Waterfowl Habitat Use on a Texas Reservoir with Hydrilla

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Abstract: Densities of waterfowl (Anatidae) and American coots (*Fulica americana*) were compared across habitats to evaluate the relative use and value of reservoir habitats, particularly hydrilla (*Hydrilla verticillata*) beds. Hydrilla was selected by ducks as a group over all other habitats ($P < 0.05$) and was the most selected habitat ($P < 0.05$) for American wigeon (*Anas americana*), gadwalls (*A. strepera*), northern shovelers (*A. clypeata*), canvasbacks (*Aythya valisineria*), and ring-necked ducks (*A. collaris*). Five other duck species selected hydrilla as 1 of several (>1) habitats most selected ($P < 0.05$). In all seasons, American coots selected hydrilla and the hydrilla-emergent interface ($P < 0.05$). Hydrilla was an important habitat component for waterfowl and coots and may improve the value of reservoirs for wintering waterbirds.

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Faced with wetland losses, wildlife managers look to human-made water bodies as potential waterfowl habitat (Chabreck 1979). Deep-water reservoirs generally are considered low quality habitat for many wetland birds (Wiebe 1946, White and Malaher 1964), and the inundation of valuable bottomlands makes the impact on wildlife 2-fold (White and Malaher 1964). In Texas, reservoirs cover approximately 672,274 ha; many of these are in the north-central region, which supports large numbers of wintering waterfowl (Texas Parks and Wildl. Dep. 1982). Understanding the use of reservoirs by wetland birds is paramount when considering wildlife interests in reservoir management strategies.

The introduction of hydrilla to Florida in 1960 (Blackburn and Weldon 1969) created a serious management problem. Hydrilla is an exotic, rooted, submerged macrophyte known for its ability to invade and quickly dominate a water body (Haller and Sutton 1975, Haller 1978); it has been identified in at least 13 states (Johnson and Montalbano 1987) and continues to spread. Hydrilla often is considered a nuisance plant due to interference with recreation (Haller 1978), objections of waterfront property owners (Gasaway et al. 1977), and competition with native

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plant species (Haller and Sutton 1975). Eradication efforts have been substantial. However, hydrilla can be valuable to wetland wildlife. Hydrilla is an important food for herbivorous birds, including common moorhens (*Gallinula chloropus*, Mulholland and Percival 1982, O'Meara et al. 1982), American coots (Montalbano et al. 1979, Hardin et al. 1984), and several waterfowl species (Montalbano et al. 1978, 1979; Hardin et al. 1984). Hydrilla also supports forage fish and macroinvertebrates (Moxley and Langford 1982, Watkins et al. 1983) which can be used by wetland birds.

Hydrilla was first observed in Lake Fairfield, Texas, in 1984 (Durocher 1986, Kirk Strawn, pers. commun.). This study was initiated in 1986 and provided the first assessment of waterfowl associations with hydrilla outside of Florida. Specific objectives were to determine the relative use of hydrilla by waterfowl and to assess the potential impact of hydrilla on the value of reservoirs as waterfowl habitat.

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Methods

Study Area

Lake Fairfield is a 1,053 ha cooling reservoir for the Big Brown Steam Electric Station located 18 km east of Fairfield in Freestone County, Texas. Mean water depth was 6.5 m and annual fluctuation was <1 m. Dam construction was completed in 1969 and the lake reached mean pool level of 94.5 m above sea level in 1971. Recreational use included fishing, boating, and water skiing, but no waterfowl hunting was permitted on the lake or in adjacent areas. Upland vegetation surrounding the lake was typical of the post oak (*Quercus stellata*) savannah region of Texas (Gould 1962).

Habitat Sampling

Vegetation of the lake was surveyed every season from summer 1986 through fall 1987. Seasons were defined by solstices and equinoxes. Plots were distributed to concentrate sampling effort on the littoral zone which exhibited the only variability in vegetation composition or coverage. Of 23 50 × 50 m plots, 3 were randomly located within open water areas (>50 m from shore) and 20 were randomly placed with 1 edge at the shoreline, encompassing the littoral zone. Open water plots were visually examined for aquatic vegetation and littoral zone plots were sampled using line transects. Three randomly located, 50-m lines perpendicular to shore were established in each littoral zone plot. Beginning at the shoreward edge above the high water mark, the plant species directly above or below a point at each 0.5 m along each line were recorded. Results from littoral zone plots were extrapolated to represent that area of the lake ≤50 m from shore (227.4 ha or 22% as digitized from aerial photographs). Open water plot results represented the 825.6 ha (78%) of the lake >50 m from shore. Areal coverages of the habitats were used as availability measures for habitat selection calculations.

