HABITAT USE BY SYMPATRIC MALLARD *ANAS PLATYRHYNCHOS* AND AMERICAN BLACK DUCK *ANAS RUBRIPES* BROODS IN A FORESTED AREA OF QUÉBEC, CANADA

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Habitat use by mallard Anas platyrhynchos and American black duck Anas rubripes broods was studied in Abitibi, Québec, on four shared wetlands in June-July 1988 and 1989. Average water levels were c. 0.5 m lower in 1988 than in 1989, changing the proportions of habitats available. Black duck broods used scrub-shrub, emergent and aquatic bed wetlands in 1988, whereas mallards used emergent and aquatic bed wetlands almost exclusively. In 1989 before plant emergence occurred (prior to 25 June), both duck species used habitats according to their availability. After this, scrub-shrub wetlands were avoided by both species, and mallard preferred aquatic bed wetlands. The pattern of use by mallard broods changed from 1988 to 1989 (from emergent wetlands to more available scrub-shrub wetlands with emergents) but not for black duck. Forested scrub-shrub wetlands were used by black duck even during low availability in 1988 suggesting that this species found dense cover desirable. The array of habitats most used by broods of both species overlapped greatly in this study, but the extent of this overlap fluctuated with changes in water level and habitat availability.

Keywords: Sympatric Mallard, American Black Duck, Brood, Habitat

Introduction

Following a decline in numbers beginning in the late 1950s, the status of the American Black Duck *Anas rubripes* has been a matter of increasing concern for wildlife managers. Simultaneously, the distribution of Mallard *Anas platyrhynchos* in North America has increased eastward so that breeding and wintering areas of Black Duck and Mallard now overlap largely (Rusch *et al.* 1989). In the Clay Belt zone of north-central Ontario, Ross & Fillman (1990) observed diminishing numbers of Black Duck from 1973 to 1982-83, while Mallard numbers remained relatively constant. In the Clay Belt zone of Québec, data from banding activities between 1965 and 1971 show an increasing proportion of Mallard captured relative to Black Duck (Ministère du Loisir, de la Chasse et de la Pêche du Québec, Rouyn-Noranda, unpubl. data). Farther east and north in the boreal forest of central Québec, Bordage (1988) noted similar changes in Black Duck and Mallard numbers from aerial surveys performed between 1985 and 1987. Although the highest concentrations of breeding Mallard

in North America occur in the prairie pothole region (Bellrose 1979), Mallard also breed successfully in forested regions (Gilmer *et al.* 1975, Bellrose 1979, Kirby *et al.* 1985, Monda & Ratti 1988). However, there are few studies of habitat use by Mallard breeding in forested areas (Gilmer *et al.* 1975, Merendino *et al.* 1993).

Most Black Duck breed in the boreal forest (Bellrose 1979, Bordage 1988). Black Duck broods typically use streams (Seymour 1984, Bordage 1988) and flooded thicket areas with emergent vegetation, which are ponds frequently created by beaver *Castor canadensis* (Renouf 1972, Ringelman & Longcore 1982).

Studies of allopatric populations indicate that habitat use by breeding Mallard and Black Duck may overlap at landscape and wetland scales. Little is known, however, of the relative habitat preferences of sympatric Mallard and Black Duck (see Coulter & Miller 1968, Laperle 1974, Courcelles & Bédard 1979, Merendino *et al.* 1993, Merendino & Ankney 1994).

Studies of relative habitat preference may help us to understand the shift in Mallard and Black Duck numbers in areas where they are currently sympatric. Brodsky *et al.* (1989) demonstrated that Mallard and Black Duck preferred to mate with the phenotype with which they were raised. Sympatry may increase the likelihood of interspecific pair formation due to close contact or mixing of broods. Interspecific interactions of broods have a higher probability of occurring if both species (colour morphs) use similar habitats at the wetland scale in the area of sympatry. Furthermore, management for habitats preferred by Black Duck but less used by Mallard may prove to be a means to maintain Black Duck populations where they overlap with Mallard.

The objective of this study was to examine habitat use by brood-rearing Mallard and Black Duck on shared wetlands in the Clay Belt zone of north-western Québec, and to enhance our understanding of how increased interaction with Mallard may have influenced Black Duck populations.

