound except in the last two winters.

*Size of wintering populations*

The coverage in 1971–1973 makes it possible to estimate total population sizes of the most important wintering species for South Sweden (with the exception of the northern part of the west coast). Corrections for varying aerial survey efficiency were made by using data from the parallel ground/air counts (Table II). In coastal districts, correction for missing sectors in year X were undertaken by multiplying

Table II. Mean efficiency of aerial surveys as percentage of the numbers counted from the ground (in brackets) in different districts based on parallel counts from the air and ground/boats. Total number of localities used in these comparisons: 821. − = No comparisons obtained or numbers counted in the district too small. Note that data from Halland are based only on surveys in January 1972 (and November 1971 for *Melanitta*). Efficiency estimates for 1971 were made with a faster aircraft and partly untrained crew and were lower

| Species | Open coast | | | Archipelagoes | | Total for all areas |
|---|---|---|---|---|---|---|
| | Halland | Scania | Öland | Blekinge | East coast | |
| *Anas platyrhynchos* | 88 (3751) | 89 (7905) | 70 (4892) | 60 (900) | 90 (1138) | 78 (20,751) |
| *Aythya fuligula* | – | 101 (3437) | 83 (4058) | 97 (10,086) | 90 (2800) | 98 (23,001) |
| *Bucephala clangula* | 55 (1109) | 75 (3103) | 80 (2963) | 58 (775) | – | 78 (8414) |
| *Clangula hyemalis* | – | 82 (516) | 97 (12,000) | – | 135 (3385) | 105 (15,900) |
| *Melanitta* sp. | 104 (2046) | – | 54 (85) | – | – | 103 (2131) |
| *Somateria mollissima* | 103 (546) | 89 (1712) | 59 (223) | – | 56 (57) | 86 (2647) |
| *Mergus serrator* | – | – | – | – | – | 39 (1231) |
| *Mergus merganser* | – | – | – | – | – | 64 (384) |
| *Cygnus olor* | 90 (580) | 96 (997) | 95 (762) | – | – | 94 (2339) |
| *Cygnus cygnus* | – | – | – | – | – | 80 (162) |

Table III. Estimated total January populations of different species of Anatidae in Sweden in 1971–1973. Note that the northern parts of the west coast (north of area A in Fig. 1) and the offshore areas of Gotland are not included in the estimates. + = present

| Species | 1971 | 1972 | 1973 |
|---|---|---|---|
| *Anas platyrhynchos* | 67,300 | 84,720 | 74,190 |
| *Anas crecca* | 10 | 70 | 70 |
| *Anas penelope* | 10 | 30 | 70 |
| *Anas acuta* | + | + | + |
| *Anas clypeata* | 0 | + | 0 |
| *Anas strepera* | 0 | 0 | + |
| *Aythya marila* | 1100 | 130 | 370 |
| *Aythya fuligula* | 52,980 | 58,710 | 85,140 |
| *Aythya ferina* | 100 | 260 | 470 |
| *Bucephala clangula* | 17,660 | 21,430 | 27,840 |
| *Clangula hyemalis* | 71,170 | 62,670 | 74,430 |
| *Melanitta fusca* | 670 | 2150 | 2650 |
| *Melanitta nigra* | 630 | 450 | 260 |
| *Polysticta stelleri* | 0 | + | + |
| *Somateria mollissima* | 1640 | 3030 | 3000 |
| *Mergus serrator* | 2470 | 2490 | 3690 |
| *Mergus merganser* | 8460 | 9340 | 14380 |
| *Mergus albellus* | 390 | 260 | 440 |
| *Cygnus olor* | 6600 | 6730 | 8160 |
| *Cygnus cygnus* | 1950 | 1800 | 1940 |
| Total | 233,140 | 254,270 | 297,100 |

the total for these sectors in one year with full coverage of the district (year A) with the annual index for the district in year X (for calculation of indices, see below). As most important areas were counted in all years considered, corrections for missing coastal sectors were small. Moreover, all areas were at least covered in one winter. Inland, corrections were made in the same way for areas that were counted at least once. As some areas have never been counted, estimates for inland areas are minima. However, most areas of any importance for waterfowl are included in the counts in at least some years. Estimated totals are given in Table III.

Somewhat less than half the Mallards *Anas platyrhynchos* were seen on inland waters (Table IV). The correction factor for coastal Mallards was negligible, whereas inland about 25 % was added for areas not surveyed in the year in question. A few more Mallards might have populated areas not included in the counts, but these are probably unimportant as most ice-free areas were included.

Scaups *Aythya marila* and Pochards *Aythya ferina* were only found in relatively small numbers (Table III). A few might have been overlooked in large flocks of Tufted Duck

Table IV. Total number of Mallards *Anas platyrhynchos* in different Swedish districts (Fig. 1) in 1969–1974. Bold figures are estimates based on regional indices and partial counts (see text)

| District | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|---|---|
| *Coast* | | | | | | |
| A | – | – | 1050 | 1130 | – | – |
| B | 5600 | 3800 | 4800 | 6250 | 5610 | – |
| C | 7440 | 5460 | 6570 | 8580 | 9660 | 8500 |
| D | 2040 | 1450 | 2490 | 1400 | 3660 | 3930 |
| E | **1500** | **550** | 870 | 3800 | 2170 | – |
| F | 980 | 1200 | 1120 | 3840 | 2200 | – |
| G | – | – | 160 | 1110 | 740 | – |
| H | – | – | 570 | 1630 | 930 | – |
| K | **2250** | 940 | 1230 | 3220 | 3350 | – |
| L | 5320 | 5310 | 5030 | 5430 | 5900 | 4280 |
| M | – | – | 160 | 270 | 1200 | – |
| N | – | – | 130 | 1260 | 1050 | – |
| O | – | – | **4900** | **4100** | 3430 | 2580 |
| Stockholm town | 7170 | 5730 | 5280 | – | 2300 | 2520 |
| *Inland* | – | – | **32,700** | **40,200** | **32,000** | – |
| Total | – | – | 67,260 | 84,720 | 74,190 | – |

Table V. Total number of Tufted Ducks *Aythya fuligula* in different Swedish districts (Fig. 1) in 1969–1974. Bold figures are estimates based on regional indices and partial counts (see text)

| District | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|---|---|
| *Coast* | | | | | | |
| A | – | – | + | 10 | 0 | – |
| B | 330 | 260 | 880 | 390 | 400 | – |
| C | 20,520 | 13,490 | 7130 | 8240 | 12,900 | 9760 |
| D | 8980 | 6800 | 4240 | 6600 | 10,900 | 8290 |
| E | **22,000** | **26,000** | 8380 | 11,760 | 21,580 | – |
| F | 80 | 190 | 4640 | 6580 | 7020 | – |
| G | – | – | 570 | 1000 | 890 | – |
| H | 310 | 1000 | 240 | 520 | 4950 | – |
| K | 1800 | 910 | 1800 | 3600 | 2270 | – |
| L | 6460 | 11,100 | 8140 | 2770 | 10,520 | 15,700 |
| M | 0 | 0 | 30 | 20 | 80 | – |
| N | 0 | 0 | 120 | 120 | 1650 | – |
| O | **12,000** | **> 4000** | **15,000** | **16,000** | 10,600 | 14,800 |
| Stockholm town | 2020 | 1180 | 1290 | – | 620 | 980 |
| *Inland* | 470 | 470 | 520 | 400 | 760 | – |
| Total | 74,970 | > 65,400 | 52,980 | 58,710 | 85,140 | – |

*Aythya fuligula,* but this does not alter the overall picture.

The Tufted Duck was the dominating species in inshore waters. In 1973, all localities of any importance were visited, as were most Tufted Duck localities in the winters of 1970–1972 (Table III, V). As Tufted Ducks often appear in huge, dense flocks there is a risk of counting errors, but even so, estimates of the total population are probably fairly accurate as few flocks can have been overlooked.

The Goldeneye *Bucephala clangula* (Table VI) mainly occurred in areas with full coverage of counts, and only small corrections (5 %) had to be made for Goldeneyes present in areas not surveyed. Aerial surveys accounted for a large

Table VI. Total number of Goldeneyes *Bucephala clangula* in different Swedish districts (Fig. 1) in 1969–1974. Bold figures are estimates based on regional indices and partial counts (see text)

| District | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|---|---|
| *Coast* | | | | | | |
| A | – | – | 620 | 840 | – | – |
| B | **1400** | **1300** | 1310 | 1020 | 1030 | – |
| C | 4380 | 5340 | 2300 | 2830 | 3260 | 2970 |
| D | 3610 | 3550 | 5040 | 3370 | 7230 | 4900 |
| E | **1900** | **1400** | 1080 | 2040 | 3180 | – |
| F | 1140 | 0 | 690 | 1380 | 2320 | – |
| G | – | – | 290 | 600 | 290 | – |
| H | – | – | **200** | 280 | 270 | – |
| K | **1250** | 790 | 1910 | 3400 | 4090 | – |
| L | 2460 | 3200 | 2330 | 2710 | 2750 | 3360 |
| M | – | – | 180 | 150 | 330 | – |
| N | – | – | 120 | 60 | 340 | – |
| O | – | – | **500** | 1650 | 1400 | 2200 |
| *Inland* | – | – | 1090 | 1120 | 1350 | – |
| Total | – | – | 17,600 | 21,430 | 27,840 | – |

Table VII. Total number of Long-tailed Ducks *Clangula hyemalis* in different Swedish districts (Fig. 1) in 1971–1974. Bold figures are estimates based on regional indices and partial counts (see text). Note that counts were incomplete in area D (Hanöbukten) and off Gotland (L), where only counts from the shore were made.

| District | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|
| *Coast* | | | | |
| A | 0 | + | – | – |
| B | 10 | 20 | 30 | – |
| C | + | + | + | + |
| D (partial) | 7130 | 4230 | 11,160 | 5120 |
| E | 1030 | 1640 | 780 | – |
| F | 170 | 100 | 370 | – |
| G | (110) | ? | 4140 | – |
| H | 4700 | 8200 | 9800 | – |
| K | **25,000** | 16,100 | 22,000 | – |
| L (partial) | 5670 | 8510 | 7640 | 6260 |
| M | 850 | 860 | 160 | – |
| N | 2500 | 1000 | 3470 | – |
| O | **24,000** | **22,000** | 15,000 | 11,500 |
| Total | 71,170 | 62,670 | 74,430 | – |

proportion of the Goldeneyes in some areas, and corrections were made for varying aerial efficiency.