Vegetation of Lake Fairfield was grouped into 9 habitats: hydrilla, emergents, emergent-hydrilla interface, submergents other than hydrilla, floating-leaf plants, nonpersistent emergents, terrestrial vegetation, unvegetated shoreline/shallow water, and open water (Table 1). Three habitats (nonpersistent emergent, terrestrial vegetation, and other submergents) were not included in habitat selection calculations due to low availability (≤1.0%) and low bird use. Deleting unused habitats from the analysis did not appreciably alter test results in terms of the order of habitat selection or significance of interhabitat differences; moreover, it probably reduced the Type II error rate (Alldredge and Ratti 1986).

Hydrilla habitat was defined as those areas of the lake with "beds" of hydrilla. Hydrilla occurred along much of the periphery of the lake but did not extend >50 m from shore.

Emergent habitat included species with persistent plant parts throughout the year (Cowardin et al. 1979). Taxa included cattail (*Typha* spp.), common reed (*Phragmites communis*), rush (*Juncus effusus*), bullwhip bulrush (*Scirpus californicus*), and knotgrass (*Paspalum distichum*). Cattail was the most abundant emergent on the study area, lining much of the shoreline.

The emergent-hydrilla interface was that area in which the above mentioned emergents abutted or mixed with hydrilla beds. The interface was delineated as 1 m to either side of the area in which both plant types occurred.

American lotus (*Nelumbo lutea*) and pondweed (*Potamogeton nodosus*) constituted the floating-leaf habitat. American lotus was abundant and occurred almost exclusively in shallow areas with soft substrate. Pondweed was more evenly distrib-

Table 1. Percent coverage of habitats on Lake Fairfield, Texas, 1986–87.

	1986		1987			
Habitat	Summer[a]	Fall	Winter	Spring	Summer	Fall
Open water	90.7[b]	89.7	94.3	93.4	88.3	86.6
Hydrilla	2.8	3.9	1.9	1.0	4.2	5.1
Emergent	2.2	2.4	2.4	2.5	2.4	2.2
Floating leaf	2.0	1.6	0.0	1.5	2.4	1.4
Unvegetated shallow water	0.8	1.5	1.0	1.0	1.0	2.4
Other submergents	0.9	0.5	0.0	0.2	1.0	1.0
Terrestrial vegetation	0.1	0.0	0.2	0.2	0.5	0.6
Emergent/hydrilla	0.6	0.3	0.1	0.1	0.4	0.4
Nonpersistent emergent	0.1	0.1	0.0	0.1	0.0	0.3

[a] Seasons are bounded by solstices and equinoxes.
[b] Percent of the 1,053-ha reservoir.

uted about the lake and often grew within hydrilla beds in small patches or as individual plants.

Unvegetated shoreline/shallow water habitat included those areas with <50 cm of water and lacking vegetation. Areas lacking vegetation in water >50 cm was classified as open water habitat. All of the lake >50 m from shore, as well as a large proportion ≤50 m, was included in this habitat, making it by far the most abundant (Table 1).

Waterfowl Surveys

Waterfowl populations of Lake Fairfield were censused to determined species present, numbers, and habitat associations. A motorboat was driven slowly around the edge of the lake to observe all birds present. Double-counting was minimized by attempting to avoid flushing birds and, if birds flushed, to observe where the birds flew and not include any birds in the sample which could have been previously censused. Surveys were conducted semimonthly during the falls of both years and winter and spring of 1987; weekly during summer 1986; and monthly during summer 1987. Thirty-seven surveys were completed; 17 were conducted in 1986 and 20 in 1987. Surveys were conducted in the morning and on weekdays, when possible, to avoid weekend boat disturbance. Duration of surveys ranged from 3 to 6 hours and direction around the lake was alternated.

Data collected during waterfowl surveys were analyzed to determine habitat selection using Friedman's 2-Way ANOVA (Conover 1980:299–308) to test if selectivity indices differed across habitat types. A selectivity index for each survey and species was derived by dividing the number of birds observed in a habitat (use) by the areal coverage (in hectares) of that habitat (availability) (Johnson and Montalbano 1984). Surveys in which the species or group of interest was not observed were not included in the analysis. Comparing ranked densities with surveys as blocks allowed for analyses of comparable data even across changes in habitat availability and overall bird population sizes. An F approximation was used as the test statistic for Friedman's test rather than a chi-squared approximation because of increased test efficiency (Conover 1980). Selection was calculated for species with ≥5 independent observations, i.e., observations of distinct flocks or individuals. If Friedman's test indicated differences among habitats ($P < 0.05$), Fisher's LSD multiple comparison procedure (Ott 1984:365–370) was used to determine the order of selection and interhabitat differences. Habitat selection was calculated for each season and over all seasons, accounting for seasonal changes in habitat availability.