Study Site

This study was conducted on an upper section of the Harricana River and one tributary, the Laine River, situated 20 km northwest of Val d'Or, Québec (48° 03'N, 77° 47'W). This region lies on the extensive clay deposits of the southern Precambrian Shield (Remick 1969) near the eastern limit of Mallard breeding distribution. Agriculture, forestry and mining have reduced the extent of the original boreal forest relatively recently in this area (Ministère de l'Energie et des Ressources, Québec 1985).

The Harricana River is 45-75 m wide and forms floodplain wetlands which extend 300 m on average (max. 910 m) on both sides of the river. The Laine River is 30 m wide with wetlands extending 160 m on both sides. Channels are 3-5 m deep with banks levelling quickly to form shallow basins that are permanently flooded. Palustrine wetland complexes modified by beaver are present. Aspen *Populus tremuloides* and birch *Betula papyrifera* dominate in areas surrounding wetlands. Mixed stands of hardwoods and conifers *Picea spp.*, *Abies balsamea*, old and cultivated hay fields *Poa spp.* and burned (in 1984) conifer sites characterised the remaining upland areas.

Methods

Four palustrine wetlands were selected for detailed observation of unmarked broods; they were chosen as a representative sample of habitats available on the study site (**Table 1**). Wetlands A and C were floodplains of the Harricana River (**Figure 1**). Approximately 14ha (43%) of A was visible from a tree tower 18m high. Wetland B was on a section of the Laine River of which 21ha (95%) was visible from a 15m tree tower. Wetland C was observed from a boat where about 13ha (24%) was visible. In wetland D, about 16ha (70%) was visible from a 7m metal frame tower. Two observers surveyed a wetland each for 3-4 hours per day from late May through July during 1988 and 1989. Daylight hours were divided into three observation periods: morning (sunrise - 10:30), mid-day

(10:35 - 16:00) and evening 16:05 - sunset). We visited wetlands in a different period each day and systematically sampled the available daylight period in three days.

Water level fluctuations were recorded by regularly marking the water level on a bridge support and noting the changes from the highest level observed.

Use-availability Analyses

We used the adjusted G statistic (*Williams' correction*), which is regarded as more appropriate for small samples than the Chi-square (Sokal & Rohlf 1981), to test whether Mallard and Black Duck broods used habitats in proportion to availability. When statistically significant differences were detected, we used the Bonferroni confidence interval technique (Neu *et al.* 1974) to determine which habitats were selected or avoided.

Availability was defined considering the total surface area of each habitat type (open water excluded) within the 4 observed wetlands combined (**Figure 2**). Habitat boundaries were delineated on 1:2,700 maps made from scale enlargements of 1:15,000 aerial photographs, showing spatially distinct patches of vegetation at a minimum size of 0.01 ha. Each patch was classified based on dominant plant species as: forested, deciduous scrub-shrub, persistent emergent (P), non-persistent emergent (NP) and aquatic bed wetland (Cowardin *et al.* 1979, see **Appendix A**).

Use was defined in two ways, each requiring us to make different assumptions. First, we scanned the observed wetland every five minutes during the length of the observation period and noted the habitat where each brood was present. This definition (hereafter termed 'timed use') enabled us to weight habitat types according to the relative amount of time broods spent in each. Hens and broods could swim through an area to reach another for different activity. Thus habitat used during swimming may not have represented habitat actively selected. Therefore use was recorded only if the hen or at least one duckling was either feeding, preening or resting in a particular habitat. We assumed that hens and

Table 1. Habitat availability in wetlands (n=4) on the Harricana River, Québec, and their use by brood-rearing black ducks and mallards, June and July 1988-89.

	Available area (ha) with use index[a]		
Habitat type	1988	Early[b] 1989	Late 1989
Forested	10.8_{M-}	15.9	7.6
Scrub-shrub		17.4	$16.3_{BD,M-}$
P[c] Emergent	$7.2_{BD,M-}$		7.6
NP Emergent	11.7	19.5	12.0
Aquatic Bed	3.4^{M+}		3.1^{M+}
Total	33.1	52.8	46.0

[a] "+" is habitat used more than predicted by its availability, and "-" is used less. Use-availability analyses follow Neu *et al.* (1974). G tests were between obs and expt use as predicted by habitat availability. Obs use is given in **Table 2**. For 1988, df=3; BD: G=13.4, p< 0.005,M: G=66.3, p<0.001; for early 1989, df=2, BD: G=1.1, p>0.5, M: G=2.7. p>0.1; for late 1989, df=4, BD: G=21.3,p<0.001, M: G=23.7, p>0.001. Forested and Scrub-shrub wetlands in 1988, were pooled to meet G-test requirements. Emergents and Aquatic Bed wetlands were flooded in early 1989 and treated as shallow water habitat.

