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ORIGINAL ARTICLES

Hunting disturbance and the timing of autumn migration in *Anas* species

Veli-Matti Väänänen

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In Europe, waterfowl hunting is a popular recreational activity, especially in waterfowl staging and wintering areas, but also in breeding areas such as Finland. This paper gives an account of hunting disturbance, timing of autumn migration and refuge use in *Anas* species in eutrophic wetlands in central Finland (63°N, 27°E) during 1995-1999. Based on the timing of migration, duck species may be divided into early and late migrants. In two lakes (total area 2.2 km^2) which were monitored on a weekly basis during 1995-1998, numbers of late migrants, i.e. mallard *Anas platyrhynchos*, teal *Anas crecca* and wigeon *Anas penelope*, increased towards the opening of hunting season on 20 August, whereas shoveler *Anas clypeata*, pintail *Anas acuta* and garganey *Anas querquedula* migrated early, and peak numbers of these species occurred already in the beginning of August. Consequently, in Finland's inland lake area, hunting disturbance relates differently to early and late migrating species. Immediately after the opening of the season the numbers of dabbling ducks collapsed and the average numbers in the wetlands were only 9.3% of the numbers present at the end of the protection period in 1995-1998. A corresponding decrease in numbers occurred in 13 lakes (total area 8.5 km^2) in the Finnish inland lake district in 1999. After the beginning of the open season numbers of wigeon, teal and mallard decreased in unprotected areas, but increased in a refuge area. In Finland, refuge areas with high-quality foraging and moulting habitats for waterfowl are few, so a network of waterfowl reserves could mitigate the effects of hunting disturbance.

Key words: disturbance, hunting, migration, reserve, waterfowl

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Waterfowl populations and their habitats are under increasing human recreational pressure (e.g. Davidson & Rothwell 1993, Madsen & Fox 1995, Madsen 1998a). In Europe, the hunting bag of waterfowl has increased and about 11 million ducks and geese are shot annually by approximately 3.2 million hunters (Scott 1982, Owen & Black 1990). Most of these birds are shot in their staging and wintering areas, but hunting is a pop-

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ular recreational activity in their breeding areas as well; in Finland, for example, the annual bag is almost one million ducks (Ermala 1991).

Disturbance caused by hunting has been shown to affect waterfowl behaviour (see reviews in Davidson & Rothwell 1993, Madsen & Fox 1995). Hunting activities increase escape flight distances in ducks and geese (Owens 1977, Gerdes & Reepmeyer 1983, Arctander, Fjeldså & Jensen 1984, Madsen 1985). Hunting disturbance also affects the foraging behaviour of waterfowl (Madsen & Fox 1995), and e.g. wigeon *Anas penelope* and mute swan *Cygnus olor* lose daily foraging time because of disturbance (Mayhew 1988, Madsen 1998a). Hunting activity may also modify the diurnal activities of waterfowl. In British refuge areas, wigeon mostly feed during the day, but are night-time foragers on most sites outside the refuges (Owen & Williams 1976). Similar patterns have been detected for many species, e.g. in Denmark, North America and Greece (Madsen & Fox 1995).

Hunting disturbance may lead to local redistributions of ducks, and the numbers of waterfowl have increased following the establishment of reserves (Madsen & Fox 1995, Madsen 1998b). However, there is a lack of studies of the wider-scale effects of hunting disturbance on waterfowl distribution which compare numbers and distribution of birds to regional/national hunting practises or refuge distribution.

Species differ in their sensitivity to disturbance. Madsen, Pihl & Clausen (1998) noticed that species which stay close to the coast or inland and are concentrated in relatively large flocks are most sensitive to disturbance. Most of these species which are herbivorous are also popular quarry species. Periods of sensitivity to disturbance may vary and it has been suggested that periods of low nutrient reserves and/or increased energy expenditure are most critical in staging and wintering areas (Madsen & Fox 1995, Dehorter & Tamisier 1998).