In the Long-tailed Duck *Clangula hyemalis*, the coverage was far from complete. In 1973 most areas on the mainland coast plus Öland could be surveyed from the air in ideal weather. Counts were not obtained from the offshore waters of Gotland, nor from other areas far out at sea in the Baltic. Moreover, only sample line transects were made in some important waters off Scania. The total number counted in 1973 was 74,000 (Table VII). At least 5,000 were probably present in Scanian waters not surveyed. The offshore waters of Gotland were surveyed in February 1974, and 30,000 Long-tailed Ducks were counted. As conditions were similar in 1973 and 1974, and as numbers counted from the shore were similar in the two winters, it is reasonable to suppose that similar numbers were present in the offshore waters in 1973, making the total population in Swedish waters this winter about 110,000 at a minimum.

The Velvet Scoter *Melanitta fusca* and Common Scoter *Melanitta nigra* mainly stay in offshore waters and thus offer the same survey problems as the Long-tailed Duck. However, most areas of importance for the species were surveyed and the values obtained probably show the magnitude of the populations (Table III). The same applies to the Eider *Somateria mollissima* (Table III, VIII). For this species it should be remembered that the northern part of the west coast that was only surveyed in one year and is not included here is a far more important winter area for the species than the areas included.

Table VIII. Total number of Eiders *Somateria mollissima* in different Swedish districts (Fig. 1) in 1969–1974. Bold figures are estimates based on regional indices and partial counts (see text)

| District | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|---|---|
| *Coast* | | | | | | |
| A | – | – | 120 | 230 | – | – |
| B | 820 | 690 | 660 | 950 | 930 | – |
| C | 170 | 240 | 120 | 250 | 310 | 930 |
| D | 210 | 120 | 290 | 480 | 650 | 1660 |
| E | 10 | 10 | 60 | 230 | 140 | – |
| F | – | – | 20 | 10 | 70 | – |
| G | – | – | 20 | 30 | 10 | – |
| H | – | – | 10 | 90 | 120 | – |
| K | 170 | 40 | **30** | 190 | 300 | – |
| L | 170 | 90 | 100 | 210 | 250 | 222 |
| M | – | – | + | 90 | 10 | – |
| N | – | – | 40 | 20 | 50 | – |
| O | – | – | **170** | **280** | 150 | 340 |
| Total | – | – | 1640 | 3060 | 2990 | – |

Table IX. Total number of Goosanders *Mergus merganser* in different Swedish districts (Fig. 1) in 1969–1974. Bold figures are estimates based on regional indices and partial counts (see text)

| District | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|---|---|
| *Coast* | | | | | | |
| A | – | – | 70 | 20 | – | – |
| B | 120 | 100 | 150 | 150 | 150 | – |
| C | 740 | 2470 | 790 | 150 | 350 | 190 |
| D | 940 | 880 | 1020 | 610 | 1160 | 190 |
| E | **1700** | **850** | 490 | 790 | 1520 | – |
| F | 390 | 20 | 510 | 60 | 530 | – |
| G | – | – | 360 | 390 | 180 | – |
| H | – | – | 550 | 260 | 510 | – |
| K | 330 | 360 | 130 | 120 | 140 | – |
| L | 520 | 720 | 620 | 550 | 470 | 540 |
| M | – | 4000 | 160 | 610 | 1150 | – |
| N | – | – | 900 | 500 | 570 | – |
| O | – | > 6000 | **2000** | **3000** | 2300 | 3200 |
| Stockholm town | 270 | 280 | 140 | – | 10 | 10 |
| *Inland* | 440 | 430 | 570 | 2030 | 5340 | – |
| Total | – | > 16,110 | 8460 | 9340 | 14,380 | – |

The Red-breasted Merganser *Mergus serrator* is difficult to count from the air, so our counting efficiency was low (Table II). Moreover the species stays offshore and is thus easily overlooked from the shore. The estimates are therefore uncertain.

The counts of Goosander *Mergus merganser* in coastal areas were almost complete in 1973, and as the species occurred well dispersed in small flocks in the archipelagoes, the estimates for 1971 and 1972 are also fairly accurate (Table III, IX). However, some flocks might have been overlooked on large inland lakes and the estimates should be regarded as minima. In the cold winter of 1970, most inland and archipelago areas were frozen and the Goosan-

Table X. Total number of Mute Swans *Cygnus olor* in different Swedish districts (Fig. 1) in 1969–1974. Bold figures are estimates based on regional indices and partial counts (see text)

| District | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|---|---|
| *Coast* | | | | | | |
| A | – | – | 370 | 400 | – | – |
| B | **450** | **500** | 360 | 210 | 540 | – |
| C | 1230 | 1850 | 2020 | 2160 | 2170 | 3760 |
| D | 280 | 200 | 320 | 240 | 440 | 500 |
| E | **1070** | **350** | 540 | 510 | 740 | – |
| F | 430 | 220 | 270 | 200 | 420 | – |
| G | – | – | 80 | 160 | 160 | – |
| H | – | – | 40 | 110 | 160 | – |
| K | 690 | 120 | 380 | 540 | 870 | – |
| L | 700 | 490 | 440 | 590 | 460 | 770 |
| M | – | – | 10 | 40 | 250 | – |
| N | – | – | 70 | 50 | 220 | – |
| O | – | – | **1350** | **1000** | 1100 | 1220 |
| Stockholm town | 340 | 400 | 230 | – | 70 | 340 |
| *Inland* | 230 | 200 | 120 | 220 | 530 | – |
| Total | – | – | 6600 | 6730 | 8160 | – |

Table XI. Total number of Whooper Swans *Cygnus cygnus* in different Swedish districts (Fig. 1) in 1969–1974

| District | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|---|---|
| *Coast* | | | | | | |
| A | – | – | 0 | 0 | – | – |
| B | 80 | 10 | 170 | 100 | 100 | – |
| C | 1030 | 670 | 580 | 320 | 320 | 270 |
| D | 60 | 110 | 90 | 110 | 100 | 20 |
| E | 10 | + | 30 | 0 | 15 | – |
| F | 5 | 0 | + | 0 | 5 | – |
| G | – | – | 0 | 0 | 0 | – |
| H | 0 | 0 | 0 | 0 | 0 | 0 |
| K | 80 | 10 | 60 | 120 | 70 | – |
| L | 480 | 160 | 380 | 370 | 330 | 290 |
| M | – | – | 0 | + | 0 | – |
| N | – | – | 0 | 20 | 10 | – |
| O | – | – | 20 | 30 | 10 | 10 |
| *Inland* | 570 | 750 | 620 | 730 | 970 | – |
| Total | – | – | 1950 | 1800 | 1940 | – |

ders accordingly well concentrated. More than 16,000 were found.

The Smew *Mergus albellus* is rare in Sweden, mostly occurring in small flocks, but the few known concentration areas were surveyed from the ground.

The Mute Swan *Cygnus olor* and the Whooper Swan *Cygnus cygnus* are easily detected from the air, and thus the counts were highly accurate (Table III, X, XI). Few Mute Swans were seen inland, whereas in the Whooper Swan a substantial proportion of the population was recorded inland, often on small waters. In the mild winters some Whooper Swans might therefore have been overlooked.

*Distribution and habitat selection*

The midwinter distribution of the different species expressed as the highest count for each locality in 1967–1974 is seen from Figs. 2–12, which should be read in conjunction with Fig. 1, showing the coverage in different districts. This manner of presentation was preferred to mean values as it shows the potential value of a locality for a waterfowl species. In Sweden, as in other northern areas, the winter distribution of waterfowl is much influenced by ice, and mean values will be very much influenced by the number of icy winters included in the calculations. As most archipelago areas were only surveyed in the mild winters of 1971–1974, whereas areas of open coast include both mild, normal, and cold winters, distribution maps based on mean values will be biased. Moreover, many localities were only covered in two or three seasons, whereas others were covered in all eight seasons. However, in most cases numbers counted in the different areas were rather similar in winters of similar character.

The Mallard was widely distributed in the country both on inland and coastal waters (Fig. 2, Table IV). In general, more Mallards were noted in the SW than in the east coast areas. During icy winters the archipelagoes were largely evacuated.

