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Abundance and productivity of ducks on boreal lakes in northern Sweden

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The numbers of duck pairs and broods present within a 56 km² study area, predominantly pine and spruce forest, in the coastal region of northern Sweden were estimated during 1977. The study area contained 95 relatively small, shallow lakes, covering 3.6 per cent of the total area. In May, three counts showed a total of 108 duck pairs, and during July 91 broods were recorded. The duck species observed were: mallard (*Anas platyrhynchos*), teal (*A. crecca*), wigeon (*A. penelope*), pochard (*Aythya ferina*), tufted duck (*A. fuligula*), velvet scoter (*Melanitta fusca*), goldeneye (*Bucephala clangula*), smew (*Mergus albellus*), red-breasted merganser (*M. serrator*) and goosander (*M. merganser*). The mean values for the whole survey period were 2.2 pairs and 1.9 broods per km of lake shoreline, or 54 pairs and 46 broods per 100 hectares of the entire area covered by lakes.

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1. Introduction

The European waterfowl population is a joint resource for which, because of its dicsrete breeding sites, migration routes and overwintering areas, all the countries involved must be jointly responsible. Its proper management is therefore more difficult than that of stationary game species. The need for proper management is particularly urgent and important now because of the steadily increasing exploitation of wetlands, mainly for silvicultural and agricultural purposes. The urgent need for reliable population estimates has already led to some European joint projects, which have yielded much information about the magnitudes and dispersion patterns of the waterfowl populations that winter in Europe (Atkinson-Willes 1976). Within northern Fennoscandia, some studies have been made in the breeding grounds around the coastal area of the Gulf of Bothnia (e.g. Hildén 1964 and Grenquist 1965) and in the mountains inland (Pehrsson 1976), but for the intervening coniferous forest belt with its numerous lakes, there is only scattered information on pair numbers, as reviewed by Haapanen (1973). However, an aerial census of the ducks and swans breeding north of 65° N has recently been undertaken (Haapanen & Nilsson 1978). Productivity estimates for duck populations are almost completely lacking, because of the practical difficulties (relatively few roads, deep snow cover on the ground when the birds arrive) which therefore make surveys very time-consuming in the boreal forests, where the duck densities are generally low.

The aim of this investigation was to obtain rough estimates of the population sizes and of production of ducks on boreal lakes in the above-mentioned region of northern Sweden. To aim at a genuine estimate of productivity, i.e. the number of fully fledged ducklings produced per female (or pair), for large areas and for all duck species would have been unrealistic. Instead, a less ambitious assessment of the numbers of pairs and broods was carried out. Consideration of habitat selection by ducks within the same area is dealt with in another paper (Danell & Sjöberg 1978).

2. Study area

The study area is situated in the coastal region of northern Sweden (63°50–55' N, 20°35–47' E). Three

map squares, each 5 × 5 km in area, were chosen (those numbered 20K8h, 20K8i and 20K9i of the Swedish National Grid System, see Fig. 1), all situated within the county of Västerbotten.

The bedrock of the study area consists of "migmatite, veined gneiss derived from the phyllite series" (Gavelin & Kulling 1955) and the surface deposits are Quaternary, "moraine with low boulder content, sandy and gravelly" (Granlund 1943).

The estimated mean annual temperature lies between 2–4° C and the mean temperature for the warmest month (July) is 15° C (Ångström 1953). The plant growth period (daily mean air temperature ≥ 6° C) is 140—160 days (Johannessen 1970). The mean annual precipitation is 450—550 mm (Wallén 1953). The lakes are ice-covered from early November to early May, or for 180—200 days (Ångström 1958).

The study area lies on the border between the middle and the southern boreal vegetation zones (Ahti et al. 1968). Mixed forests of Scots pine (*Pinus silvestris* L.) and Norway spruce (*Picea abies* (L.) Karst.), with scattered birches (*Betula* spp.), predominate in this area. In some places there are tracts of cultivated land.

3. Methods

A. Lake characteristics

The extent of the shorelines and the areas of all the lakes occurring within the study area were measured directly from the relevant sheets of the Economic Map of Sweden (scale 1 : 10 000). The area of each lake which had a water depth of less than 0.5 m was estimated during a field survey made in July 1977. On the same occasion water samples were taken (for measurements of pH and specific conductivity) and records made of the dominant emergent hydrophyte species and the total cover of emergents. The lake surroundings (within 100 m of the shoreline) were classified into 13 habitat types, the relative areas of which were estimated to the nearest 10 per cent.