Results

General habitat use by waterfowl was based on observations of 12 species observed on Lake Fairfield during surveys: American wigeon, blue-winged teal (*Anas discors*), canvasback, common goldeneye (*Bucephala clangula*), gadwall, green-winged teal (*A. crecca*), mallard (*A. platyrhynchos*), northern pintail (*A. acuta*), northern shoveler, ring-necked duck, ruddy duck (*Oxyura jamaicensis*), and wood duck (*Aix sponsa*). Waterfowl densities were highest ($P < 0.05$) in hydrilla in all seasons except summer 1986 (Table 2); however, summer 1986 calculations were based exclusively on wood ducks which showed a strong affinity for American lotus. Combining all species and seasons, density in hydrilla was higher than in all other habitats. Of the 10 species of ducks demonstrating differential habitat use ($P < 0.05$; Table 3), densities in hydrilla were greater than in any other habitat for American wigeon, gadwalls, canvasbacks, northern shovelers, and ring-necked ducks. Green-winged teal, mallard, and wood duck densities were highest in floating-leaf habitat, but not significantly higher ($P > 0.05$) than hydrilla. Hydrilla was one of several habitats with highest ($P < 0.05$) densities of blue-winged teal and ruddy ducks. Ducks rarely used emergent, open water, unvegetated shoreline/shallow water, and emergent-hydrilla interface habitats.

In all seasons, American coot densities were highest ($P < 0.05$) in hydrilla and emergent-hydrilla interface habitats (Table 4). In winter, coot densities were higher ($P < 0.05$) in emergent-hydrilla interface habitat than hydrilla. Other habitats received relatively little coot use.

Discussion

Selection of hydrilla by waterfowl on Lake Fairfield may have been food related. Submergent aquatic beds support an abundance of macroinvertebrates (Krull 1970, Watkins et al. 1983) and general observations on Lake Fairfield indicated that invertebrates were abundant in hydrilla. Taxa observed in hydrilla beds included Corixidae, Gastropoda, and Amphipoda, which can be important waterfowl foods (Swanson et al. 1977). Invertebrates are most important for the highly carnivorous northern shoveler but benefit other species as well. Hydrilla also provides succulent vegetative material which is important in diets of herbivorous ducks including American wigeon (Anderson 1959), gadwalls (Paulus 1982), canvasbacks (Bartonek and Hickey 1969), and ring-necked ducks (Hardin et al. 1984). These characters made hydrilla high quality habitat for a diversity of waterfowl species (Johnson and Montalbano 1984).

Studies of waterfowl habitat selection in Florida also have shown hydrilla to be important habitat. Johnson and Montalbano (1984) found that hydrilla was a highly selected habitat and supported a greater diversity of duck species than other plant communities on Lake Okeechobee, Florida. In other Florida studies, hydrilla was an important waterfowl food item (Montalbano et al. 1979, Hardin et al. 1984). Reductions in waterfowl abundance were observed following hydrilla removal by grass carp (*Ctenopharyngodon idella*) (Gasaway and Drda 1977, Gasaway et al. 1977). On Lake Fairfield, waterfowl species richness was highest in hydrilla habitat, and waterfowl numbers and species richness increased across years in response to increased areal coverage of hydrilla (Esler 1990).

Floating-leaf habitat also was important, particularly for mallards, green-winged teal, and wood ducks. American lotus beds probably provided cover and

Table 2. Mean waterfowl densities (*N*/ha) across seasons and habitats on Lake Fairfield, Texas, 1986–87. Within seasons, habitats sharing a common letter did not differ ($P > 0.05$).

		Habitat[a]					
Season (*N*)	Surveys	HYD	EMG	E/H	FLT	USS	OPN
Summer 1986 (64)	7	0.015B	0.000B	0.000B	0.413A	0.000B	0.000B
Fall 1986 (359)	6	1.217A	0.000B	0.115B	0.184B	0.032B	0.006AB
Winter 1987 (154)	5	0.452A	0.305AB	0.000C	0.000C	0.396C	0.005BC
Spring 1987[b] (99)	6	0.593	0.157	0.000	0.011	0.561	0.000
Fall 1987 (1959)	6	4.956A	0.036BC	0.072BC	3.818AB	0.013C	0.005BC
Overall (2,635)	30	1.432A	0.089BC	0.037C	0.899B	0.187C	0.003BC

[a] Habitat abbreviations: HYD = hydrilla; EMG = emergent; E/H = emergent-hydrilla interface; FLT = floating leaf; USS = unvegetated shoreline/shallow water; OPN = open water.
[b] Differences not signficant ($P = 0.0728$).