[b] Early is prior to plant emergence (1-25 June), late is after (26 June-31 July 1989).

[c] P:persistent, NP:non-persistent. **See Appendix A.**

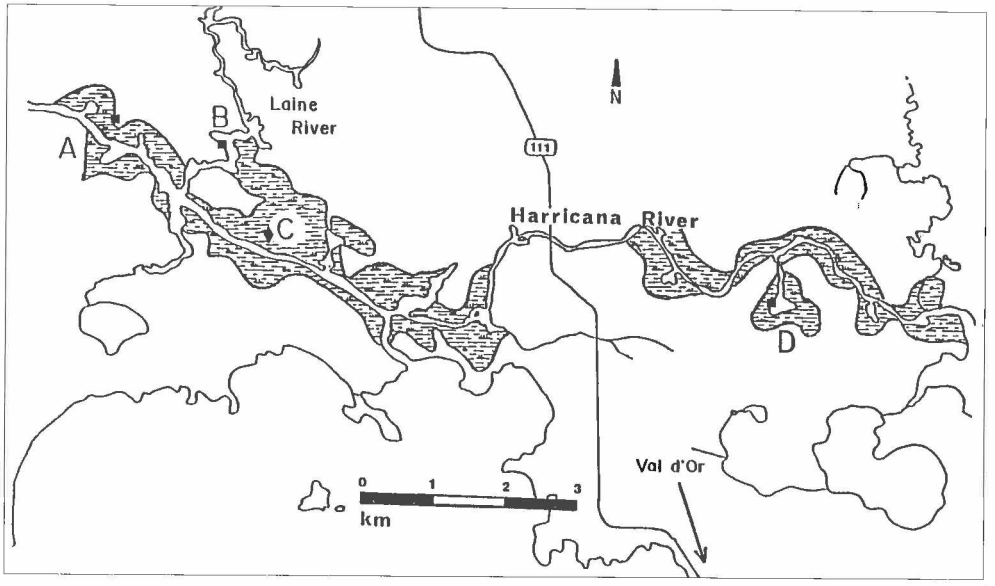

Figure 1. Four palustrine wetland complexes along the Harricana and Laine Rivers, Québec, were observed for Mallard and Black Duck broods, in June-July 1988 and 1989. Complexes were similarly composed of forested, scrub-shrub, emergent, and aquatic bed wetlands. Area visible from observation tower or boat: A: 14 ha B: 21 ha, C: 13 ha, D: 16 ha. The locations of observation towers are marked by squares; the observation boat is marked by a diamond.

broods used habitat i at time t+5 min independently of their use of the same habitat at time t. This is reasonable because during the minimum time interval (5 min), a brood could swim across an entire observed wetland and use all habitat types.

Second, use was recorded as the presence of a brood in a habitat at least once during an observation period. For example, a brood could only have been recorded as using a particular habitat twice if observed during two periods (*ie* on different days) or if a different habitat was used in between during the same period. By collecting use data as presence/absence per brood-period (hereafter presence/absence use), we can abide by a second assumption required for the application of G tests; the probability of recording a presence is similar for Black Duck and Mallard in all habitats. Visibility of broods of an individual species in each habitat was not estimated but we recognise that it may not have been equal in each type, probably being poorer in forested and scrub-shrub wetland than in the habitats with shorter vegetation. This second use definition enabled us to decrease the heterogeneous visibility effect: a brood observed during 5 min in a habitat produced the same use value as a brood visible during 30 min while using another habitat. We are, however, no longer able to provide an estimate of time spent in each habitat. According to this definition, the first assumption (of independence of observations) is again reasonable as the minimum time interval between sightings in the same habitat is 10 min (time necessary for a brood to use habitat i at time t, habitat j at time t + 5 min, and again habitat i at time t + 10 min). At least 30% of use observations were obtained from different broods (identified by a species-age index [Gollop & Marshall 1954]) or from the same brood but in different observation periods.

