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Habitat use by different-aged duck broods and juvenile ducks

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Habitat use by different-aged broods and juveniles of teal *Anas crecca*, mallard *A. platyrhynchos* and goldeneye *Bucephala clangula* was investigated in southern Finland during 1988-1993. The study focused on within-lake habitat use and the use of flooded wetlands. Downy ducklings of all three species showed significant preference for *Carex*-stands. As the dabbling ducks grew older, their habitat use diversified, juveniles in particular also made considerable use of floating vegetation. Conversely, habitat use by goldeneye became more uniform: goldeneye juveniles were almost exclusively seen in open-water and floating vegetation habitats. All three species, but especially teal, used flooded areas intensively. Two thirds of teal downy broods were seen along flooded shores which comprised only seven percent of all shore habitats. Preliminary data suggested that the preferred habitat types, *Carex* and flooded shores, harboured more nektonic invertebrates and emerging insects than did the other shore types.

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Studies of habitat use by birds have often identified differences between the sexes of a given species (e.g. Selander 1966, Cody 1985a, Winkler & Leisler 1985). Age-related differences have seldom been considered; In Cody (1985b), for example, they are only mentioned once (Morse 1985). However, due to differences in diet or mobility, a species may depend on several distinctly different habitats during its life history (see Wiens 1989).

In studies of duck habitat use during the breeding season three age-categories have usually been considered: pairs, broods, and juveniles (Evans & Black 1956, Patterson 1976, Pehrsson 1984, Nummi & Pöysä 1993), and relative association with vegetation cover has been considered for broods of different age (Bengtson 1971). It is known that, along with growth and plumage development, the diet of ducklings also changes (Chura 1961, Perret 1962, Sugden 1973). This change partly reflects differences in effectiveness of subsurface feeding by ducklings of various ages (Pehrsson 1979). Furthermore, as ducklings grow, the unspecialised bill, typical for newly-hatched ducklings, starts to show species-specific features (Goodman & Fisher 1962, Sugden 1973). Considering these age-related changes in diet, foraging behaviour and bill morphology, we may also expect changes in habitat requirements. Habitat requirements of downy ducklings are especially interesting because most duckling mortality takes place at this stage (e.g. Ball et al. 1975, Talent et al. 1983, Orthmeyer & Ball 1990), and because this mortality may be linked with food shortage (Street 1977, Hill et al. 1987).

We studied habitat use by ducklings in two age-classes as well as habitat use by juveniles. We also surveyed the amount of potential invertebrate food organisms present in different kinds of vegetation as this may play a crucial role in habitat selection by duck young. In some North American studies the preference of broods for wetlands with emergent herbaceous vegetation and flooded bushes has been shown (Ringelman & Longcore 1982, Talent et al. 1982, Monda & Ratti 1988), although in the prairies the importance of different vegetation types is often uncertain due to pronounced water-level fluctuations (see refs. in Kaminski & Weller 1992). In boreal areas, the use of different vegetation types within a lake has previously only been studied for duck pairs (Nummi et al. 1994). In addition to considering the role of different kinds of shore vegetation we also focus on the use of flooded wetlands by ducks.

Study area

The study area comprised 51 lakes situated in a 39 km^2 boreal watershed in southern Finland (61°10'N, 25° 05'E). All lakes and small ponds containing water throughout the summer were included; one lake close to the Evo Game Research Station was, however, excluded as it was influenced by human disturbance. In considering the use of flooded areas, we included one pothole which often dries out during late summer. Lakeshore types ranged from oligotrophic bog and forest with no emergent plants to more eutrophic shores with lush stands of *Carex* spp. and *Equisetum* spp.

Material and methods

Habitat measurements

Habitats were described according to Nummi & Pöysä (1993, 1995). Since the water-bodies in the study area generally are very stable from year to year, we only used data from one year (1989). Shoreline vegetation types were marked on field maps and the total shoreline length of each type was later measured from these maps for each lake. The shoreline lengths of each vegetation type were then pooled for all lakes, and the percentage of each vegetation type of the total shoreline in the study area was calculated from these pooled data. This procedure gave the expected proportion of different habitat types with which the observed use by ducks was compared (see below). In final analyses of observed and expected habitat use, only the three most common shore habitat types were included: 1) no emergent vegetation, 2) *Phragmites*, 3) *Carex* (mainly *C. rostrata*). These comprised 91% of the total shoreline and were the only habitat types in which sufficient duck data were obtained.

The lakes also had »floating-plant« and »open-water« habitats. These were only included in comparisons of habitat use by birds of different age. Data from these habitats were not included in the examination of observed and expected use of habitat types because of the difficulty of transforming them to shoreline units comparable to the length-based shore habitat data.