Finland is one of the most important breeding areas for ducks in Europe (see Hagemeijer & Blair 1997). In Finland the hunting season is open from 20 August to the end of December, and the season begins so early in August that flightless young ducks, and especially fledged young with undeveloped primaries, are frequently encountered (Väänänen 1992). Moreover, the wing moult period of breeding females is still continuing at the opening of the hunting season (Väänänen 1999).

My study describes the effects of hunting disturbance, especially during the early part of the hunting season, in relation to autumn migration in dabbling ducks in the lake district of central Finland. The development in numbers of ducks outside and inside a refuge is compared.

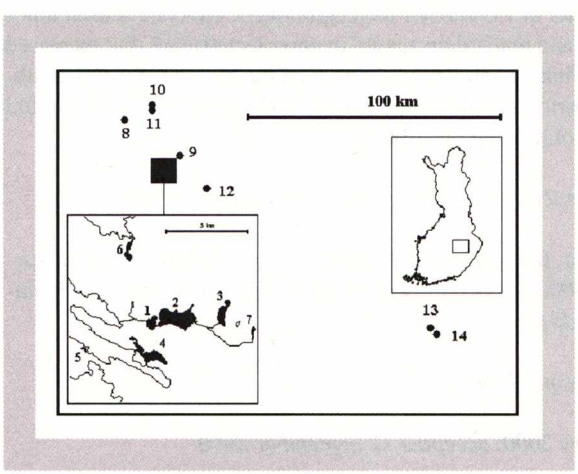


Figure 1. Distribution of the 14 studied wetlands in Central Finland: 1) Pieni Lapinjärvi (0.25 km^2), 2) Iso Lapinjärvi (1.8 km^2), 3) Keskimmäinen (0.4 km^2), 4) Valkeinen (0.8 km^2), 5) Tavinsalmi (0.04 km^2). 6) Hämeenlahti (0.3 km^2), 7) Ylimmäinen (0.3 km^2), 8) Patajärvi (1.7 km^2), 9) Hökönen (0.5 km^2), 10) Kojoonselkä (2.0 km^2), 11) Karvaselän saaret (0.2 km^2), 12) Pikku Siili (0.3 km^2), 13) Särkijärvi (0.55 km^2), 14) Härkinlampi (0.06 km^2).

Study area, material and methods

Most of the data were gathered from a group of four eutrophic wetlands (wetlands 1-4 in Figure 1) in central Finland (63°N, 27°E) during 1995-1999. The lakes are surrounded by cultivated fields and their sizes range within 0.25-1.8 km^2 (total area 3.2 km^2). Emergent vegetation covers about 30% of the total lake area, and dominant stands consist of sedges *Carex* spp., horsetail *Equisetum fluviatile*, reed *Phragmites australis* and bullrush *Shoenoplectus lacustris*.

The lakes were monitored for dabbling duck numbers during summer and autumn, and censuses were conducted using the 'round count' method (Kauppinen 1983, Kauppinen, Koskimies & Väisänen 1991). Autumn duck numbers were censused once in each lake just before the opening of the duck hunting season, i.e. between 17 and 19 August (most frequently on 18 or 19 August). The duck hunting season opens on 20 August at 12:00 all over Finland and results of censuses have been taken to estimate the numbers of dabbling ducks present in central Finland at the opening of the season. In the censuses, ducks in the whole lake area (including dense vegetation stands) were counted carefully from canoe.

Two of the lakes (wetlands 2 and 3 in Figure 1, total

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area 2.2 km²) were monitored weekly from 15 July to late autumn (end of the ice-free period) during 1995-1998. On average, study lakes were covered by ice in the last week of October. Censuses were made during the weekend and most often in the middle of the day, but in the beginning of the open season censuses were done early in the morning to avoid the effects of hunting activities. If there was any disturbance before a census (hunting may start already at dawn), the census was done on the following day. During the open season, hunting activity in the study area was high compared to the months when hunting did not occur; in these months human activity (only a few fishermen) was negligible.

