Wilson Bull., 107(1), 1995, pp. 55–63

WETLAND USE BY BREEDING AND POSTBREEDING FEMALE MALLARDS IN THE ST. LAWRENCE RIVER VALLEY

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ABSTRACT.—We examined the use of wetland habitats by female Mallards (*Anas platyrhynchos* from March 1990 through July 1992 in the St. Lawrence River Valley, a focus area under the North American Waterfowl Management Plan. Female Mallards spent most of their time breeding in forested-live wetlands (40%) and postbreeding in forested-dead wetlands (35%). According to wetland availability data, breeding and postbreeding females indicated selectivity for emergent and scrub-shrub wetlands. During postbreeding, they used fewer ($\bar{x}$ = 2.6, ± 0.2 [SE]) individual wetlands of larger size ($\bar{x}$ = 192 ha ± 30 ha) compared to the breeding season ($\bar{x}$ numbers = 4.1 ± = 0.2, P = 0.003; $\bar{x}$ size = 101 ha ± = 15 ha, P = 0.001). Moreover, females typically spent the postbreeding season in the vicinity of, or within, their breeding wetlands, hence conservation must simultaneously address breeding and postbreeding requirements. Protection of wetland complexes that contain a diversity of habitat types of differing sizes is recommended. *Received 29 March 1994, accepted 1 Oct. 1994.*

Mallards (*Anas platyrhynchos*) are declining throughout their primary breeding range in the prairie pothole region of North America (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1986). As prairie habitats are lost to agriculture, secondary breeding habitats in northern forests have become increasingly important to the continental population (Gilmer et al. 1975, Trost et al. 1987). However, outside of prairie pothole habitats, research on dabbling ducks in general, and Mallards in particular, is meager. Such lack of data is especially significant in the St. Lawrence River Valley (SLRV) because it contains some of the most pristine wetlands—70% of which are forested—remaining in the northeastern United States (U.S. Fish and Wildlife Service 1991) and is a focus area under the North American Waterfowl Management Plan (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1986). Hence, information on seasonal patterns of wetland habitat use should assist in identifying priority measures designed for protecting these important habitats, as well as increasing our understanding of Mallard ecology. Further, although the Mallard is the most frequently represented duck species in the literature worldwide (Heitmeyer 1987), traditional waterfowl research and management favoring breeding and wintering periods have resulted in a relatively poor understanding of postbreeding populations and their habitats (Hoh-

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man et al. 1992). We designed this study to examine habitat use patterns by female Mallards during breeding and postbreeding seasons in the SLRV.

STUDY AREA AND METHODS

We conducted the study within a 126-km^2 portion of the SLRV in northern New York (75°15′W, 44°38′N). Topography there is flat with rolling hills, and elevation ranges from 76 to 122 m above sea level (Will et al. 1982). Landscape in the SLRV is 53% forested, 35% agricultural, 11% wetlands, and 1% human-made structures (Grover 1978). Wetland conditions are pristine and consist of diverse complexes of forested swamps, shrub swamps, emergent marshes, wet meadows, farm ponds, rivers, and streams (Barnes et al. 1990, U.S. Fish and Wildlife Service 1991). Geology is extensively described in MacClintock and Stewart (1965) and wetland vegetation in Geis et al. (1977).

We captured female Mallards from 23 March through 27 April, 1990–92, using decoy traps (Sharp and Lokemoen 1987), and attached a 20-g radio-transmitter dorsally to each bird using a harness (Dwyer 1972). We removed primary covert number two on each female and used black-and-white surface area (mm^2) and dry weight (mg) of this feather to determine age using an improved version (G. Krapu, pers. comm.) of the discriminant function initially published in Krapu et al. (1979).

We used a hand-held yagi antenna (3- or 4-element) and 150–151 Mz scanning receiver to "home in" on birds and locate them in particular wetland basins. Homing was the process by which we approached birds on foot or from a truck only until we could identify the individual wetland basin the bird was using. Our objective was to locate radio-marked females in individual basins delineated on U.S. Dept. of Interior, National Wetlands Inventory maps (1:24,000). We were not concerned with documenting subtle movements within individual wetland basins, so telemetry error was negligible (Frazer et al. 1990).