For the study of brood use of flooded shores (mainly beaver ponds), the percentage of flooded shores of the total shoreline was calculated for the years 1988-1993. The average of these yearly values was then used in analyses of observed and expected use of flooded shores.

Duck data

The duck data were obtained during the summers 1988-93 for the three most commonly occurring species in the study area: mallard, teal and goldeneye. Average breeding densities ranged from 0.53 (goldeneye) to 0.66 (mallard) pairs per kilometre of shoreline (Nummi & Pöysä 1995). Ducks were censused in the period June-August, and 35 censuses were conducted at each lake, approximately one every second week. In each census all visible birds were counted from a fixed point using binoculars or a telescope, whereafter the lake was circled in a boat or on foot (Koskimies & Väisänen 1991). All observations of broods which had not moved because of the disturbance caused by the observer were marked on a field map and the vegetation type in which they were seen was noted. It is likely that some broods remained undetected in the more complex habitats such as flowages (bodies of water formed by overflowing or damming) and *Carex*-stands. However, because these habitats were used by broods more than expected (see below) the possible detection bias should not affect our conclusions. The age of the broods was determined following the classification used by Pirkola & Högmander (1974). As the total number of censuses was the same for all lakes, the total number of broods and juveniles was pooled over time and lakes when different habitat types were considered in the analyses.

Throughout this study, broods were divided into two groups: age-class I and age-class II-III. The actual ages of ducklings in these groups according to Pirkola & Högmander (1974) are: mallard age-class I (1-18 days), age-class II-III (19-55 days); teal age-class I (1-12 days), age-class II-III (13-35 days); goldeneye age-class I (1-22 days), age-class II-III (23-63 days). The reasons for the division are both practical and ecological: downy ducklings of age-class I differ clearly in their foraging behaviour from older ducklings (Chura 1961, Pehrsson 1979). Age-classes II and III were pooled in order to obtain enough data for the analyses.

Statistical analyses of habitat use

The G-test was used to compare observed and expected use of different shore habitats by broods and juveniles.

The expected use assumes random habitat use, as calculated on the basis of the proportion of each shoreline type of the total shoreline in the study area. A similar observed-expected comparison was made for flooded versus non-flooded shores.

Differences in habitat use between age-classes of each species were also compared with the G-test. In this case both floating-plant and open-water habitats were also included. Because goldeneyes in older age-classes make so little use of shoreline habitats, the analyses differed for goldeneye and dabbling ducks. For dabbling ducks comparisons were made between habitat types: 1) no vegetation/*Phragmites* (pooled due to scarcity of data), 2) *Carex*, and 3) floating plants. For goldeneye the comparison was made between habitat types: 1) *Carex*, 2) floating plants, and 3) open water.

Food resource sampling

Nektonic invertebrates and emerging insects were continuously trapped from the end of May to the end of July in 1989-1992 (as in Nummi & Pöysä 1993 with one additional year). Traps were checked once a week on average and trapping procedures were identical at all lakes. However, only data from the three most common habitats and from flooded shores have been included in this study, i.e. 16 sites on nine lakes.

Free-swimming invertebrates were caught with activity traps as described in Murkin et al. (1983). We used glass jars equipped with white plastic funnels with openings of 140 mm at the wide end and 20 mm at the narrow end. Traps were suspended 20-40 cm below the surface of the water which was 50-100 cm deep. On non-vegetated shores the traps were set close to the shore whereas in vegetation stands they were set beyond the outer edge of emergent plants.

Emerging insects were captured from the same sites as nekton in traps consisting of a 5-litre plastic bucket and an orange plastic funnel with openings of 200 mm at the wide end and 40 mm at the narrow end (Danell & Sjöberg 1977). Emergence traps floated at fixed sites on two styrofoam panels that were attached to the bucket with metal rods.

Two activity traps and two emergence traps were used at each trapping site and there were two fixed trapping sites per lake. Animals from activity traps were identified and their size was assigned following the taxon list and six length categories given by Nudds & Bowlby (1984). The most commonly occurring invertebrates in our activity trap catches were Cladocera, Hydracarina, Dytiscidae, Corixidae, Oligochaeta, Chironomidae and Ephemeroptera (for a complete taxon list, see Pöysä et al. 1994). For calculation of the food abundance index, the number of individuals within each taxon was multiplied by the mean size of its length category. In addition to Chironomidae, only a few Ephemeroptera, Odonata and Trichoptera were present in the traps for emerging insects; therefore no size classification was used. Food abundances are given as indexes of free-swimming invertebrates per 100 trap days, and as total numbers of emerging insects per 100 trap days. The abundances are averages of the four years from all sites of each vegetation type.

