Lake selection by Goldeneye ducklings in relation to the abundance of food

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Introduction

Overland travels by ducklings of different species have been reported by several authors, e.g. Beard (1964), Erskine (1971), Poston (1974), Ball *et al.* (1975), Alison (1976) and observed in the Goldeneye *Bucephala clangula* by Sirén (1952, 1957a). In the present paper the overland movements from lake to lake by non-fledged Goldeneye ducklings are correlated with the food supply in different lakes. Other factors which might initiate overland travels are also discussed and some aspects of the evolution of this behaviour with reference to the abundance of food are mentioned.

Food of Goldeneye ducklings

Adults and larvae of aquatic insects are the main food items of Goldeneye ducklings (Bauer & Glutz 1969; Eriksson 1976). Prey, such as water-boatmen (*Notonecta*, Corixidae), dytiscid beetles including larvae (Dytiscidae), and damsel fly and dragon fly larvae (Odonata), which are freely swimming or well exposed on the bottom or vegetation seem to be preferred.

Study area

Field work was carried out in 1974–1977 in Svartedalen, approximately 40 km north of Göteborg in south-west Sweden. The area consists mainly of coniferous forests and most of the lakes are oligotrophic. The smaller of them have a rich vegetation of water-lilies *Nymphaea alba* and *Nuphar lutem*, whereas this vegetation is restricted to the shallower parts of the larger lakes. Smaller patches of emergent vegetation, mainly reed *Phragmites australis (communis)*, sedges *Carex* spp., and horsetail *Equisetum fluviatile*, are found along the shores of most of the lakes. Goldeneye is the most common waterfowl species which breeds in the area, and yearly surveys of the breeding population in an area of 55 km² were carried out during 1971–1977. In the present paper data accumulated from field work performed within a limited area of about 3 km² (Figure 1) is treated. The complete names of the lakes included in the present study are given in Figure 1 together with the abbreviations used in the text and tables.

Methods

Selection of lakes by the ducklings

On the basis of observation of Goldeneye broods the number of duckling days (the sum of the number of days each of the ducklings was present in the study area) up to 15th July in each year was calculated. The percentage of duckling days on each lake was used as an indication of the preference for the lakes by the ducklings. In order to give a measure of the observation effort, the total number of lake visits by an observer during the period of 15th May to 15th July is given in Table 1. When a change in the number of ducklings in a lake was recorded, it was assumed that this change occurred on the middle day of the period between the succeeding visits. The calculation of duckling days was more accurate during 1975–1977 than in 1974, when comparatively few lake visits were made. To investigate if the use of

Table 1. Number and distribution of duckling days during the breeding period, and the number of lake visits by an observer.

Year	Total number of duckling days	Distribution of duckling days in the different lakes, %								Total number of lake visits during 15 May–15 July
		A	M	K	O	TN	TS	NR	ÖR	
1974	27	0	0	63	0	37	0	0	0	45
1975	288	24	3	47	25	0	0	0	0	125
1976	230	0	3	86	10	0	0	0	0	222
1977	99	0	0	42	58	0	0	0	0	242

different lakes is dependent on the place where the broods were hatched, the distance between each lake and the nearest nest-box where a clutch hatched was compared with the percentage of duckling days. The Spearman rank correlation coefficient, r_s, with correction for ties according to Siegel (1956, p. 201–13) was calculated. The rank of the