The smallest wetland of the lake group is a game reserve (wetland 1 in Figure 1), and the only lake in the study area without hunting or other human activity during the open season. As the lake is almost overgrown, it serves as a good habitat for dabbling ducks only when the water level is high. The total area of the lake is 0.25 km², of which about half is suitable dabbling duck habitat in the best years. Numbers of ducks in the refuge were censused from canoe (using binoculars and telescope) just before the opening of the hunting season on 20 August, and from the shore a few days after the opening of the season. In this area, ducks were mostly inside dense vegetation stands a few days after the opening of the season which made them difficult to count. However, ducks made short escape flights when marsh harriers *Circus aeruginosus* overflew the area. These occasions presented opportunities to count ducks, but the results were obviously underestimates as not all ducks necessarily took to their wings.

In 1999, 13 eutrophic wetlands (wetlands 2-14 in Figure 1, total area 8.5 km²) were censused just before (16-19 August) and after (21-26 August) the opening of the hunting season to get a wider-scale picture of the effect of hunting disturbance. The study lakes are situated in Finland's inland lake district and the largest distance between the study lakes was about 140 km. Study lakes 2-9 (see Fig. 1) were censused by the author and are the best breeding areas of dabbling ducks in our study area. Lakes 10-14 (see Fig. 1) were censused by voluntary field assistants.

A G-test was used to test for differences in the numbers of dabbling ducks before and after the opening of the season. A G-test was also used to test for differences between the number of ducks present in the reserve immediately after the opening of the hunting season (at 12:00) vs the numbers of ducks present in the whole wetland area just before the opening of the season.

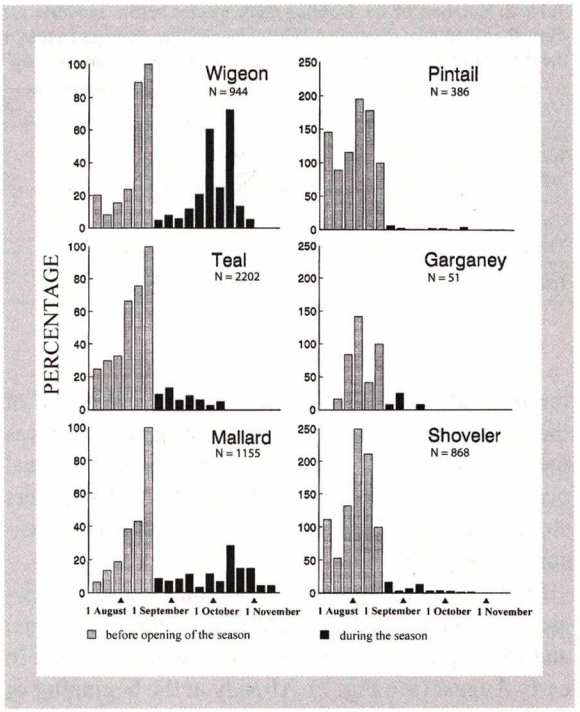


Figure 2. Phenology of six dabbling duck species in wetlands 2 and 3 (see Fig.1) from 15 July to the end of the ice-free period given for one-week periods based on data from 1995-1998. The last observation before the opening of the hunting season is set at 100% (righternmost grey bar). N gives the total number of observations of each species during the study period.

Results

Timing of autumn migration

Numbers of the late migrants mallard *Anas platyrhynchos*, teal *Anas crecca* and wigeon increased during the summer towards the beginning of the hunting season (Fig. 2). After the opening of the season the highest percentages of the peak numbers in August were 77.2% for wigeon and 28.7% for mallard (Table 1). The last

Table 1. Average number of six dabbling duck species before and after the opening of the hunting season in wetlands 2 and 3 (see Fig. 1) during 1995-1998. 'A' gives the percentage of the number registered just after the opening of the season compared to the numbers at the last census just before the season, and 'B' gives the maximum numbers (in %) registered after the opening of season in relation to maximum numbers registered before the season opened.

