Research *You Can Use*

Habitat Value of Golf Course Wetlands to Waterbirds

Researchers measure which pond characteristics are important for waterbird habitat.

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As natural wetlands decline in availability and quality, alternative habitats become increasingly important to wetland-dependent wildlife.

Urbanization, roads, and other human-induced changes to natural areas continue to alter and degrade wetlands nationwide. As natural wetlands decline in availability and quality, alternative habitats such as created wetlands may become increasingly important to wetland-dependent wildlife. Wetland-dependent birds, often referred to as waterbirds, seem well suited to use created wetlands when appropriate habitat is available.

In urban and suburban areas, golf course ponds have excellent potential to provide valuable habitat in areas that otherwise lack suitable habitat for waterbirds. Anyone who has spent time on a golf course has noticed a variety of birds such as ducks, geese, herons, and the little peeps running along pond shorelines. It seems clear that many species of waterbirds use golf course ponds. What is unclear, however, is what characteristics of golf course ponds are important for waterbird species.

STUDYING FLORIDA GOLF COURSES

A two-year study (2001 and 2002) in southwest Florida was conducted to determine the habitat value of golf course ponds to waterbirds. Our objectives were to identify the diversity and abundance of waterbirds using golf course ponds and to evaluate the effects of numerous habitat variables on waterbird use. Habitat and hydrological variables were quantified at each pond to determine the relationship between these components and waterbird abundance and species richness. Hydrological variables included trophic status, as an indicator of food availability, and avail-

able shallow water (1.3 ft.) habitat around each pond's perimeter. Habitat features included shoreline and littoral zone vegetation type and cover, and adjacent landscape features (e.g., golf course, residential housing, construction, etc.).

All species studied in this project were waterbirds and are defined as any water-dependent bird species.[14] Members from the following orders of birds were surveyed: Ciconiiformes (wading birds), Gruiformes (short-legged and other wading birds), Pelecaniformes (diving birds), Anseriformes (waterfowl), Podicipediformes (grebes), Coraciiformes (kingfishers), and Charadriiformes (shorebirds). Birds from these orders represent a variety of bird sizes, morphology, foraging techniques, and major substrate used for foraging (e.g., bare mudflat vs. open water). Because the degradation of wetland habitat has affected nearly all species of wetland-dependent birds, it is important to consider more than one species when determining the functionality of created ponds on golf courses for waterbirds. Therefore, all waterbird species observed in the ponds or within 5.5 yards of pond edges were included during surveys.

Created wetlands, such as those found on golf courses, may provide valuable habitat to waterbirds.

Species were categorized into six foraging guilds, defined by their major foraging techniques, food types, and substrates listed for each species,[3,4] as well as personal observations of foraging birds on golf course ponds. Foraging guilds were used in the analysis of waterbird site selection because there were normally too few observations to conduct separate analyses for each species. Twelve golf courses were surveyed during this study, nine owned by Bonita Bay Group and three by Watermark Communities Incorporated. All golf courses were located in Lee or Collier County in southwest Florida.

Golf courses were selected to provide a diversity of study sites within the study area without previous knowledge of the quality or nature of habitat associated with ponds on those golf courses. A total of 183 golf course ponds from these 12 courses were monitored during the study. Annual surveys were conducted during January through April. This study focused on birds that were actively using golf course ponds; therefore, only waterbirds observed in the water or within five yards of the water's edge were recorded. Birds that flew over ponds but were not obviously foraging or did not stop at the pond were not included in the analyses.

Shoreline vegetation is important for many foraging and nesting birds, as well as for birds seeking shelter and protective cover.[14] During this study, shoreline vegetation was delineated by the pond's waterline because the centers of the ponds were generally too deep to allow growth of vegetation other than purely aquatic plants. Percent cover of shoreline and aquatic vegetation was visually estimated. Percent cover class[2] was used to quantify visual estimates of vegetative cover, which was classified into seven terrestrial and four aquatic categories.

Measurements of the landscape features adjacent to the ponds were taken simultaneously with the shoreline vegetation. The effective foraging area within the littoral zone was quantified to determine its influence on site selection of golf course ponds, particularly by wading birds (e.g., herons and egrets). Four water-chemistry parameters were measured to determine the trophic status (i.e., biological productivity) of golf course ponds: water clarity and total chlorophyll a, phosphorus, and nitrogen.