In the inland areas north of Scania, most of the Mallard were noted on urban waters, whereas only 25 % were counted on natural waters, mostly small rivers. The proportions on the different types of water varied only slightly between cold and mild winters as the same waters were mostly available each year.

In Scania the distribution of Mallard on various types of waters shifted markedly between cold and mild winters. In the hard winter of 1970, the proportion on urban waters was twice that in the other, milder winters (Table XII). Hansson (1966) found an increase on urban waters in Scania in cold weather, but the

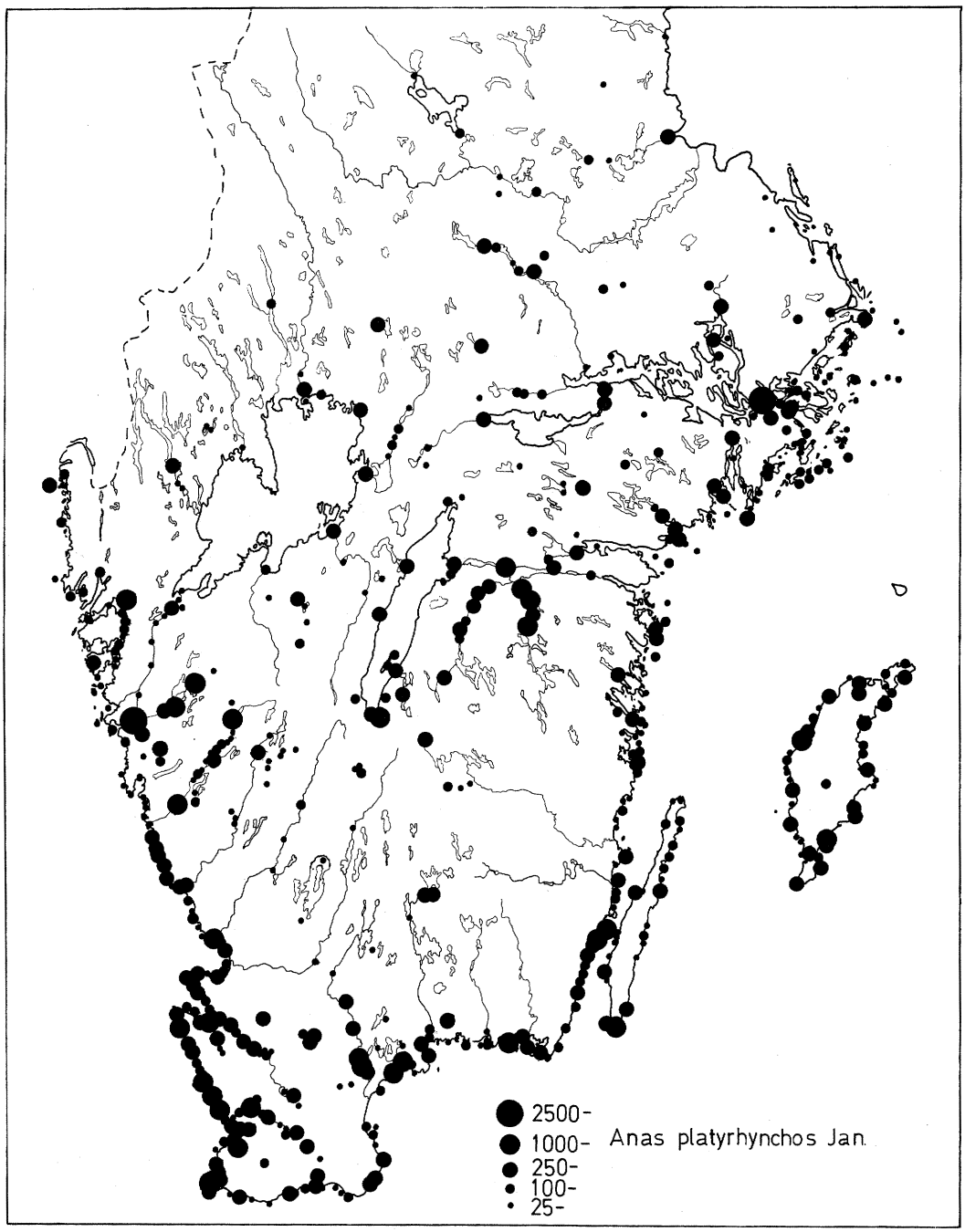



Fig. 2. Midwinter distribution of Mallard *Anas platyrhynchos.*

Mallard soon dispersed to natural habitats again in milder weather.

In areas of open coast the Mallard were concentrated in areas with stony shores and especially with protruding peninsulas and small skerries. In the archipelagoes, numbers were

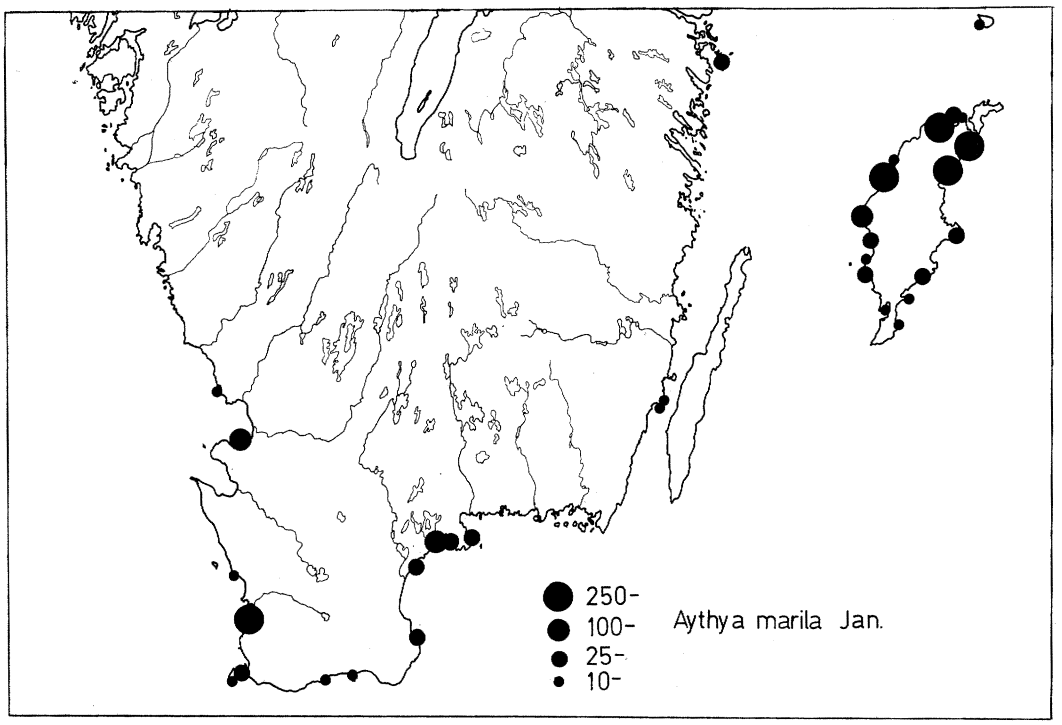



Fig. 3. Midwinter distribution of Scaup *Aythya marila.*

relatively small compared to the open coasts. The majority of the Mallard were found in the innermost zone due to a concentration in harbours and small communities (Table XIII).

Scaup were only found regularly in Scania and in a few localities in Gotland, whereas all other occurrences were in more temporary localities (Fig. 3).

Tufted Ducks were concentrated on the Baltic coast and Öresund with only a few regular occurrences of moderately large flocks in west coast estuaries and harbours (Fig. 4, Table V). The majority of the Tufted Ducks were found on traditional sites used each year. In the archipelago areas these sites had to be abandoned in years with ice, but mostly the flocks merely moved to nearby areas with open water. Some flocks had traditional sites in the innermost bays in mild periods and moved to other traditional sites in the island zones in harder weather. In the areas south of the Stockholm archipelago, the majority were found

Table XII. Percentage distribution of Mallards *Anas platyrhynchos* in different types of habitats in Scania 1970–1974

| | 1970 | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|---|
| Estimated total population | 11,700 | 13,400 | 18,400 | 21,000 | 20,600 |
| Percent counted on | | | | | |
| coastal areas | 70 | 79 | 64 | 77 | 75 |
| urban waters | 16 | 9 | 9 | 7 | 8 |
| rivers | 14 | 9 | 17 | 9 | 4 |
| lakes | 0 | 3 | 10 | 7 | 13 |