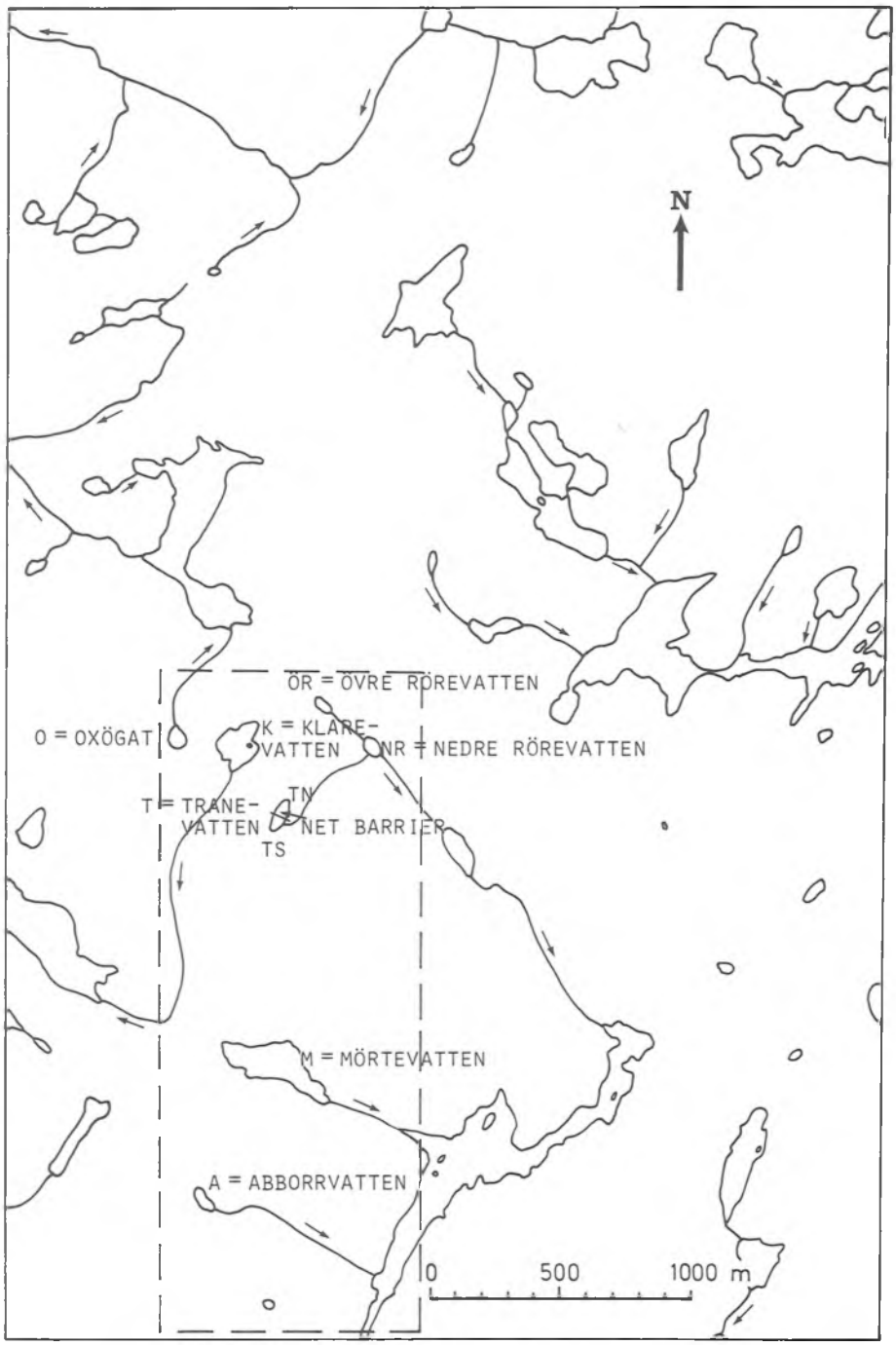

Figure 1. Part of Svartedalen with the area included in the present study enclosed by broken lines. The abbreviations of the names of lakes used in the text and tables are given.

lakes with regard to utilization by ducklings in different years was compared by the Kendall coefficient of concordance, W, with correction for ties according to Siegel (1956, p. 229–39). This test was performed in order to determine if the same lakes were preferred from one year to another. The 95% level was used in all significance tests.

Measurement of food abundance

The abundance of potential prey was measured by sweep net hauls, using a long-handled net at randomly selected places along the shore. Sampling was performed around 20 June in each year in order to obtain an index of the food situation of the ducklings during the non-fledged period. Lakes A, M, K, O, and T were investigated during 1974–1977, and in 1976 and 1977 Lakes NR and ÖR were also included. Lake T had been divided into two parts with a net barrier for fishery investigations, and each part was regarded as a separate lake, TN and TS respectively (of Figure 1), and hence also as separate study units. Ten horizontal hauls through three metres were performed in each lake on each sampling occasion. The net opening was 0·07 m^2 and mesh size 1·3 mm. The mean number of food organisms caught per sample of ten sweep net hauls in each lake (excluding NR and ÖR since no sampling was done in these lakes in 1974 and 1975) was calculated, together with the coefficient of variation, CV, to obtain an index of the food situation in each year.

