

Male sex bias in Eiders *Somateria mollissima* during spring migration into the Gulf of Finland

Mikael Kilpi, Markus Öst, Alekski Lehikoinen & Arne Vattulainen

Kilpi, M., ARONIA at Sydväst Polytechnic & Åbo Akademi University, Raseborgsvägen 6–8, FIN-10600, Ekenäs, Finland. (E-mail: mikael.kilpi@sydvast.fi)

Öst, M. & Lehikoinen, A., Department of Ecology and Systematics, P.O. Box 65, FIN-00014, University of Helsinki, Finland

Vattulainen, A., Hanko Bird Observatory, HALIAS, 10900 Hanko, Finland

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We recorded the sex ratio of adult Eiders migrating into the Gulf of Finland during spring (March–May) 2001 by visual observations at Hanko Bird Observatory, SW Finland. A total of 22 509 males and 17 234 females were sexed during migration, giving a highly significant departure from an even sex ratio ($P < 0.001$). The count thus indicated 56.6% males in the migrating population. Counts of local breeding birds in the vicinity of the bird observatory in April averaged a sex ratio of $55.9\% \pm 0.09\%$ males in the flocks before median laying (range 54.1%–59.0%). Thus, both on a local and regional scale, the population of Eider in the Gulf of Finland is male dominated. The observed sex ratio is roughly similar to sex ratios observed in the wintering area in Danish waters, but deviates from previous, local, reports from the Finnish coast, suggesting an even sex ratio. The timing of the most pronounced male excess in the migrating flocks suggests that unpaired males move into the Gulf, rather than males that have terminated the bond with an already incubating female. We discuss the plausibility of alternative hypotheses for the observed male bias.

1. Introduction

Sex ratios at hatching in waterfowl generally seem close to unity (Swennen *et al.* 1979, Blums & Mednis 1996), but adult sex ratios are often skewed in favour of males (Blums & Mednis 1996). The possible reasons for this are not well understood, but three main hypotheses exist; (1) hunting mortality differs between sexes, (2) overwinter survival of males is higher due to male dominance on wintering grounds, and (3) mortality during breeding is female biased (Hario 1983, Scott & Clutton-Brock 1989, Blums & Mednis 1996).

The Eider (*Somateria mollissima*) is a socially monogamous duck (Hario *et al.* 1995, Hario *et al.* 2002), as documented on the breeding grounds in the Baltic Sea. Eiders in the Baltic are claimed to show an even sex-ratio during the breeding season (Hildén 1964, Almkvist *et al.* 1975, Hario & Selin 1988, Hario *et al.* 1995, 2002), and in a recent study Hario *et al.* (2002) present good evidence for a rate very close to unity in a breeding population in the central part of the Gulf of Finland. On the wintering grounds in Denmark, however, Baltic Eider populations seem to be skewed in favour of males (58%–64% males; Noer *et al.* 1995). Scott and Clutton-Brock (1989) report an

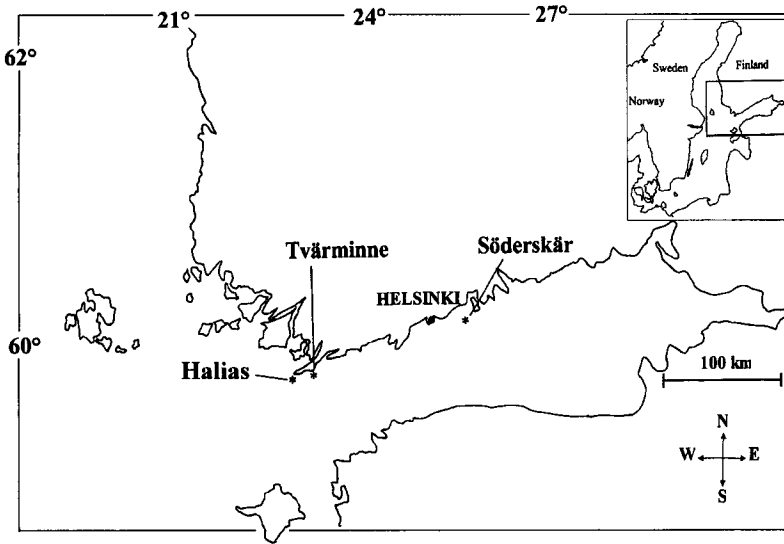


Fig. 1. Map of the Gulf of Finland and the study area. Shown are the Hanko Bird Observatory (Haliás), Tvärminne, where local breeding birds were monitored, and Söderskär, representing the easternmost large breeding colony of Eiders in the Gulf of Finland.

overall average ratio only slightly male biased (52.3%) based on published data.