LOTS OF WATERBIRDS RECORDED

During January-April 2001 and 2002, 10,474 waterbirds were observed during surveys of 183 man-made ponds on 12 golf courses. We observed 42 species of waterbirds (30 in 2001 and 40 in 2002) over both years. The most common behaviors of all birds observed were associated with foraging, and the least common with nesting activities. Approximately 46% of all waterbirds observed used golf course ponds as foraging habitat. The remaining 54% also may have used the golf courses as foraging habitat, but they were engaged in other activities (resting, preening, etc.) during surveys.

The diving birds guild was the most commonly recorded. Anhingas (in 2001) and double-crested cormorants (in 2002) were also observed on more study ponds than any other species. The second most frequently observed guild was Open Water, with little blue herons (*Egretta caerulea*) most abundant over the two-year study period. The dense vegetation wader guild was observed least.

LARGER PONDS, MORE WATERBIRDS

The major objective of this study was to determine the influence of pond

Shoreline and adjacent landscape features of the ponds on 12 golf courses in southwest Florida were measured to determine their influence on waterbird use.

characteristics on bird use. Differences among golf courses may have been due to variables that were not easily captured by analyses, but may have included differences in human use, management practices, or location of the courses relative to other resources that were not quantified during this study (e.g., distance to nesting colonies). However, we did analyze the influence of the total pond surface area on each golf course (versus the surface area of individual ponds) on waterbird use and found a significant relationship, indicating that the total pond surface area explains some of the variation in average bird abundance among golf courses.

Several major factors appeared to influence waterbird use of golf course ponds at the landscape and individual pond scale. Golf courses with more total pond surface area had more birds on average. Greater pond surface area (in the form of larger or more numerous ponds within the same golf course) may provide advantages such as reduction of effort required of the birds when moving among ponds to find food.

At the individual pond scale, pond size influenced waterbird use by 4 of the 6 foraging guilds. Larger ponds may be able to provide more foraging opportunities and habitat types to support a greater diversity of waterbirds. This relationship has been reported for birds in other freshwater habitats.[1,6,7,11] However, the availability of food, the most crucial feature for determining foraging habitat suitability for waterbirds, includes not only density but accessibility of suitable prey.[5,9] Many waterbirds are unable to access prey in open-water areas. For example, wading birds and shorebirds are confined to water depths no greater than their leg length. Indeed, the effective foraging area was a better predictor of pond use by the majority of wading birds (open-water waders) than either surface area or perimeter.

Observed differences in bird presence among golf courses may also be related to the course location relative to other landscape features important to waterbirds, such as natural wetlands, flooded pastures, and roosting or nesting areas. Once a golf course has been selected, birds may then select from available ponds within the course based on more specific pond features such as pond size or vegetation structure and density.

Analysis of waterbird site preference for other pond features resulted in a wide range of habitat variables selected by each foraging guild. However, several similarities exist among the selected variables. For example, trees and shrubs provide roosting and resting habitat for several foraging guilds. Short vegetation in the littoral zone and along the shoreline of the ponds was selected by several foraging guilds, probably because it allowed for increased predator detection while foraging. Ponds with man-made structures such as walls and ledges around the perimeter were avoided by one foraging guild (dipping and dabbling foragers), probably because they impeded movement into and out of the water.

The large number of species of waterbirds observed during this study indicates that golf course ponds are used by many different types of waterbirds, principally as foraging habitat (46%). The extent to which waterbirds used golf course ponds in this study was primarily related to pond size, ability of the birds to access prey, and habitat features that influenced security and foraging success. The low densities also suggest there is ample opportunity to increase the value of golf course ponds to waterbirds.

OPPORTUNITIES FOR HABITAT IMPROVEMENT

The wide range of habitat variables selected by each foraging guild indicates that providing a diversity of habitat features among ponds within a golf course would provide the greatest benefits to the largest number of species. To accomplish this goal, ponds could be managed as a wetland complex, whereby different ponds or sections of ponds are enhanced or modified to meet guild-specific needs. For example, creating areas along ponds that have dense shrub cover would benefit dense-vegetation waders, trees can provide roosting sites, and the creation of shallow foraging areas will benefit wad-

The littoral zone is important to birds such as herons and egrets that wade in shallow water areas to search for food.