In order to determine whether the lakes changed from year to year with regard to the abundance of food organisms, the Kendall coefficient of concordance was calculated with correction for ties. The relationship between the abundance of food and the selection of lakes by Goldeneye ducklings was investigated by calculating the Spearman rank correlation coefficient with correction for ties.

Results

The distribution of duckling days in the different lakes investigated is shown in Table 1. The preference for different lakes did not change significantly during the years (Kendall coefficient of concordance, $p < 0{\cdot}01$, $k = 4$, $N = 8$, symbols according to Siegel 1956). A significant, negative correlation ($r_s = -0{\cdot}73$, $p < 0{\cdot}05$) between the distance to the nearest nest-box where a clutch hatched and the lake preference was found in 1974, while no significant relationships between these two variables were found in the following years.

Estimates of the abundance of food are given in Table 2. Water-boatmen (*Notonecta*, Corixidae), larvae of *Dytiscus* and *Acilius*, small dytiscid adults (mainly *Hyphydrus ovatus*), damsel fly and dragon fly larvae (Odonata), *Chaoborus* larvae, and water-mites (Hydracarina) appeared in the samples. According to Table 3 the best food situation probably occurred in 1974. The variation in food abundance in the different lakes did not change markedly during the study period (Table 3), and the rank of the

Table 3. Mean number (±S.E., n = 6) and coefficient of variation (CV) of potential Goldeneye prey per sample of ten sweep net hauls in each of the lakes A, M, K, O, TN, and TS.

Sampling	$\bar{x} \pm$ S.E.	CV
18–20 June 1974	31 ± 16	124
23–24 June 1975	20 ± 10	119
21–22 June 1976	20 ± 9	109
20–22 June 1977	15 ± 7	106

Table 2. Mean Number (±S.E., n = 10) per net haul of potential Goldeneye prey.

	Sampling date			
Lake	18–20 June 1974	23–24 June 1975	21–22 June 1976	20–22 June 1977
A	9·7 ± 3·5	1·4 ± 0·4	2·0 ± 0·6	1·4 ± 0·4
M	5·8 ± 3·2	1·2 ± 0·7	1·0 ± 0·5	0·4 ± 0·2
K	0·8 ± 0·5	2·7 ± 1·2	2·4 ± 0·8	1·2 ± 0·4
O	1·6 ± 0·4	6·4 ± 2·5	6·2 ± 1·6	4·7 ± 1·4
TN	0·5 ± 0·3	0·1 ± 0·1	0·1 ± 0·1	0·6 ± 0·3
TS	0·2 ± 0·1	0·1 ± 0·1	0·5 ± 0·2	0·8 ± 0·5
NR	No sampling		1·7 ± 0·4	1·1 ± 0·5
ÖR	No sampling		0·1 ± 0·1	0·2 ± 0·1

lakes with reference to the abundance of food did not change significantly from year to year (test of Kendall coefficient of concordance, $p < 0{\cdot}05$, $k = 4$, $N = 6$, Lakes NR and ÖR excluded). The selection of lakes by the ducklings was positively correlated to the abundance of food in three out of four seasons (1975, $r_s = 0{\cdot}94$; 1976, $r_s = 0{\cdot}69$; 1977, $r_s = 0{\cdot}75$; $p < 0{\cdot}05$), while a negative but non-significant relationship was found in 1974.

Discussion and conclusions

Some aspects of the evolution of overland travels

As the Goldeneye broods do not always hatch in nests near a shore, the newly hatched ducklings must sometimes perform overland travels of varying distance to reach any feeding locality at all. However, the ducklings preferred lakes other than the one nearest to the hatching place during three out of four years. This result suggests that some lakes have advantages which are more important with regard to the chance of survival than a short distance from the hatching place.

Ball *et al.* (1975) found negative correlations between the distance travelled and duckling mortality of Mallard *Anas platyrhynchos* and Wood Duck *Aix sponsa*. Sirén (1952, 1957a) and Alison (1976) also suggested that movement on land increases the risk of mortality due to predation. If this assumption is also valid in our Goldeneye population, those factors which initiate overland travels to water areas other than those nearest the nest must in other ways increase the duckling survival.