Species	Before	After	A	B
Wigeon	193	15	7.8	77.2
Teal	582	54	9.3	13.2
Mallard	334	29	8.7	28.7
Pintail	46	3	6.5	3.3
Garganey	12	1	8.3	17.6
Shoveler	96	15	15.6	6.2
Total	1263	117	9.3	

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Table 2. Numbers of six dabbling duck species before and after the opening of the hunting season in 13 wetlands (total area 8.5 km^2) in the Finnish inland lake district in 1999. The relative changes in total numbers of ducks, and the ranges of change in number of individuals in the different lakes from before to after the opening of the hunting season are shown. + = positive change, - = negative change.

Species	Before	After	Relative change (%)	Range of change
Wigeon	177	81	-44.2	-48 - +18
Teal	560	68	-87.9	-100 - +1
Mallard	529	151	-71.5	-87 - +21
Pintail	22	2	-90.9	-8 - +2
Garganey	8	-	-100.0	-4 - -1
Shoveler	29	2	-86.2	-15 - +3
Anas spp.	20	9	-52.3	-6 - -5
Total	1345	315	-76.6	

mallards did not leave the study area until the end of the ice-free period. Among the late migrants, teal was the earliest to leave, and no migration peak of teal occurred in late autumn (see Fig. 2); teal numbers steadily decreased after the beginning of the open season (see Fig. 2).

Shoveler *Anas clypeata*, pintail *Anas acuta* and garganey *Anas querquedula* migrated early (early migrants) and the highest numbers of these species occurred in early August (see Fig. 2). Already at the beginning of the hunting season, the numbers of shoveler and pintail had dropped from the peak (60.3% and 48.9%, respectively) and during the open season the numbers of these early migrants remained low (see Fig. 2).

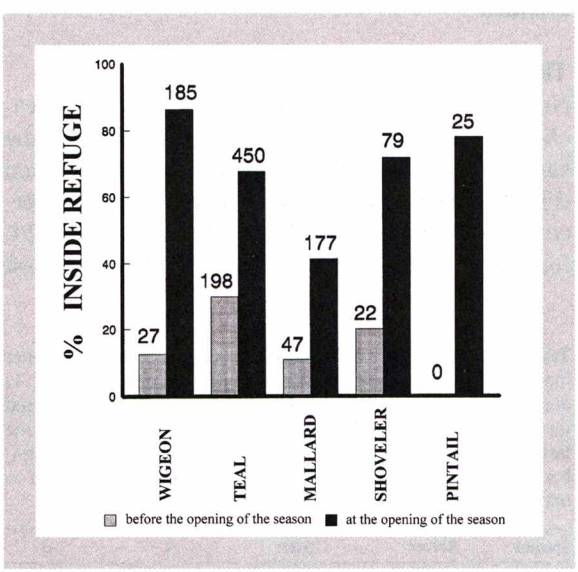


Figure 3. Percentage of the numbers of five dabbling duck present inside the refuge before (17-19 August) and immediately after the opening of the hunting season on 20 August at 12:00 as compared to the numbers of dabbling ducks observed in wetlands 1-4 (see Fig. 1) before the opening of the season (17-19 August) presented as means of 1996, 1998 and 1999.

Hunting disturbance

Immediately after the opening of the season the number of dabbling ducks collapsed in lakes monitored weekly and the decrease was significant in all species ($G > 13.7$, $df = 1$, $P < 0.001$). The average numbers were only 9.3% of the numbers registered at the end of the protection period (see Table 1). There was no significant difference between the species when the numbers immediately before and after the opening of the season were compared ($G = 8.363$, $df = 4$, $P > 0.05$, excluding the small data set on garganey).