Table 1

Waterbird species observed during surveys of 183 golf course ponds in southwest Florida during 2001 and 2002. Total abundance, average density (average abundance/total ha for all golf course ponds), and number of ponds where species were observed in 2001 and 2002 are listed. Species are ranked by numbers observed within each guild classification.

Species	Total Abundance	Average Density (No./ha)	Occurrence (number of ponds)	
			2001	2002
Diving Birds				
Double-crested cormorant (*Phalacrocorax auritus*)	3,078	6.564	105	107
Anhinga (*Anhinga anhinga*)	943	2.011	111	119
Pied-billed grebe (*Podilymbus podiceps*)	247	0.527	38	7
Hooded merganser (*Lophodytes cucllatus*)	240	0.512	9	3
Lesser scaup (*Aythya affinis*)	78	0.166	N/A	25
Ring-necked duck (*Aythya collaris*)	1	0.002	N/A	1
Ruddy duck (*Oxyura jamaicensis*)	1	0.002	N/A	1
Open-Water Waders				
Little blue heron (*Egretta caerulea*)	677	1.444	100	21
Great egret (*Ardea albus*)	533	1.137	107	79
Snowy egret (*Egretta thula*)	530	1.130	74	79
Tricolored heron (*Egretta tricolor*)	420	0.896	73	108
Great blue heron (*Ardea herodias*)	340	0.725	85	2
Glossy ibis (*Plegadis falcinellus*)	249	0.531	24	68
White ibis (*Eudocimus albus*)	208	0.444	31	78
Wood stork (*Mycteria americana*)	76	0.162	18	29
Sandhill crane (*Grus canadensis*)	7	0.015	2	14
Dense-Vegetation Waders				
Green heron (*Butorides virescens*)	96	0.205	21	1
Black-crowned night-heron (*Nycticorax nycticorax*)	22	0.047	4	35
American bittern (*Botaurus lentiginosus*)	1	0.002	N/A	4
Dipping and Dabbling Foragers				
Common moorhen (*Gallinula chloropus*)	511	1.090	17	2
Mottled duck (*Anas fulvigula*)	475	1.013	58	8
Blue-winged teal (*Anas discors*)	130	0.277	16	28
American coot (*Fulica americana*)	48	0.102	2	1
Wood duck (*Aix sponsa*)	2	0.004	N/A	70
Hybrid (mottled duck and mallard)	1	0.002	N/A	1
Moist-Soil Foragers				
Killdeer (*Charadrius vociferous*)	497	1.060	99	2
Unidentified shorebird	362	0.772	22	2
Greater/lesser yellowlegs (*Tringa melanoleuca/flavipes*)	288	0.614	58	0
Ring-billed gull (*Larus delawarensis*)	162	0.345	19	10
Common snipe (*Gallinago gallinago*)	35	0.075	12	60
Laughing gull (*Larus atricilla*)	8	0.017	N/A	3
Willet (*Catoptrophorus semipalmatus*)	7	0.015	4	9
Black-bellied plover (*Pluvialis squatarola*)	3	0.006	N/A	36
Black-necked stilt (*Himantopus mexicanus*)	4	0.009	N/A	1
Bonaparte's gull (*Larus philadelphia*)	1	0.002	1	45
Aerial Piscivors				
Bald eagle (*Haliaeetus leucocephalus*)	4	0.009	N/A	4
Belted kingfisher (*Ceryle alcyon*)	157	0.335	33	67
Brown pelican (*Pelecanus occidentalis*)	2	0.004	2	0
Forster's tern (*Sterna forsteri*)	7	0.030	2	2
Least tern (*Sterna antillarum*)	2	0.004	N/A	1
Osprey (*Pandion haliaetus*)	16	0.034	N/A	10
Royal tern (*Sterna maxima*)	5	0.021	2	1
STUDY SUMMARY	10,474	22.337		

Table 2

Foraging guilds with general description of foraging techniques used for classification and representative species for each guild.