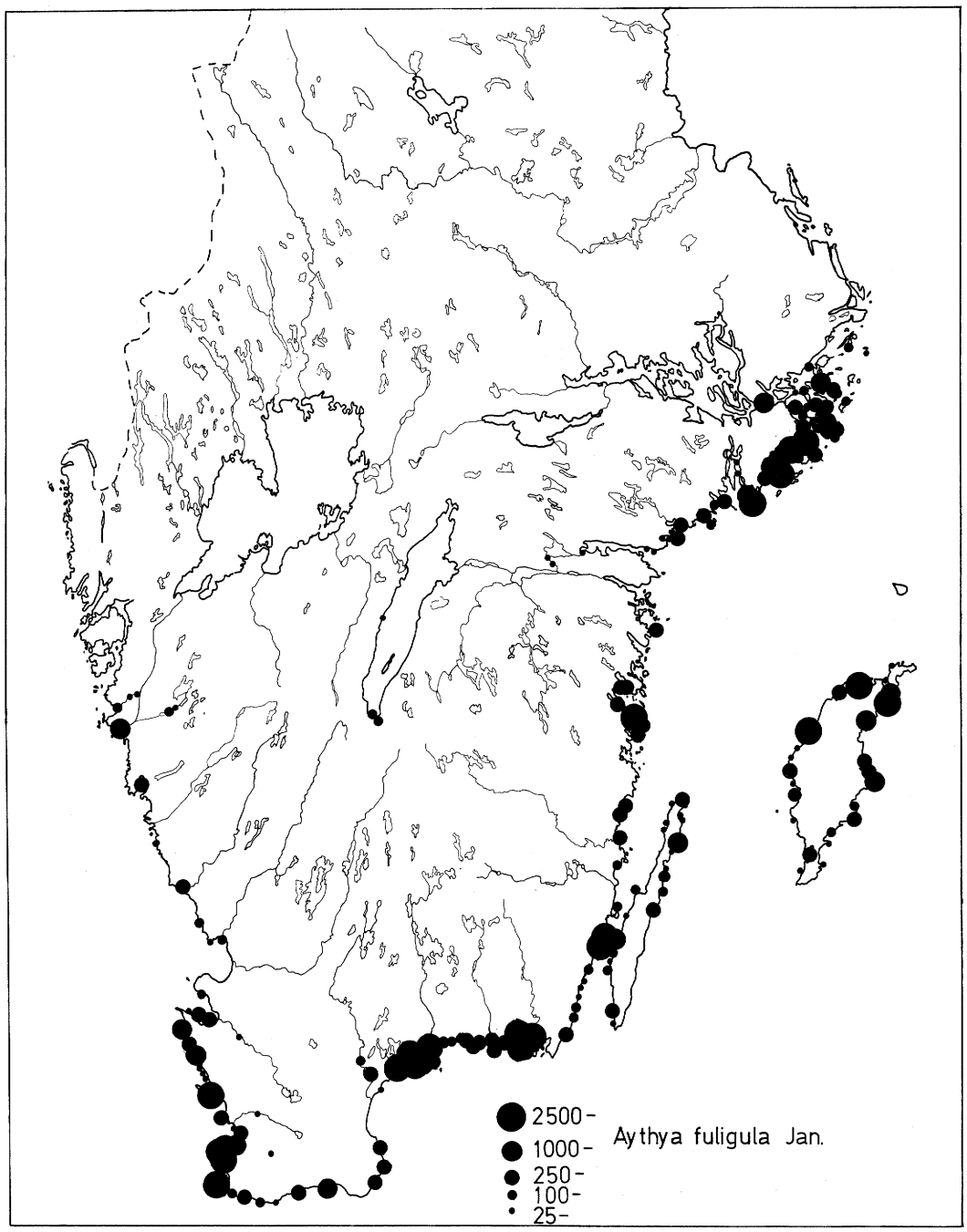



Fig. 4. Midwinter distribution of Tufted Duck *Aythya fuligula.*

near harbours (Table XIV), where they found sheltered resting places (Nilsson 1972b). In Scania, a large proportion of the Tufted Ducks were found on ponds near the coast where they spent the day resting, making night-time feeding flights to areas at sea (Nilsson 1972b).

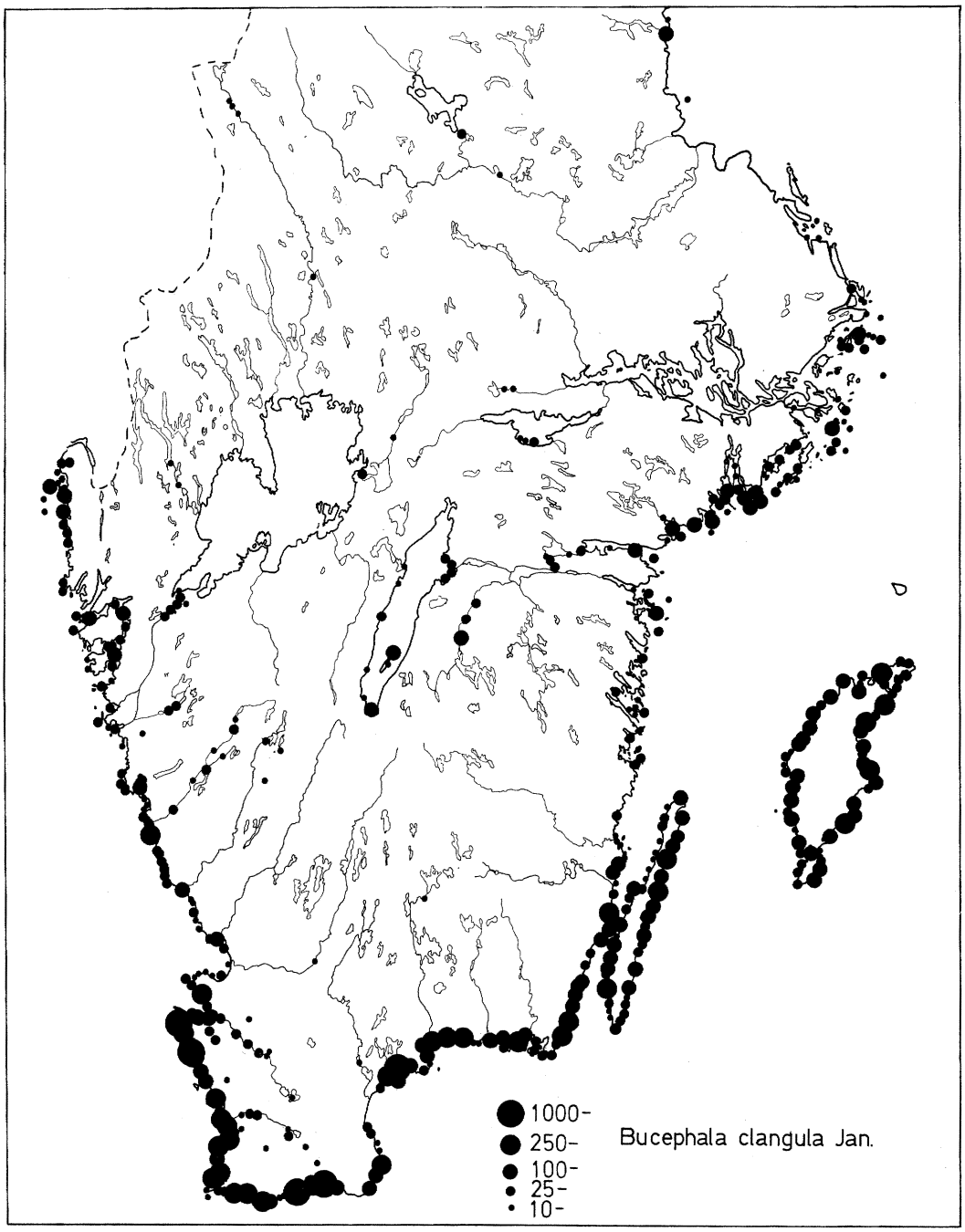



Fig. 5. Midwinter distribution of Goldeneye *Bucephala clangula.*

The Pochard was mostly scattered in small numbers in flocks of Tufted Ducks. Concentrations of more than 25 birds were found on eight localities in districts C, D, E and F.

Goldeneyes were mainly found along the open coasts with especially large concentrations