B. Pair counts

All lakes were surveyed in the morning (0600—1200) on three occasions during the spring (9—10, 12—13

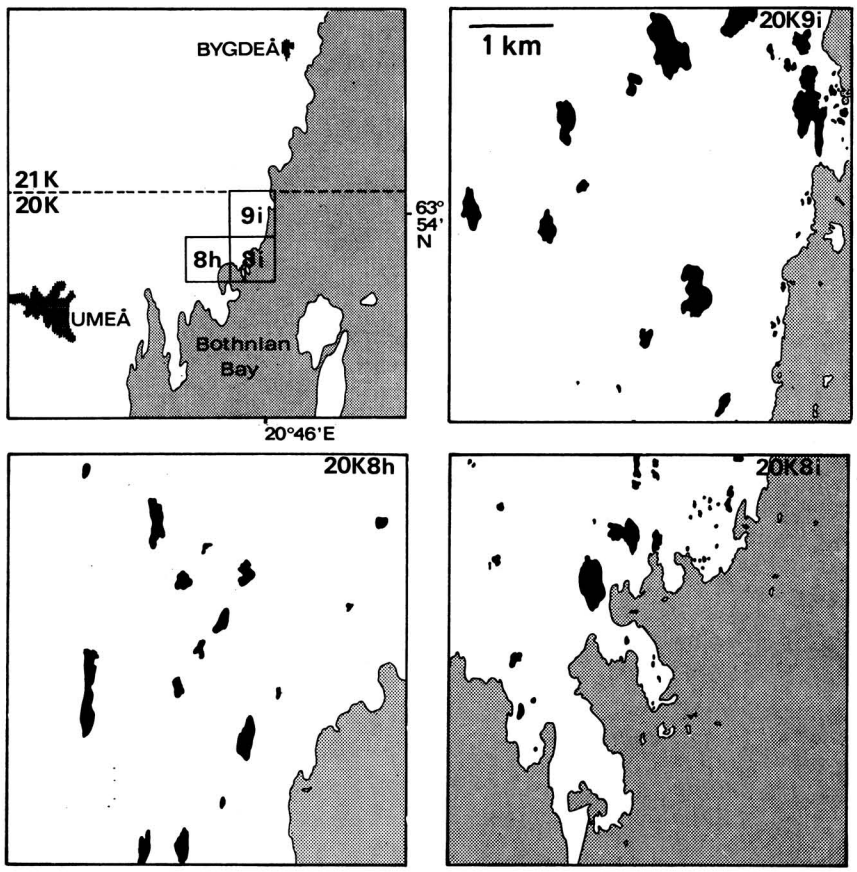

Fig. 1. The study area within the coastal region of northern Sweden, showing the three map squares each 5 × 5 km of the Swedish National Grid System used, which together comprised a land area of 55.6 km². The 95 boreal lakes are shown in black. Permission for reproduction approved by the Security Officer of the National Land Survey of Sweden, 7 November 1977.

and 23—25 May 1977). At the time of the first count, carried out when the birds had arrived and already paired, the lakes were mainly ice-covered, but on average open water formed 30 per cent of the lake area. At the time of the final pair count all the lakes were ice-free and the females (except those of the tufted duck) had started to incubate, while most drakes were seen alone. Birds were recorded as 'pairs', 'lone drakes or hen birds' or 'gathered birds'.

For the purpose of determining the sizes of the breeding populations in terms of breeding pairs, each 'pair' or 'lone drake' was assumed to represent one nesting pair (Dzubin 1969). For the study area as a whole the number of pairs of each species has been expressed as the mean of the values for the three separate count dates. In addition, the number of pairs has been estimated by the method proposed by Evans & Black (1956) and Dzubin (1969), whereby one nesting pair was assigned to a given pond for each 'pair' or 'lone drake' that was recorded on or near the same pond on three of the four counts (in this study, two of the three counts). The figures for pairs have not been corrected for any sex ratio imbalances.

C. Brood counts

All lakes were surveyed at least once during July. A second survey was made in those lakes in which emergent hydrophytes were abundant and in all lakes in which one or more ducklings were found or whose presence was evidenced by the behaviour of the duck at the time of the first brood count. Each survey team consisted of four men and two dogs (well-trained game dogs, generally German pointers). A canoe was used for surveying the larger and well-vegetated lakes. For the smallest lakes a smaller team was used, but consisting of at least one man and one dog.