Foraging Guild	General Description	Species
Diving Birds	Forage in a variety of water depths, but were generally observed in open water	Grebes, cormorants, anhingas, mergansers, scaup, ruddy and ring-necked ducks
Open-Water Waders	Forage in shallow water with low-density vegetation	Herons, egrets, ibises, storks, cranes
Dense-Vegetation Waders	Forage in shallow water surrounded by dense vegetation	Night and green herons, bitterns
Dipping/Dabbling Foragers	Forage by surface dipping or dabbling in shallow water	Mottled ducks, blue-wing teal, moorhens, coots
Moist-soil Foragers	Forage in muddy or moist-soil areas along the shoreline	Sandpipers, yellowlegs, stilts, willets, killdeer, snipes, gulls
Aerial Piscivores	Generally use perches to search for prey and then dive from a height to capture prey	Terns, kingfishers, eagles, osprey, pelicans

ing birds and numerous other species. Not only would this type of management strategy benefit waterbirds, but it could also provide greater management options for the golf course.

Maintenance problems associated with wet areas along edges of ponds may be ideal for modifications to benefit waterbirds while simultaneously reducing management costs and maintenance challenges. Consequently, opportunities likely exist on many golf course ponds to improve habitat for waterbirds while providing financial savings and generating positive public relations for practices that provide benefits to wildlife.

LITERATURE CITED

1. Celada, C., and G. Bogliani, 1993. Breeding bird communities in fragmented wetlands. *Bolettino Zoologia* 60:73-80.

2. Daubenmire, R. F. 1959. A canopy-coverage method of vegetational analysis. *Northwest Scientist* 33:43-64.

3. De Graaf, R. M., N. G. Tilghman, and S. T. Anderson. 1985. Foraging guilds of North American birds. *Ecological Management* 9:493-536.

4. Ehrlich, P. R., D. S. Dobkin, and D. Wheye. 1988. The birder's handbook. Simon and Schuster Inc., New York.

5. Gawlik, D. E. 2002. The effects of prey availability on the numerical response of wading birds. *Ecological Monographs* 73:329-346.

6. Gibbs, J. P., J. R. Longcore, D. G. McAuley, and J. K. Ringelman. 1991. Use of wetland habitats by selected non-game waterbirds in Maine. United States Fish and Wildlife Service, Resource Publication 9, Washington, D.C.

7. Hoyer, M. V., and D. E. Canfield, Jr. 1990. Limnological factors influencing bird abundance and species richness on Florida lakes. *Lake and Reservoir Management* 6:133-141.

8. Kushlan, J. A. 1978. Feeding ecology of wading birds. pp. 249-297. *In* S. Winckler (ed.) Wading birds. National Audubon Society. Research Report No. 7, N.Y.

9. Kushlan, J. A. 2000. Research and information needs for heron conservation. pp. 331-342. *In* H. Hafner (ed.) Heron conservation. Academic Press, San Diego, Calif.

10. LAKEWATCH. 2001. Florida LAKEWATCH/Project COAST Annual Data Summaries for the year 2000. Department of Fisheries and Aquatic Sciences, University of Florida/Institute of Food and Agricultural Sciences Library, University of Florida, Gainesville, Fla., USA.

11. Nudds, T. D. 1992. Patterns in breeding waterfowl communities. pp. 540-567. *In* G. L. Krapu (ed.) Ecology and management of breeding waterfowl. University of Minnesota Press, Minneapolis, Minn.

12. Powell, G.V.N. 1987. Habitat use by wading birds in a subtropical estuary: Implications of hydrography. *Auk* 104:740-749.

13. Statistical Analysis Systems Institute. 2001. SAS/STAT User's Guide, version 8.02. Statistical Analysis System Institute, Cary, N.C.

14. Weller, M. W. 1999. Wetland birds: Habitat resources and conservation implications. University Press, Cambridge, U.K.

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Table 3

Proportion of birds engaged in various behaviors recorded during surveys of golf course ponds in southwest Florida in 2001.

Behavior	Proportion
Foraging or associated movements	45.9
Stationary/resting	34.8
Moving but not obviously foraging	7.6
Wing drying	3.9
Flushed	2.1
Preening	5.4
Nesting activities	0.3