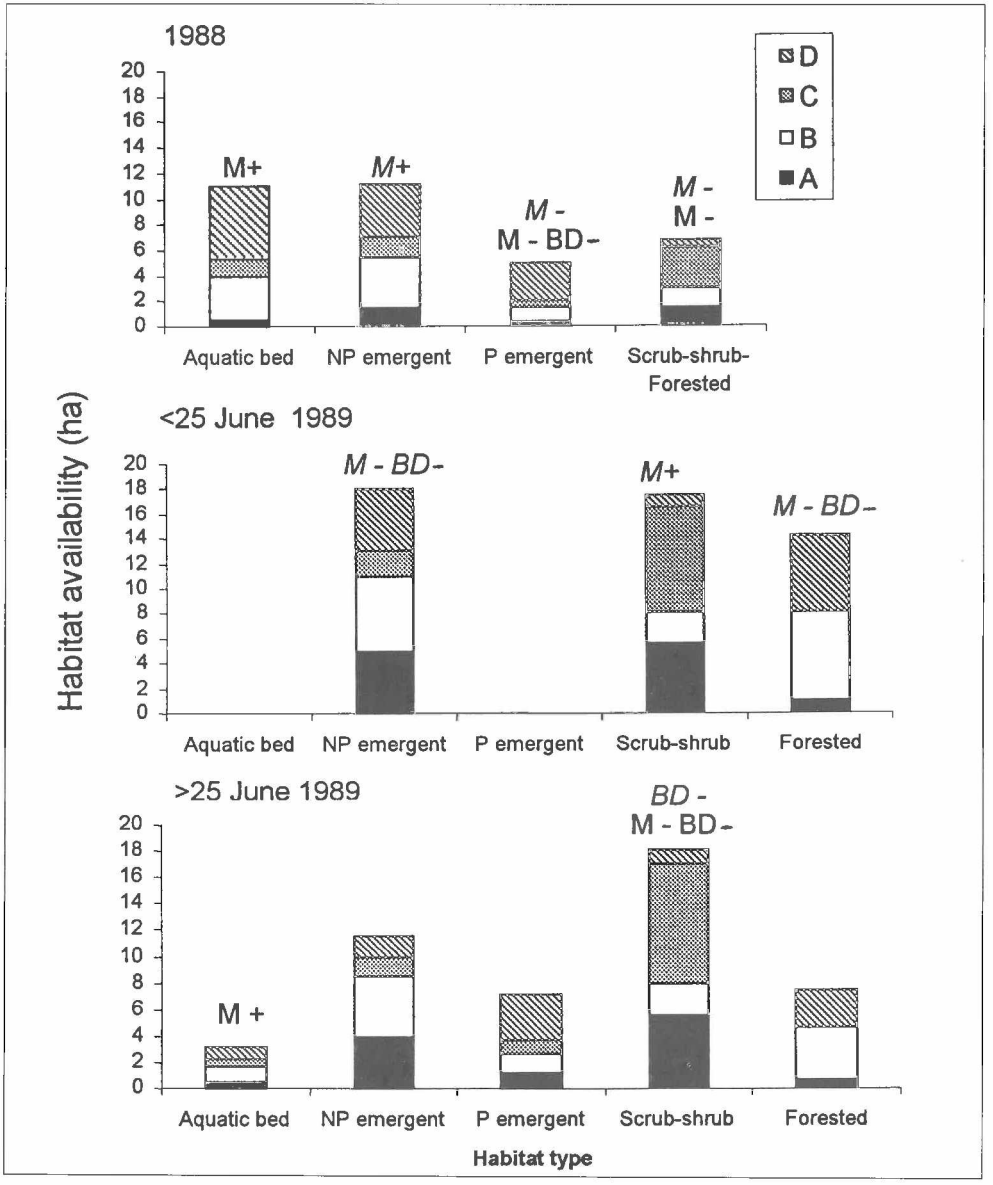

Figure 2. Habitat availabilities in wetlands (A-D) on the Harricana River, Québec, and indices of use by brood-rearing Black Duck (BD) and Mallard (M), June and July, 1988-89. Index "+" is habitat used more than predicted by its availability, and"-" is used less. Indices are results of use-availability analyses following Neu et al. (1974), based on two definitions of use: timed use (indices in italics) and presence/absence use (plain face indices). Use values are given in **Table 2** (timed use) and **Table 3** (presence/absence use). Forested and Scrub-shrub wetlands in 1988 were pooled to meet G-test requirements. Emergents and Aquatic Bed wetlands were flooded 25 June 1989 and treated as shallow water habitat. P=persistent, NP=non-persistent.