4. Results

On average pine and spruce forests formed 82 per cent of the lake environs, the rest being farmland, mires, seashores etc. Within each km^2 of the study area there were 1.7 lakes, with a mean extent of 2.1 ha. Of the 95 lakes, which accounted for 3.6 per cent of the whole study area, 55 were less than 0.5 ha in extent (Table 1). Of the lake surface area within the study area, 61 per cent was less than 0.5 m deep and 46 per cent was covered by emergent hydrophytes. The sedge *Carex rostrata* Stokes was the dominant emergent plant in 60 of the 95 lakes. The values for pH and specific conductivity (μS/cm) showed wide ranges: 3.7—8.6 and 17—2900, respectively. However, two-thirds of the pH and conductivity values lay between 3.7—4.8 and 17—50, respectively.

The most common duck species encountered during the May pair counts were tufted duck, mallard and goldeneye (Table 2). The highest numbers for duck broods were recorded for tufted duck, teal and mallard (Table 3). Dabbling ducks accounted for 38 per cent of the duck pairs and 51 per cent of the duck broods recorded. The average densities for the whole study area (land surface included) were 1.9 duck pairs per km^2 and 1.6 broods per km^2.

For 6 of the 15 mallard broods recorded, accurate counts of the number of ducklings could be made. The mean number of ducklings

Table 1. Size distribution and total shoreline lengths and water areas of 95 boreal lakes of different kinds, present within the study area (55.6 km^2) in northern Sweden.

Lake sizes (hectares)	Total number of lakes in each size group	Total area represented by each size group (ha)	Total area of water < 0.5 m deep (ha)	Total lake area covered by emergent hydrophytes (ha)	Total length of shoreline (km)
0 — 0.10	28	1.7	1.7	1.6	3.0
0.11 — 0.50	27	6.2	5.3	2.8	5.7
0.51 — 1.00	11	8.1	4.9	2.3	4.7
1.01 — 2.00	8	10.5	7.4	7.1	4.5
2.01 — 3.00	9	23.3	16.7	14.1	7.8
3.01 — 4.00	1	3.2	0.3	0.0	0.8
4.01 — 5.00	2	9.6	2.4	4.3	2.0
5.01 — 10.00	3	23.6	6.8	6.0	4.6
10.01 — 15.00	1	13.4	1.3	1.3	1.6
15.01 — 20.00	2	33.7	18.9	6.7	5.1
20.01 — 25.00	3	66.4	56.4	46.0	9.3
Overall totals	95	199.7	122.1	92.2	49.1

Table 2. Numbers of dabbling and diving duck pairs recorded in 1977 in 95 boreal lakes within the study area (55.6 km²) in northern Sweden. The numbers of pairs shown are the mean values for the three separate counts; the 'constancy' values (see under Methods) are shown in brackets.

	Numbers of pairs	Pairs/km² of study area	Pairs/km shoreline	Pairs/km² total lake area	Pairs/km² lake area < 0.5 m deep
Mallard *Anas platyrhynchos* L.	17.3 (11)	0.3	0.4	8.7	14.2
Teal *A. crecca* L.	12.0 (3)	0.2	0.2	6.0	9.8
Wigeon *A. penelope* L.	12.0 (6)	0.2	0.2	6.0	9.8
Pochard *Aythya ferina* (L.)	0.7 (0)	0.0	0.0	0.4	0.6
Tufted duck *A. fuligula* (L.)	35.7 (9)	0.6	0.7	17.9	29.2
Velvet scoter *Melanitta fusca* (L.)	0 (0)	0	0	0	0
Goldeneye *Bucephala clangula* (L.)	17.0 (11)	0.3	0.3	8.5	13.9
Smew *Mergus albellus* L.	0.3 (0)	0.0	0.0	0.2	0.2
Red-breasted merganser *Mergus serrator* L.	3.0 (0)	0.1	0.1	1.5	2.5
Goosander *M. merganser* L.	10.0 (5)	0.2	0.2	5.0	8.2
Total	108.0 (45)	1.9	2.2	54.1	88.5

Table 3. Brood numbers of dabbling and diving ducks recorded in 1977 in 95 boreal lakes within the study area (55.6 km²) in northern Sweden. The brood numbers shown are the highest recorded values for all broods found.