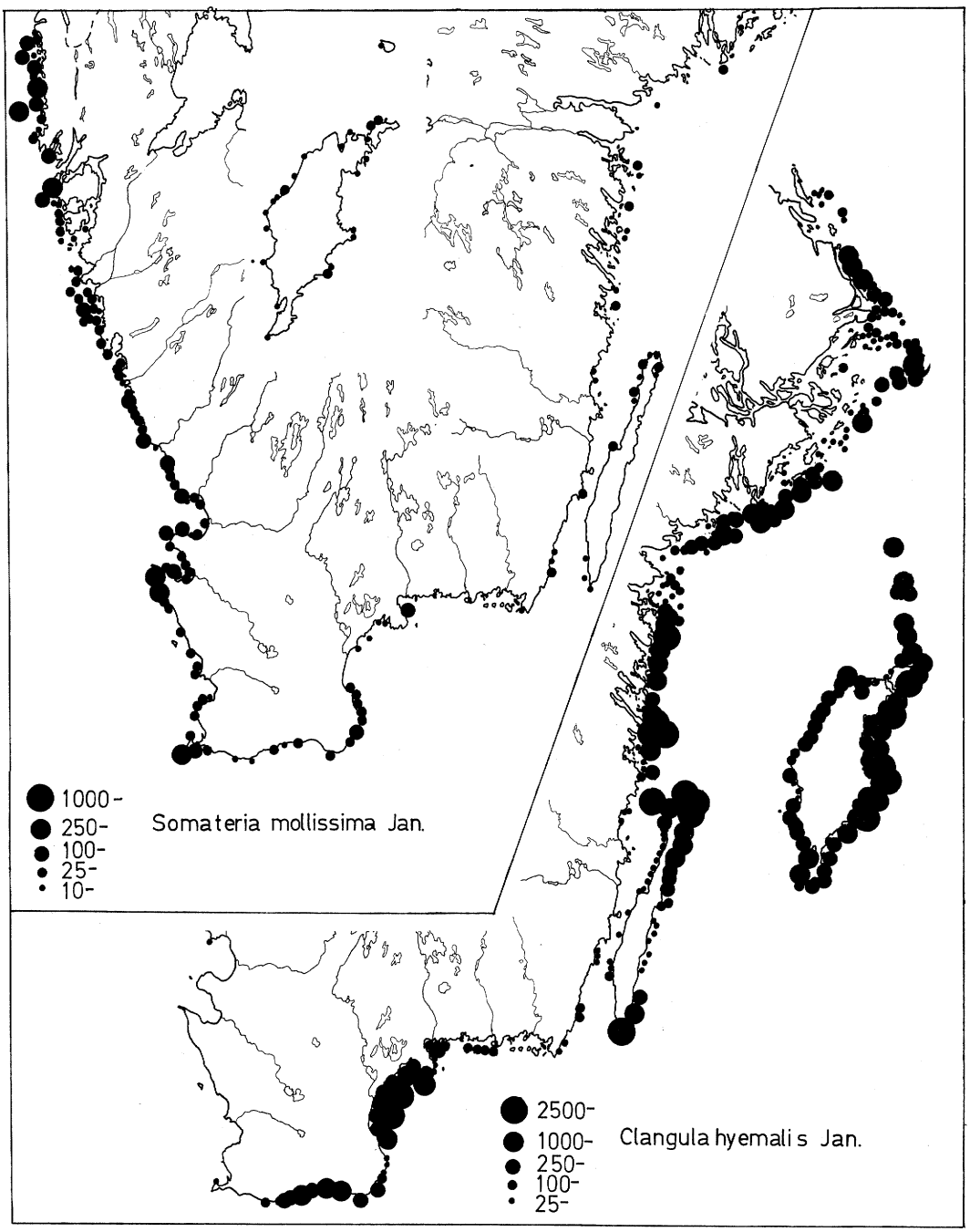



Fig. 6 and Fig. 7. Midwinter distribution of Long-tailed Duck *Clangula hyemalis* on the south and east coast. On the west coast only small numbers on few localities were recorded. Midwinter distribution of Eider *Somateria mollissima*. The isle of Gotland is inserted in the centre of the Swedish mainland.

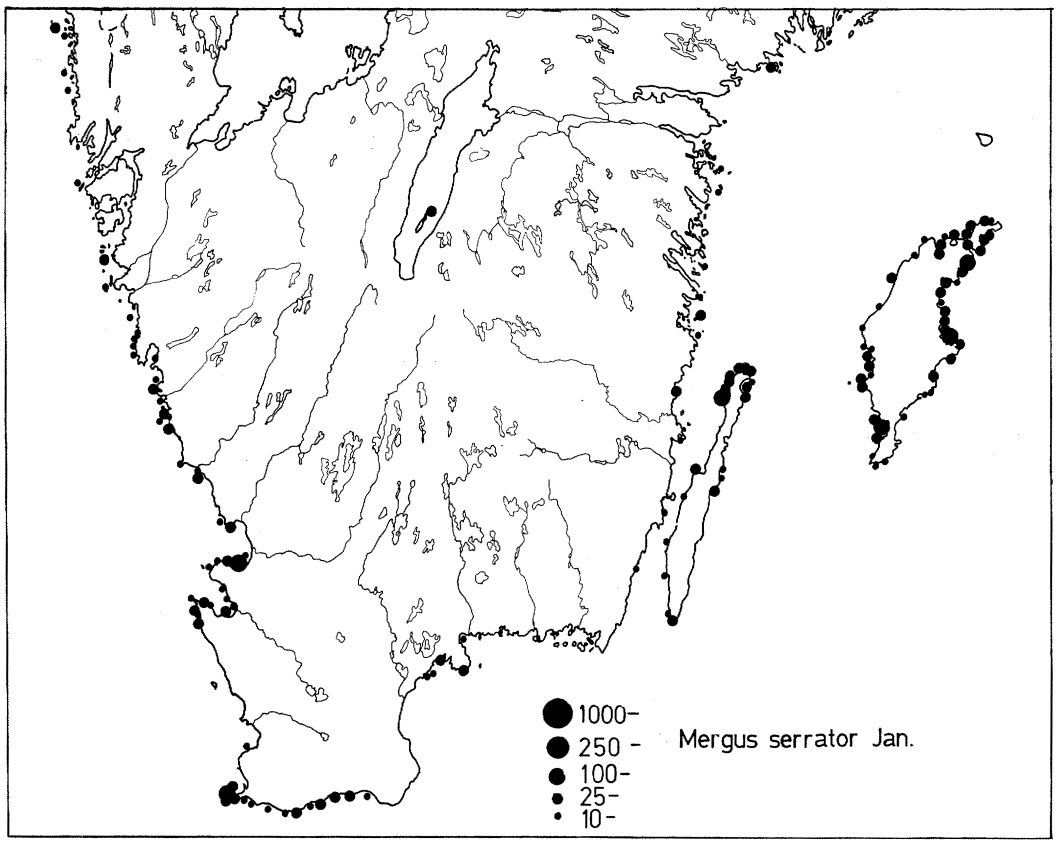



Fig. 8. Midwinter distribution of Red-breasted Merganser *Mergus serrator*.

in the Öresund and on the south coast of Scania, whereas numbers counted in the archipelagoes were small even in mild winters (Fig. 5, Table VI). In the archipelagoes the majority of the Goldeneyes occurred in the island zones (Table XIII).

Table XIII. Percentage distribution of different species in the four main zones of east coast archipelagoes in the mild, almost ice-free winters of 1971–1973

| Species | Per cent found in the different zones | | | | Total numbers counted |
|---|---|---|---|---|---|
| | Innermost bays | Middle zones | Outer island zone | Sea shallows | |
| *Anas platyrhynchos* | 47 | 26 | 19 | 9 | 13,418 |
| *Aythya fuligula* | 45 | 53 | 2 | 0 | 38,487 |
| *Aythya ferina* | 100 | 0 | 0 | 0 | 80 |
| *Bucephala clangula* | 29 | 42 | 26 | 3 | 3001 |
| *Clangula hyemalis* | + | 4 | 29 | 67 | 59,718 |
| *Somateria mollissima* | 5 | 21 | 55 | 19 | 496 |
| *Mergus serrator* | 32 | 11 | 39 | 18 | 90 |
| *Mergus merganser* | 26 | 43 | 29 | 2 | 8495 |
| *Cygnus olor* | 39 | 35 | 26 | 1 | 2166 |

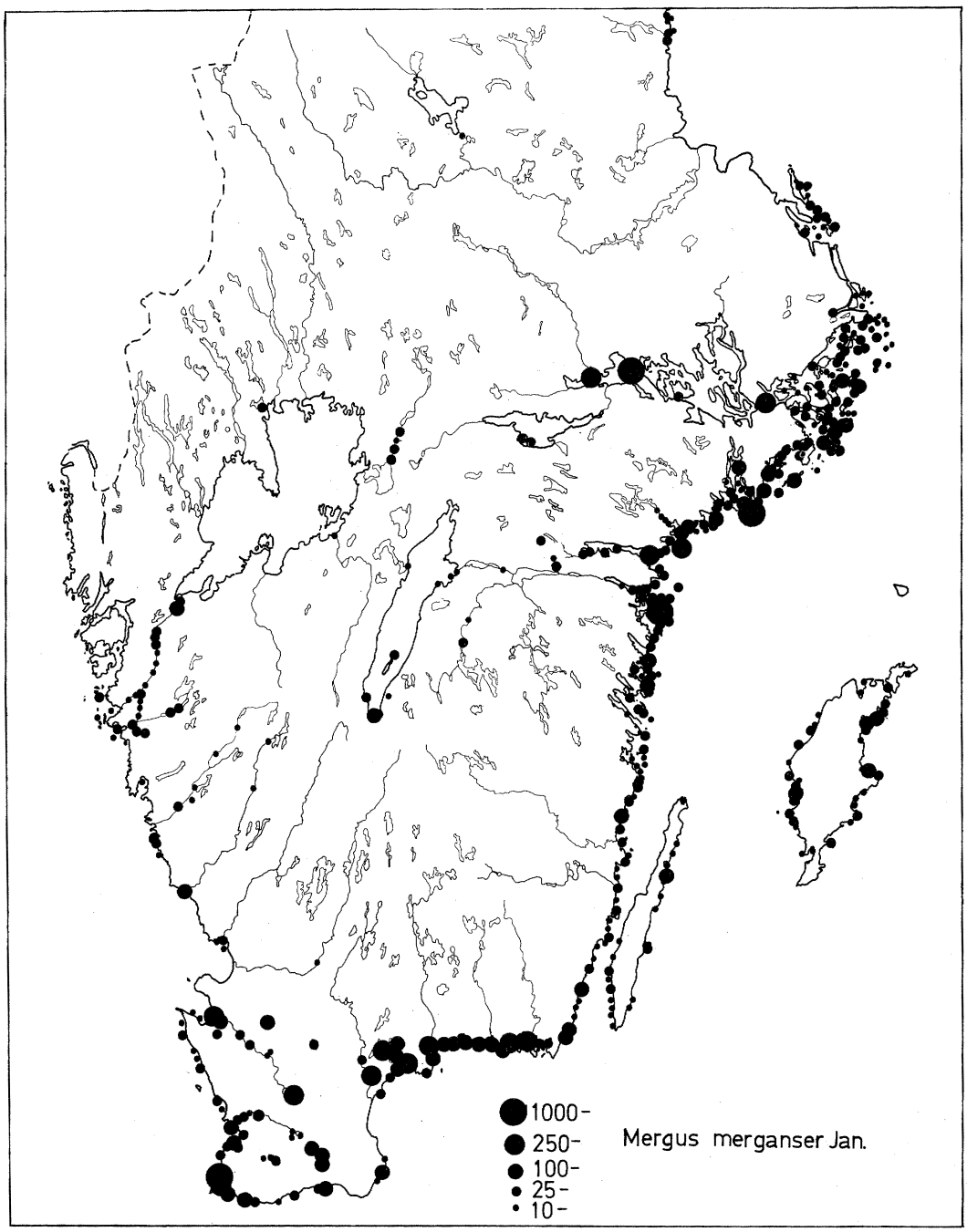



Fig. 9. Midwinter distribution of Goosander *Mergus merganser*.