Black Duck-Mallard use comparisons

The hypothesis that Mallard and Black Duck broods use habitats differently was tested using each use definition with a *G* statistic. Upon obtaining significant results, we tested all pairs of habitats for significant differences in use by each species (2x2 *G* tests, Sokal & Rohlf 1981). We are confident that visibility of Black Duck and Mallard broods in a particular habitat did not differ, i.e. that the probability of being sighted was independent of species.

Between year comparisons

Differences in habitat use between 1988 and 1989, for both species, were analysed by using a simultaneous test procedure (STP; Sokal & Rohlf 1981:728).

Results

Annual differences in water level caused differences of habitat availability between 1988 and 1989. Water levels were 0.3 - 0.8 m higher from early May to August 1989 compared to 1988. Consequently, emergent plants did not appear above the water surface until late June. For this reason, we divided the 1989 data into two periods: (1) before and (2) after plant emergence, which occurred around 25 June, and performed separate habitat analyses. When the first broods appeared in early June 1988, emergent plants had already formed relatively dense patches. In 1989, NP-emergent habitats were not available to early broods, however, some forested and scrub-shrub patches (which were never flooded in 1988) were available to them until mid-June.

Use vs Availability

In 1988, timed use analyses showed that Black Duck used all habitats according to their availability (G=8.807, p>0.05), whereas presence/absence use analyses showed that they avoided P-emergent habitats, using other habitats according to their availability (G=13.4, p<0.005) (**Figure 2**). Mallard broods used some habitats differently than expected from their availability (timed use: G=197.2, p<0.001; presence/absence use: G=66.6, p<0.001) (**Figure 2**). Mallard broods selected aquatic beds and avoided other habitats according to timed use analyses. They either selected NP-emergent wetlands according to timed use analyses or ignored it according to presence/absence analyses (**Figure 2**).

In 1989, before plant emergence (25 June), both species selected scrub-shrub habitats and avoided NP-emergents and forested habitats according to timed use analyses (BD: G=48.7, p<0.005; M: G=103.8, p<0.005). According to presence/absence use analyses, they used all habitats according to their availability (BD: G=1.1, p>0.1; M: G=2.7, p>0.1) (**Figure 2**).

After 25 June 1989, Black Duck broods avoided scrub-shrub habitats (timed use: G=17.26, p<0.005; presence/absence use: G=23.7, p<0.001) (**Figure 2**).

Black Duck-Mallard use comparisons

Habitat use by Black Ducks and Mallards differed in 1988 according to both definitions of use (**Table 2**, timed use: G=42.44, p<0.001; **Table 3**, presence/absence use: G=8.36, p<0.01). Black Duck broods were associated with forested scrub-shrub wetlands while Mallards were associated with aquatic bed habitats (presence/absence use: 2x2 G=7.64, p<0.05). In 1989, both before and after 25 June, habitat use by Mallards and Black Ducks did not differ (**Tables 2** and **3**).

Between year comparisons

Analyses were performed using only presence/absence use, which is more robust to yearly differences in visibility and we only compared habitat use between 1988 and after 25 June 1989, when all possible habitats were available. Mallard broods showed significant differences in use patterns (**Table 3**). STP tests produced the following array of habitats ordered (from left to right) as those associated with after 25 June 1989 to those associated with 1988:

Forested scrub-shrub P-emergent
NP-emergent Aquatic bed

Table 2. Habitat use as the number of observations of brood-rearing Black Ducks and Mallards noted during scans at 5 min interval (timed use) in four wetlands along the Harricana River, Québec, June-July 1988-89.

	Use[a] 1988 (p)		Use <25 June 1989 (p)		Use >25 June 1989 (p)	
Habitat type[b]	Black Duck	Mallard	Black Duck	Mallard	Black Duck	Mallard
Forested	13 (0.23)	2 (0.02)	10 (0.18)	9 (0.12)	10 (0.27)	9 (0.16)
Scrub-shrub			43 (0.75)	67 (0.87)	5 (0.13)	22 (0.38)
P emergent	7 (0.12)	1 (0.02)	4 (0.07)	1 (0.01)	8 (0.21)	12 (0.21)
NP emergent	26 (0.46)	104 (0.70)			13 (0.34)	13 (0.23)
Aquatic bed	10 (0.18)	48 (0.31)			8 (0.05)	11 (0.02)
Total	56	154	57	77	38	47

BD-M differences, for 1988: G = 42.4, df = 3, p <0.001; for < 25 June 1989: G=4.2, df =2, p >0.12, for late 1989: G=7.9, df = 4, p >0.1.
[a] Use: presence of a brood noted every 5 min during an obs. scan (ie period of 3-4 hrs).
[b] Refer to **Figure 2**.