In 1999, the numbers of dabbling ducks in the 13 wetlands of the Finnish inland lake district also decreased (76.6%) after the beginning of the season (Table 2). The decrease in the numbers of the different duck species was significant ($G > 22.0$ in all species, $df = 1$, $P < 0.001$, excluding the small data set on garganey).

On average, 63.0% of the dabbling duck numbers found in the entire wetland study area (wetlands 1-4 in Figure1) before (17-19 August) the opening of the season were observed in the refuge immediately after the opening of the season (on 20 August at 12:00), whereas, on average, 20.5% were present in the refuge before (17-19 August) the opening of the season (Fig. 3). This change in the numbers of ducks in the refuge was significant ($G = 332.5$, $df = 1$, $P < 0.001$). After the opening of the season, the numbers of wigeon, teal and mallard decreased in the unprotected areas (see Fig. 2 and Table 1) but increased in the refuge area (Table 3).

Table 3. Average numbers of the three most commonly occurring dabbling duck species before and after the opening of the hunting season in a refuge and two wetlands with hunting (wetlands 2 and 3, see Fig. 1) in 1996, 1998 and 1999. Differences between areas were tested with a G-test. *** : $P < 0.001$.

Species	Refuge Before/After	Hunting area Before/After	G
Wigeon	27/120	111/ 9	157.3 ***
Teal	198/294	437/ 57	174.9 ***
Mallard	47/144	312/ 55	177.3 ***
Total	272/558	860/121	363.8 ***

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Discussion

Hunting disturbance and autumn migration pattern

The pattern of autumn migration in the *Anas* species seems to be divided into two main types: early and late migrants. Among the late migrants, mallard and wigeon were relatively abundant in their breeding areas in late autumn although numbers were on average 10-fold higher immediately before the opening of hunting season. In Danish wetlands peak numbers of bagged mallard and teal were recorded in the beginning of the open season (first half of September), whereas most wigeon were bagged in October (e.g. Clausager 1989). During the baseline years in Danish refuge experiments, wigeon numbers peaked during October-November, but in subsequent years after the establishment of reserves, numbers peaked between October and December (Madsen 1998b), indicating that wigeon tend to remain longer in reserves.

Shoveler is clearly an early migrant in Denmark (bag statistic: e.g. Clausager 1989; refuge experiment: Madsen 1998a) as are breeding shoveler and garganey in Latvia (Mihelsons, Mednis & Blums 1986). After establishment of experimental refuge areas in Denmark even pintails were present in the refuges by the end of December, and also shovelers stayed longer in refuges, whereas hardly any dabbling ducks stayed until December before hunting restrictions were imposed (Madsen 1998b). Furthermore, Danish bag statistics (see e.g. Clausager 1989) indicate that the pintail is not as early a migrant in Denmark as it is in the Finnish inland areas, where the numbers of bagged pintails are low after August, even though pintail is abundant in the breeding duck communities (Kauppinen & Väänänen 1999). In central Finland only late-hatched pintails and shovelers were present in the breeding areas at the beginning of the hunting season (Väänänen 1992, 1996).

In the Finnish inland lake area hunting disturbance affects breeding early and late migrants differently. The late migrants mallard, teal and wigeon suffer greatly from hunting disturbance, which seems to affect most of the breeding populations present near hatching areas at the opening of the season (Väänänen 1996). On the other hand, most early migrants, including shoveler, pintail and garganey, avoid being hunted in central Finland as they migrate in early August. Migration of shoveler, pintail and garganey begins right after the primaries have fully developed, whereas late migrants may remain later in breeding areas in order to accumulate fat reserves for migration and wintering (Väänänen 1992, 1996).

Use of refuges and local distribution

Hunting disturbance can cause local redistribution of waterfowl in staging and wintering areas and it has been documented that waterfowl seek shelter in refuge areas (Madsen & Fox 1995). In Danish experimental refuges the numbers of quarry dabbling ducks increased 4- to 50-fold from before to after the establishment of refuges (Madsen 1998b).