Factors which might influence the selection of lakes by the ducklings

1. Abundance of food

A comparison of the food situation in the different years (Table 3) with the rank correlation coefficients between food abundance and lake selection shows that the Goldeneye ducklings did not select the lakes with the greatest abundance of prey in 1974, which probably was the season with the best food situation. However correlations between food abundance and lake selection were found in the following three years. This result suggests that the selection of lakes by the ducklings is dependent on the abundance of food at least in seasons with comparatively low food supplies.

2. Distance from the hatching place

Only in 1974 did the ducklings appear on the lakes nearest the hatching place, whereas the best feeding lakes were selected in three following years, when the food situation was probably less favourable (Table 3).

3. Territorial behaviour

No indications of territorial interactions between different broods were observed. For example, two Goldeneye broods were present simultaneously in Lake K, an area of 2·08 hectares.

4. Predation pressure from pike

The risk of predation by pike *Esox lucius* is thought to affect the selection of lakes by broods of Bufflehead *Bucephala albeola* (Erskine 1971), and in the Svartedalen area predation by pike on Mallard ducklings has been confirmed (Pehrsson 1977). However, of the lakes included in the present investigation, only Lake M has been shown to contain pike during the 1970's (Schmuul 1973). Therefore, the selection of lakes by Goldeneye ducklings cannot be related to the risk of predation by fish. Moreover, the presence of pike usually also implies the presence of other fish species such as perch *Perca fluviatilis*, which to some extent feed on the same kinds of aquatic insects as the Goldeneye, and it cannot be excluded that situations of exploitation competition between freshwater fish and Goldeneyes may occur (Eriksson unpublished). Therefore, avoidance of 'pike lakes' by Goldeneye ducklings may be explained by a poor food supply rather than by high predation pressure.

5. Home range tenacity

Goldeneye females show a strong nest site tenacity (Sirén 1957b; Nilsson 1971; Rajala & Ormio 1971; Eriksson unpublished). Furthermore, most female Goldeneye probably live long enough to rear a sufficient number of broods during their life-span to make advantageous the learning through experience of where to take their young to maximise their survival. As ducklings, with few exceptions, were seen in the same lakes year after year (Table 1), the occurrence of such behaviour cannot be excluded. However, as the same lakes generally contained the greatest food supplies during successive years (Table 2), the regular presence of ducklings may equally well be explained by a selection of the best feeding localities. Also the best feeding lakes may be remembered by the female and influence her

subsequent choice. Therefore these factors may be connected with each other and difficult to separate. An increase of adult Goldeneye following increased abundance of invertebrate prey after eradication of a fish population in a lake (by rotenone treatment) was found by Eriksson (unpublished). This result suggests that tenacity to certain lakes is not very strong.

Food as a factor limiting the number of Goldeneye ducklings

In seasons with comparatively low food supplies, the ducklings select the best feeding lakes, and this behaviour implies an increased chance of survival until fertile age, which outweighs probable increased mortality risks during movement on land. The behaviour would not have evolved if the net result was not an increased chance of survival, and as food is one factor that affects the selection of lakes, it seems probable that food situations critical to the non-fledged ducklings occur regularly. Otherwise, the overland travels would eventually disappear. When enough food is available in the lakes that are nearest the nest, travels to other lakes are avoided, and it is reasonable that a greater part of the ducklings survive until fledging in such seasons, as the mortality risks taken during travels on land are minimised. Since the present results suggest that the food situation might be important to the non-fledged ducklings, this factor should be taken into account in management practices.

Acknowledgements

The investigation was carried out at the Department of Zoology, University of Göteborg. I am greatly indebted to Olof Pehrsson, who made a large part of the brood observations, and I would like to thank everyone who has assisted me in preparing the manuscript. The study was supported by grants from the Lundgren, Längman, Hierta-Retzius, and Colliander foundations.

Summary

In three out of four years lakes other than those nearest the nests were preferred by ducklings of Goldeneye *Bucephala clangula*, with significant correlations between abundance of food and preference for certain lakes. Overland travel must be of selective advantage, and therefore the factors necessitating such movement must be more important than the mortality risks involved. Food supply is a factor which may initiate travel on land and thus be of significance in the control of duckling survival.