Long-tailed Ducks were almost entirely confined to the Baltic coast (Table VII, Fig. 6). A few marked concentration areas could be distinguished: the south coast of Scania, Hanöbukten, the northernmost coast of Öland, the east coast of Gotland, and the archipelagoes of

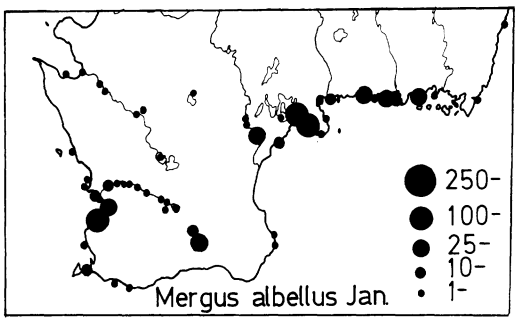



Fig. 10. Midwinter distribution of Smew *Mergus albellus* in Scania and Blekinge. In areas not shown in the map more than 10 Smews were recorded on 5 localities on Gotland and 3 localities on the east mainland coast. Single Smews were noted on a further 30 localities south of Vänern-Hjälmaren-Mälaren.

Småland and Stockholm. In the archipelagoes they were concentrated over shoals well off the coast and on the outermost skerries (Table XIII). Most of these shoals have a depth of only a few metres and are often used by large flocks each winter. Away from the open coasts the Long-tailed Duck are often well distributed out to a depth of 10–15 m mostly in small groups, but some feed in deeper water. North of Öland some of these flocks were recorded 8–10 km from the shore, but in February 1974 large flocks were also found on the isolated shallow Kopparstenarna 20 km N of Gotska Sandön. On Öland the Long-tailed Ducks are markedly concentrated to the northernmost part of the island, whereas similar areas further to the south are almost devoid of Long-tailed Ducks except in cold winters (the concentrations on south Öland were noted in 1970).

The Velvet Scoter and Common Scoter were only found in any numbers in Laholmsbukten on the west coast. Small numbers were also recorded in Hanöbukten and on northern Öland in some years. Both species occurred well offshore.

The Eider (Fig. 7, Table VII) is mainly a west coast species, but small numbers were regularly encountered in the outermost skerries and archipelagoes in the Baltic. Most Eiders were found in rather shallow water quite near the coast or islands.

Of the sawbills, the Red-breasted Merganser was mainly found on the west coast and in areas with open coast in the Baltic; the numbers found in the archipelagoes were negligible even in mild winters (Fig. 8). Red-breasted Mergansers were often encountered well offshore.

The Goosander (Fig. 9, Table IX) was common in the archipelagoes and inland during mild winters and was only seen in larger numbers on open coasts in cold weather. In the archipelagoes the Goosander was widely distri-

Table XIV. Percentage distribution of Tufted Ducks *Aythya fuligula* on different types of habitats in 1971–1974

| Habitat type | 1971 | 1972 | 1973 |
|---|---|---|---|
| *South Sweden (A–L, Fig. 1)* | | | |
| Harbours | 55 | 69 | 33 |
| Ponds near the sea shore | 6 | 8 | 7 |
| Open coast | 16 | 7 | 18 |
| Bays (often sheltered) | 15 | 5 | 18 |
| Archipelagoes | 7 | 11 | 24 |
| Total number recorded | 32,400 | 40,400 | 64,900 |
| *East coast (M–O, Fig. 1)* | | | |
| Harbours | 29 | 8 | 31 |
| Bays | 52 | 11 | 34 |
| Island zones | 19 | 82 | 35 |
| Total number recorded | 7200 | 15,600 | 16,200 |

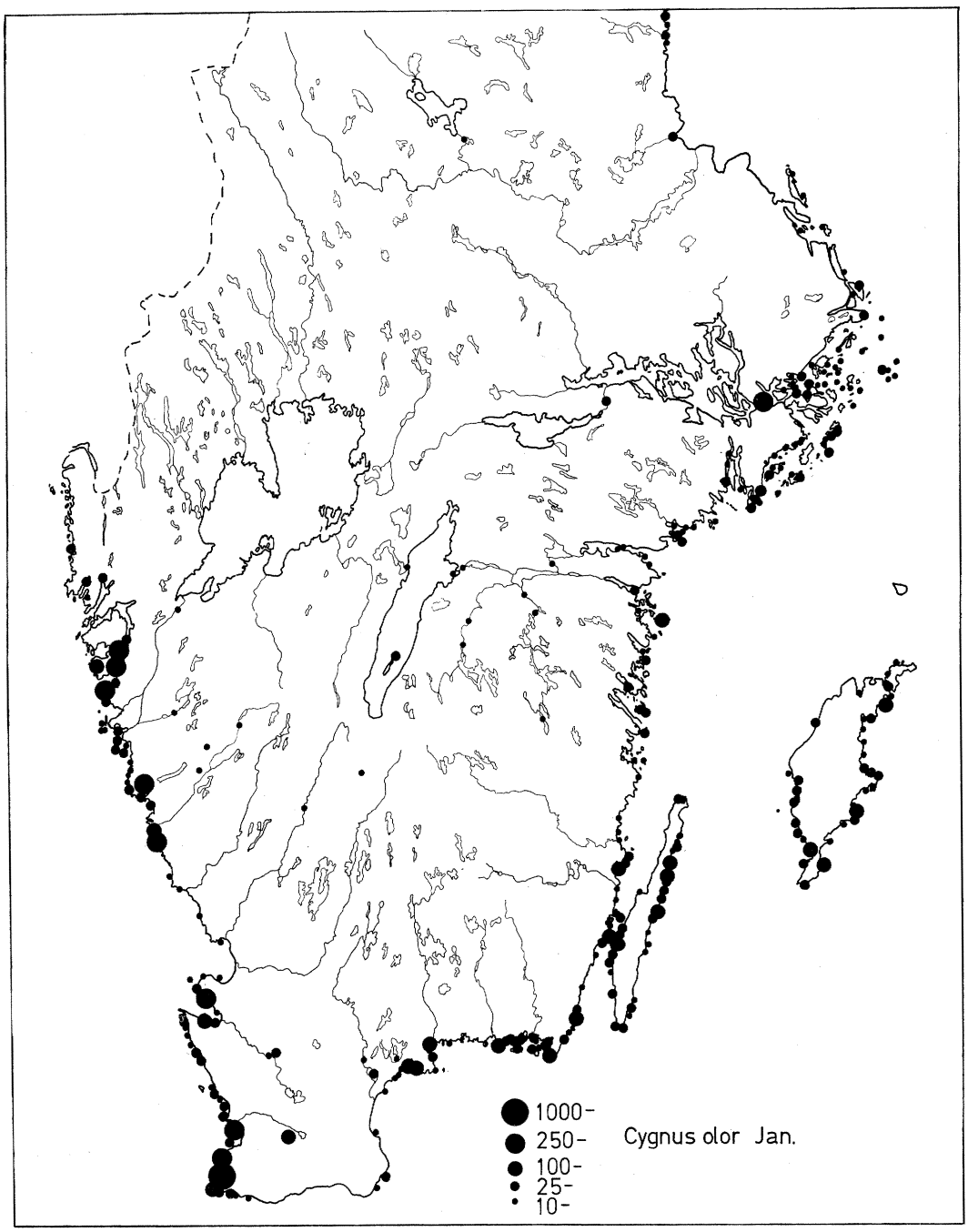



Fig. 11. Midwinter distribution of Mute Swan *Cygnus olor*.

buted from the innermost areas to the outermost skerries (Table XIII), whereas on open coasts they mostly occurred in estuaries, near harbours etc. In cold weather large concentrations occurred in some places.