(Underlined habitats received similar use in both years.)
For Black Ducks, differences between years could not be detected (**Table 3**).

Discussion

Studies of habitat use involving unmarked individuals in a forested environment require a definition of use (presence/absence) that is robust to differential visibilities between covered forest habitats and more open ones. Such a definition, however, prevents more detailed study of use in terms of time spent in each habitat. In this study, results of analyses using two definitions of use (presence/absence and timed) were generally similar providing insight about patterns of habitat utilisation by Black Duck and Mallard broods during two years of differing habitat availability in a forest area.

Use vs Availability

In 1988, Mallard broods made extensive use of non-persistent emergent and aquatic bed habitats. Black Duck broods used these habitats in addition to forested and scrub-shrub wetlands. In early 1989, however, NP-emergents were rare or not available until late June and all habitats (including shallow water where plant emergence ultimately occurred) were used by both Mallard and Black Duck broods. Both species used scrub-shrub wetlands which presumably provided food and cover, when NP-emergents were less available. Later, after plant emergence, Mallard and Black Duck broods avoided scrub-shrub wetlands.

The importance of herbaceous plants in supporting a high biomass of aquatic invertebrates and in providing escape cover has been identified (Krapu 1979; Reinecke & Owen 1980). In prairie wetlands, Mallard broods typically show preference for emergent vegetation (Mack & Flake 1980) and for high emergents-water interspersion (Kaminski & Prince 1981; Ball & Nudds 1989). Forested and scrub-shrub wetlands, which provide cover from bad weather and predators are also important to waterfowl (Coulter & Miller 1968; Ringelman & Longcore 1982; Kirby *et al.* 1985). Ringelman & Longcore (1982) noted that alder-shrub communities with herbaceous understorey may form food rich habitats for broods, because of symbiotic nitrogen fixation in alder root nodules (see Tilton & Bernard 1975). However, ericaceous shrubs apparently offer little food and shelter and are relatively avoided by Black Duck and Mallard (Courcelles & Bédard 1979; Ringelman & Longcore 1982).

Table 3. Habitat use as presence/absence during observation periods of brood-rearing Black Ducks and Mallards in four wetlands along the Harricana River, Québec, June-July 1988-89.

	Use[a] 1988 *(p)*		Use ≤25 June 1989 *(p)*		Use >25 June 1989 *(p)*	
Habitat type[c]	Black duck	Mallard	Black duck	Mallard	Black duck	Mallard
Forested	7 (0.20)	2 (0.04)	6 (0.38)	8 (0.40)	5 (0.17)	5 (0.11)
Scrub-shrub	7 (0.20)	2 (0.04)	6 (0.38)	8 (0.40)	2 (0.07)	7 (0.15)
P emergent	2 (0.06)	1 (0.02)			4 (0.14)	7 (0.15)
NP emergent	17 (0.50)	22 (0.47)	4 (0.25)	4 (0.20)	10 (0.14)	16 (0.35)
Aquatic bed	8 (0.24)	22 (0.47)			8 (0.28)	11 (0.24)
Total	34	47	16	20	29	47

BD-M differences, for 1988: G = 8.36, df = 3, P <0.01; for early 1989: G=0.12, df =2, P >0.9, for late 1989: G=1.7, df = 4, P >0.5. Late 1989-1988 differences, for BD: G = 5.03, df = 3, P >0.1; for M: G = 17.2, df = 3, P <0.001.

[a] Use: presence of a brood at least once during an obs. period (3-4 hrs).

[b] Refer to **Figure 2**.

Black Duck-Mallard yearly use comparisons

The water level changes between 1988 and 1989 allowed us to identify some differences in use of habitats by brood-rearing Mallard and Black Duck. During 1988, a year of relatively low water levels, Mallard broods were rarely observed in forested-scrub-shrub habitats, whereas Black Duck used them as well as NP-emergent habitats. In 1989 after 25 June, Mallard were more frequently observed in forested and scrub-shrub habitats than in 1988, thus using habitats similar to those used by Black Duck broods. Changes in Black Duck habitat use between years were not detectable. They used forested-scrub-shrub habitats even during periods of relatively low availability, suggesting that cover may be more desirable to brood rearing Black Duck hens than Mallard. Black Ducks did not appear to prefer aquatic beds as Mallard did. Such habitats may provide food but less cover than emergent and scrub-shrub habitats. In a diked wetland in Ohio, Barclay (1970) noted a similar propensity by Black Duck pairs to use wooded areas, whereas Mallard used more open habitats.