The Finnish population is a significant part of the total Baltic population, with 150 000–200 000 breeding pairs (Desholm *et al.* 2002). The few studies done off the Finnish coast (Hildén 1964, Hario *et al.* 1995, 2002) describe sex ratios of small population segments at the edge of the breeding range of the Eider in the Baltic Sea (Hildén & Hario 1993).

We studied sex ratios of Eiders migrating into the Gulf of Finland, as well as recording sex ratios at local breeding colonies in the western Gulf. We were primarily interested in the sex ratio of a more substantial population in the Gulf, which may hold some 20 000–30 000 breeding pairs (Hario, pers. comm.), to see whether the even sex ratio reported previously from the Finnish breeding grounds was upheld in a larger data set. We thus studied a larger population segment, which breeds closer to the central production areas for Eiders on the Finnish coast (Hario 1996). We here present evidence that the sex ratio is male biased, and discuss this finding in the light of the main hypotheses put forward to explain male bias in adult waterfowl sex ratios.

2. Material and methods

We counted migrating Eiders within identification distance of Hanko Bird Observatory (Haliás;

59°50'N, 23°00'E) by means of spotting scopes (20–60×) from 5 March until 23 May 2001. Haliás lies at the western entrance of the Gulf of Finland on the tip of the Hanko peninsula (Fig. 1). The visible migration at Haliás reflects the passage of the entire breeding population in the Gulf (Lehikoinen & Vähätalo 2001). The eastern edge of larger breeding colonies lies about 140 km east of Hanko, at Söderskär (Fig. 1).

At Haliás, Eiders pass close, and the primarily small flocks of a maximum of a few tens of birds allows accurate recording of the sex ratio in the group based on plumage characteristics. We consider here only flocks of adult plumaged Eiders migrating towards the east into the Gulf, so young drakes were omitted. All data are presented as sums for 5-day periods, starting from 5 March.

We also recorded the sex ratio of birds breeding on the islets off Haliás by regular counts (6 counts, 11–21 April), and of birds associated with local breeding colonies from the time the first females laid (10 April, median laying date 26 April at Tvärminne 15 km east of Haliás ($n = 131$ nests, Kilpi & Öst, unpubl.; Fig. 1)). Breeding birds at their nesting colonies only reluctantly move by flying, so it is unlikely that they have been confused with truly migrating birds. At the time of counting, the birds are closely associated with specific breeding islands, and few females had started incubation, and so were present in the near-shore flocks. Although a slight underestimation

of females is possible with our method of counting breeding birds, this bias is likely to be negligible.

Numerical values are presented as means \pm SD, and we used non-parametric tests, since data did not fulfil the requirements of parametric tests.

3. Results

A total of 22 509 males and 17 234 females were sexed during migration (56.6% males), a highly significant departure from an even sex ratio ($\chi^2_1 = 351.6$, $P < 0.001$).

The counts of local birds averaged a sex ratio of 55.9% \pm 0.09% males in the flocks before median laying ($n = 6$ counts, range 54.1%–59.0%), significantly deviating from unity ($\chi^2_1 = 7.8$, $P < 0.01$). The average number of birds in these counts was 620 \pm 101 males and 489 \pm 89 females.

The migration counts (Fig. 2a) showed a pronounced peak period covering about 2 weeks starting at the end of March, during which time the bulk of the excess males passed. There was an overall difference in the cumulative frequency distribution of males and females migrating into the Gulf in the course of the season (two-tailed Kolmogorov-Smirnov test: $D = 0.07$, $n_1 = 17\ 234$, $n_2 = 22\ 509$, $P < 0.001$). One-tailed Kolmogorov-Smirnov tests revealed that the cumulative frequency distribution of males increased more rapidly with time than that of females (one tailed: $D = -0.07$, $P < 0.001$); the largest deviation in favour of males was observed during the time period 19 April–3 May; i.e. male bias peaked only slightly after the peak migration period (Fig. 2b). After 3 May there was a slight female bias (Fig. 2a, b), however, the overall numbers of migrating birds were small in May.