Table 3. Mean waterfowl densities (*N*/ha) across habitats and over all seasons on Lake Fairfield, Texas, 1986–87. Row values sharing a common letter did not differ ($P > 0.05$).

		Habitat[a]					
Species (*N*)	Surveys	HYD	EMG	E/H	FLT	USS	OPN
Mallard (1061)	10	1.498A	0.039B	0.000B	1.644A	0.000B	0.001B
Northern shoveler (637)	10	1.252A	0.013BC	0.000C	0.007BC	0.019BC	0.003B
Green-winged teal (543)	11	0.668A	0.115AB	0.000C	0.682ABC	0.180BC	0.000C
Blue-winged teal (90)	5	0.673A	0.158AB	0.000B	0.000B	0.614A	0.000B
Wood duck (86)	17	0.023AB	0.007BC	0.000C	0.174A	0.023BC	0.000BC
Canvasback (59)	6	0.184A	0.000B	0.000B	0.000B	0.000B	0.002B
American wigeon (41)	8	0.098A	0.000B	0.054B	0.000B	0.000B	0.001B
Ruddy duck (35)	5	0.098A	0.000C	0.138BC	0.000C	0.000C	0.003AB
Gadwall (30)	5	0.109A	0.000B	0.000B	0.000B	0.000B	0.000B
Ring-necked duck (23)	8	0.129A	0.000B	0.000B	0.000B	0.000B	0.000B

[a] Habitat abbreviations: HYD = hydrilla; EMG = emergent; E/H = emergent-hydrilla interface; FLT = floating leaf; USS = unvegetated shoreline/shallow water; OPN = open water.

Table 4. Mean American coot densities (*N*/ha) across seasons and habitats on Lake Fairfield, Texas, 1986–87. Within seasons, habitats sharing a common letter did not differ ($P > 0.05$).

		Habitat[a]					
Season (*N*)	Surveys	HYD	E/H	EMG	USS	OPN	FLT
Fall 1986 (23,384)	5	88.58A	70.07A	2.06B	1.51BC	0.80BC	0.35C
Winter 1987 (14,370)	5	99.17B	284.92A	5.13C	2.66D	0.36D	0.00E
Spring 1987 (926)	6	9.82A	11.21A	0.79B	0.62B	0.01C	0.03C
Fall 1987 (43,136)	6	117.92A	42.68A	0.24C	0.91BC	0.74B	1.28C
Overall (81,826)	25	68.21A	84.00A	1.68B	1.20B	0.41B	0.39C

[a] Habitat abbreviations: HYD = hydrilla; E/H = emergent-hydrilla interface; EMG = emergent; USS = unvegetated shoreline/shallow water; OPN = open water: FLT = floating leaf.

food resources for ducks. These areas occurred in shallow portions of the lake that were less accessible by motor boat traffic which may have influenced duck use.

Hydrilla was an important habitat component for American coots, corroborating previous observations. Coots consumed significant amounts of hydrilla on Lake Fairfield (Esler 1989); selection of habitats with hydrilla was very likely food related. Selection of the hydrilla-emergent interface in winter reflects this habitat's function as both a food source and escape cover for coots no longer in large rafts of migrating individuals. Coot numbers were highly correlated to hydrilla abundance on Lake Fairfield (Esler 1990). In Florida, hydrilla has been shown to be an important food for coots (Montalbano et al. 1979, Hardin et al. 1984), but selection of hydrilla as a habitat type has not previously been demonstrated.

Once established, introduced plant species often are prolific due to lack of competition or natural controls (Elton 1958). Although hydrilla often is considered a pest species when dense monotypic stands develop, it may have positive influences in reservoirs such as Lake Fairfield. Because of the depth, slope, and turbidity of Lake Fairfield and similar reservoirs, the infestation may not become extreme, eliminating problems with recreation and fish populations. Hydrilla provides highly used habitat for many birds of social and economic importance. The most effective method of hydrilla control, the stocking of grass carp, has been shown to reduce the value of wetlands to birds (Gasaway and Drda 1977). Re-evaluating hydrilla eradication policies, as suggested by Johnson and Montalbano (1987), may be applicable in this situation.

Open water dominates deep reservoirs and is not used by many wetland birds. The replacement of open water by hydrilla represents an increase in vegetative diversity and foraging opportunities. Native plants with comparable functions and, perhaps, greater wildlife value may not have the vigor to thrive in these reservoirs. The invasion of hydrilla in reservoirs in Texas and elsewhere is likely to continue, and its value to wildlife should be considered in reservoir management plans.

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