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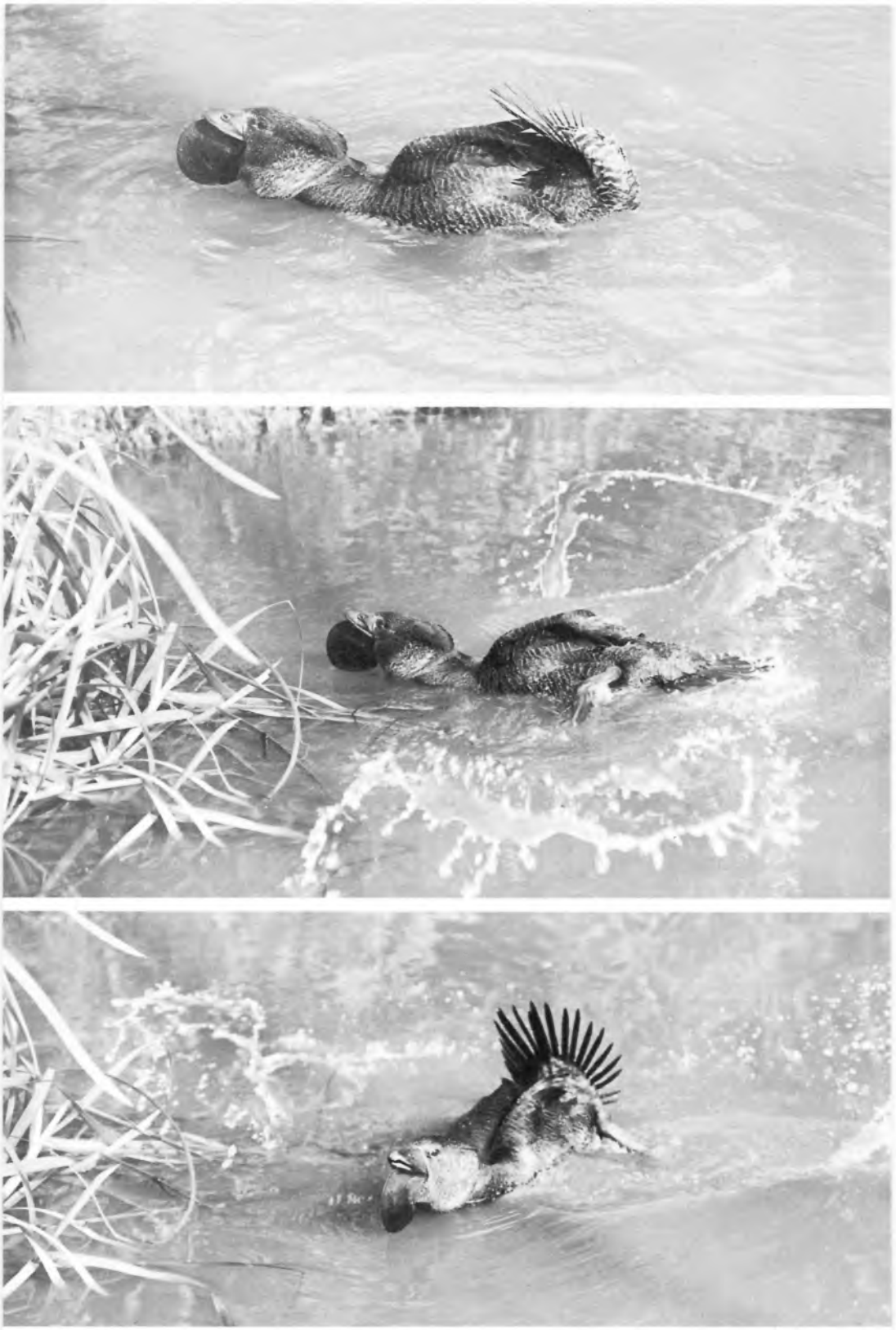

A male Musk Duck *Biziura lobata* performing its elaborate display; (top) preparing to kick; (middle) the Paddling-kick, with tail lowered; (bottom) the climactic Whistle-kick, with tail fanned and held over the back. For more photographs and information see *Wildfowl* 26, page 113. (*Philippa Scott*)