4. Discussion

Our results indicate a male biased sex ratio in the Eider population migrating into the Gulf of Finland. This bias resembles the winter sex ratio originally reported by Noer *et al.* (1995), and hence represents an expected ratio given that most males and females undertake a migration. The counts of local breeding birds off Halias also indicated an excess of males among birds associated with

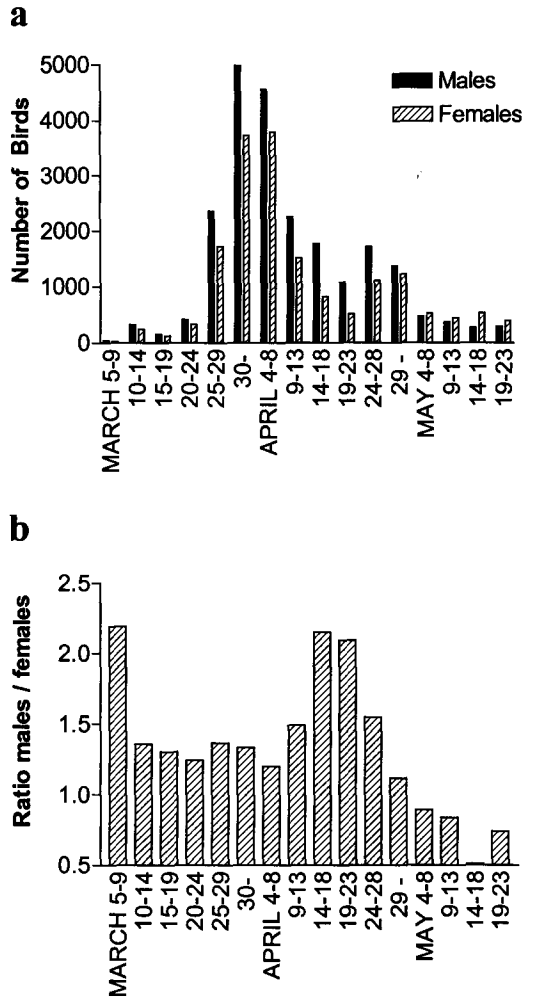


Fig. 2. Timing of migration (a) during spring 2001 in 5-day periods, separating the number of males (black bars) and females (hatched bars) for Eiders migrating into the Gulf of Finland. The lower panel (b) shows the temporal pattern of the ratio males:females over the same period summed over 5-day periods.

specific breeding islands. Noer *et al.* (1995) calculated sex ratios of birds shot by hunters in Denmark, and recalculating these values (Table 6 in Noer *et al.* 1995) using only adult birds, gives an average male proportion of 61.0% \pm 2.7% ($n = 5$ years) in the Danish bag, which is even more biased towards males than the proportion recorded by us. The strong male bias in the Danish hunting bag may partly be explained by differential moult migration by the sexes; males arrive at the wintering grounds prior to females.

Eiders in the Gulf of Finland are strictly socially monogamous (Hario *et al.* 2002), with a strong seasonal pair bond. The bulk of the excess males we observed, passed roughly within the main migration period, which suggests that they were not birds that had broken their seasonal bond to a female already incubating, and hence were free to move. Eiders off Halias and those breeding in the eastern-central part of the Gulf of Finland breed synchronously (Hario *et al.* 1999). Male residence is probably strongly influenced by pair-bond maintenance from arrival until the female is firmly incubating a full clutch, a period of at least 2–3 weeks. Given that the median laying date close to Halias was 26 April, males freed from the pair-bond would not have been available in larger numbers until May. Although laying starts ca. 1–2 weeks earlier in the southern parts of the Baltic Sea, we do not believe that this time interval is sufficient to allow males to attempt mating a second time in the Gulf of Finland. Furthermore, if the excess males would represent males that have already bred successfully further south, we would expect the male bias to peak late in the season, in May, whereas in fact the sex ratio of late migrants in May is slightly female biased (Fig. 2a, b). This suggests that the excess males were indeed unpaired males.

The ratio we recorded clearly differs from previous even sex ratios reported from the Finnish population (Hildén 1964, Hario *et al.* 1995, 2002). This discrepancy may have been influenced by several factors. First of all, we recorded the sex ratio of a large population, of which a substantial part breeds closer to the main breeding areas off the Finnish coast (see Hildén & Hario 1993). In the eastern-central part of the Gulf of Finland, where the sex ratio demonstrably is close to unity (Hario *et al.* 1995, 2002), Eider populations have been decreasing since the mid-1980s (Hario *et al.* 1999), and this area is clearly a marginal area for Eiders. In the western part of the Gulf of Finland, Eider populations have been comparably more stable during this decline (Hario *et al.* 1999), and it is possible that the sex bias is associated with more stable populations, since these populations have experienced more benign feeding conditions (Öst & Kilpi 1997, Westerborn *et al.* 2002). In the central-eastern part of the Gulf of Finland, the populations of the staple food for Eiders, blue

mussels, *Mytilus edulis*, have been heavily declining since the mid 1990s (Westerborn *et al.* 2002). Two alternative scenarios exist for why sex ratios might be closer to unity further east in the Gulf of Finland. First, excess males may terminate their eastward migration prior to reaching areas largely devoid of sufficient blue mussel stocks. Alternatively, it is possible that even if an excess of males might migrate into the marginal areas, males would tend to move out from the area very rapidly because of the poor feeding conditions. We cannot as yet distinguish between these two alternatives. Furthermore, more extensive documentation of sex ratios would be needed from within the Baltic breeding areas to ascertain that male bias is truly more common in stable populations than in marginal, declining populations.