Concentrations of Smew were only found in

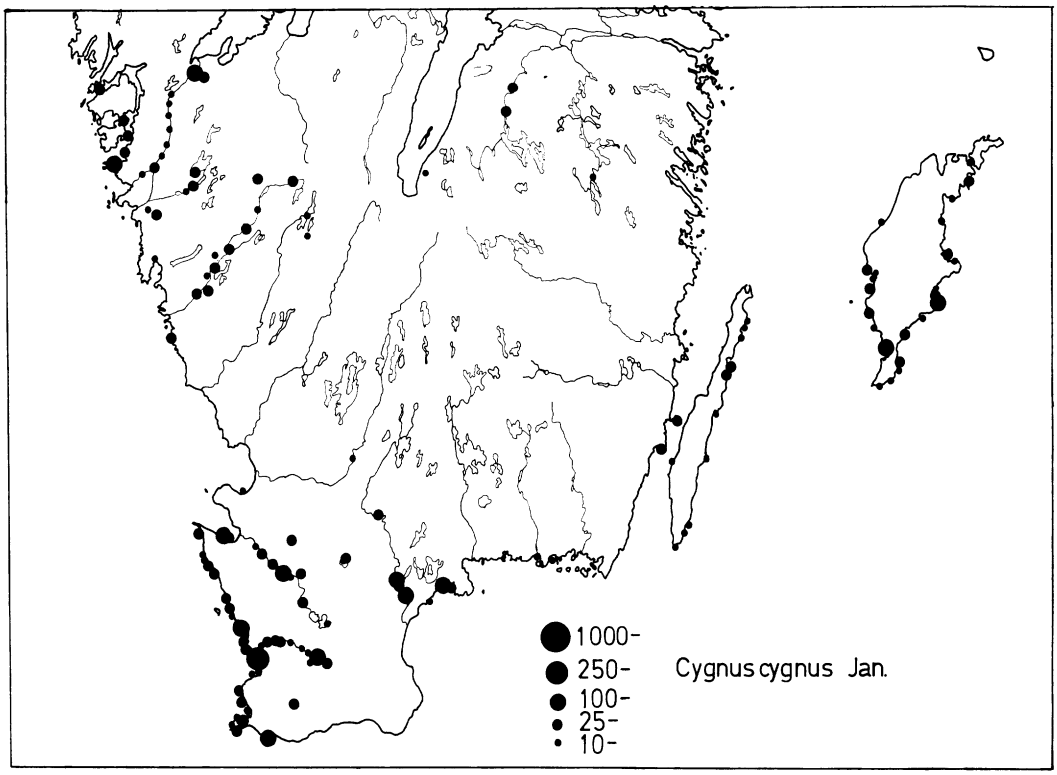



Fig. 12. Midwinter distribution of Whooper Swan *Cygnus cygnus*. In areas not shown on the map more than 25 individuals were noted on 5 localities and between 10 and 25 individuals on a further 6 localities.

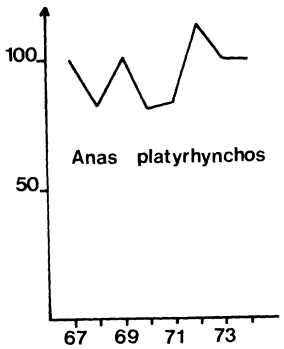
two traditional localities, the harbours of Malmö and Sölvesborg (Fig. 10). In other localities Smew were only seen irregularly or in small numbers.

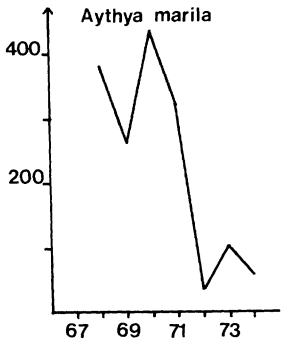
Mute Swans were mostly concentrated on coastal waters; not many were seen inland (Table X, Fig. 11). In mild winters Mute Swans were widely distributed in the east coast archipelagoes (Table XIII) and along the open coasts, whereas large concentrations were found at a few localities. Whooper Swans were found both inland and on the coast, often being concentrated in a small number of localities, mostly the same each year (Fig. 12, Table XI).

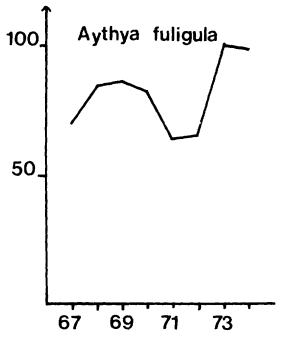
*Fluctuations*

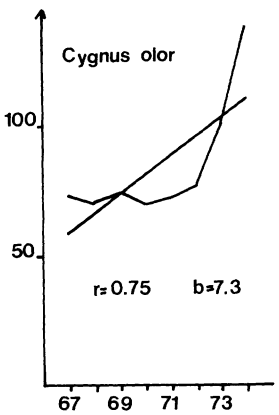
As all localities were not covered in each year, it is not possible to use the totals obtained directly to study annual fluctuations, but indices for the population levels in each winter had to be calculated. As 1973 had the best coverage of the counts it was chosen as base year with index = 100 for all species. Indices for 1972 (and 1974) were calculated by expressing the totals for the different species in 1972 (and 1974) on all localities that were also counted in 1973 as percentage of the totals for the same localities in 1973. Indices for 1971 were calculated by expressing the totals at all common localities for 1971–1972 as percentage of the totals for these localities in 1972, then multiplying these percentages with the annual indices for 1972. The indices in the other years were calculated similarly by comparing the paired years 1970–1971, 1969–1970, 1968–1969, and 1967–1968. The fluctuations are shown in Fig. 13.

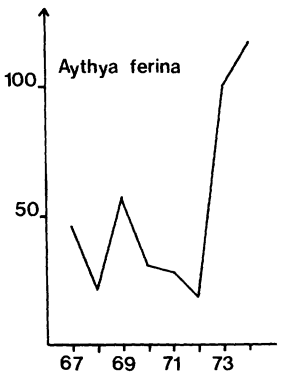
In the Mallard the indices do not indicate any tendency in the wintering population to increase or decrease, only fluctuations between different winters. Low midwinter indices were

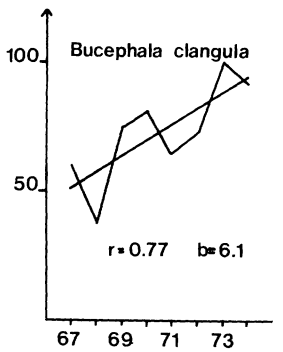


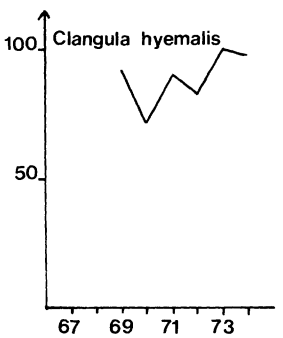



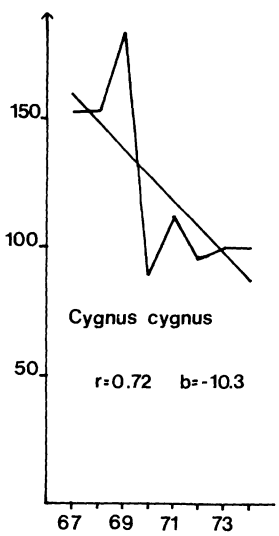



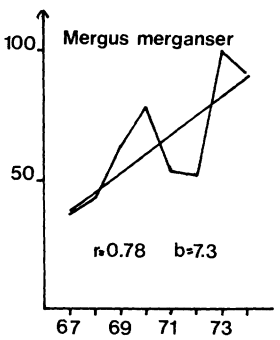



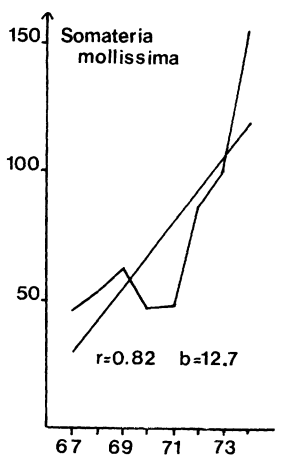



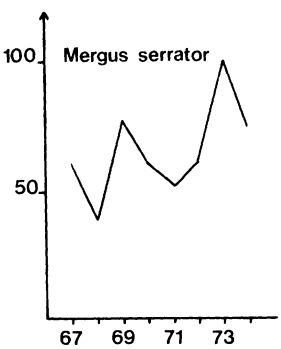



noted in the cold winters of 1968 and 1970 probably due to emigration. The low index in the fairly mild winter of 1971 might be due to a reduction of the population during the 1970 winter. January 1972 was not especially mild (Table I), but the high index might be due to mild weather in December causing more Mallards than normal to remain in Sweden. December indices in 1971 were much higher than normal, whereas November indices were on the normal level. In a series of midwinter counts from the coasts of Scania in 1964–1973 (Nilsson 1974), a significant correlation was found between high temperatures and high Mallard indices. The lower indices in coastal areas during cold winters were probably due to a shift to urban waters and to emigration (Table XII).

In the Scaup the highest indices were noted in the coldest winters. A marked reduction in Scaup numbers occurred after the 1971 winter. It should be noted that all Scaup localities were checked from the ground, so the decrease is not due to Scaups being overlooked in flocks of Tufted Duck during the aerial surveys.

The Tufted Duck indices show a decrease after the hard 1970 winter, with low indices in 1971 and 1972 and a marked increase to January 1973. This reduction is mainly localized to the southernmost part of the country and might partly be explained by the mild weather in later winters causing more Tufted Ducks to stay in the east coast archipelagoes, but there was also a real reduction in the size of the wintering population after the cold winter of 1970, probably due to increased mortality that winter. The same decrease was found in indices calculated on November counts and monthly waterfowl counts that are not influenced by ice conditions in coastal areas. In Scania, substantial numbers of dead and weakened Tufted Ducks were found during the coldest periods. The high indices in 1973 might be caused either by good production in summer 1972 or by mild weather in autumn causing more Tufted Ducks to remain during the winter or a combination of both factors. In a longer series of counts from Scania (Nilsson 1970b, 1974) a decrease was found after the hard 1962/63 winter, followed by an increase up to 1969, then a decrease followed again after the 1969/70 winter.