The array of habitats used by Mallard greatly overlap those most used by Black Duck hens. This overlap, however, fluctuated with water level and habitat availability. In our study, Black Duck broods used both emergent and forested-scrub-shrub cover even when the latter was relatively rare. Provision of forested and scrub-shrub habitats with little emergent cover will probably fail to favour Black Duck broods over Mallard. Conversely, management of emergent wetlands with aquatic beds but without forested and scrub-shrub habitats may favour Mallard in brood-rearing areas shared with Black Duck. Black Duck broods appear to prefer a larger array of available habitats than Mallard. Most attempts to improve wetlands by creating a higher emergents-open water ratio will not favour Black Duck over Mallard. Studying historical Mallard replacement of Black Duck on the fertile wetlands of southern Ontario, Merendino *et al.* (1993) came to a similar conclusion.

For proper management of Black Duck habitats, we must have a better understanding of how sympatric Black Duck and Mallard use habitats at the wetland scale (see Merendino & Ankney 1994). This study contributes to this understanding by examining differences in habitat use by sympatric Mallard and Black Duck hens during the brood-rearing period. How nest site selection and territory establishment differ between sympatric pairs is still unclear.

A large overlap in Black Duck and Mallard breeding distributions is apparent at the continental scale, but few areas exist where one can find relatively stable populations with equal

numbers of breeding pairs (see Rusch *et al.* 1989; Ross & Fillman 1990). Small sample sizes for at least one species and overall low densities may preclude conclusive results for habitat preference analyses (eg Barclay 1970). Areas of such overlap are often remote but studies of sympatric breeding populations are needed, especially where the overlap is of recent occurrence such as in central Québec (Bordage 1988), where incidentally, little is known about the possible effects of recent major habitat changes upon the Black Duck population (Rusch *et al.* 1989).

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Appendix A. Plant species by habitat. Classification follows Cowardin et al. (1979) and taxonomy follows Marie-Victorin (1964).

Habitat classes Common name	Species name
Forested	
Balsam fir	*Abies balsamea (L.) Mill.*
Birch	*Betula papyrifera Marsh.*
Poplar	*Populus tremuloides Michx.*
Spruce black	*Picea mariana (Mill.) BSP.*
Tamarack	*Larix laricina (Du Roi) K. Koch.*
Scrub-shrub	
Alder	*Alnus spp.*
Dwarf-birch	*Betula pumila L.*
Red-osier dogwood	*Cornus stolonifera Michx.*
Willow	*Salix spp.*
Bog rosemary	*Andromeda glaucophylla Link.*
Leatherleaf	*Chameadaphne calyculata (L.) Moench*
Spiraea	*Spiraea latifolia (Ait.) Borkh.*
Sheep Laurel	*Kalmia angustifolia L.*
Swamp Laurel	*K. polifolia Wang.*
Sweet gale	*Myrica Gale L.*
Persistent emergent	
Black-girded wool-rush	*Scirpus atrocinctus Fernald*
Bulrush	*Scirpus spp.*
Common rush	*Juncus effucus L.*
Sedges	*Carex spp.*
Water parsnip	*Sium suave Watt.*
Grasses etc.	*Zizania spp., other mem. of Gramineae fam.*
Non-persistent emergent	
Horsetail	*Equisetum spp.*
Spike-rush	*Eleocharis spp.*
Larger blue-flag	*Iris versicolor L.*
Sweet-flag	*Acorus Calamus L.*
Aquatic bed	
Amphibeous knot-weed	*Polygonum amphibium L.*
Broad-leaved arrow-leaf	*Sagittaria latifolia Willd.*
Bur-reed floating	*Sparganium fluctuans (Morong) B.L. Robinson*
Bur-reed narrow-leafed	*S. angustifolium Michx.*
Emerged pondweed	*Potamogeton epihydrus Raf.*
Variegated pond-lily	*Nuphar variegatum Engelm.*
Water-weed	*Elodea spp.*