We relocated radioed females 4–7 days/week and attempted to locate all females on each day. Females not located on a particular day were given priority the following day to standardize tracking effort. Individual birds were located only once each day to control for autocorrelation bias (Swihart and Slade 1985). The breeding season was defined as the interval between the first and last egg laid during the year. Individual birds were assigned postbreeding status the following day or when we observed them in flocks, whichever came first. Telemetry began the third week of April and ended the last week in July.

We studied the six major types of palustrine wetlands used by Mallards on our study area: forested-live, forested-dead, scrub-shrub, emergent, farm pond, and river. Forested-live types were dominated by living broad-leaved deciduous trees, primarily red maple (*Acer rubrum*), American elm (*Ulmus americana*) and ash (*Fraxinus* spp.). Forested-dead types were dominated by dead trees, but were similar to forested-live wetlands in species composition. Scrub-shrub types were dominated by deciduous broad-leaved shrubs, mainly speckled alder (*Alnus rugosa*), willow (*Salix* spp.), silky dogwood (*Cornus amomum*), and meadowsweet (*Spirea alba*). Emergent types were dominated by narrow-leaved persistent herbaceous vegetation, principally sedge (*Carex* spp.), cattail (*Typha* spp.), bulrush (*Scirpus* spp.), and spike rush (*Elocharis* spp.). Farm pond types were small (<11 ha) open water wetlands created and maintained by people. River types were open water wetlands with channels of high gradients and velocity.

We divided the study area into 1-km^2 blocks and used only blocks that contained ≥ 1 radio-location for each year. We used an electronic digitizer to measure the area of all wetland basins that fell within boundaries of study area blocks and individually coded each basin. Percent composition of wetland types was determined separately for each 1-km^2 block.

Study areas were 69 km^2 (i.e., 69 blocks) in 1990, 84 km^2 in 1991, and 81 km^2 in 1992, and pooled size over three years was 126 km^2. Only 42 (33%) of the 126 study area blocks were shared among all three years, 24 (19%) between two years, and the remaining 60 (48%) were unique to a given year. However, despite low overlap in blocks among individual years, percent composition of wetland types was nearly identical for yearly study areas, and the greatest difference between any two years was 6% for forested-live wetlands. Percent wetland habitat covering the yearly study areas was 32.8% in 1990, 32.3% in 1991, and 31.0% in 1992, respectively.

For each bird at each location, we recorded the type and size of the individual wetland basin. Number of wetlands used by each female was the total number of different wetland basins where we obtained at least one location. Percent use of each wetland type was calculated for each female by dividing the number of locations in each wetland type by the total number of locations; for analysis, percent use data were normalized by arcsine transformation. Size of individual basins was averaged to yield a mean wetland size for each bird during each season; for analysis, wetland size data were weighted by the number of locations obtained in individual basins.

We used one-way analysis of variance to test for yearly differences in percent use of different wetland types, mean wetland size, and number of wetlands used during each season. We used unpaired t-tests to test for differences in habitat use between breeding and postbreeding seasons and between ASY and SY females. Data were managed and analyzed using PC SAS (SAS Institute 1988).

RESULTS

We radio-marked 128 female Mallards over three years (44 in 1990, 44 in 1991, 40 in 1992). We omitted from analysis 31 birds that either disappeared within two weeks of marking, were found dead upon first radio-location, dropped their radios, or wore defective radios. The breeding sample, therefore, included 97 females (41 ASY, 52 SY, 4 unknown age) that we separated into individual year-age data sets. The postbreeding sample, also divided into separate year-age data sets, was reduced to 74 females (32 ASY, 39 SY, 3 unknown age) after accounting for birds that disappeared or died during the breeding season.

Wetland use was similar ($P > 0.05$) between ASY and SY females, within and between seasons, so we pooled the data on age class (including birds of unknown age) and tested for differences among years and between breeding and postbreeding seasons. Analysis was based upon 1670 breeding season radio-locations (367 in 1990, 666 in 1991, and 637 in 1992) and 1017 postbreeding radio-locations (307, 388, 322). Mean ($\pm$SE) number of locations obtained per bird over the three years was 16.6 ($\pm$0.94) during the breeding season (11.8 $\pm$ 1.2 in 1990, 21.8 $\pm$ 2.2 in 1991, 16.8 $\pm$ 1.2 in 1992) and 13.7 during the postbreeding season (14.0 $\pm$ 1.8, 17.6 $\pm$ 1.8, 10.7 $\pm$ 0.9).