Table 1. Observed versus expected use of the three most common shore habitats by teal, mallard and goldeneye young of different age. The percentage of observed number of broods (age-classes I and II-III) or individuals (juveniles) are shown; N is the number of observations. Expected use is the percent availability of the shore habitats. The three common habitat types comprise 91% of the total shoreline. Goldeneye juveniles are omitted because of their negligible use of shore habitats, df = 2 in all cases.

	Observed use			Expected use
Teal	I N = 26	II-III N = 32	juv. N = 84	
No vegetation	4	19	24	44
Phragmites	8	12	19	29
Carex	88	69	57	27
	$G = 44.37$ $P < 0.001$	$G = 24.33$ $P < 0.001$	$G = 33.98$ $P < 0.001$	
Mallard	I N = 15	II-III N = 21	juv. N = 71	
No vegetation	13	5	10	44
Phragmites	13	6	48	29
Carex	73	67	72	27
	$G = 13.98$ $P < 0.001$	$G = 20.52$ $P < 0.001$	$G = 66.75$ $P < 0.001$	
Goldeneye	I N = 35	II-III N = 19		
No vegetation	17	32		44
Phragmites	11	16		29
Carex	71	53		27
	$G = 29.78$ $P < 0.001$	$G = 5.79$ $P > 0.05$		

Results

Use of different habitat types

Dabbling ducks of all ages used *Carex* shores more and non-vegetated shores less than expected, as did age-class I goldeneyes (Table 1). About 70-90% of dabbling duck brood observations were made in *Carex* shores although these comprised only about one quarter of all shore habitats.

Within-lake habitat use by teal did not seem to change much during the brood period (Table 2), but juvenile teal associated strongly with floating vegetation as well as sedges. Sedge-stands were also much used by mallard broods, and juveniles were often found among *Carex* and floating vegetation (Table 2).

There were clear differences in habitat use between different age-classes of goldeneye; the *Carex* habitats were much preferred, but only by age-class I (Table 2). For age-class II-III, more than two-thirds of the observations were made in open water and among floating plants. Juvenile goldeneyes made almost no use of habitat types associated with the shoreline.

Table 2. Percentage use of different types of vegetation by teals, mallards and goldeneyes of different age. N is the number of observations. The number of mallard observations was too low to permit testing; the test for teal could only be done between age-class II-III and juveniles.

Teal	I N = 26	II-III N = 37	juv. N = 126
No vegetation/*Phragmites*	12	27	27
Carex	88	59	37
Floating plants	0	14	36
		G = 8.55, df = 2, P < 0.05	
Mallard	**I N = 17**	**II-III N = 23**	**juv. N = 122**
No vegetation/*Phragmites*	24	30	16
Carex	65	61	42
Floating plants	12	9	42
Goldeneye	**I N = 44**	**II-III N = 84**	**juv. N = 122**
Carex	57	12	3
Floating plants	18	32	38
Open water	25	56	59
		G = 60.02, df = 4, P < 0.001	

Use of flooded areas

The broods of all species (age-classes pooled) used flooded areas more than expected (G-test, P < 0.001 in all cases) (Fig. 1). Teal and goldeneye juveniles also made more use of the flowages than expected (G-test, P < 0.001 in both cases) whereas mallard juveniles did not (G-test, P > 0.05).

Food resources on different kinds of shores

The amount of both nektonic invertebrates and emerging insects was low on the non-vegetated and *Phragmites* shores surveyed, clearly higher on *Carex* shores, and higher still on flooded shores (Table 3).

Discussion

Similarities and differences in habitat use of dabbling ducks and the goldeneye

It is well documented that duck broods use well-vegetated wetlands more than do adult pairs (Patterson 1976, Nummi & Pöysä 1993). It is now evident that there are also differences in habitat use by duck broods of different age, and that habitat use may differ more between young of different age in one species than between young of corresponding ages in different species.

At age-class I, when the ducklings were less than three weeks old, broods of all species preferred *Carex*-shores. Even goldeneye, a diving duck, made considerable use of

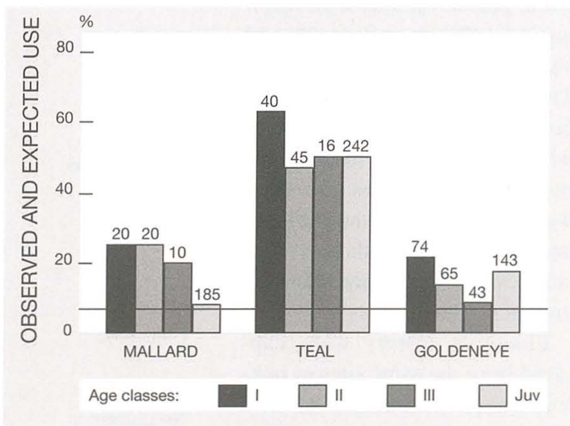

Figure 1. Observed and expected use of flooded areas (in %) in relation to use of other shore habitats by duck broods in age-classes I, II and III, and by juveniles. The horizontal line marks the expected use (7%) of flowages and the numbers of observations are noted above the bars.

well-vegetated shores at this stage. Very young goldeneye ducklings often pick invertebrates from plants and the water surface as do dabbling ducks. Bengtson (1971) also found that very young diving duck broods spent much time in habitats of emergent vegetation.