	Broods	Broods/km² of study area	Broods/km shoreline	Broods/km² total lake area	Broods/km² lake area < 0.5 m deep
Mallard	15	0.3	0.3	7.5	12.3
Teal	24	0.4	0.5	12.0	19.7
Wigeon	7	0.1	0.1	3.5	5.7
Pochard	0	0	0	0	0
Tufted duck	30	0.5	0.6	15.0	24.6
Velvet scoter	4	0.1	0.1	2.0	3.3
Goldeneye	9	0.2	0.2	4.5	7.4
Smew	0	0	0	0	0
Red-breasted merganser	0	0	0	0	0
Goosander	2	0.0	0.0	1.0	1.6
Total	91	1.6	1.9	45.6	74.5

(age classes IIa—III according to Gollop & Marshall 1954) per brood was 3.3. The corresponding figure for 10 teal broods was 3.4. In the 21 broods of tufted duck, the mean number of ducklings (age classes Ib—III) per brood was 2.7. For all three species the range was wide, 1—7. The broods of velvet scoter were all found within 500 m of the shoreline of the Bothnian Bay. The other duck species had a more even distribution over the three squares.

5. Discussion

The value of 3.6 per cent for the area occupied by lakes within the study area as a whole is somewhat lower than the Västerbotten average, viz. 6.4 per cent (National Central Bureau of Statistics 1972). It is more difficult to assess how representative the water chemistry data for the study area are, in relation to other areas of northern Sweden. The predominance of coniferous forests, together with the relative 'poverty' of the bedrock and soils of the area, would suggest nutrient-poor and acid lake waters. In fact, the measurements showed waters even more acid than those examined in Västerbotten during a survey made in 1972 (Dietrichson 1975). The relatively few lakes in the study area which were found to have a higher electrolyte content and neutral or basic water were mostly located close to the brackish-water coastline of the Bothnian Bay.

The different duck species arrive at somewhat different times during the spring. In consequence it is difficult to obtain reliable estimates for all species on one and the same occasion. The time span between early (e.g. mallard) and late (e.g. tufted duck) arrivals is generally shorter in northern than in southern Fennoscandia. The late spring of 1977 may further have favoured the present investigation, with only three pair counts made, by further reducing this time difference.

If the brood figures are regarded as valid for the study area, then the 'method of constancy' (see under Methods) used for calculating pair numbers seemed to underestimate the pair figures in these habitat types. The other method used (mean of observations) gave pair estimates that were more closely related to the brood numbers. The pair figures for teal, however, formed an exception. The teal is a very difficult species to survey, especially during the time of the spring flood, when the pairs are scattered and are often hidden in small ditches within the forests, etc. However, their broods are more easily estimated when they move to permanent waters later on.

The species composition of the duck populations in the Västerbotten area was closely similar to that found on the opposite shore of the Bothnian Bay (Pohjanmaa district of Finland) (Haapanen 1973), but in our study area the tufted duck was more abundant and the pochard less common than in Finland.

The densities of ducks recorded for the study area in Västerbotten, 54 pairs per km² of lake area, is high as compared with the figures obtained from ground counts in northern Finland, 23 pairs per km² (calculated from the figures given for 'Forest Lapland' by Haapanen, 1973) and even with those for central and southern Finland, 28—57 pairs per km² (calculated from Table 1 in Haapanen 1973). These Finnish surveys were made in eutrophic lakes or coastal bays, whereas only a few of our lakes belonged to these habitat types. On the average, our lakes were also considerably smaller than the Finnish lakes. The multitude of small and shallow, but apparently less eutrophic, lakes in our study area yielded higher counts of ducks (per unit of lake area) than did the fewer but larger and more eutrophic lakes in Finland.

Haapanen and Nilsson (1978) have presented preliminary estimates of diving ducks obtained from aerial censuses. The pair value for coastal northern Sweden (corrected for differing species efficiency pertaining to ground/air comparisons) is 27 per 100 km² surface (land + water), a very low value compared to our value of 120.

It must be pointed out that the values for brood size obtained for mallard, teal and tufted duck (3.3, 3.4 and 2.7, respectively) in the present study are only approximate, because of the difficulty of finding all the ducklings of a given brood, especially when they are almost fully fledged. However, the brood sizes recorded indicate a low degree of productivity per female, at least for the dabbling ducks. Linkola (1962) reported the following brood sizes: mallard 7.0, teal 5.9 and tufted duck 4.1 for southern Finland, and from Iceland Bengtson (1972) cited values of 3.5, 3.7 and 2.3 for the fully fledged young per female of mallard, teal and tufted duck, respectively.

A further conclusion from the present study is the necessity for full documentation of the characteristics of any aquatic area, viz. lake morphometry, water chemistry, emersed and submersed vegetation, etc., in parallel to the duck surveys. Only in that way can reliable evaluations of the abundance and productivity of the duck populations of different regions be made in the future.

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