Forested-live wetlands comprised 46–51% of the wetland area and were used by female Mallards 37–42% of the time during breeding and 23–28% during postbreeding; seasonal differences were evident ($P < 0.05$)

TABLE 1

PERCENT AREA AND USE OF SIX WETLAND HABITAT TYPES BY FEMALE MALLARDS DURING BREEDING AND POSTBREEDING SEASONS IN THE ST. LAWRENCE RIVER VALLEY, NORTHERN NEW YORK, 1990–1992[a]

Wetland type	Year	% Area	% Use		P^b
			Breeding	Postbreeding	
Forest-live	1990	47.2	41.6	27.8	0.13
	1991	51.2	42.3	22.7	0.02
	1992	45.6	37.4	24.5	0.06
	1990–1992	51.1	40.2	24.9	0.01
Forested-dead	1990	32.1	7.6	25.6	0.05
	1991	29.1	13.7	42.0	0.01
	1992	32.8	17.6	35.5	0.07
	1990–1992	25.3	13.3	34.5	0.01
Emergent	1990	6.2	28.9	27.9	0.82
	1991	4.6	20.0	5.9	0.01
	1992	9.0	21.5	18.8	0.55
	1990–1992	8.2	23.4	17.7	0.10
Scrub-shrub	1990	11.5	21.6	18.6	0.71
	1991	12.2	21.2	27.6	0.74
	1992	9.7	23.1	19.2	0.60
	1990–1992	12.1	22.1	21.5	0.73
Farm pond	1990	2.1	0.0	0.0	—
	1991	1.9	2.1	1.9	0.92
	1992	1.9	0.2	2.0	0.29
	1990–1992	1.5	0.7	1.4	0.51
River	1990	0.9	0.3	0.0	—
	1991	1.0	0.8	0.0	—
	1992	0.9	0.1	0.0	—
	1990–1992	1.9	0.4	0.0	—

[a] Yearly sample sizes (breeding, postbreeding) were 31, 22 females in 1990; 28, 22 in 1991; 38, 30 in 1992.
[b] P-values from t-tests comparing yearly wetland use between seasons.

during 1991 and overall (Table 1). Forested-dead wetlands comprised 25–33% of the wetland area and were used by female Mallards 8–18% of the time during breeding and 26–42% during postbreeding; differences between seasons were conspicuous ($P \leq 0.05$) during two of three years and overall. Emergent wetlands comprised 5–9% of the wetland area and were used by female Mallards 20–29% of the time during breeding and 18% during postbreeding. During 1991, use of emergent wetlands declined to a low of 6% during postbreeding ($P = 0.01$); otherwise, emergent wetlands were used at similar levels ($P > 0.05$) between seasons. Percent use of scrub-shrub wetlands was 22% during both seasons ($P >$

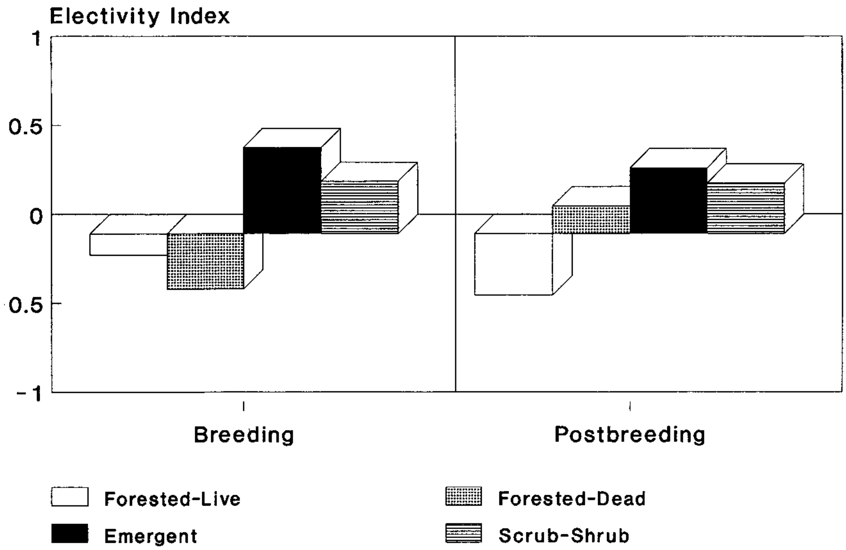

FIG. 1. Habitat electivity indices for female Mallards breeding and postbreeding in the St. Lawrence River Valley, northern New York, 1990–92. Sample sizes were 97 and 74 females for breeding and postbreeding seasons, respectively.