As dabbling ducks and goldeneyes grew older their use of habitat shifted in different directions. The pattern of habitat use by goldeneyes changed clearly at age-class II-III. At this stage they often used open habitats which apparently reflects the fact that goldeneyes obtain most of their food by diving at age-class II-III. In dabbling ducks the habitat use pattern did not differ much between age-classes I and II-III. Goldeneye juveniles mostly used the open-water area where dabbling ducks were rarely seen. Instead, teal and especially mallard juveniles made more use of the floating vegetation zone than the younger age-classes.

Table 3. The mean and SE (based on averages of four years, N = 4) of nektonic invertebrates as modified index (see methods) of abundance and number of emerging insects on different kinds of shorelines in 1989-1992. Nektonic invertebrates as an index of animal abundance per 100 trap days and emerging insects as numbers of animals per 100 trap days. Number of trapping sites used in each of the four years is given in parentheses.

	Nektonic invertebrates		Emerging insects		
	$\bar{x}$	SE	$\bar{x}$	SE	
Phragmites	330	33	21	3	(1)
No vegetation	446	80	26	3	(7)
Carex	1008	110	53	7	(6)
Flooded shores	2127	290	172	30	(2)

Importance of food and flooded areas to young ducks

Our preliminary data indicated that the preferred habitat types, *Carex*-stands and flooded shores, also harboured a high abundance of invertebrates that constitute potential food for the young ducks. The high food abundance may explain why ducks prefer certain shore habitats. It may also explain why breeding mallards are also often found in *Carex*-vegetation (Kaminski & Prince 1984, Kirby & Riechmann 1985, Nummi et al. 1994). Lowered predation risk in well-vegetated shore habitats may also play a role in explaining the habitat preferences observed here. But as suggested by Pehrsson (1979), a well-vegetated shoreline may in fact be a rather dangerous habitat because of mammalian predators.

Flooded areas, mostly dammed by beaver, were especially favoured by teal although young ducklings of the other species also used them. Beaver impoundments are known for their high invertebrate production (McDowell & Naiman 1986, Nummi 1989). Downy ducklings forage by picking invertebrates from emergent plants or floating debris (Beard 1953, Chura 1961, Johnston & Naiman 1987, Nummi 1992). As flooded areas usually have sinuous shorelines that tend to accumulate decomposing vegetation, they are structurally well-suited for foraging downy ducklings.

In new flowages or in isolated ponds which freeze to the bottom fish populations are low and ducks face little competition for food from fish. In this situation many nektonic invertebrates vulnerable to fish predation abound; these include the large cladocerans, corixids, notonectids and dytiscids (Eriksson et al. 1980, Bendell & McNicol 1987, Nummi 1989, Pöysä et al. 1994). Cladocerans are especially exploited by teals (Nummi 1993) although the downy young of many other duck species also exploit them (Collias & Collias 1963). The density of the benthos is high in older beaver flowages (McDowell & Naiman 1986, Nummi 1989) and in fish-less ponds (Mittelbach 1988, McNicol & Wayland 1992).

Teals still used flowages a great deal at the juvenile stage, during which their diet has been found to hold a high percentage of invertebrates (Nummi 1993). However, for mallard juveniles, which consume considerable amounts of seeds, flooded areas seemed not to be important.

Management implications

This study showed that duck broods of different age may use different kinds of habitats (see also Pöysä & Virtanen 1994). One very important habitat type to all young ducklings are flooded areas. Although these flowages may comprise only a limited fraction of wetlands in a landscape, their value for ducks and other wetland birds at certain life stages can be great - at least in boreal wetlands. It is very likely that in many areas the number of wet depressions has diminished greatly during the last 50 years as a result of intensive draining (Järvinen et al. 1977). In wildlife management as well as in nature conservation more emphasis should be placed on preserving small, occasionally flooded wetlands such as the ones described in this study (for the use of small ponds, see Nummi & Pöysä 1995). Likewise, because of the role of beaver in creating suitable habitats for waterfowl (Nevers 1972, Nummi 1992), the possibility of managing beaver populations in connection with general wetland conservation (Ermer 1984, Naiman et al. 1988) should be taken into account in Europe.

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