Pochards were counted in relatively small numbers and indices are not very reliable. They show marked fluctuations with the highest values in the last two very mild winters.

For the Goldeneye, indices show an increasing trend during the period concerned. The coverage for the species was not very thorough during the first two years but regional indices show the same pattern as the national indices. The peak during 1970 and reduction to 1971 is probably due to inadequate sampling. In 1971 Goldeneyes were dispersed over large areas, e. g. in the archipelagoes, many of which were not covered in 1970 (and included in the index calculations), whereas the majority of all Goldeneyes in 1970 were concentrated to areas in the south with good coverage in the counts. High indices in 1973 and 1974 might be due to unusually mild winter weather.

The data for the Long-tailed Duck in the first two years were too incomplete to allow calculation of indices. In the six years for which indices were obtained, no clear tendency was found. The same was found in a longer series from the south coast of Scania.

The Eider indices show an increasing trend interrupted only by the cold winter of 1970 and the more normal winter of 1971. More Eiders probably remained in the Baltic due to mild winters, but other factors may also have played a part as the same increase was found on the southern part of the west coast (Table VIII). It should, however, be noted that the winter population of Eiders in the Baltic is a negligible fraction of the breeding population and that the main winter areas for the Swedish Eider

Fig. 13. Midwinter indices (y-axis) for Swedish Anatidae in 1967–1974. For calculation of indices, see text. Correlation coefficients and regression lines are given in diagrams where significant trends were found.

are not included. In Scania a steady increase in the number of wintering Eiders has occurred since 1964 (Nilsson 1974).

Indices for the Red-breasted Merganser show marked fluctuations. A high index for 1973 with large numbers in all main areas on the east coast was probably an effect of mild weather. Numbers counted in the other mild winter, 1974, were lower probably due to cold weather in December (Table I).

The Goosander indices show an increasing trend. The same pattern was also noted for the coast of Scania from 1964–1970, whereas lower numbers were noted here during the last four mild winters (Nilsson 1974). The peak in 1970 was probably partly due to a concentration of Goosander, whereas they were more dispersed in 1971 and 1972 (Table IX). Dispersal does not entirely explain the decrease that was also noted in indices based on monthly counts. Increased mortality probably occurred during the cold 1970 winter. The peak in January 1973 might have been caused by good production in summer 1972 or by more Goosanders remaining in mild weather. In January 1974 numbers were lower but December was cold, so many Goosander probably left the country then. In Scania an increasing trend was found from 1964–1969/70 (Nilsson 1974). The Goosander population was probably reduced after the hard winter of 1962/63, when high mortality was noted in many areas, and then recovered.

For the Mute Swan, the indices show a quite stable level during 1967–1972, although there were fluctuations in relation to the ice situation when the separate districts were examined (Table X). The indices for 1973 and 1974 were markedly higher, probably because more Mute Swans than normal stayed in Sweden during the mild winters. In Scania a marked increase in Mute Swan numbers was found from 1964 to 1974 (Nilsson 1974).

In the Whooper Swan the indices for 1967–1969 were markedly higher than the indices for later years (Table XI). The winter population in 1970 was smaller at the coasts of Scania and Gotland, the two important coastal winter areas, whereas no marked reduction in numbers was noted from inland areas. Inland, Whooper Swans are mostly concentrated on running water and are thus not so sensitive to cold weather as on the coasts, where they stay in shallow areas that soon freeze in cold weather. The population in 1971–1974 remained at a low level. The reduction was probably partly due to a greater dispersal of Whooper Swans to small waters not covered in the counts during the milder winters. In 1971 and 1972 few such areas were available, so part of the decrease might be due to an increased mortality during the cold 1970 winter.

## DISCUSSION

Sweden is situated on the northernmost limit of the winter distribution of most Anatid species (Atkinson-Willes 1969). The winter populations of many species are accordingly small compared to the total northwest European population (Atkinson-Willes 1972) or compared to areas further to the SW such as Denmark (Joensen 1968, 1974). For other species, e. g. Mallard, Tufted Duck, Goldeneye, Long-tailed Duck, Goosander, and Whooper Swan, Sweden harbours an appreciable proportion of the NW European winter population.

In inland Sweden, the Mallard was the only common species in winter due to its good adaptability to urban areas, where feeding by people is important. Mallards were common also on the coasts, but diving ducks dominated here.

The composition of the diving duck populations was found to be different in different parts of the Swedish coast. Marked differences were found between archipelago areas and areas with open coast, but also between the Baltic and the west coast. The Tufted Duck was the dominating duck in all inshore areas of the Swedish Baltic coast and in the Öresund. The Goldeneye on the other hand was common on the open coasts but was less numerous in the archipelago areas in the Baltic. The Goldeneye was also important on the west coast, where it dominated over the Tufted Duck. Among the sawbills the Goosander dominated markedly in the archipelago areas, whereas the proportions between the Goosander and the

Red-breasted Merganser were more equal in areas with open coast. The Red-breasted Merganser dominated over the Goosander on the west coast.

Comparing the Swedish data with similar data from the southern part of the Baltic (Joensen 1968, 1974, Nehls 1969, Schmitt in litt.) it was found that the Tufted Duck was still the dominant inshore species, but Scaup and Pochard were more common than in Sweden. The Goldeneye was also important here as on the open coasts of Sweden. In offshore waters the Long-tailed Duck was the only really common species in the Baltic, but Eiders increased in numbers to the southwest.

The wintering populations of diving ducks in Finland and Estonia are small and dominated by small groups of Goldeneye and Goosander in inshore areas (Kumari in litt., Pirkola in litt.).

Among the factors affecting the winter distribution of waterfowl and other birds, availability of food supplies is probably the most important (Lack 1968), although topography, availability of suitable resting places, disturbance, traditions, etc. will influence the distribution patterns observed (Hochbaum 1960, Nilsson 1972b). Weather and ice conditions play a large part in determining the food supply (Nilsson 1970b).

Different species of diving ducks have different diving abilities (Dewar 1924, Nilsson 1972b). With the formation of ice, inferior divers will have difficulty in finding sufficient quantities of food in the northernmost areas. This might be the cause of the marked regional differences in the composition of diving duck populations found in the Baltic. The dominance of an excellent diver as the Long-tailed Duck in the offshore areas of the Baltic might be seen in relation to this factor. Other aspects of feeding ecology are, however, also important.

The Tufted Duck and the Goldeneye can dive to almost the same depths, but the Tufted Duck normally feeds mostly at night, whereas the Goldeneye is mainly a daytime feeder (Nilsson 1970c). This difference is probably caused by a difference in diet: the Tufted Duck is mainly a mollusc feeder taking large quantities of *Mytilus edulis,* whereas the Goldeneye to a larger extent takes more mobile animals such as various crustaceans (Nilsson 1972b). In hard weather the Tufted Duck feeds both day and night, whereas the Goldeneye mainly feeds in daytime even in hard weather. In cold periods the Goldeneye will thus be hard pressed and feed intensively all day (Nilsson 1970c). When the weather becomes still harder there is no margin left and the Goldeneyes have to leave the areas, the smaller females leaving first (Nilsson 1970b). The Tufted Duck can compensate for the hard periods by feeding more in daytime.

These differences in feeding ecology might be part of the explanation of the different distribution of the species in the Baltic. The Tufted Duck will have a better chance of staying in the archipelago areas as long as open water is available. However, in the northernmost parts of the Swedish archipelagoes and in Finland and Estonia, small groups of Goldeneye, mainly stronger males, are found, but only a few Tufted Ducks are seen. This anomaly might be due to the greater sociability of the Tufted Duck that winters in large flocks and which cannot find sufficient food supplies in the northernmost areas. Small numbers of Goldeneye can, however, remain in favourable areas, such as shallow parts kept open by a current.

Similar factors affect the sawbills. The Goosander is larger, feeds less intensively (Nilsson 1970c), and takes larger prey than the Red-breasted Merganser (Madsen 1957). The Goosander thus has a wider margin and can stay further to the north and does not leave until the ice conditions become really difficult.

Even if the availability of food in relation to the feeding ecology of the different species is the ultimate factor behind regional distribution, the severity of the winter and especially the shifting ice conditions are the prime proximate factors behind the local distributions and fluctuations of wintering waterfowl populations in Sweden. Marked changes in the local and regional distribution of Swedish waterfowl were accordingly found between different winters, the national midwinter indices partly

reflecting changes due to varying severity of the winters concerned.

In the light of these relationships, genuine long-term changes in the strength of the populations are difficult to detect in only eight years. Most of the fluctuations noted could thus be attributed to shifts in the distribution of populations in relation to the severity of the winter. However, real decreases in the wintering population were noted after the hard winter of 1970 for the Tufted Duck, Goosander, and Whooper Swan. The increases noted in the populations of some species during 1967–1969 were probably a recovery after the hard winters of 1962/63, probably retarded by the cold winter of 1965/66. Increases during later years might be due to mild winter weather affecting the distribution of the different populations and/or an increase after a reduction in the cold winter of 1969/70. Fluctuations might also be caused by good production in the preceding summer, but no such cases could be clearly distinguished here. However, when the data from counts in several countries have been analysed, there will be greater possibilities of separating the different factors behind the fluctuations observed in separate countries and in NW Europe as a whole.

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