0.05), but these wetland types comprised only 10–12% of the wetland area. Use of farm pond and riverine wetlands was only 2%, but these wetland types comprised a small (≤2% each) proportion of the wetland area. Seasonal differences were small ($P \geq 0.05$), and in some years we did not locate postbreeding females in these wetland types (Table 1).

Seasonal use of wetland types did not differ ($P > 0.05$) among years; only postbreeding use of emergent wetlands approached significance among years ($F = 2.81$, 2 df, $P = 0.07$). To examine percent use data relative to percent availability data, we applied an electivity index (Ivlev 1961) to the pooled data, where indices <0 indicated low selection and indices >0 indicated high selection. Electivity analyses for the four major wetland types used revealed high selection indices for emergent and scrub-shrub wetlands and low indices for forested-live wetlands during both seasons (Fig. 1). Selection indices for forested-dead wetlands were low during breeding and high during postbreeding (Fig. 1).

Female Mallards generally used smaller wetland basins during breeding (84–124 ha) than postbreeding (120–246 ha), and seasonal differences were evident ($P < 0.05$) overall and in 1992 (Table 2). Female Mallards always used more ($P < 0.05$) wetland basins during breeding than postbreeding. For years pooled, mean (±SE) number of wetlands used by

TABLE 2

MEAN SIZE AND NUMBER OF WETLANDS USED BY FEMALE MALLARDS DURING BREEDING AND POSTBREEDING SEASONS IN THE ST. LAWRENCE RIVER VALLEY, NORTHERN NEW YORK, 1990–1992[a]

Variable	Year	Breeding season			Postbreeding season			P^b
		$\bar{x}$	SE	Range	$\bar{x}$	SE	Range	
Wetland size (ha)	1990	84.3	22.4	2.4–584	193.6	59.3	0.4–729	0.06
	1991	87.1	25.2	0.8–605	120.0	29.2	1.2–533	0.40
	1992	124.2	26.4	0.4–729	245.5	54.4	0.8–729	0.04
	1990–1992	100.7	14.5	0.4–729	192.1	29.6	0.4–729	0.01
No. of wetlands	1990	3.8	0.27	1–8	2.8	0.34	1–7	0.02
	1991	4.9	0.47	1–10	3.1	0.36	1–8	0.01
	1992	3.9	0.33	1–10	2.2	0.27	1–8	0.01
	1990–1992	4.1	0.21	1–10	2.6	0.19	1–8	0.01

[a] Yearly sample sizes (breeding, postbreeding) were: 31, 22 females in 1990; 28, 22 in 1991; 38, 30 in 1992; 97, 74 1990–1992.

[b] *P*-values from t-tests comparing yearly means between seasons.

individual females during breeding was 4.1 ($\pm$0.21) and ranged from 1 to 10. During postbreeding, mean number of wetlands used declined to 2.6 ($\pm$0.19) and ranged from one to eight wetlands. There were no yearly differences ($P > 0.05$) in wetland size or number used during breeding and postbreeding.

DISCUSSION

Among ducks, Mallards breed in the greatest variety of habitats, and quantifying and describing their habitat patterns is often difficult (Bellrose 1976). Breeding and postbreeding female Mallards used all wetland habitats in the SLRV, but our assessment of the four most frequently used wetland types indicated that emergent and scrub-shrub types were selected above forested types of live- or dead-timber. High use of emergent and scrub-shrub wetlands during breeding and postbreeding suggests that these wetlands provide cross-seasonal benefits to female Mallards, especially during years of normal water levels. In 1991, for example, below normal rainfall and snowfall the preceding winter (NOAA, U.S. Dept. Commerce, Asheville, North Carolina) caused water levels to drop considerably (J. E. Lamendola, pers. comm.). That year, use of emergent wetlands by females declined to a low of 6% during postbreeding; otherwise, percent use of emergent wetlands always exceeded availability. In the densely forested Adirondacks, female Mallards also appeared to select the scarcer emergent and scrub-shrub wetlands over forested wetlands (Dwyer 1992).