The sex ratio shows a stronger male skew for adults than for juveniles (Noer *et al.* 1995), consistent with the assumption that sex ratio bias is explained by higher female mortality. But is the male sex bias on a population level in Baltic Eiders related to differential hunting mortality, differential overwinter survival of the sexes, or higher female breeding season mortality? The hunting mortality hypothesis is unlikely to provide an explanation for the observed pattern, since the sex ratio of shot birds either roughly corresponds to the sex ratio recorded in aerial counts (Noer *et al.* 1995), or it may in fact be more strongly skewed towards males; e.g., the total Finnish eider bag amounts to 25 000–27 000 birds, of which ca. 70% are males (Desholm *et al.* 2002).

To the best of our knowledge, no information exists on whether the overwinter survival of males is higher due to male dominance on wintering grounds, a hypothesis suggested by Blums and Mednis (1996). However, several facts indicate that female mortality may be higher during the breeding season. Females face severe breeding stress associated with their capital breeding strategy (e.g., Korschgen 1977), and predation rates on ground-nesting females may be higher (Thomas 1988). White-tailed Sea Eagles (*Haliaeetus albicilla*), a novel mortality factor in the Gulf of Finland, preferably target incubating Eider females rather than males (Kilpi & Öst 2002), which can locally result in strongly skewed sex ratios. Breeding stress may also interact with contaminants in the Baltic, e.g., severe or sub-clinical lead

poisoning was diagnosed in 23% of females that died of emaciation after incubation (Franson *et al.* 2000, 2002). Also outbreaks of avian cholera in sedentary breeding populations in Danish waters (Christensen *et al.* 1997), close to the wintering areas of Eiders breeding in the northern Baltic, may have increased the male bias in the winter population. Thus, the number of Eiders affected by the avian cholera epizootics in 1996 and 2001 was estimated to total 3500–4000 females and only ca. 400 males (Christensen *et al.* 1997, Desholm *et al.* 2002).

However, outbreaks of pathogens may also skew the sex ratio in the opposite direction. Thus, Eider males breeding in the Archipelago Sea close to the Hanko peninsula to the west, have recently been struck by mortality events associated with epizootics in spring (Hollmén *et al.* 2002). In 1998, a large die-off, probably affecting thousands of males, occurred in the archipelago west of Hanko during early breeding. Females have apparently not been affected by these die-offs, for unknown reasons (Kilpi, unpublished). Obviously, more research is needed to explore the mechanisms underlying the observed male bias in Baltic Eiders, and to verify that this bias has really increased in recent years. We also need to quantify the role of different mortality factors in male and female Eiders, both during the breeding and non-breeding season.

Selostus: Koirasvoittoinen sukupuoli-jakauma Suomenlahden kevätmuuttavilla ja pesivillä haahkoilla *Somateria mollissima*

Määritimme aikuisten keväällä (maaliskuu–toukokuu) Suomenlahdelle muuttavien haahkojen sukupuoli-jakauman näköhavainnoin Hangon lintuasemalla Lounais-Suomessa. Kaikkiaan 22 509 muuttavan koiraan ja 17 234 naaraan sukupuoli määritettiin; lukusuhte eroaa merkittävästi tasaisesta sukupuoli-jakaumasta. Laskentamme mukaan koiraiden osuus muuttavasta populaatiosta oli siis 56.6%. Lintuaseman läheisyydessä huhtikuussa ennen muninnan mediaanipäivää laskemienne paikallisten pesimälintujen keskuudessa koiraiden osuus oli $55.9\% \pm 0.09\%$

(vaihteluväli 54.1%–59.0%). Suomenlahden haahkopopulaatio havaittiin siis koirasvoittoiseksi sekä paikallisella että alueellisella tasolla. Havaitsemamme sukupuoli-jakauma muistuttaa lajin talvehtimisalueilla Tanskan vesillä havaittua jakaumaa, mutta eroaa aikaisemmin Suomen rannikolta raportoiduista tuloksista. Koiraslintujen osuuden huipun ajoittuminen muuttoparvissa viittaa pikemminkin siihen, että parittomia koiraita muuttaa Suomenlahdelle, kuin että parisiiteensä katkaissaita koiraita saapuisi alueelle. Pohdimme vaihtoehtoisia hypoteeseja, jotka voisivat selittää havaitsemaamme koirasvoittoisuutta.

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