These findings indicate that the redistribution pattern is the same in the Finnish breeding areas, where ducks used the refuge more than hunting areas after the opening of the season. The increase in numbers in the refuge did not compensate for the decrease in the hunting area; i.e., there was an abrupt overall decrease in the numbers of waterfowl present in the study area. In addition, the number of ducks in the refuge increased even before the season opened as a result of increased activity by hunters exploring the wetlands (V-M. Väänänen, pers. obs.).

Hunting practises and regional distribution

About 200,000 duck hunters go hunting on the first day of the open season (Ermala & Leinonen 1995). Hunting activities are largest in the best breeding and foraging habitats, i.e. in eutrophic wetlands. In central Finland, duck hunters willingly hunt in the wetlands at dawn and during the day in vegetated stands, either on foot or in boats and canoes. As a result of the methods used, most ducks are driven away from areas where hunting occurs.

Research on the large-scale regional or national effects of hunting disturbance on waterfowl distribution is scarce (Madsen & Fox 1995). Only a few studies have documented large-scale redistribution associated with hunting disturbance. Hunting of pink-footed geese *Anser brachyrhynchus* in the major staging areas in Denmark can result in the emigration of almost the entire population to the Netherlands within one day (Madsen & Jepsen 1992). Similarly, most of the Norwegian greylag geese *Anser anser* migrate southwards to staging grounds prior to or during the first days of the open season, and the early mass departure is ascribed to disturbances associated with hunting (Lorentsen 1988, Follestad 1994). There are no large-scale data sets which may be used to assess the effect of hunting disturbance on the regional distribution of ducks in Finland. However, as local-scale disturbance effects have been demonstrated to be common at least in the Finnish inland lake district, regional changes in the distribution of the species and decreases in the numbers of dabbling ducks seem possible.

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Management implications

Due to hunting disturbance in the study area, especially during the first days of the open season, ducks are prevented from using the best feeding habitats during the daytime, and probably they lose much foraging time (see Mayhew 1988, Madsen & Fox 1995, Madsen 1998a). This may be very disadvantageous for ducks (see e.g. Dehorter & Tamisier 1998), as they accumulate body stores to obtain enough fuel to fly to their staging and wintering areas during this period (V-M. Väänänen, pers. obs.). It is also well known that body condition affects hunting vulnerability. Hence, ducks with low fat reserves are more vulnerable to hunting (Hepp, Blohm, Reynolds, Hines & Nichols 1986, Reinecke & Schaffer 1988, Heitmeyer, Fredrickson & Humburg 1993). Dehorter & Tamisier (1998) suggest that in wintering areas hunting vulnerability results from a combination of energy demand, habitat selection, chronology of migration and trophic status.

At the beginning of the hunting season in central Finland flightless young ducks occur regularly, especially fledglings with undeveloped primaries (Väänänen 1992). The wing moult period of breeding females is continuing, and 50% of adult females in the bag have undeveloped or even unchanged primaries (Väänänen 1999).

In Finland, the number of protected areas for waterfowl is insufficient, and most of the existing refuge areas are situated within towns and villages, where shooting is prohibited because of human settlement and recreational activity. However, these refuges are not usually high-quality feeding or moulting habitats unlike the most important breeding and staging areas, i.e. eutrophic wetlands. In Finland, there is a need to establish a network of reserves for waterfowl in eutrophic wetlands, as was done in Denmark (Madsen & Fox 1997, Madsen et al. 1998). The main reasons to establish such a network in Finland are: (i) to provide an undisturbed wing moult period for breeding females in the best moulting areas, (ii) to obtain high-quality, disturbance-free feeding habitats, and (iii) to prevent mass departure of waterfowl caused by disturbance from hunting activities.

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