Mallards are relatively recent breeders in forested habitats of northeastern North America (Heusmann 1974), and forested wetlands comprised 76% of the wetland area in our study. At 53%, absolute use of forested wetlands (live- and dead-timber) appeared high, until examined in relation to the composition of forested wetlands. Our results complement studies of Mallard habitat use in forested wetlands in the Adirondacks (Dwyer 1992) and Minnesota (Gilmer et al. 1975), where high use was a function of high availability. However, use of forested-dead wetlands always exceeded coverage during postbreeding, particularly in the dry year of 1991. The seasonal shift to forested-dead wetlands during postbreeding probably was related to duration of moisture in these wetlands. For example, forested-dead wetlands were associated primarily with semi-permanent water regimes, whereas forested-live, emergent, and scrub-shrub wetlands were associated mostly with less permanent seasonal-saturated regimes (see Cowardin et al. 1979).

The functional role of wetland complexes for breeding dabbling ducks is related to wetland availability (Nudds and Ankney 1982). In early spring, small and less permanent wetlands were always first to thaw and yield invertebrates and were used intensively by pairs when larger wetlands were still frozen. We also observed females frequenting temporary water areas that formed in early spring from snow-melt water collected within small upland depressions. These were maintained by spring rains, their availability changed daily depending on air temperature, humidity, and rainfall, and they usually vanished by early May, when females entered larger wetlands and remained relatively sedentary for the remainder of the breeding season.

The most wetlands used by any female during the breeding season was 10 ($\bar{x}$ = 4.1), and some females used only one wetland basin during the entire breeding season. In forested wetlands of Minnesota, breeding females used 4–13 ($\bar{x}$ = 8.6) wetlands (Gilmer et al. 1975), and prairie-nesting females in North Dakota used seven to 22 ($\bar{x}$ = 15) wetlands (Dwyer et al. 1979). Fundamental differences between number of wetlands used in the SLRV and the aforementioned studies probably was related to wetland distribution and size (Nudds and Ankney 1982). For example, females in the North Dakota study used more wetlands, but wetland size averaged only 1.6 ha (Dwyer et al. 1979). In the SLRV, where wetland size averaged 9.5 ha (range = 0.04–867.3 ha), females apparently meet their breeding requirements within fewer wetland basins. However, postbreeding females used fewer and larger-sized wetlands than did breeding females. These seasonal changes were consistent from year to year, and the larger wetlands probably were conducive to their molting ecology (e.g., restricted mobility) and flocking, postbreeding behavior.

Intensive management of wetland habitats using water level manipulation to change vegetation composition is difficult to propose for the SLRV, given that the large watersheds contain some of the most pristine and unpolluted wetlands remaining in the northeast United States (U.S. Fish and Wildlife Service 1991). We recommend protection of wetlands from human encroachment and associated threats of development as the best conservation strategy.

Habitat use data can provide insights into the selection and prioritization of habitats for protection. For example, our data indicated that wetland basins dominated by emergent and scrub-shrub vegetation were important to female Mallards during breeding and postbreeding. Protection of breeding habitat should also emphasize small nonpermanent wetlands and sheetwaters associated with agricultural fields that thaw before large permanent wetlands early in the breeding season. Further, female Mallards typically spend the postbreeding season in the vicinity of, or within, their breeding wetlands, so habitat protection should simultaneously address both periods.

ACKNOWLEDGMENTS

Financial support was provided by the U.S. Fish and Wildlife Service (Cooperative Agreement No. 14-16-005-89-9007) and Federal Aid in Fish and Wildlife Restoration (Project W-81-R) through the New York State Dept. of Environmental Conservation (NYSDEC), New York State Conservation Fund. Partial support was provided by the Adirondack Wildlife Program at the State Univ. of New York, College of Environmental Science and Forestry. We thank B. L. Swift and other NYSDEC personnel for logistical support; J. H. Smith for field assistance; and R. H. Brocke, R. E. Chambers, C. P. Dwyer, R. A. Malecki, and H. B. Underwood for reviewing an earlier draft of the manuscript. We are grateful to SLRV landowners for allowing us access to their land.

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